MICHIGAN STATE UNIVERSITY COLLEGE OF ENGINEERING **SPRING 2023**

DESIGN DAY

MICHIGAN STATE UNIVERSITY

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Executive Partner Sponsor

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On behalf of everyone at Meijer, I want to extend a warm welcome to all of you who are joining us today for the 31st annual Design Day.

Meijer is honored to support MSU as it continues its mission of education and innovation, and we are excited to introduce you to the incredible work of our students. Every participant has poured their heart, soul, creativity, and ingenuity into their projects.

Meijer is proud to be the Executive Sponsor of this extraordinary program that showcases the talents of MSU's engineering students, who will one day help shape the communities in which we live and the businesses in which we work. At Meijer, we prize outside-the-box thinking because that's what helped Meijer grow from one store in Greenville to over 260 stores. We distinguished ourselves by not settling for the status quo and forging our own path, and today you will see others doing the same.

Meijer is pleased to support the emerging leaders within the MSU College of Engineering and are excited for all of you—family, friends, and faculty—to see what we see in this impressive group. We hope you enjoy your time and leave inspired by the incredible work of our students. Together, we will continue to build a better future for everyone.

Congratulations to everyone who helped make this year's Design Day a success.

Terrence Ledbetter

Senior Vice President and Chief Information Officer

Meijer

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Welcome from the Dean

As Dean of the College of Engineering, on behalf of the entire faculty, staff and students, I welcome you to Design Day!

Since the first Design Day in 1994, it has grown into the premier undergraduate academic event of the semester, featuring over 100 capstone teams and 700 seniors from all 10 of the College's academic programs.

We are pleased to acknowledge Meijer as our Design Day Executive Partner Sponsor and TechSmith as our Design Day Directing Partner Sponsor. Our Design Day Supporting Partner Sponsors include Amazon, Anthropocene Institute, Auto-Owners Insurance, MSUFCU, Roosevelt Innovations and Urban Science. We thank all of our sponsors for their generosity and their ongoing commitment to Design Day.

As you explore the exhibits throughout the Engineering Building, you are encouraged to take time to learn about the projects by talking with our students. They are an incredible group of people who love to share their enthusiasm for engineering.

Starting in their first semester, our freshmen learn about the importance of engineering and the positive impact that engineers make on society and the world around them in our Cornerstone and Residential Experience for Spartan Engineers program. Be sure to stop by and see how they innovate, communicate and perform at the highest levels in an increasingly global and demanding world.

The headliners of Design Day are our graduating seniors as they present their design projects through exhibits, posters and presentations. Their projects represent the capstone of their educational career. You will see that our graduating MSU engineers are ready to lead, create and innovate.

Our capstone programs and Design Day would not be possible without the continued support of our capstone project sponsors who provide both funding and a professional experience for our capstone design teams. We appreciate their generosity and their time.

Please join us for the Design Day Awards Ceremony in Anthony Hall Room 1281 at 1:15 pm when we will honor all of our talented Spartans, the best of the best.

Dr. Leo Kempel

Dean of the College of Engineering

Professor of Electrical and Computer Engineering

Michigan State University

Design Day Events Schedule: Friday, April 28, 2023

EVENTS	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	Noon	1 p.m.
Audio Enthusiasts and Engineers		2nd Floor Rm 2228 8:00 a.m. – Noon					
Engineering Students Organizations		1st Floor West Wing Lobby 8:00 a.m. – Noon					
ECE 410 Demonstrations			2nd Floor 2200/2300 Hallways 9:00 a.m. – Noon				
EGR 100 Demonstrations			2nd Floor 2300 Hallway 9:00 a.m.-Noon				
ME 412 Demonstrations		1st Floor Room 1252 8:00 a.m.-Noon					
ME 470 Competition		1st Floor Room 1345 8:00 a.m. - 11:30 a.m.					
ME 478 Competition		3rd Floor Room 3400 8:00 a.m.-Noon					

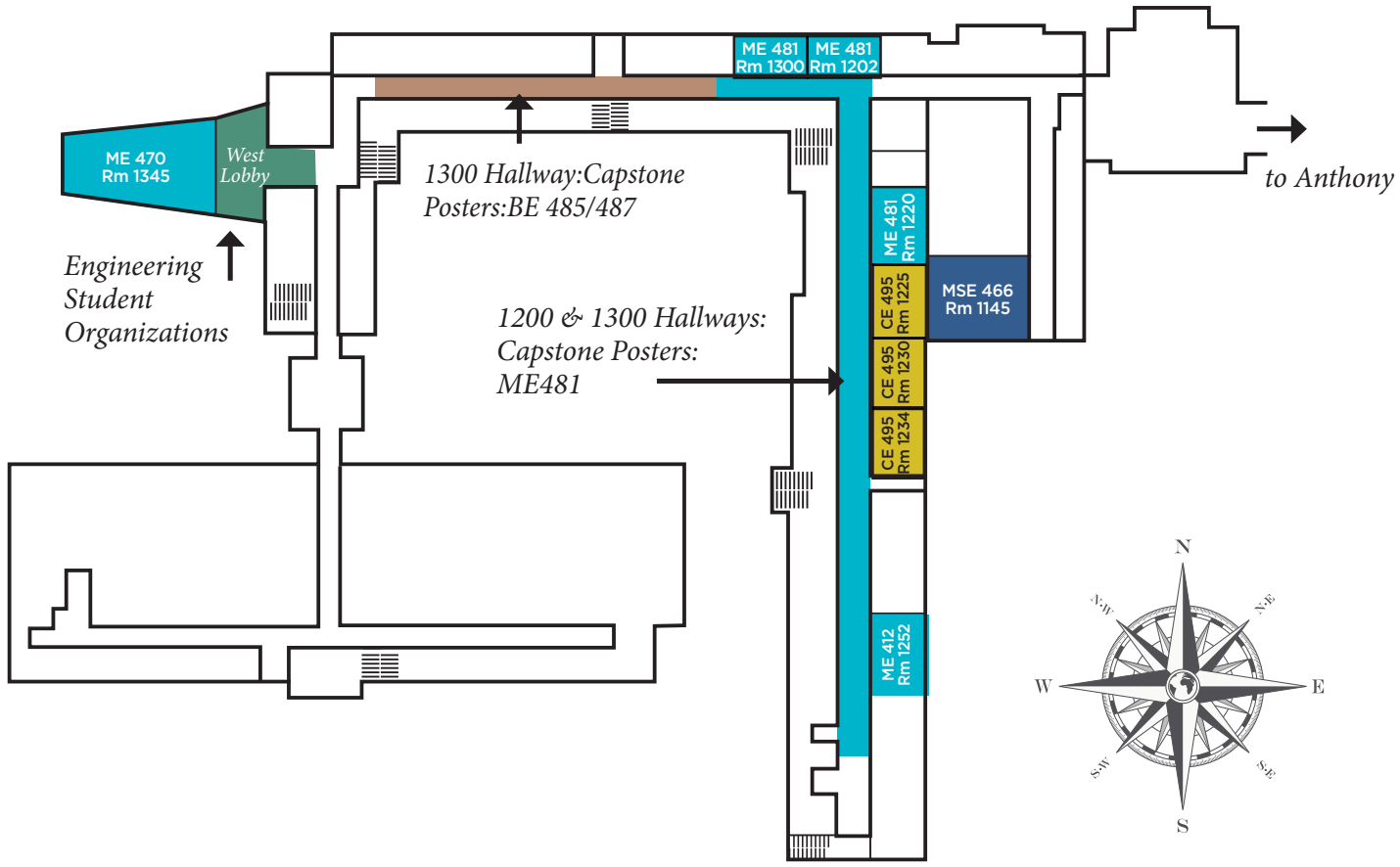
CAPSTONE COURSES							
All Capstone Posters for most projects, including BE485/487 and ChE 434		BE and ME 1st floor 1200/1300 hallways ECE on 2nd floor 2200 hallway ChE on 2nd floor 2400 hallway CSE on 3rd floor 3200/3300 hallways 8:00 a.m.-Noon					
AESC 410/SCM 472 Project Presentations		1st Floor Rooms 1235, 1255, 1257 & 1260 Anthony Hall: 8:00 a.m. – 11:30 a.m.					
CE 495 Project Presentations		First & Second Floors – Rooms 1225, 1230, 1234 & 2243 8:00 a.m. - Noon					
ECE 480 Project Presentations			2nd Floor Rooms 2205 and 2330 8:30 a.m. – 11:40 a.m.				
ME 481 Project Presentations		1st, 2nd & 3rd Floors Rooms 1202, 1220, 1300, 2435 & 3540 8:00 a.m. - 11:30 a.m.					
MSE 466 Project Presentations			1st Floor Room 1145 8:30 a.m. – 11:30 a.m.				

OPENING AND AWARDS							
High School Opening			1st Floor Anthony, Room 1279 8:15 a.m. - 8:30 a.m.				
High School Awards			1st Floor Engineering, Room 1345 12:15 p.m. - 12:30 p.m.				
MSU Awards			1st Floor Anthony, Room 1281 1:15 p.m. - 2:00 p.m.				

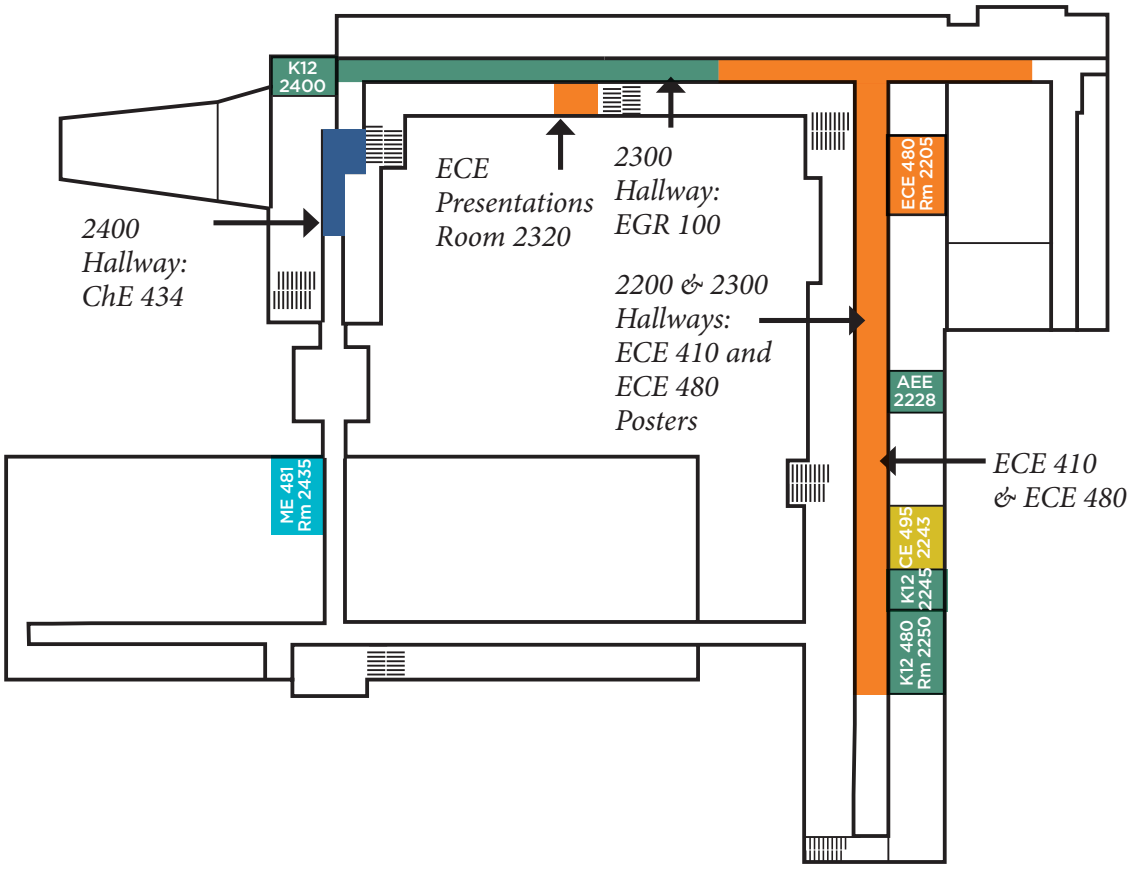
Social Media Links:
"Like" the College: https://www.facebook.com/MSUEGRS
"Follow" the College: https://twitter.com/MSU_EGR

To stay up to date w/Careers in Engineering:
“Like” Us http://www.facebook.com/pages/The-Center-for-Spartan-Engineering/226159694117936
“Follow” Us: https://twitter.com/msuengineers

1st Floor Engineering

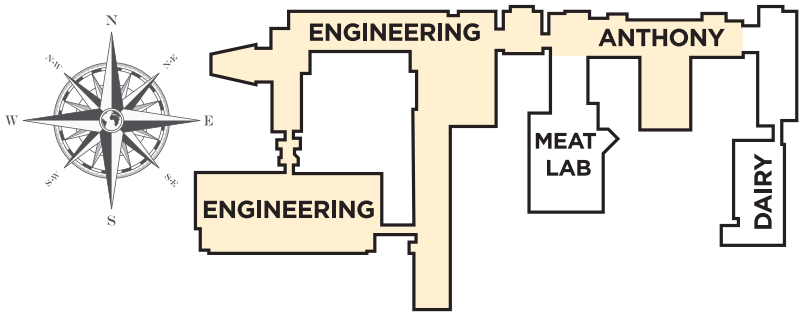


2nd Floor Engineering

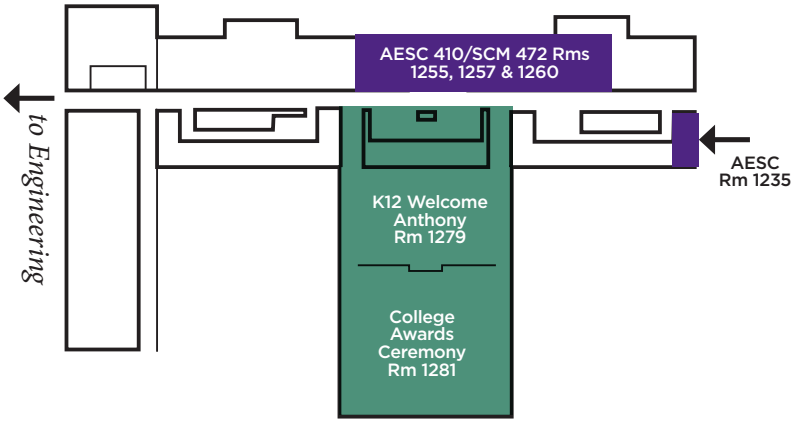


Design Day Floor Plans of the MSU Engineering Building

Overview



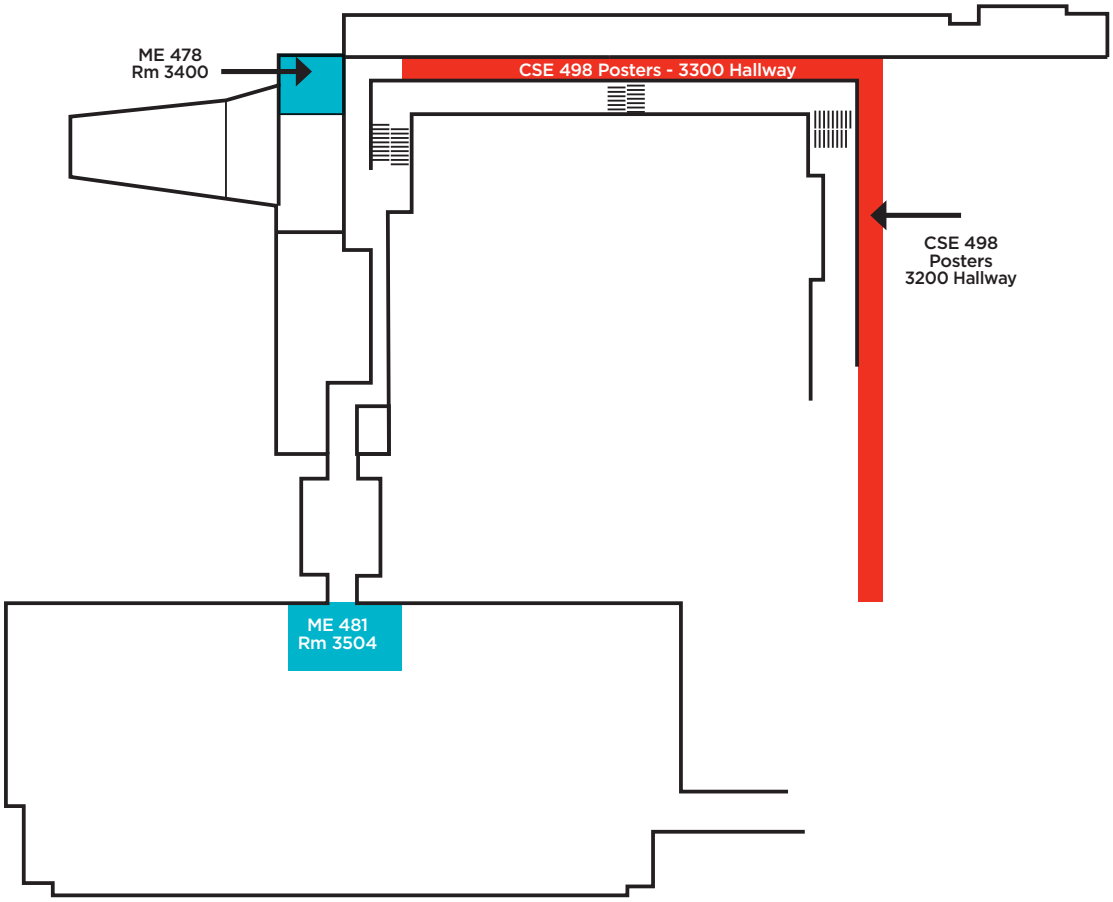
1st Floor Anthony



Color Legend:

- AES / SCM
- CSE
- BAE
- ECE
- CEE
- ME
- ChE & MSE
- Joint/ Other

3rd Floor Engineering



High School Innovation & Creativity Day

Precollege Student Voting: **During the morning on Design Day all visiting precollege students will be viewing Engineering Projects and voting.**

During this time, college students will have a chance to interact with "non-engineering" students and demonstrate the underlying principles from their projects. This interaction allows the college students an opportunity to practice explaining engineering concepts to non-engineers. As the precollege students work their way through the wide variety of presentations, they will get an overview of the many different branches of engineering. Additionally, as the precollege students see both entry-level and advanced engineering applications, it allows them to see the natural progression of engineering. Lastly, this session also provides a chance for the precollege students to interact with student organizations within the College of Engineering.

The following schools and groups will be participating in this Fall's Design Day events: Detroit Area Precollege Engineering Program (DAPCEP), Macomb Mathematics Science Technology Center (MMSTC), TBD, Women in Engineering (WIE).

	1279 Anthony Hall Auditorium: Check-in for all schools	K'NEX Bridge Team Build Room 2250	VEX Robotics Room 2400	1st & 2nd Floor Voting/project viewing	LED Labyrinth Competition Room 2245
8:00–8:15	Check in for all schools				
8:15–8:30	Welcome & voting procedures – Drew Kim, Assistant to Dean, and Luis Donado, Assistant Director				
8:40–9:30		MMSTC	DAPCEP	TBD	WIE
9:35–10:20		DAPCEP	TBD	WIE	MMSTC
10:25-11:10		TBD	WIE	MMSTC	DAPCEP
11:15-12:00		WIE	MMSTC	DAPCEP	TBD
12:15–12:30	Awards Ceremony, 1345 Engineering Building				

http://www.egr.msu.edu/future-engineer/ **LIKE US: https://www.facebook.com/futurespartanengineers**

MEMBERS OF THE ORGANIZING COMMITTEE FOR HIGH SCHOOL INNOVATION & CREATIVITY DAY SPRING 2023

Drew Kim
MSU Engineering Assistant to the Dean Recruitment, Scholarships, and K-12 Outreach

Dean Buggia
Instructor and Technology Teacher, Okemos High School

Luis Donado
Assistant Director of MSU Engineering Recruitment and K-12 Outreach

Pahoua Nguyen
Logistics Coordinator/Office Manager

Bob Watson
MSU Engineering K-12 Outreach LEGO and VEX Robotics Coordinator

VEX ROBOTICS

Our team of experts has designed a lab experience to give precollege students an introduction to robots. Students will work in small groups and have a hands-on approach learning to control the VEX robot. They will write programs using Robot C language, and they will program the robot to be controlled by a remote control. Application and discovery of how programming works will be similar to lessons presented in science and math classes. Each team will discover how to adjust their programs based upon the program inputs and actual output (robot performance). During each phase, new challenges will be introduced to engage the students. This will reinforce new ideas and concepts while exposing students to the newly emerging capabilities of student-controlled robotics programs.

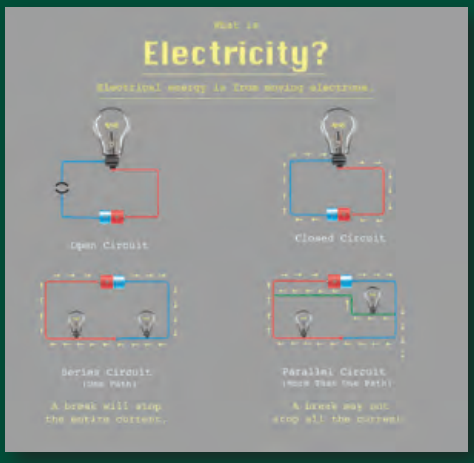
INTERDISCIPLINARY ENGINEERING BUILD

In this build you and your team will be integrating practices from multiple fields of engineering to build and evaluate a support system. Support systems can range from simple beams to intricate bridges composed of gussets, trusses, cables, etc. These types of systems are used throughout Civil, Mechanical and Structural Engineering works. This session will start with a brief introduction to the forces and stresses that act on support systems. Additionally, you will see how digital sensors can read and convey data about these stresses to a computer. We will also look at the computer code that takes this raw data and converts it into a format that can easily be interpreted.

During the build portion of this session, you and your team will be given the design constraints for the structure. Utilizing the information learned at the start of the session and the limited materials provided, your team will need to design and then construct a model to be tested. Your finished structure will be placed on one of our test beds for evaluation. With the help of MSU Engineering students, the results will be collected by a sonic ranging sensor. These data points will be interpreted by the computer program and your team will be evaluated on percent deflection of your support. Throughout this session you will need to listen, learn and utilize your team to be successful. Good Luck.

LED LABYRINTH COMPETITION

The circuit activity at Design Day provides students with an opportunity to manipulate the path of the electrical current in a circuit by switches. Using basic principles of circuits and parallel/series connection concepts, student groups will turn on and off switches to direct current in a premade electrical circuit with LEDs indicating each active branch. Since an LED allows the current to pass through in only one direction, students should identify the different paths they create by activating different branches, which might be connected in series or in parallel. The event will be scored by how many LEDs can be turned on without breaking the closed circuit.



THE K12 AWARDS: FALL 2022

EGR 100 Solar Car Competition 1st place
Emma D., Grace M., Sophia S., and Emma T.

EGR 100 Solar Car Competition 2nd place
Michael A., Gabriel B., Claire O., and Joshua T.

EGR 100 3-D Printing 3rd place
Karsten B., Eli G., Soami K., and Calvin P.

VEX Robotics winning team is from Women in Engineering admitted students

Bridge competition is won by a student from Detroit Area Pre-College Engineering Program.

Labyrinth LED – The entire Women in Engineering students who participated won as they have completed most LEDs to light up.

EGR 100 Introduction to Engineering Design

Dr. Jenahvive Morgan
Course Instructor

Course Project

EGR 100, Introduction to Engineering Design, is a college-level course required of all incoming first-year engineering students. It is an integral part of the CoRe (Cornerstone and Residential) Experience. The course introduces students to the engineering profession and the engineering design process through team-based, interdisciplinary design projects and assignments. There are 927 students enrolled in EGR 100 this semester.

For the final course project, the student teams selected from eight project types: **(i) Create a Phone App, (ii) 3D Printing CAD Drawing, (iii) Design a Mini Solar Car, (iv) Water Filtration System Design, (v) Create an Adafruit LED Circuit, (vi) Design a Battlebot, (vii) Costa Rica Community Designs, and (viii) CoRe Industry-Sponsored Projects.** CoRe Industry-Sponsored Projects involved collaborations with Eli Lilly on Drug Manufacturing Requirements.

http://www.egr.msu.edu/core/

Fall 2022 EGR 100 Project Award Winners

l-r: Jenahvive Morgan, Emma Delcotto, Sophia Spencer, Emma Telepo, Grace Millbauer, Tamara Reid Bush

l-r: Jenahvive Morgan, Gabriel Brewer, Mann Aswal, Claire Osborne, Tamara Reid Bush

Applied Engineering Sciences

Capstone Course Sponsors

We thank the following sponsors for their generous support of the Applied Engineering Sciences senior capstone course. We gratefully acknowledge the Supply Chain Council for their project support.

Alpine

American Axle & Manufacturing, Inc.

Applied Materials

Caterpillar

Clarience Technologies

DRiV

Harley Davidson

The Home Depot

John Deere

KLA Corporation

Meijer

NASA/ASU

Raytheon

RENK

SLB

Snackwerks

Trane Technologies

Applied Engineering Sciences
The Capstone Projects

Dr. Laura J. Genik
Director
Applied Engineering Sciences

Dr. Sri Talluri
Professor of Operations
and Supply Chain Management
The Eli Broad Graduate
School of Management

Graduate Teaching Assistants

Sneha Abhyankar
MBA (2023)

Muhammad Khan
MBA (2023)

Jose Naime
MBA (2023)

Chaitanya Shankaragallu
MBA (2024)

Presentation Schedule – 1st floor Anthony Hall, Room 1235

Time	Team Sponsor	Project Title
8:25 a.m.	Raytheon Technologies	Material Availability Forecasting
8:50 a.m.	RENK America	Commodity Management System
9:15 a.m.	DRiV	Data Management for Global Automotive Aftermarket
Break		
9:50 a.m.	Trane Technologies	Carbon Reduction in Transportation
10:15 a.m.	Trane Technologies	Supply Chain Resiliency in Procurement
10:40 a.m.	Harley-Davidson	Supplier Capacity Tool and Analysis

AESC 410 Capstone Course
Senior Capstone Project

The culmination of coursework in engineering and business, the Capstone course for Applied Engineering Sciences focuses on a semester long project from a sponsor (industry or non-profit) typically at the confluence of modern business operations and engineering or technical issues. The course is interdisciplinary with Supply Chain Management.

AESC 410/SCM 472 8:25 a.m. Anthony Hall, First Floor | Room 1235

Raytheon Technologies
Material Availability Forecasting

Founded in 1922, Raytheon Technologies is a major defense contractor specializing in weapons and military and commercial electronics. Their goals are to advance aviation, build smarter defense systems and create innovations to take us deeper into space. The project focus is within Raytheon's Intelligence and Space division, which specializes in developing advanced sensors, cyber services and software solutions.

Today the inability of supplier partners to deliver consistently on these three aspects presents work scheduling and staffing concerns driven by available material. This material scheduling variability precludes optimized work area staffing. The plant of focus is in Forest, Mississippi.

Utilizing agreed upon methodologies, predictions will be developed for material availability and schedule performance. The methodologies will be tested for a specific work area using a real-world dataset for expected outcomes. If successful, datasets will be combined across multiple related work areas, which form a value stream.

Following the conclusion of this project, Raytheon will have the improved ability to forecast material availability at a work area or across multiple work areas in a value stream. This improves all business-related performance aspects from material availability, including staffing deployment, reduced cost from work area down-time, and improved on-time-delivery to their end customers.

Raytheon Technologies

Michigan State University
Team Members (left to right)

Ian McMaster
Birmingham, Michigan

Justin Jawanda
Sterling Heights, Michigan

Rani Jirjees
Sterling Heights, Michigan

Maryam Esho
Muskegon, Michigan

Henry Han
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Brandon Flaherty
Grosse Pointe, Michigan

Raytheon Technologies
Project Sponsor

Terry Stiles
Forest, Mississippi

Teaching Assistant

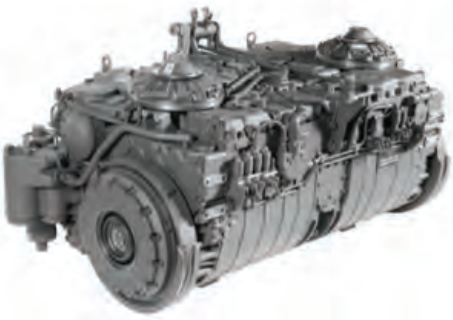
Muhammad Khan

RENK America
Commodity Management System

RENK America is the US headquarters of the RENK Group, a global company that supplies transmissions, engines, and test equipment to customers in the commercial and military industries. The company was formed in July 2021 and is owned by Triton Private Equity. In 2021 RENK Group purchased the Muskegon site from L3Harris and is focused on improving internal processes and efficiencies within its Supply Chain organization.

The company wishes to reduce waste and increase available time to focus on more strategic initiatives. To achieve this, RENK America plans to introduce automation and smart logic to create deliverables in the form of a smart purchase order checklist and purchase order write-up tool.

The overall goal of the project is to develop a documented sourcing strategy and categories for RENK America by creating a map for sourcing and benchmarking the industry's best practices. The project will also include developing a risk index for all suppliers, mapping the supplier onboarding process, and weighting the process for RFQs/RFPs and other industry benchmarks. The weights should include willingness, adaptability for the future, such as data analytics, visibility tools, ASN compatibility, etc. Additionally, the weights should also include willingness to work with RENK America on capital initiatives such as consignment, VMI, etc. The goal is to tie the live ratings into a month supplier scorecard rating.



RENK

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Rami Souguir
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Deron Bilezikjian
Canton, Michigan

Renk America
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Muskegon, Michigan

Tanner Myers
Muskegon, Michigan

Teaching Assistant

Jose Naime

DRiV
Data Management for Global Automotive Aftermarket

Tenneco is a global steward of more than 30 of the automotive industry's widely known brands. It is one company, made up of four business groups: Performance Solutions, DRiV, Clean Air and Powertrain. Tenneco serves both global aftermarket and OEM customers with design, engineering, manufacturing, and distribution capabilities. DRiV is Tenneco's aftermarket product solutions group. Their mission is to deliver advancements in aftermarket that help people get the most out of every vehicle, ride, race, and journey.

DRiV chartered a design project with the our team, to examine improvement opportunities for their global automotive aftermarket enterprise, specifically in supplier management tools. Their current supplier management portal for DRiV includes onboarding, contracts/agreements, RFQs, scorecards, surveys, and performance management through Ivalua – a procurement software platform dedicated specifically to supplier and spend management.

The desire of DRiV for a competitive business advantage and increased process efficiency inspired the sponsor and our team for a value proposition project, with consideration of potential alternatives to Ivalua. The project scope applicability spanned all seven business lines with the intent to maximize versatility and relevancy to all procurement needs within the DRiV business unit.

Deliverables and checkpoints of the improvement project included assessments of current state, benchmarking evaluations, and gap analysis. Benchmarking featured evaluation of other industry leaders in supplier management and best practices used. Gap analysis examined capabilities and shortfalls of Ivalua, steps necessary to close gaps, and total cost of ownership. The final deliverable of the design project included a comparison of current state and proposed future state, using the results of the mentioned assessments to recommend a new supplier management software.

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Matthew Segall
Huntington Woods, Michigan

Julia Martin
St. Clair Shores, Michigan

Zach Samp
Walled Lake, Michigan

Mikayla Norton
Howell, Michigan

Nathan Harville
Goodrich, Michigan

Isabella Rodrigues
Birmingham, Michigan

DriV
Project Sponsor

Ramneek Sandhu
Southfield, Michigan

Teaching Assistant

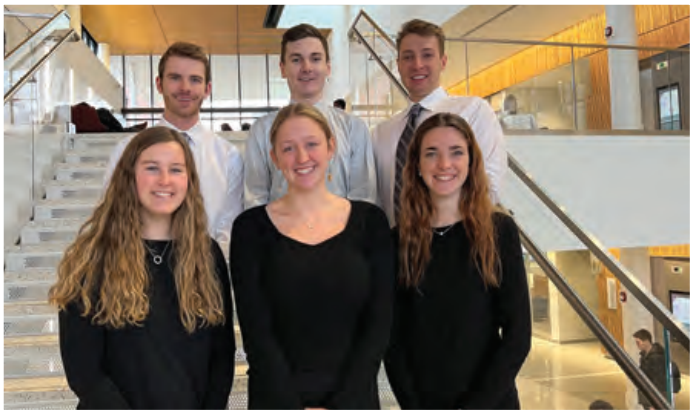
Chaitanya Shankaragallu

Trane Technologies
Carbon Reduction in Transportation

Trane Technologies is a leading manufacturer of innovative climate heating, ventilation, and air conditioning (HVAC) systems, devoted to setting daring goals and driving bold innovation to achieve a better tomorrow. Driving the project is Trane Technologies' determination to make its business practices more sustainable. The company is participating in a Gigaton Challenge, a pledge to reduce carbon emissions by one billion tons by 2030.

Thus far, Trane has made progress in production warehouses, office spaces, and inventory warehouses to reduce 50 million tons of carbon emissions. Trane Technologies achieved these reductions through electrification, installation of solar panels and high-efficiency equipment, and the substitution of refrigerants to those with lower global warming potential. For Trane Technologies to reach its carbon reduction goal by 2030, their transportation division must be analyzed to determine ways to reduce its carbon footprint even further. The project is focused on processing and understanding the data Trane Technologies has collected to determine baseline emissions at their current activity. From there, the focus is on identifying and developing future carbon reduction opportunities that can be implemented in their transportation sector. Analysis of shipping data will be limited to residential HVAC products, focusing on the Southeast region of the United States with application to Trane Technologies transportation via trucking. These products consist of residential heating and cooling systems such as air conditioners, furnaces, heat pumps, air handlers, coils, ductless variable refrigerant systems, control systems, thermostats, air purifiers, and humidifiers. Consideration of foreign footprint and the complete supply chain will be forgone. Following these goals, the intent is to apply the processes and solutions for the Southeast region to the other regions.

TRANE TECHNOLOGIES



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Brandon Barrows
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Madison Hall
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Audrey Ratliff
Petoskey, Michigan

Anna Brandl
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Trane Technologies
Project Sponsors

Adam English
Davidson, North Carolina

Tom France
Davidson, North Carolina

Stephanie Rinaldi
Davidson, North Carolina

Teaching Assistant

Chaitanya Shankaragallu

AESC 410/SCM 472 10:15 a.m. Anthony Hall, First Floor | Room 1235

Trane Technologies
Supply Chain Resiliency in Procurement

Trane Technologies is a multinational corporation with their US headquarters located in Davidson, North Carolina. Being one of the world's leading manufacturers of HVAC and refrigeration systems, Trane's brands help bring sustainable and efficient solutions to buildings, homes, and transportation. Trane Technologies has several sustainability goals that they are already achieving including reducing their carbon footprint to net-zero by 2030, eliminating refrigerant, and optimizing water use. The products sold require supplier parts from all over the world, creating a complicated supply chain network of over 20,000 suppliers that need to be consistently monitored and updated.

The events of the past three years have had a profound impact on the way that companies must approach the supply chain. A combination of the Covid 19 pandemic, port congestion, global turmoil, and other unexpected issues have made risk management and mitigation in the supply chain much more important. These factors have motivated industry leaders to get ahead of the curve and focus on strengthening their risk assessment measures.

The end goal of this project is the creation of a three-year roadmap providing potential solutions to current and future challenges caused by supplier risks. Achieving this goal is made possible by summarizing current supplier risks and assessing the potential impact of these risks. This information is then used to benchmark best practices of supplier risk identification and mitigation.

TRANE TECHNOLOGIES

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Team Members (left to right)

Neel Patel
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Mitchell Payne
Spring Lake, Michigan

Trane Technologies
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Teaching Assistant

Sneha Abhyankar

Harley Davidson
Supplier Capacity Tool and Analysis

Harley Davidson is one of the most iconic motorcycle companies in the world. To perform at this level a company needs to have a sophisticated supply chain. In order to continue to achieve this level of excellence, Harley Davidson is hoping to improve the transparency into the capabilities of its nearly 500 suppliers.

In the last couple of years supply chains around the world have had to alter strategies in order to meet radical changes in demand and supply. In a world where the supply chain landscape can change rapidly, companies need instant insights into a supplier's capabilities. Harley Davidson is hoping to gain this valuable insight over the course of this project.

The scope of this project is for the team to build a database and dashboard that can access and analyze supplier capabilities to make real-time purchasing and production decisions efficiently and accurately. Harley Davidson does not currently have a tool which specializes in this and that has resulted in a loss of time and savings.

This tool will allow the team to review the industry and enable them to make business decisions based on the accurate understanding of Harley Davidson supplier capabilities. By reviewing the supplier database, the team will gain a better understanding of the company, and which manufacturing and production direction to move forward with based on supplier capabilities. This plays a key role in manufacturing visibility and provides transparency in supplier based procurement decisions.

HARLEY—DAVIDSON

Michigan State University
Team Members (left to right)

Christian Dudley
Detroit, Michigan

Owen Kroeger
Grand Blanc, Michigan

Adriana Jones
Detroit, Michigan

Mackenzie Hoecherl
Charlotte, North Carolina

Jacob Peery
Hartland, Michigan

Lauren Barksdale
Detroit, Michigan
(not pictured)

Harley Davidson
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Lauren Alban
Minneapolis, Minnesota

Margaret Lear
Atlanta, Georgia

Teaching Assistant

Jose Naime

Applied Engineering Sciences
The Capstone Projects

Dr. Laura J. Genik
Director
Applied Engineering Sciences

Dr. Sri Talluri
Professor of Operations
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The Eli Broad Graduate
School of Management

Graduate Teaching Assistants

Sneha Abhyankar
MBA (2023)

Muhammad Khan
MBA (2023)

Jose Naime
MBA (2023)

Chaitanya Shankaragallu
MBA (2024)

Presentation Schedule – 1st floor Anthony Hall, Room 1255

Time	Team Sponsor	Project Title
8:25 a.m.	KLA	Supplier Master Data Management
8:50 a.m.	KLA	Supplier Relationship Management Optimization
9:15 a.m.	KLA	Best-in-Class Global Direct Materials Sourcing Process
Break		
9:50 a.m.	Alpine Supply Chain Solutions	Storage Type Analysis & Goods- to-Person Evaluation
10:15 a.m.	Applied Materials	Semiconductor Supplier Risk Index
10:40 a.m.	Home Depot	On-Time and Complete Performance Improvement

AESC Engineering Program

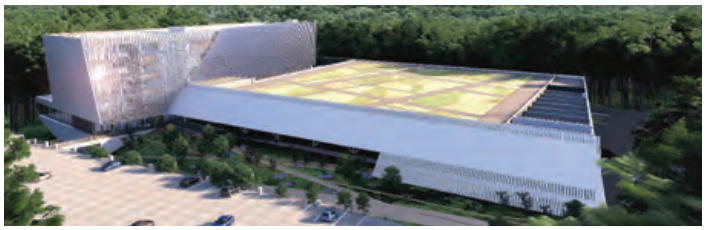
Since its inception, the Applied Engineering Sciences program has been successful in attracting students with diverse interests and varied backgrounds. Employers have especially responded positively to the graduates who bring a unique blend of courses and experiences to the workplace. These students are heavily recruited by a wide range of organizations with starting salaries to those of other engineering programs.

KLA
Supplier Master Data Management

KLA is an American corporation and leader in the process controls industry. KLA reaches across many different industries including, automotive, IOT, and artificial intelligence. Their process control and process enabling solutions help customers achieve leading edge performance. Now, with KLA's fast business developments, its supplier master data management (SMDM) is becoming a core focus for KLA.

In its SMDM, KLA's indirect procurement department is facing issues with internal data input and usage, such as inconsistent contact formats of its global suppliers, and outmoded supplier information. Therefore, KLA has tasked us to look for a sustainable process to manage its supplier master data as well as collect and clean the data with AI technology.

In order to help KLA mitigate and address these concerns, our team sought to minimize the struggle of data incongruity for users by analyzing the current data that KLA provided. Through this analysis, our team was able to form a comprehensive list of possible new software for the company's use and utilize the visualization tool to compare the competitiveness of these software applications to select the optimal one. This list is comprised of functional recommendations for new software that address KLA's business needs and enhances their overall effectiveness. The list also indicates what software the team believes to be the best fit in terms of cost and functionality for KLA's specific requirements.



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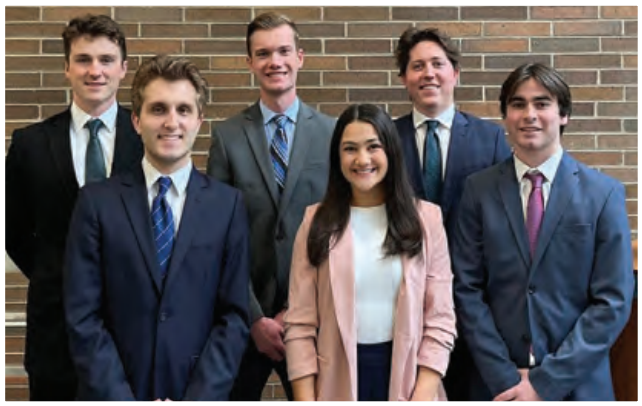
KLA
Supplier Relationship Management Optimization

KLA is a world leader in the production of state-of-the-art yield management and process control systems within the semiconductor and nanoelectronics industry. Since its founding in 1997, the organization has seen widespread success, making it one of the five largest semiconductor equipment manufacturers worldwide and a dominant player in the process control industry. Central to the organization's success has been building close relationships with key strategic suppliers. Employing cutting edge Supplier Relationship Management (SRM) tools within the company's procurement division has been and continues to be a critical component in supporting these objectives.

KLA currently utilizes SAP Ariba as its SRM tool, an extension of the SAP Enterprise Resource Planning System. The team at KLA has regarded the system in its current form as incapable of fulfilling the organization's SRM objectives. The SRM tool that best suits the needs of KLA must excel in risk management, insurance monitoring, compliance, code of conduct, diversity and inclusion, sustainability, supplier segmentation and scorecard creation, invoicing, payment processing, and seamless communication.

KLA tasked our team to search for innovative, industry-leading SRM technologies that possess the functionality capable of exceeding the company's procurement objectives. The team will aggregate, analyze, and compare various SRM solutions with the end goal of recommending the single most capable technology. Implementation of this technology would provide KLA with a more efficient and effective method of managing their supplier base.



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KLA Corporation
Best-in-Class Global Direct Materials Sourcing Process

KLA Corporation, a semiconductor manufacturing company headquartered in California, is the leading supplier of integrated circuits, nanoelectronics, and semiconductors.

In today's world, there is a need for a global direct materials sourcing strategy that can keep up with the increasing complexity of global business models. Sourcing processes today must properly value the current trends and expected impact of sustainability, cybersecurity, and intellectual property within the strategic sourcing process and supply base.

Our team developed a best-in-class global direct materials sourcing process that utilizes a technology platform (software) to provide unforeseen insight on suppliers which will support the complexity of KLA's global business and embrace change for future years.

The process enables KLA to utilize the newly introduced software which incorporates historical data storage, global reach and consistency, ease-of-use for end users, and ability to adjust cross-functional requirements.

Initially, the technology platform scores the suppliers that will rank the suppliers on the minimum standardized requirements of sourcing capabilities.

Furthermore, the software will employ artificial intelligence to predict future trends that will aid with global sourcing capabilities and will sort out the trends that will have a greater impact on sourcing in the future. Artificial intelligence is becoming more prevalent with evolving technology, which will help identify future trends that can improve the global supply chain in a positive manner.

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AESC 410/SCM 472 9:50 a.m. Anthony Hall, First Floor | Room 1255

Alpine Supply Chain Solutions
Storage Type Analysis and Goods-to-Person Evaluation

Alpine Supply Chain Solutions, which is a consulting firm that focuses on operational improvement, has tasked our team to perform a pick type analysis and conduct a high-level return on investment analysis. This will allow implementation of efficient processes within the supply chain of Guhring, a large manufacturer of tools in the metals industry that has been faced with the challenge of increasing overall efficiency and effectiveness within the warehouse associated. In addition, Guhring has the objective of increasing and improving technological advancements within the operations of the company.

Our team will focus on a multitude of different tasks ranging from data cleansing and data analysis to internal and external research to assess the best recommendation for the client.

In addition, we will utilize data information on outbound, inbound, labor, inventory, and SKU growth data to complete all tasks associated with the engagement. The provided information will contain all background knowledge necessary to complete this engagement successfully.

With the combination of data analysis and research, our team will be able to provide Alpine Supply Chain Solutions and Guhring recommendations. We have backgrounds in applied engineering, supply chain management, information technology, law, and more. We will utilize our unique backgrounds to provide the utmost value to the client during this engagement period.

