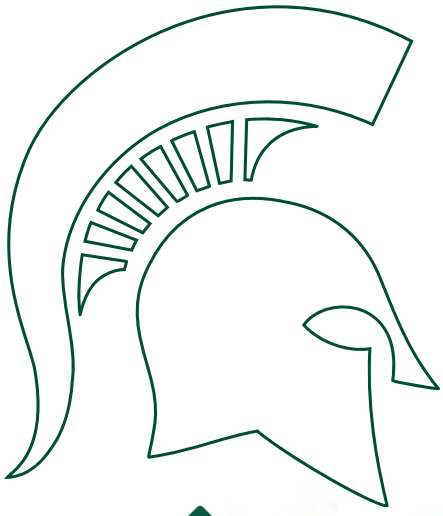
MICHIGAN STATE UNIVERSITY COLLEGE OF ENGINEERING **SPRING 2025**

# DESIGN DAY



MICHIGAN STATE UNIVERSITY

HENRY FORD HEALTH Innovations

Executive Patron Sponsor

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Innovations

# Congratulations, Design Day Participants

## Welcome to MSU Design Day!

As the flagship of Henry Ford Health's mission to advance healthcare through invention and discovery, Henry Ford Innovations (HFI) proudly supports MSU students as they deliver bold solutions to real-world challenges.

HFI and MSU share a vision of advancing innovation through technology and entrepreneurship. Our partnership is strong and is already making a difference in the lives of patients, students, and the community. That impact shines through in initiatives like these:

**Solving Real World Problems:** A Henry Ford physician collaborated with MSU biomedical students to develop a technology that enhances communication during laparoscopic surgery training. Together, they formed a company to produce this hands-free laser pointer, speeding up surgical guidance with pinpoint accuracy.

**Conducting Innovative Capstone Projects:** Henry Ford has backed over twenty capstone projects in the last year alone, many led by MSU engineering students partnering with our physicians. One standout is the PaRTS Capstone (Pathology Robotic Transport System), where MSU's ECE team is designing a robot to streamline specimen and material transport through the halls of Pathology and Laboratory Medicine.

**Advancing Entrepreneurship:** We have partnered with MSU Research Foundation to mentor early-stage healthcare companies in Detroit, enabling them to scale and test innovations within our clinical infrastructure.

Our MSU colleagues—students, faculty, and staff—spark our pride and inspiration, energizing us for the groundbreaking work we will do together. Design Day is a launchpad for all participants and promises a future rich with transformative potential.

Enjoy the day!

**Scott Dulchavsky, MD, PhD**
Roy D. McClure Chairman of Surgery,
Henry Ford Health

**Lisa Prasad**
Vice President and Chief Innovation Officer,
Henry Ford Health

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# **Welcome** from the Dean

## As Interim 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 130 capstone teams and 700 seniors from all 10 of the College's academic programs.

We are pleased to acknowledge Henry Ford Health as our Design Day Executive Patron Sponsor and TechSmith as our Design Day Directing Patron Sponsor. Our Design Day Supporting Patron Sponsors include Amazon, Anthropocene Institute, Delta Dental, Meijer, MSUFCU, 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 and Anthony Hall, 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.

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. Be sure to stop by and see how they innovate, communicate, and perform at the highest levels in an increasingly global and demanding world.

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 p.m. when we will honor all of our talented Spartans, the best of the best.

**Dr. Ioannis (John) Papapolymerou**
Interim Dean of the College of Engineering
Professor of Electrical and Computer Engineering
Michigan State University

# Henry Ford Health is proud to support Michigan State University Design Day

We are honored to support **Michigan State University Design Day** and applaud the unwavering commitment of MSU's academic programs. MSU engineers exemplify leadership, creativity, and innovation, and we celebrate the incredible design projects that showcase their talents and dedication. At Henry Ford Health, we believe in the power of education and the transformative impact of innovation in healthcare.

We are excited to provide Michigan State University students the opportunity to apply their classroom learnings to create real-world solutions supporting health.

Together, we look forward to shaping the future.

HENRY FORD HEALTH®
Innovations

# Design Day Events Schedule:
## Friday, April 25, 2025

| EVENTS | 8 a.m. | 9 a.m. | 10 a.m. | 11 a.m. | Noon | 1 p.m. |
|---|---|---|---|---|---|---|
| **Audio Enthusiasts and Engineers** | 2nd Floor Rm 2228<br>8:00 a.m. – Noon | | | | | |
| **Engineering Student Organizations** | 1st Floor Lobby<br>8:00 a.m. – Noon | | | | | |
| **ECE 410 Competition** | | 2nd Floor 2200 Hallway<br>9:00 a.m. – Noon | | | | |
| **ME 412 Competition** | 1st Floor Room 1252<br>8:00 a.m. – 11:30 a.m. | | | | | |
| **ME 470 Competition** | 1st Floor Room 1345<br>8:00 a.m. – 11:15 a.m. | | | | | |
| **ME 478 Competition** | | | | 1st Floor Room 1240<br>11:30 a.m. – 1:00 p.m. | | |

| CAPSTONE COURSES | | | | | | |
|---|---|---|---|---|---|---|
| **All Capstone Posters for most projects, including BE485/487 and ChE 434** | BE and ME 1st Floor 1200/1300 Hallways<br>ECE on 2nd Floor 2200 Hallway<br>ChE on 2nd Floor 2400 Hallway<br>CSE on 3rd Floor 3200/3300 Hallways<br>8:00 a.m. – Noon | | | | | |
| **AESC 410/SCM 472 Project Presentations** | Anthony Hall 1st Floor - Rooms 1235, 1255, 1257<br>8:00 a.m. – 11:30 a.m. | | | | | |
| **CE 495 Project Presentations** | 2nd & 3rd Floors - Rooms 2243, 2320, 2400, 3400, 3540<br>8:00 a.m. - Noon | | | | | |
| **ECE 480 Project Presentations** | 2nd Floor Rooms 2245 & 2250<br>8:00 a.m. – 12:50 p.m. | | | | | |
| **ME 481 Project Presentations** | 1st & 2nd Floors – Rooms 1202, 1220, 1300, 2435<br>8:00 a.m. – Noon | | | | | |
| **MSE 466 Project Presentations** | 1st Floor Room 1145<br>8:00 a.m. – 10:40 a.m. | | | | | |

| OPENING AND AWARDS | | | | | | |
|---|---|---|---|---|---|---|
| **MSU Awards** | | | | 1st Floor Anthony Room 1281<br>1:15 p.m. - 2:00 p.m. | | |

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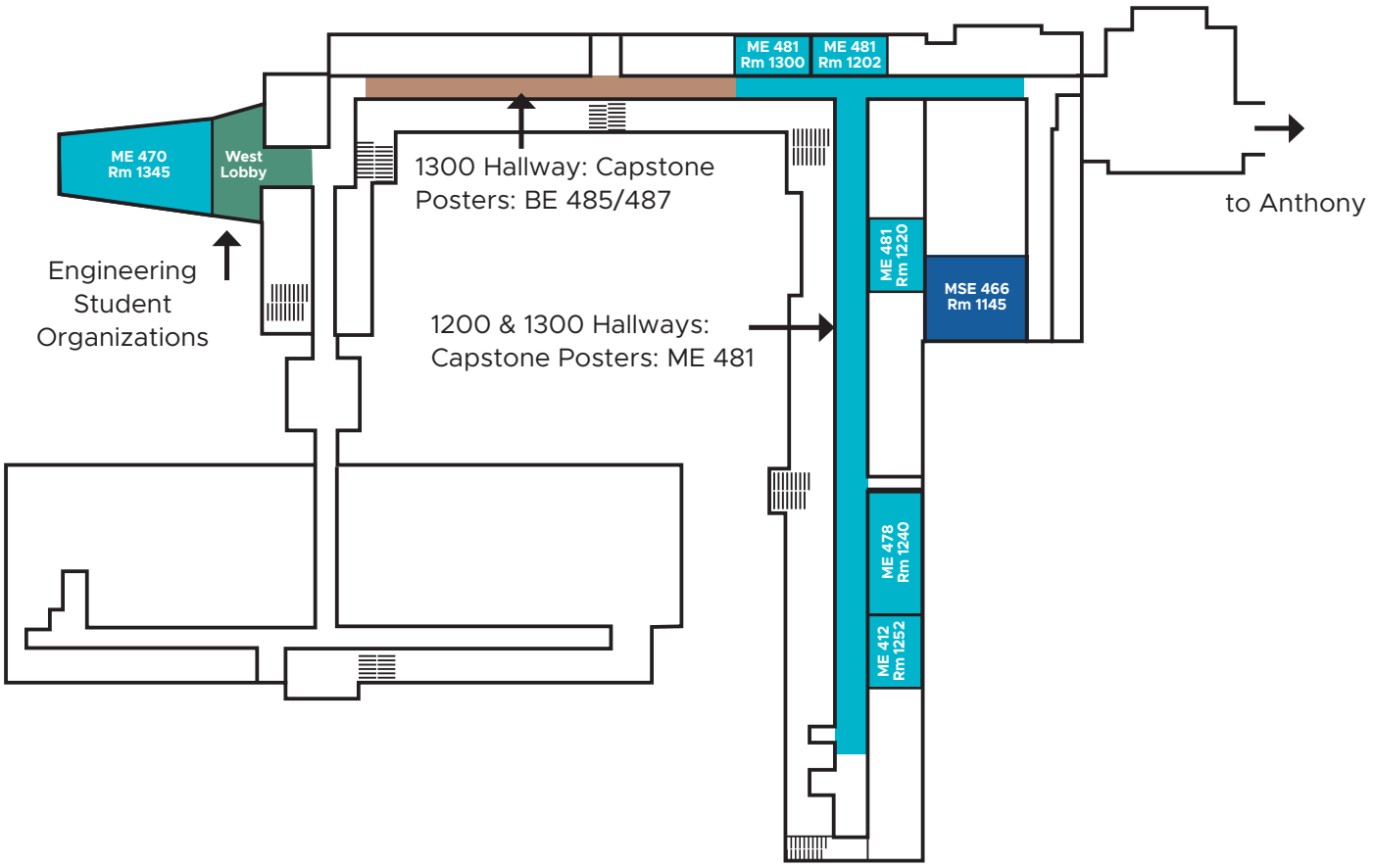
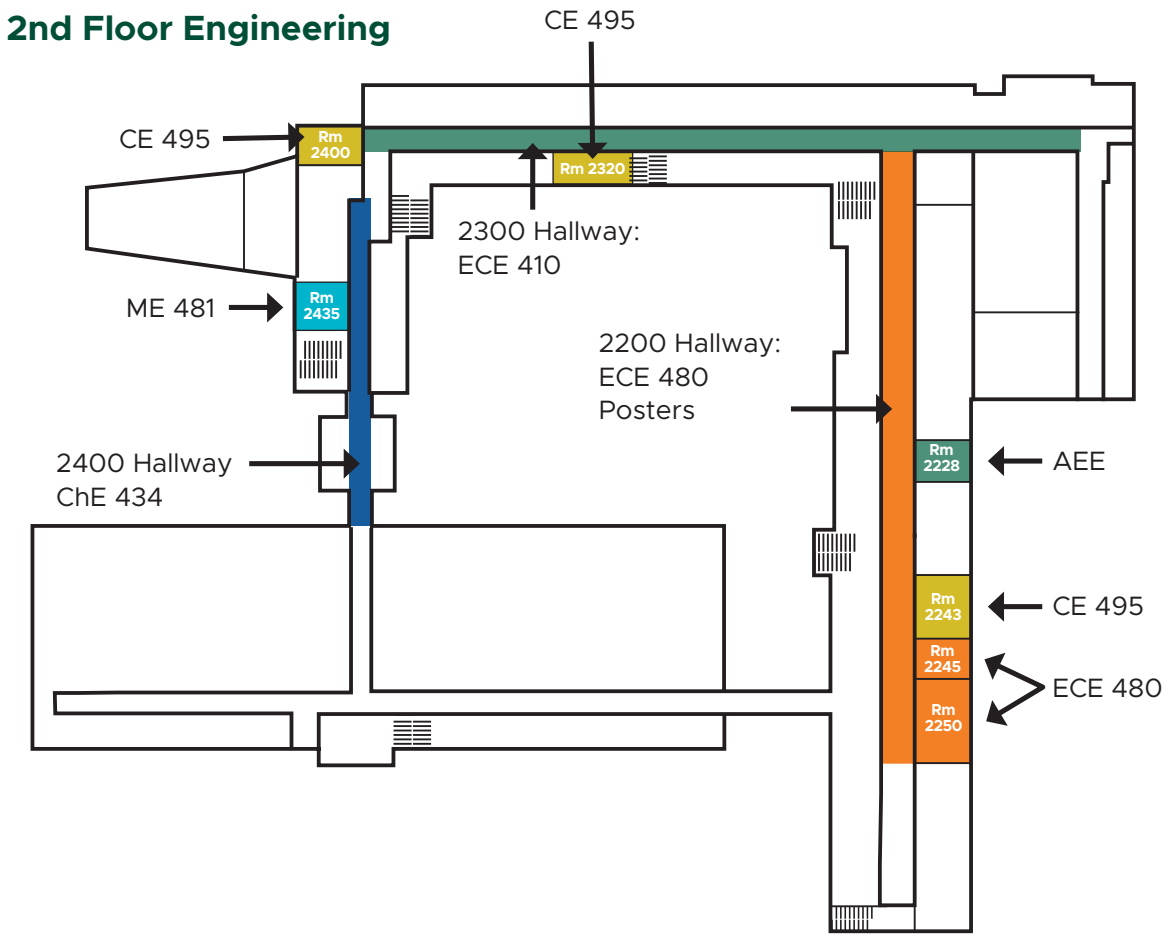
### To stay up to date w/Careers in Engineering:

instagram.com/msuengineers/

## 1st Floor Engineering

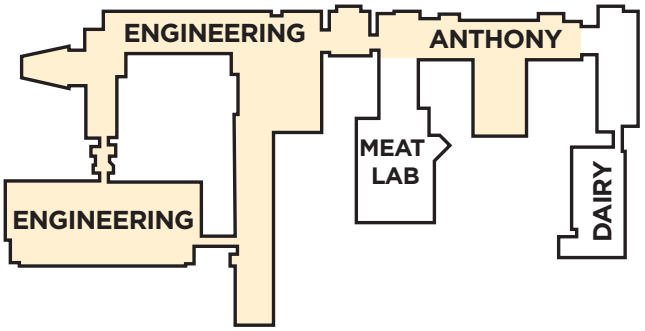



## 2nd Floor Engineering

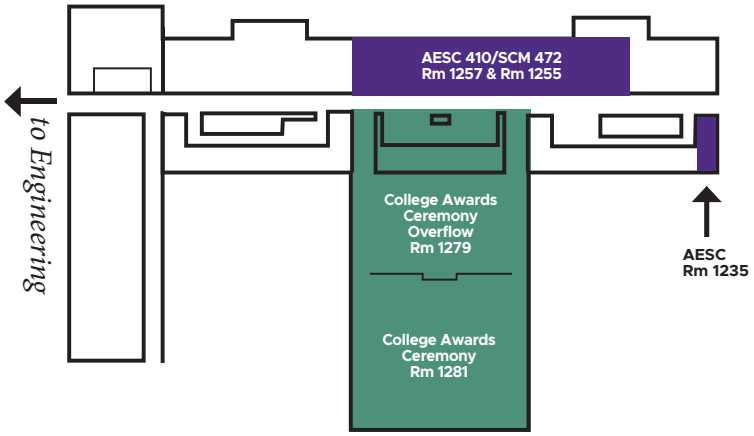


# Design Day Floor Plans of the MSU Engineering Building

## Overview



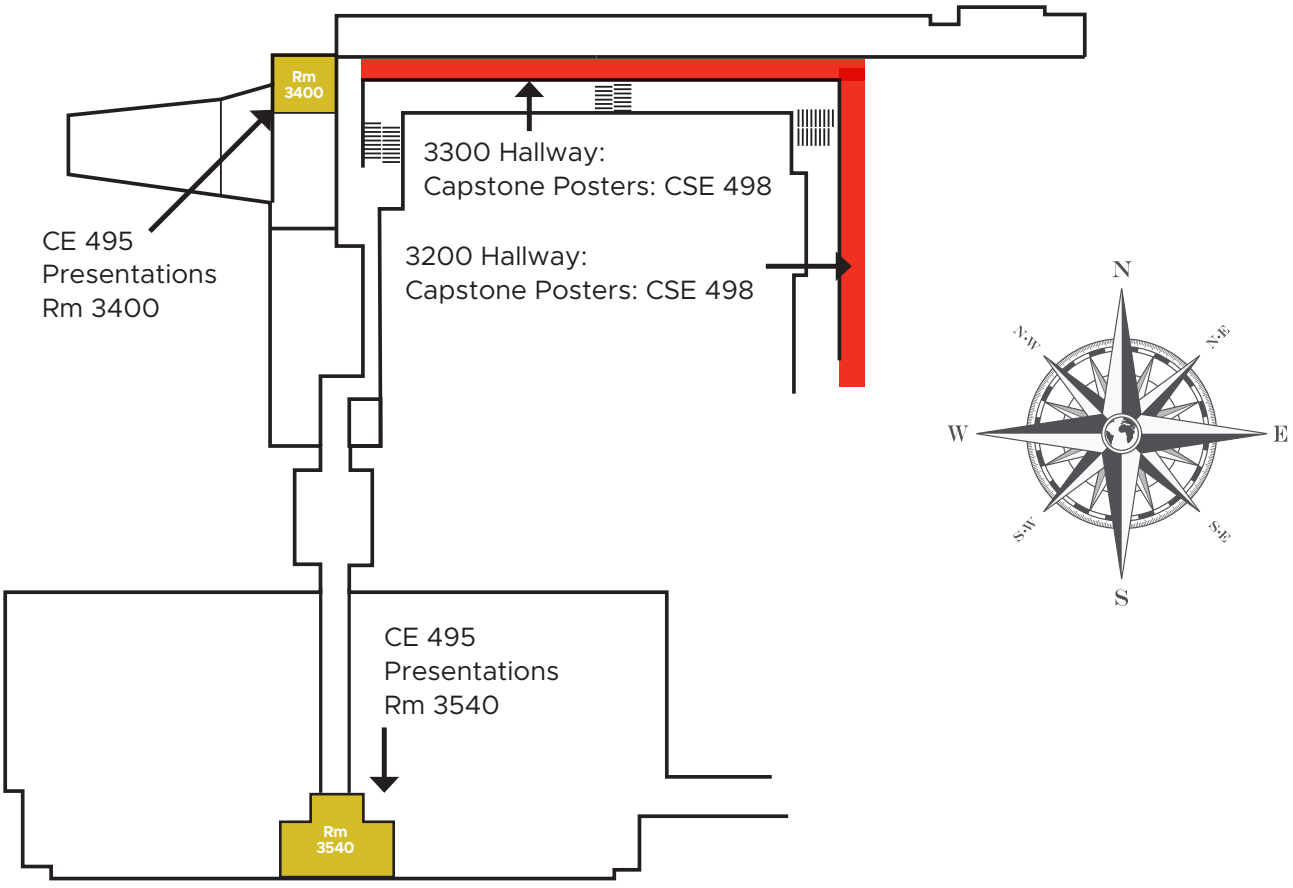

## 1st Floor Anthony




**Color Legend:**

- AESC/SCM
- CSE
- BE
- ECE
- CE
- ME
- ChE & MSE
- Joint/Other

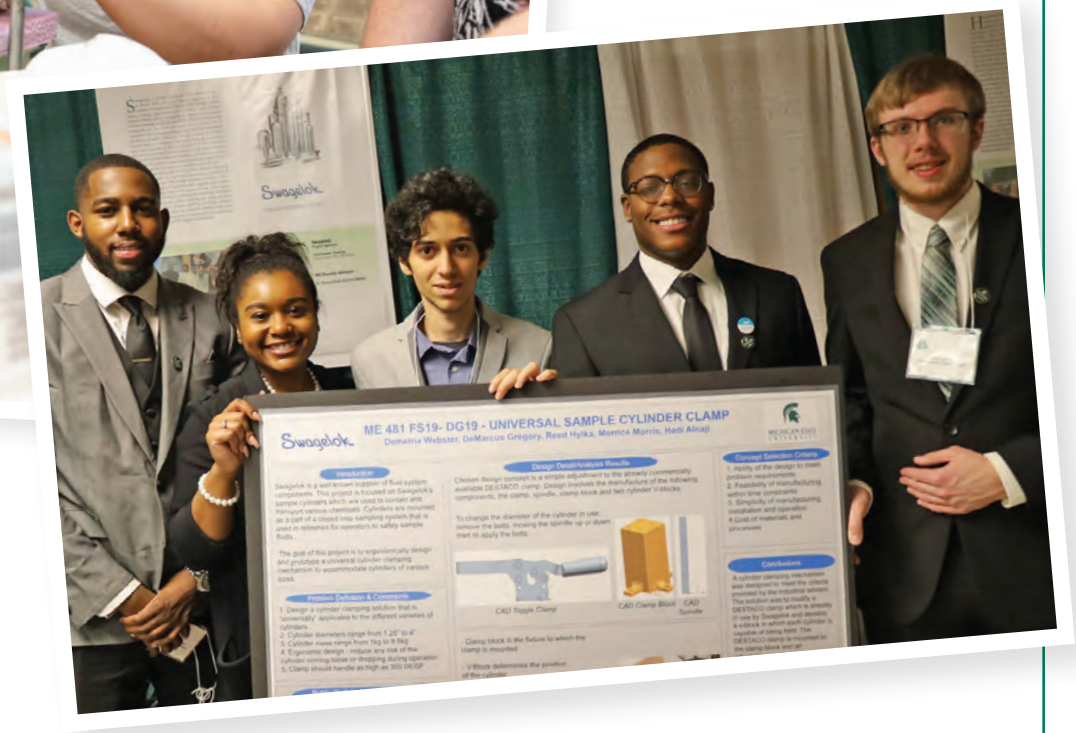
## 3rd Floor Engineering



MICHIGAN STATE UNIVERSITY

COLLEGE OF ENGINEERING FALL 2025

# DESIGN DAY




**Look for Fall Design Day projects coming in December 2025!**

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.

Alro Steel Corporation

American Axle & Manufacturing

Applied Materials

Asahi Kasei Plastics North America

BASF

Gerdau Special Steel North America

Hanson International

Hauschild SpeedMixer, Inc.

Illinois Tool Works

KLA

La-Z-Boy, Inc.

MSU Bikes

MSU College of Engineering

MSU College of Nursing

MSU IPF: Building Performance Services

Sun Chemical

# 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**

**Pratik Bhattacharjee**
MBA 2026

**Arun Chauhan**
MBA 2025

**Grant Freeman**
MBA 2025

**Nthanda Manduwi**
MBA 2026

### Presentation Schedule – 1st floor Anthony Hall, Room 1235

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:25 a.m. | Alro Steel Corporation | Maximizing Fiber Laser Offloading and Processing |
| 8:50 a.m. | American Axle & Manufacturing | Transportation Mapping of Outside Service Providers |
| 9:15 a.m. | BASF | Facility Inventory Optimization |
| 9:40 a.m. | Break | |
| 9:50 a.m. | Sun Chemical | Demand Forecasting Model |
| 10:15 a.m. | Asahi Kasei Plastics North America | Classifier Toolless Chute Design |
| 10:40 a.m. | Asahi Kasei Plastics North America | Scale Deck Cover Design |
| 11:05 a.m. | Applied Materials | Exploration of Semiconductor Supply Chain Regions |

## AESC 410 Capstone Course

### Senior Capstone Project

The culmination of course work 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.

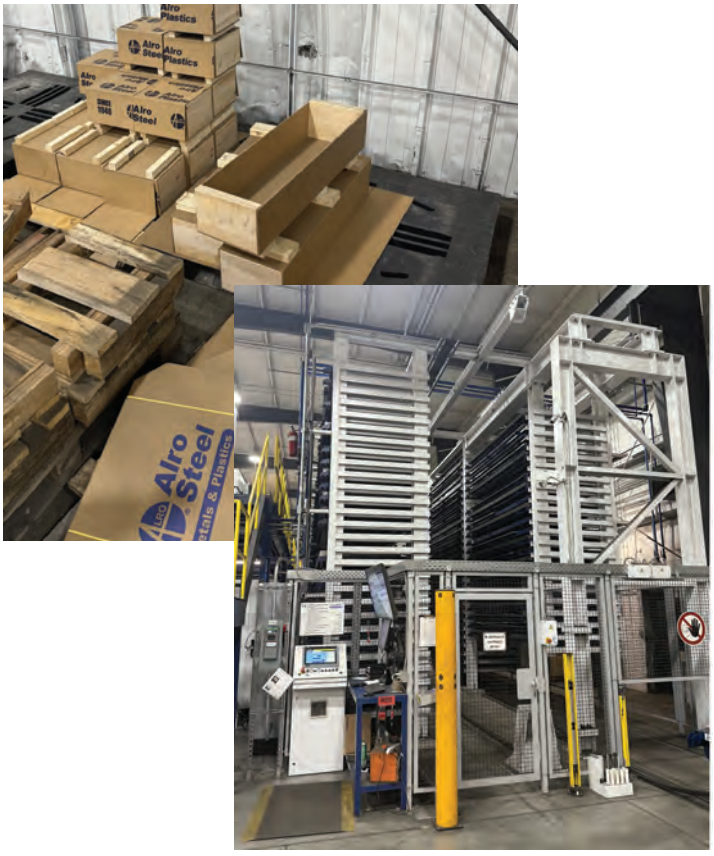
# Alro Steel Corporation

## Maximizing Fiber Laser Offloading and Processing

Alro Steel Corporation, a leader in metal distribution and processing, is preparing for the expansion of its largest facility in Potterville, Michigan. With 81 locations across 16 states and more than 75 years of experience serving U.S. manufacturing, the company remains committed to enhancing operational efficiency. In anticipation of this growth, Alro Steel Corporation is focusing on optimizing its Plate Laser Department to improve productivity and ensure a seamless transition as the facility expands.

The Plate Laser Department is a critical area of operation, housing advanced Trumpf Fiber Lasers, including two integrated with an automated STOPA storage and retrieval system. While these technologies have significantly improved processing capabilities, further enhancements are required to streamline laser cutting, storage, and automation. The primary objective of this project is to refine the efficiency of offloading and packaging laser-cut parts to support continuous machine operation and reduce production delays.

To achieve these goals, the project will involve a comprehensive evaluation of current workflows, floor space utilization, material handling processes, and packaging techniques. One key aspect of the solution will be the use of CAD modeling to redesign the warehouse floor space, layout of cut parts, and box dimensions. To minimize handling, the best approach was to design and implement custom box variations that lay flat on the unloading tray, enabling parts to be stacked directly on top. Once all cutting is complete and stacking has been accomplished within the machine, the box will be folded and taped automatically then taken to its final location. Eliminating the need to hand stack parts into the shipping box will significantly increase workflow and enable the machine to cut continuously without any delay.

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***Team Members*** (left to right)

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**Sienne Prideaux**
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**Chloe Casenave**
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**Cole Scribner**
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**Alro Steel Corporation**
***Project Sponsors***

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**Joel Major**
Lansing, Michigan

**Teaching Assistant**

**Grant Freeman**

# American Axle & Manufacturing

## Transportation Mapping of Outside Service Providers

American Axle & Manufacturing is a global leader in driveline and metal forming technologies, with a footprint spanning over 80 locations across North and South America, Asia, and Europe. AAM strives to deliver high-performing technology that helps reduce the cost of vehicle development programs and is fast and efficient.

AAM currently lacks a structured way to track and analyze how spending is allocated across its Outside Service Providers (OSP). This project is intended to provide a solution by developing a heat map on Tableau that creates visualizations of OSP spending distribution, transportation frequency, and utilization. The heat map will provide an insight into where the spend is going, how much is tied to each OSP, and find opportunities for optimization and insourcing.

By using this approach, the project will help identify potential cost-saving opportunities, such as optimizing transportation modes and improving supplier utilization. The end goal is to reduce transportation and purchasing costs, speed up production, and improve financial transparency.

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***Team Members*** (left to right)

**Justin Holtz**
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**Arun Chauhan**

# BASF
## Facility Inventory Optimization

BASF is a global innovator in the chemical industry. With sustainability at the forefront, the company is committed to creating chemical solutions that merit economic prosperity, environmental protection, and social responsibility. BASF offers a variety of high-performance materials across multiple industries such as energy, agriculture, automotive, and more.

The Coatings business group is one of eight primary groups, and overlooks material solutions such as surface treatments, OEM coatings, automotive refinish coatings, and decorative paints.

In an ongoing effort to optimize efficiency and manage costs, BASF is exploring alternative solutions for storage of their e-coating inventories. The complexities of the hazardous and temperature-controlled materials have provided challenges in their warehousing facilities. BASF is looking for possible options to avoid increased inventory holding costs at the current facilities. This project evaluates options for optimizing existing storage capacity and assessing new alternative inventory solutions to improve operational efficiency for BASF.

The focus is on assessing the feasibility of expanding and reconfiguring the current warehouse to optimize space utilization and improve operational efficiency. The team is exploring internal and external solutions for the facility, such as prefabricated buildings, implementation of rack storage, mobile shelving, and mezzanine flooring. In addition, the project will explore the possibility of constructing a new sustainable and cost-effective storage facility.

The goal of the project is to find a solution to reduce future inventory costs while maintaining operational efficiency and supporting BASF's sustainability commitments. Alternatives will be evaluated based on cost-effectiveness, scalability, and alignment with operational needs.

BASF
We create chemistry

### Michigan State University
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**Tristen Lycos**
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**Kendra Bell**
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### BASF
***Project Sponsors***

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**Donique Jeffries**
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### Teaching Assistant

**Grant Freeman**

# Sun Chemical
## Demand Forecasting Model

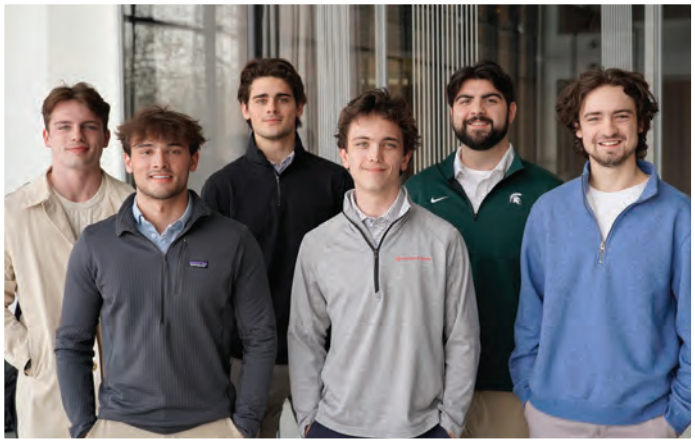
Sun Chemical, the world's largest printing inks and coatings producer, manages a complex supply chain with 40,000+ SKUs and diverse customer demands. This project enhances demand forecasting by improving inventory management, product transition accuracy, and SKU classification.

The team is implementing an intermittent demand forecasting model to better predict low-velocity SKUs, replacing monthly averages with an order frequency-based approach. This method aims to reduce excess inventory and improve forecast accuracy. In addition, the team is developing a historical trend-based forecasting model to address product transitions to predict demand shifts when SKUs are phased out. This will help prevent obsolete inventory buildup and stock shortages. For custom product forecasting, a clustering strategy is being introduced to group similar SKUs based on product attributes, improving inventory planning and procurement efficiency.