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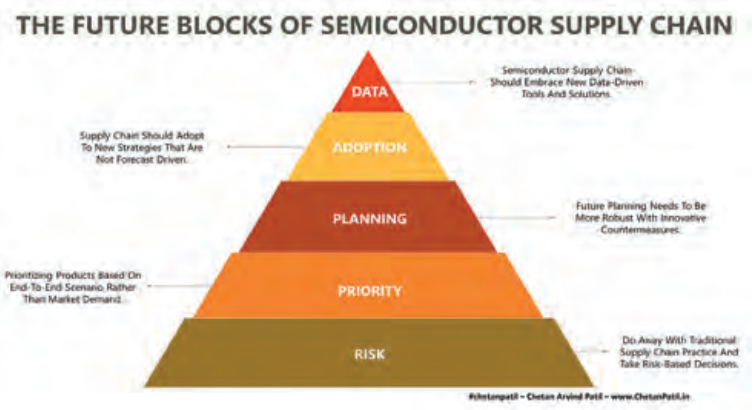
Applied Materials
Semiconductor Supplier Risk Index

Founded in 1967, Applied Materials has established itself as a prominent equipment, service, and software provider to the semiconductor, display, solar photovoltaic, and related industries. The company is committed to developing and delivering innovative solutions that help improve device performance, reduce power consumption, enhance yield, and optimize costs. With its diverse product portfolio, Applied Materials caters to a wide range of customers, including manufacturers of semiconductor chips, displays, and other electronic devices.

Currently, Applied Materials has limited visibility into their semiconductor supply chain and is looking for a way to assess and prioritize their supplier risk. This project is to assess the major risks affecting their supply chain and potential future risks. This project will help Applied Materials clarify and validate their understanding of their supplier risk.

To achieve this, our team will create a supplier risk matrix that evaluates and prioritizes suppliers based on the level of risk they pose to the business, providing a systematic way of addressing potential risks.

To create this risk matrix, our team will first conduct research and identify critical risk factors affecting the suppliers operating within the semiconductor supply chain, and then identify the most critical ones. Subsequently, our team will assign weights to each of these risk factors based on the research findings, and document the methodology used to determine the weights. Finally, this weighted risk analysis will be applied to applied materials suppliers to show its effectiveness. This supplier risk matrix will be used by Applied Materials to better evaluate and determine critical suppliers.



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make possible

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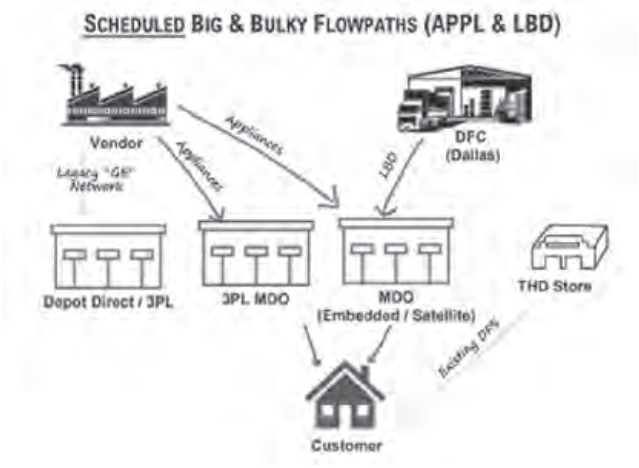
The Home Depot
On-Time and Complete Performance Improvement

The Home Depot is a large retail company based in Atlanta, Georgia. They specialize in building materials, home improvement supplies, and many different services. Founded in 1978, The Home Depot started with just two stores. Now, the company has grown to become the largest home improvement retailer in the world. The Home Depot has over 2,200 stores in operation, and employs more than 400,000 associates.

One of the most significant challenges that The Home Depot faces is managing the delivery of their "Big and Bulky" items, which refers to items such as appliances and furniture. To address this, the company has initiated a project to improve the Must Ship By Dates (MSBD) for these items with the goal of improving On-Time and Complete performance (OTC) and reducing dwell time at Market Delivery Operations (MDOs).

To achieve this, The Home Depot is working to improve the predictability and consistency of their delivery network by analyzing the appropriate data. This includes collaborating with suppliers to streamline the ordering process, optimizing their delivery routes, and implementing new technologies to improve tracking and maximizing the visibility of shipments.

In order to obtain a successful outcome, efficiency, predictability and consistency in delivery, and customer satisfaction all must be kept in mind.



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Presentation Schedule – 1st floor Anthony Hall, Room 1257

Time	Team Sponsor	Project Title
8:00 a.m.	Clarience Technologies	Evaluation & Recommendation of MRO Spend Vendors
8:25 a.m.	Caterpillar Inc.	Geo Tracking Inside the Warehouse
8:50 a.m.	Caterpillar Inc.	Optimal Facility Design
9:15 a.m.	Caterpillar Inc.	Ergonomic Order Picking
Break		
9:50 a.m.	American Axle & Manufacturing	TRMF - Forklift Free Facility
10:15 a.m.	Snackwerks	Uptime Monitoring and Improvement Plan
10:40 a.m.	John Deere	Global Steel Pricing Model
11:05 a.m.	Meijer	Network Capacity Modeling

Applied Engineering Sciences Awards

The Applied Engineering Sciences Design Program presents three awards on Design Day. The Most Impactful Award is given to the team whose project will potentially have the most immediate impact on their sponsor. The team whose project will produce the most sustainable results for their sponsor receives The Most Sustainable Award. Finally, the Mike Sadler Competitive Edge Award is given to the team that strives to achieve the highest possible outcome in order to attain the next level of success. The winning project is considered to have "flipped the field" with an innovative and creative solution that results in a competitive edge that not only solves the problem but distances itself from the competition.

AESC 410/SCM 472 8:00 a.m. Anthony Hall, First Floor | Room 1257

Clarience Technologies
Evaluation & Recommendation of MRO Spend Vendors

Clarience Technologies is a multinational company, whose goal is to bring "Total Visibility" in the transportation sector. It is the parent company to several other brands involved in the commercial transportation industry, such as Truck-Lite, Davco, and Rigid.

Clarience Technologies has requested research and recommendations for the company's maintenance, repair, and operations (MRO) spend across its operations in North America. MRO spend is a subcategory of the indirect spend of a company related primarily to consumables at their manufacturing facilities. Clarience Technologies does not have strategic suppliers between their plants and subsidiaries, and has each company oversee their own purchasing. Individual purchasing means that there is a large amount of duplicate clerical work and no central database of what is being bought. The goal of this analysis is to try to standardize MRO purchases throughout the company. To meet this goal Clarience Technologies wishes to reduce their MRO supplier pool, decrease the amount of clerical work, and add increased visibility into their purchasing activities.

In conjunction with Clarience Technologies, our team has conducted a series of analyses on potential MRO suppliers. During the analysis, many factors that are important for suppliers have been considered, such as location, financial picture, pricing, and tracking techniques. With the end analysis, Clarience Technologies will be able to clearly rank potential MRO suppliers, reduce their clerical work, reduce costs, and reduce the complexity of their purchasing process.

Clarience™ TECHNOLOGIES

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Caterpillar Inc.
Geo Tracking Inside the Warehouse

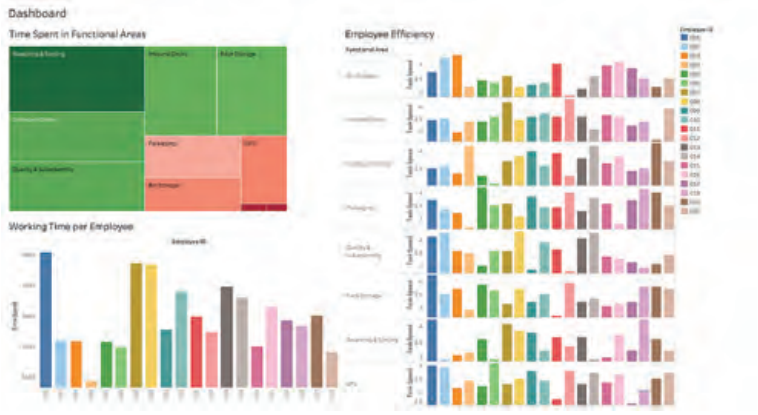
Headquartered in Irving, Texas, Caterpillar is the world's leading manufacturer in construction and mining equipment. With 107,700 employees worldwide and serving 193 countries, Caterpillar is dedicated to helping customers build a better, more sustainable world.

The company operates in three primary sectors-Construction Industries, Resource Industries, and Energy and Transportation Industries. Caterpillar is seeking to improve plantwide efficiency by implementing a tracking system to allocate employees throughout their warehouses.

Our solution is built on Ultra-Wideband (UWB) technology, which enables us to track employees' movements within the warehouse and measure their time spent in each functional area with precision. This real-time data allows us to conduct more effective process reviews and waste analysis, resulting in a more efficient and productive workforce.

We have developed a Tableau dashboard that provides a visual representation of the real-time data collected from the warehouse. The dashboard showcases key metrics: time spent in each functional area, the speed at which work is being completed, and individual employee efficiency. It enables us to continuously monitor the warehouse operations and make data-driven decisions to improve productivity and cost-effectiveness.

With interactive charts and graphs, the dashboard enables easy identification of trends and patterns in employee productivity, helping us track progress towards our productivity goals.



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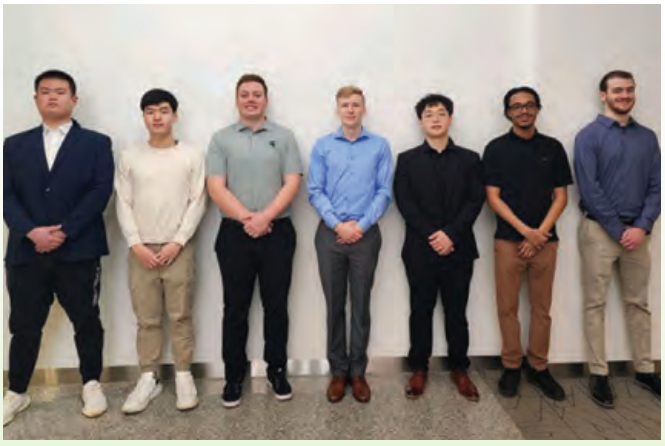

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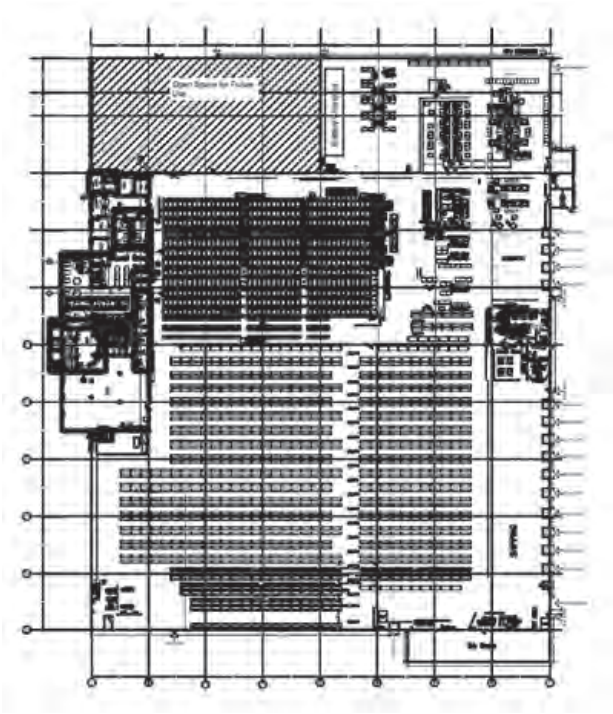
Caterpillar Inc.
Optimal Facility Design

Caterpillar Inc. was founded in 1925 by merging two manufacturing companies. Today it is the world's leading manufacturer in construction and mining equipment, with multiple locations in every continent.

The wide range of locations makes it very important for all of their facilities to efficiently work and communicate with one another. Currently the logistics center, which serves multiple locations, has expanded its physical presence to two separate buildings, leading to a decrease in operational efficiency. Sponsored by Caterpillar, our project consists of redesigning its operations by creating a facility layout that is most optimal for future growth.

The focus of this project consists of implementing new storage units that increase storage capacity, automating processes to decrease headcount, and re-designing the physical layout with the decided new storage units to increase flow of the product.

The team was able to gain inventory and historical data in Excel in order to calculate the optimal storage density of the facility. This allows for a comparison of alternative storage options by using storage density as the driving metric. With the estimated amount of storage needed, Caterpillar will then be able to reach out to the storage companies in order to create a cost analysis. The best storage option chosen will then be implemented to the facility layout. The AutoCad facility layout is reordered with the new storage units to increase square footage of the facility. Caterpillar Logistics Center can then implement the improved layout into their current facility.



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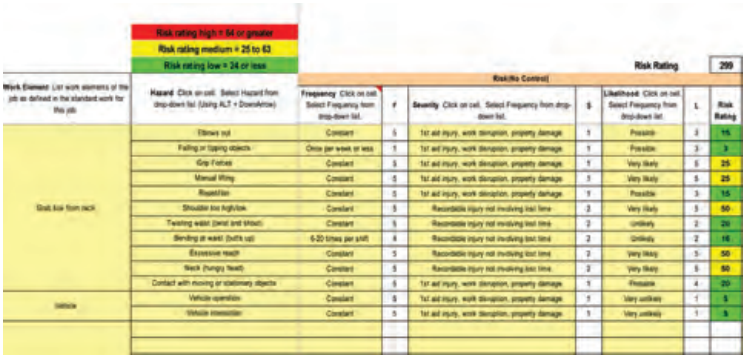
Caterpillar Inc.
Ergonomic Order Picking

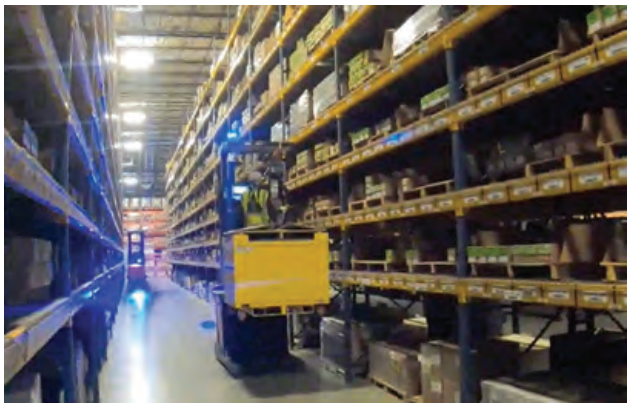
Caterpillar is the world leader in the manufacturing of construction and mining equipment, diesel/natural gas engines, gas turbines, and diesel-electric locomotives. To speed up the assembly process for customer products, Caterpillar provides "kits" that include multiple parts grouped into one container. This improves customer shopping because one can order a whole kit that includes all the products that they need in one place.

This project is to help achieve a risk-free environment in warehousing locations across America. Employees currently encounter ergonomic stresses during their shift while order picking, such as unnecessary movements on their backs and shoulders when reaching for items. Such stresses could lead to injuries and on-the-job incidents.

Our team is exploring changes to the process, storage type, material handling equipment, personal protective equipment, and other injury-reducing opportunities to make Caterpillar a safe environment to work in with minimal risk.

We analyzed a video, provided by Caterpillar, of the picking process in one of many of their warehouses. By reviewing the video and using a Safety FMEA chart provided by Caterpillar, we will identify the biggest risks in the process and assign them a number using a scale based on severity and frequency. We will present a solution from two lenses: current state improvement and a long-term perspective. The current state improvement consists of process changes to mitigate safety concerns, while the long-term solution involves process automation to improve efficiency. The company could then implement the current state improvement while planning for and executing the suggestions for a long-term improvement.





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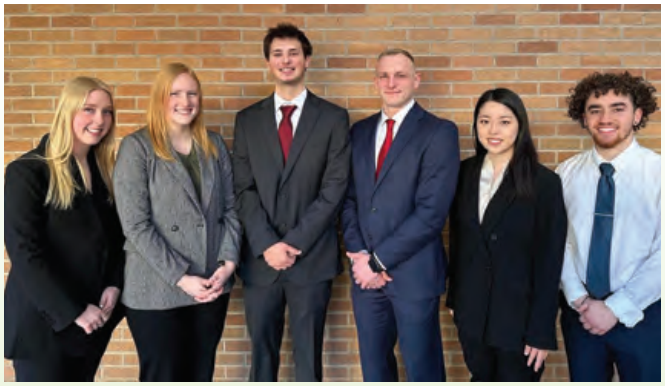

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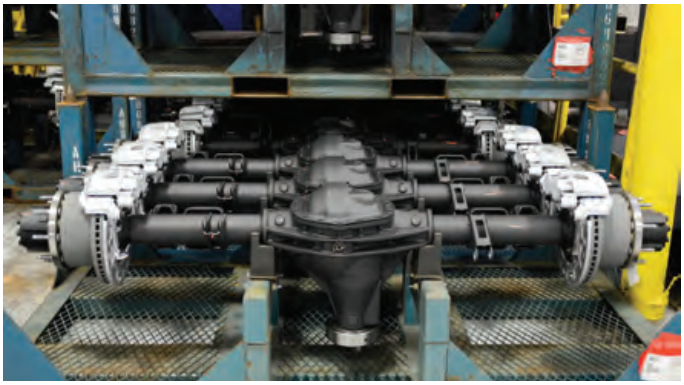
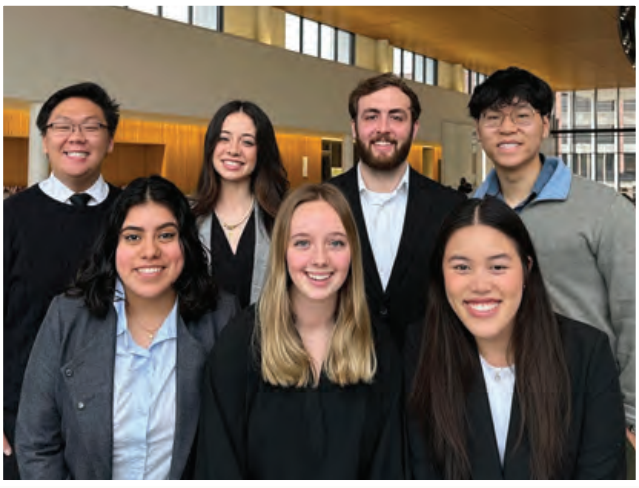
American Axle & Manufacturing
TRMF – Forklift Free Facility

Founded in 1994 and based in Detroit, Michigan, American Axel & Manufacturing (AAM) is a Tier 1 automobile supplier of driveline and drivetrain components and systems, with over 80 locations spanning from the Americas to Asia and Europe. AAM supplies original equipment manufacturers (OEMs) around the world in the passenger car, light truck, and commercial vehicle groups. The company delivers efficient, powerful, and innovative solutions to support electric, hybrid, and internal combustion vehicles. AAM focuses on being safe, sustainable, and innovative to advance global mobility while providing value to their stakeholders.

In order to increase plant safety and sustainability, AAM's goal is to reduce its dependency on heavy machinery and forklifts. To carry out this goal, they assigned our team to design and test six new material handling routes at their Three Rivers Manufacturing Facility. The goals of this project were to improve facility safety, decrease downtime, and optimize operating costs. To achieve these goals, the team based the route designs on safety protocol, production line KPIs, and material handling efficiency.

To assist AAM in the implementation of the new routes, we delivered multiple documents. The first of these documents was a drawing of the six route designs, including each stop's route paths and locations. These drawings supplied optimal material handling routes to properly service production lines and route signals to inform operators on proper pick-up, drop-off, and required stop locations. Finally, to further support the implementation process of the project, the team provided AAM with standard work documentation for training drivers to understand and operate the six new routes successfully.





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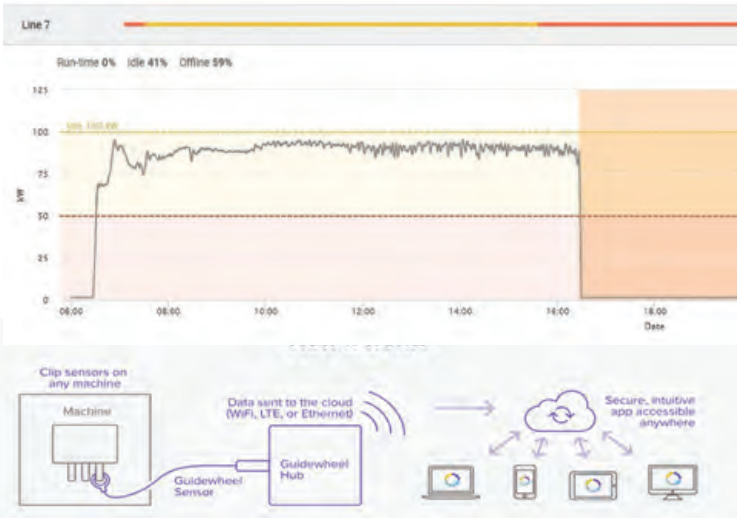
Snackwerks
Uptime Monitoring and Improvement Plan

Founded in 2016 in Battle Creek, Michigan, Snackwerks was created with innovation, flexibility, top-tier quality, competitive, and pricing in mind. Continuing the tradition of food in the Cereal City, Snackwerks partners with emerging brands from food companies of varying sizes. Lean processing line, high quality and food safety standards, and a hard-working, knowledgeable team, provide its customers with a first-class experience. Snackwerks was founded and is led by a team of veteran food industry leaders.

In order to understand where improvements are needed Snackwerks utilizes a tool called Guidewheel data to help better understand the manufacturing plant's downtime, the effective line uptime, and which delays are due to human intervention. Guidewheel's mission is to empower all of the world's factories to reach sustainable peak performance. Their plug-and-play FactoryOps platform makes the power of the cloud accessible to any factory, inspired by a simple, universal truth that every machine on the factory floor has a power cord. Guidewheel then clips onto any machine to turn its real-time "heartbeat" into a connected, active learning system that empowers teams to reduce lost production time, increase throughput, and perform better overtime.

With the use of Guidewheel, we will analyze their data to better understand where improvements can be made. We will be able to use this data to first understand downtime for individual machines and then be able to give reasons for these downtimes. We will also be able to understand how the machines work together and how that affects productions. After understanding all of this, we can evaluate the downtime cost and increased spending on labor. Once we have done all of this, we will be able to provide possible solutions towards lowering downtime.



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John Deere
Global Steel Pricing Model

For the past 180 years John Deere has been developing cutting edge technology to serve the agricultural industry worldwide.

Our team worked with Elliot Shriver from John Deere to develop a working global steel pricing model.

The model includes the total landed cost of plate steel from accurate forecasting indexes as well as a breakdown of the individual supply chain logistics cost.

The model focuses on the exporting countries South Korea, India, and China, while importing to the United States. The live data of each location is being used for current and forecasted costs of logistics and steel prices to create decisions in the model.

This allows John Deere to reduce manual tasks within the model. At the same time, our team has gained experience implementing real-time data in Microsoft Excel.

The end results of the model provide evidence for new alternatives of steel sourcing, as well as significant time and cost savings. There is a future opportunity to create CO2 emission calculations within the current model to improve sustainable sourcing decisions.

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Meijer
Network Capacity Modeling

Meijer is a family-owned grocery store chain, operating in the Midwest for over 85 years. They strive to grow and innovate the company by focusing on their core values such as their customers, competition, freshness, family, and health and safety. Meijer products are broken down into four networks: Grocery, Fresh, Frozen, and General Merchandise. The project provides the opportunity to gain insights into their supply chain through data provided for the frozen network consisting of four nodes located in Lansing, Newport, Tipp City and Pleasant Prairie.

The main goal of our project is to create a model to predict capacity trends at each distribution center for the frozen network. The model will help to make short- and long-term decisions demonstrated from the findings in the data. A forward-looking approach will be taken throughout the entirety of the project to best aid Meijer in their capacity planning models and strategies. A key outcome of the achievement of these goals, is that Meijer will be able to find better ways to reduce logistic costs. Another key outcome of this model will allow Meijer to find ways to increase service levels of the distribution fill rate. With proper capacity modeling, Meijer ensures that the items are shipped timely to service customer needs.

The project will entail collaboration and challenging ideas against existing models. Excel, PowerPoint, and PowerBI are platforms that will be utilized to create and present these models for the frozen network and expand to other networks if time permits. The variables being used for capacity measurements include inbound and outbound cases per week, alongside the active number of stock pallets and reserved pallet positions in the distribution center. The model that will be created will allow our team to proactively forecast the demand to plan for future capacity requirements.

meijer

Michigan State University
Team Members (left to right, top to bottom)

Natalie D'Agostino
Chesterfield, Michigan

Addison Guitar
Shelby Township, Michigan

Elizabeth LaRochelle
Troy, Michigan

Morgan Kravitz
Buffalo Grove, Illinois

Maddie Sackman
Ann Arbor, Michigan

Emily Hart
Troy, Michigan

Meijer
Project Sponsors

Mike Moss
Grand Rapids, Michigan

Quintin Neubauer
Grand Rapids, Michigan

Lara Werner
Grand Rapids, Michigan

Teaching Assistant

Muhammad Khan

Applied Engineering Sciences
The Capstone Projects

Dr. Laura J. Genik
Director
Applied Engineering Sciences

Dr. Sri Talluri
Professor of Operations
and Supply Chain Management
The Eli Broad Graduate
School of Management

Graduate Teaching Assistants

Sneha Abhyankar
MBA (2023)

Muhammad Khan
MBA (2023)

Jose Naime
MBA (2023)

Chaitanya Shankaragallu
MBA (2024)

Presentation Schedule – 1st floor Anthony Hall, Room 1260

Time	Team Sponsor	Project Title
8:25 a.m.	SLB	Analyzing Price Cycles in Oil Field Chemicals Market
8:50 a.m.	SLB	Mitigating Commodity Price Volatility in Supply Chains
9:15 a.m.	SLB	Framework for Supplier Rationalization
Break		
9:50 a.m.	NASA	Psyche Mission: Art & Exhibit Archiving System
10:15 a.m.	NASA	Psyche Mission: Capstone Marketplace
10:40 a.m.	NASA	Psyche Mission: Public Arts Activity Analysis

SCM 472 Experimental Learning with Industry Problems in Supply Chain

Supply Chain Management seniors in the Broad College of Business have the opportunity to work in a multidisciplinary team with Applied Engineering Students by enrolling in SCM 472 for their capstone experience. This collaborative opportunity has been in place since 2015.

SLB
Analyzing Price Cycles in Oil Field Chemicals Market

SLB is a global technology company driving energy innovation for a balanced planet by providing technology for reservoir characterization and drilling. The mission of the company is to create innovative scientific technology that will accelerate decarbonization on a global scale and allow energy access to all. To meet these goals and solve industry challenges, the company is working to abate emissions, improve performance in the oil and gas industry, scale new energy systems to accelerate the transition to low-carbon energy, and deliver digital to scale by accelerating time to value.

Literary research will be conducted by our team on the effectiveness and performance of oil field chemicals raw materials against a specific set of publicly available producer price indices from January 2021 to January 2023 relating to chemical manufacturing, fertilizers, and organic chemicals. Using data analysis skills, a mathematical model studying correlation patterns between the raw material and producer price indices will be created. In studying the highest correlations between the producer price and raw material indices, time lags between these two data sources will be identified.

Through research and data analysis, we will understand market conditions related to oil chemical prices and implement a mathematical model that will be used for future price comparisons at SLB. The mathematical model will allow SLB to visualize the impact of oil price fluctuations and will allow for future cost comparisons and forecasts to be made. The relation between these raw materials and the publicly available indices will determine similarity and correlation patterns that will help SLB to develop more sophisticated forecasting models in the future for the price of those chemicals.

Michigan State University
Team Members (left to right)

Olivia Mlynarek
Grosse Pointe, Michigan

Calvin Somers
Huntington Woods, Michigan

Brooke Zellman
Grand Haven, Michigan

Jackson Hamm
Grand Haven, Michigan

Kaitlyn Ristic
Clinton Township, Michigan

Nathan Spadafore
Petoskey, Michigan

SLB
Project Sponsor

Manish Sharma
Sugar Land, Texas

Teaching Assistant

Muhammad Khan

AESC 410/SCM 472 8:50 a.m. Anthony Hall, First Floor | Room 1260

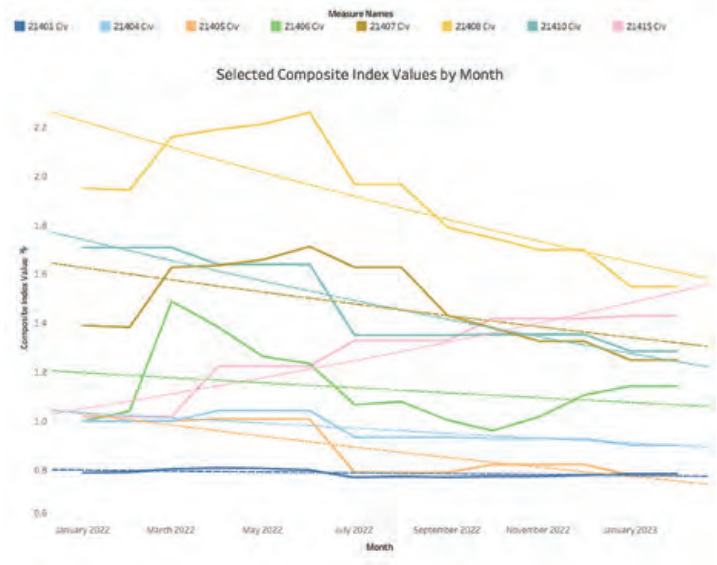
SLB
Mitigating Commodity Price Volatility in Supply Chains

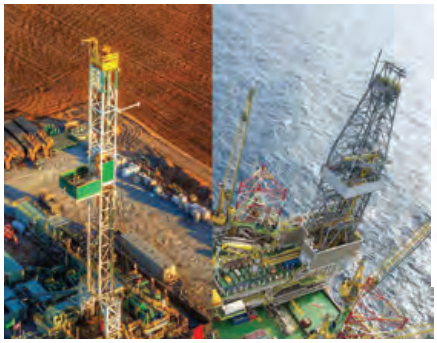
Schlumberger (SLB) is a global technology company headquartered in Paris, France. SLB is the world's largest offshore drilling company, providing leading innovation to the oil and gas industry.

Prices within the oil industry are extremely volatile and influenced by many different variables of which many cannot be forecasted. Cost models enable SLB to analyze and manage costs associated with its operations and services. Schlumberger operates in a highly competitive market, where managing costs is essential to profitability and competitiveness.

SLB tasked our team with mapping their existing composite cost models to publicly available indices provided by them. The purpose of this task is to align SLB's cost models with the indices to improve their cost estimates. The provided data consists of 15 cost models (1-year monthly data) to be compared against eight Bureau of Labor Statistics (BLS) Producer Price Index (PPI) indices as well as two commodity materials: copper, and nickel.

Our team used regression analysis to identify the models with the highest correlation and determine if any time lag existed between the performance of the model and the PPI indices. The findings of our research were compiled in a case study to be given to SLB. Our case study involved analyzing the effectiveness of SLB's current cost models and identifying areas for improvement. By conducting a detailed analysis of their current models, the case study provides SLB with insight into how accurate their cost models are as well as areas to be improved.





Michigan State University
Team Members (left to right, top to bottom)

Mohit Ambavaram
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Kevin Wang
Okemos, Michigan

Anjay Yaple
Birmingham, Michigan

Gavin DeWitt
Plymouth, Michigan

Bo Stockbridge
San Diego, California

Matthew Greenwald
Charlotte, North Carolina

SLB
Project Sponsor

Manish Sharma
Houston, Texas

Teaching Assistant

Muhammed Kahn

SLB
Framework for Supplier Rationalization

SLB is an oilfield services company that provides technology for reservoir characterization, production, drilling, and processing to the oil and gas industry. SLB has thousands of suppliers, spanning multiple different categories. The focus of this project is on Maintenance, Repair, and Operations (MRO) suppliers. The problem is that there are too many suppliers in the MRO category. Having nearly 10,000 suppliers in just the MRO category makes it difficult to manage efficiently and effectively. This can also lead to a reduction in negotiation power and jeopardy of data quality and inflation control.

The goal of this project is to develop a methodology or framework of reducing and optimizing the MRO suppliers in the United States. SLB is currently looking for new alternatives and perspectives to evaluate its supplier base and how to rationalize it. This framework should be able to translate globally. To develop a framework for supplier rationalization, it is important to truly understand the meanings of MRO and tail spend. Using data provided by SLB, it is then possible to implement strategies that may result in optimizing the supply base.

Our methods are based on industry benchmarking and academic support, as well as trial and error when performing data analysis. The framework we will be creating will include a research paper, highlighting key points and methods we found through our research on tail spend, as well as our framework implemented on the data given, to understand how the methods work. Using Tableau, we can manipulate and display the data in ways in order to determine what strategies work best with the company. A combination of these things should result in a framework that can be used globally, along with the recommendations and results of the current MRO suppliers in the United States.

Michigan State University
Team Members (left to right)

Brett Leuffgen
Algonac, Michigan

Rapheal Amaral de Silveria
Feira de Santana, Brazil

Clara Martin Digon
Burgos, Spain

Peter Jacobsen
Saline, Michigan

London McMurray
Farmington Hills, Michigan

Shu Xu
Fujian, China

SLB
Project Sponsors

Yinting Huang
Houston, Texas

Joao Miquelotti
Bogotá, Colombia

Jeff Smith
Houston, Texas

Teaching Assistant

Sneha Abhyankar

AESC 410/SCM 472 9:50 a.m. Anthony Hall, First Floor | Room 1260

NASA
Psyche Mission: Art & Exhibit Archiving System

The NASA Psyche Mission, led by Arizona State University, has a goal of reaching the asteroid "Psyche," which is orbiting the Sun between Mars and Jupiter. This asteroid is primarily made of metal and will be able to provide a unique history of terrestrial planets. The launch date for this project is set for October 2023.

Through the NASA Psyche Inspired internship, college students from around the country have created artwork in many forms over the past six years to promote awareness surrounding the mission. This artwork has been displayed in various locations throughout the United States and exhibits are continuously updated and created. As new artwork and exhibits are introduced to the mission, the works must be cataloged and tracked.

Our project focuses on exhibiting and formatting art projects and research done surrounding the NASA Psyche Mission. In order to complete this project, a site has been created to house all data surrounding the projects, including information about location, availability for exhibit, medium, genre, creator, and artist background.

For the site creation, data has been entered using past Excel files, forming the basis of a database with the ease of access of a website. This site was formatted using Omeka, which utilizes SQL as a means of data presentation.

Using this site, members of the mission, artists, curators, and spectators can access information regarding all of the artwork being exhibited, pieces in storage, or items that can be accessed only digitally.

Michigan State University
Team Members (left to right)

Jacob Johnson
Lake Orion, Michigan

Paulina Sandoval
Detroit, Michigan

Leyna Gatti
Clinton Township, Michigan

Kato Ruiz
Keller, Texas

Miranda Pelton
Clarkston, Michigan

Vivek Patel
Novi, Michigan

NASA Psyche Mission
Project Sponsor

Cassie Bowman
Tempe, Arizona

Teaching Assistant

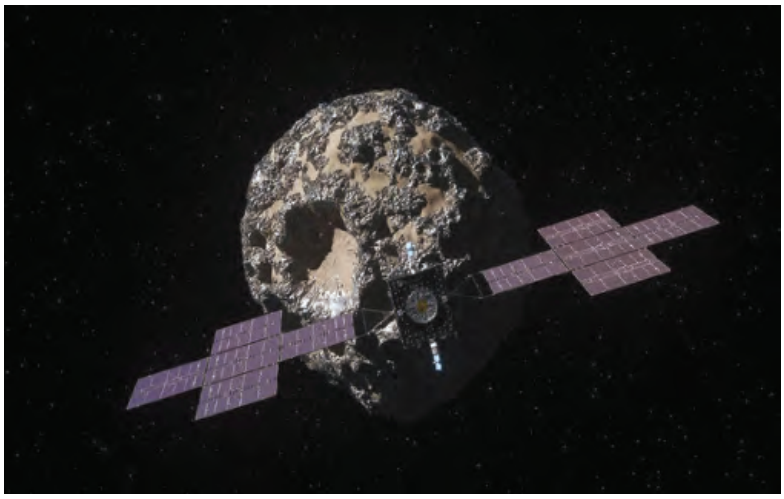
Mohammed Khan

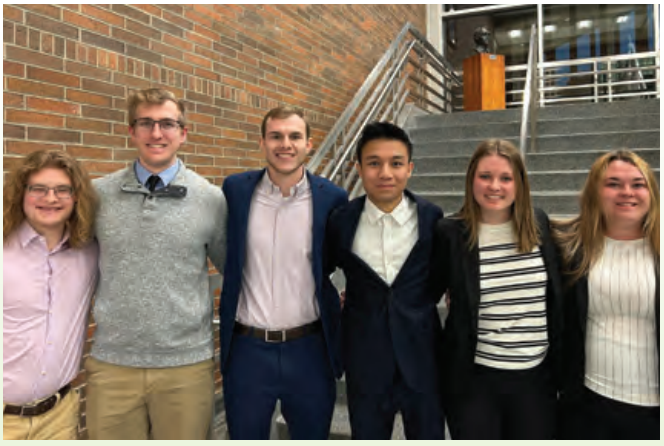
NASA
Psyche Mission: Capstone Marketplace

The NASA Psyche Mission is an Arizona State University (ASU)-led initiative which seeks to learn more about the history of our early solar system. The goal of the mission is to launch a spacecraft, which will journey into our solar system's main asteroid belt, and settle into an orbit around a unique metal-rich asteroid called Psyche. The asteroid's metallic makeup is hypothesized to be leftover core material from an early planetesimal (a building block of the rock planets), and therefore could shed light on our planet's development.

Student capstone projects have been a part of advancing the NASA Psyche Mission but are limited in scope by time and university constraints. To reach the full potential of capstone projects, ASU's goal is to build an online project marketplace to aid in forming interdisciplinary capstone teams and making it easier for projects to continue from year to year if needed.

This marketplace will aid in the formation of stronger capstone teams by enabling searching for specific skillsets, long-term communication on project statuses, and sourcing students from different universities. This project will deliver feedback on the current website, suggestions for organization and overall content, and analysis of the challenges of forming inter-university capstone teams.





Michigan State University
Team Members (left to right)

Benjamin Bowles
Troy, Michigan

Nathan Oberer
Troy, Michigan

Devyn Garner
Jackson, Michigan

Tuan Hoang
Okemos, Michigan

Chloe Korth
Lake Orion, Michigan

Jessica Fox
Lake Orion, Michigan

NASA Psyche Mission
Project Sponsor

Cassie Bowman
Tempe, Arizona

Teaching Assistant

Sneha Abhyankar

AESC 410/SCM 472 10:40 a.m. Anthony Hall, First Floor | Room 1260

NASA
Psyche Mission: Public Arts Activity Analysis

The Psyche Asteroid Mission will launch in October 2023, and will arrive at the asteroid in 2029. During this time, the Psyche team is interested in launching a community engagement program. This project creates a logistics plan for that program.

The logistics plan discusses how to promote the mission within the arts community and intends to prepare an art exhibit composed of a curation of the public's artwork. This exhibit is inspired by the Coral Reef Knit Exhibit previously featured in the Smithsonian's National Museum of Natural History and is focused on gathering artwork depicting imaginative textures that may exist on the asteroid. The logistics plan discusses how to market the exhibit to the public, curate and collect artwork created by the public, and create an exhibit of that art.

To engage the public, a social media campaign will be launched and organizations such as senior living homes, student organizations, and school programs will be contacted via an informational email. This email will contain a brief overview of the project and arts activities that can foster imaginative reconstructions of the asteroid's surface. The pieces will be submitted to the NASA Psyche Mission project office at ASU via digital submissions. Several dimensions are considered when receiving submissions, such as weight of the package, medium used by the artist, and the artist's personal information. The Psyche Mission will then curate the submissions based on the submission guidelines and request they be mailed in for display. Some target mediums include knitting, crochet, clay, and paper mâché.

The success of this project will be determined by the quantity and quality of the submissions. The final display will include a wide variety of art mediums and may be exhibited to the public through the end of the Psyche Mission.

Michigan State University
Team Members (left to right)

Patty Lare
Detroit, Michigan

Zac Hintz
Petoskey, Michigan

Lillian Jones
Eaton Rapids, Michigan

Darius Walker
Battle Creek, Michigan

Matthew Hanna
Novi, Michigan

Emma Borowski
Ortonville, Michigan

NASA Psyche Mission
Project Sponsor

Cassie Bowman
Tempe, Arizona

Teaching Assistant

Jose Naime

AESC 410 Awards 2022

As punter for Michigan State University's football team, Mike Sadler was well known for giving his team a competitive edge by flipping the field with perfect punts that pinned the opponents back near their own end zone.

In addition to being well known as an outstanding punter, Mike was also well known for being an outstanding scholar, exemplifying what it means to be a true student-athlete.

Mike was the first football player in Spartan history to earn Academic All-America honors four times. He was a two-time first-team Academic All-American, a National Football Foundation Scholar-Athlete, and a William V. Campbell trophy finalist.

Mike completed an undergraduate degree in Applied Engineering Sciences in just three years and then went on to earn a master's degree in Public Policy. After graduating from MSU in 2015, he was excited to begin Stanford Law School.

The Mike Sadler Competitive Edge Award is presented annually to the Applied Engineering Sciences capstone team that that strives to achieve the highest possible outcome in order to attain the next level of success. The winning project is considered to have "flipped the field" with an innovative and creative solution that results in a competitive edge that not only solves the problem but distances itself from the competition.

"I am very proud to call myself an Applied Engineering Sciences alumnus. The program has fostered within me maturity, discipline, leadership, and a worldy sense of systems thinking."

- Mike Sadler

The AESC 2022 Mike Sadler Competitive Edge Award:

Team Caterpillar
"End-to-End Kit Process Optimization"

Left to right: Matthew Ginter (AESC), Isabella Cueny (SCM), Allie Percy (SCM), Sara Fusco (AESC), Nicholas Caldwell (AESC)

The AESC 2022 Most Impactful Award:

Team RENK "Purchase Order Compliance Package Process"

Left to right: Tony Messenia (AES Alumni Board Member), Addison Dunham (AESC), Maggie Lear (SCM), Kory Ernster (AESC), Cole Gibbs (SCM)

The AESC 2022 Most Sustainable Award:

Team BASF "Herbicide Data Visualization and Forecasting"

Left to right: Jessica Laze (SCM), Samantha Powers (AESC), Brennan Parks (AESC), Jessica Mo (SCM), Emme Darkowski (AESC)

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Dr. Dana Kirk, PE
Assoc. Professor
Biosystems &
Agricultural Engineering

Dr. Luke Reese
Assoc. Professor
Biosystems &
Agricultural Engineering

About the Program

Graduates of the MSU Biosystems Engineering (BE) Undergraduate Program are expected to succeed in diverse careers where they integrate and apply principles of engineering and biology to a wide variety of globally important problems. MSU Biosystems Engineering graduates are expected to attain that success by:

- identifying and solving problems at the interface of biology and engineering, using modern engineering techniques and the systems approach,
- analyzing, designing, and controlling components, systems, and processes that involve critical biological components,
- demonstrating a professional foundation that includes vision, adaptability, creativity, a practical mindset, effective communication skills, continuing professional growth, and ethical conduct, and
- working inclusively and equitably in diverse, cross-disciplinary environments towards sustainable solutions.