By integrating data analytics and forecasting techniques into Sun Chemical's SAP APO system, this project will provide a scalable solution to reduce costs, optimize inventory, and enhance supply chain performance.



SunChemical®
a member of the DIC group
Color & Comfort



### Michigan State University
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### Sun Chemical
***Project Sponsor***

**Ian Smillie**
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### Teaching Assistant

**Arun Chauhan**

# Asahi Kasei Plastics North America
## Classifier Toolless Chute Design

Asahi Kasei is a Japanese-based company and a leading manufacturer of high-performance engineering plastics and polymers. The plastics and polymers have diverse applications spanning across many industries, such as automotive, electronics, housing and construction, pharmaceuticals, and medical devices. Asahi Kasei has more than 11,000 employees in North America and 46,000 around the world, serving customers in more than 100 countries. Automotive is the primary focus of the Fowlerville, Michigan location. Automotive tier one manufacturers buy products from Asahi Kasei to make various components, and they also have collaborative relationships in place with OEMs.

At the Fowlerville plant they manufacture plastic pellets that are used in the production of many automotive components. To identify and sort plastic pellets based on size and shape, they use classifiers. Discharge chutes at the end of the classifier direct the product into cardboard boxes for shipping. The classifiers are disassembled, cleaned, and inspected during product changeover. At the start of the project, the discharge chutes were aligned and secured to the classifier by standard nuts and bolts. The chutes were a burden to disassemble and reinstall. There was also concern that the fasteners loosen over time due to vibration and could potentially fall into the product, thus providing a serious quality and safety concern.

To help Asahi Kasei eliminate the risk of loose fasteners falling into the product and to streamline the changeover process, our team has been tasked with designing a mechanism to attach and secure the chute to the classifier. A successful design can be handled easily and doesn't require tools, minimizing downtime and operational delays, but also enhances assurance in product quality. If the model proves effective, Asahi Kasei may opt for widespread implementation of the toolless design across the Fowlerville plant.


AsahiKASEI
ASAHI KASEI PLASTICS NORTH AMERICA

**Michigan State University**
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**Roy Travis**
Fowlerville, Michigan

**Holly Trpik**
Fowlerville, Michigan

**Teaching Assistant**

**Pratik Bhattacharjee**

# Asahi Kasei Plastics North America
## Scale Deck Cover Design

Asahi Kasei Plastics is a subsidiary of Asahi Kasei Corporation, a Japanese multinational company with operations in the Material, Homes, and Health Care Sectors. Since its founding in 1922, it has consistently grown through the practice transformation of its business portfolio to meet the evolving needs of every age. Through their innovative electronic parts and systems used in smartphones, housing and construction materials, and medical devices, they can produce cutting-edge products across multiple industries.

The project presented involves their post-manufacturing packaging practices. As boxes of product are filled, there are floor scales that weigh and densify the product by shifting the plastic pellets. During product changeovers, the scales are cleaned to prevent cross contamination of pellets, which is vital to the quality standards of Asahi Kasei. The scales are also cleaned to ensure no plastic pellets are caught underneath, which can cause false scale readings. To perform this task, along with any potential maintenance, the scale deck cover is removed to gain access to the entirety of the scale. Safety concerns relating to the scale are the weight and size of the cover, with the additional complication of tooling being adjusted so often, which causes potential for it to wear down or be lost.

The objective of this project is to improve the safety, efficiency and quality by redesigning the scale deck cover and present a formal recommendation to Asahi Kasei. The proposed design aims to streamline the product changeover process to make it more seamless and efficient. Safety remains the top priority, ensuring more secure working environments, while additional benefits of saving time and money with the process happening faster. By implementing this solution, the company can enhance overall workflow, minimize potential hazards and improve productivity which should ultimately lead to a more effective process.

AsahiKASEI
ASAHI KASEI PLASTICS NORTH AMERICA

**Michigan State University**
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**Molly Hemgesberg**
Freeland, Michigan

**Sydney Herring**
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**Asahi Kasei Plastics North America**
***Project Sponsor***

**Roy Travis**
Fowlerville, Michigan

**Teaching Assistant**

**Pratik Bhattacharjee**

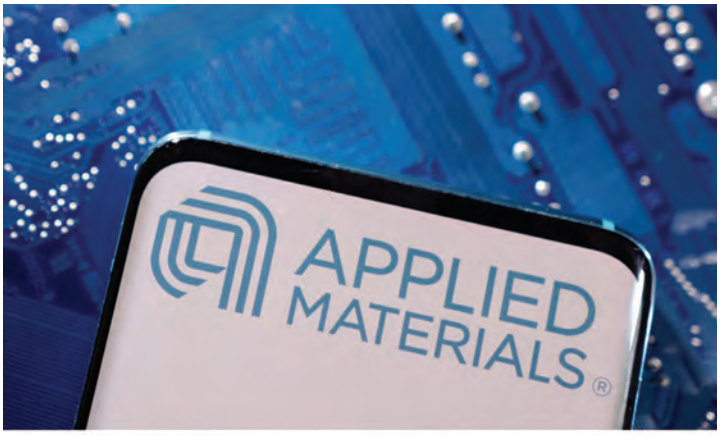
# Applied Materials

## Exploration of Semiconductor Supply Chain Regions

Applied Materials is a leading company in the semiconductor industry that specializes in materials engineering solutions that enable the production of advanced chips and electronic devices. The company develops cutting-edge technologies in semiconductor manufacturing, display production, and related industries. By providing innovative equipment, software, and services, Applied Materials helps drive advancements in computing.

The company has tasked our team with researching global supply chain and manufacturing options within the semiconductor industry. Applied Materials currently has supply chains in regions such as North America, Europe, and Asia but is looking to expand into new territories. The objective is to identify regions best suited for a new Build-To-Print (BTP) semiconductor supply chain while also determining regions that should be avoided. Expanding into new regions will enable Applied Materials to increase market share, reduce risks such as trade disruptions and natural disasters, and strengthen its leadership in the semiconductor industry.

To achieve this, our team has evaluated and recommended potential and non-potential regions for the supply chain ecosystem. We have developed a balanced scorecard with key metrics to objectively assess each region's advantages and challenges. Using the scorecard, we have quantified and compared different locations, scored them accordingly, and justified our recommendations. Through this analysis, we will provide a strategic recommendation that supports Applied Materials' long-term supply chain stability and growth.




APPLIED MATERIALS®

**Michigan State University**
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**Morgan Cummings**
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**Stephanie Korkmaz**
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**Applied Materials**
***Project Sponsor***

**Aaron Fong**
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**Teaching Assistant**

**Pratik Bhattacharjee**

# 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**

**Pratik Bhattacharjee**
MBA 2026

**Arun Chauhan**
MBA 2025

**Grant Freeman**
MBA 2025

**Nthanda Manduwi**
MBA 2026

### Presentation Schedule – 1st floor Anthony Hall, Room 1255

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:00 a.m. | MSU College of Engineering | Evaluating the Environmental Effects of a Food Hub |
| 8:25 a.m. | Gerdau Special Steel North America | Plant Water System Optimization |
| 8:50 a.m. | Gerdau Special Steel North America | Digitization & Business Process Automation of Regulatory Inspection |
| 9:15 a.m. | Gerdau Special Steel North America | Plant Water Optimization and Sustainability |
| 9:40 a.m. | Break | |
| 9:50 a.m. | Illinois Tool Works | Global Logistics – Supply Chain Metrics and Dashboard |
| 10:15 a.m. | KLA | Create Cost Legitimacy Model for All Major Direct Material Commodities |
| 10:40 a.m. | La-Z-Boy Inc | Create a Custom LCA Tool |
| 11:05 a.m. | MSU Bikes | Sustainable Recycling of End-of-Life Bicycle Tires at MSU |

## 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.

**AESC 410/SCM 472 | 8:00 a.m.** Anthony Hall, 1st Floor | Room 1255

# Michigan State University College of Engineering

## Evaluating the Environmental Effects of a Food Hub

Flint Fresh is an organization in Flint, Michigan, dedicated to increasing access to fresh, organically grown produce for residents of Flint and Genesee County. Established in 2016, Flint Fresh works closely with local farmers and stakeholders to create equitable and sustainable food systems. By providing fresh fruits and vegetables directly to residents, the organization strives to combat food insecurity and promote healthier eating habits across the region.

Currently, Flint Fresh distributes its products through two primary methods: the first is their Veggie Box Program, a subscription-based service that delivers boxes of fresh fruits and vegetables directly to residents' doorsteps; the second is their presence at local farmers' markets, where they offer fresh, locally sourced fruits and vegetables directly to residents in convenient community locations, providing residents with the flexibility to shop for fresh produce at accessible locations. While these distribution methods have significantly improved food access, they also present environmental considerations. The impact of Flint Fresh's operations varies based on two key factors: how products are sourced (locally in-state vs. out-of-state), and the method of distribution (home delivery vs. to farmers' markets).

To assess these impacts, the team's goal is to use a life cycle analysis to evaluate the environmental footprint of delivering a box of fruit and vegetables, while also assessing the four potential operational strategies to determine which one has the lowest environmental impact. This approach will ensure that Flint Fresh's mission aligns with environmentally responsible practices, while maintaining an efficient and equitable food distribution system.



College of Engineering
MICHIGAN STATE UNIVERSITY

**Michigan State University**
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**Dalety Aveiro**
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**Nthanda Manduwi**

# Gerdau Special Steel North America
## Plant Water System Optimization

Gerdau Special Steel is the largest producer of Special Bar Quality (SBQ) steel in North America, with operations across the country. Serving primarily the automotive industry, Gerdau specializes in manufacturing safety-critical, high-wear components using an energy-efficient and environmentally responsible approach. Water plays a crucial role in their operations, supporting fire suppression, equipment cooling, quenching, and advanced closed-loop systems designed to minimize waste. To strengthen their sustainability efforts, Gerdau has implemented sophisticated treatment and reuse systems, cascading water strategies, and integrated water management practices. However, as the company pursues more ambitious conservation goals, identifying inefficiencies and optimizing water use has become a top priority.

The proposed project enhances water system efficiency at the Huntington plant through advanced monitoring, data collection, and optimization. A key initiative is the installation of RFID water meters to precisely track water usage and provide real-time data on circulation patterns, enabling the identification of inefficiencies and areas for improvement. By analyzing this data, the project will uncover opportunities to enhance water reuse, particularly in optimizing blowdown water recirculation. Additionally, evaluating water demand patterns will help reduce excess consumption and improve overall system performance. These data-driven insights will support the development of best management practices, lower operational costs, and advance Gerdau's long-term sustainability objectives, reinforcing their commitment to environmental responsibility and resource efficiency.

GERDAU

**Michigan State University**
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**Grant Freeman**

# Gerdau Special Steel North America
## Digitization & Business Process Automation of Regulatory Inspection

The objective of this project is to modernize Gerdau Special Steel's regulatory inspection process by replacing its outdated pen-and-paper system with a centralized digital solution using PowerApps. This transition will enhance communication, streamline workflows, and improve the accuracy and efficiency of inspections. By digitizing inspection forms, automating supervisor notifications, and integrating real-time data access, the new system will significantly reduce inspection errors, minimize delays, and ensure compliance with regulatory standards. This project also supports Gerdau Special Steel's mission to deliver dependable Special Bar Quality (SBQ) steel in North America while fostering a risk-free work environment and sustainable practices.



**Measurable Objectives:**
- **Reduce** "pencil-whipping" incidents by at least **50%**.
- **Decrease** inspection errors by **30%**.
- **Cut paper and printing** resource usage by **75%**.
- **Improve** inspection process efficiency **by at least 5%** through automated workflows and enhanced oversight mechanisms.

**Project Value to Gerdau Special Steel, North America:**
- **Boosts efficiency and cuts costs** by enabling faster compliance tracking, instant data access, and reducing paper/printing expenses while minimizing permit violations and penalties.
- **Improves data accuracy and reproducibility** through enhanced data integrity and scalable digital workflows for all inspection types.
- **Reduces legal risks and supports sustainability**, aligning with Gerdau's commitment to delivering high-quality SBQ steel.
- **Ensures compliance with safety regulations.**

GERDAU

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# Gerdau Special Steel North America
## Plant Water Optimization and Sustainability

Gerdau Special Steel's Monroe Mill Project aims to optimize the plant's water filtration system to enhance efficiency and reduce waste, supporting corporate sustainability goals. Water is essential in the steel industry for cooling, safety, and processing. This project focuses on conservation and efficiency as part of a broader initiative by Gerdau Special Steel NA. A dedicated team is assessing inefficiencies to develop recommendations for transitioning from single-use to multi-use water systems, minimizing city water intake, and reducing wastewater discharge in the Electric Arc Furnace process. The initiative aligns with Gerdau's net-zero emissions goal by 2030 and ISO 14001 standards, with plans to cut at least 130,000 gallons of water daily.

**Project Objectives**

- Identify inefficiencies in the filtration system.
- Develop strategies for water conservation and reuse.
- Implement real-time monitoring for diagnostics.
- Reduce greenhouse gas emissions from water treatment.

Following an on-site visit to the Monroe, Michigan facility, the team will leverage firsthand insights to provide targeted recommendations.

**Implementation Approach**

The team is conducting a detailed analysis of Monroe Mill's water system, ensuring sustainability improvements without disrupting operations. This includes:

- Evaluating water use in key areas like cooling and rolling mills.
- Optimizing the filtration process.
- Exploring real-time monitoring tools.

As water conservation becomes a growing industry priority, this project aims to develop a scalable model for other Gerdau plants, strengthening the company's environmental commitment.

GERDAU

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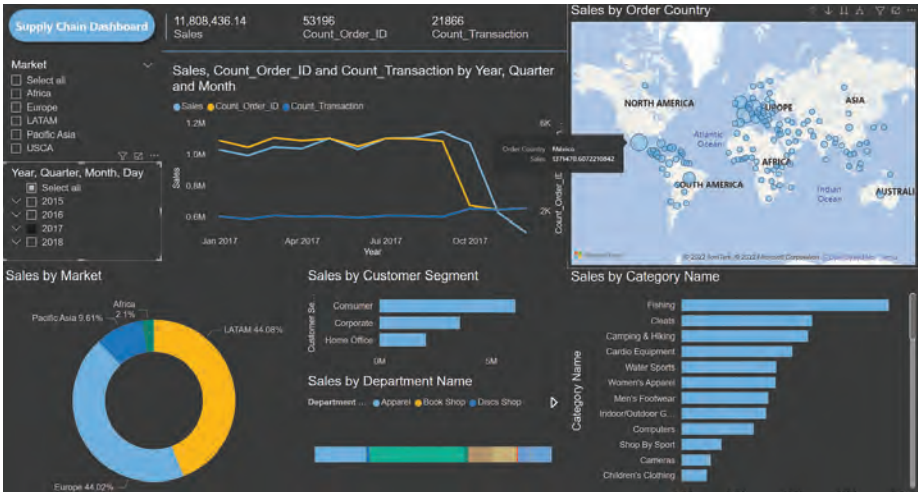
**AESC 410/SCM 472 | 9:50 a.m.** Anthony Hall, 1st Floor | Room 1255

# Illinois Tool Works

## Global Logistics – Supply Chain Metrics and Dashboard

Illinois Tool Works (ITW), a Fortune 200 multi-industry manufacturing leader with annual revenue of $16 billion, operates across seven business units: Automotive OEM, Construction Products, Food Equipment, Polymers & Fluids, Specialty Products, Test & Measurement and Electronics, and Welding. Founded in 1912 by a small group of tool inventors, ITW has grown to over 45,000 employees.

ITW's global logistics branch manages an annual spend exceeding $500 million across all business units, with a significant portion allocated to ocean freight and air cargo. However, the company's current reliance on manual, Excel-based analysis limits its ability to make timely, cost-optimized shipping decisions.




To address this challenge, ITW has requested the development of a **Global Logistics Supply Chain Dashboard** to provide a data-driven visualization of key logistics metrics. The project aims to improve cost efficiency and operational decision-making by:

- Defining key performance metrics for air and ocean freight, including cost, shipment volume, origin/destination, and regional spend distribution.
- Building a **dynamic Power BI dashboard** that aggregates and presents logistics data in an intuitive, actionable format.
- Exploring AI-driven automation to integrate and analyze data, reducing manual efforts.

This solution will equip ITW's logistics team with real-time insights, enhancing decision-making and improving overall efficiency. By automating data visualization and eliminating manual Excel reports, the dashboard will streamline ITW's logistics strategy and drive significant cost savings.


ITW

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**Pratik Bhattacharjee**

# KLA

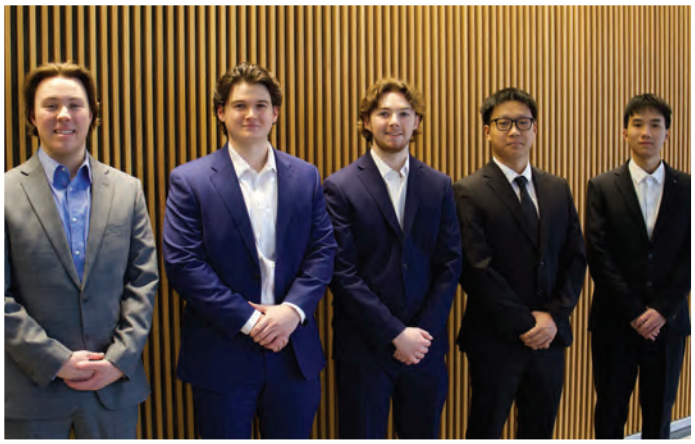
## Create Cost Legitimacy Model for All Major Direct Material Commodities

KLA Corporation is headquartered in Milpitas, California and conducts business all over the world. Since the formation of KLA in 1997, they are known as leaders in supplying technology equipment in the semiconductor industry, the nanoelectronics industry, and the integrated circuits industry. KLA's mission is to advance humanity by creating ideas and devices that guide and transform the future of technology.

KLA knows that the semiconductor, nanoelectronics and integrated circuits industries have grown and changed since the formation of the company and will continue to grow into the future. For KLA to continue to be leaders in these industries, they know they must differentiate themselves in all aspects of their business, including purchasing and supplier negotiations. Supplier cost increases are prevalent in the industries KLA operates in, and KLA often has no way of challenging the legitimacy of these price increases.

Due to the large amount of cost increases KLA has recently seen in their negotiations with suppliers for many of their major commodity areas, KLA's procurement team has asked us to help them challenge the legitimacy of cost increases that their suppliers propose. To do this, we will create an easy-to-use cost legitimacy model using publicly sourced information on past and current prices on three of KLA's major raw material commodities as well as union labor and non-union labor.

The objective of this project is to make a model that is easy to use for all buyers at KLA so that when they encounter a price increase from a supplier, they can use our model to challenge the price change. This model will positively impact KLA's margins through cost mitigation using fact-based negotiation techniques.

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**Nthanda Manduwi**

# La-Z-Boy, Inc.
## Create a Custom LCA Tool

La-Z-Boy, Inc., founded in 1927 by Edward N. Knabusch and Edwin J. Shoemaker in Monroe, Michigan, is one of the world's leaders in furniture manufacturing. Famously known as the inventor of the reclining chair in 1928, La-Z-Boy has notably become a staple throughout the furniture industry with the manufacturing of state-of-the-art sofas, recliners, futons, and more.

Succeeding in becoming a global powerhouse throughout the industry, La-Z-Boy has since set its sights on a new mission to achieve net zero emissions. While always striving to maintain environmental stability throughout all supply chain practices, La-Z-Boy is looking for a tool that can measure and assure global GHG emissions.

To accomplish this mission, La-Z-Boy has instilled confidence in a group of Michigan State University Supply Chain Management and Applied Engineering Science students to create a custom Life Cycle Assessment tool that can be used throughout the company.

As a team, we plan on breaking down this project piece-by-piece to maximize potential and ensure overall team success. We will start by breaking down a single product, overseeing what materials get inputted, and what emissions come out. Once we have this process mastered, our goal is to then incorporate our tool over the rest of La-Z-Boy's inventory.

The comprehensive goal of this project is to create a fully sustainable LCA tool that spans over the entirety of the company's Tier 1 supply chain process. This includes both procurement from suppliers and transportation services so we can reduce emissions and achieve stable improvements to our environmental footprint.


L A Z B O Y®

### Michigan State University
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# MSU Bikes

## Sustainable Recycling of End-of-Life Bicycle Tires at MSU

Michigan State University is known for its efforts in sustainability and environmental impact. With a rise in abandoned bikes around campus, a new problem has emerged. MSU Bikes has been accumulating old and unusable bike tires which MSU Recycling once claimed at a reasonable price. However, MSU Recycling recently informed the MSU Bikes that it would have to drastically increase the fee to recycle the tires due to previously unmentioned wear on machines and labor hassles. The main issue is the inner metal wire bead that is found in many of the tires which MSU Recycling must remove before recycling. The new fees of $1.00 per tire are unfeasible for MSU Bikes due to the sheer volume of tires. Our project aims to address and overcome the challenges associated with recycling bicycle tires that are no longer usable or repairable. Specifically, we will design a device using Computer-Aided Design (CAD) to efficiently extract the metal bead wire from these tires. This initiative seeks to alleviate the burden on MSU Recycling. By developing this device, we intend to reduce recycling costs and enhance the efficiency of tire processing. Additionally, we will assess the expenses involved in creating the device and estimate the potential revenue from selling the extracted metal, thereby contributing to the sustainability efforts of MSU Recycling. We are also seeking funding from the school to help reduce the overall costs of both MSU Bikes and MSU Recycling. This funding may be used to provide materials for the building of this device and hire a laborer for MSU Bikes to run the device. Ultimately, our innovative CAD solution will streamline tire recycling, reduce costs, and reinforce MSU's commitment to sustainability.


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# 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**

**Pratik Bhattacharjee**
MBA 2026

**Arun Chauhan**
MBA 2025

**Grant Freeman**
MBA 2025

**Nthanda Manduwi**
MBA 2026

**Presentation Schedule – 1st floor Anthony Hall, Room 1257**

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:25 a.m. | MSU College of Nursing | MSU College of Nursing Scheduling Assistant |
| 8:50 a.m. | Hanson International | Exploring Untapped Opportunities for Advanced Tooling and Machining |
| 9:15 a.m. | MSU IPF: Building Performance Services | Developing Building Energy Models on MSU Campus |
| 9:40 a.m. | Break | |
| 9:50 a.m. | Hauschild SpeedMixer, Inc. | Innovating Product Design and Documentation |
| 10:15 a.m. | Hauschild SpeedMixer, Inc. | Preventative Maintenance Map & Schedule Optimization |
| 10:40 a.m. | Hauschild SpeedMixer, Inc. | Developing an Optimized Supply Chain and Inventory Management System |
| 11:05 a.m. | Hauschild SpeedMixer, Inc. | Optimizing Warehouse Layout and Storage Efficiency |

## 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 comparable to those of other engineering programs.

# MSU College of Nursing

## MSU College of Nursing Scheduling Assistant

The MSU College of Nursing Scheduling Assistant wants to streamline the process of scheduling equipment and rooms for class, lab, and personal sessions. The College of Nursing has 14 separate rooms that can be booked by both students and faculty, and over 600 pieces of large equipment that can be moved in and throughout certain rooms. Our team's task is to compile this information into a database, and make sure that all members of the college can intuitively get the room access and equipment they need. Faculty can schedule lab sessions so students can either fulfill requirements for a class or get the extra practice they need. Administrators will be able to look at real-time data about class and equipment usage, so they can properly report these numbers at the end of each year. Built using Python Flask for backend, MySQL for database management, and JavaScript for frontend interaction, the scheduling assistant will deliver on project objectives. Replacing the current manual processing system, some critical goals include a user-friendly interface, improved efficiency, and scalable design. Key features include real-time availability display, automated recommendations, and administrative oversight of the system. This will reduce scheduling conflicts, create greater user satisfaction, and increase faculty efficiency by knowing where equipment is and where it needs to go. Students and faculty will be able to view their reservations within the application, keeping all of the information users will need inside of their account. Select administrators will have access to view and manage all reservations, monitor and report on usage trends, and have access to update lab room and equipment inventories with the application's scalability. The end result will be complete system integration.


College of Nursing
MICHIGAN STATE UNIVERSITY

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**Cate Kovacic**
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**Teaching Assistant**

**Arun Chauhan**

# Hanson International

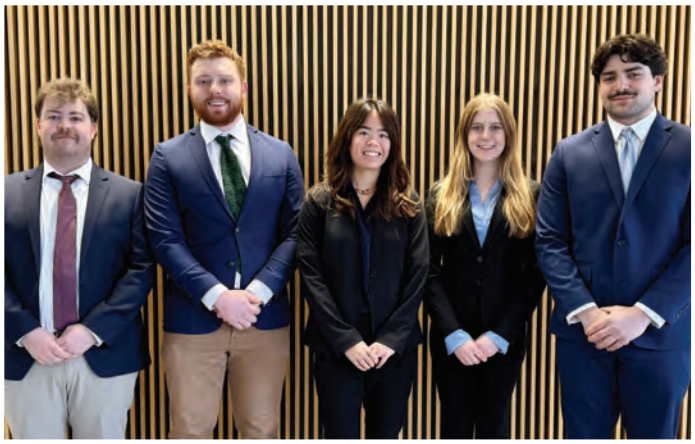
## Exploring Untapped Opportunities for Advanced Tooling and Machining

Founded in 1966, Hanson International has decades of experience working with the biggest American automotive companies to create world-class precision molds. Hanson specializes in designing, building, sampling, and inspecting aluminum die casting molds. Located in St. Joseph, Michigan, Hanson International operates a 42,000 sq ft. manufacturing and tooling facility as well as a specialized 10,000 sq ft. die casting facility designed specifically for testing and inspecting mold quality.

A major strategic goal for Hanson International is to leverage their decades of expertise in creating high-pressure die-cast tooling for the automotive industry to increase sales by diversifying into other industries. Hanson International boasts state-of-the-art precision machining equipment and is also seeking to find new ways to utilize their capabilities and competence.

The main objectives of this project were to collaborate with the Hanson sales team to identify potential customers they can reach out to in order to generate increased sales, as well as to conceptualize new and creative uses of Hanson's existing machining capabilities to diversify their product mix, take advantage of any unutilized capacity, and generate revenue growth. To do so, the team analyzed Hanson's existing capabilities and manufacturing capacity, conducted competitive analysis on Hanson's main competitors, and researched potential new partners and products that aligned with Hanson's capabilities who showed strong growth potential.

HANSON INTERNATIONAL



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### Teaching Assistant

**Pratik Bhattacharjee**

# MSU IPF: Building Performance Services

## Developing Building Energy Models on MSU Campus

The MSU Infrastructure Planning and Facilities (IPF) Building Performance Services Department is responsible for overseeing the maintenance, operations, and overall performance of all buildings on MSU campus. This includes a multitude of variables to monitor closely to ensure a building is running at the best performance possible. This is no easy task as MSU is one of the largest campuses in the United States, with over 560 buildings. With such a large number of buildings, energy use is a key point for IPF to monitor and maintain to ensure all energy is being used as efficiently as possible. To do this, having up-to-date energy models of all buildings is imperative. For this project, providing that was exactly the goal. Physics-based energy modeling tools that require input of actual building asset information and other building attributes were utilized to help determine limits for utility consumption of specific facilities. This also enabled improved foundational basis for previous models to be compared. Ideally, the project called for five energy models to be created for five distinct building types: general classroom/office, residence hall, laboratory/research, athletics, and auxiliary. Based on the amount of time provided for this project, as many models as possible were completed. These models will have multiple applications for IPF to utilize, including providing a standardized visual display for tracking current utility consumption/spend, comparison of energy performance over time, enable the forecasting of energy project performance based on different investment scenarios, and current state predictive load forecasting as well. Hopefully, these models will be useful for MSU IPF to utilize for years to come.

Infrastructure Planning and Facilities
MICHIGAN STATE UNIVERSITY


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East Lansing, Michigan

**Teaching Assistant**

**Arun Chauhan**

# Hauschild SpeedMixer, Inc.

## Innovating Product Design and Documentation

Hauschild SpeedMixer, Inc. is a leading manufacturer of high-performance mixing technology, serving a wide range of industries. Since its inception in 1974, the company has pioneered cutting-edge centrifugal mixing technology, ensuring precise and consistent material distribution with every use.

With a strong reputation for innovation and customer satisfaction, Hauschild aims to strengthen its market position by enhancing product usability and simplifying the purchasing process. This project focuses on improving current product documentation and optimizing accessory designs to improve customer satisfaction and achieve greater operational excellence.

As Hauschild expands its product offerings, addressing gaps in the accessory line and optimizing customer engagement becomes increasingly critical. To support this initiative, our team has been tasked with developing user-friendly specification sheets for accessories, refining accessory designs, optimizing designs based on customer use cases, and updating user manuals to enhance product usability and functionality.

Our team, composed of Supply Chain Management and Applied Engineering Sciences students, developed solutions across these key focus areas to bridge the gap between the technical functionality of the machines and customer needs. The primary objective was to ensure all documentation is clear, concise, and easy to understand.

By implementing these comprehensive solutions, our team will support Hauschild in enhancing customer engagement and market penetration by streamlining the purchasing process, increasing customer satisfaction, and expanding market reach.


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**Nthanda Manduwi**

# Hauschild SpeedMixer, Inc.

## Preventative Maintenance Map & Schedule Optimization

Hauschild SpeedMixer, Inc. is a global company that is the industry leader when it comes to bladeless centrifugal mixing technology. Based in Germany, they have offices worldwide that service cliental in many sectors, from the cosmetic industry to the paint industry.

This project aims to enhance Hauschild SpeedMixer's preventative maintenance services by designing a strategic and data-driven approach to optimize scheduling, reduce travel expenses, and improve resource allocation. Currently, maintenance services require significant travel and logistical coordination, which can be inefficient and costly. By analyzing machine location data and developing an optimized scheduling system, this project will streamline maintenance operations and ensure a more proactive service approach.

Beyond optimizing scheduling, the project will also focus on customer engagement strategies to target clients who have yet to utilize Hauschild SpeedMixer's maintenance program. By identifying and reaching these customers, the team aims to increase participation in preventative maintenance services, ultimately improving equipment longevity and reducing unexpected downtime for clients.

The team will apply principles of logistics, data analysis, and strategic planning to develop a comprehensive solution that enhances service efficiency and customer satisfaction. The outcome of this project will provide Hauschild SpeedMixer with actionable recommendations and a scalable framework to improve operational effectiveness while reducing overall service costs.

This initiative not only offers students hands-on experience in supply chain optimization and customer engagement strategies but also contributes to the long-term success of Hauschild SpeedMixer's national maintenance operations.


Hauschild SpeedMixer®

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**Arun Chauhan**

# Hauschild SpeedMixer, Inc.

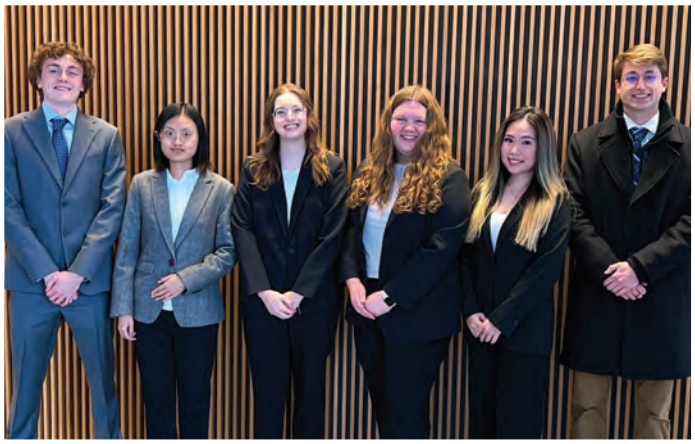
## Developing an Optimized Supply Chain and Inventory Management System


Founded in Germany in 1974, Hauschild SpeedMixer, Inc. is a global leader specializing in mixing technologies, offering an array of products, including bladeless laboratory and industrial mixers. The company decided to expand in 2020 by opening locations across the United States.

The mixers use closed containers of different sizes and designs to mix products more efficiently. The company offers high precision devices that enable the mixing of many different substances including fluids, powders, and pastes. The mixers serve a valuable purpose in a variety of industries such as electronics, cosmetics, aerospace, and manufacturing.

With a diverse portfolio and a global customer base, an efficient supply chain is crucial to the success of Hauschild SpeedMixer's operations. Our project focuses on the design of a comprehensive supply chain system that optimizes inventory levels and implements effective replenishment strategies. By analyzing historical sales data, our team will determine appropriate stock quantities needed to ensure the company has consistent inventory availability while minimizing costs.

In addition to inventory management and planning, our project addresses logistics optimization by evaluating container versus pallet shipping and the trade-offs between sea and air freight. All of these strategic decisions play an important role in balancing cost efficiency and delivery speed, ensuring Hauschild SpeedMixer, Inc. can meet the demands of customers across the globe.



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**Arun Chauhan**

# Hauschild SpeedMixer, Inc.

## Optimizing Warehouse Layout and Storage Efficiency

Hauschild SpeedMixer, Inc. is a German Company that produces centrifugal mixers for fast, precise, and bubble-free mixing of liquids, pastes, and powders. These mixers are used in countless industries ranging from cosmetics, electronics, aviation and more. In the Farmington Hills location they distribute these machines, mixing cups, and attachments across the United States.

The Optimizing Warehouse Layout and Storage Efficiency project, sponsored by Hauschild SpeedMixer, Inc., focuses on enhancing warehouse organization, safety, and efficiency through a structured labeling and storage system. The project seeks to improve inventory management by designing an optimized layout for machines, pallets, cups, and lids, ensuring maximum space utilization while streamlining workflows. A key focus is implementing a more effective sorting system, potentially incorporating QR codes or barcode scanning to enable quick and accurate inventory tracking, reducing retrieval times and minimizing inefficiencies. By enhancing organization and accessibility, the project aims to boost order fulfillment speed, decrease operational costs, and improve overall warehouse productivity.

Additionally, the team will develop standardized operating procedures (SOPs) and conduct employee training to facilitate a smooth transition and ensure long-term adherence to the new system. Establishing clear protocols will not only improve efficiency but also contribute to workplace safety by reducing clutter and creating well-defined pathways. The project's impact will be assessed through measurable key performance indicators (KPIs), such as space utilization, retrieval efficiency, and inventory accuracy, allowing the team to quantify improvements and identify areas for further optimization.

Beyond immediate operational enhancements, the project is designed with scalability in mind, ensuring that the warehouse system can support future growth without causing major disruptions to the supply chain. By reducing inefficiencies and standardizing processes, the team aims to create a sustainable model that can be adopted across similar warehouse environments.


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## Applied Engineering Sciences

# AESC 410 Awards 2024

**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 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 2024 Mike Sadler Competitive Edge Award

Team Munters

"Product Packing Design Optimization"

Left to right: Kaylin Nguyen, Kyle Lee, Jade Candela, Isaac Richardson, Michael Harper, Hana Duncan, (Karen Sadler)

## The AESC 2024 Most Impactful Award

Team Perrigo

"Machine Vision Test Unit"

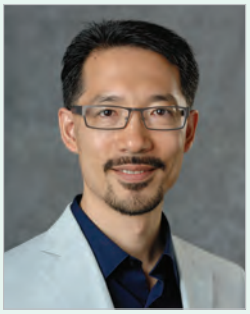
Left to right: Cameron Cowland, Chance Wilczynski

## The AESC 2024 Most Sustainable Award

Team Kautex Textron

"Identifying a Circular Economy for Plastic Composites"

Left to right: Shreya Peddi (SCM), Jack Deak, Kaitlin Ifkovits, Yashi Kumar (SCM), Charles Eppink, Natalia Pittendrigh (SCM)



**Dr. Sanghyup Jeong, PE**
**Assist. Professor**
**of Biosystems**
**& Agricultural**
**Engineering**

**Dr. Luke Reese**
**Assoc. Professor**
**of 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

# 2024/25 Projects

**Full descriptions and project posters are at:**
**https://canr.msu.edu/bae/senior-design-2025**

**Public presentations (April 25, 2025, 1 p.m.) 116 Farrall Hall or https://msu.zoom.us/j/97714737403**

*Treatment of harmful algal blooms in Soldan Dog Park pond*
Ingham County Parks
**Cyanobacteria Treatment** - Ben Bridge, McKenzi Brundage, Samuel Dougherty, & Mariam Shahab
**Faculty Advisor** - Dr. Dawn Dechand

*Prevention of harmful algal blooms in Soldan Dog Park pond*
Ingham County Parks
**SDP Prevention** - Janie Cooper, Ella Harrell, Dov Myers, & Amari Selby
**Faculty Advisor** - Dr. Dawn Dechand

*Carbon intensity calculator for Michigan dairy farm renewable natural gas site selection*
Consumers Energy *(project under Non-Disclosure Agreement)*
**The Digesters** - Jakob Harper, Ellen Mayes, Tushar Mukkatira, & Collin Neal
**Faculty Advisor** - Dr. Daniel Uyeh

*Nature's Pulse: Mass producing an innovative pulse-based snack*
IFT Product Development Competition
**Team IFT** - Grace Dickerson, Sebastian Hawkes, Ella Hubbard, & Tessa Versace
**Faculty Advisor** - Dr. Kirk Dolan

*Hog feet color improvement*
Clemens Food Group
*(project under Non-Disclosure Agreement)*
**Team Clemens** - Ben Getzen, Aidan Kile, Christina Lin, & Peyton Ma-Wong
**Faculty Advisor** - Dr. Bahar Aliakbarian

*Developing phosphorus removal column system using Eden Lakes' TimberChar™*
Eden Lakes *(project under Non-Disclosure Agreement)*
**Team Eden Lakes** - Praneeth Dattagupta, Renae Kenney, Shayla Le, & Catherine Maurer
**Faculty Advisor** - Dr. Younsuk Dong

*Feasibility study of greywater reuse for dairy plant CIPs*
Glanbia *(project under Non-Disclosure Agreement)*
**Team Glanbia** - Hunter Carene, Cavanaugh Doud, Brett Dumaw, & Begawan Samad
**Faculty Advisor** - Dr. Wei Liao, PE

*Preventing foreign material contamination in corned beef through detection*
E. W. Grobbel
*(project under Confidential Disclosure Agreement)*
**Team Grobbel** - Quinn Armstrong, CJ Buchta, Avery Partlow, & Kelley Titus
**Faculty Advisor** - Dr. Ilce Medina Meza

*Optimizing a rapid block cooler for cheddar cheese production*
Tillamook *(project under Non-Disclosure Agreement)*
**Team Tillamook** - Kathryn Benson, Wes Broda, Jacqueline Hawkins, & Justin Pecora
**Faculty Advisor** - Dr. Ian Hildebrandt

*Phosphorus reduction through electrodialysis in pharmaceutical reverse osmosis reject*
Perrigo *(project under Non-Disclosure Agreement)*
**Team Perrigo** - Briya Berry, Lizzy Cross, Swathi Kambhatla, & Nikolay Siratskiy
**Faculty Advisors** - Dr. Jade Mitchell & Dr. Emily Julien

*Improving existing oat transport system into food service mixer*
Jiffy *(project under Non-Disclosure Agreement)*
**Team Jiffy** - Jordan Dashner, Tyler Hillman, Kylie Jamrog, & Rosie VanLuven
**Faculty Advisor** - Dr. Yan "Susie" Liu

*Implementing a gMNP tuberculosis biosensor in Peru*
Dr. Kenny Briceno, Peru
**Team EWH Tuberculosis** - Matteo De Mattia, Mary Jane Hellem, Sophia Spencer, & Mimi Tarter
**Faculty Advisor** - Dr. Vangie Alocilja

*Affordable water sanitation for poor rural Peruvian Amazon communities*
Dr. Kenny Briceno, Peru
**Team Vida del Río** - Anna Dziedzic, Alex Griffin, & Isabella Pucci
**Faculty Advisor** - Dr. Vangie Alocilja

# 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 ~ Target
Ellen Bornhorst, PhD ~ PepsiCo
Holly Bowers ~ Consumers Energy
Jessica Bruin ~ Kellanova
Lisa Buchholz ~ Corteva Agriscience
Matt Burtt ~ AbbVie
Shelley Crawford ~ Jiffy
Michelle Crook, PE ~ MDNR
Laura Doud, PE ~ MDOT
Cassaundra Edwards ~ Tillamook Creamery
Gene Ford ~ Standard Process
Jeremy Hoeh, PE ~ EGLE
Eric Iversen, PE ~ PEA Group
Andrew Johnson ~ John Bean Technologies (JBT) Food Tech
Kevin Kowalk, PE (Chair) ~ EA Engineering, Science, and Technology (MI) PLC
Mitch Miller ~ Yoplait
Amber Mostiller ~ E. W. Grobbel
Rob Yoder ~ BDI, Inc.
Dave Young ~ Perrigo

## Board (Ex-officio)

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


*BE Showcase Evaluations & Public Presentations*

*BAE 2023_24 Industry Advisory Board Meeting & Evaluators*

BE Showcase 2024, see www.canr.msu.edu/bae/senior-design-2024

**If you are interested in sponsoring a BE 485/487 capstone project for the 2025_26 Senior Design teams, please contact Dr. Sanghyup Jeong at jeongsa1@msu.edu or Dr. Luke Reese at reesel@msu.edu.**

# ChE Process Design and Optimization

**Dr. R. Mark Worden**
**Class Instructor and Professor of Chemical Engineering**

**Austin Rodriguez**
**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 solve complex, open-ended design problems. As the students progress through CHE 433, completion of their assignments requires increasingly more effort, initiative, knowledge and individual responsibility. In CHE 434, students typically design an entire commercial-scale chemical plant and perform detailed economic analyses to assess and optimize the plant's profitability.

For over 50 years, MSU's CHE 434 students have worked intensively for one to two months solving the annual American Institute of Chemical Engineering (AIChE) Student Design Competition problems, which vary from year to year. CHE 434 uses these realistic, industry-based problems to enhance chemical engineering students' capstone design experience in three ways: 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 independent 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 the College of Engineering's 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.

## 2025 Design Competition Problem: "Blue Hydrogen"

The "Blue Hydrogen" chemical process designed in this year's AIChE Student Design Competition problem involves converting natural gas into hydrogen ($H_2$) and carbon dioxide ($CO_2$), which is a greenhouse gas that contributes to global warming. The $H_2$ can either serve as a fuel that produces no greenhouse gas or a reactant to produce value-added chemicals or fuels. The term "Blue Hydrogen" refers to $H_2$ that is produced from a fossil fuel (e.g., natural gas) by a process

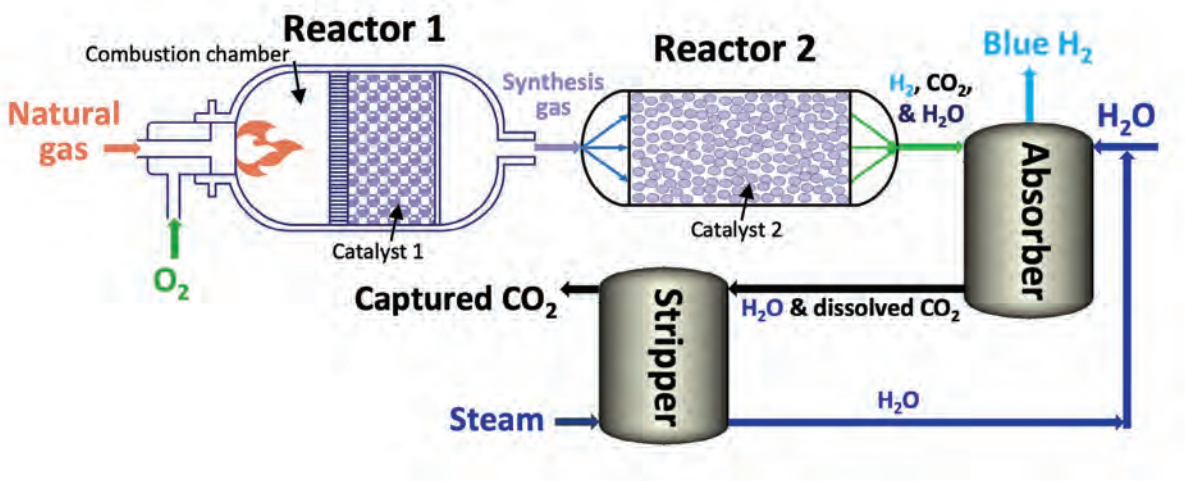



**Fig. 1: Process flowsheet for AIChe Student Design Competition Problem**

that captures the $CO_2$, rather than releasing it into the atmosphere. Thus, a Blue-Hydrogen production process combines the advantages of using an inexpensive and abundant fossil fuel (natural gas), with the low greenhouse-gas emission profile of a "green" chemical process.

A simplified flow diagram for the Blue Hydrogen process is shown in Fig. 1. Natural gas is delivered into Reactor 1, where a portion of it is burned in a combustion chamber to heat the remainder of the natural gas enough for it to be catalytically converted into synthesis gas, which is a mixture of carbon monoxide (CO), $H_2$, $CO_2$, and water ($H_2O$). In the second reactor, the CO and $H_2O$ are catalytically converted into $H_2$ and $CO_2$. The $CO_2$ generated in these reactions is recovered by dissolving it into a water-based solution in an absorber column. That solution is then heated with steam in a second column to strip the $CO_2$ out of the solution. The resulting, nearly pure, $CO_2$ gas is captured, compressed, and either used for some commercial purpose (e.g., hydroponic plant growth) or injected as a supercritical fluid deep into the earth for long-term storage.

After CHE 434 students have optimized their processes, they prepare 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., whether to build a new chemical plant) are made by stakeholders having diverse academic backgrounds, the reports are expected to be understood by a wide range of audiences.

# National Award in 2024 AIChE Design Competition

*Lauren Petrie*

Since 1968, MSU has had the best record nationally for winning awards in the AIChE Student Design Competition, and the AlChE national win streak continued in 2024. MSU chemical engineering senior Lauren Petrie received first place in the individual category for designing "Power-to-Gas" process that uses a renewable source of electricity to power conversion of waste $CO_2$ into a gaseous fuel.

In 2024, MSU also won an Outstanding AIChE Student Chapter Award, which is given to student chapters based on exceptional participation, enthusiasm, program quality, professionalism, and involvement in the university and community. Co-Presidents Walter Kretzer and Ryan Stearns accepted the award on behalf of MSU's Chapter.

# Student Poster Presenters on Design Day

The nature of Chemical Engineering students' capstone design experience is not compatible with small-scale, hands-on models for Design-Day demonstrations. Chemical Engineering seniors' Design-Day contribution consists of presenting a lay-level poster of their 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. Pictures of some of this year's presenters are shown below. Presenters of team solutions are Jessica Smith (left) and Katie Hector (right) for Team 1, and Joshua Aylward (left) and Tyson Humphries (right) for Team 2. Presenters of individual solutions include Lindsey Piper and Weeam Guetari.

*Jessica Smith (left) and Katie Hector*

*Joshua Aylward (left) and Tyson Humphries*

*Lindsey Piper*

*Weeam Guetari*

# The Capstone Projects

**Dr. Martin Crimp**
**Professor of Chemical Engineering and Materials Science**

**Amir Mirtaleb**
**Graduate Teaching Assistant**

## Course Description

MSE 466 is a senior level course for Materials Science and Engineering majors that provides students with a team-based capstone design experience. A major aspect of this course is having the students apply their course-learned background knowledge and critical thinking skills in materials science and other disciplines to real-life material/component failure problems. Such 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 solve real-world engineering problems via a systematic engineering approach. By focusing on specific component failures, the student teams learn how to confront open-ended problems that require them to develop a strategic design plan and to execute the methodology for assessing how and why the failure occurred. These open-ended studies are conducted using established investigative procedures and constraints for carrying out failure analysis. This semester, there are four 3-member teams carrying out investigations on real material/component failures.

### Presentation Schedule – 1st Floor Room 1145

| Time | Team Name | Project Title |
|---|---|---|
| 8:00 a.m. | The Hammerheads | Failure Analysis and Metallography of a Claw Hammer |
| 8:40 a.m. | ConRod Hall | Examining the Failure of a Hyundai Genesis Connecting Rod |
| 9:20 a.m. | Veggie Tales | Failure Analysis of Commercial Food Prep Blades |
| 10:00 a.m. | MowTown Breakdown | Failure Analysis of Fractured Lawnmower Blades |

## MSE 466 | 8:00 – 10:40 a.m. Engineering Building, 1st Floor | Room 1145

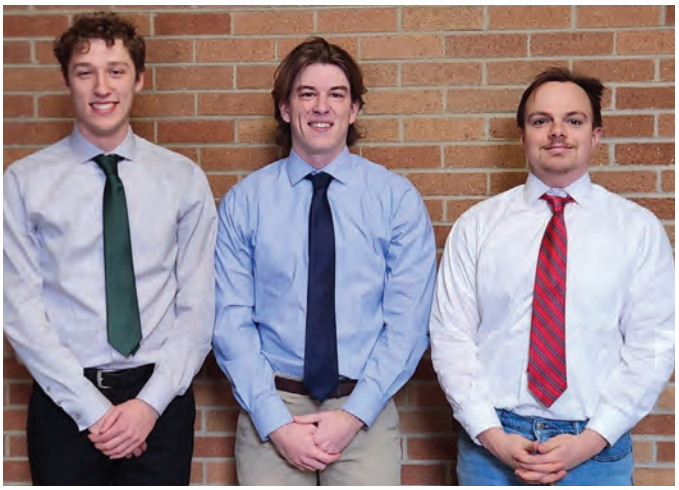
### Team Name: The Hammerheads

### Project Name: Failure Analysis and Metallography of a Claw Hammer

#### Time: 8:00-8:40 a.m.

*(Left to right) Andrew Robinson, Kendall Gonya, James Avery*

Many tools being used within industrial and at-home settings are expected to tolerate extreme compressive, tensile, or bending forces. Hammers typically withstand a user's lifetime, and it is rare that one would fail within normal operation. Nevertheless, the face of a claw hammer, in the neck transition region, exhibited a complete fracture. The make and model of the hammer was unknown, but the fracture surface and knowledge of common processing techniques of hammers indicate that it was hot forged. Visual and metallographic observations of the fracture surface were utilized to analyze the failure. Stereomicroscopy, scanning electron microscopy/energy dispersive spectroscopy, Rockwell hardness, and Vickers microhardness were conducted to assess the potential root cause of the fracture. A chemical analysis by optical emission spectroscopy by a third party provided additional insight into the material behavior for further evidence of how the hammer fractured.



*(Left to right) Connor Wasick, Justin DeHoff, Michael Orlando*

### Team Name: ConRod Hall

### Project Name: Examining the Failure of a Hyundai Genesis Connecting Rod

#### Time: 8:40-9:20 a.m.

Connecting rods (con rods) are a key part in an internal combustion engine, transmitting the energy from the combustion chamber to the rest of the drivetrain by linking the piston head to the crankshaft. The connecting rod from a 2015 Hyundai Genesis Coupe failed at 60,000 miles while in use and a complete fracture occurred near the base of the neck at the crankshaft connection. Various microscopy techniques, such as stereomicroscopy and scanning electron microscopy were used to analyze the fracture surface, specifically to differentiate primary and secondary damage on the rod. The additional use of chemical analysis and various material characterization methods led to an in-depth understanding of why the part failed.

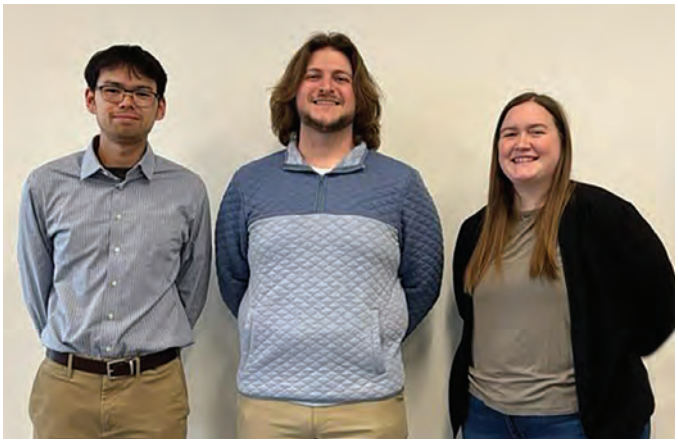
## Team Name: Veggie Tales

## Project Name: Failure Analysis of Commercial Food Prep Blades

### Time: 9:20-10:00 a.m.

*(Left to right) Riley Turner, David Dungan, Jessica Salinas*

Stainless steel is widely used in food preparation equipment due to its excellent corrosion resistance, strength, and durability. The Easy Chopper 2, a tough commercial food prep tool, uses 301 full hard stainless-steel blades to chop and dice ingredients. In a restaurant kitchen setting however, two adjacent top blades of the chopper fractured during normal use – posing a potential food safety hazard. To determine the cause of failure of the blades, a comprehensive failure analysis was performed utilizing a variety of experimental methods and techniques. The fracture surfaces were analyzed using optical microscopy and scanning electron microscopy (SEM) to document fracture morphology, potential crack initiation sites, and potential failure modes. Chemical composition analysis was conducted to validate the composition of the blades, while hardness testing was used to verify conformance to the material specifications of 39-45 Rockwell C. Metallographic examination was conducted to analyze the microstructure for signs of defects or any material discrepancies. The data collected from the materials characterization methods provided insight into the failure mechanism of the blades to determine the details surrounding the failure event. Understanding the failure mechanisms involved with the blades led to a better understanding of what engineering methods can be used to prevent failures like this from occurring in the future, minimizing risks to human health and economic waste.



*(Left to right) Sean Cardno, John Mastrogiacomo, Lauren Hassenzahl*

## Team Name: MowTown Breakdown

## Project Name: Failure Analysis of Fractured Lawnmower Blades

### Time: 10:00-10:40 a.m.

When doing any form of landscaping, in this case cutting the grass, failure of equipment leads to frustration, lost time, and in some cases personal injury. Having equipment similarly fail several times could be an indication of poor manufacturing, a quality control issue, or misuse by the operator. In this case, a Troy Bilt zero-turn tractor lawn mower had three blades that failed on the mower while in use. In this project, a variety of non-destructive and destructive testing methods were utilized to determine a possible cause for the failures. This process began with documenting the failed blades, primarily done with macrophotography and stereomicroscopy. From there, the blades were then sectioned for easier handling and observing. After careful consideration, some sections were cleaned and reimaged to view the fracture surfaces more effectively. Following cleaning, various hardness tests, as well as dye penetrant tests, were performed. In addition, sections of the blades were used to conduct tensile and Charpy impact tests. With the remaining material, microstructure analysis and scanning electron microscopy were utilized to form a more complete picture of the material and failure of the blades.

# HEALTH, WEALTH, CLIMATE, & SECURITY

Anthropocene Institute

anthropoceneinstitute.com

# The Capstone Projects

**Dr. Anthony Ingle**
**Teaching Specialist**

**Faculty Advisors:** Professors Chatti, Engle, Hashsham, Ingle, Kumar, Li


Chatti


Engle


Hashsham


Ingle


Kumar


Li

### Presentation Schedule

| Room | Time | Team |
|---|---|---|
| **Room 2243** 2nd Floor | 8:00 a.m. | Team 1 - Spartan Engineering Services |
| | 9:20 a.m. | Team 2 - Sustainability Synergy |
| | 10:40 a.m. | Team 3 - Spartan Civil Works |
| **Room 2320** 2nd Floor | 8:00 a.m. | Team 4 - Point 72 Engineering |
| | 9:20 a.m. | Team 5 - Common Grounds CEE |
| | 10:40 a.m. | Team 6 - Spartaneers Design Team |
| **Room 2400** 2nd Floor | 8:00 a.m. | Team 7 - Spartan Contracting |
| | 9:20 a.m. | Team 8 - Green Civil Engineering Company |
| | 10:40 a.m. | Team 9 - Steel Horizon |
| **Room 3400** 3rd Floor | 8:00 a.m. | Team 10 - Red Cedar Consulting |
| | 9:20 a.m. | Team 11 - Capital City Civil Engineering |
| | 10:40 a.m. | Team 12 - Spartan Solutions |
| **Room 3540** 3rd Floor | 8:00 a.m. | Team 13 - Great Lakes Civil Company |
| | 9:20 a.m. | Team 14 - Red Cedar Engineering |

## 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, hydrological, pavement, structural, and transportation 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.

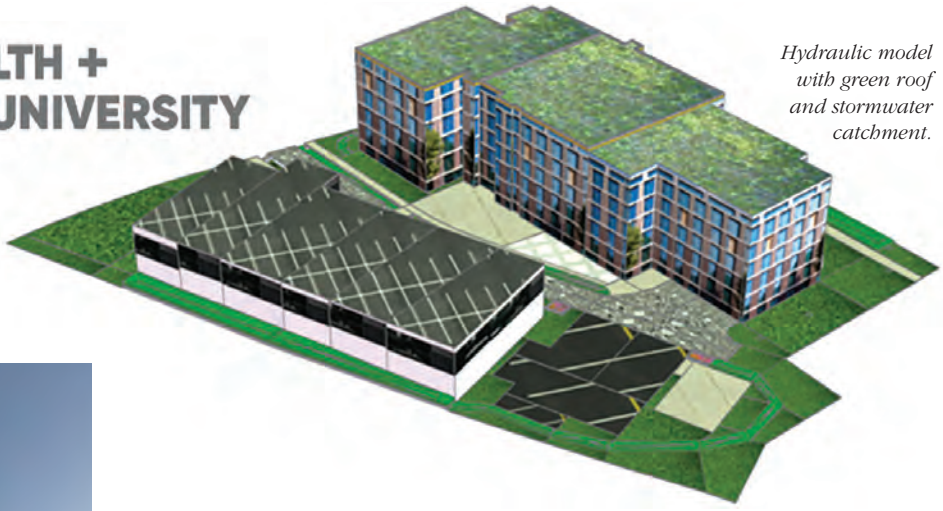
# CE 495 SENIOR DESIGN IN CIVIL & ENVIRONMENTAL ENGINEERING

## MSU and Henry Ford Health Research Building in Detroit, MI

Henry Ford Health has partnered with Michigan State University in the development of a cutting-edge medical research facility for Henry Ford Health + Michigan State University Health Sciences. The development is part of a wide range of investments surrounding the existing Henry Ford Hospital campus. Community development initiatives are intended to transform Detroit's New Center neighborhood into a vibrant, walkable community with state-of-the-art residential, commercial, retail, recreational and health care components. As a part of the partnership, MSU civil and environmental engineering students have engaged with the planning and design teams to better understand the project.

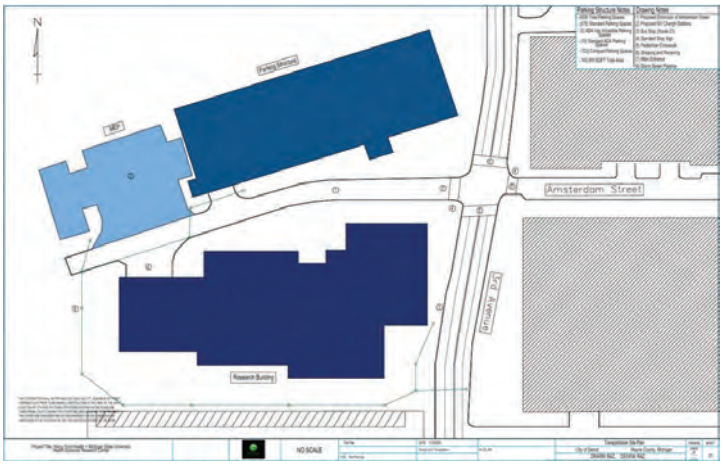
The existing 13-acre site is predominantly paved as a parking lot, an evolution from its industrial past. The new research building is expected to be eight stories and approximately 335,000 gross square feet. Research areas of focus will include (but aren't limited to) cancer, neuroscience, immunology and infectious diseases, with a particular interest in health inequities and disparities and social determinants of health. A new 600-space parking structure will be built adjacent to the building, offsetting the loss of surface parking spots, and allowing for more green space to be added. The students prepared preliminary designs based upon provided basic land survey and soil sampling data. The students' designs are independent of the current construction plan but are based on the same realistic constraints within the project site.