BE 485 / BE 487 Courses

Biosystems Engineering student teams, enrolled in the two-semester biosystems design capstone experience, BE 485/487, develop, evaluate, and select design alternatives to solve real-world problems. Projects are diverse, but each reflects systems thinking by integrating interconnected issues affecting the problem, including critical biological constraints. The engineering design process is documented in a detailed technical report. Teams present project designs to engineering faculty and a review panel of professional engineers for evaluation. Each BE 485/487 capstone design team prepares and presents a design solution in report, poster, and oral formats to industry, faculty, peers, and the public that:

- Requires engineering design
- Combines biology and engineering
- Solves a real problem
- Uses a holistic approach
- Interprets data
- Evaluates economic feasibility

2022/23 Projects

Full descriptions and project posters are at:
www.egr.msu.edu/bae/SS23NewsBEShowcase
Public presentations msu.zoom.us/j/93618840145 (April 28, 2023, 1 pm)

Optimizing ultrasonic aspirator settings to maximize viable cell extraction
Stryker (project under Non-Disclosure Agreement)
Team Stryker 1 - Christina Berels, Anna Burgess, Jordyn Gerdes, & Chloe Zaborney Kline
Faculty Advisors - Dr. Vangie Alocilja & Dr. Ilce Medina Meza

Tissue pathology viability testing after ultrasonic aspirator extraction
Stryker (project under Non-Disclosure Agreement)
Team Stryker 2 - Mary Borowski, Adam Easter, Emeline Pioch, & Jack Westerkamp
Faculty Advisors - Dr. Ilce Medina Meza & Dr. Vangie Alocilja

BE 485/487 8:00 a.m.- Noon Engineering Building, First Floor | 1300 Hallway

Whey protein concentration process evaluation and predictive modeling to control yield
Tillamook (project under Non-Disclosure Agreement)
Team Tillamook - Ben Alexander, Ava Borri, Kate Mann, & Stephanie Nomoto
Faculty Advisor - Dr. Bahar Aliakbarian

Regulatory feed sampling process and ergonomics improvement
Michigan Department of Agriculture and Rural Development
Team MDARD - Ryan Eberline, Marshall Humphrey, Claire Kolar, & Kate Wernicke
Faculty Advisor - Dr. Tim Harrigan

Assessment of commercial innovative technologies to reduce microbial load in wheat
Mennel Milling Company (project under Non-Disclosure Agreement)
Team Mennel Milling - Ryan Danaj, Lindsey Hassel, Rachael Lewallen, & Aaron Newberry
Faculty Advisor - Carly Gomez & Dr. Yan "Susie" Liu

Wetland restoration for improved natural function, research, and educational use
Corey Marsh Ecological Research Center
Team Corey Marsh - Ali Ahmad, Katie Dailey, Lauren Falzarano, & Allison Smith
Faculty Advisor - Dr. Dawn Dechand

Sulfur compound removal from tail gas CO_2 for methanation
Quantalux (project under Non-Disclosure Agreement)
Team Quantalux - Yangcheng Gao, John Grivins, Xiaoheng Lyu, & Gregory Rouland
Faculty Advisor - Dr. Wei Liao, PE

Baked pastry promotional process line improvement
Kellogg's (project under Non-Disclosure Agreement)
Team Kellogg's - Megan Baechle, Emily Hamilton, Katie Jensen, & Reema Patel
Faculty Advisor - Dr. Kirk Dolan

Integration of a visioning quality control system
Clemens Food Group (project under Non-Disclosure Agreement)
Team Clemens - Emily Gorr, Robert Gurecki, Kevin Mozel, & Jarod Williams
Faculty Advisor - Dr. Narendra Das

Maintaining natural water supply requirements for a distilled beverage
Distilled Beverage Manufacturer (project under Non-Disclosure Agreement)
Stream Team - Grant Gmitter, Megan Mancina, Chance Poulos, & Madison Pritchett
Faculty Advisor - Dr. Steve Safferman, PE

Energy audit decision support tool for MDNR facilities
Michigan Department of Natural Resources
Team MDNR - Christina Abel, Alec Christy, Lexi Szurna, & Mitchell Wojtowicz
Faculty Advisor - Dr. Truman Surbrook & Al Go

Process line sanitation optimization for cooked meat products
EW Grobbel (project under Non-Disclosure Agreement)
Team Grobbel - Savana Bellows, Andrew Kearney, & Andres Lanzas
Faculty Advisor - Dr. Sanghyup Jeong, PE

Apple trellis post structural and economic evaluation
MSU Clarksville Research Station
Team Clarkesville - Jake Crippes, Grace Dempsey, Hannah Gruber, & Jake Willsea
Faculty Advisor - Dr. Dan Guyer & Phil Hill

Industry Advisory Board

The purpose of the Industry Advisory Board is to facilitate the exchange of ideas between board members, faculty, and students of the BE program. Its function is to improve continuously the BE program quality by keeping it current and relevant to industry needs. Regular and adjunct board members also serve as external project evaluators.

Board

Janelle Barnes (Chair) - Target
Holly Bowers - Consumers Energy
Jessica Bruin - Nestlé Nutrition
Lisa Buchholz - Corteva Agriscience
Matt Burtt - AbbVie
Shelley Crawford - Jiffy
Michelle Crook, PE - MDNR
Laura Doud, PE - MDARD
Cassaundra Edwards - Tillamook Creamery
Gene Ford - Standard Process
Jeremy Hoeh, PE - EGLE
Eric Iversen, PE - PEA Group
Kevin Kowalk, PE - EA Engineering, Science, and Technology (MI) PLC
Jeffrey Mathews, PhD - PepsiCo
Mitch Miller - General Mills-Yoplait
Steve Radke - John Bean Technologies (JBT)
Nate Wood, PE - Perrigo
Rob Yoder - BDI, Inc.

Board (Ex-officio)

Todd Forbush - Techmark, Inc. (ASABE MI Section)

BE Showcase Evaluations & Public Presentations - April 28, 2022
www.egr.msu.edu/bae/SS22NewsBEShowcase

BAE 2021_22 Industry Advisory Board Meeting, April 28, 2022

If you are interested in sponsoring a BE 485/487 capstone project for the 2023/24 Senior Design teams, please contact Dr. Dana Kirk at kirkdana@msu.edu or Dr. Luke Reese at reesel@msu.edu.

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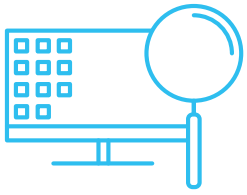

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we employ over **480** Spartan grads companywide

The Capstone Projects

Dr. Anthony Ingle
Teaching Specialist

Faculty Advisors: Professors Cetin, Haider, Hashsham, Ingle, Kodur, Li, Zockaie


Cetin


Haider


Hashsham


Ingle


Kodur


Li


Zockaie

PRESENTATION SCHEDULE ROOM 1225

Time	Team	Room 1225
8:00 a.m.	Team 1 - Red Cedar Consultants	First Floor Room 1225
9:20 a.m.	Team 2 - Champions Engineering Group	First Floor Room 1225
10:40 a.m.	Team 3 - CJ WATAC Construction	First Floor Room 1225

PRESENTATION SCHEDULE ROOM 1230

Time	Team	Room 1230
8:00 a.m.	Team 4 - Green Engineering Solutions	First Floor Room 1230
9:20 a.m.	Team 6 - Envision Construction	First Floor Room 1230
10:40 a.m.	Team 7 - East Lansing Consultants	First Floor Room 1230

PRESENTATION SCHEDULE ROOM 1234

Time	Team	Room 1234
8:00 a.m.	Team 5 - JPECS Engineering	First Floor Room 1234
9:20 a.m.	Team 8 - Spartan Engineering Solutions	First Floor Room 1234
10:40 a.m.	Team 9 - GREEN (Great Lakes Region Environmental Engineering Network)	First Floor Room 1234

PRESENTATION SCHEDULE ROOM 2243

Time	Team	Room 2243
8:00 a.m.	Team 10 - Truss US Engineering	Second Floor Room 2243
9:20 a.m.	Team 11 - Barn-Hill Consultants	Second Floor Room 2243
10:40 a.m.	Team 12 - Spartan Consultants	Second Floor Room 2243

CE 495 Senior Design in Civil & Environmental Engineering

Undergraduates in civil and environmental engineering must take CE 495. This capstone course prepares students for the workplace by providing an experience with the following challenges:

- A project with multiple issues that must be resolved using civil and environmental engineering knowledge;
- Formulation of conceptual solutions and resolution of conflicting design elements;
- Development of plans that comply with regulations and provide a basis for cost estimates;
- Balancing individual responsibility and group participation in a team based effort;
- Preparation of written reports and oral presentations.

Each team is responsible for developing a design that addresses environmental, geotechnical, hydrological, pavement, transportation, and structural issues for the project. A student project manager coordinates each team. Design reports are judged by the faculty; progress reports and the oral presentations are judged by a board of practicing professionals.

CE 495 SENIOR DESIGN IN CIVIL & ENVIRONMENTAL ENGINEERING

Engineering and Digital Innovation Building

The anticipated location is in the central academic district, in proximity to the Engineering Building, near the STEM Teaching and Learning Facility. Proximity to the functions that occur in these existing buildings in the central academic district is critical to the collaborative nature of the teaching, learning and research. Site evaluation will account for infrastructure requirements. Planning will set the stage for future demolition of infrastructure such as the Urban Planning and Landscape Architecture Building, the decommissioned Water Reservoir, and adaptive reuse of release space for further thematic colocation in buildings, including Engineering, thereby reducing capital renewal.

The building is envisioned to comprise two components. One would be dedicated to digital learning with active classrooms, teaching laboratories, student project studios, and e-sports. The other part would be dedicated to laboratories supporting experimental and computational research, core facilities, clean rooms, and flexible modular research units; and vibrant community spaces to support informal gathering and collaboration.

The new building will support an increase in enrollment of new undergraduate students in computational sciences and digital literacy disciplines and in graduate related programs; prepare MSU graduates with skills in computational sciences and digital literacy necessary for postgraduate success; and become MSU's center for excellence in advanced manufacturing, materials science, ultrafast science, and quantum computing including heterogeneous micro-electronic technologies.

The project should emphasize implementation of green infrastructure. Green infrastructure refers to systems and practices that use or mimic natural processes to infiltrate, evapotranspire, or harvest stormwater at its source. The University is seeking proof-of-concept level designs that examine how green infrastructure could be integrated into the particular site to meet multiple environmental, educational, and economic objectives. The development must be consistent with MSU's campus master plan.

Aerial photo site location.

Architectural rendering of building

Red Cedar Consultants
Holly Grow, Environmental
Lindsey Gawthrop, Geotechnical
Reid Gwyn, Hydrology
Brandon Strickland, Pavements
Lauren Doerr, Project Manager
Brandon Kettenbeil, Structures
AJ Raykovich, Transportation

Champions Engineering Group
Erik Hopkins, Environmental
Nick Ardelean, Geotechnical
Eric Schulte, Hydrology
Javier Urrea, Pavements
Jake Obrien, Project Manager
Mingzhao Lin, Structures
Lawrence Aldaoud, Transportation

CJ WATAC Construction
Taylor Higgins, Environmental
Chris Bitz, Geotechnical
Jacklyn Garavaglia, Hydrology
Aidan Niyontsinzi, Pavements
Conor Crysler, Project Manager
Will Flynn, Structures
Anthony Bennett, Transportation

Green Engineering Solutions
Brian Merle, Environmental
Cameron Wirth, Geotechnical
Lindsey May, Hydrology
Nathan Maher, Pavements
Colin Young, Project Manager
Ethan Conlan, Structures
Afiq Izzuddin Awai, Transportation

JPECS Engineering
Claire Van Gilder, Geotechnical
Emily Davis, Hydrology
Sydney Janssen, Pavements
Paul Durante, Project Manager
Evan Campau, Structures
John Racine, Transportation

Envision Construction
Andrea Vera, Environmental
Carson Stachelski, Geotechnical
Shriya Deshmukh, Hydrology
Trinity Glover, Pavements
Isabella Sio, Project Manager
Patrick Hodorogea, Structures
Roland Ingram, Transportation

East Lansing Consultants
Jade Arundell, Environmental
Joe Dec, Geotechnical
Alex Wallace, Hydrology
Kobe Ferguson, Pavements
Maxwell Julien, Project Manager
Jax Plumert, Structures
Matt Keyes, Transportation

Spartan Engineering Solutions
Olivia Sutherland, Environmental
Brennan Sollenberger, Geotechnical
Jacob Fenech, Pavements
Josh Soyka, Project Manager
Andrew Webster, Structures
Rachel Peters, Transportation

Great Lakes Region Environmental Engineering Network
Varun Vallury, Environmental
Julia Bove, Geotechnical
Sarah Anderson, Hydrology
Mathias Dahl, Pavements
Joseph Buswinka, Project Manager
Sean Parsa, Structures
Alyssa Lifschitz, Transportation

TRUSS US Engineering
Emily Kerr, Environmental
Richard Carbajal, Geotechnical
Allison Gustafson, Hydrology
Brandy Lopez, Pavements
Angel Jaime, Project Manager
Tyler Sladick, Structures
Mian Wei, Transportation

Barn-Hill Consultants
Joshua Gleason, Environmental
Zhiying Ou, Hydrology
Sabas Gutierrez Gonzalez, Pavements
Olivia Elgazar, Project Manager
Jack Bohl, Structures
Seba Aldhamen, Transportation

Spartan Consultants
Donny Jasurda, Environmental
Ben Champine, Geotechnical
Conrad Johnson, Hydrology
Logan McCall, Pavements
John Young, Project Manager
Alex Ploehn, Structures
Jared Arnett, Transportation

CE 495 SENIOR DESIGN IN CIVIL & ENVIRONMENTAL ENGINEERING

PROFESSIONAL SEMINAR SPEAKERS

Michele Buckler, P.E.
Diamler Automotive Group

Craig Dashner, P.E.
OHM Advisors

Brad Ewart, P.E.
Soil & Materials Engineers, Inc.

Megan Jacobs, P.E.
Soil & Materials Engineers, Inc.

Leanne Panduren, P.E.
Rowe Professional Services

Dee Parker, P.E.
Michigan Department of Transportation

James Ranger, P.E.
Michigan Department of Transportation

Robert Rayl, P.E.
RS Engineering LLC

Chuck Rolfe, P.E.
OHM Advisors

Miranda Spare, P.E.
Michigan Department of Transportation

Roy Townsend, P.E.
Washtenaw County Parks and Recreation

PROFESSIONAL EVALUATORS

Engineers and scientists associated with the following firms, municipalities, and companies donated time to provide students with a practicing professional's perspective. We gratefully acknowledge their generous contributions.

Sam Baushke, P.E.
Geosyntec

Casey Bonner, P.E.
HNTB

Michele Buckler, P.E.
Diamler Automotive Group

Ryan Butler, P.E.
Consumers Energy

Dan Christian, P.E.
Tetra Tech MPS

Jim Corsiglia, P.E., S.E.
Carnaghi Structural Consulting

Brian Davies, P.E.
Hubbell, Roth & Clark

Tyler Dawson, Ph.D., P.E.
NTH Consultants

Jordan Doddie, P.E.
HNTB

Max Drenth, P.E.
Harley Ellis Devereaux

Mike Ellis, P.E.
Barr Engineering Co.

Jayson Graves, P.E.
Soil & Materials Engineers, Inc.

David Hayden, P.E.
DLZ

Jared Heinze
Hardesty and Hanover

Pete Johnson, P.E.
RS Engineering

Al Kaltenthaler, P.E., S.E.
C2AE

Peter Margules, P.E.
NTH Consultants

Cole Moody, P.E.
HTNB

Jon O'Brock, P.E.
Materials Testing Consultants

Alex Oosterhoff, P.E.
RS Engineering

Sarah Ross, P.E.
Practical Engineers, Inc.

Emily Schlanderer, P.E.
Black and Veatch

Brandon Simon, P.E.
Progressive AE

Stephen Subu, P.E.
Consumers Energy

Michael Thelen, P.E.
Consumers Energy

Roy Townsend, P.E.
Washtenaw County Parks and Recreation

Brandon Williams, P.E.
Spicer Group

Design Day Awards Fall 2022

Rolla C. Carpenter Senior Design Award

The Rolla C. Carpenter Senior Design Award ($700 and medallions) is presented to the best team as judged by the faculty and a panel of practicing engineers.

Rolla C. Carpenter, Renaissance Engineer, was a graduate of The State Agricultural College in 1873 with a Bachelor of Science degree. After earning a Master of Science Civil Engineering, he was appointed professor of the Department of Mathematics and Civil Engineering at The State Agricultural College, which would later become MSU. He designed bridges, built ice houses, taught students French, astronomy, mathematics, mechanical drawing, hydrostatics, hydraulics, survey, and civil engineering. He prepared the design and working drawings for the Farm Lane Bridge, laid a water supply pipe to Williams and Wells Halls, and designed a pile driver for a dam built across the Red Cedar River. He later designed several buildings on campus, including the Mechanical Building, which was constructed in 1885. Throughout all of his work on campus, he involved students throughout the analysis, design and construction, forming what was essentially the first senior capstone design class.

BARR FTC&H

The faculty and students of the Department of Civil and Environmental Engineering gratefully acknowledge the generous contributions from Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) and Barr Engineering Co.

Rolla C. Carpenter Senior Design Award Winners, Fall 2022

Team 5: C+E Engineering Group

Left to Right: Molly Hojnacki, Natalie Fylak, Jordan Pack, Austin Affer, Nicole Villarreal
Not pictured: Yipeng Chen


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ChE Process Design and Optimization

Dr. Mark Worden
Class Instructor and Professor
of Chemical Engineering and
Biomedical Engineering

Sankha Basu
Ph.D. Student and
Teaching Assistant of
Chemical Engineering

Course Description

The Chemical Engineering Program's capstone design sequence includes Process Design and Optimization I and II (433 and 434, respectively). In these courses, students integrate content from earlier courses to complete complex, open-ended design assignments. As the students progress through CHE 433, their assignments require increasingly more effort, initiative, knowledge and individual responsibility. In CHE 434, students typically design an entire commercial-scale chemical plant and use detailed economic analyses to optimize the plant's profitability.

For over 50 successive years, MSU's CHE 434 students have worked intensively one to two months solving the annual American Institute of Chemical Engineering (AIChE) Student Design Competition problem. CHE 434 uses these realistic, industry-based problems to enhance chemical engineering students' capstone design experience for three reasons: 1) the AIChE problems provide real-world, open-ended design experiences typical of what students are likely to face after graduation; 2) the AIChE problems require students to do self-directed, active learning, including project-specific research, to solve the problem; and 3) the AIChE problems serve as a national benchmark for MSU's chemical engineering students to demonstrate excellence in their professional skills.

As the Chemical Engineering program's contribution to Design Day, several CHE 434 students typically present posters describing their solutions to the current year's AIChE Student Design Competition problem. Names and pictures of this year's presenters are provided at the end of this article.

Closing Critical Gaps to Enable a Circular Economy of Plastics

This year's AIChE Student Design Competition problem is a complex, real-world one that requires collaboration of engineers, businesses, and governments: how to cost-effectively produce high-quality, new plastic products from recycled plastic products. The two-step chemical process involves (1) breaking down the polymers composing the recycled plastics into small molecular building blocks, and then (2) assembling the molecular building blocks into new, virgin plastics that can be shaped to form new commercial products.

This "Circular Economy of Plastics" approach has multiple dimensions of societal value. First, it addresses environmental problems associated with disposal of used plastic products. Second, it generates a diverse mix of valuable products, including new, virgin plastics and an array of oils that would otherwise have to be produced from petroleum.

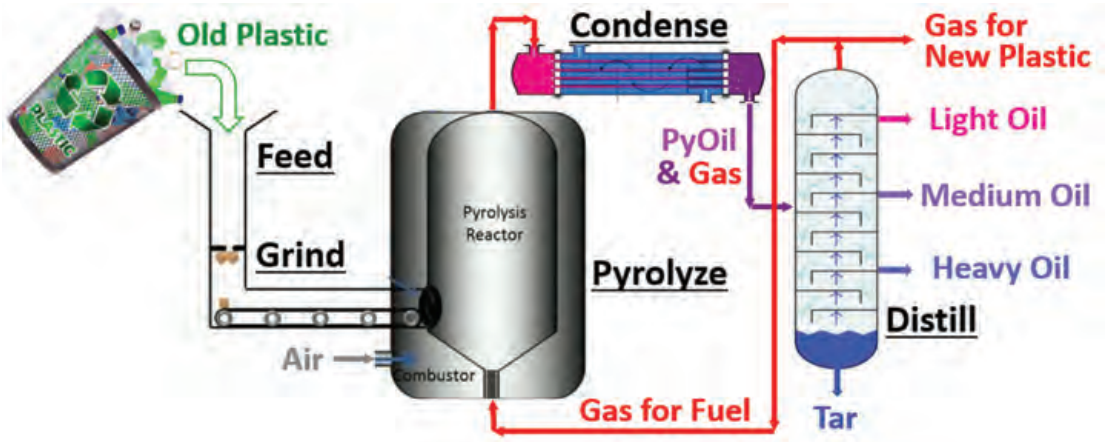
The process flowsheet for this year's AIChE problem is shown in Figure 1. First, old plastic products are collected and ground into small pieces. The ground plastics are fed to a pyrolysis reactor that heats them to a temperature that gasifies the plastics by breaking down the large polymer molecules that compose the plastic into a pyrolysis gas that contains a diverse mixture of smaller molecules. The pyrolysis gas is cooled in a condenser to form a pyrolysis oil (PyOil) and a reactive gas that can either be converted into new plastic products or burned as fuel to heat the pyrolysis reactor.

While the chemical reactions involved in this design challenge problem are not novel, the increased emphasis placed on producing new, virgin plastics from recycled plastics is. This problem also places an increased emphasis on having students integrate knowledge of a broad range of public health, safety, and welfare concerns, as they make informed judgments considering the impact of their engineering solutions in global, economic, environmental, and societal contexts.

CHE 434 students design a chemical plant able to meet the need specified by AIChE in a two-step process. In the first step, they perform hand calculations to estimate the performance and size of the major required pieces of industrial equipment (e.g., reactors, condensers, and distillation columns). In the second step, they refine their estimates of equipment size and performance using a commercial computer-aided-design (CAD) program (e.g., ASPEN) that is able to efficiently solve large systems of equations simultaneously.

Once students have developed a detailed CAD-based simulation of the production plant, they optimize the plant's profitability using detailed economic calculations that account for changes in the value of money over time (inflation). The resulting discounted cashflow rate-of-return value calculated for the optimized process would be used by a company to assess whether to make a large investment in the designed production plant.

Process Flowsheet for 2022-2023 AIChE Student Design Competition Problem



After completing their designs, CHE 434 students submit professional-quality written reports up to 50 pages long. These reports include details of the manufacturing plant's equipment, operating conditions, personnel needs, capital investment, fixed costs, capital costs, and a detailed economic analysis. The reports are graded based on both their technical quality and their communication effectiveness. Because decisions on major capital investments (e.g., building a new production plant) are made by stakeholders having diverse academic backgrounds, the reports are expected to be understandable by a wide range of audiences.

Student Poster Presenters on Design Day

The nature of Chemical Engineering students' capstone design experience does not lend itself well to small-scale, hands-on models that are convenient for Design Day demonstrations. For that reason, Chemical Engineering seniors' contribution to Design Day consists of presenting a lay-level poster of their design solution to the AIChE Design Competition problem and discussing with prospective students, current students, parents, and others the nature and advantages of careers in Chemical Engineering.

Two-person Team Solution Poster Presenters at the AiChE Student Design Competition this year

Madison Melby and Harrison Ameel

James VanAntwerp and Ben Laubach

Camden Mills and Rana Elladki

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As part of the Renaissance Health Service Corporation family of companies, Roosevelt Innovations offers the support of an enterprise with the nimbleness of a start-up. We empower individuals to embrace an entrepreneurial mindset in their role and their career. Everyone's efforts shape the direction and impact the success of the company.

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Employees and interns have opportunities to work with customers and business resources to identify problems and propose unique solutions. Not only is innovation encouraged but is one of our seven core values. The success of the company depends on the successes of each individual. Together, we make Roosevelt Innovations better every day.

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At the heart of Roosevelt Innovation's success are our people. We offer established career paths that lead transparently from entry-level to senior leadership. Our leaders of tomorrow are the people we hire today.

Learn more about our career and internship opportunities at **rooseveltsolutions.com/careers**.

The Capstone Projects

Dr. Martin Crimp
Professor of Chemical Engineering and Materials Science

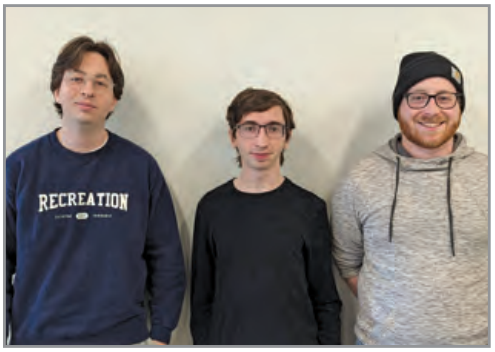
Tyler Johnson
Graduate Teaching Assistant

Course Description

MSE 466 is a senior level course for Materials Science & Engineering majors, providing students with a team-based capstone design experience. A major aspect of this course is to have students apply their course-learned background knowledge and skills in materials science and other disciplines to real-life design problems. A failure analysis investigation (FAI) fits this context. Failures are a major motivating factor for promoting more innovative designs or design changes. A failure analysis investigation provides a unique platform to design and to solve real-world engineering problems via systematic engineering approaches. By focusing on a specific design failure, the student teams learn how to confront an open-ended problem that requires them to develop a strategic design plan and to execute the methodology for assessing how and why the failure occurred. The analysis is conducted using established investigative procedures and constraints for conducting failure analysis investigation. This semester, there are six 3-member teams carrying out investigations on real materials failures.

Presentation Schedule – First Floor Room 1145

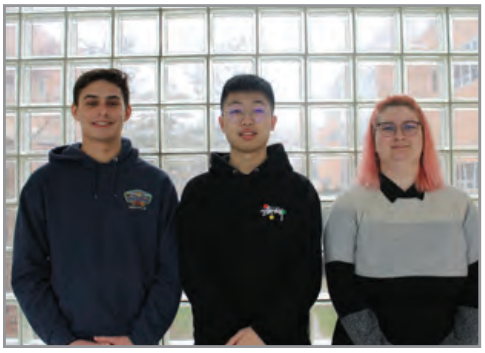
Time	Team	Project
8:30 a.m.	Break Check	Examination of a Failed Brake Pipe/Junction of a 2006 Buick Rendevous CXL
9:00 a.m.	Optical Zyllusion	Examining the Cellulose Acetate (Zylonite) Fracture of Glass Frames
9:30 a.m.	90-Degree Dream Team	Failure Analysis of a Metal Forming Die
10:00 a.m.	The Twisters	Evaluating the Failure of a 5:1 Motor Speed Reducer
10:30 a.m.	The Spraying Squad	Deburring Water Nozzle Failure Analysis
11:00 a.m.	Kelvin and the Chipmunks	Failure Analysis of Fiber Optic Cables



(left to right) Thomas DeGrove, Martin Mastrangelo, Ryan Spitzley

Team Name: Break Check
Project Name: Examination of a Failed Brake Pipe/Junction of a 2006 Buick Rendezvous CXL
Time: 8:30 a.m.

In a hydraulic automotive braking system, foot pressure on the brake pedal is transferred to the brakes through the brake lines. This system uses brake fluid to apply pressure onto the brake calipers which in turn applies friction between the rotor and brake pads, slowing and then stopping the vehicle when the calipers clamp down on the brakes. When the brake line fails, the brake fluid cannot provide this pressure to stop the vehicle. The brake line on a 2006 Buick Rendezvous CXL experienced a rupture at the junction leading to the rear left wheel brake system. The rupture and the surrounding area were thoroughly documented, and an assortment of analysis techniques were utilized to determine the cause of the rupture. These techniques included stereomicroscopy, metallography, chemical analysis and scanning electron microscopy (SEM). The information gathered from these analysis methods revealed a better understanding of what caused the brake line to rupture.



(left to right) Scott Castor, Xiaobo Wang, Lilly Martin

Team Name: Optical Zyllusion
Project Name: Examining the Cellulose Acetate (Zylonite) Fracture of Glass Frames
Time: 9:00 a.m.

For the around 75% of the world population that wears corrective lenses, any failure in their glasses can be devastating. The price of replacing them aside, being unable to see clearly severely limits the capability of an individual with bad vision to interact with the world around them. A pair of glasses was broken by a young technician in an optometrist's office while they were attempting to fix an unrelated hinge failure. Made of cellulose acetate, also known as zylonite within the optical industry, the failure of these frames was unexpected, as the material is considered to be quite durable within the industry. To determine the cause of failure of these frames, a variety of destructive and non-destructive tests were performed by the team to gain understanding of both the characteristics of the material, and what other factors may have been in play to cause this catastrophic fracture.

(left to right) Rachel Schenck, Lindsay Reiss, Lucas Rakieten

Team Name: 90-Degree Dream Team
Project Name: Failure Analysis of a Metal Forming Die
Time: 9:30 a.m.

A progressive die at Forward Metal Craft was used to bend a thin piece of metal ninety degrees. A component of the die broke while in use on January 2, 2023. Fractures occurred in multiple locations. One fracture occurred across the body of the specimen. The other fracture occurred perpendicular to the threaded hole, which was used to attach the die to the tool head. The fractures and the adjoining areas were meticulously recorded using macroscopic photos of differing angles and lighting conditions. A variety of analysis methods such as replication, stereomicroscopy, scanning electron microscopy (SEM), chemical analysis, hardness testing, finite element analysis (FEA), and metallography were employed to gain a deeper insight into the reason for failure.

MSE 466 / 8:30 a.m. - 11:30 a.m. Engineering Building, First Floor | Room 1145

(left to right) Cassidy Proctor, Jacob Grobbel, Emma Ainsworth

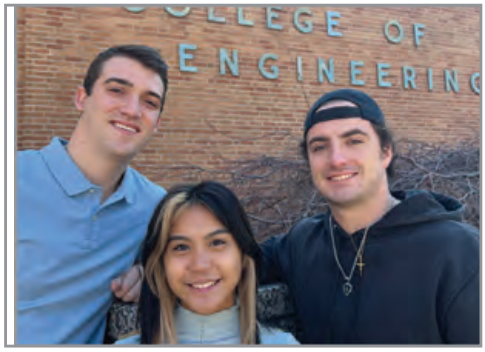
Team Name: The Twisters
Project Name: Evaluating the Failure of a 5:1 Motor Speed Reducer
Time: 10:00 a.m.

A Wittenstein NP 025 Standard 5:1 speed reducer inside a VX4000 3D sand printer, used to slow mechanical motors, was found to have failed in torsion, causing manufacturing downtime and loss of revenue. The center shaft of the speed reducer failed, resulting in a fracture. Initial inspection showed the fracture surface to be circular in cross-section, with concentric rings. It had a slightly raised center that dips down radially moving further out from the center, with a slightly raised outer edge. Cracks and relatively large pits were also seen surrounding the edge of the fracture surface. To identify what caused the failure, a variety of testing methods were used. Stereomicroscopy and scanning electron microscopy (SEM) were used to analyze the fracture surface and identify the failure mode. Chemical analysis was used to characterize the elemental makeup. Hardness testing was used to indicate the material properties while optical metallography was used to assess the microstructure. Finite element analysis (FEA) was used to assess the areas with maximum stress and displacement on the part. Comparative analysis was also performed with similarly failed parts.

(left to right) Syn Han Chua, Ryan Stahl, Amelia Hitchingham

Team Name: The Spraying Squad
Project Name: Deburring Water Nozzle Failure Analysis
Time: 10:30 a.m.

A failed water nozzle used in an industrial deburring machine was selected for further study. Pressurized water was pumped through the nozzle in order to remove burrs from machined aluminum parts during regular operation. This particular nozzle design was known to fail frequently and was subject to past concerns due to its relatively high price. Little was initially known about the part and an investigation into the composition, the stress state at the time of failure, and the design of the part was in order. The team tasked with the failure analysis of the nozzle, conducted scanning electron microscopy (SEM) and chemical analysis, among other tests, to determine the root cause of the failure in question.



(left to right) Seth Bacon, Lizette Mina, Seth Ramonaitus

Team Name: Kelvin & The Chipmunks
Project Name: Failure Analysis of Fiber Optic Cables
Time: 11:00 a.m.

Fiber optic glass has revolutionized internet speed and reliability over the course of the last 30 years. Following the two hottest weeks of the 2022 Michigan summer, Verizon Wireless and Sparrow Hospital reported network outages. Further investigation revealed catastrophic damage to 12 fibers and further damage to the entire 144-count fiber optic cable as well as evidence of possible animal tampering. After initially documenting the fracture surfaces using photography and optical microscopy, the fracture surfaces and surrounding area of the fiber optic cables were thoroughly analyzed using various analysis techniques, including tensile testing, three-point bending test, chemical analysis, and scanning electron microscopy (SEM). Details surrounding the fracture of the fiber optic cable revealed a more finalized explanation of what led to the fracture.

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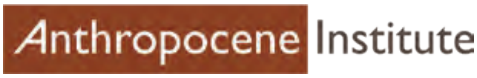

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San Jose, California

Benton Harbor, Michigan

The Capstone Projects

Dr. Wayne Dyksen
Professor of Computer Science and Engineering

James Mariani
Professor of Instruction

Tommy Hojnicki

Griffin Klevering

Luke Sperling

GRADUATE TEACHING ASSISTANTS

CSE 498 Collaborative Design

CSE 498, Collaborative Design, provides the educational capstone for all students majoring in computer science. Teams of students build software systems for a variety of clients.

During the capstone experience, students

- design, develop, debug, document, and deliver a comprehensive software system,
- work in a team environment,
- become proficient with software development tools and environments,
- develop written and oral communication skills,
- build and administer computer systems, and
- consider issues of professionalism and ethics.

Our clients are local, regional, and national including Ally Financial, Amazon, Anthropocene Institute, Auto-Owners Insurance, Bosch, Dow, Evolutio, Ford Motor Company, General Motors, Google, Kellogg's, Kohl's, Lockheed Martin Space, Magna, Meijer, Microsoft, Moii, Mozilla, MSU Federal Credit Union, Roosevelt Innovations, RPM, Stryker, TechSmith, Union Pacific, United Airlines, Urban Science, Vectorform, Vectra, Volkswagen, and Whirlpool.

Ally Financial
Ally Offers Ecosystem

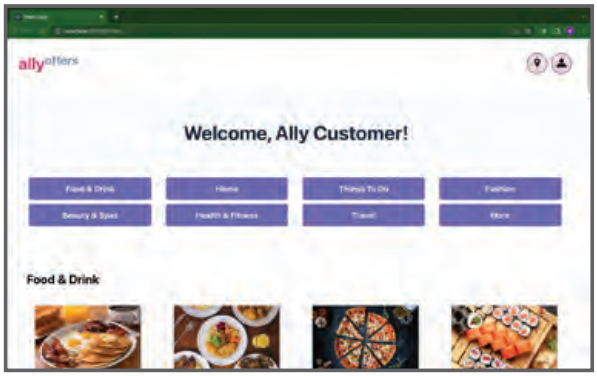
Headquartered in Detroit, Michigan, Ally is a top 25 financial holding company in the United States and a leader in digital financial services. Ally provides financial products for consumers, businesses, automotive dealers, and corporate clients in their commitment to digitalizing and innovating a seamless customer experience. As their name implies, Ally is committed to being an ally to their small business customers.

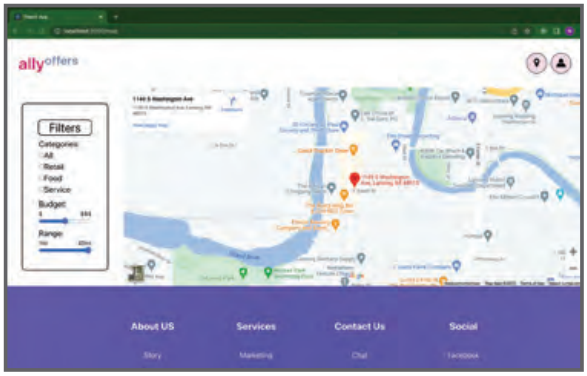
Ally customers and small businesses use our web application, Ally Offers Ecosystem, to help communities thrive and stay vibrant. Small businesses are often unable to gain traffic in their stores, as well as advertise themselves to a larger audience due to inexperience with technology or lack of a digital platform. Our Ally Offers Ecosystem helps small businesses reach a much broader audience, which in turn, benefits Ally customers too.

The platform gives access to businesses to register and upload their offers on a personalized dashboard. These offers are available to and accessible by all of Ally's customers. A business can access a personalized dashboard with analytics displaying their performance. Depending on the success of their deals, they can upload, edit, or delete any ongoing offers they would like to advertise to their customers.

Ally customers access a separate dashboard with a multitude of categories of offers to choose from, as well as save their coupons on their profile. Customers can set filters to personalize their interests, which are reflected in a map view of nearby offers. This shows Ally customers appropriate deals and ways to save when visiting businesses partnered with Ally.

Our application is written in HTML, CSS and JavaScript and is powered by the React framework. Our web app interacts with MongoDB and Express to connect to AWS and offers machine learning capabilities.





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Arvy Rajasekaran
Charlotte, North Carolina

Kevin Werner
Charlotte, North Carolina

Amazon
Amazon Group Buying Tool

Amazon is a multinational technology company that has grown to become the world's largest online retailer. Founded in 1994 by Jeff Bezos, Amazon has since expanded into various industries, including cloud computing, digital streaming, and artificial intelligence.

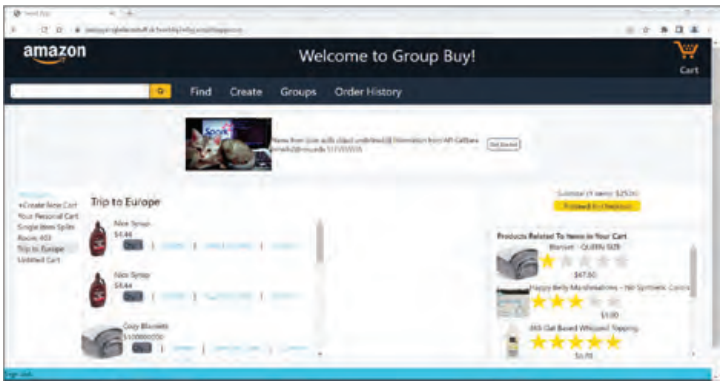
By practicing customer obsession, Amazon delivers products that bring joy and utility to their customers. The company provides shoppers with an intuitive purchasing experience, enabling items to be added to a customer's cart quickly and seamlessly. Amazon is consistently thinking about different features to enhance their product purchasing process. Currently, customers must utilize third-party services to share expenses, without a way to do so on the Amazon retail website.

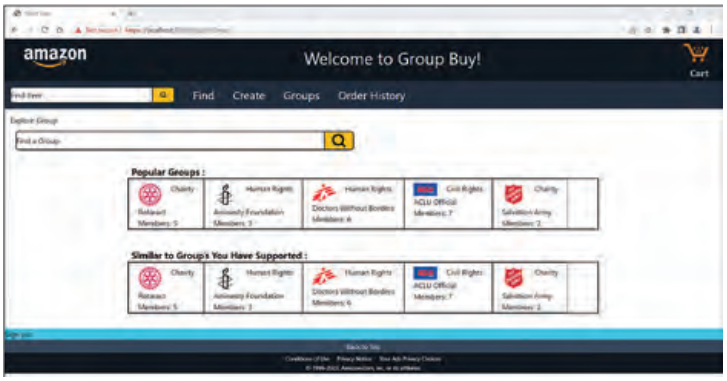
Our Amazon Group Buying Tool enhances the shopping experience by enabling users to form groups, initiate purchases with other customers, and share costs among group members. The tool also helps users to search for products and receive product recommendations based on group information and products in their cart.

Our software significantly reduces the time needed to buy items in collaboration with other customers. It also simplifies the process of purchasing items that may be challenging to afford individually, leading to an increase in sales.

The tool also makes donating to organizations easier than ever by giving users a simple method to find and contribute to group wallets. Overall, our tool provides value to a wide variety of people.

The web application is responsive and scalable due to a robust set of Amazon Web Services. The front end is hosted on AWS Amplify and back-end requests are swiftly handled by API Gateway, Lambda, and DynamoDB. Product recommendations are managed by AWS Comprehend.





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Tejas Bharath
Detroit, Michigan

Garret Gaw
Detroit, Michigan

Derek Gebhard
Detroit, Michigan

Varun Mantri
Detroit, Michigan

Mitchell Morrell
Detroit, Michigan

Anthropocene Institute
Machine Learning for Numeracy Training

The Anthropocene Institute is an organization that supports researchers, universities, and start-ups in a quest to advance necessary technologies for a better future. Their focus is currently on alleviating the current climate crisis.

In the modern day, critical thinking about numbers is a required skill for success. Being able to make quick, informed judgments with numbers is vital. Topics like government spending, bills, investing, and many more require this skill. However, many people today are currently lacking these abilities.

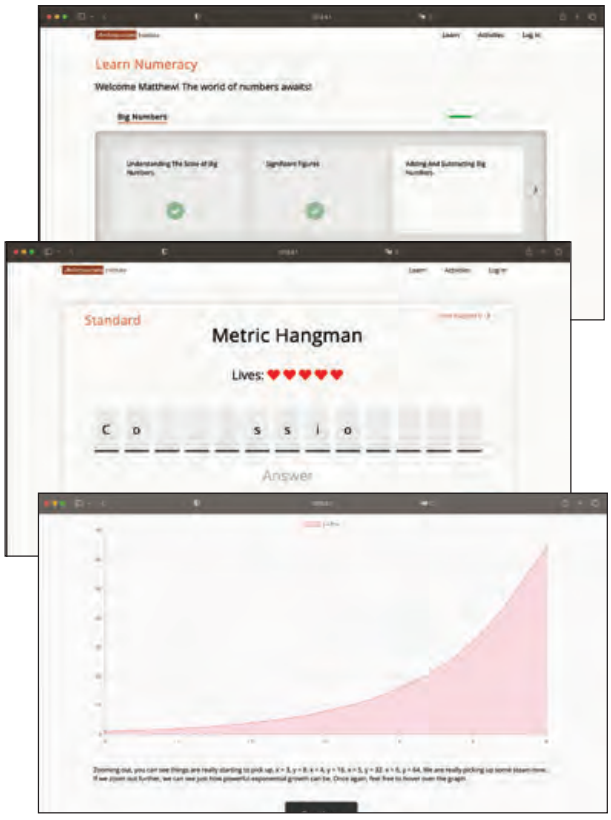
Our Machine Learning for Numeracy Training software alleviates this issue by educating the public about numeracy with an easy-to-use website that both teaches and challenges users.

The first component of our software is the instructional content, composed of three modules: big numbers, scientific notation, and units of measurement.

Each module holds a set of lessons. These lessons contain text, graphics, and questions that users interact with to master the topics. The user's progress is saved and viewable from the learn page indicated by progress bars. The user can interact with an AI chatbot for assistance at any time during their learning process.

The second component of our software is the activities. There are two main games offered: metric hangman, and estimates. Metric hangman is a classic game of hangman; however, users input metric prefixes as their guesses, either the literal prefixes or their numerical value. Estimates is a guessing game in which users are prompted with quick questions to answer about a range of topics. Their answers are graded on both speed and accuracy.

The front end of our software is written in HTML and JavaScript. The back end is composed of a mySQL database and Flask for storing and rendering content for games and user information. The software utilizes OpenAI's GPT-3 API to support the chatbot.



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Auto-Owners Insurance
The Summarizer

Auto-Owners Insurance is a Fortune 500 company headquartered in Lansing, Michigan. Auto-Owners is represented by 48,000 licensed insurance agents in 26 states and provides insurance to nearly 3 million policyholders.

As a major insurance agency, Auto-Owners receives thousands of feedback reports, employee surveys and branch audits. These documents provide Auto-Owners general information on how customers and employees view the company.

Currently, Auto-Owners employees manually review and extract key takeaways from these documents, a labor-intensive and time-consuming process.

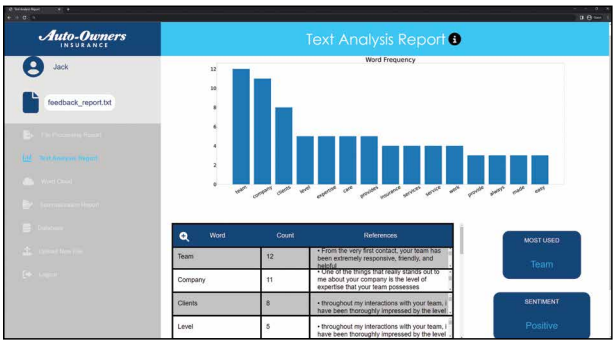
The Summarizer is a web application that reduces the time needed to review documents by quickly processing them and distilling them down to key components for the user to view.

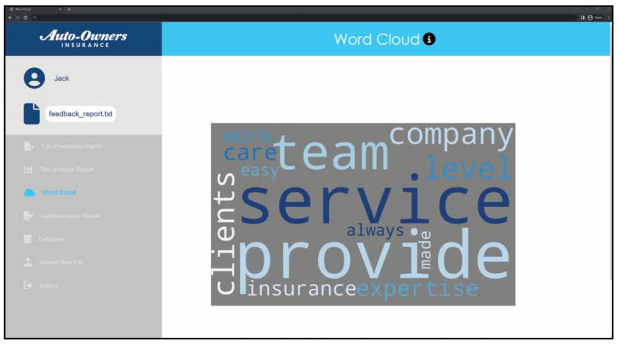
Users start by uploading a document they want summarized to the web application. Our software then processes the document and displays key metrics such as word frequencies, the overall sentiment of the document, as well as a document summary.

The metrics are displayed in a visually intuitive interface which includes tables, graphs and a word cloud. Users can click between tabs to view the different aspects of the summary report. Administrators can also view summary reports from previously uploaded documents.

Our software cuts down on the time Auto-Owners' employees spend to understand the feedback they receive and gives them more time to act on it. This gives Auto-Owners the ability to make quick and effective changes so they can continue to deliver excellent service and quality products to their customers.

Our front end of the application is built with HTML, CSS and JavaScript, while the back end is implemented with Python Flask. The data for the application is stored in an SQLite database.





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Bosch
Web Interface for CarMaker Simulation Tool

Bosch, founded by Robert Bosch, is a German multinational engineering and technology company headquartered in Gerlingen, Germany. Bosch is a leading global supplier of automotive technology and services, having more than 100 locations all over the world.