HENRY FORD HEALTH + MICHIGAN STATE UNIVERSITY Health Sciences



*Hydraulic model with green roof and stormwater catchment.*


*Architectural rendering of the new building looking north.*




*Preliminary site plan layout.*

## Team 1: Spartan Engineering Services

**Back row (left to right):** Ethan Jhamb (S), Seth Trojian (PM), Sebastian McChesney (T), Jay Dingwall (P) **Front row (left to right):** Leah Barnett (H), Andrew Steere (E), Haley Bowman (G)

## Team 2: Sustainability Synergy

**Back row (left to right):** Alaina Dorset (P), Lily Blastic (S), Alison Delor (G), Garrett Johnson (T) **Front row (left to right):** Sarah Scott (E), Julianna Thompson (H), Katie Jarrad (PM)

## Team 3: Spartan Civil Works

**Back row (left to right):** Zhicheng Hai (H), Garrett Gambaro (P), Nolan Meder (PM), James Humphrey (G) **Front row (left to right):** Ashton Yates (E), Shane Temple (T), Julia Bishop (S)

## Team 4: Point 72 Engineering

**Left to right:** Nicholas Magda (PM), Brian Thompson (P), Nathan George (T), Natalia Sultana (E), Victoria Redruello (H), Jake Mortimore (H)

## Team 5: Common Grounds CEE

**Left to right:** Fadi Shehada (P), Bryan Arnold (E), Charlie Folger (H), Jarret St. John (PM), Lillian McGlinchey (S), Alexa Thompson (T), Nick Sokol (G)

## Team 6: Spartaneers Design Team

**Left to right:** Olivia Palm (E), Jazlyn Hagenbuch (H), Aaron Wildrick (T), Gabe Kleinsorge (P), Brian Vila (S), Bekah Leonard (PM)

## Team 7: Spartan Contracting

**Left to right:** Max Moeller (S), Luke Apostol (P), Akshay Sivakumar (E), Sameer Narayan (PM), Daniel Aburto (H), Carlos Stibitz (G)

### KEY TO TEAM ROLES

E = Environmental
G = Geothermal
H = Hydrology
P = Pavements
PM = Project Manager
S = Structures
T = Transportation

## CE 495 | 8:00 a.m. – Noon Engineering Building, 2nd & 3rd Floors | Rooms 2243, 2320, 2400, 3400, 3540

### Team 8: Green Civil Engineering Company

**Left to right:** Andrew Wright (G), Madelyn Grant (S), Grace Hurst (E), Sarah Stephenson (PM), Aaron Amidon (P), Kaitlyn King (T), Jaelle Lampert (H)

### Team 9: Steel Horizon

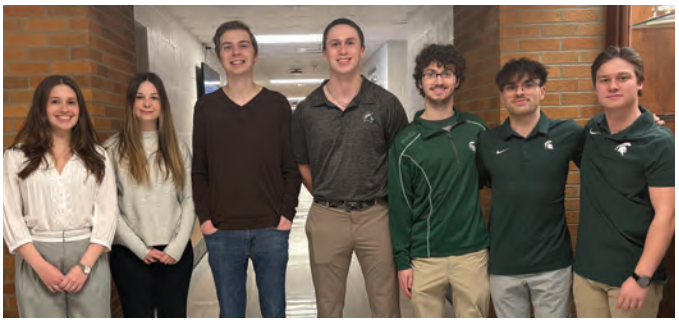
**Left to right:** Brynne U'Selis (T), Katarina Parker (E), Jose Van Horn (G), Alyssa Koukis (P), Sam Tietjen (S), Joy Eljbeily (PM), Trey Scovill (H)

### Team 10: Red Cedar Consulting

**Left to right:** Cade Person (E), Lara Darwish (G), Adam Coats (PM), Torrance Turner (H), Drew Karkau (T), Emily Schoepke (S), Grant Fowler (P)

### Team 11: Capital City Civil Engineering

**Back row (left to right):** Kyle Johnson (S), Breanna Ziegler (P), Jacob Crook (G), Ella Moore (T) **Front row (left to right):** Sydney Walsh (PM), Katie DeVlaminck (H), Maddie Rogers (E)



### Team 12: Spartan Solutions

**Left to right:** Maria Basaldua (H), Maggie Bottoms (E), Logan McCall (T), Jonathan Crockett (G), Carson Peters (S), Matthew Souri (PM), Jimmie Elizando (P)

### Team 13: Great Lakes Civil Company

**Left to right:** Landon Rauch (P), Jacob Kozik (G), Seth Sharples (T), Kenzie Stabler (E), Jacob Estabrooks (PM), Simon Patano (H), Qi Tian (S)


### Team 14: Red Cedar Engineering

**Back row (left to right):** Noah Bush (PM), Austin Boughton (S), Jacob Thelen (P), Eric Johnson (T) **Front row (left to right):** Connor Martin (E), Lake Van Natter (H), Jadyn Morris (G)

### KEY TO TEAM ROLES

E = Environmental
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S = Structures
T = Transportation

# CE 495 SENIOR DESIGN IN CIVIL & ENVIRONMENTAL ENGINEERING

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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.

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# Design Day Awards Fall 2024

## Rolla C. Carpenter Senior Design Award

*The Rolla C. Carpenter Senior Design Award ($700 and medallion) 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.

*The faculty and students of the Department of Civil and Environmental Engineering gratefully acknowledge the generous contributions from Fishbeck, and Barr Engineering Co.*

## Rolla C. Carpenter Senior Design Award Winners, Fall 2024

### Team 2: Red Cedar Engineering Group


Left to right: Reese Worden, Shane Williams, Dane Herczeg, Reegan Kelly, Daniel Gubrud, Owen Woods, Ricardo Ochoa


# Your career in technology begins at Delta Dental of Michigan!

As one of the nation's largest dental plan administrators, Delta Dental of Michigan has technology at its core.

Opportunities in technology are diverse from planning, establishing and maintaining complex internal networks to researching, designing and building reusable software that dives deep into data.

Delta Dental has the most advanced data centers in Michigan. Interns are given front-line experience in systems and processes and work directly with technical teams.

Your work at Delta Dental will be on the leading edge of engineering and the computer and data sciences. It will also help to fulfill our mission of improving oral health care and support efforts that build healthy, smart, vibrant communities.

Our commitment to employee engagement will challenge you to grow and discover your highest potential.

## Here are just a few highlights:

- Gain hands-on experience with some of the latest software and hardware technologies
- Write and deliver software that will be used by real customers
- Be part of a scaled agile team, using processes such as scrum and kanban
- Help to manage enterprise software development in the health care industry
- Use advanced public cloud technologies that are in high demand
- Identify and utilize industry best practices where security and performance are critical
- Develop skills in designing and building reusable software components by applying advanced computer science concepts
- Experience data science practices with data wrangling, analytics with potential Artificial Intelligence/Machine Learning application opportunities

**Start planning your future.**

Visit www.deltadentalmi.com/careers.

best places to work

Computer Science and Engineering

# Capstone Course Sponsors

We thank the following companies for their generous support.

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Detroit, Michigan

Pontiac, Michigan

Auburn Hills, Michigan

Benton Harbor, Michigan

Battle Creek, Michigan

# The Capstone Projects

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**Professor of Computer Science and Engineering**

**James Mariani**
**Professor of Instruction**

Samantha Kissel

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, Corewell Health, Delta Dental, General Motors, Google, HAP, Henry Ford Innovations, Kohl's, Launch, Magna, McKesson, Meijer, Microsoft, Mozilla, MSU Federal Credit Union, NetJets, RPM, Stryker, TechSmith, Union Pacific, United Airlines, Urban Science, UWM, Vectra AI, Volkswagen, Whirlpool, and WK Kellogg Co.

# Ally Financial
## AI System Testing Framework

Ally Financial, headquartered in Detroit, Michigan, is a leader in the U.S. financial services industry. Recognized as one of the nation's largest online-only banks, Ally provides an array of online banking services to approximately 11 million customers.

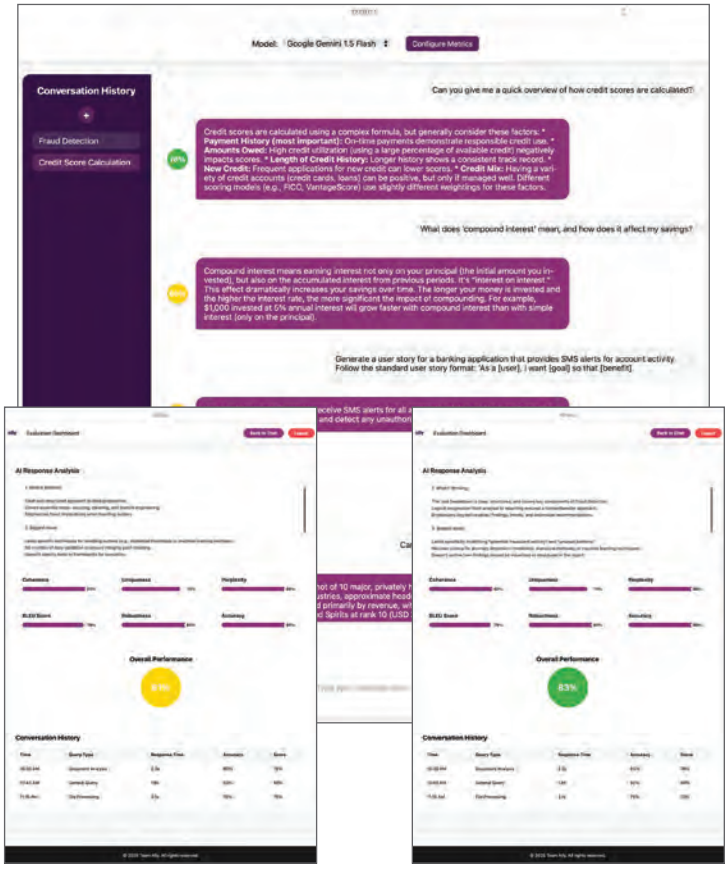
Given recent increased interest in artificial intelligence, Ally Financial is experimenting with using generative artificial intelligence (GenAI) to automate various internal business processes. Research conducted thus far by Ally and others is promising, but GenAI's novelty and complexity create concerns regarding its reliability of performance.

Currently, there is no testing framework in place to accurately assess where GenAI excels and when it should be used in business practices. Without such a framework, it is time-consuming to identify use cases where it is appropriate to apply GenAI.

Our AI System Testing Framework evaluates how a GenAI model performs on a specific task. Given a prompt, the application indicates how well the GenAI model responds to the prompt by displaying meaningful evaluation scores associated with the interaction such as accuracy and relevancy.

After accessing the application, a user interacts with GenAI through a chatbot-like interface. The user prompts the GenAI with a professional use case and reference response, receives an output, and is then redirected to an evaluation page. The evaluation page provides a visualization of scores on how well the AI performed for that use case. Additionally, the user views past interactions and the scores associated with those interactions.

The front end of this system is built using HTML, CSS, and JavaScript. The back end is implemented in Python and uses the Flask library to create a web application. A server provided by the MSU Division of Engineering Computing Services (DECS) is used to host a PostgreSQL database where relevant data is stored.

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# Amazon

## Semantic Search for Code and Architecture Assets

Amazon, located in Seattle, Washington, is a global leader in technology and a global e-commerce powerhouse. Originally founded by Jeff Bezos in 1994, Amazon has since expanded into a dominant force in cloud computing through Amazon Web Services (AWS) and is the parent company of over 100 subsidiaries.

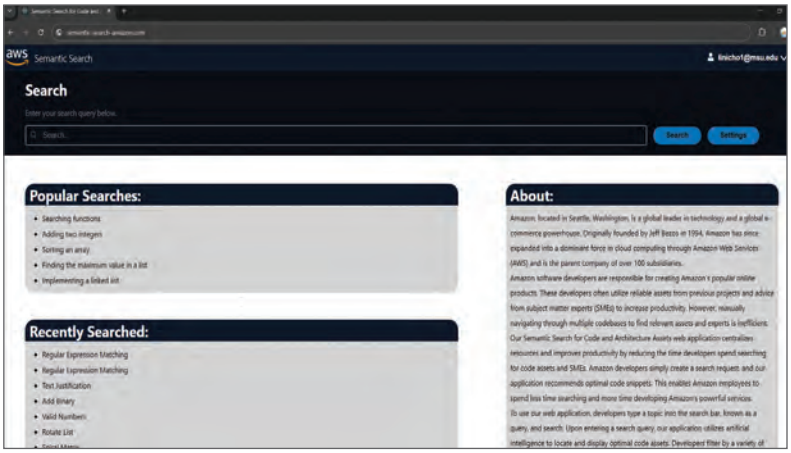
Amazon software developers are responsible for creating Amazon's popular online products. These developers often utilize reliable assets from previous projects and advice from subject matter experts (SMEs) to increase productivity. However, manually navigating through multiple codebases to find relevant assets and experts is inefficient.

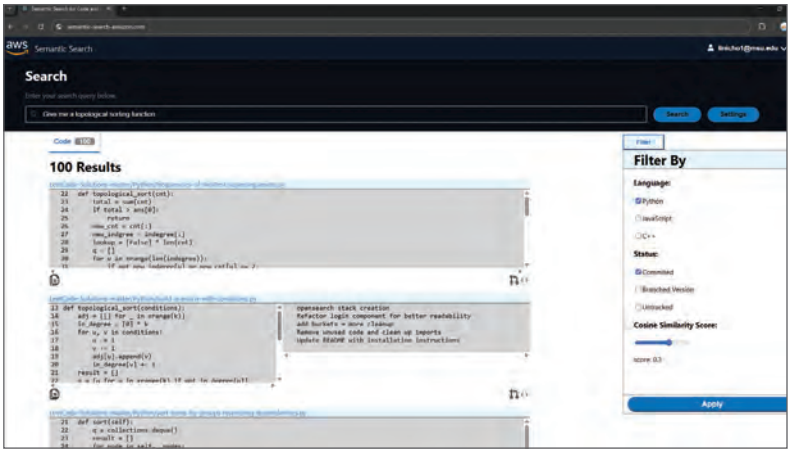
Our Semantic Search for Code and Architecture Assets web application centralizes resources and improves productivity by reducing the time developers spend searching for code assets and SMEs. Amazon developers simply create a search request, and our application recommends optimal code snippets. This enables Amazon employees to spend less time searching and more time developing Amazon's powerful services.

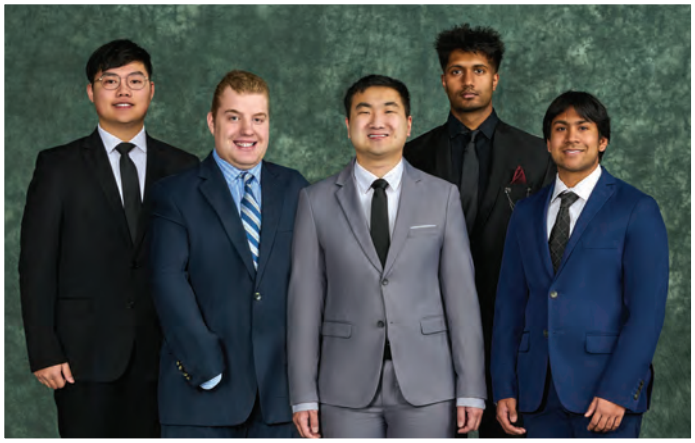
To use our web application, developers type a topic into the search bar, known as a query, and search. Upon entering a search query, our application utilizes artificial intelligence to locate and display optimal code assets. Developers filter by a variety of options to find the assets that best suit their needs.

Our web application mobilizes various codebases into a single platform for developers to access templated code, minimize workflow disruption, and contact the SMEs with ease.

Our web application utilizes a suite of technologies provided by AWS. The front end is built with React and hosted on AWS Amplify, while back-end operations are handled by Amazon API Gateway, AWS Lambda, and Amazon S3. Amazon OpenSearch is used to search for relevant code assets.



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# Anthropocene Institute

## Balancing the Power Grid with Nuclear Power

The Anthropocene Institute is an organization located in Palo Alto, California since 2012. Their mission is to unite entrepreneurs, thought leaders, and investors to advance clean energy, technology, and climate policy.

Anthropocene Institute promotes nuclear energy as a possible option for clean energy. However, nuclear energy is a controversial solution among policymakers, energy market traders, and even the general public. Despite this, there are many benefits to nuclear energy that the public may not be aware of.

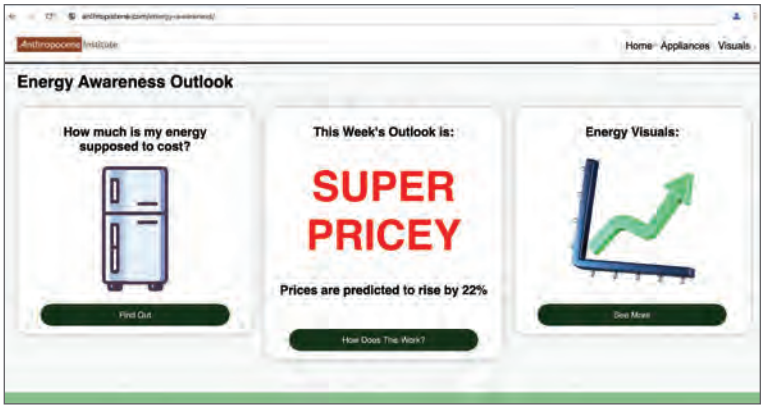
Our Balancing the Power Grid with Nuclear Power system empowers consumers to be more informed about the current state of the California energy market. Our software collects real-time data from the energy market to build interactive data elements that users view to learn more about the current state of the energy market.

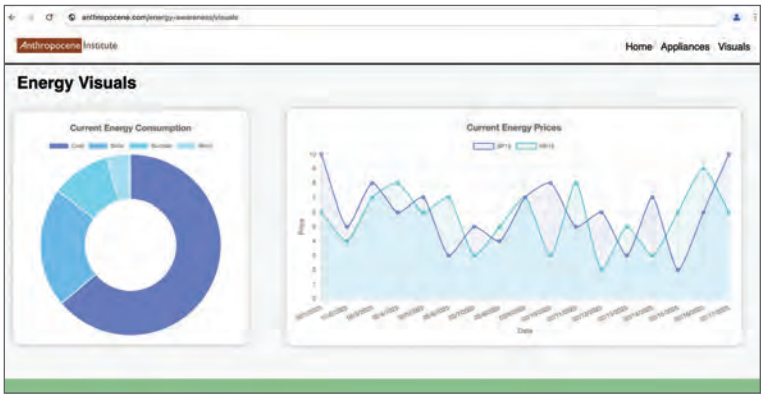
The first element is an energy forecast, which provides a visual of the current price movement within the energy grid. This forecast also ties to an alert system where users sign up to receive customized messages when there are spikes in energy market prices.

Additionally, there is an appliance calculator which enables users to input information about their energy bill and household appliances. The calculator displays the true cost in energy consumption that those appliances have on the grid over time, empowering the user to make informed decisions as a consumer.

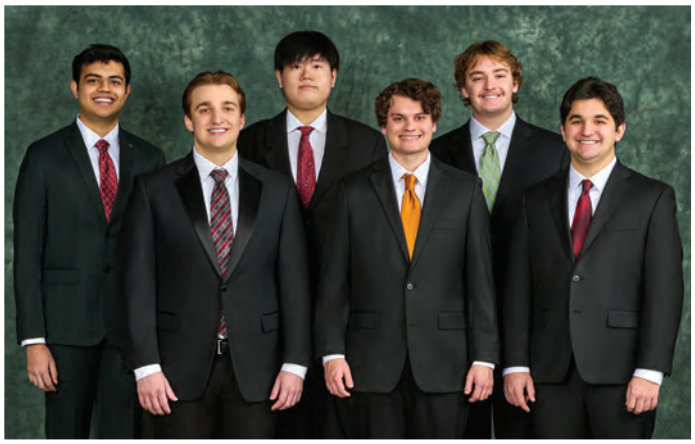
The energy outlook page showcases multiple elements that display data on energy usages, prices, and carbon emissions. These visuals are interactive and downloadable into simple data formats for further individual research.

The front end of our web application is in HTML, CSS, and JavaScript. The back end is implemented with Python Flask and is connected to a MySQL database.




Anthropocene Institute



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# Auto-Owners Insurance
## Next Step Insight

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 6 million policyholders.

As a major insurance company, Auto-Owners employs around 6,000 associates across a wide array of positions and locations. As such, there are often employees who are ready for promotion or who need to be relocated.

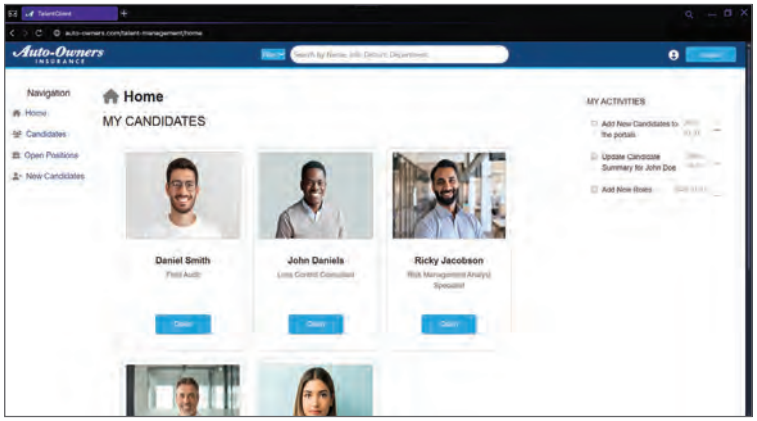
Auto Owners currently uses an existing system to identify these individuals based on certain criteria. However, manually analyzing and updating the current system is a complex and tedious task, making the process needlessly labor-intensive and time-consuming.

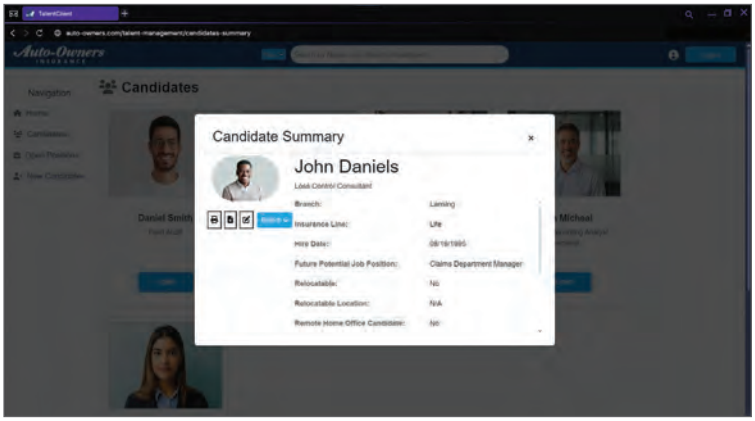
Our Next Step Insight is a web application that significantly reduces the time needed to review possible candidates by filtering employees based on specified criteria. It utilizes a machine learning model to automatically recommend candidates who are a good match for the selected operation based on their employee summary.

Users start by selecting a position that needs to be filled, along with any filters to apply to the search. Our software eliminates potential candidates that do not align with the search criteria and highlights the employees that the machine learning model recommends for the job.

Our website decreases the time that the Human Resources department needs to spend organizing potential candidates' details, enabling them to more efficiently compare candidates. This gives Auto-Owners the ability to fill available roles quickly so they can continue to have a capable and well-staffed team.

The front end of our application is built with HTML, CSS and TypeScript, while the back end is implemented with Spring Boot 3. The data for our application is stored in a Microsoft SQL database.

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# Corewell Health

## AI for Med Students Learning About Basket Management

In February of 2022, two Michigan hospital management companies, Beaumont Health and Spectrum Health, merged into what would become Corewell Health. Corewell Health is now the largest health system in Michigan, running 22 hospitals across Michigan, employing over 65,000 people, and treating over 1.3 million patients.

Electronic health records (EHRs) are a crucial part of today's healthcare. They are a convenient way for doctors to quickly check a patient's lab results, prescriptions, charts, messages, and more. However, medical students and residents lack the training required to use these systems efficiently in real-world environments.

Our AI for Med Students Learning About Basket Management is a web application that trains medical students and residents in efficiently handling patient messages, lab results, and prescription requests.

Our software provides students with daily tasks that consist of multiple questions for each of the three categories listed above. Students must respond to a variety of AI-generated questions that reflect a message that a physician might receive from an actual patient. Students must also review a patient's lab results and write the patient a message about any abnormalities or concerns the student may have. Finally, students must practice ordering or refilling prescriptions for patients.

Our system grades the students' responses to each patient case based on completion and provides an AI-generated example for the student's learning. The student then compares their answer to the LLM's to improve their responses for future cases.

Our front-end software is written with ReactJS, and our back end is written in Golang. We use Flask and OpenAI's API for the LLM microservice, and our data is stored in a Supabase SQL database.


Corewell Health™

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# Delta Dental of Michigan, Ohio and Indiana
## 3D Analysis of Dental Patient History

Delta Dental provides dental insurance coverage to more than 90 million Americans. They operate in all 50 states, making them one of the largest dental insurance providers in the United States.

Delta Dental processes millions of claims per year from their subscribers. When the claims go through their claims processing system, further human review by adjudicators may be required to correct malformed data or to review the validity of the claim.

Claims are reviewed through the context of the patient's dental history, which Delta Dental has comprehensive access to. This includes any procedures or treatments performed on any patient, leading to a massive amount of data.

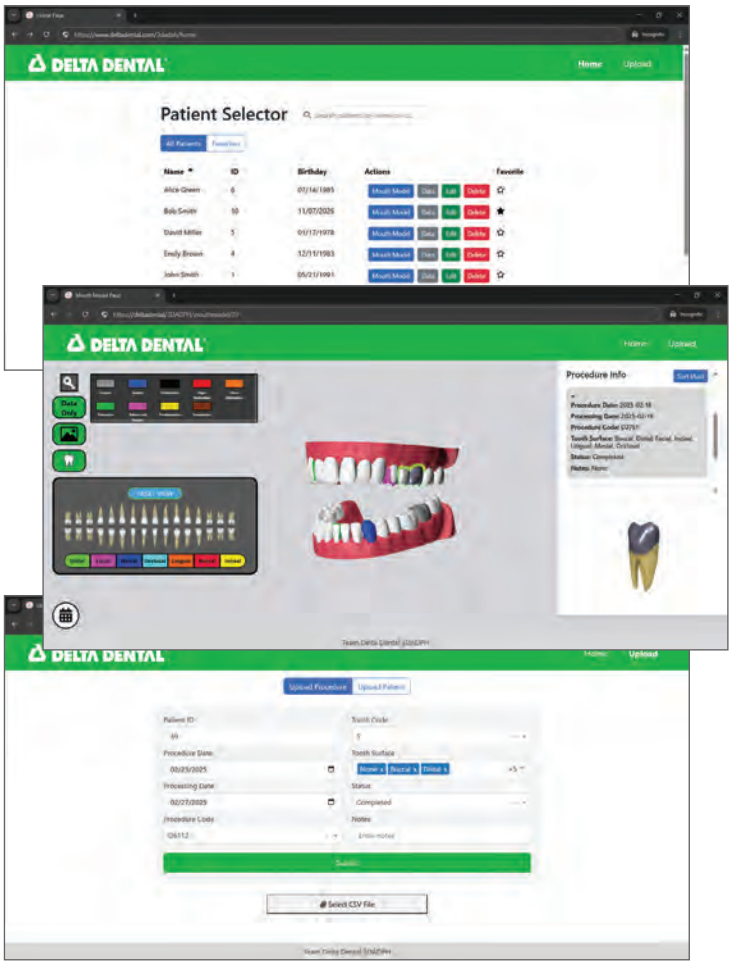
The 3D Analysis of Dental Patient History assists adjudicators by visualizing the dental patient history. Our web application features a 3D model that shows a patient's entire dental history where the user rotates, zooms in, and selects specific teeth on the model. Selecting a tooth displays all information about its previous procedures and treatments as well as a more detailed individual tooth model.

In the web application, users edit existing data and upload new data. Inputting information can be done manually through a form or by uploading other records that are kept on file.

Once new data is uploaded, users view the patient's information in the 3D model. With access to a patient's complete dental history, past procedures and treatments are viewed in chronological order.

Our application streamlines claim reviews by enabling Delta Dental employees to quickly and accurately visualize patient history, saving valuable time and effort.

The front end of our web application is built with Angular. Three.js is used to display 3D models and Bootstrap provides formatting for the front end. Java Quarkus is used for connecting Angular to the PostgreSQL back end.

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# Delta Dental of Michigan, Ohio and Indiana
## DSL Tooling Ecosystem (dSLATE)

Delta Dental is the nation's leading dental insurance provider, serving over 90 million Americans in all 50 U.S. states, Puerto Rico and other U.S. territories. Delta Dental of Michigan is one of the 39 independent Delta Dental companies and has been serving the citizens of Michigan since 1957.

Delta Dental of Michigan developed their own domain-specific language (DSL) to handle complex insurance rate calculations alongside the use of Excel spreadsheets. The DSL is used in a variety of tools scattered across different platforms. However, this affects the efficiency of business operations because it is time-consuming to navigate between the various components.

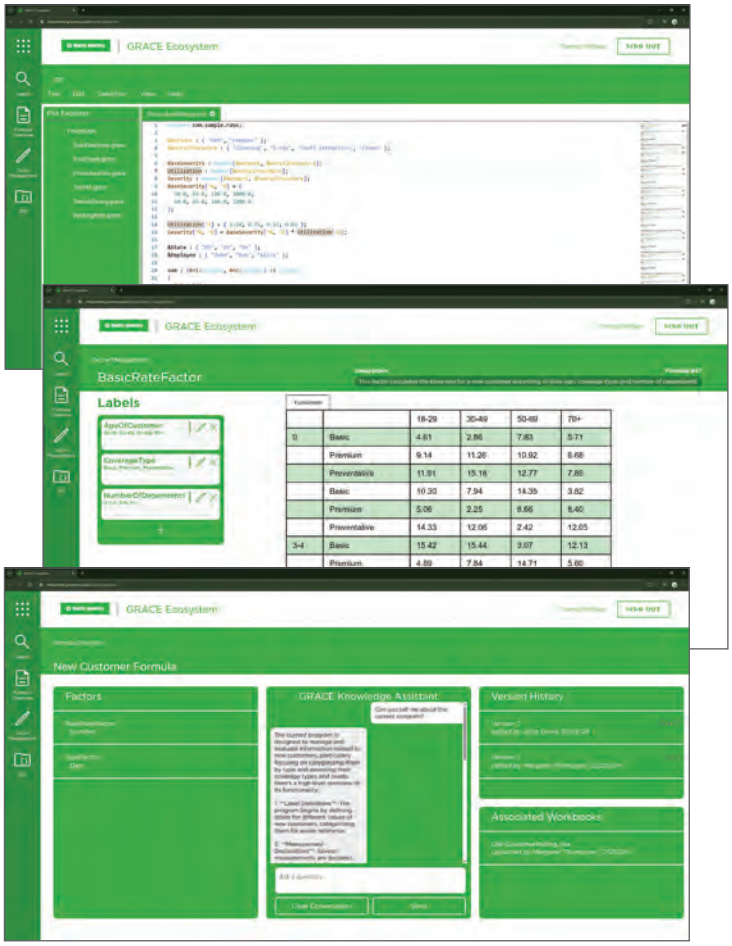
Our DSL Tooling Ecosystem (dSLATE) is a web application that provides a user-friendly environment with all the necessary tools for underwriters and developers to perform rate calculations in Delta Dental's DSL.

The tooling ecosystem includes an overview with the ability to create, search, and navigate for active insurance formulas and factors within the system, aggregating any information needed for calculations into one convenient location.

Our web application also gives developers access to an integrated development environment designed specifically for the DSL. This tool streamlines the transfer of Excel data into DSL code and shows formulas and factors involved in the process. The environment enables editing and creation of new formulas as well.

Users ask further questions of the included DSL knowledge assistant. The knowledge assistant provides information to help users understand a formula and its factors.

The front end of our system is written using Angular. The back end uses Java Quarkus with a MongoDB database to host Delta Dental's existing core libraries and data. Microsoft's Azure OpenAI service is used to handle the DSL knowledge assistant.

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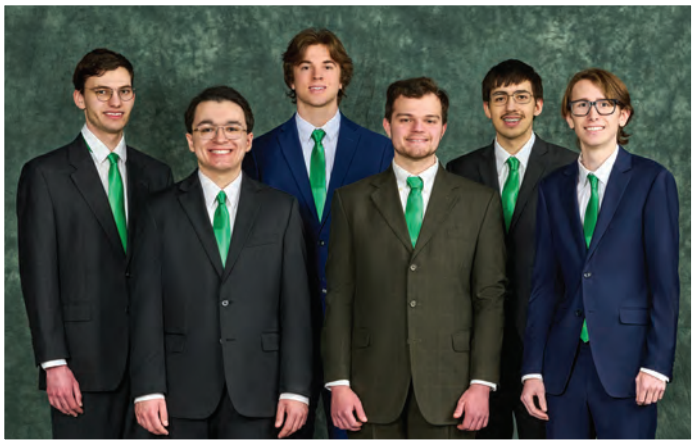

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# General Motors
## Global Waste Management System

General Motors (GM) is a global automotive company that has proven through more than a century of automotive design and engineering to be a force of continuous innovation.

GM is focused on reaching zero waste and emissions by 2035 as they lead progress among automotive manufacturers.

However, compiling accurate waste data across a multinational corporation to inform sustainable operations is no easy feat, and converting waste data spanning years into useful information is challenging. Accurate data collection at GM relies on waste managers avoiding error during manual input, however mistakes are inevitable.

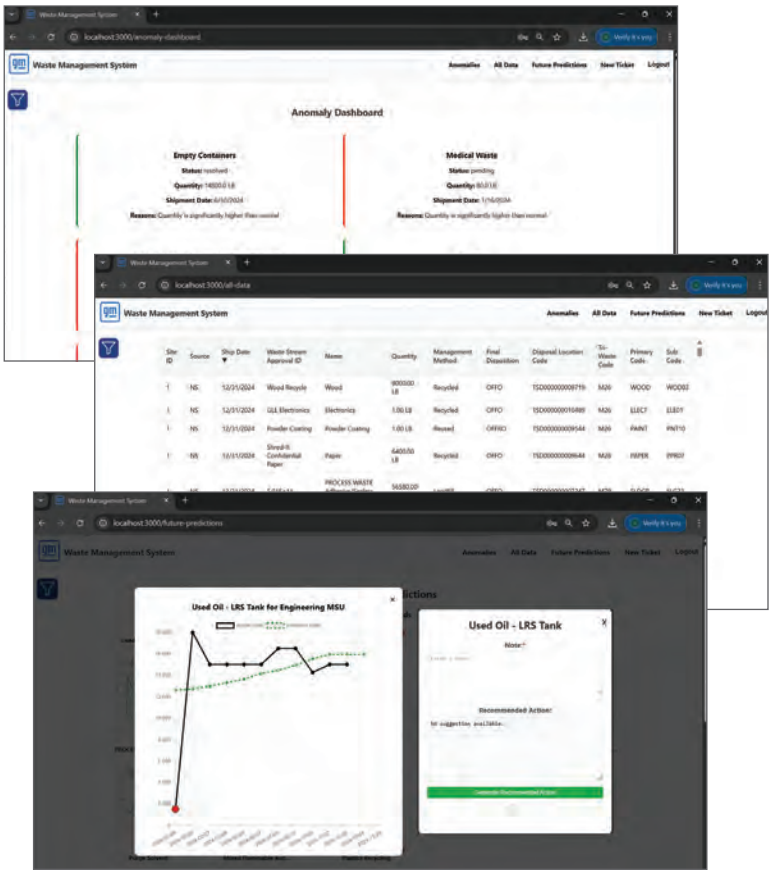
Our Global Waste Management System addresses these problems and promotes informed sustainability progress in GM operations through an intuitive web application.

Our web application supports robust data filtering and editing all while ensuring proper authorization. However, it has two truly outstanding features. Those are statistical error checking of data entries and predictive waste trend analysis.

Statistical error checking software prevents manual data entry errors by using a variety of metrics to identify anomalies. When a waste data entry error is made, the waste manager is prompted to resolve the issue or bypass it. Our software also includes capabilities for users to define what qualifies as an error.

With accurate data, it is possible to make informed sustainability decisions if the data can be visualized in a meaningful way. Our waste trend analysis predicts what the near future will look like in terms of waste production at GM using advanced data analysis. Predictions are displayed in multiple easy-to-read ways.

The front end of the Global Waste Management is built using React while the back end utilizes Flask, Python libraries, and MySQL.

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# HAP
## Customer Intent Engine and Training Tool

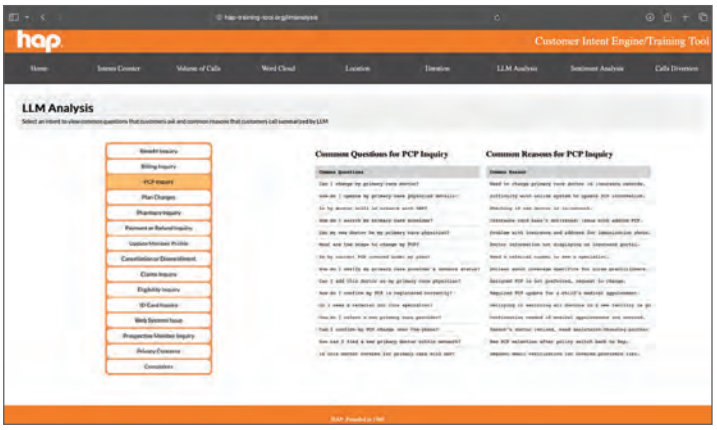
Health Alliance Plan (HAP), founded in 1960 and headquartered in Troy, Michigan, is an innovative and trusted health insurance provider with a mission "to enhance the health and well-being of the lives we touch." HAP was one of the first 21 health plans in the United States to publicly report on the quality of care.

Every day, HAP receives numerous customer service inquiries in their call center that range across a variety of customer needs. With such diverse inquiries, there is a lot of information that a call center representative needs to be prepared to both receive and relay. Training representatives for all these different scenarios is a time-consuming and overwhelming process.

Our Customer Intent Engine and Training Tool enables representatives to enhance their customer service skills by providing valuable insights from historical customer calls. Our software analyzes transcripts from past calls, identifies the customers' intents, and displays the information in numerous ways on our web application.

Our website offers interactive dashboards where users explore the details of past customer inquiries from various perspectives such as call frequency, commonly used words for specific topics, most frequently asked intents, and more. Users click on specific dashboard pages to gain further insight into a given topic. Our application also provides a smart chatbot to enable customer service staff to ask questions as they use the website for training.

Our front-end software is developed using HTML, CSS, and JavaScript, while the back end is implemented using Python Flask with PostgreSQL as the database. The software leverages Python for data analysis and generates interactive dashboards using the Python Dash library. The chatbot is trained and implemented using the Hugging Face library in Python.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# Henry Ford Innovations
## Electronic Laboratory User's Guide (eLUG)

Henry Ford Health is one of the nation's leading healthcare providers based out of Detroit, Michigan. More than 6,000 medical professionals and researchers work towards ensuring that Henry Ford Health is at the forefront of modern medicine. Their engagement in over 2,000 research projects every year proves their dedication to medical innovation.

It is crucial that clinicians and medical professionals can properly collect and handle specimens from their patients for lab testing. This is why Henry Ford Health created the Electronic Laboratory User's Guide (eLUG). The eLUG houses a lab testing catalog that provides guides on correct specimen collection methods.

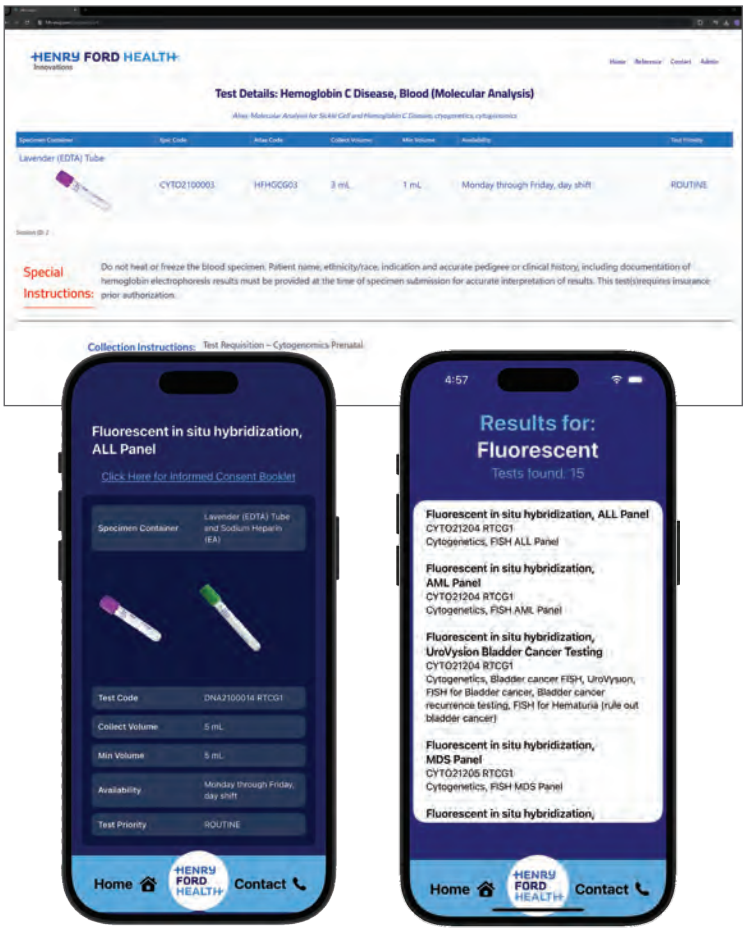
eLUG was originally developed over 20 years ago, can be difficult to navigate, and many of its features are outdated.

Our improved eLUG features a modern, user-friendly interface improving the experience for day-to-day users, both internal and external. Along with a web application, we offer a mobile application to increase the guide's accessibility.

The improved search feature finds any guide within a few keystrokes. Additionally, shareability is a vital component of modern healthcare workflows. Our web application enables the simple sharing of test pages with unique links, while the mobile application provides direct access to corresponding web pages, ensuring smooth collaboration.

Security is a big concern in healthcare, and our application has three separate layers of secure access: a user, an admin, and a webmaster.

The eLUG web application is developed with HTML, CSS, JavaScript, and ReactJS, while the mobile application is developed with Xcode and Swift. Both are powered by a MySQL database, with the mobile application utilizing a RESTful API to fetch data.

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# Henry Ford Innovations
## Modernizing Robotic Surgery Education 2.0

Henry Ford Health is a leading not-for-profit healthcare organization headquartered in Detroit, Michigan. Founded over 100 years ago, Henry Ford Health is recognized nationally due to its commitment to community care and breakthroughs in education, research, cancer treatment, and more.

As partners, Henry Ford Health and Michigan State University collaborate to innovate medical education and patient well-being.

Residents learning new surgical methods involving robotic equipment must first learn how to operate it effectively. There is a need for specialized software to adapt this education to newer generations of surgeons.

Our Modernizing Robotic Surgery Education 2.0 system improves the learning experience with new data analysis and discussion forums.

With our user-friendly focus, our updated software implements a personalized experience for both students and instructors. Employing a widget system, users enjoy a custom dashboard with valuable insights that streamlines the robotic surgery learning process.

Additionally, we have a mobile iOS application that connects to our web application. Data synchronizes between both applications, ensuring real-time updates.

Our software solution also features a discussion forum, where instructors and students collaborate, ask questions, and obtain feedback.

The platform links its data to a private and secure cloud server which stores data and settings, including login data. Users must undergo multifactor authentication to enhance security.

Our web-application uses Flask, PyTorch, Docker, JavaScript, Dash, HTML, and CSS to provide a seamless experience. We use Swift to extend the application to iOS platforms.


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# Henry Ford Innovations

## MSU-HFH Research Synergy Vanguard Portal (RSVP) 2.0

Henry Ford Health (HFH), based in Detroit, Michigan, is a leading healthcare system renowned for its commitment to innovation in medical research. In partnership with Michigan State University, HFH bridges the gap between clinical needs and academic expertise across both institutions.

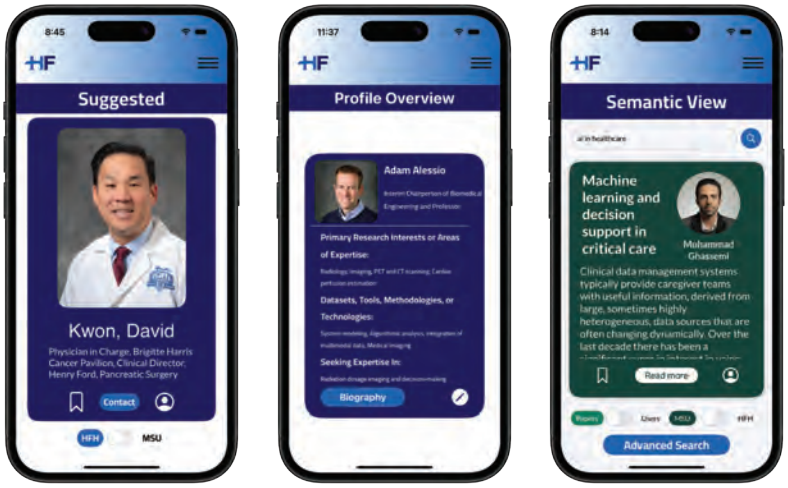
Despite this partnership, clinicians at HFH and faculty at MSU face challenges in connecting across disciplines due to fragmented communication channels and a lack of centralized resources. This hinders the potential for interdisciplinary research and limits opportunities for collaboration among clinicians and experts such as engineers and scientists.

Our Research Synergy Vanguard Portal (RSVP) 2.0 addresses this challenge by providing both a web- and mobile-based platform that streamlines collaboration. The system helps users find research partners not only across institutions but also within their own organizations. The system intelligently analyzes user expertise and research interests to recommend ideal collaborators, creating a seamless and efficient networking experience.

Our mobile app introduces a swipe-to-match feature, enabling users to quickly browse and connect with potential collaborators. This new feature, along with automatic message suggestions, further encourages meaningful collaboration in a manner that fits the fast-paced schedule of many users.

With advanced semantic search capabilities, users refine their searches using multiple inputs, ensuring precise and relevant results in seconds.

Our portal is built using a ReactJS front end and a Flask back end for application logic. We utilize Bidirectional Encoder Representations from Transformers (BERT) for natural language processing to enhance search capabilities, and Elasticsearch for efficient search performance.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# Launch by NTT DATA
## Everyday Agent

Launch, a subsidiary of NTT Data, accelerates product development by delivering innovative engineering solutions. With offices across the Americas, Launch partners with industry leaders like Jeep and Adidas to transform ideas into scalable technology.

People frequently misplace essential items like keys and wallets, leading to frustration and wasted time. Existing solutions, such as tracking tags, require manual setup, while voice assistants lack real-time object detection. A more intuitive, hands-free solution is needed to seamlessly integrate item tracking into daily life.

Our Everyday Agent is a wearable device powered by artificial intelligence that tackles this problem. Equipped with a compact camera, the device continuously scans the user's surroundings to detect and log their items' locations. Using this information, Everyday Agent provides the last known location of an item. If an object cannot be accurately located, the system analyzes past user habits and suggests the most likely location.

Users interact with Everyday Agent by saying, "Hey Agent," followed by their query. When they request location services, the device responds with either a precise location or an estimate. It also functions as a voice assistant, answering general questions.

A companion mobile app provides users with a dashboard displaying their most frequently misplaced items. Each item is listed alongside a description, such as "on the kitchen counter," and its last shown GPS-based coordinate, plotted on an interactive map.

Our Everyday Agent uses a Raspberry Pi Zero 2 W with a camera, speaker and microphone. The mobile app is written in Swift, and the product software is written in Python using multiple models. You Only Look Once, Places365, Roboflow and ORB-SLAM are used for image recognition. Microsoft Azure is used for speech, text and natural language processing as well as a virtual machine. PyTorch is used for the predictive location algorithm.


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# Magna
## Manufacturing Tracking System

Magna, founded in 1957 as a small tool and die shop, has evolved into a global automotive technology and manufacturing powerhouse. They are a key player in the automotive industry, supplying components and systems to major vehicle manufacturers worldwide, and shaping the future of mobility solutions.

In order to stay ahead of the competition, Magna needs to keep track of all of its goods and materials throughout the manufacturing process. Unfortunately, with so many factories and products, this can be very difficult. Manufacturers need a more efficient way to track and identify materials that make up their products.

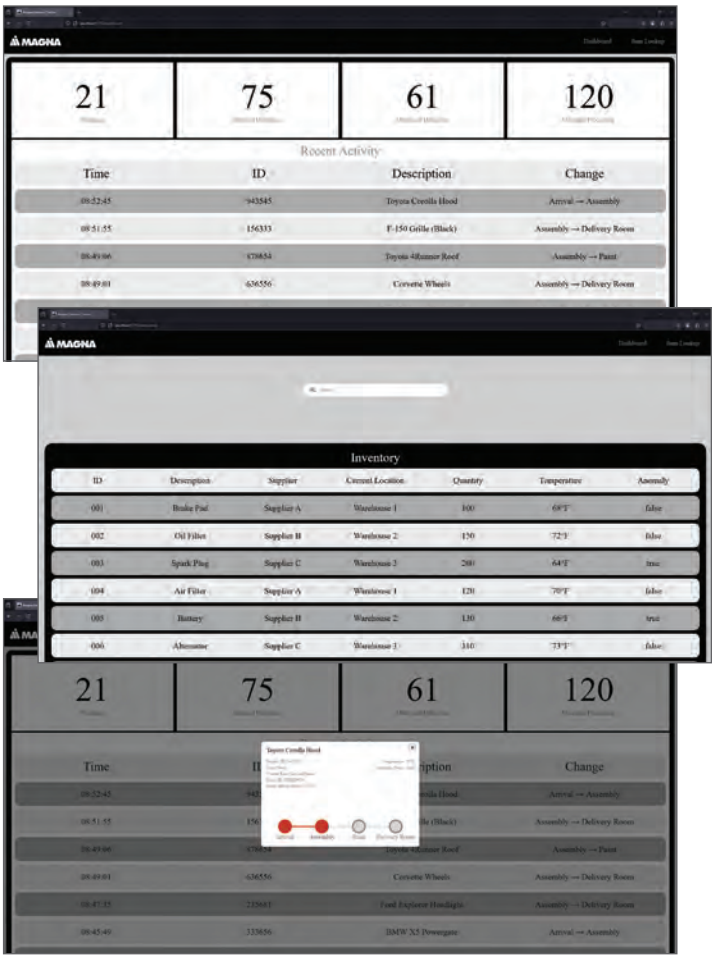
Our Manufacturing Tracking System solves this problem for Magna by creating a digital record of materials as they pass through the manufacturing process. Our web app interface provides key information about material details and movement history.

Users gain real-time insight on the most recent material movements in the factory as well as the ability to find what materials make up a product. Our system displays factory sensor data in real time, enabling operators to detect manufacturing problems early, reducing waste and improving production.

Our software is built on blockchain technology, ensuring that every record is permanent and cannot be altered. The blockchain also enables users to view the entire history of a product as it navigates through Magna's supply chain. Operators visualize these chains of events using our web app.

By combining real-time monitoring with secure digital records, our software improves efficiency and reduces costly errors.

Our system runs on Hyperledger for blockchain security with a Node.js back end to efficiently handle large volumes of real-time data from IoT sensors and material tracking logs. The front end uses Vue.js for a smooth UI interface that enables operators to view updates instantly as the material moves through production.

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# McKesson
## Vulnerability Scan and Detect

McKesson is a Fortune 10 healthcare company that streamlines pharmaceutical delivery and patient care across the globe. McKesson strives to improve patient outcomes by seamlessly integrating technology into pharmaceutical services worldwide.

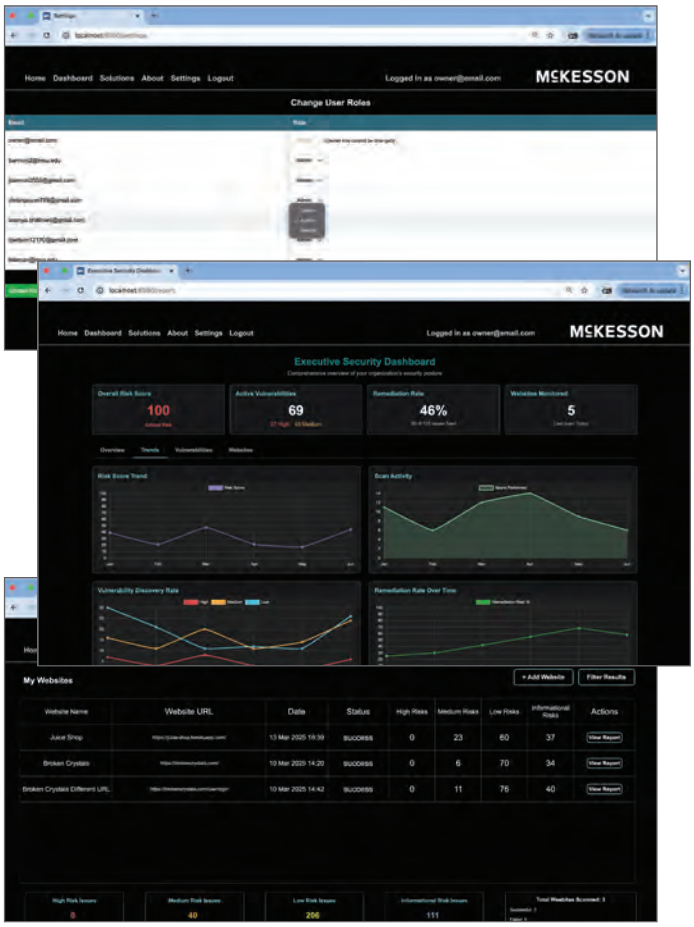
Healthcare environments depend on strong cybersecurity measures to protect sensitive patient data and prevent disruptions in critical hospital operations and pharmaceutical supply chains. Even a single vulnerability in a web application might serve as an entry point for cyber threats, putting patient privacy and healthcare infrastructure at risk. Identifying these weaknesses before they can be exploited is crucial in maintaining a secure digital environment.

Our Vulnerability Scan and Detect tool provides a proactive approach to cybersecurity by analyzing web applications for potential security flaws. After a user simply enters a URL, our system conducts a thorough scan, detecting vulnerabilities that could be leveraged in cyberattacks.

Once the scan is complete, a detailed report is generated, highlighting identified risks along with actionable recommendations to mitigate them. Risk statistics are visualized with easy-to-read charts, enabling users to understand risks at a glance. All reports are stored in a secure database which is linked to the web application for a seamless view of scan history.

This system enables healthcare organizations to address security gaps efficiently, reducing the likelihood of data breaches, system outages, or unauthorized access to critical information.

The application is built using a Flask-based back end to manage scan requests and process results. The front end is built with HTML, CSS, and JavaScript to provide an intuitive user experience for entering URLs and reviewing reports. The scanning process utilizes industry-standard security testing frameworks to provide accurate and comprehensive vulnerability detection.

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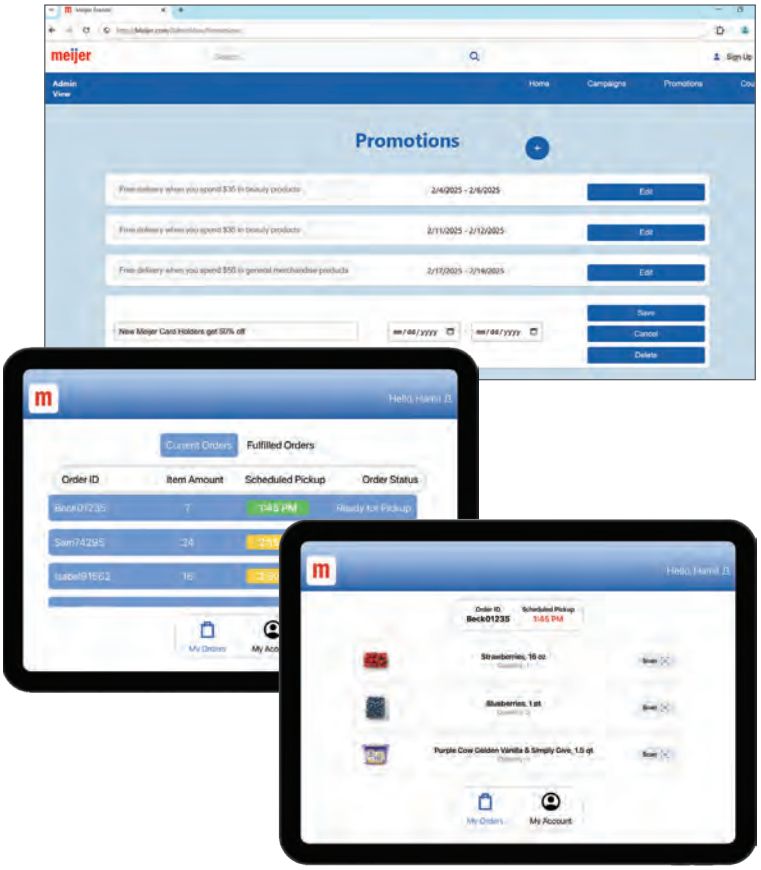
# Meijer
## Online Customer Experience with Meijer Branded Products




Meijer is a prominent Midwest supercenter chain headquartered in Grand Rapids, Michigan, with over 260 stores across six states. Meijer is committed to offering value and quality throughout its 18 in-house brands.

With consumers having several options to choose from when selecting a grocery store, it is important for Meijer to foster their brand and provide incentives for people to continue shopping at their stores.

Our Online Customer Experience with Meijer Branded Products promotes the Meijer brand by providing a centralized location for customers to interact with Meijer products and business practices. The experience features a website for customers to peruse Meijer's in-house brands, including two brand new product lines. Our software hosts an online ordering and pickup system to facilitate purchase of these items.

Online order pickup from the customer-side website modernizes the grocery shopping experience. It eliminates traditional checkout lines and enables customers to select pickup times, check-in from their phones, and receive real-time updates on their order.

By leveraging Meijer team member specialization, orders are fulfilled optimally by assigning an employee with the best knowledge of each of the given products.

A new promotion and campaign management page enables Meijer administrators to edit and promote products, create coupons for shoppers, and have access to current promotion and product analytics.

The front end of this application uses ReactJS. The back end is implemented in C# with .NET, and the platform is hosted on Microsoft Azure. Microsoft SQL Server handles all data storage. The mobile app is written in Swift and SwiftUI.

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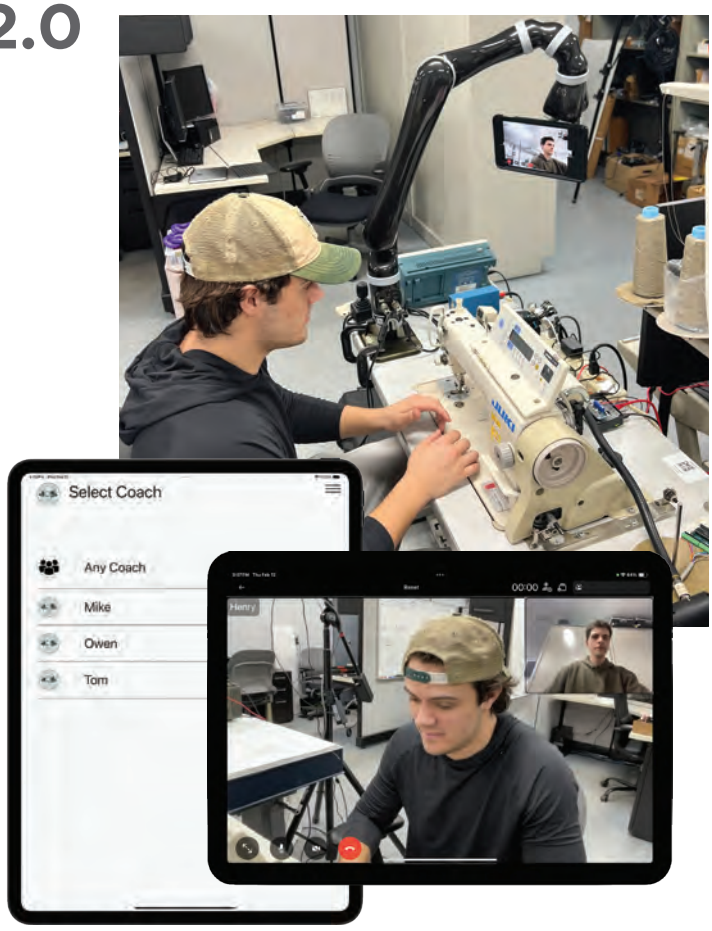
# Michigan State University
## Robotic Job Coaching 2.0




The department of Computer Science and Engineering (CSE) is the largest academic unit in the College of Engineering at Michigan State University (MSU). The department hosts 20 laboratories, each equipped with cutting-edge technologies that facilitate research in a wide spectrum of topics. MSU CSE boasts an array of industry-leading research in collaboration with departments such as robotics, special education, psychology, and more.

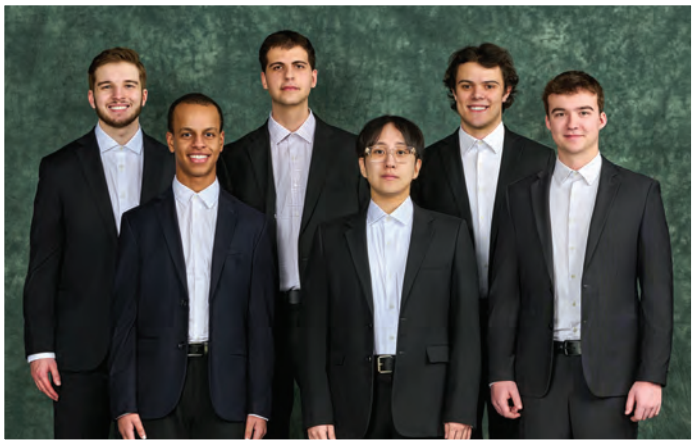
Research professionals from various fields are collaborating with the CSE department to develop an industry-leading system for workplace training. Job coaching is a valuable resource for employees with disabilities to thrive in a workplace. In-person job training requires a coach to be on-site. Virtual job coaching enables a job coach to reach multiple clients without the limitation of physical presence.

Our Robotic Job Coaching system alleviates many of the challenges with in-person job coaching. Using our system, coaches connect with any of their clients virtually through a teleconference call. Clients request assistance from a coach and enter a queue.

The client devices are mounted on a robotic arm and coaches remotely manipulate the robotic arm, enabling coaches to view the complete work area remotely. The coach is able to gain a full understanding of any problems that the employee may be experiencing, thereby facilitating better coaching.

Our system combines the effectiveness of in-person job coaching with the flexibility of virtual coaching to offer an effective and innovative solution for job coaches.

The front end of the Robotic Job Coaching system is built in Java for Android and Swift for iOS. Our back end is hosted on a Docker container running a Python Flask application with a Gunicorn server client. The robot is controlled over UDP using ROS Noetic and the ROSbridge package.



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# Michigan State University
## Test Platforms for Self-Driving Race Cars

The PoliMOVE-MSU Indy Autonomous Challenge team, a collaboration between Michigan State University and Politecnico di Milano, is a leading force in autonomous racing. The team secured first place in the 2024 Indy Autonomous Challenge, showcasing their cutting-edge innovation and engineering expertise.

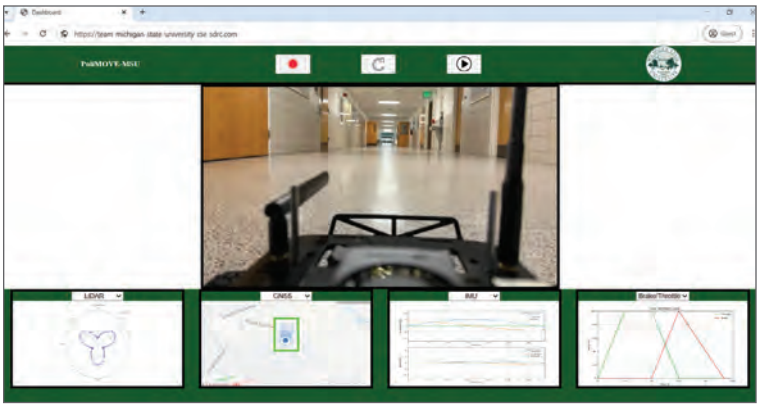
To maintain their competitive edge, the team requires high-quality, real-world sensor data to help train and test their autonomous vehicles. Currently, the PoliMOVE-MSU team does most of their data collection and autonomous systems testing within virtual environments. To create realistic environments, it is essential that realistic sensor data is utilized. However, collecting enough sensor data can be very difficult and time-consuming.