Bosch is a world leader in developing solutions for autonomous vehicles, and is on the forefront of creating, prototyping, and testing both hardware and software for these vehicles. Bosch utilizes the CarMaker simulation software to run complex simulations to test autonomous vehicles. However, CarMaker must be run on specialized workstations not present in every office, making it difficult for Bosch staff to use CarMaker on the fly.

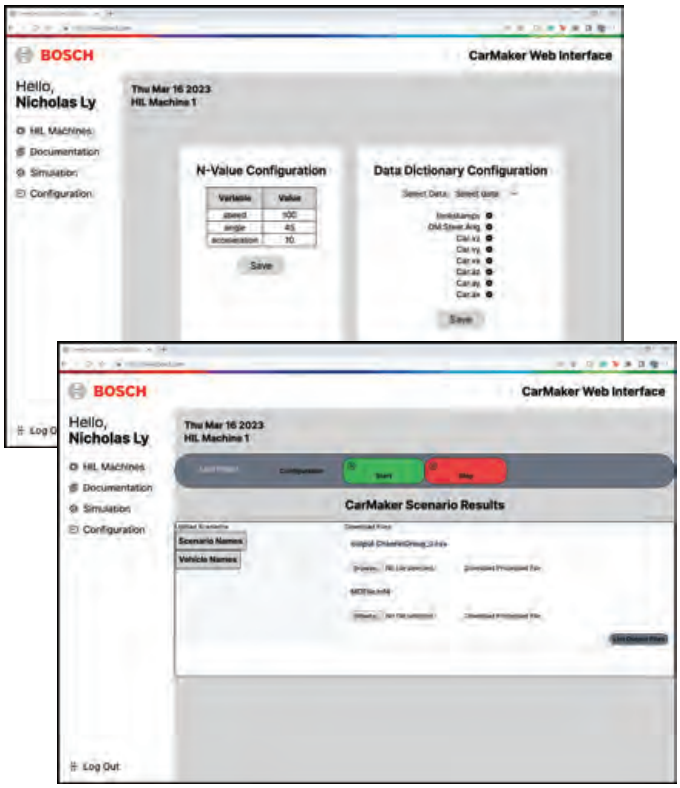
Our Web Interface for CarMaker Simulation Tool provides an easier, more efficient way for Bosch engineers to communicate with CarMaker simulators to load, run, and view the results of their simulation without ever having to touch a physical computer or install any software.

Bosch engineers have the ability to load scenarios and vehicle models, change parameters in the scenarios, start and stop simulations, view the simulation status, and download simulation results remotely, utilizing an easy-to-use web application.

Users can select the specific machine they want their simulations to run on, giving the maximum amount of control to engineers so they may further fine tune tests.

Through this application, Bosch engineers can utilize our web application to provide safer and more secure autonomous vehicles in the future.

Our web application is built using SvelteKit, Tailwind CSS, and SQLite. The web application interacts with each of Bosch's HIL machines through their own instance of a Flask REST API, allowing for control over the CarMaker simulation through HTTP requests.



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DRIVEN-4
Driven Connect Application, Server, and Backend

DRIVEN-4, recently founded in 2016 and headquartered in Saint Joseph, Michigan, provides industry-specific expertise and technological solutions to clients in the areas of Product Lifecycle Management (PLM), connected product development (IoT), connected operations (IIoT), cloud services, and cybersecurity.

Currently, DRIVEN-4 utilizes two core technologies for connected product development and operations: PTC's ThingWorx and Digi's Remote Manager. Together, they provide decentralized management and monitoring of remote devices. Users connect their devices to the Internet, monitor device health and storage, manage device firmware, download data from devices, and perform data analytics and visualizations.

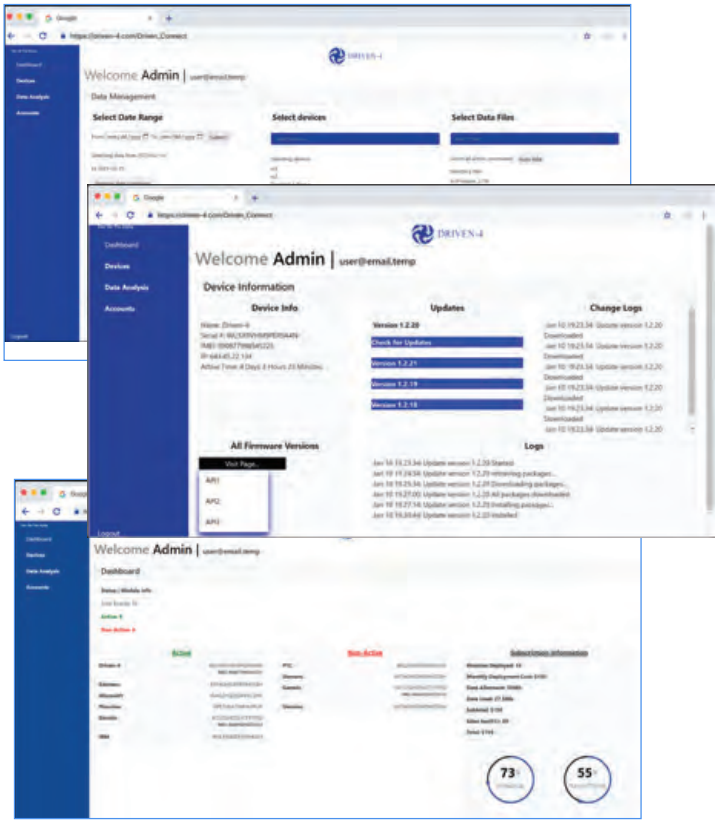
As DRIVEN-4 scales up in size, they are developing their own IoT Driven Connect Board that collects data from the device's sensors. Hosting, interacting with, and storing data from these new boards require a robust and cost-effective solution.

Our Driven Connect Application, Server, and Backend tool solves this issue with a single, streamlined web application. Registered users of an organization connect with their devices over the Internet where they can view and download device data. Users can perform custom data analytics and visualizations on collected data.

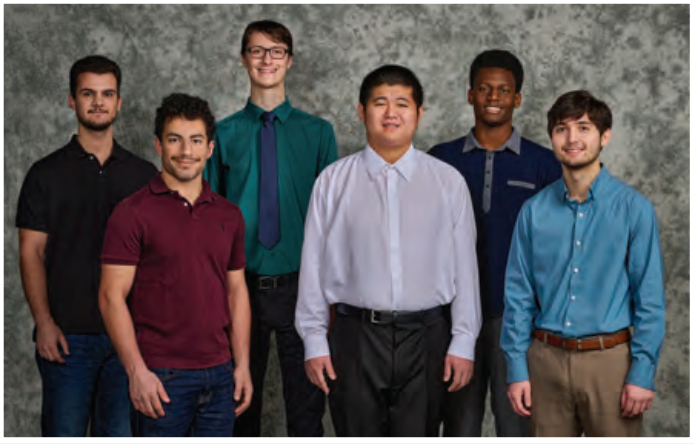
Within an organization, administrative accounts manage their users and boards. This includes adding new users, along with updating existing users' settings, and pushing mass firmware upgrades or downgrades, to any selected boards.

Lastly, DRIVEN-4 server administrators manage all organizations' users and admins, implement system level settings on devices, push firmware and enable/disable devices.

Our application is built using Python Flask, MySQL databases, and an FTP server for over-the-air firmware updates.



DRIVEN-4



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Evolutio
#BIKES4ERP Tracking

Evolutio, based in Chicago, brings visibility, simplicity, and usability to complex enterprise platforms. Evolutio and its parent company EPI-USE, are part of the groupelephant.com nonprofit. One part of this nonprofit, #BIKES4ERP, donates bicycles to rural children, mobilizing them to realize their dreams at school.

Unfortunately, there have been cases of these bikes being lost or stolen, with minimal chances of recovery.

Our #BIKES4ERP Tracking tool solves this issue by providing live tracking and alerts for the statuses of bikes through an intuitive web application.

In our tool, admins can add bikes and users of any lower-tiered role to the system. Once added to the system, a bike icon appears on the map on the home page with the color denoting its status.

Teachers with bikes assigned to them by an admin can add a student and pair them with their bike via the system page.

The status of a bike can be updated either automatically or manually. The system marks a bike as possibly stolen if it detects suspicious activity, such as traveling at a high speed or going offline for too long. The status remains as such until manually reverted. All users can make manual status updates to bikes determined by their role. Admins and mechanics can update the status of all bikes in the system, while students and teachers can only change the status of a bike assigned to them.

When a bike is marked as stolen, the assigned teacher and student receive a notification via email and text. The teacher, student, mechanics, and admins are all informed through an alert on the alerts page.

Our system uses TypeScript-based ReactJS for the web page proper. Data communications are received and processed using Amazon Web Services (AWS). The Harness CI/CD software delivery service keeps our system updated.

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General Motors
Virtual Reality Network Monitoring

General Motors (GM) is a global automotive company with an extensive network infrastructure that facilitates communication between its various facilities worldwide. They are the top automaker in the United States.

Managing GM data centers effectively can be challenging due to the size and complexity of their computer network, requiring many systems and analysts to manage.

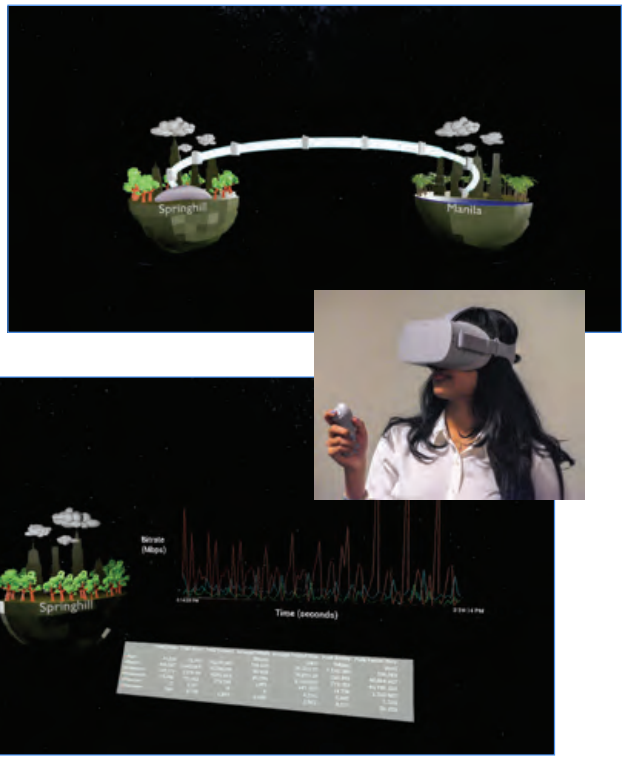
Our Virtual Reality Network Monitoring tool enables GM employees to monitor their global enterprise network's physical, logical, and digital traffic flows from anywhere in the world. Our tool provides a more interactive and holistic experience, giving users a better understanding of how data moves within the GM network. With our tool, users can quickly identify infrastructure errors and easily diagnose them.

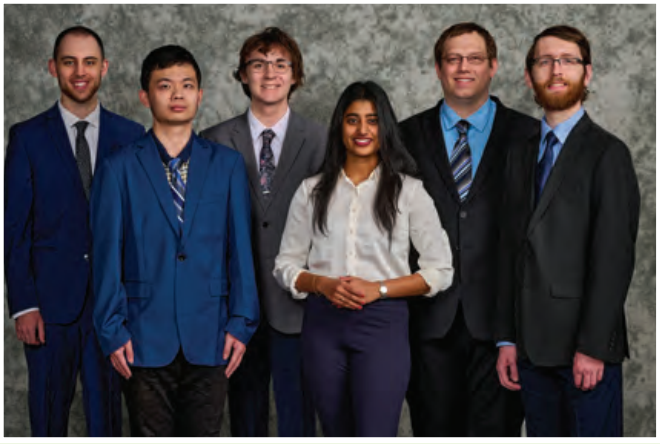
Our application facilitates user interaction with any GM data center and monitoring of its traffic with three-dimensional virtual visualizations. The tool enables users to select data sites they want to monitor from a menu option, view detailed information about a connection, such as circuits, IP addresses, and packets moving between them, and diagnose issues more comprehensively.

Users can pause the scene, select each individual packet to get more information, and even modify the display brightness, text size, and background color. The experience of using our tool leads to quicker and better network management for GM.

Our application is built on Unreal Engine 5, which processes and displays the data and environment with which the user interacts. Our tool includes the use of both UE5 and C++ for data processing and rendering.

MySQL is used for packet information storage, and WireShark is used to read the packet capture data file, enabling easy exporting of data into various formats.





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General Motors
Application Lifecycle Framework

General Motors is an American automotive manufacturing company headquartered in Detroit, Michigan, and is the top automaker in the United States.

Application distribution is vital at General Motors given the diverse set of engineering and design applications needed during manufacturing. This distribution process is handled in a secure and efficient manner by an Application Lifecycle Framework.

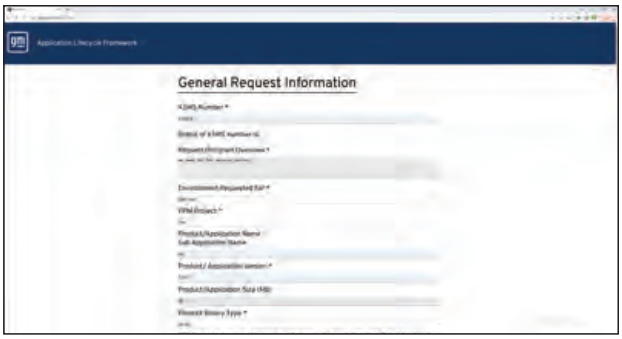
Unfortunately, General Motors' current application distribution solution is expiring, which necessitates the move to a new solution. The new solution replicates the functionality of the old application but also improves upon the existing process.

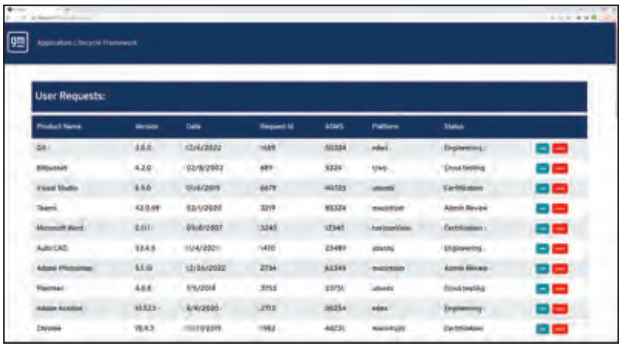
Our Application Lifecycle Framework facilitates easy request-submission for applications as well as providing a central hub for status information. It gives administrators, engineers, and testers fine-grained control during the distribution process.

When an employee needs an application on a company device for a work-related task, they submit a request to start the approval process. After submission, an administrator approves or denies the request before assigning a priority as well as an engineer for the next step. Finally, the engineer coordinates with cross-testers and distributors to complete the process. To keep all stakeholders updated, each stage of the process generates a notification.

Our web application features an easy-to-navigate user interface for non-technical personnel as well as an intuitive email notification system to keep users updated at every step of the process. This increases transparency and clarity, reducing internal errors.

For the front end, our application uses Angular, HTML, and CSS. Our system uses a MariaDB server running on Ubuntu for the back end. To communicate between the back end and front end, our application uses Tomcat with Spring Boot to serve HTTP endpoints.





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Kellogg's
GHG Scope 3 Automation

Kellogg's is a Fortune 500 company that operates both domestically and in over 180 international markets. They are most famous for their cereal and snack brands, such as Cheez-It®, Pop-Tarts®, Froot Loops® and Frosted Flakes®.

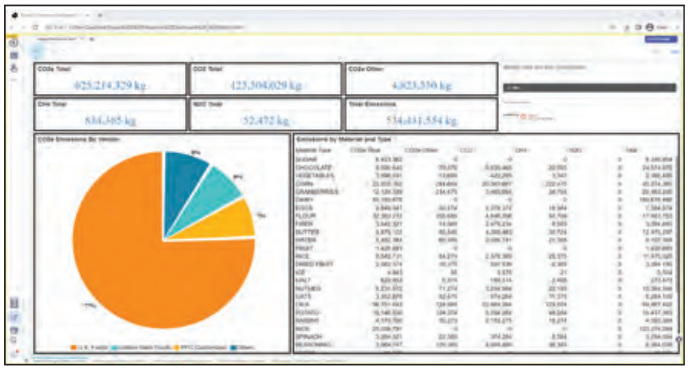
Kellogg's is committed to people and their well-being through their Better Days Promise initiative. Kellogg's plans to reduce 45% of scope 1 and 2 greenhouse gas (GHG) emissions and 15% of scope 3 emissions by 2030. Scope 3 emissions are value chain emissions that include processing of sold products, business travel, waste generated in operations, end-of-life treatment of sold products, etc.

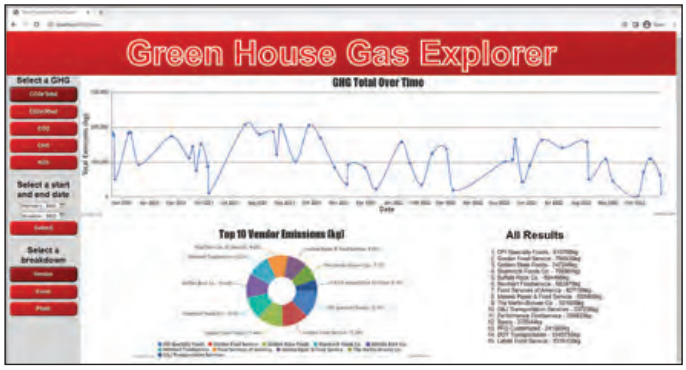
To accomplish their emissions reduction goals, Kellogg's uses an external agency for which GHG scope 3 data must be collected and analyzed manually due to their complexity. Automating the calculation and creation of easily understood visuals reduces labor costs and reliance on external assessors.

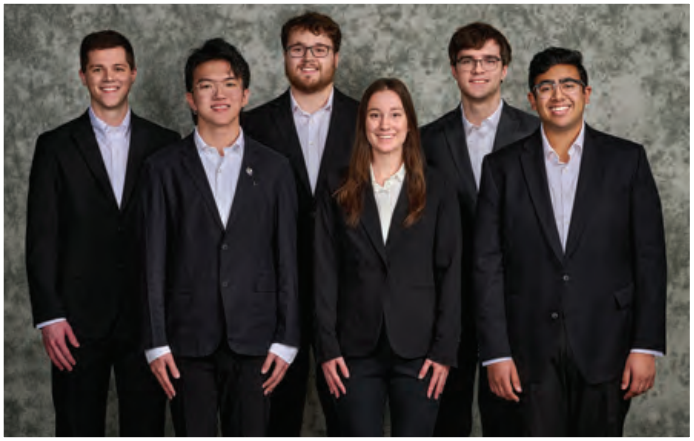
Our GHG Scope 3 Automation tool presents relevant GHG emissions data in the form of charts and graphs in a visually intuitive dashboard accessible by Kellogg's employees. Kellogg's employees directly interact with the dashboard to view and analyze the effects of different food products, factories, and vendors. In addition to the dashboard, the GHG Scope 3 Automation website provides users insight on process metrics such as kilograms of greenhouse gas emissions, what ingredients are causing the emissions, and the gases that comprise the emissions.

Our tool helps Kellogg's automate a process, leading to significant savings in both time and money.

The GHG automation process takes place in the Celonis machine learning workbench. A Python script runs within the Jupyter Notebook to perform calculations and store them. The Flask back end of our website connects to a SQL database with the calculated data. Our JavaScript front end visualizes all of the data.







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Lockheed Martin Space
SmartSat™ Software Development Kit & AI Platform

Lockheed Martin Space is a division of Lockheed Martin headquartered in Littleton, Colorado that employs over 16,000 people to build satellite systems and spacecraft.

Satellite operation is being fundamentally reshaped by SmartSat™, a software-defined satellite architecture developed by Lockheed Martin Space that enables the reprogramming of satellites while in orbit. SmartSat™ also facilitates the use of artificial intelligence onboard satellites to analyze and make decisions from collected data, such as overhead imagery and spacecraft telemetry.

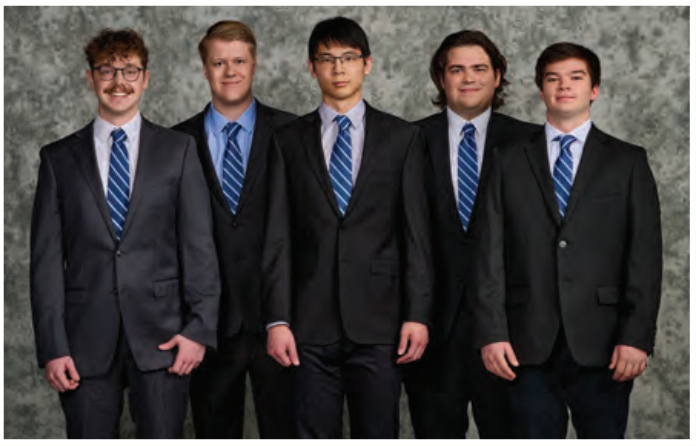
Software development for SmartSat™ is done via software development kits (SDKs) provided by Lockheed Martin Space. Each SDK is a collection of several different development tools that interact with each other. As the variety of hardware supported by SmartSat™ grows, managing the rising number of SDKs becomes cumbersome.

Our SmartSat™ Software Development Kit Manager provides a straightforward way to view, install, modify and publish SDKs for SmartSat™.

The application displays relevant available SDKs based on the development system and target satellite, as well as currently installed SDKs, in a separate table. Users select an SDK listing to inspect the contents of an SDK or manage its installation status. System administrators publish new, either built from scratch or updated from an existing version, SDKs for download.

Our system's main component is a command-line utility written in Python Flask that communicates with a MySQL server to store and retrieve SDKs. The front end is a desktop application powered by Electron and written in JavaScript. Onboard an AMD V1000 series APU, inferencing is powered by ONNX Runtime using AMD ROCm for hardware acceleration.

LOCKHEED MARTIN



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Magna
Dashboard for Data Visualization

Magna International Inc. is a worldwide automotive supplier headquartered in Canada, with their U.S. headquarters in Troy, Michigan. They have been ranked in the Fortune Global 500 for 20 years straight. Magna is the largest automotive parts manufacturer in Canada, and 4th largest in the world.

One of Magna's goals is reducing last-mile delivery-related emissions in large cities. To this end, they are piloting a program that operates an all-electric fleet of autonomous delivery robots.

Each bot generates countless data points that provide insight into delivery efficiency. Through trip data, Magna can efficiently track fleet performance and make any adjustments that will improve the efficiency of their autonomous delivery fleet.

Our Dashboard for Data Visualization provides a web app for Magna employees to track autonomous delivery data in real time.

Graphs and charts are a vital asset for being able to visualize the information from trips. Within these graphs, employees see various metrics such as battery consumption, distance traveled, trip time, average speed, emergency stop information and more.

All visualizations are updated dynamically as new data is added with respect to the database, providing Magna employees with up-to-date information for analysis of the fleet's performance.

Using our tool, Magna ensures they are reducing emissions while still providing flawless service to their employees and customers.

Magna stores data in an Amazon Web Service (AWS) storage solution. The data is cleaned with custom AWS Lambdas and delivered to Amazon DynamoDB and then QuickSight. The visualizations created in QuickSight are rendered to Magna's internal LMDD website using the Vue.js framework.

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Meijer
Organization Efficiencies Utilizing WiFi Locationing

Meijer is an all-in-one retailer with over 265 locations throughout six midwestern states. Meijer is constantly increasing the efficiency and flow of their stores to improve their offerings and services, and in turn improve customer satisfaction.

One of these systems is Mobile Shop & Scan, available to all Meijer mPerks customers. Shop & Scan enables shopping in-store with the customer's phone as they place products in the physical cart. Customers may scan items to add them to the mobile cart, clip coupons and promotions, and see the immediate offering value in the Meijer Mobile application.

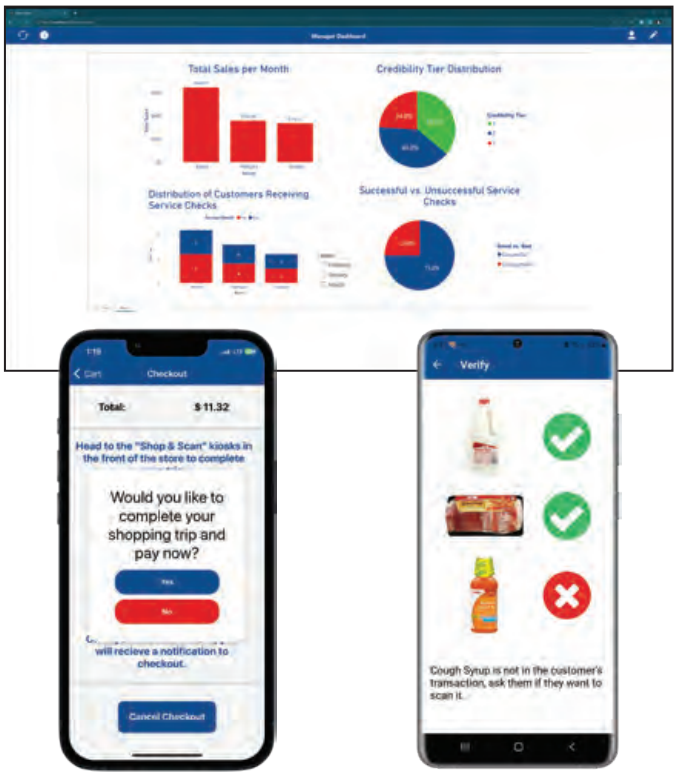
Our Organization Efficiencies Utilizing WiFi Locationing tool expands the scope of the Shop & Scan process to decrease the checkout time for shoppers. Meijer Mobile shoppers have the option to pay entirely on their mobile device without checking out traditionally.

Our software provides a dashboard that shows the manager of a Meijer location a heat map of where customers in the store are physically located, along with different metrics that can be used to make informed decisions about each employee's assignment.

Our system makes use of MIST wireless access points located throughout a store that connect to user smartphones to triangulate their location accurately. We pull live data from these access points to make predictions of customer location, as well as locations of customers who might need assistance.

If a customer requires assistance, a Meijer attendant uses our dashboard to locate the customer and perform a Service Check to help the customer quickly resolve any issues they are having.

The consumer mobile app and employee mobile app are built using React Native, while the web app is powered by ReactJS with a Microsoft Power BI dashboard. Each application uses data from an underlying Microsoft SQL database.



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Michigan State University
Improved Peer Review in CourseLib

The Michigan State University Department of Computer Science and Engineering leads several state-of-the-art graduate and undergraduate programs for more than 1,700 students. The department is committed to providing a high-quality educational experience to all of its students.

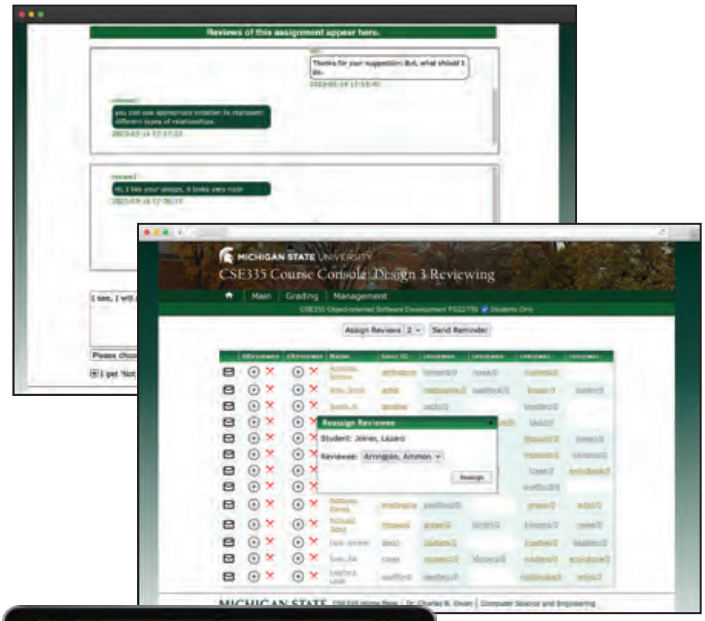
The Department of Computer Science and Engineering keeps up with growing interest by maintaining a high level of adaptability. This is achieved via CourseLib, a system of components used to create course websites. CourseLib facilitates learning through detail-oriented instruction and hands-on activities.

CourseLib's peer review system enables students to improve upon industry-valuable skills such as giving informative critiques of someone else's work, accepting feedback from others, and turning feedback into impactful improvements. The peer review system within CourseLib, while effective, has areas for improvement.

Our improvements to the CourseLib peer review system make it easier than ever for students to receive feedback on their work. Reviewers and reviewees can now have a real-time dialog with one another, making crucial communication easier than ever before.

The feedback process is enhanced through the addition of submission image annotation, allowing users to know exactly where they can make improvements. The new submission association feature makes clear which submission is being discussed. The email notification system is redesigned to effectively provide notifications in all circumstances. Instructors can now reassign individual reviewer-reviewee pairings. Finally, instructors are now notified when students submit and have not been assigned a peer review assignment.

CourseLib uses a JavaScript front end using Vue for a responsive interface and webpack for bundling. CourseLib's back end is built using PHP and SQL.



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Michigan State University
Build-an-App for Humanities Researchers

The Michigan State University Linguistics Department formed the MI Diaries team in 2020 in response to the COVID-19 pandemic. Using the MI Diaries app, the team collects and analyzes audio data to understand how people's lives and language change over time.

The MI Diaries app is an audio recording app that collects audio remotely to use in research studies. This app provides a user-friendly interface that can be used by people of all ages and technical abilities. The app collects audio data, stores it in a database, and provides basic statistics for participants.

The MI Diaries team wishes to expand the reach of their app and allow researchers from across the world to utilize its audio recording capabilities. These researchers often do not have the tools necessary to collect audio data and want to focus on their study objectives instead of the technical details of building an app.

Our Build-an-App for Humanities Researchers provides an easy way to customize the MI Diaries base app without having to touch a line of code. Researchers with minimal technical experience can produce a feature-complete and fully customized long-form audio recording app that is ready to use in their studies.

The App-Builder supports full customization of the colors, logos, and fonts, while also supporting gamification stat screens. The app can be configured to allow sign-up in-app or through an external form. While the main functionality of the app remains the same, users can create a uniquely styled app for their research.

Our solution provides an easy way for researchers to create applications tailor-made for their data collection, saving time and resources over building from scratch.

The main MI Diaries app is built using Flutter to provide a cross-platform app and can be connected to any back-end server.

The front end of our App-Builder is built using Angular 15, while the back end is implemented using Python Flask.

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Moii AI
Image Similarity System

Moii AI is a multinational MSU-born startup founded in 2019 in Troy, Michigan and Chennai, India. Moii provides real-time alerts and video feed analysis using state-of-the-art artificial intelligence technologies to increase ergonomic flow and improve home security.

Object detection requires artificial intelligence that is trained for detecting specific objects of interest. Moii currently has a system that is able to very accurately detect a limited number of objects. To expand the usability of this system, Moii is focusing on a robust system to detect many more objects at the same time.

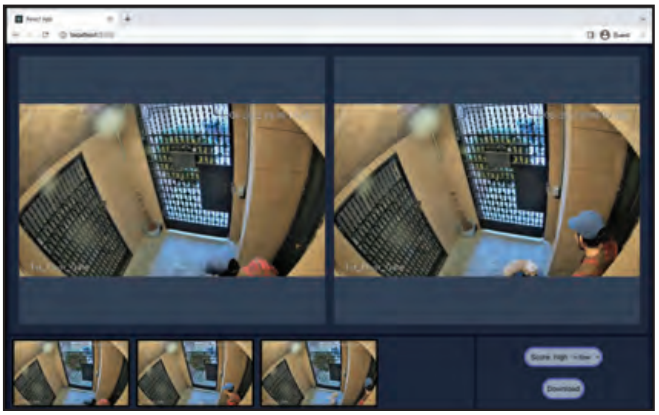
Our Image Similarity System makes searching for any type of object within Moii's expansive image database possible. A large problem is collecting enough images of a particular object to be able to detect the object reliably.

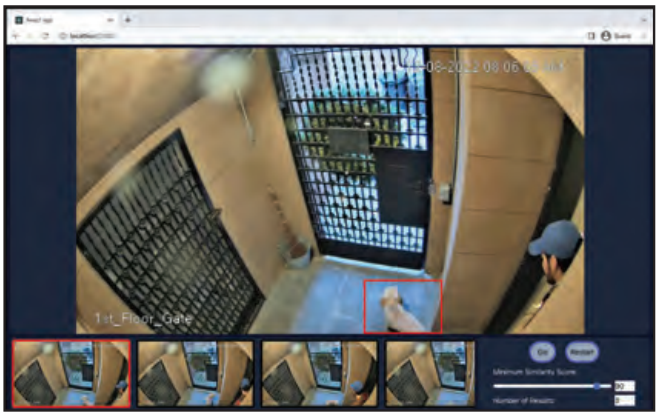
To this end, users start by uploading images and drawing boxes around the object of interest. Our software then uses machine learning to scan through hours of video footage to find images of similar objects, to provide more examples and, in turn, improve Moii's object recognition.

New images of an object are displayed on a separate page along with the original images and a score indicating how similar the found object is to the object of interest.

Using our system, Moii can quickly determine if a person or object appears in their footage with high accuracy and low cost. Using this software, Moii can more accurately inform their clients about their business and create a more secure environment.

Our system uses Google Cloud Storage to handle transfer of images, Firebase Realtime Database to sync between our front end built on React and the back end, and Google Cloud Platform to host our model. Based off a proprietary machine learning model from Moii, our PyTorch model is trained for deep template matching.





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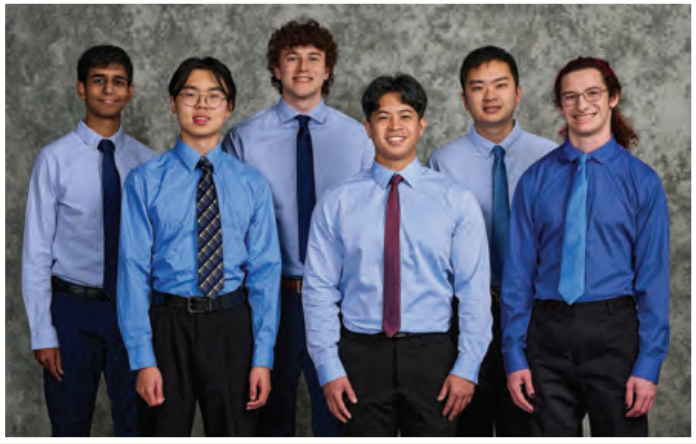

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MSU Federal Credit Union
Predictive Chatbot Experience

Established in 1937, MSU Federal Credit Union (MSUFCU) has been serving Michigan State University and the greater Lansing area for over 86 years. With over 20 branch locations statewide, 335,000 members worldwide, and managing nearly $7 billion in assets, MSUFCU strives to help its local communities thrive and achieve financial freedom.

MSUFCU offers a robust digital banking experience for members to check their balances, transfer funds, and manage all aspects of their accounts virtually. Providing exceptional banking tools is something MSUFCU already does, but they are now focusing on tools to assist members with their finances.

Our Predictive Chatbot Experience turns Fran, the MSUFCU chatbot, into a more informative and useful tool for members. Fran analyzes members' history and provides supportive financial assistance. Looking at users' accounts, our version of Fran can identify low points in their accounts, suggest when to pay bills to avoid overdraft fees, and schedule recurring bills.

For example, if a member regularly pays a bill on the 10th and Fran recognizes that the balance is low on that day, she instead suggests the member wait to pay the bill until after their payday on the 13th.

Members also can set spending goals and track them over the month, as well as request a breakdown by category of the spending in a month.

Our application is web-based and written in HTML with JavaScript and CSS. It connects to Boost.AI's chat panel and a remotely hosted MySQL database. The chatbot's logic is done in Boost.AI's low code management platform is used to train the artificial intelligence.

msufcu

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Roosevelt Innovations
Provider Analysis Toolkit

Roosevelt Innovations, LLC is the first technology solution to deliver a simple, seamless, and smart platform for health insurance companies. With industry-leading claims processing capabilities, Roosevelt has transformed operations, enabling a total treatment cost savings of $972 million. Additionally, Roosevelt has more than 22 million users on its platform and an industry-leading auto-adjudication rate of 95%.

When processing many insurance claims, there is a large amount of data generated. Data that is anomalous for any reason is cause for further investigation.

Our Provider Analysis Toolkit gives data analysts of Roosevelt Innovations a streamlined, efficient, and verbose view of the data that comes from processing claims. Users can view real-time data, exchange their thoughts with other analysts on specific data, and share reports with other analysts.

Our solution identifies statistical anomalies within the data that can help them further investigate the causes for these anomalies. Data is filtered for the analysts so that the most anomalous data is easily accessible to them in a simple, quick, and efficient manner, requiring no further mathematical calculations on the analysts' end.

Data visualizations are also provided. Whether the data is represented in tables or charts, everything is laid out in a way that is streamlined and easily digestible.

Our solution automatically flags anomalous data and provides a suite of tools for further analysis, increasing productivity of analysts.

The web application is written in Python with utilization of the Streamlit library for the front-end framework, as well as FastAPI are used for construction of the web application's APIs. The anomaly detection machine learning models were developed using the PyTorch framework and scikit-learn library, while the data is stored within a Snowflake database.

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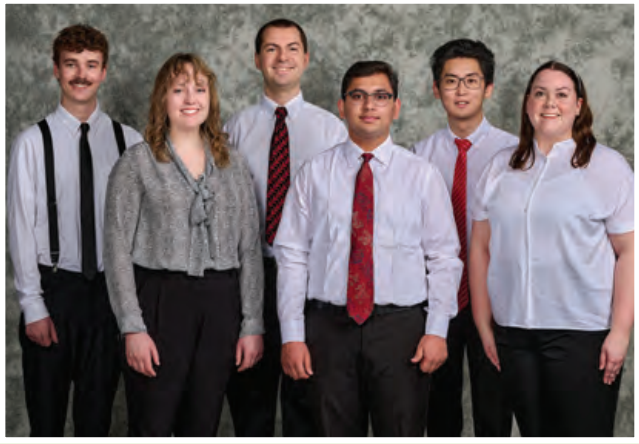

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Roosevelt Innovations
Model-Driven UI Framework

Roosevelt Innovations, headquartered in Okemos, Michigan, is a software solutions company owned by Delta Dental of Michigan. Its software solutions include customizable data services, customer portals, billing services, and industry-leading claims auto-adjudication. Roosevelt Innovations extends its services to several insurance companies across the country. Altogether, Roosevelt Innovations has over 22 million users on its platforms.

At Roosevelt Innovations, many different user interfaces are developed for insurance companies and their customers. Each new user interface is developed from scratch. This process can be very time-consuming, often requiring hours of effort from developers.

Our Model-Driven UI Framework streamlines the process of designing and building a website, creating dynamic and complex user interfaces with ease.

Our framework documents strategies and formats for creating the skeleton of a form. Once that skeleton is created, it is read by the web application and the form is displayed on the screen. Users can interact with this form and populate the data fields. Upon completing the form, users click on the submit button, at which point the entered data is validated and saved.

In addition to quicker build times, the developers can use the framework to easily create complex forms. The framework contains guidelines for validating user-entered data as well as a structure for creating fields that appear conditionally, making it very versatile. The same system can be used to create many highly customized forms specific to each customer's needs.

The framework expands upon JSON with custom keywords allowing for additional validation and manipulation of elements. The front end is built using Angular reactive forms to dynamically draw form elements on the webpage. The back end uses Quarkus to process objects and requests from the front end.

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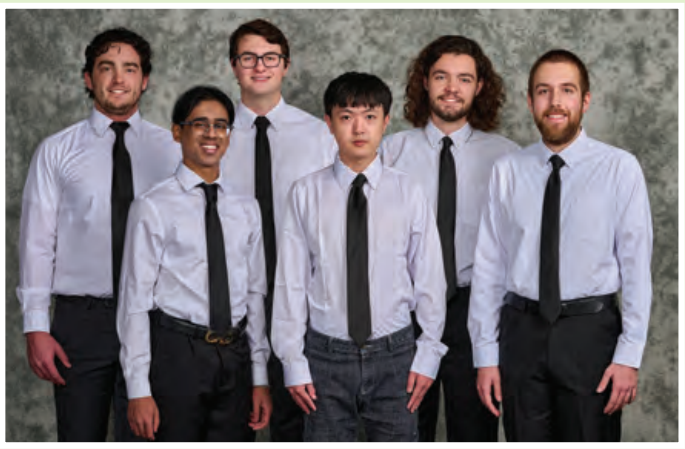

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RPM
Building Shipments using Machine Learning

RPM is an international logistics corporation which specializes in end-to-end transportation of freight and automobiles. On a monthly basis, RPM's carriers deliver 50,000 automobiles and 15,000 freight shipments. The company's headquarters are in Royal Oak, Michigan, and Amsterdam, Netherlands.

The logistics involved in the automotive industry are complex and shipments need to fit to customer specifications while adhering to carrier restrictions. Curating shipments using machine learning takes every specification into consideration.

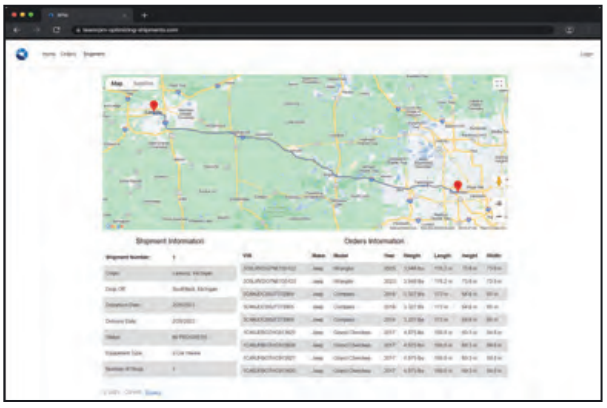
Our Building Shipments using Machine Learning web application organizes shipping orders based on features and pick-up/drop-off locations to create shipment schedules with the fewest possible stops. It also suggests the best carrier for such shipments to optimize the shipping process.

New orders are input by RPM through CSV or manual data entry, finally being verified by the user to ensure the shipping information is correct.

The process considers the VIN for each individual vehicle, make, model, and all the different vehicle specifications to organize orders and create optimized shipments. An optimized shipment has the least amount of stops and shortest route while also keeping trucks full. This improves the utilization of shipments and improves delivery time.

Our software uses various methods for creating shipments and suggesting carrier vehicle types that users can compare to select what fits their needs the best. We also provide tools for users to analyze and make necessary changes to their shipments.

Our system is built on .NET for front end development and Microsoft Azure for back-end tools and databases. Python's scikit-learn library is used to develop machine learning models to optimize shipments through clustering.



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Targets' Tip
Documenting Academic Harassment

Targets' Tip is a startup based in Okemos, Michigan, founded by an assistant professor at Michigan State University, Dr. Morteza Mahmoudi. The company's primary objective is to foster a safe academic environment for targets experiencing academic harassment. Targets' Tip offers support for targets of academic harassment by providing resources for them to report incidents and receive the help they need.

The fight against academic harassment has two major challenges: the absence of proper documentation surrounding incidents, and a tendency for cases to be forgotten or dismissed.

Our application, Documenting Academic Harassment, provides a user-friendly platform for secure documentation of academic harassment incidents to make sure that no case goes unnoticed.

Users of this application have a place to store their experiences and evidence where they do not go unrecorded and undocumented. Users can specify the date, location, and category of specific harassment incidents. The application generates a personal portfolio where the user can review and edit their reports. Both time series and pictorial visualizations of their history automatically update for the user to view a cohesive summary of their experiences.

Data collected from this application from its users is utilized to create an overview of cases from every university in the world. Incident occurrences are displayed in a heatmap visualization that filters by country, state, region, type of harassment, and department. Administrators can analyze and export the data in the heatmap to identify problems within institutions globally.

Through our application, users can have the peace of mind that their experiences are well documented and safe.

The front end of our Targets' Tip application is built using Dart and Flutter, while the data, storage and authentication is handled with Firebase.

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TechSmith
CAVE: Collaborative Audio/Video Editor

TechSmith's mission is to empower people to communicate and share knowledge using media capture and editing software. Based in East Lansing, Michigan, TechSmith's products are used by 73 million users worldwide and by every Fortune 500 company.

Collaborating with a team to create content can be challenging. Doing so often results in an individual coordinating the efforts of multiple team members or organizations, restricting the creative workflow that is essential to digital media creation. This disjointed process of indirect collaboration limits users to working sequentially and prevents all voices from being included.

Our CAVE: Collaborative Audio/Video Editor web application streamlines collaboration on media projects by enabling users to edit synchronously.

Users upload video, image, and audio files and arrange them with an intuitive timeline UI. Editors then preview the edited video at any time, and when completed, the final video can be downloaded for distribution across various platforms.

All media projects and their associated media are stored securely in the cloud where users can invite others to collaborate. Collaborators log in securely and can begin working on their project independently or together in real time.

Users need not worry about others overwriting their changes as the application ensures synchronization of contributions. By enabling team members to collaborate seamlessly, the final product better highlights the contributions of individuals and reflects a shared voice.

Our web application is built on JavaScript and ReactJS. FFmpeg runs on the client side to process media previews and the final exported project. Edits from simultaneous users are kept in sync with WebSockets. The back end is built using Node.js and is hosted on Microsoft Azure.

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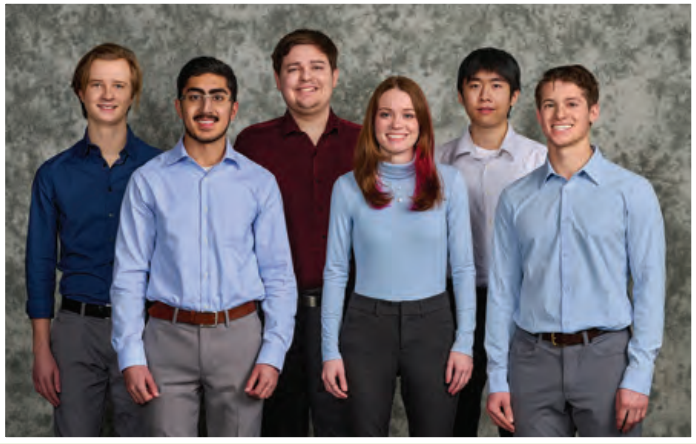

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Union Pacific
Switch Alignment Mobile Game

Union Pacific is one of the largest railroad companies in the United States, which has over 32,000 miles of track in 23 states in the west. The company primarily transports agricultural, industrial and customer products.

Misaligned switches can cause problems, such as damage to equipment, delays in train schedules and derailments. With the goal of being the safest, most reliable and most efficient railroad in North America, it is important to train newly hired field employees in a safe space with sufficient practice.

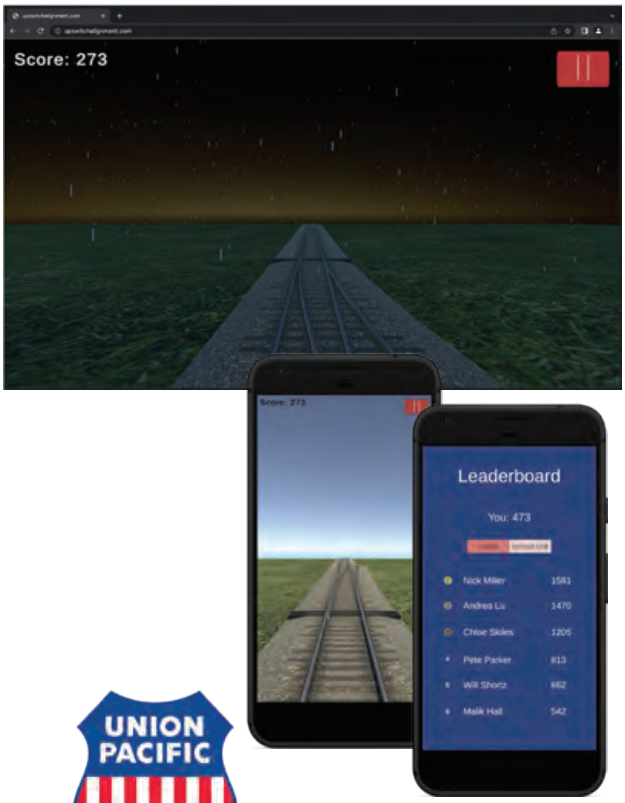
Our Switch Alignment Mobile Game teaches players to learn to identify differently aligned switches from the first-person view of a train on the railroad. The game is an infinite-runner game, with dynamically changing time and random weather conditions, such as sun, rain, and snow.

To access the gameplay, tutorial, leaderboard, and settings, the players must use their Union Pacific employee IDs. During gameplay, a train runs on an infinite random path populated by railroad tracks, and the player must identify switches correctly. Switches may be left-aligned, right-aligned, or misaligned. As gameplay progresses, new challenges are introduced, such as changing time of day and weather conditions reducing visibility.

The tutorial shows the rules of the game, as well as the leaderboard, which shows the rankings of the player's scores based on their performance. Additionally, the players can adjust the volume and other preferences in the settings menu.

Our software offers a realistic simulation for players to learn and practice switch alignment. With our software, Union Pacific can train new employees safely and practically.

Our software is developed with Unity3D and scripted with C#. The back end for the software is Oracle database, which is connected to front end through REST API.



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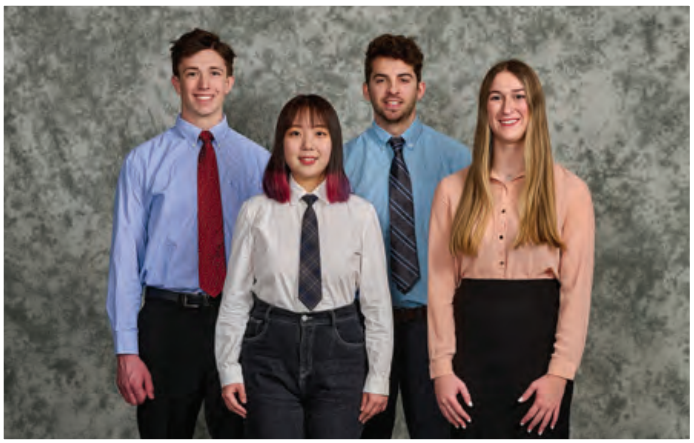

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United Airlines
Airline Passenger and Baggage Application

United Airlines is the third largest airline in the world, flying to and from over 340 destinations worldwide with a fleet of over 900 aircraft. They employ over 80,000 people, with well over 28,000 personnel working in passenger service. Due to this, nothing is more important to United Airlines than safety.

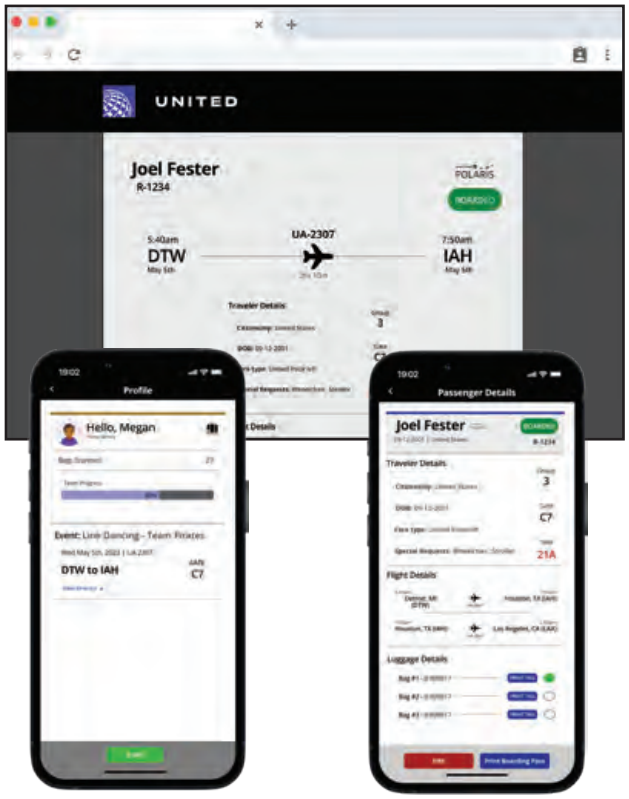
United Airlines holds Safety Rodeo events to train their staff in safety, efficiency, and accuracy in a friendly and realistic training environment. These rodeos require dozens of fake passengers and a significant amount of effort to accurately simulate standard airport operations, making it difficult for United Airlines employees to hold these vital rodeos.

Our Airline Passenger and Baggage Application tackles these issues by simulating the tools that are currently used by Customer Service Representatives and Ramp Service Employees within intuitive web and phone applications.

Our Airline Passenger and Baggage Application enables the creation of randomized passengers and bags to aid Customer Service Representatives and Ramp Service Employees in their training.

Our system employs support for phone camera and physical scanner readings of embedded QR codes on baggage tags and boarding passes to connect with our database of passengers and associated bags. Ramp and Customer Service employees have the option of checking in the associated passenger or bag. Realistic passenger and bag data errors are integrated seamlessly into the data to test the employee's attention to detail.

The front end of our application was created with the Flutter framework and Dart language to facilitate ease of cross-platform development. The back end of our application works with an Amazon Web Services Elastic Cloud Computing instance hosting our MongoDB database and our API endpoints.



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United Airlines
Aircraft Appearance Assessment Tool

United Airlines is a major U.S. airline headquartered in Chicago, Illinois. Since its founding in 1926, it has grown to be the third largest airline in the world, with routes both across the U.S. and to all inhabited continents. Due to its size, history, and ubiquity, it is a staple of the U.S. skies.

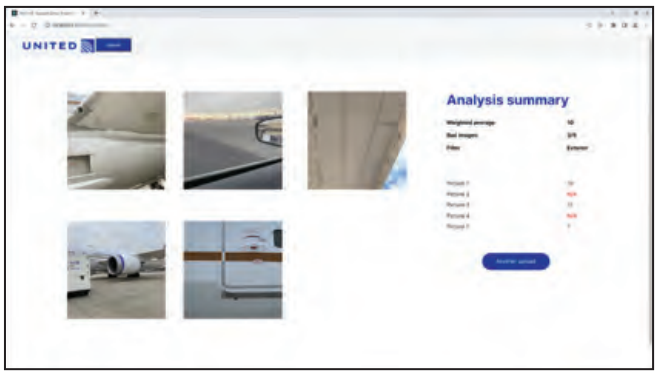
Innovating and growing as a major airline means to constantly strive for an increasingly high level of quality across a very large fleet. This requires being able to quickly identify issues so that they may be addressed promptly. However, the aforementioned fleet size makes efficient problem discovery a requisite for prompt action. As United Airlines strives to further its goals towards an ever better response, recognizing issues stands as the current bottleneck to address.

Our Aircraft Appearance Assessment Tool enables this focused and swift response by bringing problems to those who can solve them quickly within an easy-to-use web application.

Our tool uses image recognition to scan photos for actionable issues inside and outside the plane. Images are retrieved through employees manually uploading them, through emails sent to United Airlines, or through social media posts from passengers. Issues are automatically found, analyzed, and categorized from these images so engineers may fix problems as soon as they are found.

Additional sentiment analysis helps to evaluate feedback from customers obtained via Twitter posts. This sentiment data, in particular, further specifies image urgency automatically.

The web app utilizes an image recognition algorithm trained with a Convolutional Neural Networks model. The algorithm training is implemented in Python, TensorFlow, and Keras. The front end of our web app is built using ReactJS, with a Python Flask back end and MySQL database hosted on iMacs. The machine learning model is connected to the web app with TensorFlow.js.



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United Airlines
Adaptive Assessment Generator for Tech Ops Training

Based out of the Willis Tower in Chicago, United Airlines is one of the world's largest airlines with a current fleet size of over 875 aircrafts and plans to acquire 500 more. They currently operate over 4,000 flights per day spanning five continents, 74 different countries and more than 300 airports across the globe.

Maintaining a high level of safety and reliability is critical to United Airlines, and their maintenance staff undergo a series of rigorous training courses taught by United Airlines. However, manually generating assessments is a time-consuming and challenging task for instructors. To ensure that their technicians receive the best training possible, United Airlines places a strong emphasis on providing the right training platform.

Our Adaptive Assessment Generator for Tech Ops Training offers a highly interactive and collaborative platform for delivering and teaching a wide range of training topics. Designed to cater to both students and instructors, the system offers two perspectives that provide a comprehensive learning experience.

Students can browse through corresponding course materials, gaining a comprehensive understanding of various maintenance topics. Once they feel confident in their knowledge, students take quizzes to test their comprehension.

Alternatively, instructors can generate questions using our machine learning model, which creates questions that test students' understanding of the course materials. Instructors have full control over the training process, with the ability to manage students, material, and assessments through our web application. Instructors can also track individual student progress, as well as the overall milestones of the group.

Our application utilizes ReactJS for the front end, Python and Django for the back end, and Firebase for storage. The machine learning model is built using Python.

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Urban Science
OfficeBuddy

Urban Science, headquartered in Detroit, Michigan, is a consulting firm that supports every global OEM and numerous major automotive companies by providing them with service in the most efficient and effective way to increase the company's profitability and market share.

Since COVID-19 hit in early 2020, employees that work in the office have realized how convenient working remotely from home can be. However, this has caused a significant decline in socializing amongst coworkers. Urban Science conducted a study that discovered upwards of 80% of employees would be more encouraged to return to the office if they could socialize with their coworkers and rebuild bonds with their team members.

Our OfficeBuddy web application assists office workers in their transition back to in-person work by creating a convenient and robust social environment within the workplace.

OfficeBuddy enables users to select their seat before they come to the office, allowing them to sit by their friends. Users can add coworkers to their favorites list and track what days their favorite coworkers are going into the office.

Users can create public or private events that can be used for official meetings or fun events with coworkers. Users can also create groups with other users that can then be used to invite an entire group of people to attend a private or public event. Users are rewarded based on attendance, encouraging employees to utilize the office in a new and unique way.

OfficeBuddy gives employees the chance to regain the relationships within the office that might've been hurt by the COVID-19 pandemic. The OfficeBuddy application is composed of an Angular front end that utilizes HTML, CSS, and TypeScript, a .Net Core Web API, and an Azure SQL database.

URBAN SCIENCE

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Vectorform, LLC
Flexible VR Training

Vectorform, LLC is a cutting-edge technology company committed to accelerating change and solving society's most complex problems. Headquartered in Troy, Michigan, with four global offices and over 100 employees in design, engineering, and product development services, Vectorform is dedicated to creating the newest, most innovative technologies.

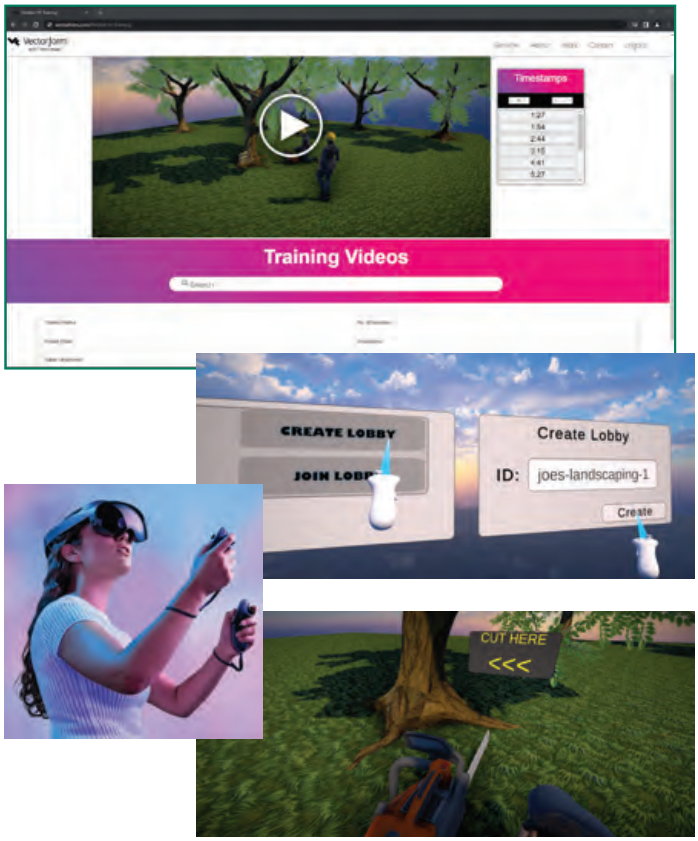
Certain careers require dangerous, time-consuming, and costly workplace training, such as law enforcement, firefighting, and construction. Traditional training methods compromise the safety of the trainee while attempting to replicate real-life situations. We have a solution: immersive technologies.

Our Flexible VR Training system provides trainees with a fully digital workspace environment that replicates life-like scenarios they will face on the job. The instruction is customizable based on company preferences, and the application supports two different training methods: a real-time human trainer and a human-like AI trainer. The AI trainer learns and adapts from live training sessions. Company officials can view recorded training sessions through our web application.

Our web application provides access to recordings of previous training sessions and information about each. Employers can set timestamps during these recordings as reference points for training evaluation.

Overall, the Flexible VR Training system is a cost-effective and safe way to train employees while providing realistic training scenarios.

The VR application is incorporated through Unity and a Meta Quest Pro VR headset. The back end is implemented with Node.js and a Microsoft Azure SQL database/mobile server. The web application uses Angular and WebGL, while the AI trainer utilizes an OpenAI API.



Vectorform
an NTT DATA Company

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Vectra
Predicting Malware Command and Control Channels

Vectra is a cybersecurity company that provides artificial intelligence-driven threat detection and response that is capable of defending against threats that bypass traditional security tools. Serving customers across the globe, Vectra redefines the standard of what it means for a network to be secure.

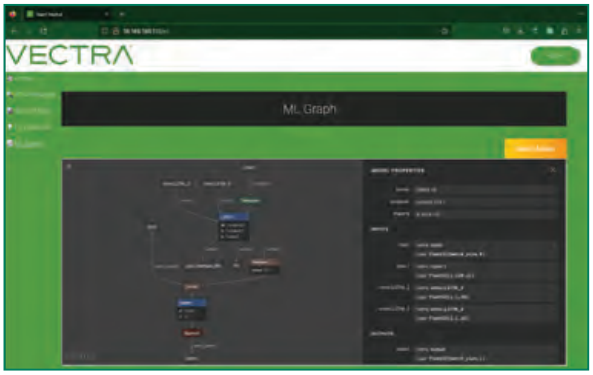
Traditional intrusion detection systems use an extensive list of previously recorded attacks known as signatures. These signature-based detection systems work well when met with known attack techniques, but when met with novel attack techniques, they fail to recognize them as threats.

Our Predicting Malware Command and Control Channels system is centered around combining signature-based intrusion detection and artificial intelligence-based intrusion detection, creating a singular robust system that draws from the strengths of both.

Our machine learning models detect command and control channels. Command and control is a technique that malicious actors use to communicate with an infected machine and send instructions for it to perform. A common factor behind many types of attacks, the presence of a command and control channel is a reliable way of detecting system compromise.

Using our web application, users gain a better understanding of the performance of our models by comparing where the signature-based system alone detects threats versus where our system detects threats. Visual representations of how our models are structured are also included to show the flow of a prediction. These tools make it easier to detect command and control channels, improving security.

Our machine learning models are built in Python using PyTorch, scikit-learn and LightGBM. Suricata is our signature-based intrusion detection system. Flask, JavaScript, and an SQLite database power the web application.



VECTRA®

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Whirlpool Corporation
SmartCook: Smart App for Induction Cooktop Cooking

Whirlpool Corporation is based out of Benton Harbor, Michigan and is one of the world's best known home appliance manufacturers. They are a Fortune 500 company with approximately $20 billion in annual sales and 54 manufacturing and technology research centers across the globe.

Recently, Whirlpool has been focusing on introducing more smart appliances for the kitchen to assist chefs of all backgrounds.

One of these appliances is the Assist Cooking with Temperature (ACT) Cooktop. This is a smart induction cooktop that assists in the automation of the cooking process with its precise temperature control and smart recipes alongside a mobile app called SmartCook.

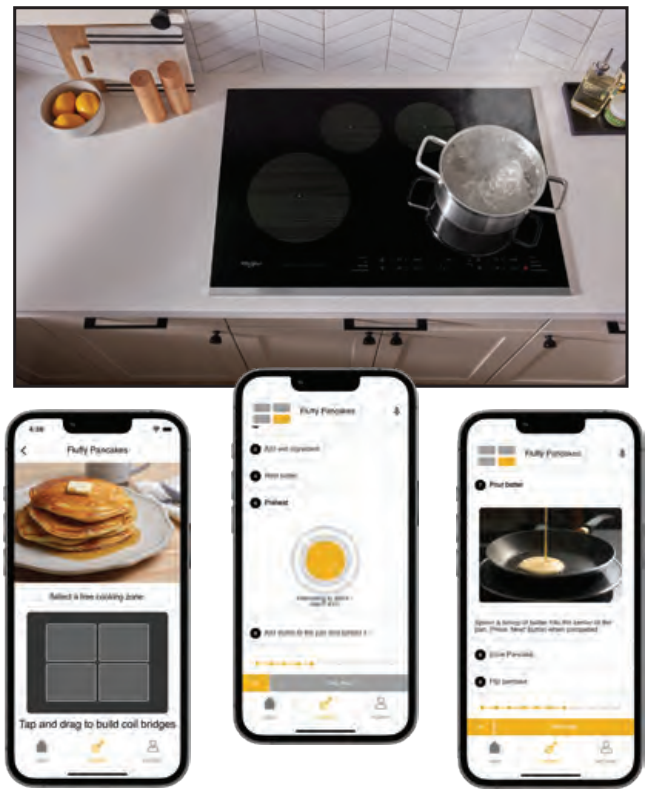
Our SmartCook application improves the quality of the user's cooking experience through automation features such as pan recognition and auto-recipe progression.

As the user cooks, the application controls the pan's temperature and autonomously progresses through a chosen recipe based on predictions of recipe progress. This minimizes the time users spend on their phone leaving more time for cooking their meal.

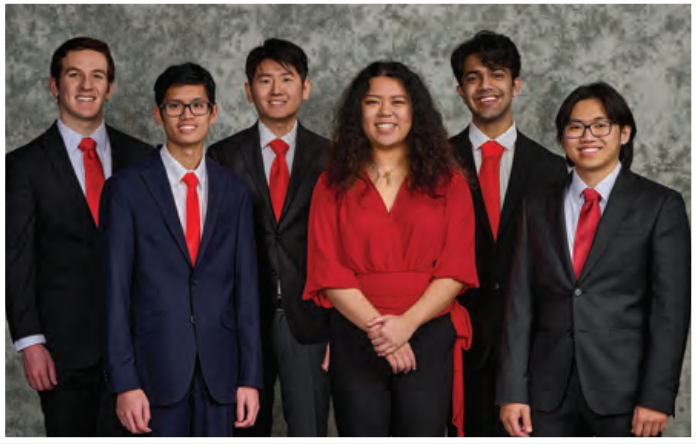
While cooking, the user is guided through each instruction, which is displayed on their iPhone or Android device. During each step of a recipe, the ACT Cooktop gathers data from the sensors on its surface. Our machine learning algorithms analyze the cooking data to determine when a step has been completed, after which the app instructs the user what to do next.

Our application helps Whirlpool achieve their vision of making cooking easy and accessible to everyone. Our app simplifies the overall cooking process and makes it less stressful for everybody from amateur to professional chefs.

The back end of our SmartCook app uses a Firebase server to store recipe data and employs scikit-learn for machine learning. The front end is created using the cross-platform SDK called Flutter.



Whirlpool



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Benton Harbor, Michigan

Design Day Awards

CSE 498, Collaborative Design, is the senior capstone course for students majoring in computer science. Teams of students design, develop and deliver a significant software system for corporate clients. The CSE capstone teams compete for four prestigious awards. Here are the winners from the fall of 2022.

Auto-Owners Insurance Exposition Award

CSE 498 capstone teams present their projects on Design Day in a variety of ways. Teams create and set up an exhibit where they demonstrate their software systems and answer questions from Design Day attendees. Each team plays their project videos and answers questions for a panel of judges.

The CSE capstone team with the best overall Design Day performance is honored with the Auto-Owners Exposition Award, which is sponsored by Auto-Owners Insurance Company of Lansing, Michigan..

Team Amazon
Amazon Review Confidence Tool

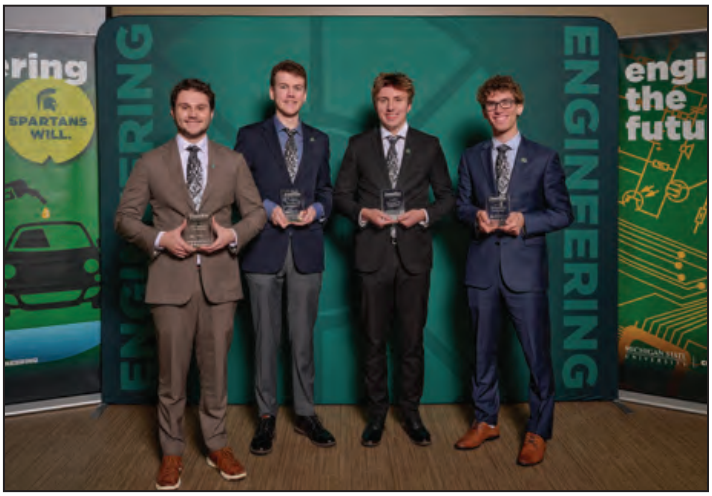
Dylan Mccarroll, Ashu Kher, Collin Cole
Nikita Gupta, Cameron Hurley, Ethan Strain,
Presented by Tony Dean and Ross Hacker of Auto-Owners

MSU Federal Credit Union Praxis Award

One of the hallmarks of CSE 498 capstone projects is that of praxis, the process of putting theoretical knowledge into practice. Teams apply a wide variety of information technologies to produce solutions to complex problems in areas such as business, engineering, computing, and science.

The CSE capstone team that engineers the software system that is the most technically challenging is recognized with the MSU Federal Credit Union Praxis Award, which is sponsored by MSU Federal Credit Union of East Lansing, Michigan.

Team Lockheed Martin Space
LiDAR and Image Fusion for Autonomous Navigation



Dom Mazza, Nathaniel Ferry, Carlo Barths, Matt Anikiej
Presented by April Clobes and Andrea Michaud of MSUFCU

While each of the awards has a principal focus, every winning team is required to deliver a comprehensive software system, and to demonstrate outstanding communication skills by presenting, demonstrating and defending their work.

TechSmith Screencast Award

TechSmith®

Each CSE 498 capstone team produces a video that describes and demonstrates their software product. Starting with a storyboard and a script, teams use Camtasia Studio to synthesize screen recordings, video, audio and other multimedia to produce their project videos.

And the TechSmith Screencast Award goes to... the CSE capstone team with the best project video. The award is sponsored by the creators of Camtasia Studio, TechSmith of East Lansing, Michigan.

Team Ally
Ally Employee Recognition Platform

Gatesana Vongphachanh, Harrison McComb
Abby Peterson, Phillip Yu, Phumapiwat Chanyutthagorn
Presented by Michael Malinak of TechSmith

Amazon Sigma Award

amazon

The CSE 498 experience represents the capstone of the educational career of each computer science major. An intense semester of teamwork produces impressive deliverables that include a formal technical specification, software, documentation, user manuals, a video, a team web site, and Design Day participation. The resulting sum, the capstone experience, is much greater than the parts.

The capstone team that delivers the best overall capstone experience is recognized with the Amazon Sigma Award, which is sponsored by Amazon of Seattle, Washington and Detroit, Michigan.

Team Whirlpool
Guided Recipe Augmentation

Rashon Poole, Joseph Kasza, Tom Choi
Quinn James, Justin King, Jiuhua Wu
Presented by E.J. Dyksen and Garret Gaw of Amazon

Building Dreams
Building Community

Since 1937, MSUFCU has been an integral part of the MSU community. We believe supporting programs such as Design Day helps prepare students to achieve their goals and dreams.

Wherever life takes you after graduation, MSUFCU can help. From the convenience of direct deposit to your free checking account to 24/7 account access through the MSUFCU Mobile app and ComputerLine,® we have the financial tools to help you engineer your next chapter.

See how MSUFCU can help you achieve your dreams today.

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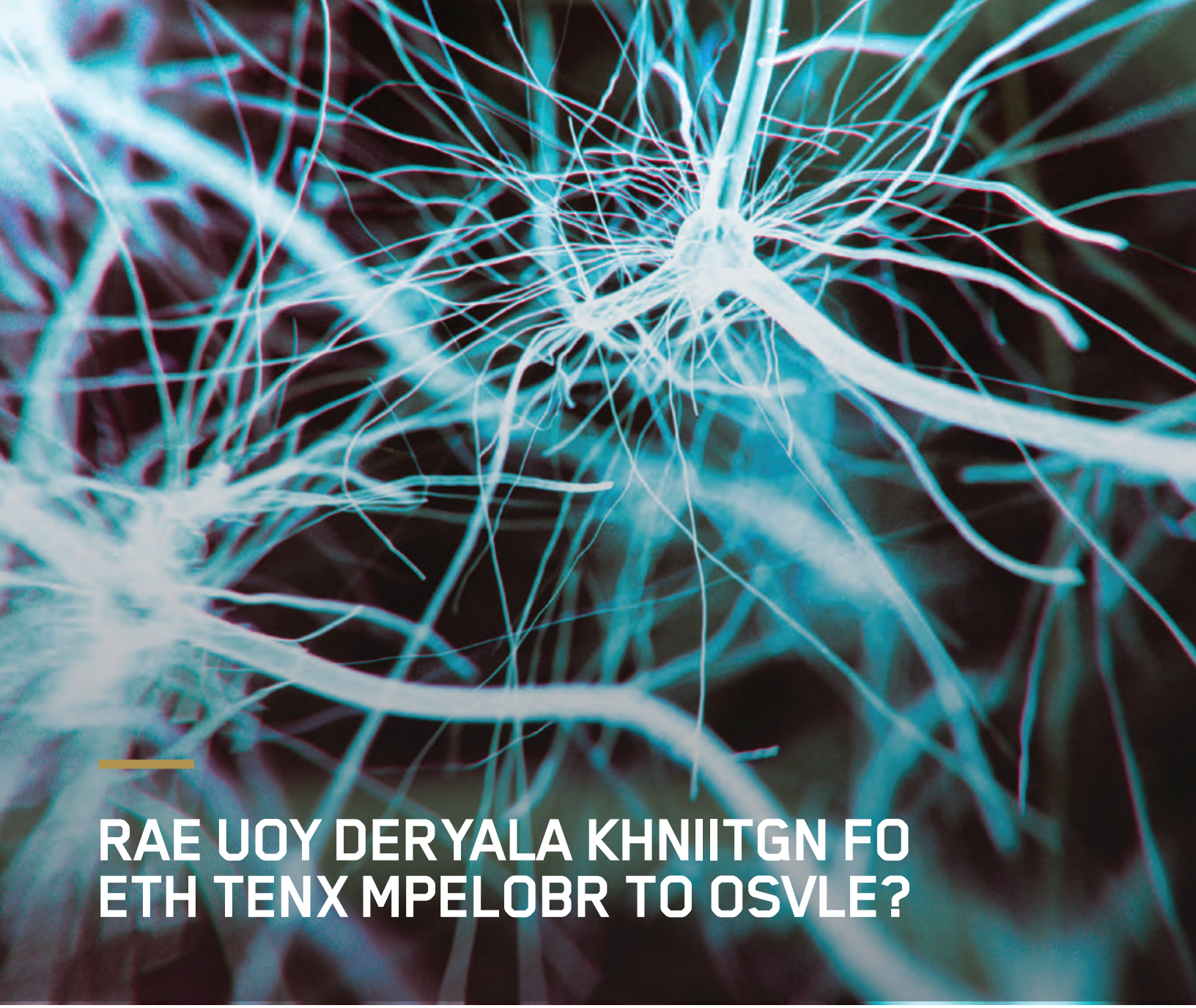

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If you can decode the above headline, then you think like an Urban Scientist.
We're the industry leader in using data analytics to do more — driving more sales, finding more unseen customers, and making more of an impact where it truly matters. At Urban Science, your brain waves can power the scientific revolution that's helping automotive manufacturers do business smarter. Because when you work with the most trusted problem-solvers in the automotive industry, you make more than a paycheck; you make a difference.

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URBAN SCIENCE®

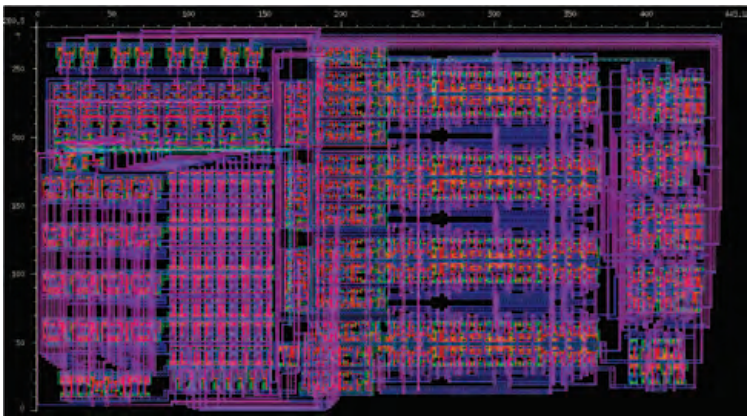
ECE 410 VLSI Design Course Introduction

Instructor:
Prof. Shannon Nicley

Design and Characterization of a CMOS 8-bit Microprocessor Data Path

Students in ECE 410 were challenged to design the schematic and physical layout of an 8-bit microprocessor data path, including an Arithmetic Logic Unit (ALU), a barrel shifter, and a register file, using CMOS circuitry and Cadence VLSI design tools. The resulting microprocessor datapath projects will be judged on their ability to satisfy several competing goals, including speed, minimization of area, number of operations and difficulty of the operation set.

TA Staff: Haojun Wang, Stephen Zajac



Spring 2022 Winning Design
2022 Intel Outstanding Project Award Winners:
Hyunmin Choi, Nicklaus Fites, Connor Schanerberger

Intel Outstanding Project Award

The Intel Outstanding Project Award ($600) will be awarded to the team that produces the best overall project, as judged by a panel of experts from industry and academia. The faculty and students of Electrical and Computer Engineering are very grateful to Intel for the generous sponsorship of this award.

Team 1
Patrick Bates
Kotlin Grammer
Jonathan Sparks

Team 2
Brian Alder
Chapin Ramseyer
Ben Torok

Team 3
Nicholas Apap
Jack Curvey
Franklin Garcia-Lopez

Team 4
Andrei Dogariu
Byungchan Go
Yuxiang Su

Team 5
Brian Garcia Ibarra
Joe Kieta
Kyle Lawson

Team 6
Connor Grant
Zainub Larji
Jason Shell

Team 7
Abel Hunegnaw
Michael Scruggs
Dylan Stanfill

Team 8
Luke Manteuffel
Manny Mateo-Saja
Josh Warminski

Team 9
Keaton Mulcahy
Kyle Neid
Maximus Sese

Team 10
Ishan Desai
Devansh Markan
Vigneshwer Ramamoorthi

Team 11
Nick Krause
Carter Mayfield
Michell Youngerman

Team 12
Daniel Mihailovic
Jorge Penalozano
Vivek Virdi

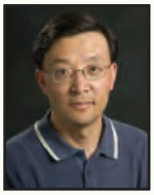
Team 13
Sam Dimitroff
Sam Gilliam
Karson Mientkiewicz

Team 14
Brandon Cherry
Jensen Dygert
Yinglun Xia

Team 15
Victor Faletti
Joseph Mackinnon
Larry Williams

Team 16
Ben Dubey
Surya Saravanakumar
Jared Stross
Ryan Young

The Capstone Projects



Dr. Jian Ren
Professor of Electrical &
Computer Engineering

ECE Project Facilitators: Virginia Ayres, Sunil Chakrapani, Mauro Ettorre, Qi Hua Fan, Ming Han, Matt Meier, Daniel Morris, Hayder Rahda, Peng Zhang


Ayres


Chakrapani


Ettorre


Fan


Han


Meier


Morris


Rahda


Zhang

Presentation Schedule – Engineering Building, Room 2205

Time	Team Sponsor	Project Title
8:30 a.m.	MSU Formula SAE/Tesla	Battery Management System
8:50 a.m.	MSU Solar Racing Team	Active Cell Balancing Battery Management System
9:10 a.m.	MSU Solar Racing Team	Field Oriented Control for Solar Motor Inverter
9:30 a.m.	Our Next Energy	Battery Cell Simulator
9:50 a.m.	Fraunhofer USA	Microwave Detector & Photodiode Safety Interlock
10:10 a.m.	BREAK	
10:20 a.m.	MSU Bikes Service Center	MSU Bikes Green Box
10:40 a.m.	Great Lakes Crystal Technologies	Measuring Diamond NV Center Charged States
11:00 a.m.	MSU IPF Power and Water	Big Data Analysis for Efficiency in Utility Generation
11:20 a.m.	FRIB	SRAM-Based Dosimetry for Heavy Ion Detection

ECE 480 Senior Design

ECE 480 is required of all electrical engineering or computer engineering majors at MSU. It prepares students for the workplace, or for graduate school, including:

- Putting into practice the technical skills learned in the classroom, on industrially sponsored team projects, under faculty guidance, doing open-ended design, giving them experience in teamwork, project management, product life cycle management, intellectual property, accommodation issues and entrepreneurship;
- Polishing their communication skills - individual and team - on proposals, reports, resumes, evaluations, posters, web pages, and oral presentations; and
- Requiring each student to complete four individual hardware/software laboratory assignments.

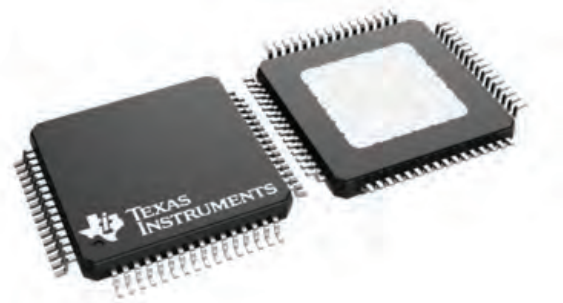
MSU Formula SAE/Tesla
Battery Management System

The global objective for this project is to assure safe operation while reducing cost and packaging issues by implementing the BMS board(s) for Michigan State University's new Formula SAE electric racecar. The BMS board(s) design must be capable of reading sensors' inputs, cell balancing, and being integrated into the racecar's data acquisition system. These specific tasks include Select Battery Monitoring (BM) chip, select microcontroller, design sensor input circuitry, and design I/O needed for system integration.

To reach the objectives above, the BMS board(s) and the vehicle's battery pack must be defined. The battery pack will consist of an assembly of Li-ion cells that will be managed from the BMS by monitoring temperature and voltage to ensure the safety of the battery cells, the vehicle, and personnel. A battery pack and sensors are components that will interact directly with the BMS board(s). The battery pack will consist of Li-ion cells used to power the vehicle's EV powertrain. The sensors used are temperature and voltage sensors. The temperature sensors are able to measure the temperature of individual cells while the voltage sensors measure the voltage of each individual cell.

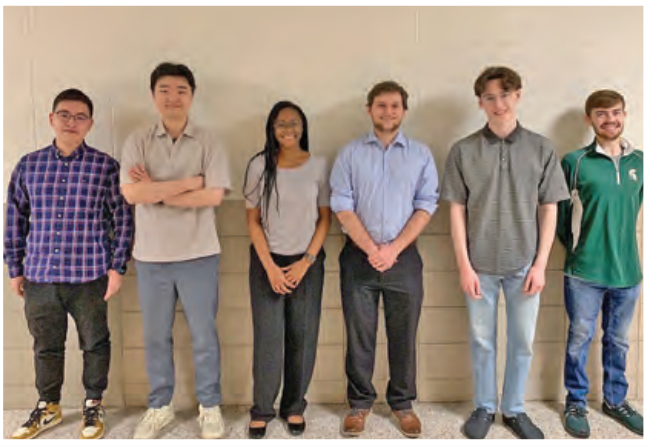
To determine if the objectives of the project have been met, testing and verification of both the hardware and control system will be conducted. Test PCBs of the BMS board(s) will be created to verify that every component is working as expected and meets the design requirements. A final board will then be created with all of the required components. When test benching is completed, the BMS can be implemented on the team's vehicle. More testing will occur with various other sensors to ensure the battery pack and BMS are operating safely and correctly.

With the correct selection of components, effective and efficient programming, and rigorous testing, the BMS would allow the battery pack to deliver power safely.



Michigan State University
Formula Racing Team

TESLA



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San Jose, California

Project Facilitator

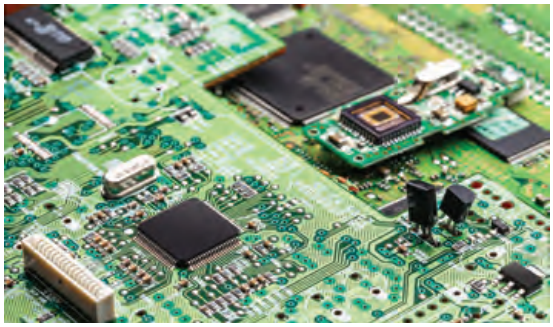
Dr. Hayder Radha

MSU Formula Racing Team
Active Cell Balancing Battery Management System

This project's purpose is to develop a Battery Management System, also known as a BMS for the Michigan State Solar Car Racing Team. Over the years, the Michigan State Solar Racing Team used BMS to implement passive cell balancing. In this project, one of our major goals is to include active cell balancing so that the sponsor may reap its benefits.

This project is divided into two major groups: hardware and software. The hardware aspect of this project includes the design and printing of a PCB along with the hardware needed to achieve active cell balancing and the ability to accurately read the voltage and temperature of the modules and the battery pack current. The software aspect of this project includes the ability to collect the data such as voltage, current and temperature and send that information via a control area network (CAN) line. Collected measurement will display any faults using the CAN line. Finally, the software should also be able to support active cell balancing.

Battery Module



Printed Circuit Board (PCB)

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MSU Solar Racing Team
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Project Facilitator

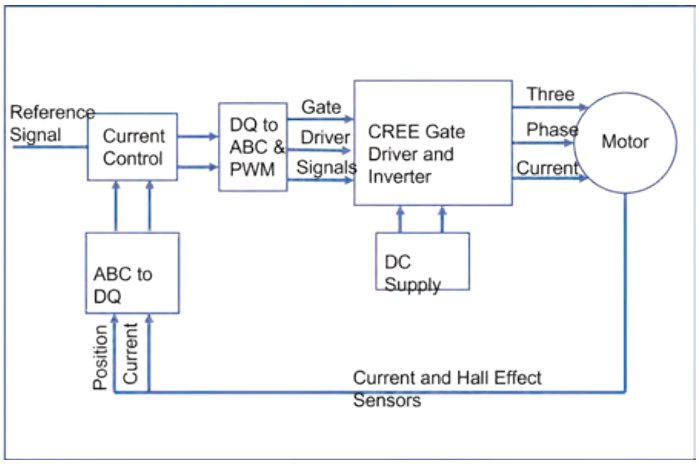
Dr. Mauro Ettorre

MSU Solar Racing Team
Field Oriented Control for Solar Motor Inverter

We were tasked by the MSU Solar Racing Team to design and code a Field Oriented Control (FOC) Motor Inverter for driving three-phase solar motor inverters. To do this, the team built a functional FOC code block diagram and implemented this with the Teensy Microcontroller for utilization on the Motor Inverter. The team utilized the Motor Inverter from Fall 2022, as well as various electrical components we deemed fit to use. Additional hardware that was needed was purchased by Michigan State.

The design implemented was able to run and drive a motor using the controller provided, through the application of Arduino software, resulting in our final design precisely controlling the torque output of the motor. It was also able to accurately read the phase and speed of the motor's rotation, as well as power consumption. The final design was also created with the sizing of each component used in mind.

The Michigan State Solar Racing Team specified several requirements that our design successfully fulfilled. Aside from the major tasks outlined above, the controller was an efficient program that interfaced with the existing hardware design. Additional hardware was efficiently sized and durable enough to withstand any rugged or environmental conditions the solar car might encounter.



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Mitchell LeGrave
Norway, Michigan

Kyle Heverly
Bloomfield, Michigan

MSU Solar Racing Team
Project Sponsor

Project Facilitator

Dr. Matt Meier

Our Next Energy (ONE)
Battery Cell Simulator

Founded in 2020, Our Next Energy (ONE) is a Michigan-based energy storage technology company headquartered in Novi, Michigan. Our Next Energy seeks to accelerate the transition to sustainable vehicle electrification by engineering innovative energy storage solutions.

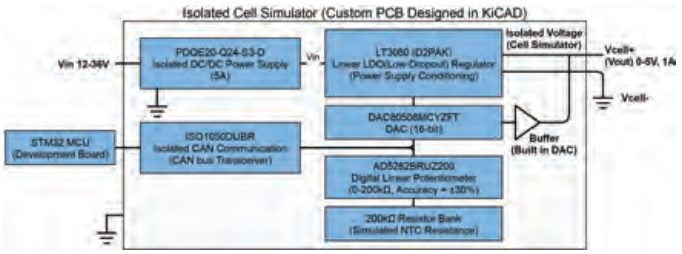
ONE is developing HV battery packs that use strings of Li-Ion based high-capacity cells. The high voltage battery packs can have series string cells of up to 112 cells. All designs are done in-house at ONE.

This project will focus on the design and prototype of a compact Battery Cell Simulator for ONE's development of HV battery packs. Using a simulated battery cell is a much safer option and is required for a majority of the development efforts. It enables the team to control the output voltage of the cell to perform testing on an HV Battery Management System (BMS).