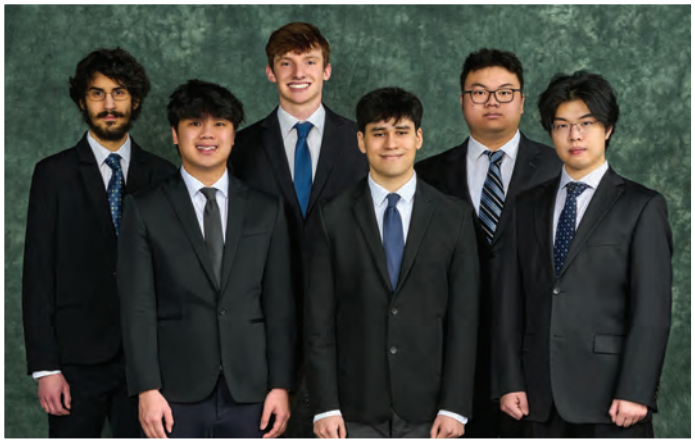
Our Test Platform for Self-Driving Race Cars (SDRC) bridges the inherent gap between the virtual testing environments and real-world autonomous driving by enabling users to collect real-world data easily with a scale model vehicle.

Our design features two main hardware systems: a 1:10 scale model of the real Indy Autonomous Vehicle and a base station, which in turn consists of a laptop, a driving chair, a steering wheel and pedals.

The base station uses a web application to control the vehicle. It sends control data from the steering wheel and pedals to the vehicle, enabling the user to control the system remotely. As the vehicle is driven through its environment, it utilizes a variety of real sensors to map its environment, which it sends back to the base station to be saved and displayed.

Using this web application, users are able to record, replay and download sensor data for any use case. The web back end is written in Python and the front end is written in HTML. The laptop communicates with the vehicle using the node system employed by the ROS2 middleware.





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# Michigan State University

## Crowd-Sourcing Intuitions of Vowel Classifications

The Michigan State University Linguistics Department provides theoretical foundation in the science of language sounds, structures, and meanings, with a focus on language variation.

One variation in language is dialect evolution. While dialect boundaries in North America have remained relatively unchanged, the ways in which people pronounce words continue to evolve.

Traditional dialect atlases rely on methods that limit their accuracy and scope, and traditional linguistics research relies on limited data points to study these shifts.

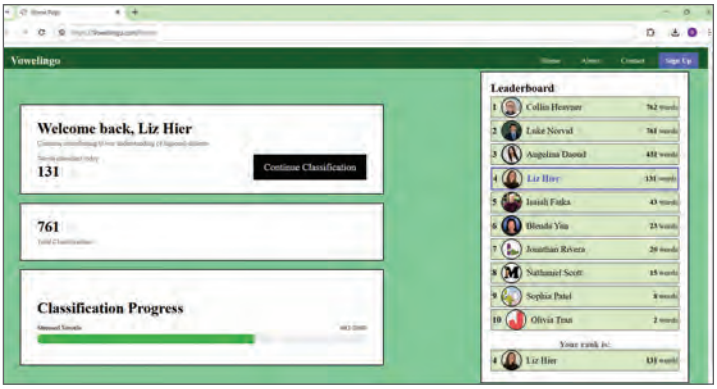
Our Crowd-Sourcing Intuitions of Vowel Classifications system reimagines linguistic data collection by introducing a web application that enables real-time vowel classification. Linguists classify thousands of words efficiently, contributing to a more comprehensive and dynamic understanding of dialect evolution.

The web application streamlines the process of vowel classification. Users begin with a pre-test to determine their dialectal distinctions. During classification, a word appears in a central display box with the targeted vowel highlighted for identification. Below the word, classification buttons displaying available lexical sets for selection are arranged into a trapezoidal shape familiar to linguists.

As users engage with the platform, their progress is displayed on a dashboard with a point system to motivate consistent participation. Researchers download classification data to conduct their own data analysis.

Our vowel classification system reveals modern dialectal trends and propels linguistics research forward.

The front end is built with React.js and structured with HTML, CSS and JavaScript to handle various data. The back end is powered by Flask which handles API requests and communication with the database.





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# MSU Federal Credit Union
## Logged-In Branch Experience

Established in 1937, MSU Federal Credit Union (MSUFCU) has been serving Michigan State University and the greater Lansing area for over 88 years. With over 24 branch locations statewide and 367,000 members, MSUFCU strives to help its local communities thrive and achieve financial freedom.

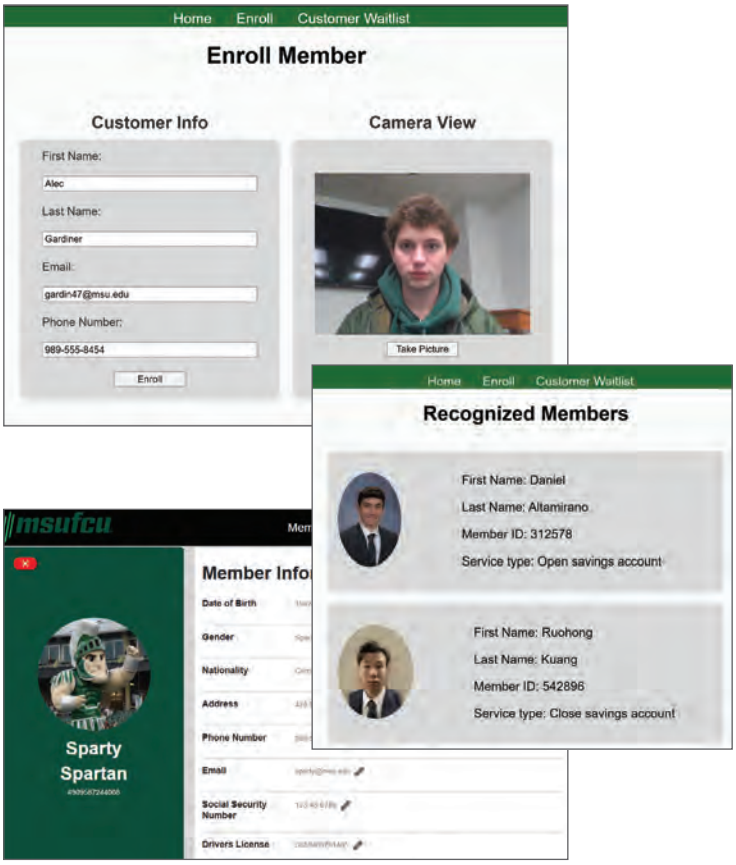
When visiting a branch, MSUFCU currently provides a standard check-in process that requires a member to input their name and wait for a teller to assist them. This process can be lengthy and contribute to member dissatisfaction. MSUFCU is looking to provide a more seamless experience where the branch recognizes members upon arrival.

Our Logged-In Branch Experience streamlines the in-person banking experience by using the organization's security cameras to identify members as they enter the building. Once a member is identified, MSUFCU staff can easily pull up relevant data and prepare to help the member.

Members are enrolled in the system by entering their name and a reference photo, which is stored securely in our system's database. When anyone enters the building, facial recognition compares their face to those stored in our database.

When our system detects a face, the teller receives a notification on their computer. If a member is recognized, the teller then quickly accesses their account information and prepares to assist the member. Conversely, the teller also has the option to ignore the notification if they won't be assisting the member or if the person detected is not an enrolled member. This process enables MSUFCU members to skip the sign-in process and fulfill their banking needs quickly and easily.

Our Logged-In Branch Experience utilizes a front end built with HTML, CSS, and JavaScript with a Python back end. Information is stored and updated using a MySQL database.

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# NetJets

## Airport Capacity and Ground Space Management

NetJets is the world leader in private aviation, having pioneered the fractional ownership model. Today, NetJets operates the largest and most diverse fleet of private jets, and safety is their top priority.

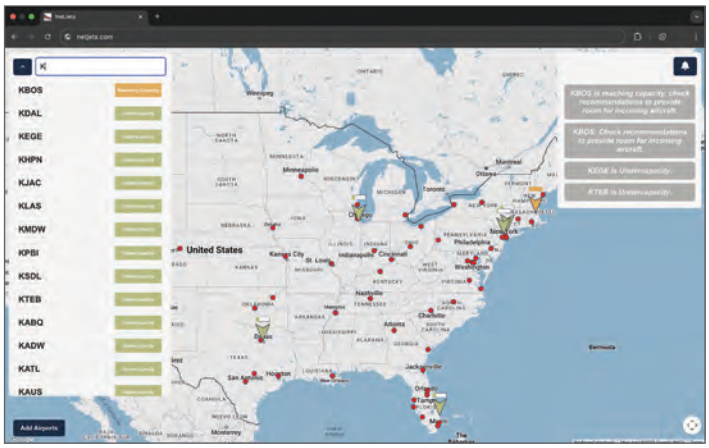
To serve their owners effectively, NetJets fleet operates in over 3,000 airports to provide a responsive on-demand service. Balancing the capacity levels of each airport is therefore a constant challenge in the quest for a high level of service in the air and on the ground: if an airport starts to near capacity, they must relocate planes to other Fixed Base Operators (FBOs) or airports to accommodate incoming flights.

Currently, NetJets employees must calculate the available ground space of airports and determine the best distribution of their planes with very limited automation. Our Airport Capacity and Ground Management system provides a visual representation of the capacity levels at their busiest airports, as well as provide recommended actions to be taken for optimal fleet management.

The user can select an airport to view by either clicking on the pin for that airport on the map view page, or through text search. Once selected, a satellite view of the parking lot layouts and locations are displayed, as well as information such as traffic overview, incoming flights, and the status of FBOs, which provide parking and plane storage.

The recommendation engine of our system provides the best course of action for the distribution of the fleet currently located at a specific airport. It considers factors such as aircraft size, repairs needed, airport capacity and weather to give recommendations on where to park the planes at that airport, including if they should be moved to a different airport.

The front end of our system is built with React, while the back end utilizes Node.js. The website is hosted on AWS with our data stored using an Amazon Relational Database Service (RDS).





NETJETS®

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# RPM
## Automated Damage Logging for Truck Drivers

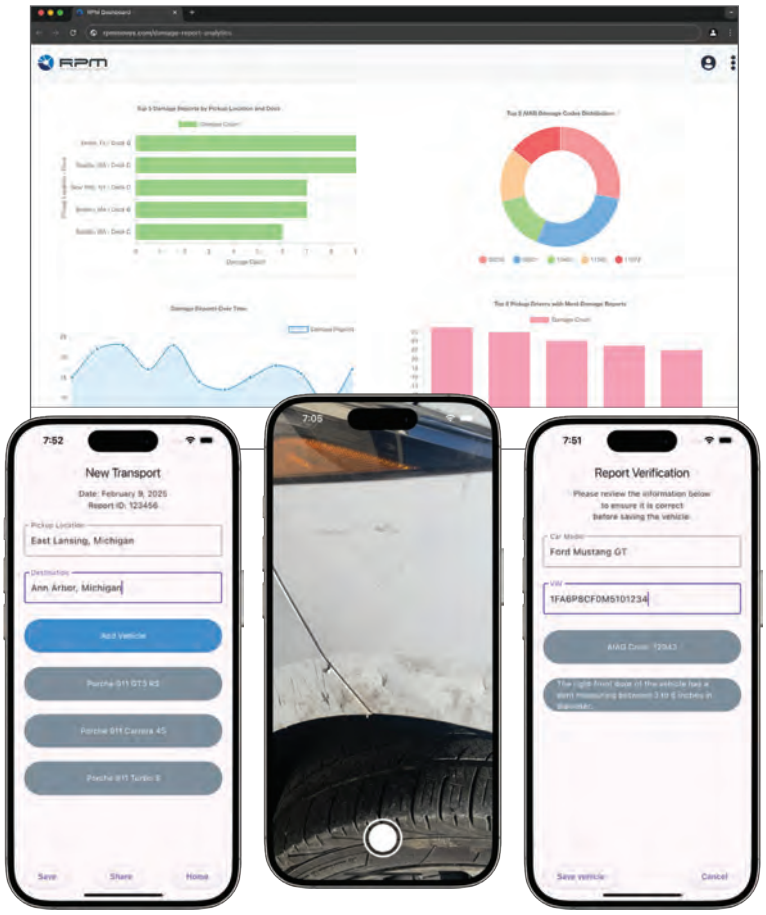
RPM is an international logistics and supply chain company based in Birmingham, Michigan. RPM specializes in freight transportation and vehicle logistics across North America and Europe. As a non-asset-based logistics company, RPM invests heavily in modern technologies and automation solutions.

RPM connects business clients with truck drivers to complete vehicle deliveries. Before transportation, truck drivers must manually log damages on each individual vehicle. This is a time-sensitive process and, when done incorrectly, can lead to costly disputes.

Our Automated Damage Logging for Truck Drivers provides drivers with a mobile app that automatically logs and classifies damages to a vehicle using photos of it. When a driver recognizes damage, they capture a photo of the vehicle and input its model and VIN. Our AI models analyze the images, identify the matching AIAG damage codes, and populate the report with a description of the damage that drivers edit before submitting. This reduces the time and effort needed for the logging process.

Our software also includes a companion web interface through which RPM's operational teams view damage reports, track user metrics, and visualize analytics. The dashboard provides real-time insights into damage trends, vehicle conditions, and reporting frequency, helping RPM optimize operations and reduce disputes. Reports from the mobile app are seamlessly transmitted to the web platform, ensuring efficient logging and retrieval.

Our mobile app is developed using Flutter, while the web interface utilizes React. A FastAPI back end, containerized with Docker and hosted on Azure, ensures scalability. Damage reports and user data are stored in a PostgreSQL database, and TensorFlow Lite enables real-time, on-device damage classification without requiring an internet connection.

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# Stryker
## Surgical Needle Tracking

Stryker is a global leader in medical technologies that offers innovative products and services to improve patient and healthcare outcomes.

Every day, millions of medical procedures are performed by surgeons who face the critical issue of retained surgical needles. These small but essential tools sometimes go missing during procedures, leading to severe complications, extended hospital stays, and costly corrective surgeries for the patient. The traditional solution is to perform additional X-rays and time-consuming manual counts, which are far from foolproof.

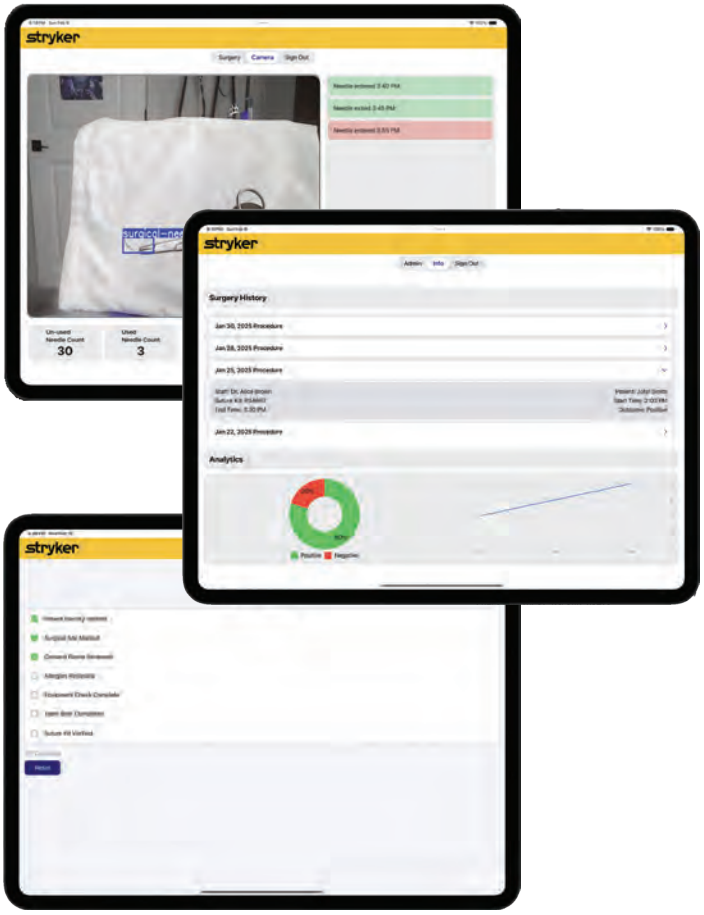
Our Surgical Needle Tracking system is an iOS app designed to detect, track, and document surgical needles in real-time during an operation to enhance patient safety and streamline surgical workflows.

Hospital administrators use the app to manage essential tasks such as inputting data for surgical procedures, creating user profiles, scheduling surgeries, and accessing valuable analytics.

Meanwhile, the app enables surgeons to focus on performing a successful procedure and worry less about needle logistics. During a scheduled procedure, the operating room staff opens the app to gain access to an intelligent camera system that detects and tracks surgical needles during the procedure. The app holds a count of needles that have been used during the surgery. If a needle goes missing, the system immediately alerts the surgery team with a visual and audio notification, preventing potential harm.

By reducing instances of retained surgical needles, our app enhances patient safety and saves time and money for hospitals worldwide.

Our app is available exclusively on iOS devices. It is developed in Swift and leverages YOLO real-time object detection and API calls to PostgreSQL for database communication.




stryker

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# TechSmith
## Watcher of Attuned Video Experiences (WAVE)

TechSmith's mission enables users to communicate and share their message through media capture and editing software. Founded in 1987, based in East Lansing, Michigan, TechSmith's products, notably Snagit and Camtasia, are employed by over 80 million users worldwide and within all Fortune 500 companies.

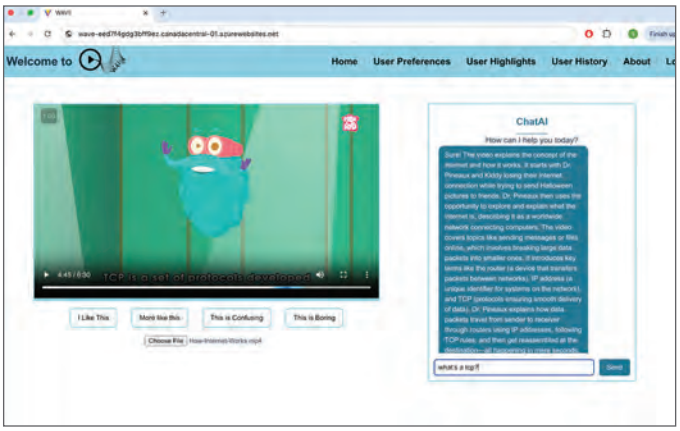
In the modern day, it is essential that videos cater to individual user's preferences to keep watchers consistently engaged. Unfortunately, on most video platforms, the video shown to the viewers is the final edited version from the creator. The video watcher is unable to express any live feedback as they watch the video and are limited to the small interaction interface underneath the video playback.

Our Watcher of Attuned Video Experiences (WAVE) web application enhances the video watching experience by editing videos according to the viewer's needs.

WAVE gives users a pre video questionnaire to declare their viewing intention. The user's preferences and viewing intention are used to determine which parts of the video the user may want to skip. Skipped sections may be added back later if the user requests additional context. Additionally, a chatbot is available next to the video player to enable users to ask questions or make requests. Over time, WAVE gains more insight into a user's preferences, enabling WAVE to tailor a better viewing experience after every video.

By continuously adapting to the viewer's behavior and feedback, WAVE ensures an increasingly personalized experience. The system not only improves viewer satisfaction but also increases video retention and engagement across diverse audiences.

WAVE consists of a React Typescript front end and a Python Flask back end. The application is hosted on an Azure web server and uses an Azure SQL server and Blob storage. In addition, WAVE leverages Open AI's Whisper, ChatGPT-4o, and FFmpeg.





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# Union Pacific
## Training Simulator Using GPS-Indexed Video

For more than 160 years, Union Pacific has been building America. Union Pacific was founded July 1, 1862, following the signing of the Pacific Railway Act. Today, Union Pacific operates across 23 western states and maintains over 32,000 miles of track, making it one of the largest railroad companies in the country.

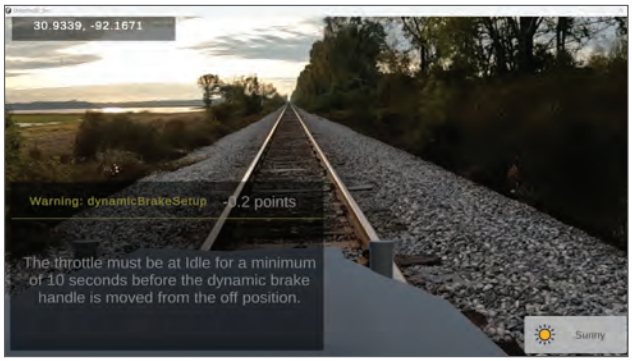
To meet the needs of consumers, Union Pacific requires experienced and knowledgeable engineers to operate the locomotives, however, training engineers on an expanding territory is difficult. The current digital training simulation requires significant time and resources to maintain and update. An expandable solution to train engineers on operating a locomotive in a variety of scenarios is desirable for Union Pacific.

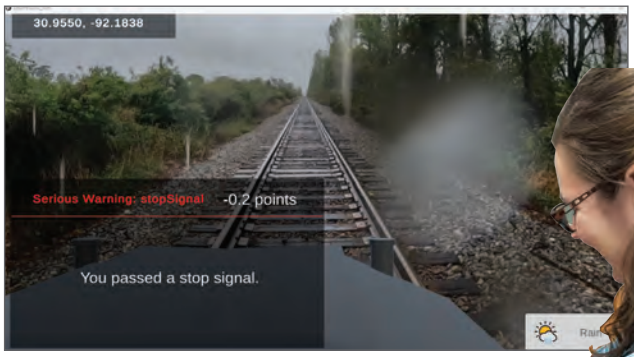
Our Training Simulator Using GPS-Indexed Video trains locomotive engineers in an expansive and realistic simulation by using real-world video. Building on top of an existing training simulator, our software plays video footage from the current track according to GPS-indexed data. Engineers operate the simulation as if it is a real locomotive, improving the training experience.

Our software reads the latitude and longitude data from the training simulation and plays the real-world video from those coordinates. The video player dynamically renders the real-world footage and adjusts the video speed to match the speed of the train in the simulation. With this, the user can reverse, accelerate, decelerate, and navigate between different scenarios.

Our software adds additional 3D objects, such as weather, lights, signage, and switches, on top of the video to create an immersive and accurate training experience.

Our system uses Unity as the front-end platform for video display, with C# scripts handling the core logic and functionality. The application programming interface is built using a .NET Core and C# to efficiently receive and process data from the back end.

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# Urban Science
## Automotive Service Advisor AI Assistant

Urban Science is a leading global data-driven consulting firm based in Detroit, Michigan, specializing in providing insights and solutions for the automotive industry. Founded in 1977, the company has leveraged data and business science to help clients increase market share, improve profitability, and enhance customer satisfaction.

Due to technical knowledge gaps and varying levels of sales expertise, service advisors often face challenges when trying to connect with customers. This disconnect can result in missed sales opportunities, inconsistent service recommendations, and an unpleasant customer experience. With recent advancements in artificial intelligence (AI), Urban Science can create innovative solutions that enhance customer interactions and drive business growth.

The Automotive Service Advisor AI Assistant is a mobile application that closes the experience gap between advisors. Our tool identifies and recommends services to customers, while delivering clear and insightful sales strategies to dealerships based on individual customer personalities.

Our software captures a vehicle's identification number and mileage, immediately displaying the customer's information and service history, along with key relevant insights.

Our system then crafts a personalized sales strategy for the advisor informed by the customer's past visits and generates service recommendations tailored to their current vehicle's mileage.

Utilizing our recommendation software and generated media, dealerships easily extract insights, resulting in a refined and optimized sales experience.

Our application is built with C# featuring a .NET MAUI front end and a .NET Core web API back end. Azure AI Services, along with Synthesia, are used to generate personalized media.


URBAN SCIENCE.

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# UWM
## Centralized Comment History Microservice

Headquartered in Pontiac, Michigan, United Wholesale Mortgage provides mortgage products and services to mortgage brokers all over the country. They are the nation's largest wholesale mortgage broker due to their innovation, efficiency and commitment to excellence.

Because of the scale of their operations and the number of brokers they cater to, UWM houses a vast amount of data. Finding pertinent transaction information, like comments, becomes tiresome and cumbersome, as they must sift through all other relevant data to find just the comment history.

Our Centralized Comment History Microservice fixes this issue by hosting all transaction comments on a separate database, which enables a faster and more streamlined retrieval.

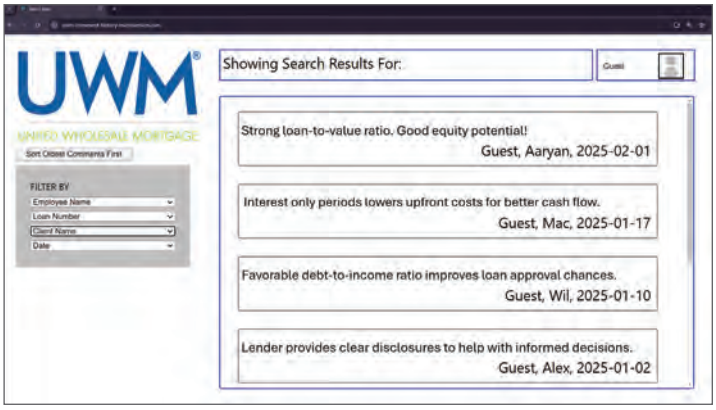
Users filter the comment history they want to find by specifying relevant information pertaining to the transaction, whether it is the loan number, the client or employee name, or the date.

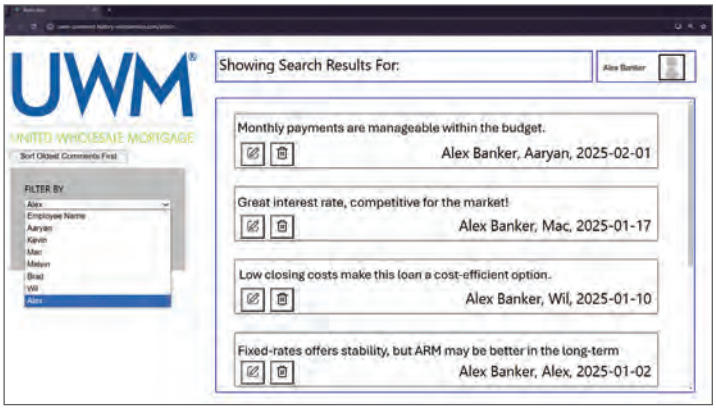
Once the history is found, our software quickly shows the user the comments of that transaction, alongside the time of that comment and who wrote it. Comments are sorted in newest or oldest order. Users can also see edit histories of the comments.

Finally, relevant employee data pertaining to the transaction, including the name of the commenter, is seamlessly shown accompanying the comments.

Our system aggregates comment data into a single platform, speeding up transaction review and increasing productivity.

Our microservice is written in C#, using React as our front end and SQL to contain the comment data. We utilize UWM's proprietary architecture and code to write an efficient and comprehensive software. We also use ASP.NET Core to connect the UI to the database.

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# Volkswagen Group of America

## Safe Journey AI 2.0

The Volkswagen Group of America is the North American subsidiary of the Volkswagen Group based in Wolfsburg, Germany. They are a global leader in automobile manufacturing and employ more than 10,000 people across the United States, distributing vehicles through a 1,000-dealer network.

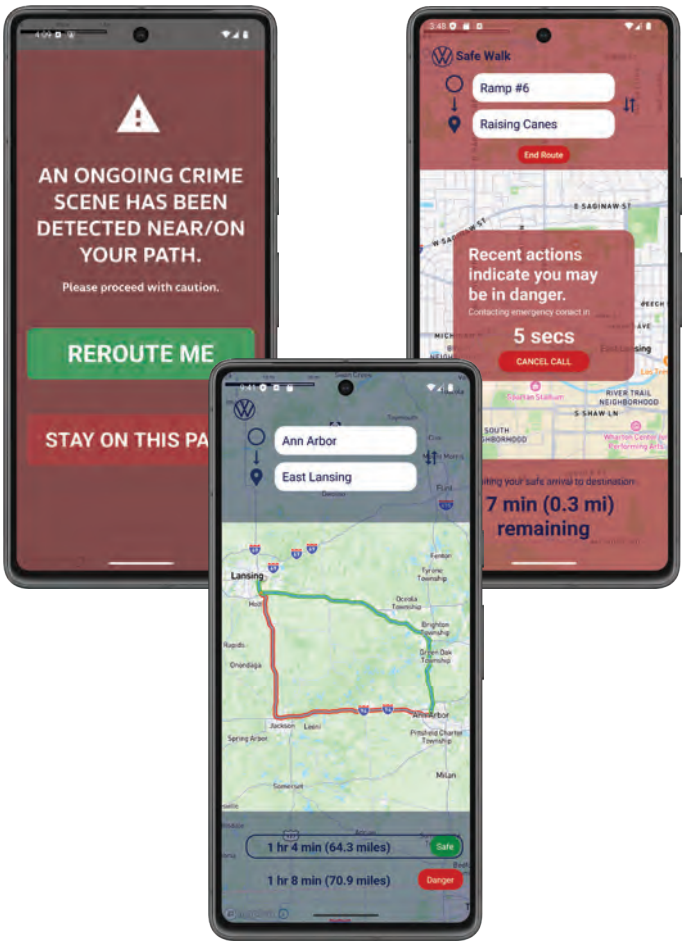
Nearly everyone uses a variation of maps to navigate from their starting point to their destination. However, many maps overlook the importance of customer safety. Therefore, users need a reliable, safe method to plot them a route that is not only fast, but safe.

Our Safe Journey AI 2.0 provides users with the fastest and safest route to their destination, considering a route's unique safety rating and real-time alerts on weather, crime, and other hazardous events that may fall on their path as they drive to their destination.

Our software doesn't just stop monitoring user safety when they leave their vehicle. Safe Walk is a feature that tracks the user from the moment they leave their vehicle until they reach their final destination. If the user takes longer than estimated or diverges onto the wrong path, a registered emergency contact is alerted, notifying them that the user may be in danger and providing them the location of the user and their vehicle.

Our system integrates into Android Auto, improving the user's safety by keeping them off their phones and streamlining their driving experience. Our program provides coverage over the entire state of Michigan, enabling reliable route planning for users. By using Safe Journey AI 2.0, users easily navigate faster and safer than ever before.

Our software is an Android Application written in Kotlin, leveraging the Mapbox SDK for navigation. Our back end is developed with FastAPI and Python, utilizing Scikit-Learn for our machine learning implementation and Firebase for data storage.

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# Whirlpool Corporation

## AI-Powered Precision Cooking with TasteLogic

Whirlpool Corporation, headquartered in Benton Harbor, Michigan, is a global home appliance manufacturer with approximately $17 billion in annual sales, 40 manufacturing and research centers, and 44,000 employees. Whirlpool's mission is to improve satisfaction and engagement with their home appliances.