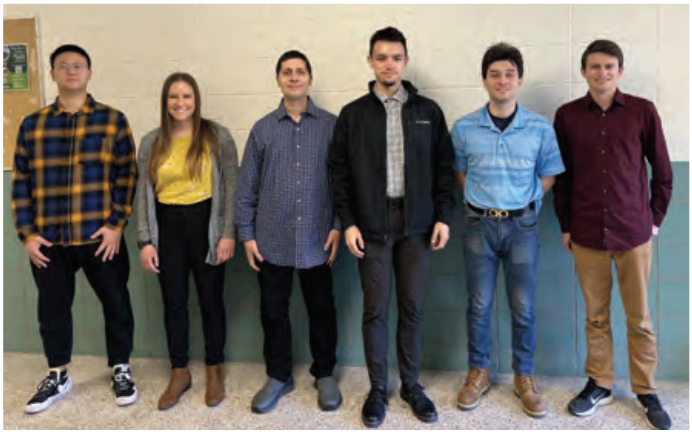
An Isolated Controller Area Network (CAN) is used due to its ability to withstand adverse conditions of the communication of the protocol. This design has an optional NTC Thermistor simulator that can be included..

This project offers test engineers a safe option for development and calibration work via an external controller for the engineers at ONE. The build and parts costs for 5x modules remained under the assigned $500 budget. The fabricated modules are designed with a focus on desired SWaP-C (Size, Weight, Power, and Cost) optimization.

Engineering practices that help us achieve our design and fabrication goals of this project are attentive design planning considerations, organization, planning, and reflection. Standards that keep us safe include diligent software testing, safe electronics handling (ESD, ventilation, eye protection), and storage protocols.



our next energy



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Kyle Neid
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Kyle Bandes
Warren, Michigan

Garrett Feinauer
Owosso, Michigan

Our Next Energy
Project Sponsor

Ashiful Khurashi
Novi, Michigan

Project Facilitator

Dr. Virginia Ayres

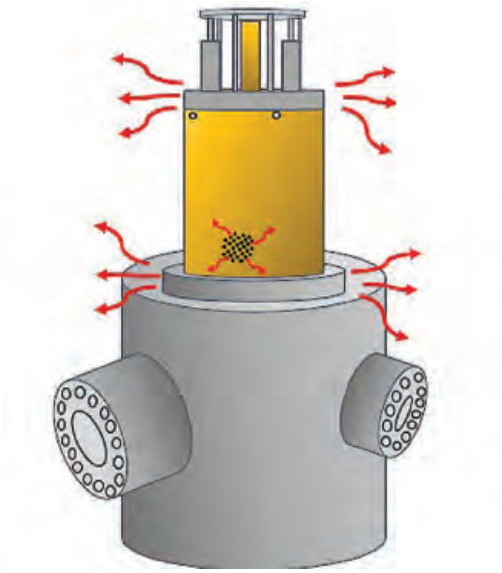
Fraunhofer USA
Microwave Detector & Photodiode Safety Interlock

The Fraunhofer USA Center for Coatings and Diamond Technologies, in partnership with Michigan State University, provides innovative R&D services based on its expertise in coating and diamond technology. The Chemical Vapor Deposition (CVD) process involves injecting a gas into a chamber while increasing the temperature. This high temperature causes a chemical reaction between the gas and substrate, resulting in a thin layer to form on the substrate. This CVD process is used by Fraunhofer for diamond growth.

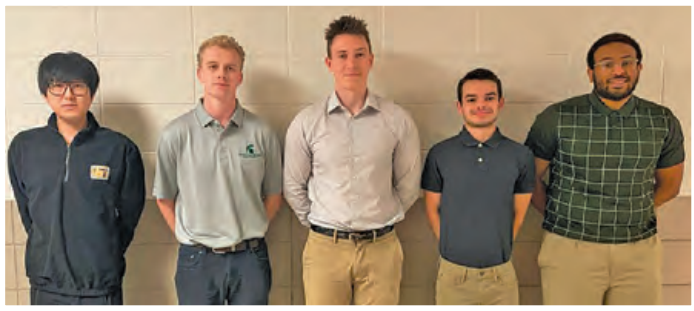
Due to the high levels of electromagnetic radiation and thermal energy involved in the CVD process, safety mechanisms are essential. Exposure to low levels of microwave radiation must be regulated when working within these environments.

The objective of this project is to create a sensor system capable of measuring microwave leakage and light intensity of plasma from the CVD reactors. To address microwave leakage, an RF detector in the form of a microstrip antenna (on a PCB) will measure the leaking microwaves. A photodiode will be used to read light intensity being emitted from the plasma within the reactor. The photodiode will act as an on/off interlock for the plasma.

The information collected by the sensors will be transmitted to a microcontroller which will convert the analog readings into digital signals and will be compatible with the communication bus currently being used by the Fraunhofer team. Safety interlocks for the entire system will then be implemented by their software team.



Fraunhofer USA



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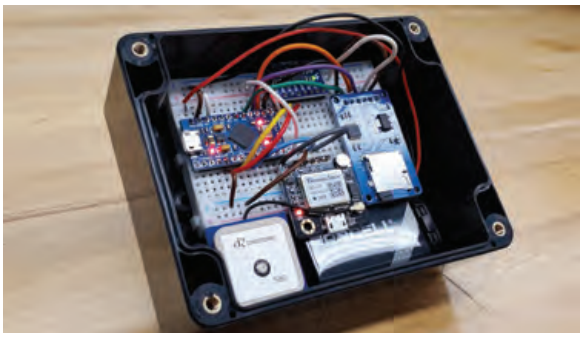
MSU Bikes Service Center
MSU Bikes Green Box

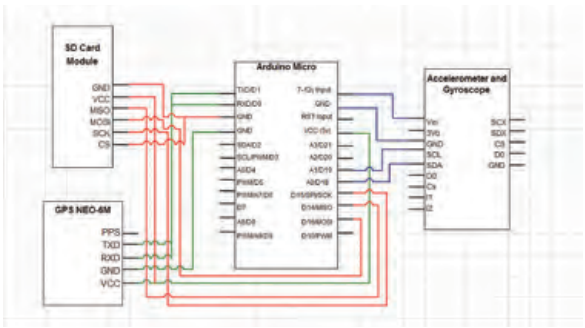
In 2003, the MSU Bikes Service Center started as a volunteer-run project dedicated to promoting the use of bikes on MSU's campus as both an environmentally-friendly as well as physically-fulfilling mode of transportation. Later, in 2006, the organization began to receive funding from Michigan State University, leading to the opening of its current location on Farm Lane.

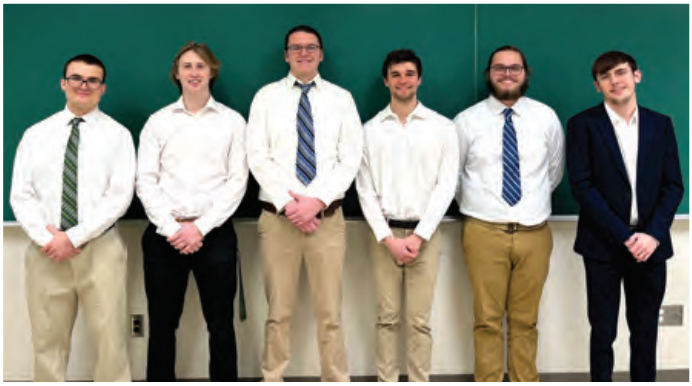
With Michigan State University having such a dense population and the high volume of bikes, electric scooters, and other micro-mobility modes of transportation present at any given time, many small-scale accidents occur across campus, despite the best efforts of all involved. To assist in further minimizing these accidents, our team is working with the MSU Bikes Service Center to create a device that will help detect these incidents on campus.

The MSU Bikes Green Box is a project aimed at creating small, easily mountable devices that, with the riders' consent, can track users and inform them of their vehicle's acceleration at any given time while in transit. The box contains an Arduino Micro microcontroller and sensors, in particular, an accelerometer, gyroscope, and GPS module, that all will provide the information required to identify both when a crash occurs and where it did occur. Furthermore, our group developed a data processing program that will properly identify different kinds of incidents such as near-miss, minor, or major accidents.

This data collection is being performed in the hopes that it can be utilized by the university to further safeguard students and faculty that choose to utilize micro-mobile devices. Our box will assist in locating accident hotspots around campus. This, in turn, can be utilized to determine what issues may be present in the area's layout and how these issues can be used to improve bike safety.







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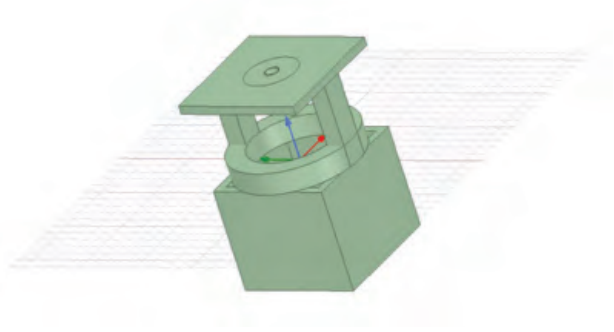
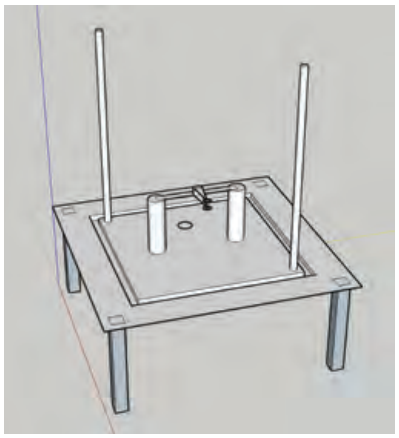
Great Lakes Crystal Technologies
Measuring Diamond NV Center Charged States

Nitrogen-doped, lab-grown diamonds have nitrogen vacancy (NV) center point defects, in which electrons can become trapped. When these electrons relax following excitation, they emit photoluminescence (PL) intensity spikes at certain wavelengths. In our case, a 515 nm beam will excite these electrons, leading to PL intensity spikes at 575 nm and 637 nm, which correspond to NV- and NV0 centers, respectively. We can measure these PL spikes to obtain an NV-/NV0 intensity ratio. An optical set-up will be created to measure these spikes. A 515 nm laser will be directed at a diamond sample enclosed in darkness. Optical bandpass filters will filter out the incident 515 nm wavelength, as well as any background PL intensity at wavelengths other than 575 nm and 637 nm. At room temperature, background PL intensity can be quite high, leading to increased SNR, which may obscure spikes, creating a signal processing challenge. The filtered diamond response will be captured using a detector, either an ocean optical spectrometer or a CCD camera. We will then perform image analysis and signal processing on the CCD camera output to isolate intensities and determine the corresponding wavelength of light. This data will then be used to calculate NV-/NV0 intensity ratios, which will allow for the characterization of point defects on the diamond.





GREAT LAKES CRYSTAL TECHNOLOGIES

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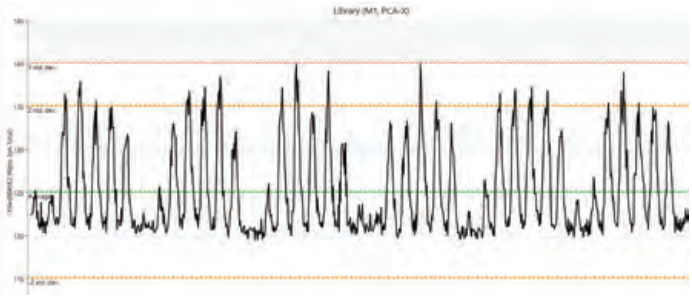
MSU IPF/Sartorius/Consumers Energy
Big Data Analysis for Efficiency in Utility Generation

Michigan State Infrastructure Planning and Facilities has been providing power and heating for MSU through the T. B. Simon Power Plant since 1965; various other plants throughout the school's history provided this service before the T. B Simon plant's construction. Today almost all the power and heat used around campus is provided by this power plant's multiple generators or other energy sources on campus, such as solar panels. Dedicated generators were initially put in place to capitalize on a byproduct of steam heating, a far safer alternative to central coal or wood stoves in buildings, and allowed power generation on top of campus-wide heating for minimal extra cost. However, as this operation has grown, so has its price. $20-$40 million is spent annually on fuel to power these generators and provide heating to Michigan State's campus.

While there is no way to cut this entirely, the goal of this project is to lower these costs by about 1%, which, while relatively small, would save the university around a quarter of a million dollars every year. Using SIMCA, a data analysis software provided by Sartorius, as well as a data historian recording millions of data points related to power use and generation by the T. B. Simon Plant, finding inefficiencies in the delivery of power to various on-campus facilities should be possible. Variables measured by the historian will be compared and analyzed for underlying trends after Principal Components Analysis (PCA) is performed using software. Comparisons will be made through scores and loading plots, as well as finding correlations between related variables. When a trend is found, we will perform research, generate models, and suggest reasonable changes to the sponsors and university. These changes are to be tested and validated by the various qualified engineers employed by the university for the T. B. Simon plant.



INFRASTRUCTURE PLANNING AND FACILITIES

SARTORIUS

Consumers Energy
Count on Us

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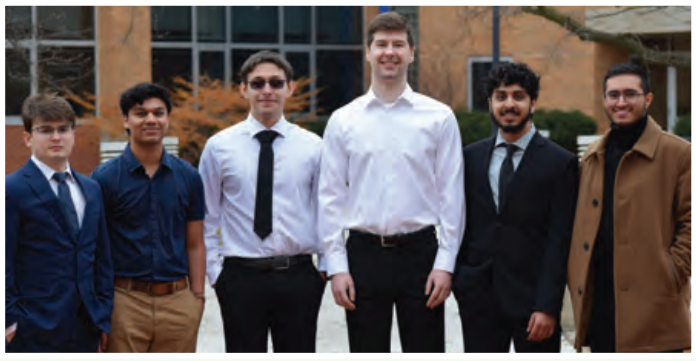
Facility for Rare Isotope Beams
SRAM-based Dosimetry for Heavy Ion Detection

In memory devices, radiation can cause soft errors in the form of bits flipping out of turn. This is called a single event upset. Studying these single event upsets can aid in many ways pertaining to technology. Understanding the causes and effects of this single event upset can help in mitigating these errors. It can also allow us to compensate for single event upsets in environments that are conducive to causing them, which is being researched by many different groups. Research has been conducted into reducing single event upsets to ensure the integrity of memory devices in environments like space or high radiation environments. However, there is another potential use of studying the effects of radiation on single event upset. Doing so can potentially enable detection of the radiation, as well as potentially measuring it based on the frequency of the upsets. This avenue of research is something that MSU's Facility for Rare Isotope Beams (FRIB) is interested in pursuing through this project. FRIB is a world-class scientific user facility for the US Department of Energy Office of Science and is located on MSU's campus. Due to its powerful, in-house isotope accelerator, much of the leading research surrounding radiation and heavy-ion particles has been performed at FRIB.

The main goal of the project as stated above is to develop an SRAM FPGA interface that acts as a dosimeter. For the purposes of this project, only the SRAM and FPGA are to be developed, with the testing of this interface as a dosimeter being done outside of the scope. The bulk of this project, therefore, pertains to developing an interface for the FPGA to be able to track bit flips in the SRAM, such that when the SRAM is given a set read/write cycle, the FPGA should be able to track and mark when a single event upset occurs, i.e., where the bits flip when they should not.

Above
UI interfacing with the ArtyZ7 FPGA

Below
SRAM Board



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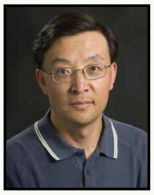
The Capstone Projects



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Professor of Electrical &
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Presentation Schedule – Engineering Building, Room 2320

Time	Team Sponsor	Project Title
8:30 a.m.	FRIB	Variable Energy Degradation Stage
8:50 a.m.	ECE NDE Lab	Robotic Arm Object Reconstruction for NDE
9:10 a.m.	ECE NDE Lab	Aerial Drone for NDE Applications
9:30 a.m.	MSU ECE Department	Scaled Down Autonomous Bus with Self-Parking Ability
9:50 a.m.	ECE Smart Lab	Scaled Teleoperated Vehicle for Smart Vehicle System
10:10 a.m.	BREAK	
10:20 a.m.	ECE Smart Lab	Visual Inertial Odometry for Underwater Laboratory
10:40 a.m.	ECE Diamond Labs	Diamond Plate Thickness Measurement
11:00 a.m.	MSU ECE Department	Wirelessly Powered Backup Camera
11:20 a.m.	MSU Biomedical Engineering	Wind Tunnel for Molecular Communication

ECE 480 Senior Design

We gratefully acknowledge the support of this semester's project sponsors: ECE Diamond Labs, ECE NDE Lab, ECE Smart Lab, Facility for Rare Isotope Beams, Fraunhofer USA, Great Lakes Crystal Technologies, MSU Bikes Service Center, MSU Biomedical Engineering, MSU Electrical Engineering Department, MSU Formula SAE/Tesla, MSU IPF Power and Water, MSU Solar Racing Team, and Our Next Energy.

The ECE Project Facilitators who supervised ECE 480 teams this semester are: Selin Aviyente, Virginia Ayres, Sunil Chaprapani, Mauro Ettore, Qi Hua Fan, Ming Han, Matt Hodek, Robert McGough, Matt Meier, Daniel Morris, Hayder Radha, Vaibhav Srivastava, Panagiotis Traganitis, Lalita Udpa, and Peng Zhang.

Facility for Rare Isotope Beams
Variable Energy Degradation Stage

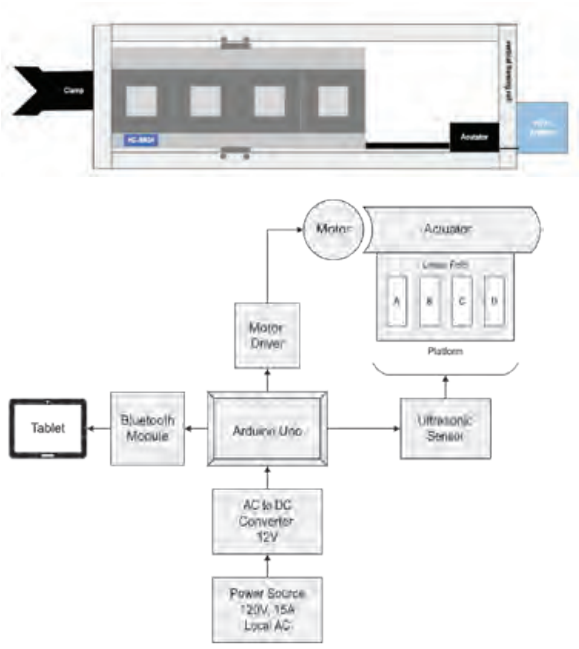
The Facility for Rare Isotope Beams (FRIB) strives to provide users with on-time delivery of ion beams and accurate characterization of beam parameters. Linear Energy Transfer (LET) energy deposition studies must be conducted to study the impact of Single-Event Effects (SEE).

SEE occurs when a single energetic particle collides with an electronic device and causes a change to its operational threshold(s). SEE can impact space-flight-qualified electronics immensely, leading to incidents that range from annoying system responses to catastrophic system failures, for example, satellites falling out of orbit.

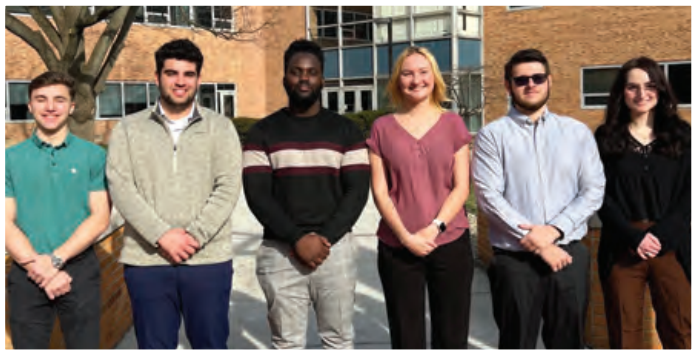
During beam path firing, controlled LET levels can be accomplished using specific thicknesses of metallic foils that degrade beam intensity until it reaches a maximum device damage threshold. An optimal device to switch between metallic foils has yet to be created.

This project is to design and build a remotely controlled, motorized stage with encoder readback to place one of several energy-degrading foils in the beam path. The stage is made of aluminum, a lightweight material. The stage contains clamps that attach to the stationary beamline stage. The stage has a sliding frame that will hold four foils, which are held in place by individual brackets. The sliding frame moves along the x-plane into four set positions and a set home position by a linear actuator. The linear actuator is controlled remotely by an Arduino. The Arduino interacts with a user interface tablet to select the foil frame position.

For this project, our goal is to test and demonstrate that the motorized stage can have movement repeatability. With the successful completion of this project, the stage will be incorporated with an existing user beamline at FRIB.



FRIB



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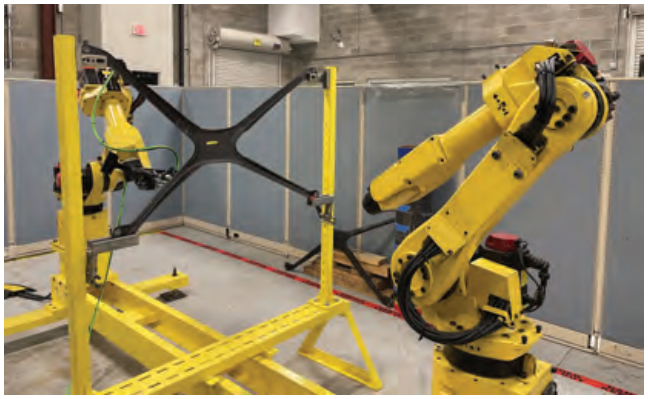
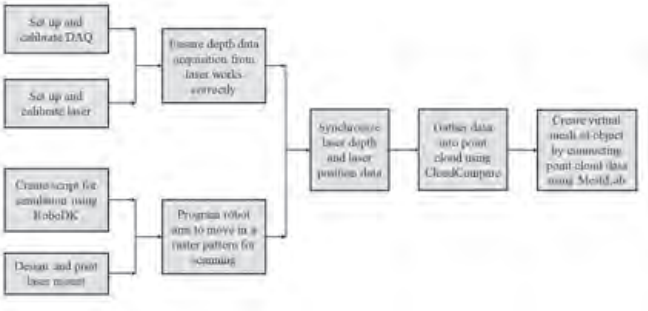
Nondestructive Evaluation Laboratory/NSF
Robotic Arm Object Reconstruction for NDE

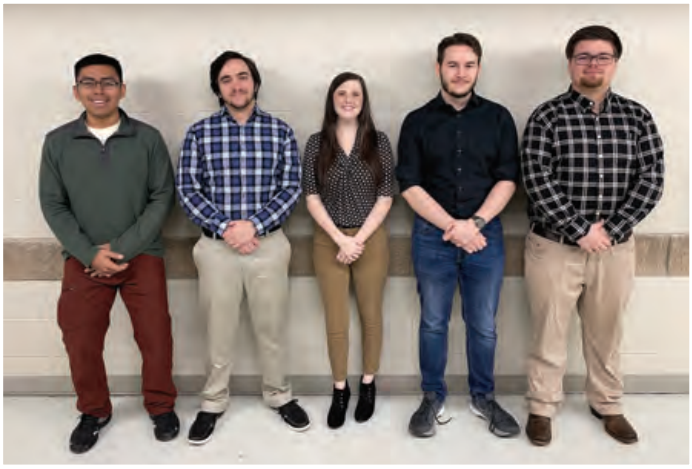
Nondestructive evaluation (NDE) consists of using non-invasive methods to analyze the structure of critical components or structures. NDE is used in any situation where it is desirable or necessary to determine the condition or structural integrity of a part or structure without damaging or disassembly. NDE is necessary in several industries such as automotive, aerospace, civil infrastructure and power.

Nondestructive testing is accomplished with the aid of a variety of external sensors that utilize ultrasound, light, magnetic fields, eddy currents, microwaves, X-rays, etc. to evaluate the surface or subsurface of the object being evaluated. Sensors are often mounted on robotic rigs which move the sensors over the object in a 2D plane for automation and consistency. Some parts, however, have complex geometries which do not allow for simple, pre-programmed movements to scan the entire surface. When evaluating objects with these more challenging geometries, it is desirable to use a robotic arm that can maneuver the sensor in 3D space around the surface of the object.

This project is to design and implement such a system to scan and reconstruct the surface of a complex-geometry object using a robotic arm with a laser distance sensor as its end effector in order to construct a computer model of the object. Additionally, the reconstructed model can be used to generate more accurate paths for the robotic arm so sensors with stricter range requirements can be deployed for further analysis of the part.







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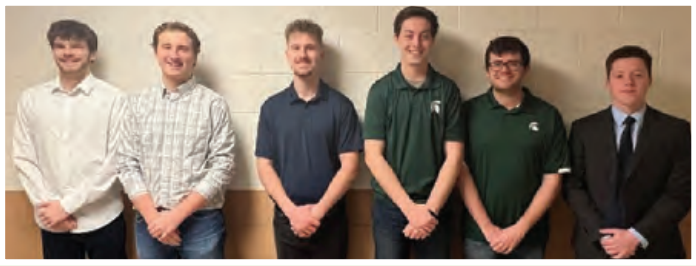
Nondestructive Evaluation Laboratory/NSF
Aerial Drone for NDE Applications

Nondestructive evaluation (NDE) techniques are used to evaluate the integrity of critical structures in power, oil and gas, aerospace, and automotive industries. These techniques are important for detecting damage precursors and performing appropriate maintenance to ensure safe and continual operation. These techniques are realized with the help of sensor technology (ultrasound, light, eddy current, etc.) that are selected based on the material and geometry of test specimen.

The sensors that are developed in academic laboratories are often mounted on an x-y scanning gantry to generate a well-defined image of the sample defects. On a manufacturing floor, the sensors need to be mounted on a robotic scanning platform, which helps them navigate the varied situations. These robotic platforms help sensors reach places where it may be precarious for human operators to work, or even impossible due to space restrictions.

This project entails designing an aerial drone for inspecting large structures such as wind turbines, power plants, and building infrastructure. The drone will perform a series of motions, and collect a stream of 2D video, which will then be converted to a 3D model using Photogrammetry tools. Students can make use of commercially available parts like Pixhawk flight controller and suitable microcontroller for control and data acquisition.

The project will serve to advance the technology of drones in NDE applications. It will add an important capability to NDE systems, namely that of automatic scanning of larger structures with access limitations.



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MSU Department of Electrical & Computer Engineering
Scaled Down Autonomous Bus with Self-Parking Ability

In early 2022, Michigan State University introduced an electric autonomous bus that serves students, staff, and faculty as part of the campus' smart mobility ecosystem. "The bus represents one of the largest electric autonomous transit vehicles to be deployed on U.S. roadways to date." The bus has 22 seats and offers level 4 autonomy which means that it can operate without any human interaction. This was developed by Karsan, a bus manufacturer, and was updated by ADASTECS technology, a San Francisco based company that specializes in automated transportation.

Our bus is a scaled down version of the MSU autonomous bus using a remote-controlled toy bus and Raspberry Pi. This bus runs and functions like a regular autonomous bus, including stopping if there is something in its way, and being able to park itself. Autonomous vehicles function by creating and updating maps of their surroundings using a variety of sensors.

Ultrasonic sensors and cameras are typically the most common sensors found on these vehicles and these are included on the scaled- down bus also. These sensors work in tandem with each other as each has their own strengths and weaknesses.

The Raspberry Pi controls the movement of the RC bus and the ultrasonic sensors will be able to detect a lane and drive through it while the camera searches for and detects an Aruco code that is stored with information to begin the parking sequence after detection.

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MICHIGAN STATE UNIVERSITY

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MSU Smart Microsystems Laboratory
Scaled Teleoperated Vehicle for Smart Vehicle System

The MSU Smart Microsystems Laboratory (SML), established in 2004, is dedicated to enabling smarter, smaller, integrated systems by modeling advanced control and design methodologies. Their research specializes in control, dynamics, robotics, and smart materials. With a current focus in autonomy, the MSU SML is dedicated to providing a solution to a safer, more reliable method of autonomous travel.

Our team has added to this effort; tasked with the job of developing a remotely human-driven scaled car to be used in a system of autonomous vehicles, all of which are aware of each other's locations and park in the safest spot. Our vehicle is capable of being controlled and viewed from a PC over Wi-Fi, with first-person view front- and back-facing cameras for visual feedback.

With our developments, users will be able to gain knowledge of autonomous vehicles and their parking habits through a safe, simulated environment with human-like feedback. All vehicles are equipped to transmit data to a centralized computer system, where positional, velocity, and heading data are used to observe and interact with the autonomous environment.

To further simulate a human environment, the driver of our car will have a realistic first-person perspective view with a video stream of both cameras, along with an intuitive user interface to allow the driver to truly interface with a realistic driving system. Our simulation is easily expandible, with capability for a virtual reality environment through compatible cameras and a steering wheel with acceleration and deceleration pedals.

All programming was done in Python and C/C++ using the open-source Robot Operating System, ROS2 Galactic on the Linux distribution Ubuntu, with packages to support multiple IP camera transmissions.

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MSU Smart Microsystems Laboratory
Visual Inertial Odometry For Underwater Laboratory

Established in 2004, the MSU Smart Microsystems Lab researches the general areas of robotics, dynamics, control, mechatronics, and smart materials. The mission of the Smart Microsystems Lab is to merge advanced modeling, control, and design methodologies with materials and fabrications to enable smarter and smaller integrated systems. The focus of current research is on electroactive polymer sensors and actuators, bio-inspired underwater robots, and underwater mobile sensing.

Visual Inertial Odometry (VIO) is needed to help identify the precise location of the vehicle or device when the GPS signal is disrupted or not incorporated. This may happen when vehicles drive under bridges, or underwater robots dive in the ocean. VIO will use cameras that are built into the device to determine its position and orientation. The cameras will be used to scan the April Tags to receive the x-y coordinates. The information being analyzed will be processed within the software and a GUI will display the estimated location to the user.

Ultimately the final design will be capable of displaying a 3D model of the robot's route error with an accuracy of 5% and a heading accuracy of 2%.

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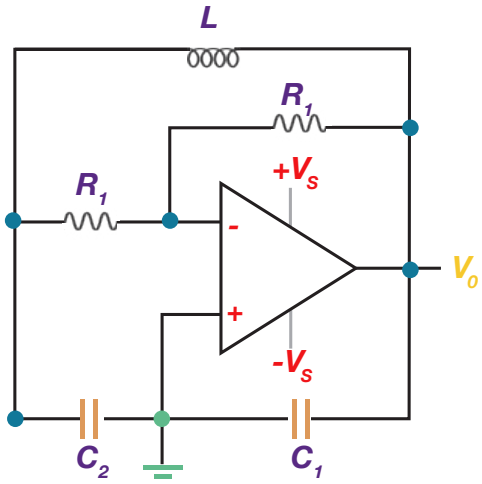
MSU Diamond Laboratory
Diamond Plate Thickness Measurement

Michigan State University is home to one of the largest diamond growing facilities in the nation. This facility grows single crystal diamonds so well that special tools are needed to see the difference between one grown in the lab and one mined underground. These diamonds are being used for research with electrical components that require both a high degree of accuracy and an ohmic contact with other components. However, before being used in the components, the diamonds must be prepared accordingly.

One of the many processes involved in preparing the diamond for use is polishing the diamond so that the surface is smooth, and the diamond will maintain a solid connection with other components. In this polishing, however, a small portion of the diamond's thickness is lost. As the quality of the diamond varies, the amount of thickness removed changes. Therefore, it is important to know how much has been removed. As the diamond is glued onto a stand before polishing, the engineers are forced to unglue the diamond plate to take any measurements. This process is tedious and adds significant time to the polishing process.

To resolve the problem, our team designed a capacitance circuit and holder, which is used to digitally display the thickness of a diamond plate. With this product, diamond plate polishers can determine how much substance is being polished off of the diamond without the need to remove the glue, measure with calipers, then repeat. Our system works as a simple device that takes a capacitance measurement of the diamond substrate and calculates the diamond plate thickness as determined by a user-input of the diamond plate area. This device will satisfy the key requirements to make this project successful. The device will measure capacitance during the polishing procedure and will be easy to move and use as needed in the lab.



Michigan State University
Team Members (left to right)

Ben Messiner
Royal Oak, Michigan

Jonathan Sparks
Jackson, Michigan

Cosmos Gyamfi
Manassas, Virginia

Surya Saravanakumar
Canton, Michigan

James Kervin
Bad Axe, Michigan

MSU Diamond Laboratory
Project Sponsor

Timothy Grotjohn
East Lansing, Michigan

Project Facilitator

Dr. Qi Hua Fan

MSU Department of Electrical & Computer Engineering
Wirelessly Powered Backup Camera

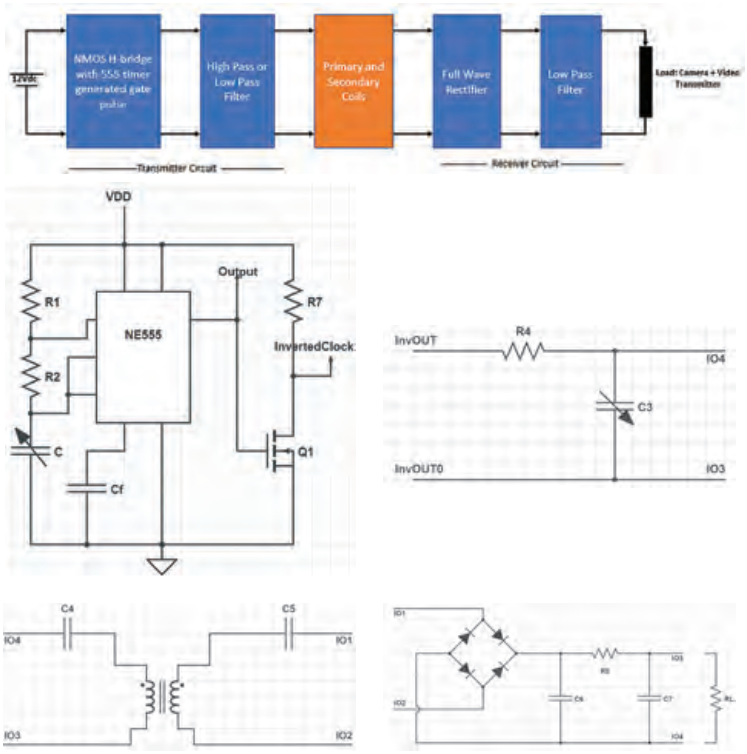
Honda's Ridgeline trucks have a known problem with the backup camera failing. The camera, which is located just above the handle for the tailgate is powered by the 12Vdc battery. The connection is made by old fashioned wire, which traverses across the hinge point of the tailgate.

For the past four years, Ridgeline trucks have been designed with a dual action tailgate. This tailgate opens in the normal manner and can also swing open sideways like a door. This extra movement causes additional stress on the cable that is responsible for delivering power to the camera and the video transmitter.

The goal of this project is to develop a wireless power transmission (WPT) system that is powered by 12Vdc and delivers 12Vdc to the load. A 12Vdc battery already exists within the Ridgeline truck which will serve as the main power source for the system. The load is made up of two components: a video camera and a video transmitter. The video camera requires 110mA and 12Vdc and the video transmitter requires 200mA at 12Vdc. This system will need to provide at least 350mA of current at 12Vdc without affecting any other electrical components in the truck.

Inductive coupling between a primary coil and a secondary coil is utilized to complete the wireless power transmission. The coils are placed in the gap between the tailgate and the truck's taillight. Therefore, the system will only be operable when the tailgate is in the closed position.

Successful completion of this project will provide the Honda Ridgeline truck with an alternative way to deliver power to the backup camera without the need of physical wire connection. This system may even have the flexibility to be implemented into other truck models that are experiencing similar issues.



Circuit Schematic Key: 555 Timer (Top Left), Transmitter Low Pass Filter (top right), Primary and Secondary Coils (bottom left), Full Wave Rectifier (bottom right)

College of Engineering
MICHIGAN STATE UNIVERSITY

Michigan State University
Team Members (right to left)

John Slivka
Manistee, Michigan

John Paul Hanna
Farmington, Michigan

Fuad Sabit
Dhaka, Bangladesh

Prince Funwie
Farmington, Michigan

Francis Kasmikha
Farmington, Michigan

Michael Scruggs
Macomb, Michigan

MSU Department of Electrical & Computer Engineering
Project Sponsor

Tim Hogan
East Lansing, Michigan

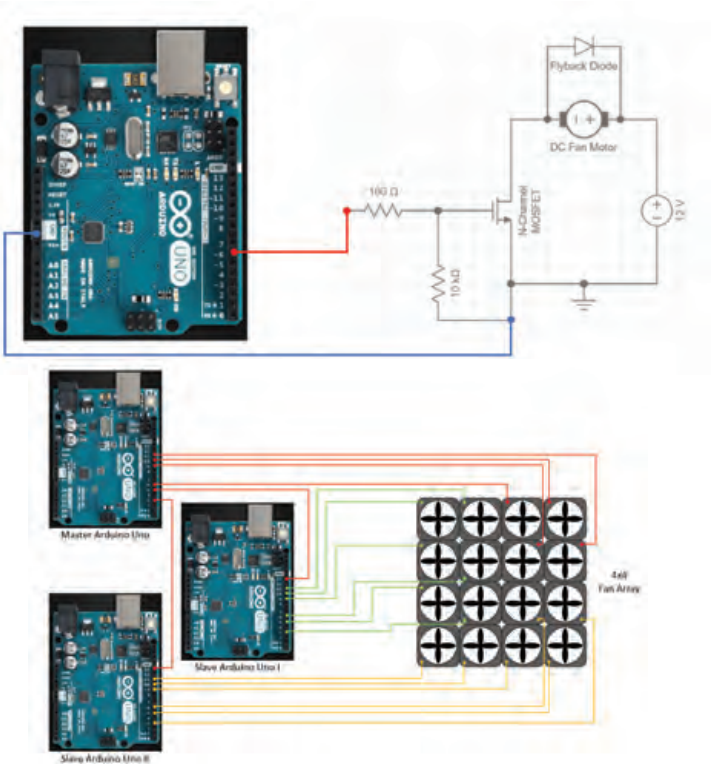
Project Facilitator

Dr. Panagiotis Traganitis

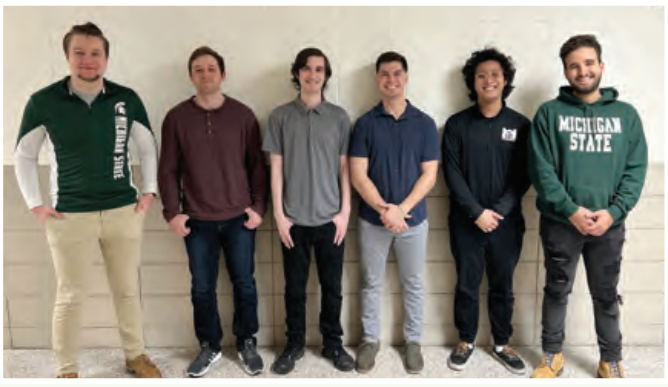
Michigan State Biomedical Engineering
Wind Tunnel for Molecular Communication

Molecular Communication is an emerging technology inspired by the molecular communication found within living organisms. This idea consists of conveying information via molecules within a controlled medium. It would potentially enable electrical devices to interface with biological cells for biomedical applications due to it being the natural way information is transported in the body on a microscale. This also would allow electrical devices to communicate with each other without the need for connecting wires, as the molecules will be able to travel through the air. One difficulty with this idea is the ability to control the direction and flow of molecules.

Our team's goal is to design and construct a wind tunnel to allow control of the flow of molecules on the macroscale. This will be achieved by creating a 4x4 array of fans that will have three different intensity settings. By combining fans with different intensity settings, the direction airflow can be altered. This will be done using a set of Arduinos wired to the fans. Overall, the device we create will enable the user to alter the direction of airflow using a GUI that will interface with the Arduinos and change the fan's intensities.



BIOMEDICAL ENGINEERING



Michigan State University
Team Members (left to right)

Joe Kieta
Livona, Michigan

Brett Williams
Kawkawlin, Michigan

Mason Rice
Northville, Michigan

Garrett Vangilder
Davisburg, Michigan

Phong Hoang
Saline, Michigan

Alihelmael Avilés Sánchez
San Juan, Puerto Rico

Michigan State Biomedical Engineering
Project Sponsor

Bige Unluturk
East Lansing, Michigan

Project Facilitator

Dr. Robert McGough

ECE Fall 2022 Awards

FIRST PLACE AWARD

Team Fraunhofer USA, Center Midwest
Control System for Microfluidic
Electrochemical Sensing

Left to Right:
Timothy Boyd, Spencer Barrer, Conner Graham,
Daniel Hawkins, Kent Bazman

SECOND PLACE AWARD

Team Magna International Inc.
Radio Frequency Power Transmission System

Left to Right:
Elijah Savoie, John Murdoch, Carter Mayfield,
Jennifer Rousseau, Daniel Karczmarczyk

THIRD PLACE AWARD

Team MSU IPF Power and Water/Consumers Energy/Sartorius
Sustainable Energy Via Machine Learning

Left to Right:
Patrick Bourke, Sarah Anderson,
Koltin Grammar, Ming Gu

ME 412 Heat Transfer Laboratory

Yuping Wang
Academic Specialist
Department of Mechanical Engineering

Cooling with a Vortex Tube

Among a variety of cooling systems that are designed to meet thermal management needs, the vortex tube cooler has some distinct advantages and is found in many applications in spot cooling or enclosure cooling (such as machining tool cooling and CPU cooling). A Ranque-Hilsch vortex tube is a simple, compact, light mechanical device that separates a single inflow of compressed air into two outflows – one hot and one cold. For this project, each student team is to design, build, analyze, and test a vortex tube. The objective is to provide sufficient cooling to a heat-generating spot. Through the process, students are expected to understand the operating principles of vortex tubes and to analyze/predict its performance with existing models. A second part of the project is for each team to conduct a review on cooling methods in general. On the testing day, compressed air and temperature measurement instrumentation will be provided. Each team will have 15 minutes to set up, demonstrate, and disassemble their device. In addition, they will also prepare a power-point slide show or video clip for the audience to explain their design decisions, fabrication, operation and analysis of their device.

Time	Station	Team Members
8:00	A	Nicholas Coubard, Andrew Culver, Nathan Phelps, Logan Wells
	B	Chak Kwok, Zachary Lang, Ryan Pawlowski, Nicholas Sarver, David Shim
8:15	A	Jon Droste, Noah Goldman, Dexter Lynch, Bhanu Makkapati, Faizan Malik
	B	Mickey Atnafe, Brandon Esquivel, Ayaan Rajabali, Tom Seaman
8:30	A	Ben Finkbeiner, Jack Girling, Jonathan Jenkins, Connor Witham, Siyuan Zhang
	B	Jyotiraditya Chavan, Carson Kipp, Dan Mo, Zack Peterson, Matt Phelan
8:45	A	John Andres, Hailey Kelley, Nathan Kramer, Joe Lambert, Ravi Mody
	B	Alexandra Iorga, Anthony Montemayor, Brady O'Shea, Jacob Rupprecht, Kai Thin
9:00	A	Nick Dodge, Nolan Houghteling, Rachel Paul, Jessica Ray, Showgo Yoshida
	B	Omran Alawadhi, Paxton Angliss, Artik Chowdhury, Peter Olszewski, Kevin Roche
9:15	A	Erin Denby, Adam Fox, Noah Gilman, Kylie Kuskowski, Jordan Piatek
	B	Ryan-Cristofer Curamen, Muad Hassan, Vaibhav Himthani, David Olawale, Richmond Zhang
9:30	A	Augusto Cucala, Parker Hatherley, David LeVasseur, Tyler Paparella, Ricardo Paz Weber
	B	Edward Kim, Joe Nelson, Emily Peterson, Jack Whitcomb, Nathan Wright
9:45	A	Xiaoqiu An, Valentin Borjas, Zach Kranstz, Mert Ozmete, Austin Tait
	B	Christian Giggy, Matthew Jasgur, Jacob Keller, Frank Rhoades, Kyle Roland
10:00	A	Philip Jeon, Justin Miller, Austin Shepp, Jake Stanesa, Calum Walton
	B	Shane Beers, Sean Lickfold, Najmi Rahim, Noah Schott, Zihan Zhang
10:15	A	Brendan Doane, Nicholas Michaels, Joey Rheaume, Noah Shephard
	B	Sohan Gupta, Jericho Herblet, Joe Kouchoukos, Jake Rutkowski, Michael Strong
10:30	A	Ashley Bolt, Matthew Bush, Thanh Mai, Kevin Upcott
	B	Bryce Houser, Jacob Huskin, Nicholas Lauinger, Connor Michel, Mitchel Semeyn
10:45	A	Cole Lutkenhoff, Lukasz Morales, Thaz Rahman, Jack Salisbury, Gus Tsalas
	B	Deaven Kirn, Zach Maccoux, David Mueller, Olivia Reyes
11:00	A	Waabe Damboba, Ross Davis, Kathleen Dewan, Eyob Mamo, Zoe Quinn
	B	Christian Jaraczewski, Olivia Lage, James Tanay, Alejandro Tlatelpa
11:15	A	Longfei Bao, Patrick Mullaly, Andrew Reddy, David Smith, Haosen Sun
	B	Scott Fingeroth, Arianna Finn, Nathan Jansen, David Knapp, Ciara Regan-Moore
11:30	A	Zaid Almodhi, Jonathan Elias, Khush Patel, Evan Petersen, Wade Varney
	B	Zachary Carpenter, Aaron Hopson, Matthew Lipscomb, Celeste Salazar, Ryleigh Turner
11:45	A	Faisal Alsuhaimi, Matt Candela, Derek Hanson, Dylan Huck, Matthew Price

ME 470 Mechanical Design & Manufacturing II

Michael Lavagnino
Academic Specialist
Department of Mechanical Engineering

Waste Collection Device

The goal in this project is to design a machine that can lift a ten pound filled waste container from the ground to an elevated bin. The teams will utilize mechanisms such as linkages, gear sets and cam-follower systems as well as a provided motor. Students will utilize materials and manufacturing capabilities from the Manufacturing Teaching Laboratory as well as premade components. The competition will be based on the amount of weight unloaded into the bin, the time it takes to unload the container and return it to its place, and the total weight of the mechanism.

Time	Team	Station	Team Members
8:00	1	A	Ahmed Abboushi, Faisal Alsuhaimi, Nicole Gibbons, Citizen Kim, Hunter Staton
	1	B	Luke Lemont, Jonathon Lewis, Matthew Mozariwskyj, Zack Peterson
8:15	2	A	Ryan Bolio, Alex Figa, Dylan Gumbinger, Luke Honer, David Twomley
	2	B	Waabe Damboba, Nolan Hoffman, Jackson Rayer, Brendan Zwiernik
8:30	3	A	Longfei Bao, Alexander Choma, Rafael De Assis Zanetti Pinto Abage, David Mueller
	3	B	Graham Bailey, Jacob Bruck, Isaiah Devougas, Wil Jozwiak
8:45	4	A	Luke Aman, Ryan Cyrowski, Mark Kemp II, Arron Stebic
	4	B	Daniel Carrillo-Solis, Zach Doerr, Dexter Lynch, Noah Schott
9:00	5	A	Lochlann Dunlavey, Sampath Eaty, Bryant Hixson, Jason Li
	5	B	Alejandro Tlatelpa, Tate Virkus, Lesheng Zeng, Richmond Zhang
9:15	6	A	Matthew Jasgur, Braeden Keener, Nic Stoller, Yang Yi, Lingyi Zhao
	6	B	Ethan Avery, Steven Coscino
9:30	7	A	Nico Boehlert Somohano, Carter Stefanovski, Saketh Vaka, Tyler Wysocki
	7	B	Jordan Arnold, Josh Bennett, Anirudh Menon, Angel Perez
9:45	8	A	Abel Barraza, Cody Bartos, Tommy Erickson, Manuel Hudecek
	8	B	Omran Alawadhi, Brandon Gonzalez, Anita Patel, Ben Walters, Jeffrey Zhou
10:00	9	A	Haley Denton, Reagan Ferschweiler, Sydney Kelly, Kory Knickerbocker, Adam Peckens
	9	B	Jenni Aubin, Ethan Azeez, Kailey Head, Aliza Opolka
10:15	10	A	Muad Hassan, Amjid Khogali-Watson, Thaz Rahman, Nick Sarafian, Brandon Tsivitse
	10	B	Stefan Bellman, Henry Kantzes, Joe Lambert, Garrett Martin
10:30	11	A	Hunter Arnett, Matt Fular, Carson Kipp, Zach Maccoux, Alex Rodriguez
	11	B	Nick Aseritis, Ellie Clark, Owen Garber, Ethan Labelle
10:45	12	A	Chenghan Cai, Jonathon DuFresne, Josh Heibeck, Logan Roeser-Nordling, John Salloum
	12	B	Charles Mercer, Marianna Osentoski, Ryan Prost, Celeste Salazar
11:00	13	B	Alexander Arnold, Bhanu Makkapati, Luke Roethemeyer, Trent Warren
	14	B	Vedi Patel, Adam Stevens, Aidan Svoboda, Nathan Wright
11:15	15	B	Michael DuFresne, Brendan Foster, Dan Mo

ME 478
Product Development

Patrick Kwon
Professor of Mechanical Engineering

Design and Demonstrate a Mechanical System for 3D Printing

The objective is to develop a mechanical system to be adopted by 3D printing machines, which can be categorized as Binder Jet Printing (BJP), Fused Deposition Method (FDM), or Scalable and Expeditious Additive Manufacturing (SEAM) using powder (sand) and resin (olive oil).

The requirements of the system are the following:

1. The system should be capable of combining and homogeneously mixing a solution of 1:4 weight ratio of olive oil and sand (i.e., 5 grams of oil and 20 grams of sand).
2. At minimum the sand should be deposited in a 1 mm thick layer on a 10 X 10 cm platform in a controlled manner.

Presumably, the system might consist of:

1. A material supplying module: this module is capable of spreading sand and depositing oil selectively with a specific weight ratio for BJP and spreading the mixture for FDM and SEAM.
2. A mixing module: mix the oil and sand to form the homogeneous solution for FDM and SEAM.
3. A deposition module: deposit a certain amount of the sand or mixed solution (10 grams).

Evaluation criteria:

1. The homogeneity of the solution or deposited sand layer will be inspected visually.
2. The quantity of the deposition will be based on the weight of each deposition.

The electric motors must be controlled by MyRio which will be provided together with a few motors. Starting from an individual project and progressing into a team project, each student needs to contribute individually, as well as collaboratively, to accomplish a series of tasks. Each team must produce the machine through a series of design and manufacturing tasks. CAD/CAM packages, CNC machining, rapid prototyping, testing, etc. will be used to produce the machine.

Teams and Team Members

Group BJP-A:
Kylie Carbary
Nick Dodge
Jack Konitsney
Matt Phelan
Jake Stanesa

Group BJP-C:
Graham Bailey
Jonathon DuFresne
Aaron Hopson
Hailey Kelley
Gus Scheier

Group BJP-E:
Syn Chua
Martin Mastrangelo
Rachel Paul
Joey Rheaume
David Smith
Cole Treece

Group FDM-B:
Seth Bacon
Thomas Burgess
Waabe Damboba
Will Jozwiak
Luke Lemont

Group SEAM:
Kylie Kuskowski
Lizette Mina
Lucas Russell
Ryleigh Turner
Conner Witham

Group BJP-B:
Ryan-Cristofer Curamen
Thanh Mai
Aliza Opolka
Evan Petersen
Janina Wollgarten

Group BJP-D:
Jeffrey Li
Jan-Luca Lubbers
Nicholas Sarver
Andrew Tabaka
Austin Tait

Group FDM-A:
Scott Castor
Scott Fingeroth
Mert Ozmete
Sarvesh Subramanian
Xiaobo Wang

Group FDM-C:
Nathan Jensen
Matthew Lipscomb
Noah Moyer
David Olawale
Emily Peterson

ME 497
Biomechanical Design

Dr. Tamara Reid Bush
Professor and Interim Chair of Mechanical Engineering

MKT 420
New Product Development

Dr. Hang Nguyen
Associate Professor of Marketing
Business College

Biomechanical Design and New-Product Development

The Biomechanical Design and New-Product Development course (ME 497/MKT 420) provides students with a unique opportunity to develop and market a real, new product that incorporates biomechanical function. Students work in inter-disciplinary teams of engineers and marketers and experience the entire process of new product development, from need identification, concept generation and testing, to product development, design analysis and launch. This course further strengthens students' knowledge and real world exposure by working with Spartan Innovations. This year General Motors provided $100 per team for prototyping costs and the Mechanical Engineering Department Endowment sponsored an in-class competition providing awards to the top three product

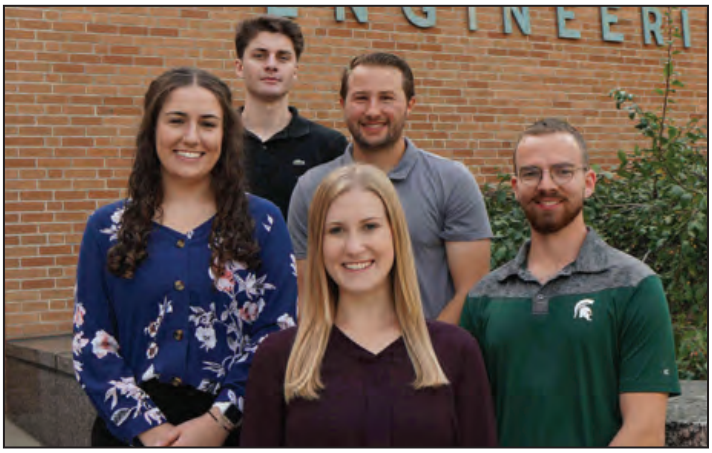
Team	Team Members	Team Slogan
01	Nicolas Basirico, Matt Baylis, Valentin Borjas, Van Duong, Kyle Pahl, Hunter Vandenbossche	**Pet Elevator:** "Raising your pet to new heights" An elevator system to assist lifting your pet
02	Nick DeBaker, Kaytlyn Gannon, Bennett Guensche, Dylan Huck, Jordan Piatek, Ben Richard	**Unlockware:** "Unlockware anywhere"
03	Haley Denton, Zoey Gendler, Nicholas Lauinger, Vedi Patel, Anna Traumuller, Nathan Wright	**Close Up:** "Close the door on back pain" An automatic assist with the dishwasher
04	Justin Gauthier, Jonathan Kaplan, Nathan Karns, Mert Ozmete, Jessica Ray, Grant Sonnenberg	**Quick Click:** "Lock and Load" A system to quickly lock a wheelchair user into a rollercoaster
05	Ellie Bartholomew, Kathleen Dewan, Emily Laing, Bella Rallis, Sophie Weitzel	**SlickSoap:** "How can something so clean be so dirty?" A novel device for soap dispensing
06	Ryan Bolio, Liam Gough, Parker Grover, Wil Jozwiak, Benjamin Jugan	**AdjustaGrip:** "Your health is in your hands" A universal weight-lifting device
07	Erin Chynoweth, Ellie Clark, Victoria Gavilan, Katherine Martin, Courtney Smith	**The Hockey Helper:** "Get into the swing of things" A wheelchair assist device for using a hockey stick
08	Grace Elder, Rachel Hulbert, Josh Ilkka, Lauren Osiwala, Josh Sobanski	**Anti-Slip Shoe Grip:** "All grip, no slip" A holder to assist users with putting on their shoes
09	Mickey Atnafe, Osh Mwakwari, Jordan Robinson, Matthew Russell, Dhruv Wadhawan	**EZCap:** "Twist, sip, and seal with ease – EZCap" A new design for your beverage lid
10	Taku Benson, Jillian Dempsey, Amanda Jeffers, Gerald Perry, Noah Shephard	**Clutch Up:** "Life within reach" A novel, adjustable grabbing device for elevated items
11	Ben Alonso, Nico Bakenhus, Gabe Dillon, Ben Mutz, Jacob Rupprecht, Jack Salisbury	**Flex Boot:** "Heal Simply" A home rehab system for the ankle
12	Diya Banerjee, Brendan Doane, Brandon Gonzalez, Nathan Kowalski, Cole Lutkenhoff, Judith Vazquez	**Sky Stroller:** "Stroll your worries away" A way to connect your stroller and luggage while traveling
13	Al Aiyash, Michael DuFresne, Sara Purdue, Carson Roodbeen, Zachary Whalen	**Helping Hand:** Assisting those who struggle with fine motor skills in their hands with stabilization and hand-grip capability

The ME 481 Fall 2022 Awards

LEONARDO DA VINCI AWARD

Left to Right:
Michael Lavagnino, Joe Nelson, Jon Droste, Minh Nguyen, Kyle Hellems
Not pictured: Andrew Culver

PRESENTATION AND EDISON AWARD



Team MSU College of Engineering.
"Mobile Storage for Easels"

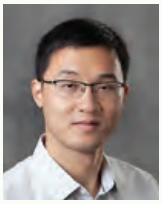
Left to Right, Back to Front
Mark McCloskey, Patrick Marchal, Michael Bachleda, Katie McMillan, Meghan Parkinson

The Capstone Projects

Dr. William Resh
Professor of Mechanical Engineering

Faculty Advisors: Seungik Baek, Tony Gao, Ricardo Mejia-Alvarez, Ahmed Naguib, Mohsen Zayernouri, Guoming Zhu


Baek


Gao


Mejia-Alvarez,


Naguib


Zayernouri


Zhu

Presentation Schedule – Engineering Building, Room 1202

Time	Team Sponsor	Project Title
8:00 a.m.	MSU College of Engineering	Combined Easel and Board Storage Cart Design
8:30 a.m.	MSU College of Engineering	Combined Easel and Board Storage Cart Design
9:00 a.m.	MSU College of Engineering	Easel Storage Cart Development and Production Build
9:30 a.m.	MSU Adaptive Sports & Recreation Club	Increased Roller Sled Mobility: Phase IV
10:00 a.m.	MSU Adaptive Sports & Recreation Club	Inclusive Sports Wheelchair: Phase VIII
10:30 a.m.	MSU Adaptive Sports & Recreation Club	Sled Hockey Transfer Platform: Phase VI
11:00 a.m.	MSU Adaptive Sports & Recreation Club	3-Wheel Drive System for Scooter: Phase 2

Mechanical Engineering Design Projects

ME 481 is a required course for mechanical engineering majors at MSU. The course provides students with a team-based capstone design experience in which they:

- Use the technical expertise, communication skills, and teaming methodologies they have learned throughout their mechanical engineering curriculum, together with their creativity, to solve real world problems
- Collaborate with practicing engineers to address problems sponsored by industry
- Develop new products or redesign existing products to reduce costs or enhance reliability and functionality
- Interact with large, medium, and small companies in the automotive, defense, aerospace, consumer products, and agricultural industries, and with US government agencies.

We gratefully acknowledge the participation support of this semester's project sponsors: Alro Steel, Asahi Kasei Plastics North America, Battleship New Jersey Museum & Memorial, Cleveland-Cliffs, Inc, Cobra AERO, Consumers Energy, General Motors, Hitachi Astemo Americas, Inc, Michigan AgrAbility, Michigan Chestnut Industry, MSU Adaptive Sports & Recreation Club, MSU AIDED Team, MSU College of Engineering, MSU Department of Mechanical Engineering, MSU Department of Theatre, MSU Solar Car Team, Our Next Energy, PPG Industries/MSU Formula Racing Team, UV-C Safe, Inc, and Wheels on Rails LLC.

MSU College of Engineering
Combined Easel and Board Storage Cart Design

Michigan State University was founded in 1855, conferred its first engineering undergraduate degrees in 1888, and has been a leader in research and teaching since that time. In preparing students for a future in the engineering field, numerous presentations and events are held. There are currently 11 undergraduate programs and 9 graduate programs, each of which participate in Design Day or the graduate research symposium. These are just two examples of when students and faculty display posters highlighting their projects to others at the university. The school currently owns 300 easels, foam boards, and binder clips used to display work across campus.

As of the beginning of the semester, the easels were stored in repurposed bakery carts with the trays removed, while the boards and clips were stored in cardboard boxes in laundry hampers. Both the bakery rack and cardboard boxes were not sturdy, nor convenient. The loading and unloading of easels was challenging and time-consuming, and the cardboard boxes that the posterboards were stored in were flimsy, leading to damage when not handled extremely carefully. Also, for shorter people, it was difficult to lift them out. Previously, it required multiple people to push both carts, which was inefficient when setting up and taking down. There were two existing improved carts provided by the sponsor, yet they only held easels. The combination of carts, boards, and clips on one vessel with a small storage footprint was essential for the college. Our goal was to create a cart that held 50 easels, 50 boards, and 250 binder clips. It was important to maximize sturdiness while minimizing weight since it had to be easy to move through doors and hallways, as well as outside when transporting it to different campus buildings. Lastly, loading and unloading the easels and posterboards had to be easy for one person to do.

College of Engineering
MICHIGAN STATE UNIVERSITY

Michigan State University
Team Members (left to right, top to bottom)

Ryan-Cristofer Curamen
Shelby Township, Michigan

Jaclyn Duff
Shelby Township, Michigan

Paxton Angliss
Flushing, Michigan

Emily Peterson
Farmington, Michigan

Beth Caldwell
Brighton, Michigan

Jessica Ray
Clarkston, Michigan

MSU College of Engineering
Project Sponsors

Sandy Christlieb
East Lansing, Michigan

Katy Colbry
East Lansing, Michigan

ME Faculty Advisor

Dr. Tony Gao

MSU College of Engineering
Combined Easel and Board Storage Cart Design

The Michigan State College of Engineering is one of the oldest and largest colleges on the MSU campus and strives to develop young aspiring engineers and prepare them for future careers. One of the ways it accomplishes this is by hosting yearly events that showcase Spartan talent and provide opportunities for students to create connections, attend seminars, and display their work. With the wide array of today's successful news and highlights, it is obvious that the College of Engineering members are pioneering leaders, embracing Michigan State University's tradition of advancing and transforming lives through innovative teaching and research.

Posterboards, along with the easels to hold them, are used at various events across the MSU campus. In the past the easels and posterboards were transported on a cart that was difficult to use and dangerous. Our goal was to design an ergonomic cart that is sturdy, allows for easier loading/unloading, and is safer than the current storage system. The new storage cart makes it easier to keep track of the easels in a safe and organized way. The foam board storage keeps the boards dry and protects against wear so they will not have to be replaced as often. Overall, the new cart is easy to manufacture and meets all the required needs specified by the College of Engineering.

College of Engineering
MICHIGAN STATE UNIVERSITY

Michigan State University
Team Members (left to right)

Valentin Borjas
Detroit, Michigan

Derek Hanson
Linden, Michigan

Austin Shepp
Flushing, Michigan

Greg Koenigsknecht
Lansing, Michigan

David Olawale
Ann Arbor, Michigan

Kyle Roland
Clarkston, Michigan

MSU College of Engineering
Project Sponsors

Sandra Christlieb
East Lansing, Michigan

Katy Colbry
East Lansing, Michigan

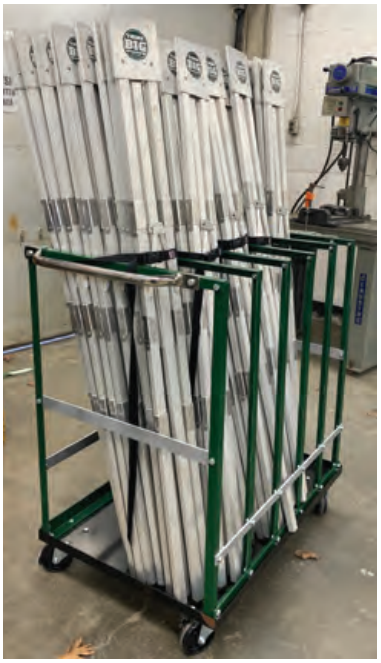
ME Faculty Advisor

Dr. Tony Gao

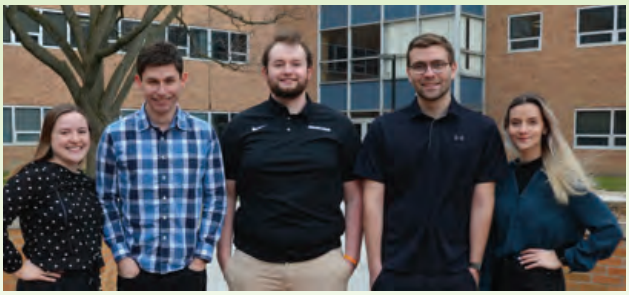
MSU College of Engineering
Easel Storage Cart Development and Production Build

The MSU College of Engineering was established in 1885, with the goal of providing an unprecedented learning environment to prepare students for their future careers in Engineering. The College of Engineering offers ten undergraduate programs and eleven graduate disciplines. The faculty and staff of the college transform lives and advance engineering knowledge through teaching and research.

The MSU College of Engineering hosts various events throughout the year, using easels to display event posters. The easels are stored on carts that carry up to 50 easels per cart. In Fall 2022, two easel storage carts were designed and built to replace the original cart design. It was imperative that the carts could be transported easily, the easels could be loaded and unloaded easily, and the number of easels on each cart could be easily counted. The goal of this project was to determine which of the two new cart designs would be best suited for long-term use and production manufacturing. To make that determination, testing of the carts and optimization of the costs was completed. Based on the selected design, three additional carts were built.



College of Engineering
MICHIGAN STATE UNIVERSITY



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MSU College of Engineering
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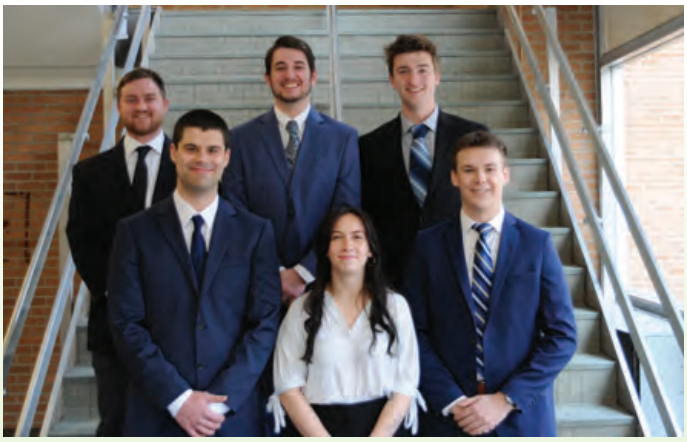
MSU Adaptive Sports & Recreation Club
Increased Roller Sled Mobility: Phase IV

Adaptive sports is growing at MSU and enables more and more people to participate in sports. From basketball to tennis to hockey, MSU Adaptive Sports is helping make more sports available to those with disabilities. The focus of this project is on hockey. Para ice hockey uses sleds to move around the ice so that users with decreased leg mobility are able to play hockey. The players use the ends of their sticks to push off of the ice and navigate around the rink.

Since ice time is very difficult to schedule at MSU, an existing hockey sled has been modified to work on hard playing surfaces like those in Dem Hall and Jenison Fieldhouse. The main goal of this project was to improve the mobility of the sled so that it acts as if it is on ice, while being used on a hard and uneven playing surface. We incorporated and enhanced the existing designs of the sled while maintaining the control and safety.

Michigan State University
Adaptive Sports & Recreation Club
Est. 2014



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MSU Adaptive Sports & Recreation Club
Inclusive Sports Wheelchair: Phase VIII

The MSU Adaptive Sports & Recreation Club is an organization in East Lansing, Michigan that has been offering free opportunities for people with physical disabilities to engage in a range of adaptive sports and games since 2014. It is a leading program that has created a safe and inclusive environment for people with disabilities and able-bodied volunteers to experience sports from an inclusive perspective. It provides a supportive and welcoming community that is continually innovating to create a place in sports for all people. The club promotes physical health, social behavior, and psychological wellness through adaptive sports and has established an integrated community through a variety of sports: sled hockey, wheelchair hockey, wheelchair rugby, and adapted track & field. The goal of the MSU Adaptive Sports & Recreation Club is to provide a self-determination approach focusing on athlete autonomy, competence, and relatability, leading to success both in sports and in other domains to ultimately improve their quality of life.

This project focused on the eighth phase of the inclusive sports wheelchair designed for an ambulatory individual with asymmetrical functionality who is also an active participant in the MSU Adaptive Sports & Recreation Club. In the seven previous iterations the steering, braking, and propulsion systems were modified to increase the effectiveness and robustness of the wheelchair. The ultimate goal of this eighth phase of the project was to further improve the overall performance of the wheelchair by building on the work of previous teams and incorporating the feedback of the intended user very closely. Some components the team strived to modify in this iteration included the stability and reliability of the chair. These improvements will hopefully allow the intended user to participate in their favorite sport, tennis, and other adaptive sports with maximum comfort and ease.

Michigan State University
Adaptive Sports & Recreation Club
Est. 2014

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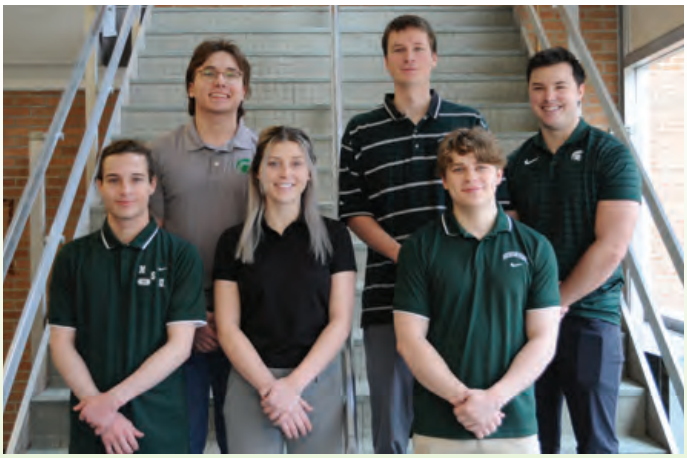
MSU Adaptive Sports & Recreation Club
Sled Hockey Transfer Platform: Phase VI

MSU's Adaptive Sports & Recreation Club is an organization that promotes health and physical activity for those with physical disabilities. The goal of this group is to provide opportunities for all by working against societal limitations that prevent access to sports. Allowing for easier access to sports gives players the opportunity to participate in independent, healthy, and social activities. The program adopts a self-determination approach that focuses on athlete autonomy, competence, and relatedness as key facilitators in the process of acquiring self-efficacy in the area of sports and physical activity. MSU Adaptive Sports & Recreation Club continuously creates applied academic initiatives for MSU students, which are intended to increase understanding of disability via engineering designs.

Our team focused on the sled hockey docking mechanism. The design involved using the existing sled hockey transfer platform from Phase V and modifying the docking mechanism to accommodate the needs of individuals with physical disabilities. The design is to enhance the users' independence while using the transfer platform and docking mechanism. The changes revolved around safety, ease-of-use, and accessibility.

Michigan State University
Adaptive Sports & Recreation Club
Est. 2014



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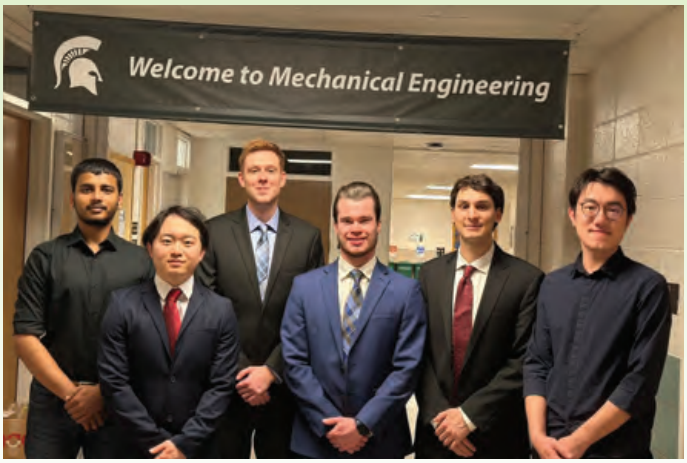
MSU Adaptive Sports & Recreation Club
3-Wheel Drive System for Scooter: Phase 2

MSU Adaptive Sports & Recreation club provides opportunities for athletes with physical disabilities to participate in sports. The club provides a variety of sports such as wheelchair hockey, wheelchair basketball, wheelchair rugby, and other events for student participants. Through sports, the Adaptive Sports & Recreation Club's goal is to help improve the physical health of the athletes and create a socially acceptable space for those participants. The Adaptive Sports and Recreation club strives to provide a variety of sports equipment that people of all different backgrounds can use.

In Phase 2 of the project, the main goal was to create a three-wheel drive system on the mobility scooter. By implementing a three-wheel drive system, the mobility scooter would be able to operate in inclement weather and provide more autonomy for physically disabled individuals. Phase 2 continued the progression of Phase 1, where a motor was installed on the front wheel. By connecting the original two-wheel drive system in the rear to the system installed prior, the scooter will have power to all three wheels. With some tuning to provide correct torque to each system, the goal will be achieved.

Michigan State University
Adaptive Sports & Recreation Club
Est. 2014



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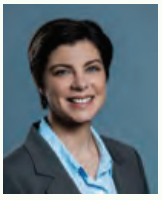
Cloud


Mukherjee


Mueller


Roccabianca


Wichman

Presentation Schedule – Engineering Building, Room 1220

Time	Team Sponsor	Project Title
8:00 a.m.	Michigan AgrAbility	Tractor Manlift Finite Element Analysis
8:30 a.m.	MSU Solar Car Team	Electric Vehicle Powertrain Development
9:00 a.m.	PPG Industries/MSU Formula Racing Team	Carbon Fiber Reinforced Polymer Wheels
9:30 a.m.	Michigan Chestnut Industry	Chestnut Harvester Design
10:00 a.m.	MSU Department of Mechanical Engineering	HPVC Build Table Design and Fabrication
10:30 a.m.	MSU Department of Theatre	Paint Can Shaker

Mechanical Engineering Design Program

Mechanical engineers make the world move and provide the energy for it to do so. One goal of the MSU Mechanical Engineering Program is to educate engineers who are prepared to lead, create, and innovate as their professional or graduate careers evolve. The Mechanical Engineering Design Program is the key element of the curriculum that supports this goal. There are five required design courses in the program which provide our students with eight hands-on team-based, 'design, test and build' projects, and numerous opportunities to practice and refine their written, oral, poster, and video presentation skills. The Design Program in Mechanical Engineering has attracted national recognition on many occasions and helps to distinguish the ME program as one of the best in the country.

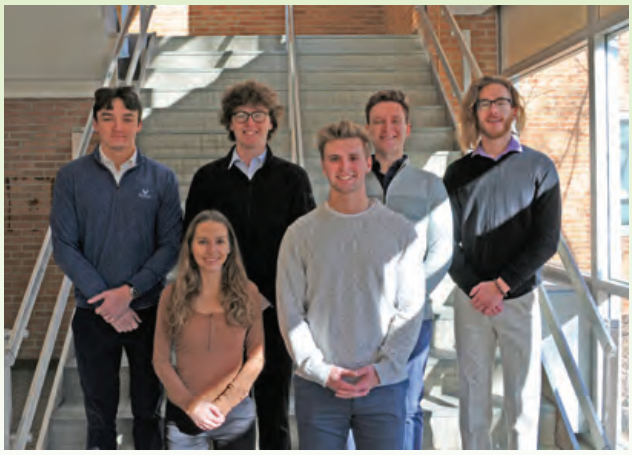
The ME faculty who supervised ME 481 design teams this semester are: Seungik Baek, André Bénard, Giles Brereton, Sunil Chakrapani, Haseung Chung, Gary Cloud, Abraham Engeda, Tony Gao, Farhad Jaberi, Lik-Chuan Lee, Zhaojian Li, Ricardo Mejia-Alvarez, Norbert Mueller, Ranjan Mukherjee, Ahmed Naguib, Thomas Pence, Sara Roccabianca, Harold Schock, Indrek Wichman, Neil Wright, Xinran (Sharon) Xiao, Mohsen Zayernouri, and Guoming Zhu.

Michigan AgrAbility
Tractor Manlift Finite Element Analysis

Michigan AgrAbility provides critical assistance to enable people in the agricultural industry with an injury, illness, or disability to continue working. With Michigan's farmer population reaching an average age of 60, this continues to be a growing issue for farmers, especially in Michigan. Farmers with mobility impairments due to spinal cord injuries, amputation, stroke, or other conditions cannot climb the steps and ladders to tall farming machinery. Michigan AgrAbility helps farmers find ways to continue doing what they love by researching and developing useful farming tools, equipment, and methods to improve farmers' ability to work on their farms. They work closely with a network of private funding organizations, including Michigan Rehabilitation Services, to provide these services.

The goal of this project was to apply finite element analysis on the manlift design that is currently used by farmers in order to propose improvements to its overall design. Some issues with the current design include the fact that it is overdesigned and weighs more than the farmers would like. This project is to address these issues without jeopardizing the structural integrity or safety of the manlift. In order to accomplish this, the main focus of the analysis was to identify all potential weak spots in the original manlift design. Our group worked to eliminate these weak spots by changing the structure and material of the manlift, taking into account various conditions the manlift might experience on the farm. With our finalized project, Michigan AgrAbility will be able to use our improved manlift design in farms across the state to assist farmers with mobility impairments. Making its overall structure stronger will help reduce any potential injuries resulting from continuous usage of the manlift.

AgrAbility
easterseals MICHIGAN STATE UNIVERSITY Extension



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Michigan AgrAbility
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MSU Solar Racing Team
Electric Vehicle Powertrain Development

The Michigan State University Solar Racing Team is a student-led organization that competitively designs and races solar-powered vehicles. Since 2000 the team has competed in two different events, the Formula Sun Grand Prix (FSGP) and the American Solar Challenge (ASC). FSGP takes place on a racetrack where teams must complete over 600 miles throughout the course of three days. ASC typically spans across four states and over 2,000 miles. While the location varies from year to year, teams compete in as many miles as possible while trying to optimize their speed and efficiency. The MSU Solar Racing Team last competed in 2022 with a multi-occupant vehicle, Aurora, that had been in development since 2016. The team is planning to return with a new single-occupant car, named Cynisca, in 2024.

Throughout Aurora's design cycle, the team has been learning and looking for opportunities to improve their vehicle design. Currently Aurora, as well as most solar powered vehicles that compete in these two races, utilizes a hub motor. This is an electric motor that mounts directly to the wheel rim and propels the vehicle forward. While these motors are designed specifically for solar car competitions with very high efficiency, they are limited in torque and speed output. Since these are made to order and only produced by two companies, hub motors typically cost anywhere from $8,000 to $20,000. The objective of this capstone project was to explore the applicability of off-the-shelf DC motors that would utilize a gearbox to drive the car. The motor efficiency is lower than the hub motors and the system efficiency of the vehicle was increased due to the current-voltage characteristics of the new motor. Our team explored various electric motors, their output capabilities, designed a gearbox to tune the speed and torque produced, and manufactured the MSU Solar Team's first gearbox prototype.

MSU SOLAR RACING TEAM

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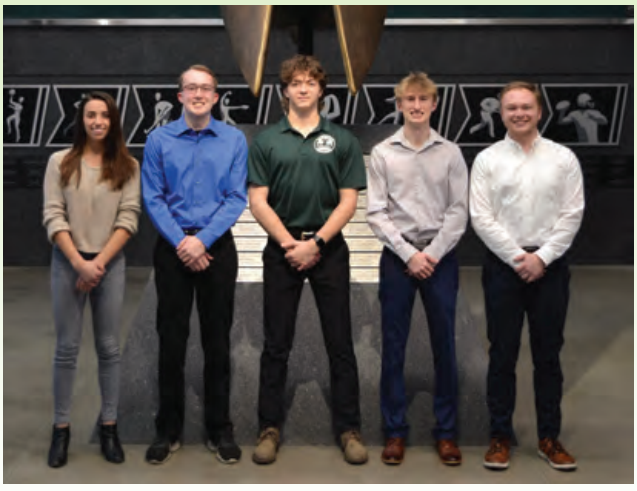
PPG Industries/MSU Formula Racing Team
Carbon Fiber Reinforced Polymer Wheels

PPG Industries is a global supplier of paints, coatings, and specialty materials, with over 135 years of experience in the industry. The company operates in over 70 countries and serves a diverse range of industries, including automotive, aerospace, industrial, and consumer goods. PPG is known for its innovation, quality, and commitment to sustainability, investing heavily in research and development to stay ahead of the competition. With its eco-friendly practices and environmentally friendly products, PPG is a leading example of a company that is both successful and socially responsible.

For the past 34 years, Michigan State University has taken part in Formula SAE (FSAE), a collegiate competition that challenges student-led teams to design, build, test, and race a small, open-wheel racecar against universities from all around the world. Over the past year, the Michigan State Formula SAE Team evaluated areas in which the vehicle could be improved. This project is to aid their performance gains and decrease simulated vehicle lap time by replacing the previously used stock OZ Racing wheels with optimized carbon reinforced wheels. Our team designed and manufactured a 7075-aluminum wheel spoke and multi-piece carbon fiber reinforced polymer barrel which are bolted together at six points and then mounted to stock wheel hubs on the vehicle's suspension system. To determine if the fabricated wheel would decrease simulated lap time, the spoke-barrel assembly was tested to determine weight, lateral stiffness, and moment of inertia. These parameters were input into a Lap Time Simulation and compared the vehicle's performance with the optimized wheel system to its performance with the OZ Racing wheel parameters. With this design, the MSU Formula Racing Team plans on producing a complete set of four wheels to be used on the vehicle in future competitions.

PPG Michigan State University Formula Racing Team



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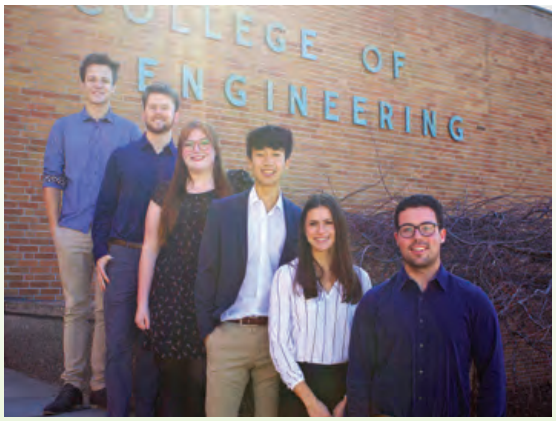
Michigan Chestnut Industry
Chestnut Harvester Design

The chestnut industry in Michigan is vast and expanding. Currently, Michigan is the top state for chestnut production. Chestnuts are a cultivated agroforestry type crop gaining popularity due to the generally low input production needs and excellent nutritional benefits, resulting in an eco-friendly and sustainable food source. In order for chestnuts to properly mature, they must first fully mature on the tree and fall out of their large spiny burs and onto the ground where they are then ready to be harvested. Currently small farms use a u-pick or handheld picking system for the chestnuts; and the large commercial farms use larger, powered machines, which tend to pick up everything. These machines have a secondary process for sorting the chestnuts from anything else collected from the ground.

The objective of the designed system is to acquire chestnuts from the ground and transfer them onboard an unmanned ground vehicle (UGV) for transportation to the collection site. The design can be attached to the UGV via the adjustable mounting system that enables universal use. The design uses electricity efficiently and eliminates unnecessary movements. This will provide time, cost, and environmental benefits. The UGV is capable of aligning itself with an accuracy of ± 10mm of the desired chestnut's centroid. Once the UGV is aligned, it will signal subsystems to transfer the targeted chestnut into our designed lifting mechanism. A big challenge was to design something that would get the chestnuts off the ground while also minimizing the chances of obstacles getting caught in the mix. These undesired obstacles include leaves, sticks, burs, and feces. The design is also able to adapt to chestnuts that are more difficult to extract from the ground due to varying grass lengths. Most importantly, the chestnut has biological variability, meaning the designed mechanism also adapts to chestnuts of various sizes and shapes.



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Michigan Chestnut Industry
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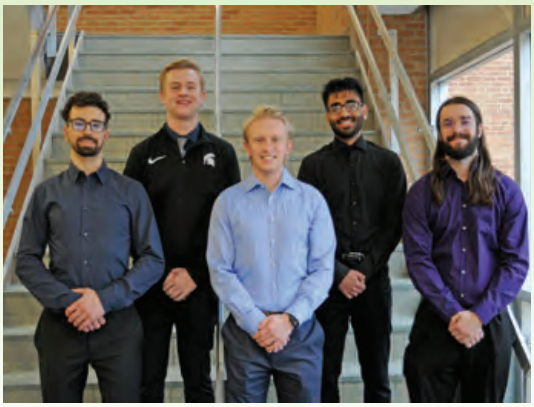
MSU Department of Mechanical Engineering
HPVC Build Table Design and Fabrication

The MSU Human Powered Vehicle Competition (HPVC) team is an organization made up of engineering students that have the objective of designing and manufacturing a three-wheeled vehicle, similar to a bicycle. This vehicle is used in competitions and other events where it can display its performance capabilities. Michigan State University's HPVC team asked for assistance in designing and fabricating a build table for their vehicle.

The purpose of this project was to build a table that could be used to efficiently fabricate and build a human-powered (three-wheeled) vehicle. This table was to be similar to a bedplate in both use and design, while being tailored specifically to the needs of the HVPC team. T-slots and holes were put in place to hold fixtures that would keep pieces of the bike in place as they were being welded or otherwise assembled. Specifications were given on the allowed deformation limit of the table and all fixtures during the build process. The table also had to be built in such a way that it could be moved without the need for heavy equipment. The team did a full 3D design of this bedplate and FEA verification before manufacturing the physical table itself. Existing materials and parts from 80/20 were utilized as much as possible to streamline the manufacturing process.

Ultimately this project will help the HPVC team as they begin to weld and assemble their vehicle, making the fabrication process of the vehicle easier and more efficient.

Department of Mechanical Engineering
MICHIGAN STATE UNIVERSITY



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MSU Department of Theatre
Paint Can Shaker

The Department of Theatre at Michigan State University "challenges the traditional, in order to create something new, unique and fresh." Each year, many shows and plays are created and performed in front of audiences wishing to receive a one-of-a-kind experience. To make this possible, the MSU Department of Theatre and the MSU Scene Shop work together to create large, detailed set pieces to bring theatre productions alive. The Department of Theatre boasts the most advanced stage technology available to students, which allows designers "the opportunity to defy conventional design." With massive projects and a busy schedule, the Department of Theatre needs fresh paint that is readily available. Working in partnership with the MSU Department of Theatre and the MSU Scene Shop, the problem of old, separated paint used for the construction of set pieces was solved by finding an effective "paint shaker" design to restore the old paint into usable paint.

Key elements addressed in this project were creating a system that would be strong enough to handle the size and weight of the paint cans, a design that would last a long period of time after multiple uses and one that would operate quietly. In addition, considerations for the safety of the operator, as well as those who would be working around the machine, were made at all stages of the design process. The main concern with paint is the separation of the oils as they sit for long periods of time, and how to effectively re-combine them. With a goal to reduce the manual labor needed to mix the separated paint, we designed a machine that mixes the paint quickly with the press of a button. Our process used oscillations to mix all layers of the separated paint and provide the right consistency for immediate use. A DC motor and a linkage system, which can be switched on and off by a control panel, supplied the desired motion on the paint. To combat vibrations and repeated use, our design is both resilient and robust.

MICHIGAN STATE UNIVERSITY
Department of Theatre

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Baek


Brereton


Mueller


Xiao


Zhu

Presentation Schedule – Engineering Building, Room 1300

Time	Team Sponsor	Project Title
8:00 a.m.	Battleship New Jersey Museum & Memorial	USS Monitor Mooring System
8:30 a.m.	MSU AIDED Team	Delivery Drone to Bus Charging Latch
9:00 a.m.	Our Next Energy	Trailer Hitch Force via Strain Gage
9:30 a.m.	Cleveland-Cliffs, Inc.	Cart Design for Moving Production Steel Rolls
10:00 a.m.	Cleveland-Cliffs, Inc.	Cart Design for Moving Production Steel Rolls
10:30 a.m.	Hitachi Astemo Americas, Inc.	Performance Characterization of a TMD for Vehicles

Mechanical Engineering Design Program Awards

The Mechanical Engineering Design Program makes two project awards on Design Day. The most significant award is the Thomas Alva Edison Design Award–a medal–given to each member of the ME 481 Capstone design team that produces the most outstanding technical design project. This award considers the team's performance over the duration of the project, their presentations, the project solution, and prototype quality.

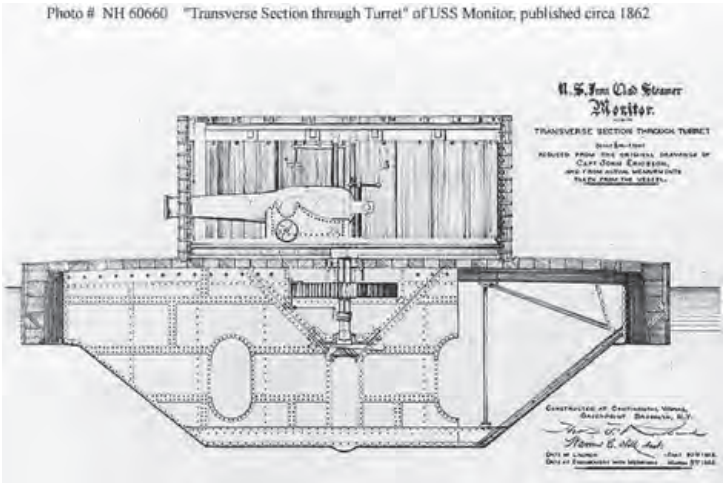
A second ME 481 Capstone award is given to the team that gives the best technical project presentation. The importance of communication of scientific and engineering ideas cannot be understated, and it is for this reason that we make the ME 481 Project Presentation Award. Award winners typically will have built an impressive prototype which forms the basis for a very clear and effective presentation of the project background and its solution, often incorporating live or video demonstrations of its functionality.