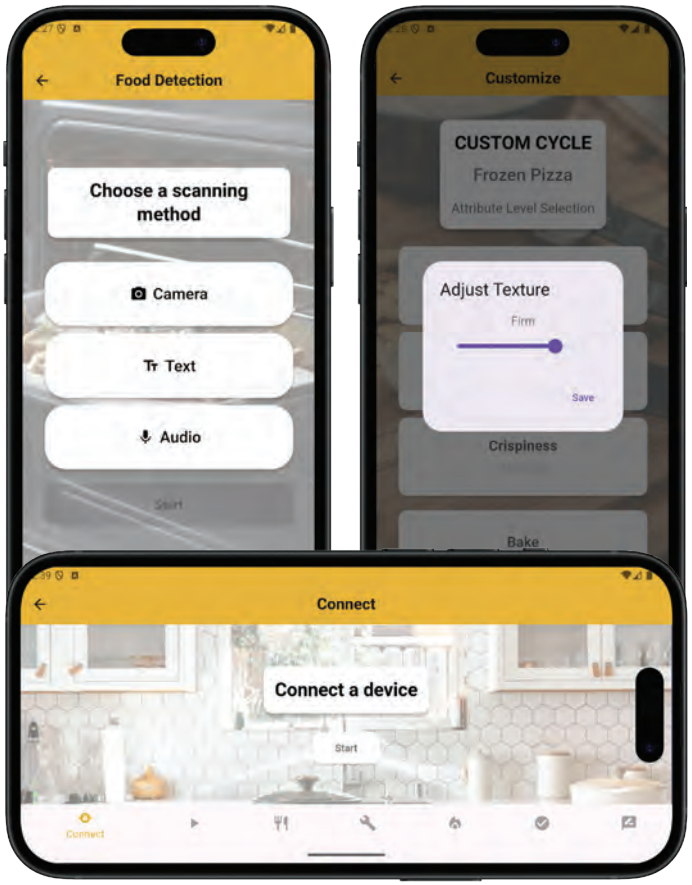
Kitchen appliances have evolved notably over the last decade. With appliances having new features, and many food options to choose from when cooking, it can be overwhelming for individuals to determine the best way to cook their food. It requires previous knowledge, trial and error, or expansive time spent on research.

Our AI-Powdered Precision Cooking with TasteLogic curates a more enjoyable user experience with Whirlpool appliances by utilizing an on-product system and a mobile app that simplifies the cooking process when using an oven.

Users begin the process by using the mobile app to identify the food they intend to cook. This is done through a manual search, verbal speech or camera detection by taking a picture of the food.

From there, the software analyzes and suggests cooking settings for the food based on attributes that the user has approved in the past. If the user does not have previous history with the current food item, the system enables them to choose their desired cooking settings based on food type specific attributes. These attributes may include browning, texture and crispiness. After cooking, the user then provides feedback to the system based on the settings used. From this feedback, the system learns and suggests the desired settings for that food in the future.

Our mobile application is built with Dart to provide a modern and simple user interface. The application is supported by a Firebase server, with API calls facilitated by OpenAI. Flutter framework is utilized to connect the front end to the back end. The oven interface utilizes Java.

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# WK Kellogg Co
## Intelligent Ticketing and Release Management

WK Kellogg Co, one of the world's leading food companies, is renowned for its iconic breakfast cereals. Based in Battle Creek, Michigan, the company has expanded its presence worldwide, delivering unfaltering quality and sustainability for over 100 years.

When a WK Kellogg Co employee requires technical support, they create an incident report through a third-party service desk web application. Each incident report needs to be manually processed by a member of WK Kellogg Co's IT team to determine the relative priority and proper responding team.

The WK Kellogg Co enterprise architecture team is responsible for tracking new releases of third-party software used by the company. It is time-consuming for them to determine whether a given release is relevant to the company's application landscape.

Our Intelligent Ticketing and Release Management system saves valuable developer time by leveraging large language models to automatically determine the priority of an incident report based on its potential impact to the business and route the report to the proper responding team.

The system also routinely checks vendor websites for updates and summarizes important changes that might affect the company's application landscape. Our web application serves as a portal for WK Kellogg Co employees to open new incident reports and enables members of WK Kellogg Co's IT team to audit the company's extensive incident report history.

Our software expedites the incident report ingestion and release note analysis processes automatically, saving time and keeping WK Kellogg Co's technologies up to date.

Our system uses Amazon Web Services to improve the sustainability of the technology footprint at WK Kellogg Co. Our web application is built using React and Tailwind for the front end and Node.js for the back end.

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# 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 2024.

## Auto-Owners Insurance Exposition Award

Auto-Owners INSURANCE

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 including the Design Day 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 Vectra AI**
AI Cyberattack Early Warning System

Alex Fortsch, Ajay Kumar, Jacob Sock
Morghane McAnelly, Graham Holley, Aleksa Popovic
**Presented by Brad Shafer and Ross Hacker of Auto-Owners**

## MSU Federal Credit Union Praxis Award

msufcu

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 Launch**
Spatial IoT Control using Apple Vision Pro

Jacob Hakala, James Ashworth, Noah Wolf
Ethan Egger, Nathan Motzny, Sanaye Lewis
**Presented by Ben Maxim of MSU Federal Credit Union**

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

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 Kohl's**
Governance of Expense in Kohl's Cloud Operations

David Lingan, Jason Lin, Samay Achar
Meredith Heberling, Aiden Dixon, Adhyan Negi
**Presented by Wendy Hamilton of TechSmith**

## Amazon Sigma Award

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 Meijer**
Increasing Awareness of Meijer Branded Products

Ishi Saripalle, Sonia Thalatoti, Robby Dewar
Mackenzi Steinmetz, Viraj Shah
**Presented by E.J. Dyksen of Amazon**

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and help shape our future.

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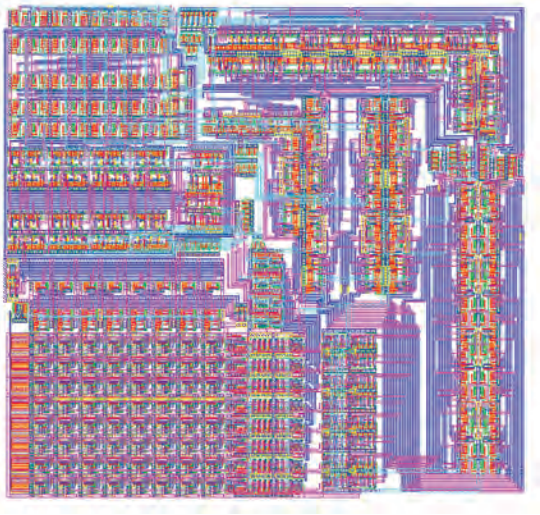
# ECE 410

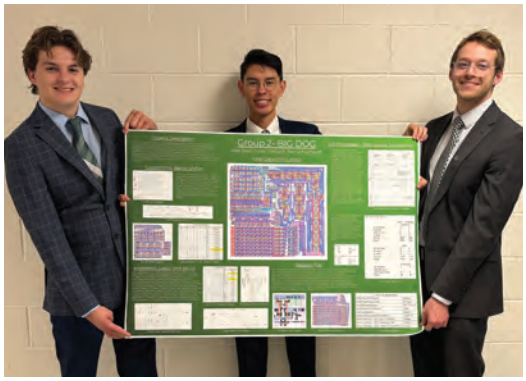
**Instructor: Prof. Shannon Nicley**

**TA Staff: Abdelrahman Abdelkader, Roshan Varadharajan, Kihong Kim**

## 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 Virtuoso 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. The Outstanding Project Award will be awarded to the team that produces the best overall project, as judged by a panel of experts from industry and academia. The top five projects will be recognized and their posters will hang in the hallways of the Engineering Building for the next year in acknowledgement of their excellence.





*2024 Intel Outstanding Project Award Winners:*
*Noah DeBack, Alex Bejin, and Ben Schuchardt*

***Team 1***
Safwat Ahnaf Aziz
Ahmed Azwad Kabir
Anwarul Amin Omio

***Team 2***
Gavin Boomsma
Jon Toomey
Lucas Wolstencroft

***Team 3***
Thu Doan
Brandon Grochowski
Maxwell Scott

***Team 4***
Balaji Ganeshbabu
Martin Goleski
Mohsen Mohamed Anas

***Team 5***
Shivanshu Ojha
Rose Spangler
Avery Wiklund

***Team 6***
Owen Gray
Junwen Xiao
John Zhou

***Team 7***
Tushig Bolorchuluun
Sai Narayanan
Pratijit Podder

***Team 8***
Chidera Ikpeama
Mario Ivanovic
Pranav Tiwari

***Team 9***
Jori Larner
Marcus Pytel
Maximillian Pytel

***Team 10***
Poulomi Dey
Jackie Dinh
Matthew Hull

***Team 11***
Gabriel Humbert
Jack Perry
Jason Polakowski

***Team 12***
Monawar Mesbah
Nick Pecktol
Brandon Trela

***Team 13***
Aaron Cordts
Corbyn Guthrie-Nelkie
Katy Samoy

***Team 14***
Brandon Bruce
Ipek Kuzkaya
Dylan Lindstrom

***Team 15***
Muhammad Hazim Faisal
Gavin Murray
Anirudh Srigiriraju
Samuel Webber

***Team 16***
Grant Bell
Ayman Berdai
Owen Wurzer
Ben Zuzga

# The Capstone Projects

**Dr. Tongtong Li**
**Professor of Electrical and Computer Engineering**

**Dr. Jian Ren**
**Professor of Electrical and Computer Engineering**

**Project Facilitators:** Mohammed Ben-Idris, Premjeet Chahal, Tom Clark, Yiming Deng, Oleksii Karpenko, Nihar Mahapatra, Jeffrey Nanzer, Nelson Sepulveda, Navid Yazdi


Ben-Idris


Chahal


Clark


Deng


Karpenko


Mahapatra


Nanzer


Sepulveda


Yazdi

### Presentation Schedule – Engineering Building, Room 2245

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:00 a.m. | MSU Bikes Service Center | Red-light Runner Alert System |
| 8:30 a.m. | MSU Facility for Rare Isotope Beams | 4-Wire Coupling Circuit for Ion Beam Quadrupole Moment Calibration |
| 9:00 a.m. | MSU Electromagnetics Research Group (EMRG) | Dynamic 5.8 GHz Phased Array for V2X Sensing and Wireless Communication Security |
| 9:30 a.m. | Fraunhofer USA, Center Midwest | Design and Fabrication of a Low-Cost Inkjet Printer for Selective Diamond Growth |
| 10:00 a.m. | Great Lakes Crystal Technologies | Upgrading Diamond Deposition Reactor Control System |
| 10:30 a.m. | Break | |
| 10:50 a.m. | Henry Ford Health | Pathology Robotic Transportation System (PaRTS) |
| 11:20 a.m. | GenoPalate Inc. | Enhancing the Food Index Page UI with Color-Coded Food Scores and Dynamic Views |
| 11:50 a.m. | Wyatt's Creative Works, LLC | Modern Organizational and Notes Apps |
| 12:20 p.m. | MSU Cyber Security Lab | Simulated Autonomous Vehicle Environment using Raspberry Pi |

# 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:

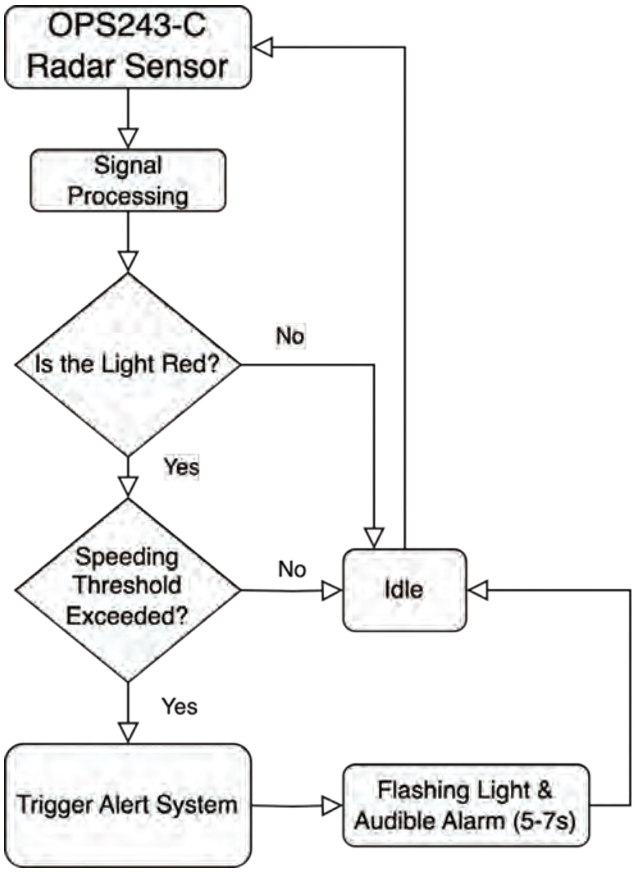
- Putting into practice the technical skills learned in the classroom, on industrially sponsored team projects, under faculty guidance, doing open-ended design, giving them experience in teamwork, project management, product life cycle management, intellectual property, accommodation issues and entrepreneurship;
- 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.

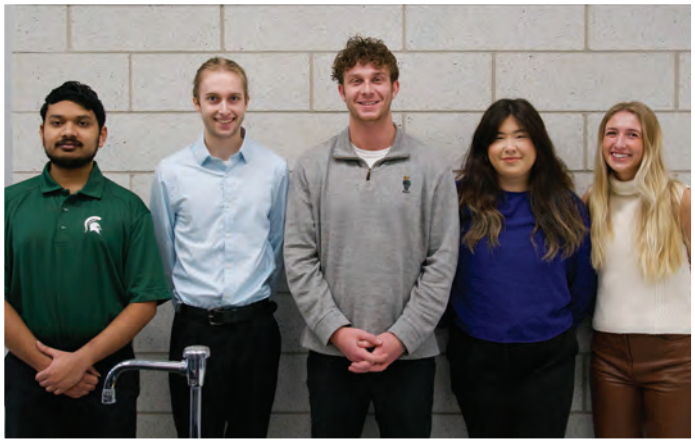
# MSU Bikes Service Center
## Red-light Runner Alert System

MSU Bikes Service Center has highlighted the need for a safer, more inviting atmosphere for all users of the shared roadway. Red- light running is a significant problem in almost every intersection, yet current traffic laws in Michigan do not allow for cameras to be used in detection and photography of the license plate of the violating vehicle. A police officer must be an eyewitness to the red-light running, but since it's nearly impossible to tell the timing of the light from the opposing side of an intersection, many such cases go unreported. Our project aims to decrease the fatal impact of neglected traffic signals.

We designed a radar sensor system to detect an oncoming car traveling at an excessive speed in the vicinity of the intersection, where cross traffic or pedestrians may be in harm's way. Our design is freestanding and compact enough to be integrated into various intersection models. We focused our design on campus communities per the needs of our client, being focused on heavily trafficked areas like Michigan State University's roadways.

We will trigger an alert system to notify motorists from all directions of the oncoming threat using visual and audible alarms. The social shaming element of the alert system should also encourage the red-light runner to make a better decision in future intersections. Blatant red-light running is a dangerous threat to innocent people who are following traffic laws. Our red-light runner project is a potential remedy to this growing problem.



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**Ben Zuzga**
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**Abigail Bilyeu**
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**MSU Bikes Service Center**
***Project Sponsor***

**Tim Potter**
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**Project Facilitator**

**Dr. Premjeet Chahal**

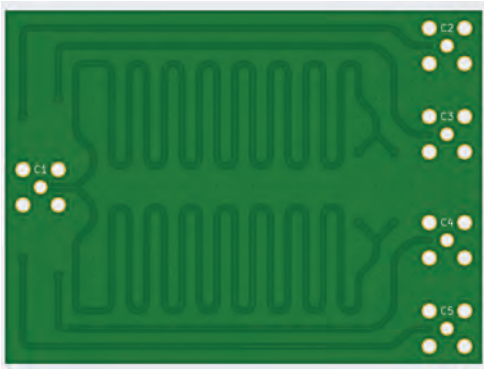
# MSU Facility for Rare Isotope Beams
## 4-Wire Coupling Circuit for Ion Beam Quadrupole Moment Calibration

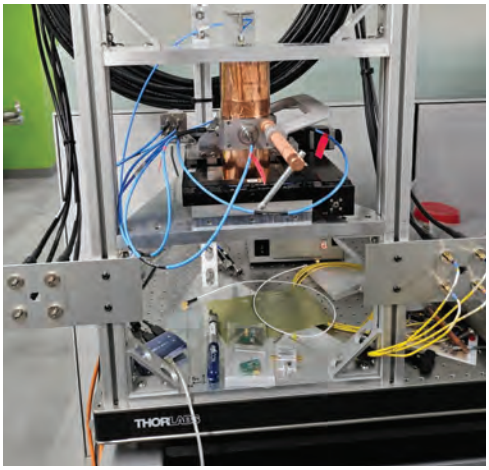
The Facility for Rare Isotope Beams (FRIB) at Michigan State University contains the world's most powerful heavy-ion accelerator. With this particle accelerator, Michigan State University helps scientists better understand the physics of nuclei, nuclear astrophysics, fundamental interactions, and applications for society.

The FRIB works with high intensity beams that require safe transportation. To facilitate this, beams require measuring and monitoring of beam size and distribution using non-interceptive diagnostics with devices called beam position monitors (BPMs). BPMs are placed along the path of the beam, and they operate by measuring the capacitance between the beam and the button on the BPM. However, their current beam position monitoring systems face a critical limitation: they lack a reliable method to simulate variation in beam quadrupole moment, which hinders the ability to analyze and improve beam dynamics.

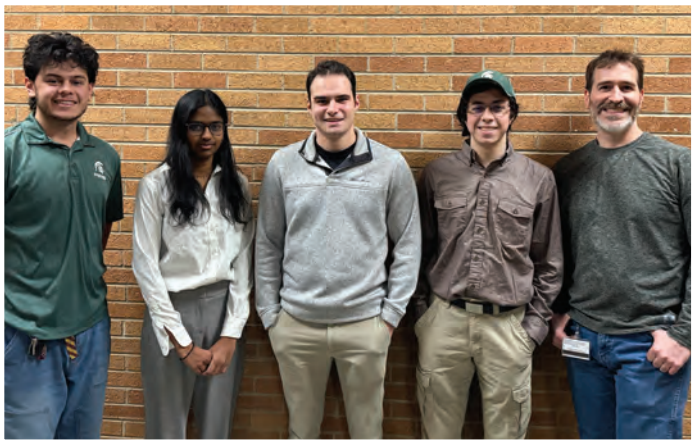
The goal of this project is to change the way this calibration procedure takes place. First, the input signal is split into four paths, enabling the calibration of quadrupole moments. After the signal is split, our circuit then attenuates each of the four channels independently, at configurable steps, to enable multiple shapes to be accounted for. The four channels will then undergo a similar treatment for phase shifting, further increasing the possible number of ways to calibrate these sensors.

Our design utilizes a custom printed circuit board (PCB), enabling reproducibility and precision. Our design also includes widely adopted SMA connection points, making it both versatile and cost-effective. The inclusion of a microcontroller makes this device easy to use and intuitive to the user.




FACILITY FOR
RARE ISOTOPE BEAMS
at Michigan State University



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**Sandhiya Suresh**
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**MSU Facility for Rare Isotope Beams**
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**Dr. Oleksii Karpenko**

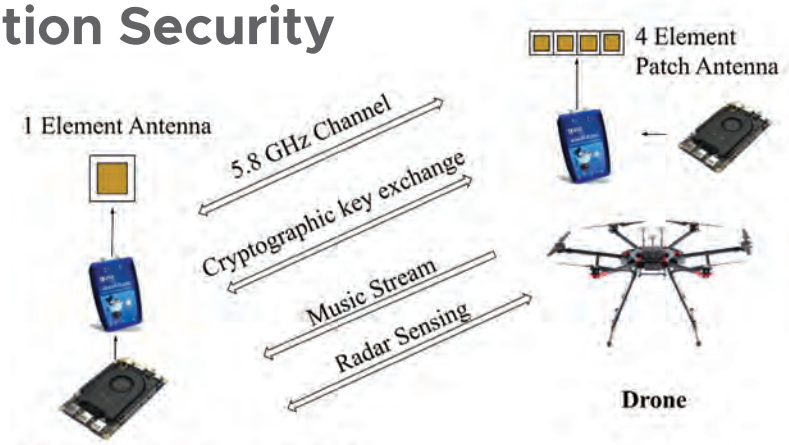
# MSU Electromagnetic Research Group (EMRG)

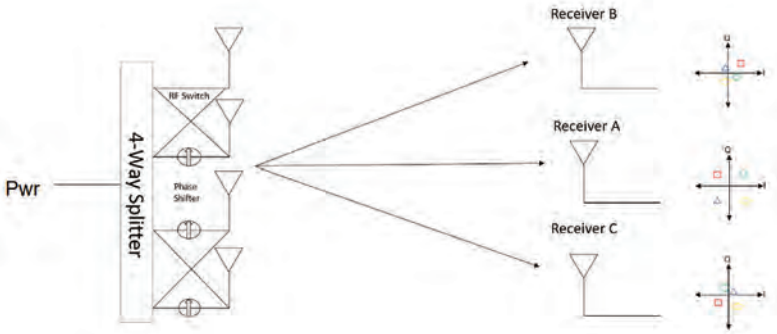
## Dynamic 5.8 GHz Phased Array for V2X Sensing and Wireless Communication Security

Over the last two decades, communication security at the physical layer has increased in importance for wireless communication. Commercial, automotive, and aerospace applications are beginning to require more wireless sensors and transceivers, thus requiring strict compliance guidelines to mitigate unintentional interference or improve robustness to hostile interference from foreign devices. These emerging concerns must be addressed to ensure safe and acceptable wireless system performance for a range of applications. The previously developed C-band Phased array communication system project enables researchers and engineers to prototype communication and sensing systems with the HackRF One software-defined-radio (SDR).

The secure communication system will be implemented in a V2X environment between a car and a drone, which enables experimentation with future 6G satellite communication networks. The integration of the C-band phased array provides a versatile platform for exploring a wide range of communication and sensing applications. Due to university restrictions on piloting drones, the majority of the tests will be conducted when the drone is in a static position.

Traditional radar sensing and tracking will be developed to further improve robustness of the communication system and validate the combination of software and physical layer communication security techniques.




emrg
Electromagnetics Research Group
Michigan State University

**Michigan State University**
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**MSU Electromagnetic Research Group (EMRG)**
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**Project Facilitator**

**Dr. Jeffrey Nanzer**

**ECE 480 | 9:30 a.m.** Engineering Building, 2nd Floor | Room 2245

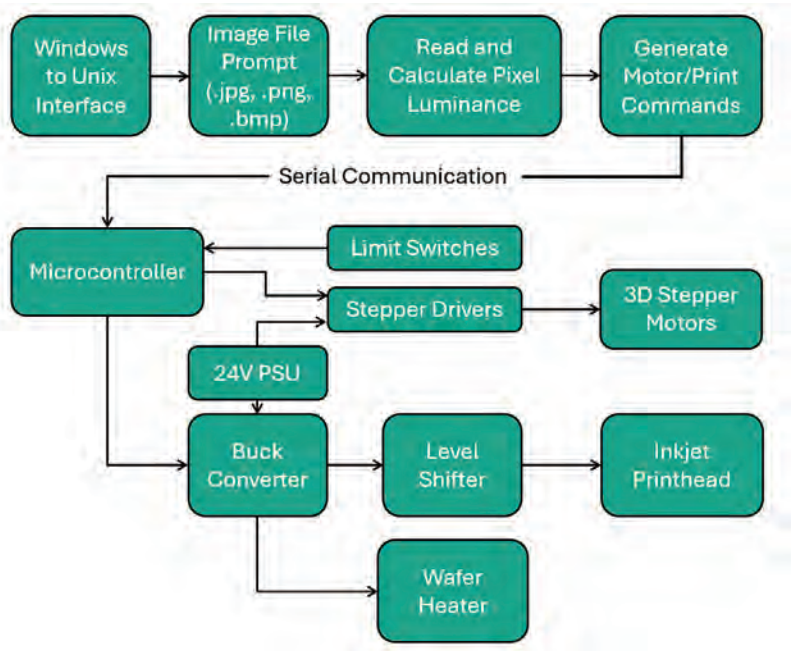
# Fraunhofer USA, Center Midwest

## Design and Fabrication of a Low-Cost Inkjet Printer for Selective Diamond Growth

Fraunhofer USA is a research group that focuses on innovation and development in electrical, software, material, and biological technologies. With an office in East Lansing, Michigan, Fraunhofer partners with MSU students and faculty on semiconductor research in coatings and diamond technologies.

Diamond is a naturally non-conductive material in its pure state but becomes semiconductive when doped with Boron atoms. The ability of this design of diamond to maintain mechanical hardness while being a viable conductor in microelectronics makes for an increasingly valuable manufacturing resource. As electronics are designed to function at higher frequencies and in hostile environments, diamond-based electronics are needed in larger quantities at lower costs. Manufacturing diamond-based chips is often done through the long and expensive process of diamond lithography.

This project aims to find a cost-effective alternative to diamond lithography. By selectively dispensing diamond seeding solution onto silicon wafers, diamond crystals can be grown in desired patterns without the need for cutting. This will be done with a modified 3D printer and inkjet printhead controlled by custom Linux software for autonomous 3D movement and solution dispensing. Images will be processed and converted into a binary matrix that is used by the microcontroller to control the stepper motors and printhead to precisely dispense the diamond seeding solution.




Fraunhofer USA

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**Project Facilitator**

**Dr. Mohammed Ben-Idris**

# Great Lakes Crystal Technologies
## Upgrading Diamond Deposition Reactor Control System

Great Lakes Crystal Technologies is a semiconductor supplier in East Lansing, Michigan, specializing in production of high-quality diamond substrates and wafers for applications in electronics, quantum computing, and optics. Since 2019, the company has developed and utilized its proprietary Chemical Vapor Diamond Disposition (CVD) reactors to produce the high-quality substrates. Initially, the CVD reactors were controlled and monitored by LabVIEW, a data acquisition and machine control programming platform.

As part of the company's ongoing commitment to improving operational efficiency and scalability, Great Lakes Crystal Technologies sought to enhance the reliability and simplicity of their reactors to support future advancements in diamond substrate production. The objective of this project was to design and implement a Programmable Logic Controller (PLC) capable of managing and monitoring the complex processes within a single CVD reactor.

To replace the existing LabVIEW-based control system, the PLC needs to communicate seamlessly with a variety of sensors utilizing a unified communication protocol, integral to the reactor's operation. The key challenge was ensuring proper connectivity and consistent data flow, as current systems based on serial communication had to be transitioned to a new architecture for interactions with the PLC, thereby enabling ease of communication and data collection while maintaining operational integrity.

With the implementation of a PLC, Great Lakes Crystal Technologies can now explore the world of automation, enabling quicker process flows and requiring minimal human intervention. Additionally, the upgraded PLC system offers long-term security benefits at the operating system level, ensuring resilience against potential vulnerabilities.


GREAT LAKES CRYSTAL TECHNOLOGIES

**Michigan State University**
***Team Members*** (left to right)

**Jim Allen**
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**Andrew Bastian**
Birmingham, Michigan

**Pranshu Dixit**
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**Nathan Grimmer**
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**John Tysar**
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**Great Lakes Crystal Technologies**
***Project Sponsor***

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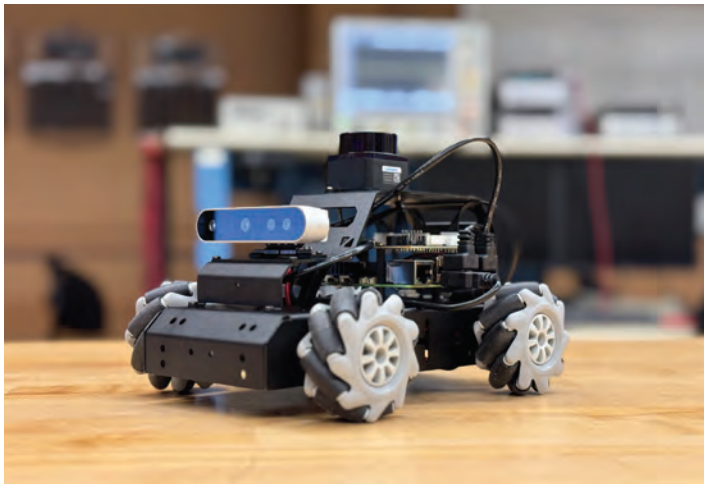
East Lansing, Michigan

**Project Facilitator**

**Dr. Nelson Sepulveda**

**ECE 480 | 10:50 a.m.** Engineering Building, 2nd Floor | Room 2245

# Henry Ford Health
## Pathology Robotic Transportation System (PaRTS)

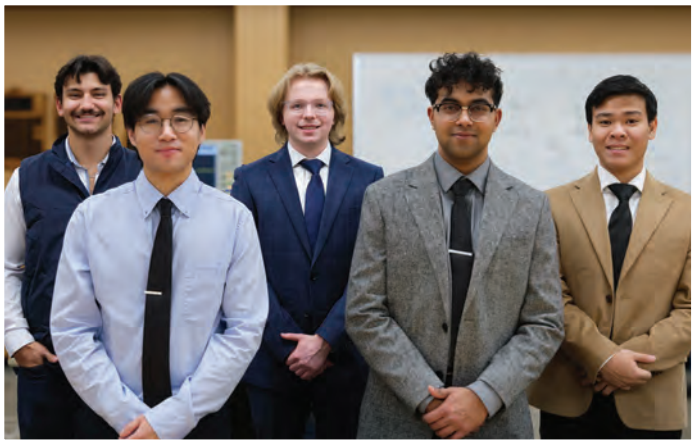


Henry Ford Health, a leader in innovation health care solutions, is building Destination Grand, a world-class facility set to open in 2029, which will integrate advanced robotic systems for day-to-day operations, including the transport of pathological specimens within the medical laboratory area. To prepare for this future, the Pathology Department aims to evaluate and implement a robotic transport system in their current facility. Our mission is to design and develop a robotic system capable of safely and efficiently transporting pathological specimens within the existing hospital environment. This system will serve as a prototype for the advanced robotic solutions planned for Destination Grand.

Pathological specimens need to be transported across a predetermined route that includes multiple turns, delivery points, and an overpass connecting two buildings. Our robot will navigate this route autonomously, avoiding obstacles and pedestrians, and be equipped with features such as adjustable height, navigation sensors, and recharging functionality, and it will be designed to transport specimen boxes of predetermined dimensions.

A user interface will enable staff to easily command the robot for deliveries or returning to base. By collaborating with Henry Ford Health, we aim to create a reliable and efficient robotic transport system that not only meets the needs of the current facility but also lays the groundwork for the future of healthcare logistics at Destination Grand. This project represents a step forward in integrating robotics into healthcare, improving operation efficiency, and enhancing patient care.

HENRY FORD HEALTH
Innovations



### Michigan State University
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**Jackie Dinh**
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**Matthew Hull**
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**Pranesh Muthukumar**
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**Yi-Hung Kan**
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### Henry Ford Health
***Project Sponsors***

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Detroit, Michigan

**Adam Baldwin**
Detroit, Michigan

**Vikas Relan**
Detroit, Michigan

### Project Facilitator

**Dr. Tom Clark**

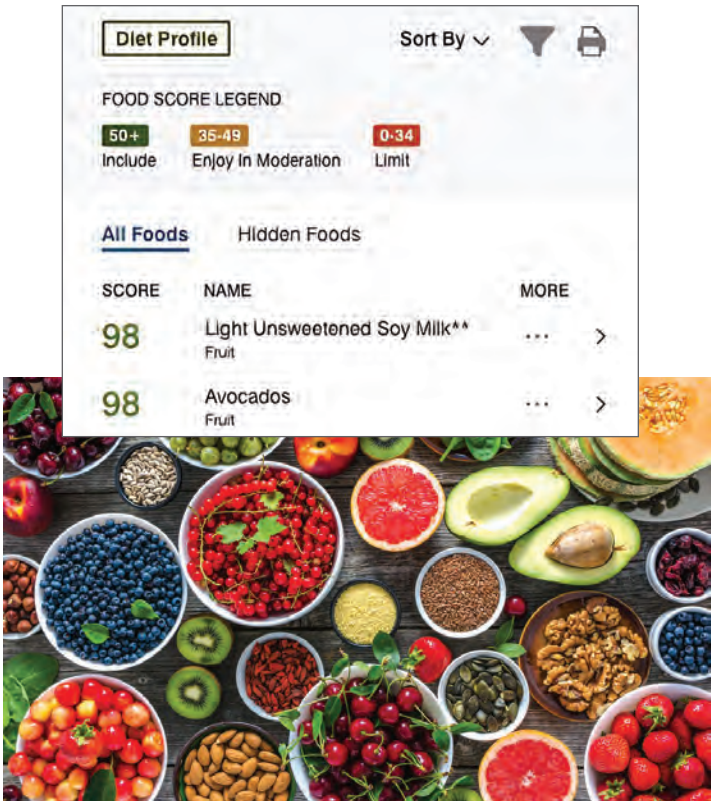
# GenoPalate Inc.