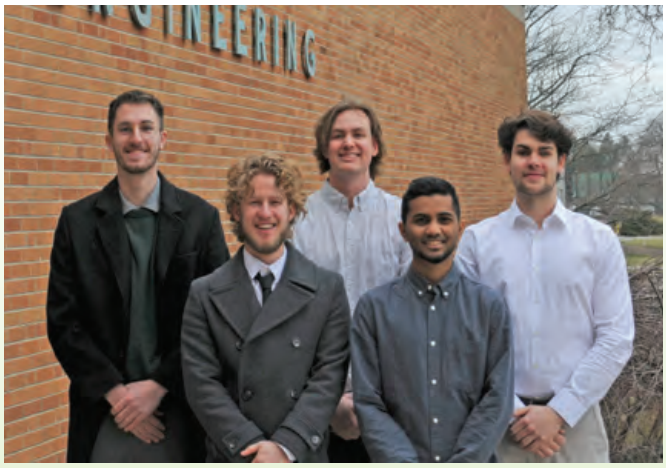
The ME Design Program also presents the Leonardo da Vinci Machine Design Award to the winners of its ME 470 Machine Design competition. The specific design problem and criteria for this competition change from semester to semester.

Battleship New Jersey Museum & Memorial
USS Monitor Mooring System

The Battleship New Jersey Museum & Memorial is a non-profit organization that maintains and operates the former warship Battleship New Jersey (BB-62) as a museum in Camden, New Jersey across the Delaware River from Philadelphia, Pennsylvania where the US Navy was founded on October 26, 1775. This floating U.S. Navy museum showcases the nation's military history from World War II to Korea, Vietnam, and active duty during the 1980s. The Battleship New Jersey Museum and Memorial's mission is to honor the legacy of the USS New Jersey and those who served on her by restoring, preserving, and exhibiting the ship's continuing history. They strive to inspire and educate future generations by showcasing the ship's role in our country's naval history.

The Battleship New Jersey Museum and Memorial is the host for the national celebrations of the 250th anniversary of the founding of the nation in Philadelphia in 2026. As part of the USA250 celebrations, and for years to come, the Homecoming 250 project is planning to construct a floating replica of the USS Monitor that will be moored alongside the USS New Jersey. To ensure the safe and cost-effective mooring of the USS Monitor, the project will require the design of a mooring system that fits the existing pier structure used by the Battleship. This will involve in-depth mathematical analysis of the current pier structure and mooring systems based on various climate conditions.





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Battleship New Jersey Museum & Memorial
Project Sponsor

Alaina Noland
Camden, New Jersey

ME Faculty Advisor

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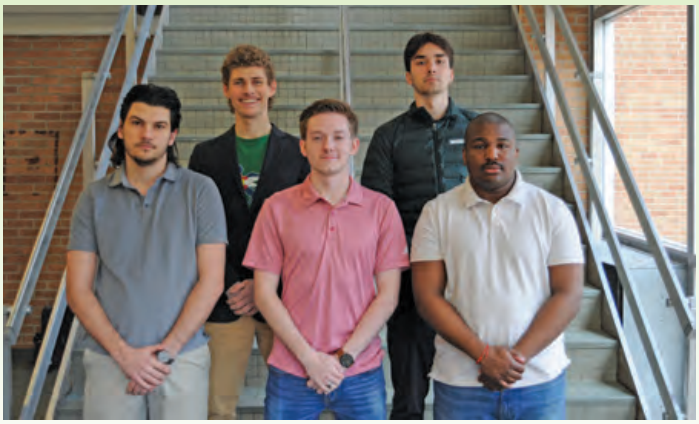
MSU AIDED Team
Delivery Drone to Bus Charging Latch

Aerial Intra-city Delivery Electric Drones (AIDED) is an undergraduate research group that is funded through a grant from NASA's University Student Research Challenge. AIDED aims to increase the range of generic multirotor package delivery drones with a safe, quiet, and affordable solution. In placing a drone latch on top of public transportation, the vehicle's range increases from around a mile to as far as the transit network's footprint spans. Using a proprietary routing and optimization software, drones can be directed from a hub to land on a bus, begin charging from it, and take off at a stop near the delivery destination. Having UAVs bring packages across town has become a contentious topic for the public. The AIDED solution reduces noise and flight risk by being on top of a bus in crowded areas rather than in the air, spending, on average, 90% of the distance on the transit vehicle. The research team is made up of 12 mechanical, electrical, computer science, and data science engineering students.

Around a year ago, a prototype of a latching solution was produced by senior mechanical and electrical engineers on the team. After hours of test landing and charging circuit design the idea was validated using a smaller, less expensive drone. Now this capstone team has been tasked with scaling up that latching solution to fit AIDED's 8-foot diameter and 20-pound payload capable drone, Hermes. The drone-bus latch features high quality manufacturing methods and materials like carbon fiber and SLS 3D printing. In practice, an infrared beacon at the center of the cone structure beckons the drone to land. Upon a successful connection between the drone and latch's charging circuit, four bars eject from the latch over a ring attached to the drone. The forces transmitted through this structure from the bus's acceleration has been simulated to ensure the drone stays secure.



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MSU AIDED Team
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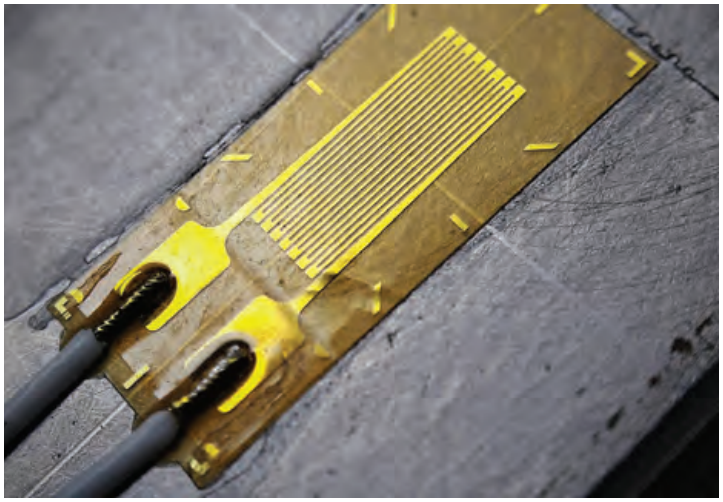
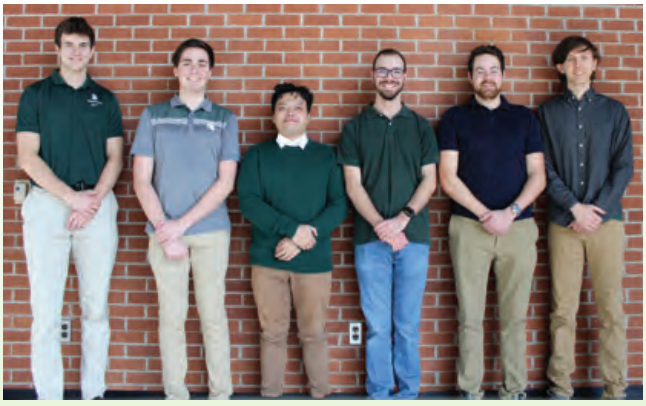
Our Next Energy
Trailer Hitch Force via Strain Gage

Our Next Energy (ONE) is a Michigan-born energy storage company focused on battery technologies that will accelerate the adoption of electric vehicles and expand energy storage solutions. The company's vision is to make electric vehicles a viable alternative for everyday use by utilizing cleaner energy sources for sustainability. ONE's mission is to improve and optimize batteries used in electric vehicles, providing more efficient power consumption that increases performance.

The goal of this project was to develop a force measurement system that could accurately measure the tractive load produced by a trailer, while canceling out all other forces such as bending and torsion. By attaching strain gauges in a certain orientation on our trailer prototype, we were able to achieve our goal as well as demonstrate an accurate force reading. With these data, a closed-loop control system can be fed with the measured force value, controlling an electric vehicle powertrain on the trailer that will make up for energy lost while towing. This project will create a better powertrain management system, thus reducing the cost and resources needed to manufacture the battery. At the same time, with less resources used, it aligns with ONE's vision of creating a more sustainable energy usage in the electric vehicle industry.



one
our next energy



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Cleveland-Cliffs, Inc.
Cart Design for Moving Production Steel Rolls

Founded in 1847 and now with 56 operating facilities, Cleveland-Cliffs, Inc. is the largest flat-rolled steel company in North America and is the leading supplier of automotive-grade steel. As a fully integrated plant, they are a self-sufficient mill that takes mined raw materials and scrap to produce all steel products. Cleveland-Cliffs, Inc. has committed to the ongoing sustainability goals in the U.S. and plans to improve water conservation and reduce carbon emissions by 25% by 2030. At the facility in Burns Harbor, Indiana, most everything sold are steel coils. These coils weigh from 50,000 to 80,000 pounds, and approximately 100 coils a day are moved to shipping, while the facility produces 500 coils.

Currently, these coils are moved one by one with a tractor, which is a very slow and inefficient process. The focus of this project was to design a cart that could carry between 4-5 steel coils at once to increase productivity. The cart had to be compatible with the tractor that has been used previously to move the coils, as well as the cranes inside of the facility, so they can be loaded onto the cart efficiently. Additionally, the cart had to support a static load of a weight upwards of 200 tons. The shafts of the cart also had to undergo fatigue analysis to ensure the cart was safe for maneuvering the facility. The design was created using CAD software Siemens NX, and Finite Element Analysis (FEA) was performed using Ansys.

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CLIFFS

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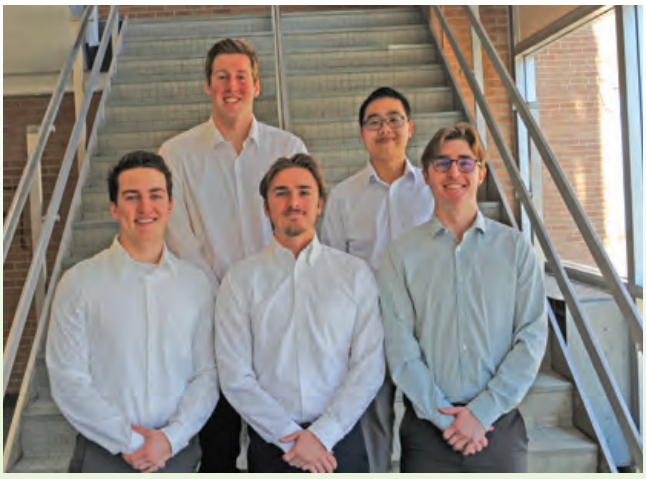
Cleveland-Cliffs, Inc.
Cart Design for Moving Production Steel Rolls

Cleveland-Cliffs is the largest flat-rolled steel supplier in North America. Their Burns Harbor facility, located in Northwest Indiana, is Cleveland Cliffs' second largest U.S. facility. Burns Harbor is a fully integrated steel mill, smelting raw iron ore pellets and casting them into slabs of steel. The plant can produce nearly 5 million net tons of raw steel annually, with their primary product being flat-rolled steel coils. Each steel coil produced at Cleveland-Cliffs weighs in the range of 50 to 80 thousand pounds. Due to their immense size, the coils are currently moved one-by-one into their shipping halls by a heavy-duty tractor. With approximately 100 coils moved per day, this process flow has proved extremely inefficient, creating a shipment delay risk. With such a high demand for these coils in the automotive, construction, and numerous other industries, Burns Harbor is in need of a solution to improve coil transportation within their plant.

Our team's task was to design a steel coil cart capable of transporting up to five coils at once between the production and shipping buildings at the Burns Harbor facility. Although manufacturing cost, cart functionality, and crane accessibility were key factors in the design process, operator safety remained the forefront of our design. Through the implementation of our steel coil cart, the total time spent in coil transportation between buildings will be cut by approximately 80% at the Burns Harbor Facility. Using materials available in-house and a compatible trailing mechanism, the steel coil cart design would be an innovative solution for the company to improve the logistics and efficiency in product transportation.

CLIFFS



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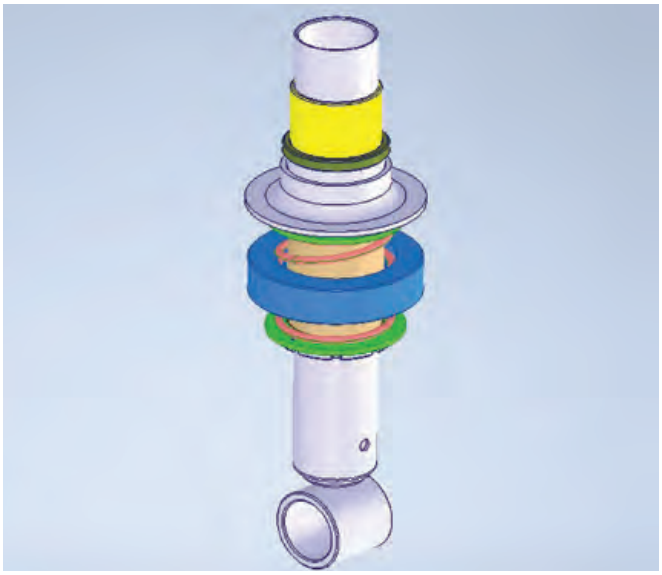
Hitachi Astemo Americas, Inc.
Performance Characterization of a TMD for Vehicles

With the global trend of electrification in passenger vehicles comes improvements to be made to these automobiles as well. One such example currently being developed by Hitachi Astemo is the use of tuned mass dampers within a vehicle's suspension to provide a smoother ride for the driver and passengers as well as improved handling capabilities. The use of a tuned mass damper as a part of a vehicle's suspension is by no means a new idea. It was first used in 1949 by French car manufacturer Citroën in their economy car—the 2CV. It was never of interest to other car manufacturers until 2005 when another French automaker, Renault, incorporated a tuned mass damper into their team's Formula 1 racecar—the Renault R26. This innovation would prove successful at cornering and gave the team a points lead ahead of their competitors until the regulatory body of Formula 1, the FIA, banned the use of tuned mass dampers in 2006.

Tuned mass dampers (TMDs) are used in many applications such as the reduction of lateral vibrations in tall buildings and communication towers, as well as the reduction in vertical vibrations in automobile suspensions. Their purpose is to reduce the vibrations that are in the system or affecting the system from the outside. The way a TMD can reduce the vibration of an existing system is by introducing a new mass that will oscillate out of phase with the same natural frequency as the system, resulting in deconstructive interference between the two oscillatory waves. In this project, a tuned mass damper will be developed and optimized for HITACHI's electric vehicles applications in the future.



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Professor of Mechanical Engineering

Faculty Advisors: Haseung Chung, Zhaojian Li, Thomas Pence, Harold Schock


Chung


Li


Pence


Schock

Presentation Schedule – Engineering Building, Room 2435

Time	Team Sponsor	Project Title
8:00 a.m.	Alro Steel	Plasma Burning Facility Process Improvements
8:30 a.m.	Asahi Kasei Plastics North America	Strand Management Application Process Improvements
9:00 a.m.	Wheels on Rails LLC	Rail Bike Design
9:30 a.m.	Wheels on Rails LLC	Rail Bike Design
10:00 a.m.	MSU Department of Mechanical Engineering	Design and Analysis of a Four-Stroke Hydrogen Engine
10:30 a.m.	Cobra AERO	Design of Two-Stroke Cycle Power Dense Engine

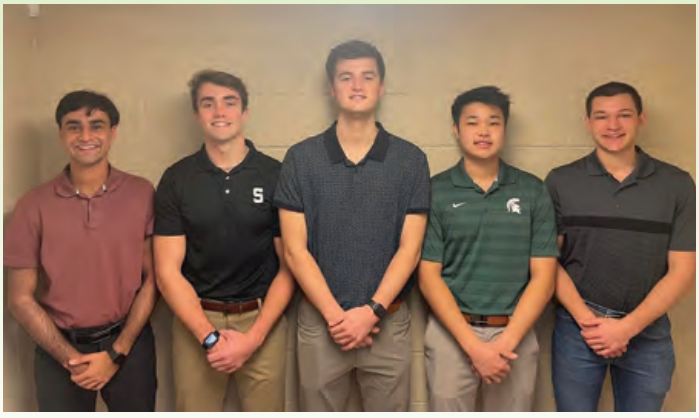
Mechanical Engineering Design Project Sponsorship

Interesting design projects that challenge the seniors in ME 481 and showcase the range of activities where mechanical engineers can work helps to make the Design Day experience special. The Design Program at MSU invites you to provide a challenging project for members of our senior class of mechanical engineers. As a sponsoring company, you introduce students to opportunities for ME students at your company; have the opportunity to create, build, and maintain relationships with students; benefit from the students' innovative design work; and bring the academic and working world together for them. Contact Jim Lang at langjame@msu.edu or 810.224.0055 to learn more about the opportunities to sponsor a design project.

Alro Steel
Plasma Burning Facility Process Improvements

Beginning in 1948, Alro Steel has transformed from a small garage in Jackson, Michigan to one of the largest distributors of metals, industrial supplies, and plastics. With 75 locations in 15 states, Alro Steel processes and distributes metals, plastics, and industrial supplies with next day delivery to over 50,000 customers in North America. Alro Steel offers a wide variety of processing capabilities to complement their metal and plastic products. For metals, they offer aluminum plate sawing, flame cutting, grinding, plasma cutting, plate laser cutting, etc. While there are numerous ways to process the raw material, each material is stored based on factors such as: length, thickness, grade, or even whether or not it's magnetic. As with any industrial metal processing, transport to and from the cutting machine can pose a safety risk, as well as some level of inefficiency. Specifically with the plasma cutter, Alro Steel wanted to know if there was a more safe and efficient way to store and transport the materials destined for the plasma cutting table.

Our team was tasked with developing possible solutions for the storage and transport of materials to and from the plasma cutting table, with worker safety being the top priority. We focused our attention to the unloading processes after the steel plate has been cut. After the plasma cutting has been completed, every steel plate must go to a separate area for an employee who then manually stamps out and collects each piece that has been cut and tabbed into that specific plate. We researched, formulated, and tested a new offloading system to increase the efficiency inside of the Alro Steel facility located in Lansing, Michigan. To compare our results with Alro Steel's current practices, we also determined the efficiency of the existing offloading processes for all the metal plates destined for the plasma cutting table.



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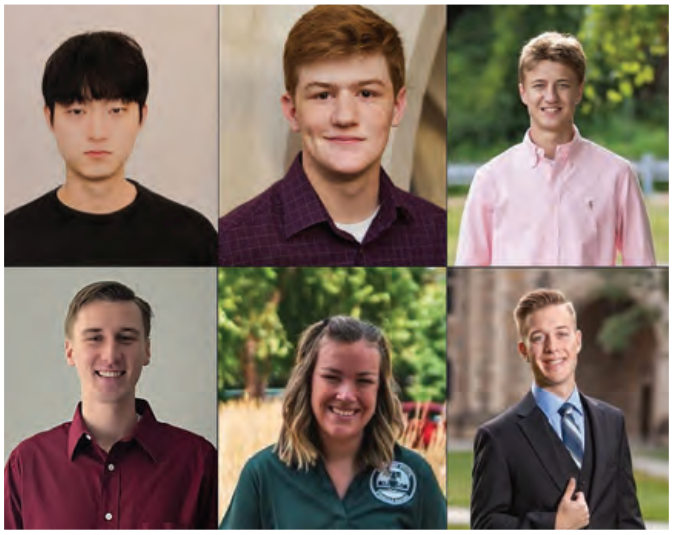
Asahi Kasei Plastics North America
Strand Management Application Process Improvements

Asahi Kasei Plastics North America, Inc. (APNA) is a leading manufacturer of innovative, high performance, engineered polymers and chemically coupled polypropylene resins in North America. With 12 pounds of product in just about every vehicle across the US, APNA's production lines require well engineered and managed manufacturing processes. APNA is deeply committed to contributing to the development of society and to anticipating in the emergence of new needs.

The task of this project was to make an improvement to the strand management during one of APNA's manufacturing processes. The design focused on strand placement and alignment as it enters the machinery to improve pellet quality and mitigate damage to expensive equipment. The design also works to remove excess water from previous manufacturing processes, preventing dripping, and improving safety on site. Finally, the design takes into account the abrasiveness of the material itself, allowing for minimal replacement and maintenance costs over time. The team hopes that, in addition to the current project, this design can be scaled and applied to lines across all of APNA's manufacturing.

AsahiKASEI
ASAHI KASEI PLASTICS NORTH AMERICA



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Fowlerville, Michigan

ME Faculty Advisor

Dr. Thomas Pence

Wheels on Rails LLC
Rail Bike Design

Wheels on Rails LLC is the first rail-biking excursion company in the state of Michigan. The company allows customers to ride on specially designed railroad bikes that coast down an inactive railroad track near Traverse City, Michigan. Macie Hefron, the owner of the start-up business, reached out to Michigan State University College of Engineering to help her create a railroad bike design of her own. The grand opening for the company is later this spring, when Macie will begin railroad bike tours.

The team was tasked with designing a custom railbike that is cost-effective to build and has several unique features. Some of these features include handicap accessibility, adjustable seats, bounce pads to prevent major damage upon collision, and a removable protective rain shield that will enable business to continue no matter the weather. Along with the design, the team conducted finite element analysis (FEA) to make sure the railbike design was safe. Also, the team provided Wheels on Rails LLC with a detailed cost analysis so the bikes would stay under a requested amount that was set by Wheels on Rails LLC. Finally, shop drawings were also made so that the bike can easily be manufactured by any build shop and not just our design team.

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Wheels on Rails LLC
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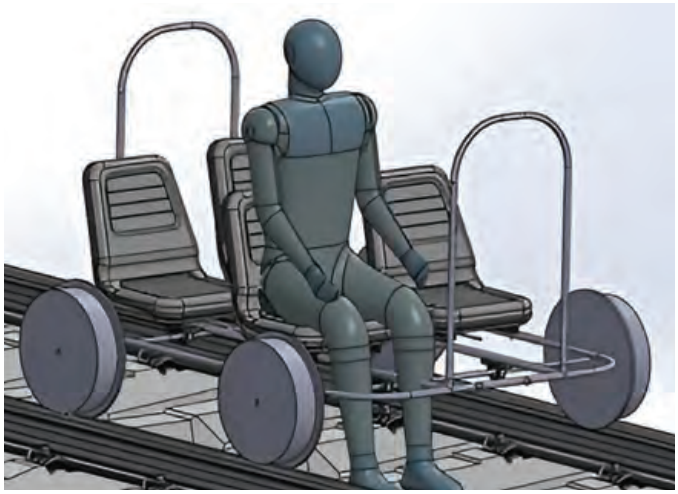
ME Faculty Advisor

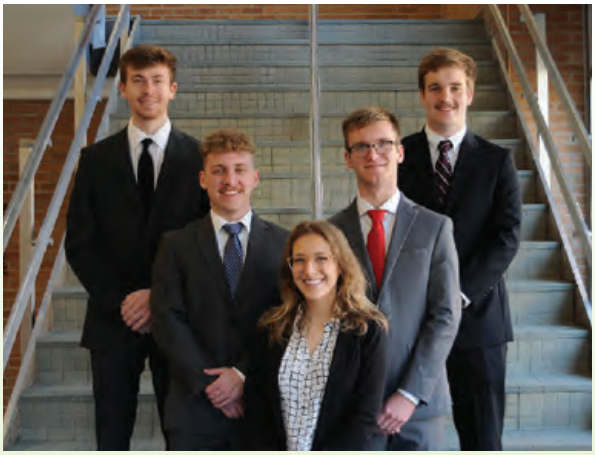
Dr. Thomas Pence

Wheels on Rails LLC
Rail Bike Design

Wheels on Rails LLC is the first company in the state of Michigan that allows rail bike riding tours on railroad tracks. They provide a new form of entertainment to the heart of Michigan that currently can't be experienced nearby. They provide accessible entertainment for people from a broad range of ages and physical mobility constraints. During this first season of operation, Wheels on Rails LLC is renting rail bikes at a high cost. Designing and creating their own rail bikes will save the company money, and improving the current designs will increase customer satisfaction.

Our team was tasked with designing a cost-efficient, improved rail bike and to aid Wheels on Rails LLC in the process of manufacturing the physical prototype. High strength steel tubing is provided to the company by Flash Steelworks, so a frame was designed with this material. In addition to designing the frame, improving upon current rail bike designs involved emphasizing a few key features. These features included increased accessibility to varying individuals' heights and mobility, storage of users' personal belongings, and weather coverage, which increased safety. All of these factors needed to be included while still maintaining a low final cost. The final design created also needed to be easily repeated so that multiple, identical bikes could be produced. Increasing accessibility included adjustable seats that enable people of varying heights to be able to comfortably reach the pedals and contribute to the movement of the bike. It also involved swivel seating to allow people with limited mobility easier access in and out of the seats. Increasing storage involved adding baskets for personal belongings and water bottle storage. A cover for the rail bike was designed as well to provide weather coverage, and it can be installed and removed depending upon the weather at the time of the riding tour. Lastly, front and rear bumpers were added to the bike design to allow for increased safety during a potential bike collision.





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Tim Potter (MSU Bikes Service Center)
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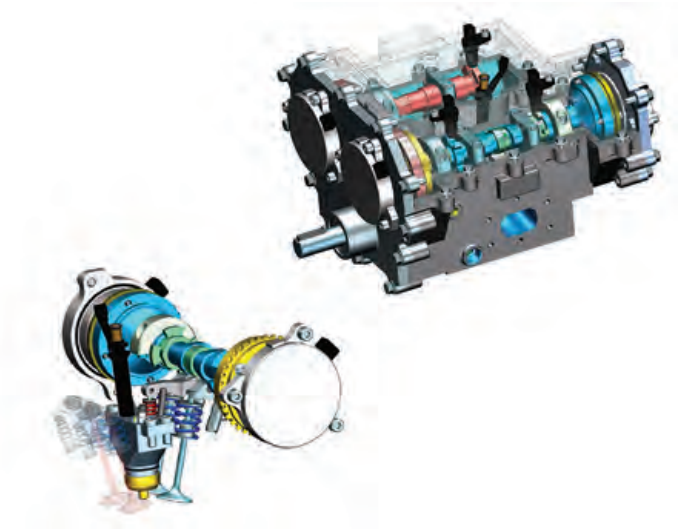
Dr. Zhaojian Li

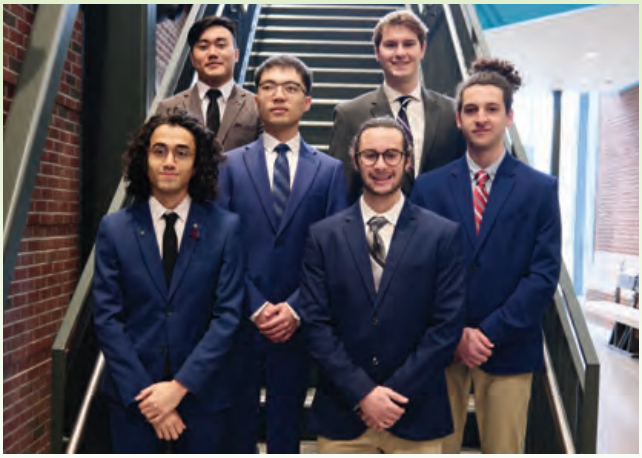
MSU Department of Mechanical Engineering
Design and Analysis of a Four-Stroke Hydrogen Engine

A faculty member from the MSU Department of Mechanical Engineering developed a patented approach to active Turbulent Jet Ignition (TJI) configured in a discrete unit cartridge, which was then licensed to Jetfire Power, LLC for commercialization. TJI systems have been known to provide very high-efficiency engine operation. With Jetfire's innovative pre-chamber air control, the system is able to robustly ignite very lean or highly dilute stoichiometric mixtures under high compression. The technology, termed a Jetfire® system, is applicable to both liquid and gaseous fuels, including gaseous hydrogen. Its key advantage over other TJI systems is its use of exhaust gas recirculation to dilute the main chamber charge, which provides both ignition advantages as well as knock resistance. This patented pre-chamber air control allows Jetfire to surpass both passive and active competing forms of TJI.

Our team focused on the design, construction, and performance analysis of a hydrogen-powered 4-stroke engine by modifying an engine that used a Jetfire system. We examined both the short- and long-term effects of hydrogen combustion on an engine and selected appropriate spark plugs and injectors that delivered the performance requirements needed. Further, to determine an optimal fuel flow rate given said performance requirements, an engine simulation using GT Suite was created that modelled torque and power output as well as engine efficiency for various fuel-air mixtures. The final, physical prototype served as an illustration of Jetfire's ultimate mission of improving engine efficiency while removing carbon from the combustion process.



Department of Mechanical Engineering
MICHIGAN STATE UNIVERSITY



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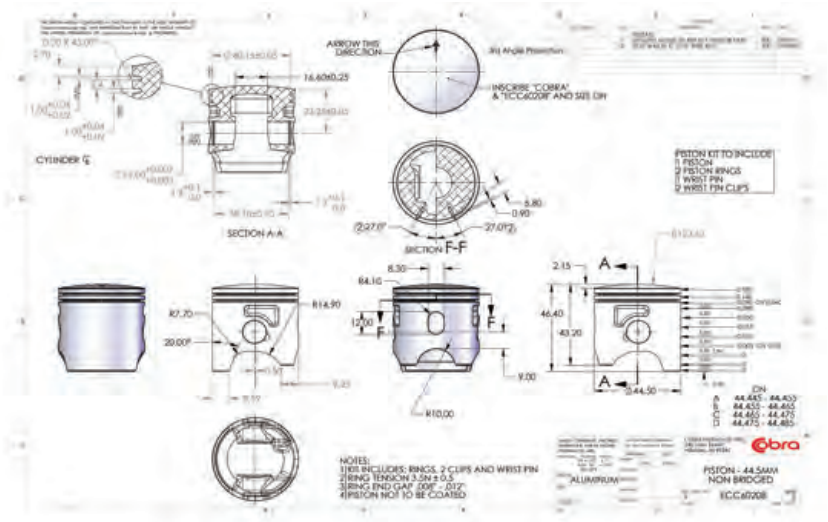
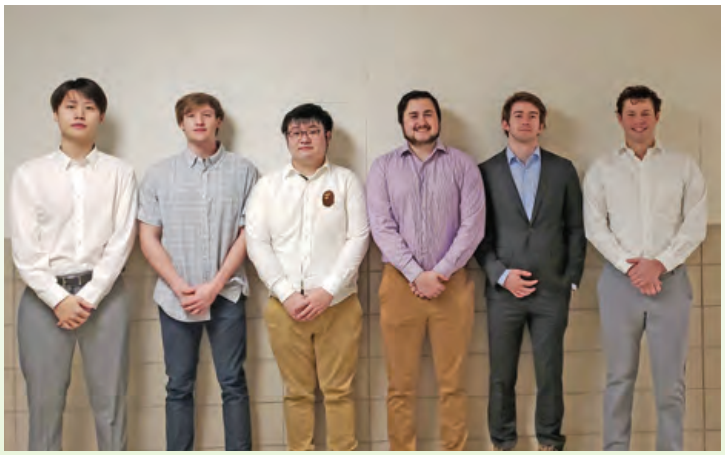
Cobra AERO
Design of Two-Stroke Cycle Power Dense Engine

Established in 2014, Cobra AERO was created to provide the world with more precise applications of advanced propulsive technologies. From small unmanned aerial vehicles to various underwater vehicles, Cobra AERO meets the market demand wherever the technology can be implemented. Cobra AERO has three varying propulsion systems that they produce: A33, A66, A99. Within these three systems, are subsystems that have been developed, or are in development, with differing design parameters. These differing design parameters allow for maximum efficiency based on the scenario or need, which makes Cobra AERO such a unique and successful company.

Our group was tasked with identifying systematic variables within a given engine and optimizing the piston seal within. During the course of the project, we used ANSYS, GT POWER, and CASE to model and analyze data that were essential to optimization methods. Linear thermal deformation, cylinder bore distortion, and cylinder bore temperature distribution of the piston shaft and the surrounding areas were modeled in ANSYS, which allowed for a visualization of where certain areas needed to be reinforced and optimized. GT POWER allowed us to gather inputs such as compression ratio, cylinder geometry, possible cylinder pressure, as well as other possible inputs that we used to input into CASE. CASE was then used to model the engine we worked with and optimize the piston seal, which was the basis of our project.





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Chakrapani


Engeda


Jaberi


Lee


Wright

Presentation Schedule – Engineering Building, Room 3540

Time	Team Sponsor	Project Title
Time	Team	Project Title
8:00 a.m.	UV-C Safe, Inc.	Germicidal Transaction Portal
8:30 a.m.	UV-C Safe, Inc.	Home Application
9:00 a.m.	UV-C Safe, Inc.	Germicidal Card Reader Cleaner
9:30 a.m.	MSU Department of Mechanical Engineering	Crisis Window Replacement
10:00 a.m.	General Motors	Sound Design for Electric Vehicles
10:30 a.m.	Consumers Energy	Turboexpander Feasibility Study

Supporting ME Design Projects

Each semester, ME 481 has a wide range of design projects for the students to select from. Many of these are from industrial sponsors. But many of these engineering projects come from groups not typically associated with engineering, such as, the Theatre Department, social service, or humanitarian groups, and MSU student groups or clubs (i.e., MSU Adaptive Sports & Recreation Club and the Sailing Club). Some of you reading this may have done your capstone project on an experience of this type.

These projects need funding and will benefit from your support through a contribution or endowment. Your gift enables the ME Design Program to continue to complete projects that help these worthwhile causes. Contact Jim Lang at langjame@msu.edu or 810.224.0055 to learn more.

UV-C Safe, Inc.
Germicidal Transaction Portal

Ultraviolet light in the C Spectrum (UV-C) is energy-rich light with a wavelength of 10 Nanometers (NM) up to over 400 (NM). UV-C light is versatile and can be used to disinfect germs and viruses, including COVID-19, on surfaces and in the air, destroying the harmful micro-organisms. UV-C Safe has established a method to disinfect currency, products, and even the air as transactions take place via the Pass-Thru Unit. The unit safely destroys germs and viruses at transaction points, using only the proper wavelengths to eliminate any human cell damage. UV-C Safe works to create the most innovative quality-of-life solutions by engaging in a multifaceted technology-based non-pharmaceutical pandemic countermeasure within the fields of research, design, manufacture, and sale of photon and proton management solution technologies to mitigate the impacts of epidemics and prevent future pandemics.

This project consisted of designing an effective method to secure the UV-C Safe device at any point of transaction that is easy to install and adjustable to different size openings where money and items are exchanged. The goal of our design group was to improve the functionality of this product due to its efficiency in eliminating viral and bacterial transmission. To ensure the universal functionality of our product design, we designed a holder that can be attached and secured to any substrate, usually a clear plastic barrier, in an attempt to prevent germs and viruses. The design was created to consist of a simplistic installation, while maintaining the structural stability and durability for usage.

UV-C SAFE.Com
GERMICIDAL

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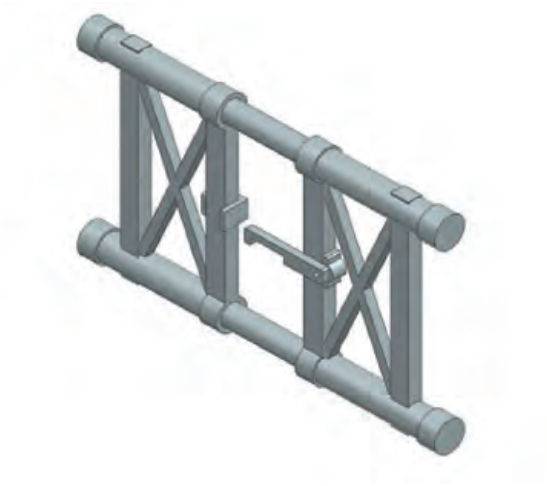
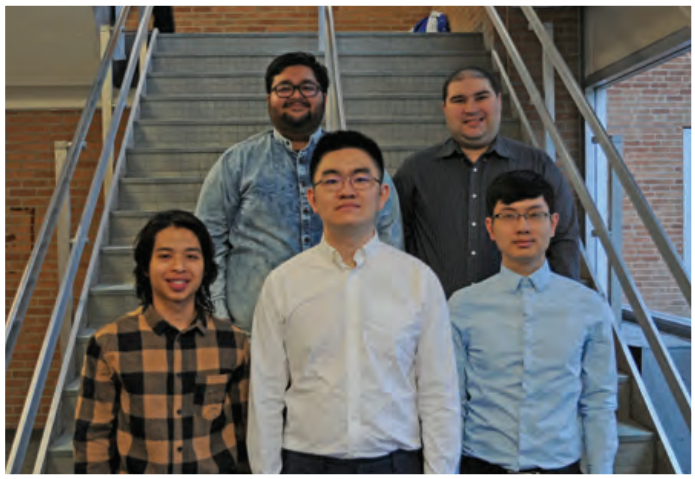
UV-C Safe, Inc.
Home Application

The COVID-19 pandemic has heightened the importance of clean indoor air and spaces. UV-C Safe's mission is to provide quality-of-life solutions to minimize the spread of the airborne pathogen and prevent the spread of diseases. The company utilizes one of the most cost-effective germicidals available, ultraviolet light in the C-spectrum, or UV-C, in its products. Shortwave UV-C light of up to 280 nanometers penetrates the cell walls of microorganisms and damages the genetic material of the cells, eventually leading to cell death. Through the application of this technology, UV-C SAFE strives to ensure the well-being of people and rebuild their trust of being indoors.

Our team was tasked with designing and building a versatile mount for a UV-C light-emitting excimer lamp. The mount was required to be conveniently installable in differing sizes of cold/hot air supply vents. To accommodate a large quantity of exposed air to the disinfecting UV-C light, a sleek and unobstructed design was chosen. For added convenience, the product was preloaded with a spring to extend automatically at the touch of a button. UV-C light has a shorter wavelength than visible light and is not visible to the naked eye, but it can still cause eye damage. Additionally, to avoid long-term retina damage, the lighting plane of the design needed to face the direction opposite of the airflow. Inexpensive cost and easy installation were the leading metrics to judge the product's performance



UV-C SAFE.Com
GERMICIDAL



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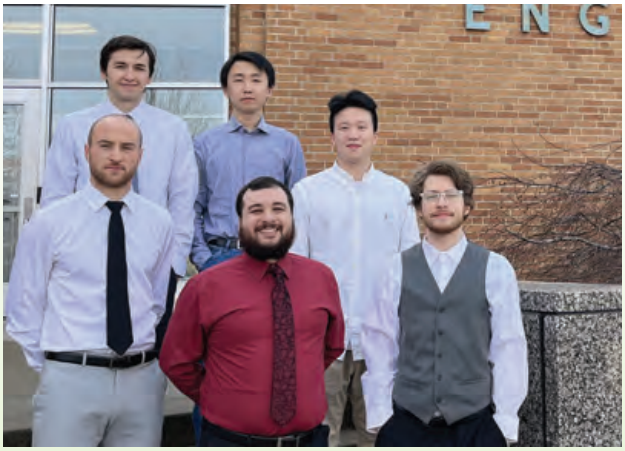
UV-C Safe, Inc.
Germicidal Card Reader Cleaner

UV-C Safe, Inc. strives to create a cleaner and safer environment for the community by using UV-C light to disinfect surfaces as well as the air we breathe. UV-C Safe specializes in two types of UV-C lighting: HUMAN-SAFE and UV-C. HUMAN-SAFE lighting has a wavelength of 222 nanometers while UV-C lighting can reach over 400 nanometers. Currently, UV-C Safe sells two main products: the Germicidal Transaction Portal and the UV-C Home Unit. The Transaction Portal cleans the air and surfaces of objects passed underneath it. Its intended use would be at a bank teller window or a pharmacy window, where transactions are made and goods are exchanged through the window. With the Home Unit installed inside the air duct, it disinfects air in any HVAC.

UV-C Safe was looking to develop a third product and tasked us with creating a mechanical prototype of a Germicidal Card Reader Cleaner. We designed and manufactured a prototype of an adjustable device that facilitates the use of UV-C Safe Lights to effectively disinfect the pin pads and pens of card readers in grocery stores and pharmacies, such as the Verifone MX 925 and MX 915, while preventing exposure to the eyes and skin, in order to provide peace of mind and safety to everyone.

UV-C SAFE.Com
GERMICIDAL



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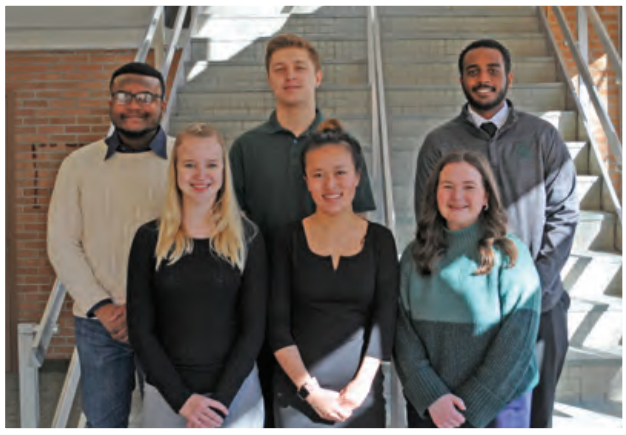
MSU Department of Mechanical Engineering
Crisis Window Replacement

During a crisis, one of the most vulnerable components of a home is a window. A window keeps elements and debris out while also insulating the home. This project is sponsored by the MSU Department of Mechanical Engineering. The team is focusing specifically on Ukraine and the impact of the Russian invasion on civilian homes. The issues of broken windows letting weather elements, debris, and undesirable air temperatures into homes has been amplified by the onslaught of winter.

The goal of this project is to design a sustainable solution for Ukrainian window replacements. This has led the team to research alternative material to glass, both as a result of shatter concerns and the general lack of glass supply. Additionally, the replacement window will be easy to install, so any individual will be able to follow simple steps to secure and adhere their window to the pre-existing frame. The scope of this project may extend beyond the Ukrainian Crisis to other crises such as natural disaster window protection.

Department of Mechanical Engineering
MICHIGAN STATE UNIVERSITY



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General Motors
Sound Design for Electric Vehicles

General Motors is an icon of the American automobile industry. Throughout the years, General Motors' innovations and boundary pursued products throughout its product portfolio. Today, General Motors produces vehicles under the Chevrolet, GMC, Buick, and Cadillac brands. GM is now moving to produce an all electric vehicle lineup. With this push towards electrification of the automobile, there are many new challenges.

The design challenge our team has faced is that of designing a new sound for an electric vehicle as part of a pedestrian alert system that is found on all of today's electric vehicles. One of the new challenges of electric vehicles is that of ensuring they are audible to pedestrian traffic in low-speed environments just like that of an internal combustion engine powered vehicle. When designing this new sound, the team had to adhere to various standards of production and testing of the sound to ensure that this new design would not only sound good to those passing by the vehicle, but also pass the regulatory requirements. The result is a sound that gives a creative new take on EV sound design.

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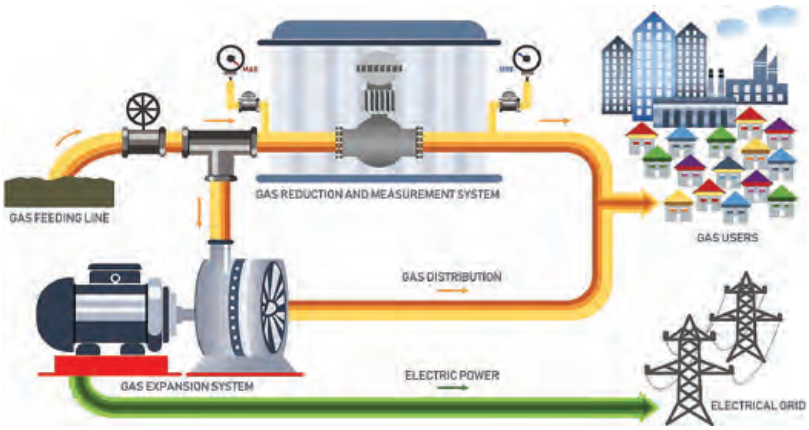
Consumers Energy
Turboexpander Feasibility Study

Consumers Energy is an investor-owned utility that provides electricity and natural gas to 6.7 million Michigan residents. The company is committed to combating climate change and is striving to reach Net Zero carbon emissions in its electric business by 2040 and in its natural gas business by 2050. To achieve this, Consumers Energy will be closing all five of its coal-fired power plants by 2025, as well as increasing the use of proven renewable technologies such as solar and wind. Consumers Energy is also exploring alternative clean energy technologies like turboexpanders.

This project is to investigate whether the implementation of turboexpanders in Consumers Energy's natural gas system is feasible. The scope of the project is comprised of four phases. Phase I entails conducting a technology screening and evaluation. For Phase II of the project, the electric energy output of the selected turboexpander was estimated based on natural gas flow data. Using these results, potential revenue from electricity sales, as well as reductions in CO2 emissions were calculated in Phase III. Finally, Phase IV consisted of investigating the use of electricity generated by a turboexpander to support hydrogen production. This included estimating the amount of hydrogen that could be generated using the available electricity, the amount of water required by the electrolyzer, the revenue from the sale of hydrogen, and the types of electrolyzers available on the market that would best suit the needs of Consumers Energy.



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