## Enhancing the Food Index Page UI with Color-Coded Food Scores and Dynamic Views

Existing food tracking and recommendation applications—such as Yuka, MyFitnessPal, and Lifesum—primarily focus on calorie tracking and dietary logging. While these tools help users monitor their overall food intake, they fall short when it comes to providing personalized, genetics-based recommendations. GenoPalate addresses this gap by offering a platform that helps users discover foods best matched to their genetic profiles, paving the way for more precise and individualized nutrition guidance.

Earlier versions of the GenoPalate app provided fundamental nutritional data and basic food suggestions but lacked robust sorting and filtering functionalities. Although recent updates introduced color-coded food scores and improved categorization, additional refinements are needed to boost user interactivity and real-time personalization. Our project builds on these foundation features by implementing a more user-friendly interface, enhanced filtering and sorting options, and customizable visibility controls.

Central to this initiative is a redesigned food index page featuring a clear, color-coded scoring system that identifies healthier (green) versus less healthy (red) choices at a glance. A refined filtering mechanism enables users to exclude items they cannot or prefer not to eat—whether due to allergies or personal preferences—while a new toggle feature lets them hide or unhide foods with ease. Users can sort items by score, food group, or nutrient content, and they will also have access to a diet profile editor. This editor supports diverse dietary preferences—from vegan (excluding meat, fish, dairy, and eggs) to vegetarian (excluding meat and fish) and pescatarian (excluding meat)—so individuals can swiftly identify foods that align with their unique needs. By offering these robust personalization tools, our project ensures that users can tailor their dietary experience to fit their goals and restrictions.




genopalate®
Eat For Your Genes

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***Team Members*** (left to right)

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**Hannah Pekarek**
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**Project Facilitator**

**Dr. Yiming Deng**

**ECE 480 | 11:50 a.m.** Engineering Building, 2nd Floor | Room 2245

# Wyatt's Creative Works, LLC
## Modern Organizational and Notes Apps

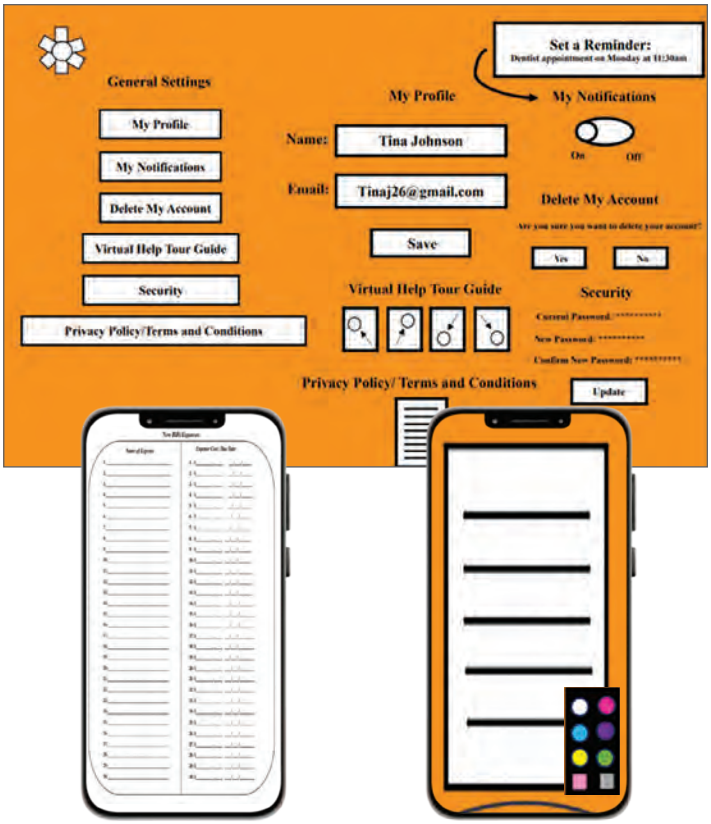
Wyatt's Creative Works is a startup company that showcases creative software solutions to everyday used apps. Founded in 2022 in Grand Blanc, Michigan, the company is a publishing and innovation production studio that is focused on creating projects designed for minimalistic organization tools for reminders and taking notes.

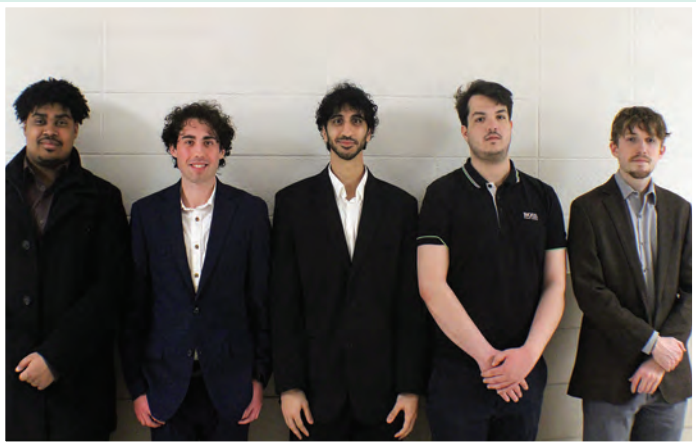
The main problem with electronic organizational tools is the need to download multiple apps to use important features such as calendar events, reminders, and note taking. Additionally, there are no specialized tools for organizing information regarding specific activities like grocery shopping, bills and expenses, as well as travel plans. Our team's focus is to create two projects for Wyatt's Creative Works, LLC: the Modern Organizational App, and the Modern Notes App, with the use of a minimalistic design.

Our team will implement a cross-platform app that focuses on organizational tools including a feature for notifications and a built-in calendar. We will continue to expand on the project from what a previous team did by using Flutter for the cross-platform API tools specifically for subscriptions and choice of language feature. The main additions will require a sign-in and a login page for each user with Firebase authentication.

In addition, our team implemented the Modern Notes app tool for creating custom notes with a flipbook design as well as a toolbar for choosing designs for notes. Utilizing the same software tools as the organizational app, it will serve to create custom notes depending on the subject of choice.

Each of the products will service a multilingual customer base with organizational and note taking tools. Cloud accessibility with Firebase will enhance the user experience with offline access to each app.



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**Talal Alkhaled**
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**Dr. Navid Yazdi**

# MSU Cyber Security Lab

## Simulated Autonomous Vehicle Environment using Raspberry Pi

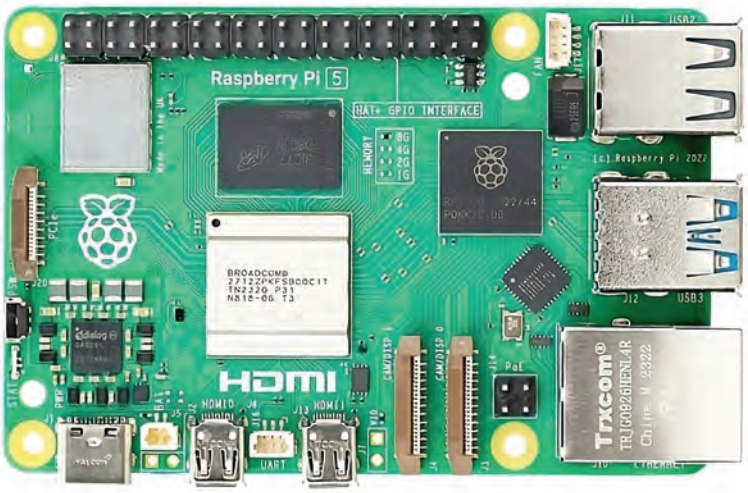
As urban populations grow and traffic congestion worsens, the need for safer, more efficient transportation systems becomes increasingly urgent. Issues such as high accident rates, inefficient fuel consumption, and limited mobility for individuals with disabilities highlight the potential benefits of advancing autonomous vehicle technologies. Semi-autonomous vehicles can be critical in reducing human error, optimizing traffic flow, and enhancing transportation accessibility.

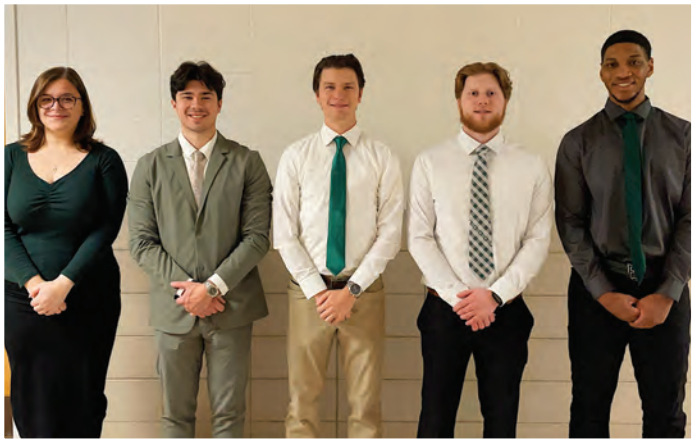
In response to these challenges, the goal of this project is to develop a hardware and software environment that replicates the characteristics of a semi-autonomous vehicle control system, like Tesla's Autopilot. The system will include a benchmarking routine utilizing a well-known machine learning model (CNN/DNN). With the usage of the Raspberry Pi 5, the project will integrate a first/third-party AI acceleration kit, a first-party camera, and actuators controlled through the Pi's GPIO.

The miniature car will be trained to perform essential autonomous driving tasks, such as flexible speeds, navigating curves, following other vehicles, parking, and responding to traffic signals and pedestrians. Key requirements set by the sponsor include computer vision and the implementation of an AI accelerator for enhanced processing and computation.

Design constraints include budget limitation, workspace size, car mobility, and the challenge of adapting image processing to a lower vantage point compared to standard datasets. Two design approaches are considered: using a pre-made RC car kit for ease and compatibility or building the car from scratch for greater customization and cost efficiency.

The goal is to complete the hardware setup and initiate the software development phase by the end of the semester, ensuring the foundation for an effective semi-autonomous vehicle prototype.



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**MSU Cyber Security Lab**
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East Lansing, Michigan

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**Dr. Nihar R. Mahapatra**

# The Capstone Projects

**Dr. Tongtong Li**
**Professor of Electrical and Computer Engineering**

**Dr. Jian Ren**
**Professor of Electrical and Computer Engineering**

**Project Facilitators:** Premjeet Chahal, Sunil Chakrapani, Mauro Ettorre, Edward Gebara, Ming Han, William Harokopus, Matthew Hodek, Robert McGough, Daniel Morris


Chahal


Chakrapani


Ettorre


Gebara


Han


Harokopus


Hodek


McGough


Morris

### Presentation Schedule – Engineering Building, Room 2250

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:00 a.m. | MSU Cyber Security Lab | Security Attacks on Machine Learning Systems |
| 8:30 a.m. | MSU Broadband Access Wireless Communications Lab | Hands-Free Control of IoT Devices Using Mind Power |
| 9:00 a.m. | MSU PUMA Lab, ECE department | Impedance-Matching Network for Ultrasonic Transducers |
| 9:30 a.m. | MSU Li Lab@IQ | Flexible ECG for Continuous Cardiac Monitoring |
| 10:00 a.m. | MSU Li Lab@IQ | 3D Printing of Microneedle Sensors for High-Density Neural Recording |
| 10:30 a.m. | Break | |
| 10:50 a.m. | PoliMOVE-MSU | Development of a Scaled Autonomous Race Car Platform with Matched Data Pipeline |
| 11:20 a.m. | Michigan Translational Research and Commercialization Innovation Hub & Fraunhofer USA | Development of a Field-Use Heavy Metal MicroFluidic Test Platform |
| 11:50 a.m. | MSU Smart Microsystems Lab | 3D Path Mapping for Autonomous Robots |
| 12:20 p.m. | MSU Nondestructive Evaluation Laboratory | Unmanned Ground Drone for Rail Structural Health Management and Nondestructive Evaluation |

# ECE 480 Senior Design

We gratefully acknowledge the support of this semester's project sponsors: Fraunhofer USA, Great Lakes Crystal Technologies, Henry Ford Health, GenoPalate Inc., Michigan Translational Research and Commercialization Innovation Hub, MSU Bikes Service Center, MSU Broadband Access Wireless Communications Lab, MSU Cyber Security Lab, MSU Department of Biomedical Engineering, MSU Department of Electrical and Computer Engineering, MSU Electromagnetics Research Group, MSU Facility for Rare Isotope Beams, MSU Li Lab@IQ, MSU Nondestructive Evaluation Laboratory, MSU Smart Microsystems Lab, MSU PUMA Lab, PoliMOVE-MSU, Wyatt's Creative Works, LLC.

The ECE Project Facilitators who supervised ECE 480 teams this semester are:
Mohammed Ben-Idris, Premjeet Chahal, Sunil Chakrapani, Tom Clark, Yiming Deng, Mauro Ettorre, Edward Gebara, Ming Han, William Harokopus, Matthew Hodek, Oleksii Karpenko, Nihar Mahapatra, Robert McGough, Daniel Morris, Jeffrey Nanzer, Nelson Sepulveda, Navid Yazdi.

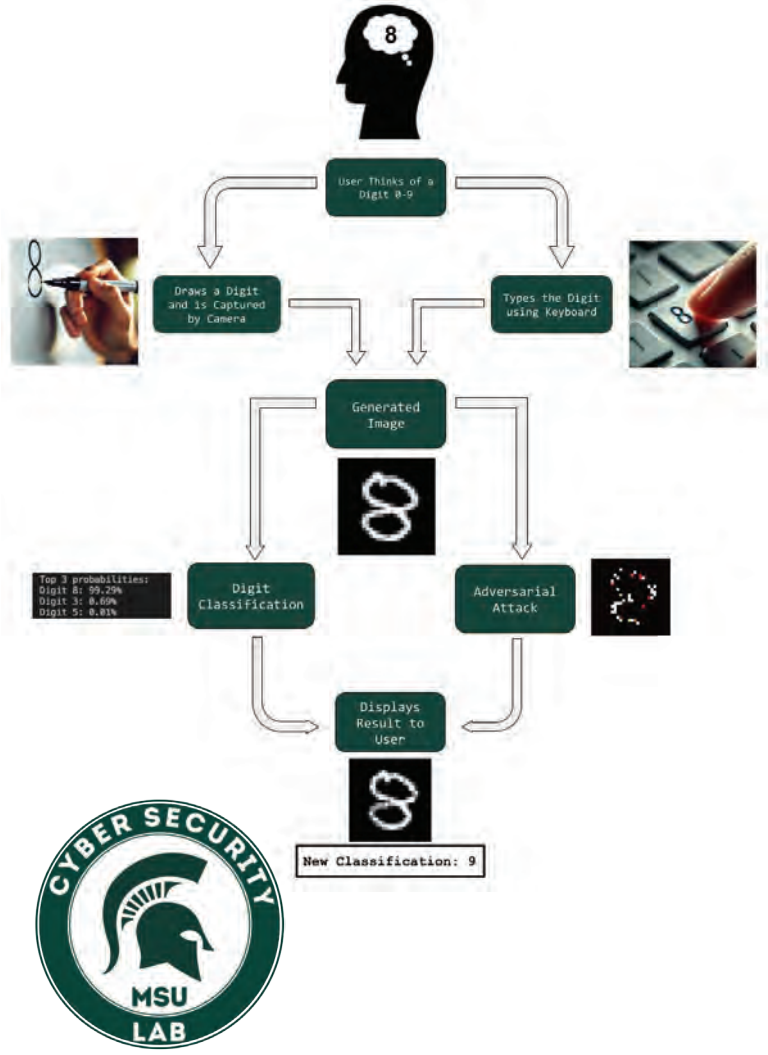
# MSU Cyber Security Lab

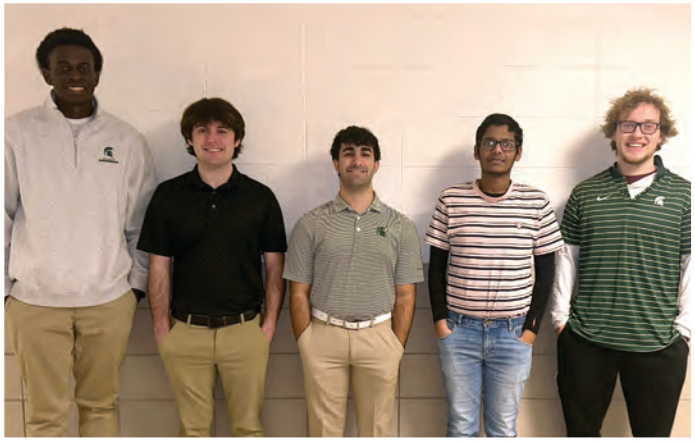
## Security Attacks on Machine Learning Systems

Deep learning, a type of machine learning (ML) that uses artificial neural networks to learn from data in a similar manner to the human brain, has become increasingly prevalent in technology today in a variety of applications. However, although it has many benefits, there are some vulnerabilities that, when exploited, can cause these models to have adverse results. This project focuses on adversarial attacks, which are one of the main weak points of ML systems. Adversarial attacks consist of intentionally altering inputs with small perturbations that are virtually undetectable to the human eye with the goal of forcing the system to misclassify the input. The consequences of these attacks can be extremely dangerous, especially when the ML model is used in safety-critical systems. For example, if an attacker were able to slightly alter an autonomous vehicle's camera input so that it misclassifies a stop sign as a speed limit sign, it could cause the vehicle to drive into cross traffic, which would be devastating.

The primary goal of the project is to develop adversarial attack methods to cause handwritten digits to successfully be misclassified with minimal modifications to the input. Furthermore, an intuitive graphical user interface will be developed to enable users to interact with the system, visualize adversarial examples, and adjust attack parameters dynamically. The program will be run on embedded hardware and enable users to draw on a digital tablet or a whiteboard for camera capture to use as input for the model, which will bridge the gap between theory and real-world implementation.

By developing ways to exploit the vulnerabilities in these ML models, engineers can better understand the weaknesses of these models and develop stronger defenses against them, enhancing the robustness of ML systems.



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**ECE 480 | 8:30 a.m.** Engineering Building, 2nd Floor | Room 2250

# MSU Broadband Access Wireless Communications Lab

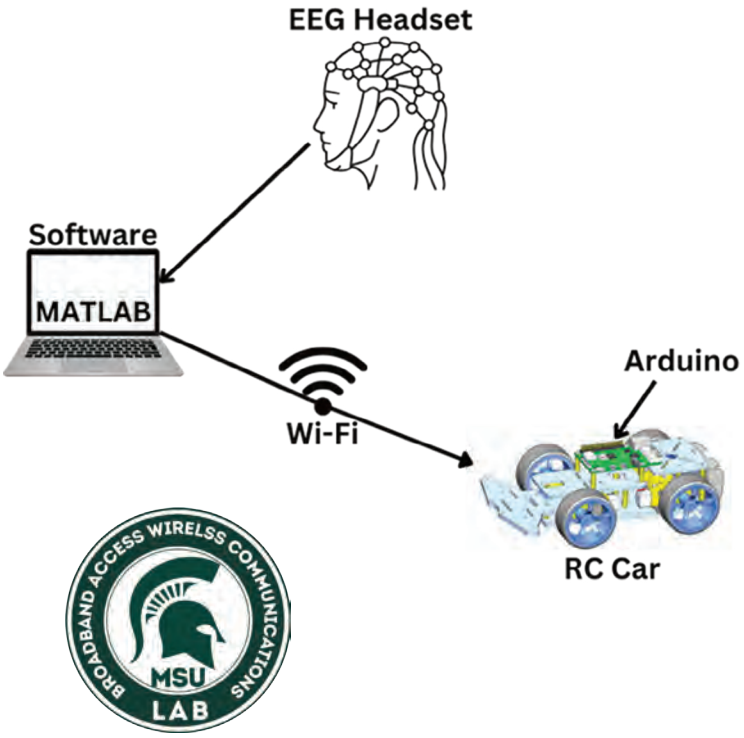
## Hands-Free Control of IoT Devices Using Mind PowerTesting of Rail Tracks

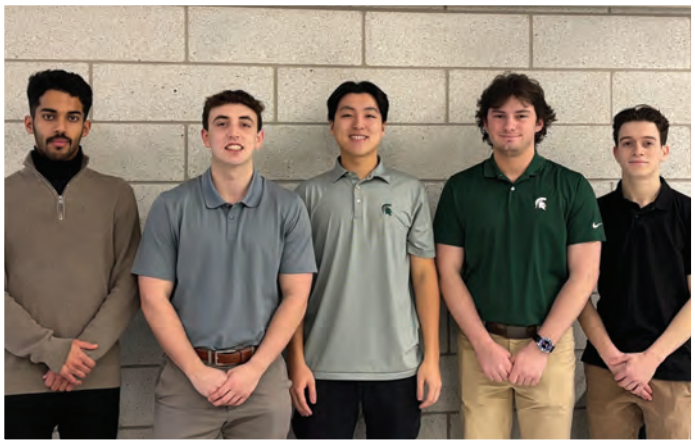
Our project explores the integration of brain-to-computer interface technology to enable hands-free control of IoT (Internet of Things) devices. Specifically, we are developing a system that enables users to control a remote-controlled (RC) car using brain signals. This project is divided into two main phases.

In the first phase, we establish a wireless communication system between a computer and the RC car. The car will initially be controlled using a keyboard or mouse, enabling us to ensure smooth directional movement with minimal latency. This phase serves as the foundation for responsive communication before introducing brain control.

The second phase involves integrating an EEG headset (EMOTIV EPOC X) to capture signals from the user's brain, which are then processed using MATLAB. The processed signals are mapped to specific commands such as moving forward, left, or right. These commands then will be transmitted to an Arduino-based RC car. By utilizing signal processing techniques and reducing noise interference, we aim to achieve reliable real-time control using only brain activity.

This project demonstrates the potential of hands-free control technology, with applications in accessibility, robotics, and human-computer interaction. Our work contributes to advancements in assistive technology, enabling individuals with mobility impairments to interact with devices in new and intuitive ways.

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**Project Facilitator**

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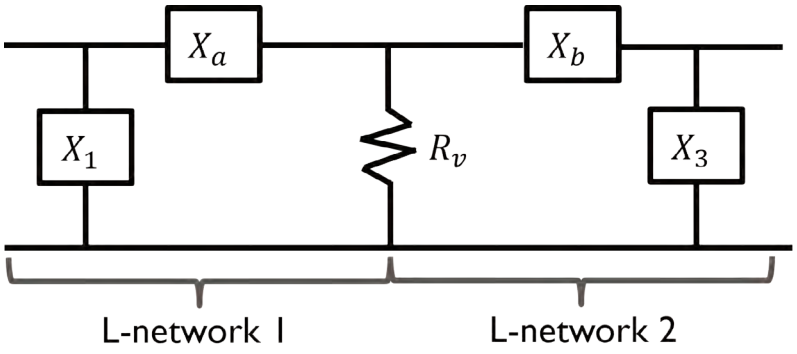
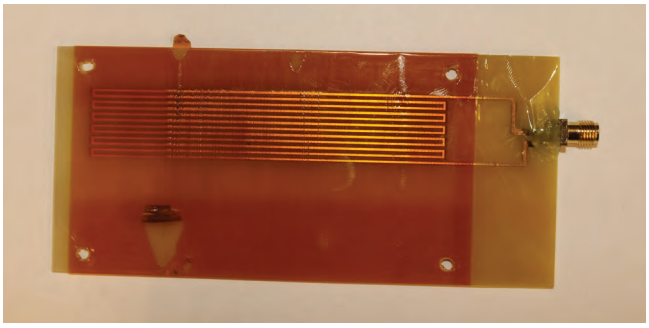
# MSU PUMA Lab

## Impedance-Matching Network for Ultrasonic Transducers

This project is to design an impedance-matching network which will optimize power transmission to and from arbitrary transducers. Impedance-matching circuits reduce the amount of reflected energy and can be approached in multiple ways. For the purposes of this project, an impedance-measuring circuit and two impedance-matching circuits will be designed. The impedance-measuring circuit will measure the impedance of a transducer at a given frequency. The two impedance-matching circuits will maximize power transmission from a 50 Ohm high-power amplifier to the measured transducer, and the power transmission from the measured transducer to a low-noise amplifier. Testing equipment, transducers, and other necessary lab equipment will be provided. A proper impedance-matching network results in optimized power usage and increased transducer performance with a plethora of applications including nondestructive evaluation and testing, ultrasonics, electromagnetics, radio communications, micro-sensing and more.



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**MSU Physical Ultrasonics, Microscopy and Acoustics (PUMA) Lab**
***Project Sponsor***

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**Project Facilitator**

**Dr. Sunil Chakrapani**

# MSU Li Lab@IQ

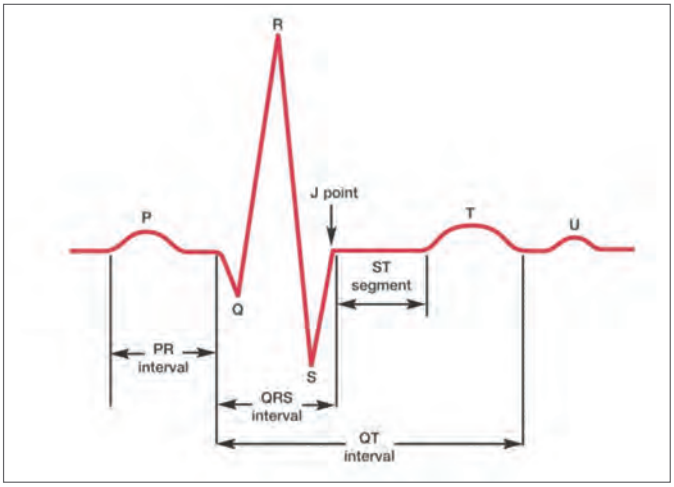
## Flexible ECG for Continuous Cardiac Monitoring

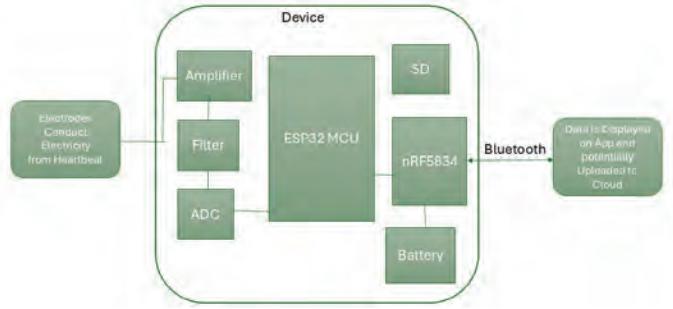
With the purpose of combining bioengineered materials with advanced manufacturing, Li Labs aims to develop bio-integrated technologies that enable us to precisely record, understand, and modulate biology. Led by Professor Jinxing Li, Ph.D. and a team of doctoral candidates, postdoctoral scholars, and research assistants, the Li Lab strives to apply these technologies to interrogate complex nervous circuits and microbial activities, with the goal of reshaping connections between the synthetic and biological worlds.

Our project involves creating a portable, wireless ECG for long-term use. An ECG is a non-invasive test that uses electrodes to view the electrical activity of the heart.

We want to collect accurate, thorough results that can detect and alert abnormal heart activity.

Our task is to improve and finalize an ECG system from the initial circuit board stage which contains components such as an MCU, CPU, Bluetooth, and battery. For the hardware phase, we are to add an SD card for memory, improve the battery life, and minimize the size of the board. For the electrode phase, we must determine the electrode patch type and material, design an effective electrode layout, and magnetically connect the circuit to the electrode leads. For the software phase, we must integrate a machine learning algorithm to detect heart abnormalities and develop a user-friendly app.




Li Lab IQ

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**Project Facilitator**

**Dr. Robert McGough**

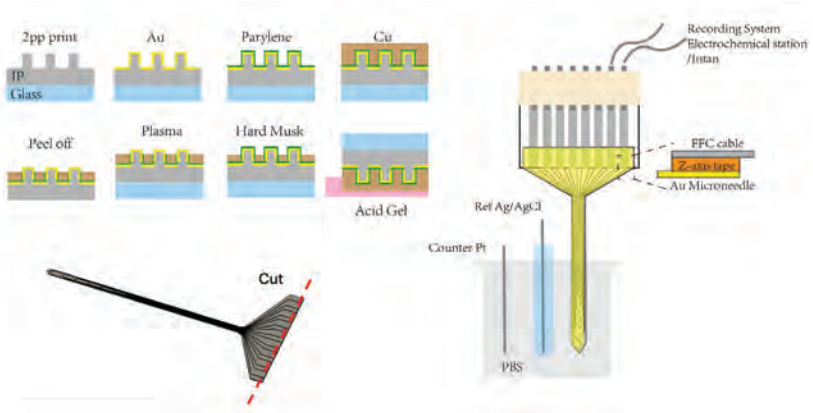
# MSU Li Lab@IQ

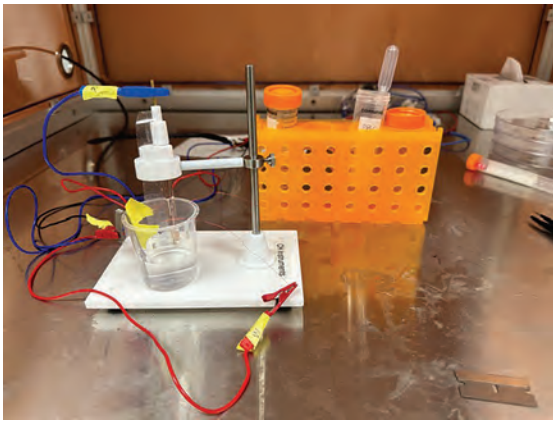
## 3D Printing of Microneedle Sensors for High-Density Neural Recording

Li Lab is dedicated to developing bio-integrated technologies to advance human and planetary health through the creation of new diagnostics, therapeutics, and sustainable materials. They focus on three main domains: micro/nanorobotics, neural interfaces and bioelectronics, and engineered living materials. Li Lab has enabled access to their advanced manufacturing equipment and materials to aid in the success of this project, which aims to develop a high-density microneedle array for advanced neuromodulation and neurorecording applications. The main goal is to design and fabricate microneedles using state-of-the-art two-photon polymerization technology, optimizing their size and geometry to enhance signal stability while minimizing tissue damage.

The project involves a multi-phase testing approach. Ex-vivo and in-vitro experiments will be conducted to analyze the microneedle array properties and its ability to provide reliable and relevant measurements during the next phase of testing. In-vivo testing will then be performed on locusts with assistance from Li Lab to evaluate the safety, functionality, and overall performance of the microneedle arrays in a biological setting.

By leveraging cutting-edge fabrication techniques and rigorous testing protocols, this project seeks to contribute to the advancement of neurotechnology, paving the way for more effecting and minimally invasive neural interfaces.



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### MSU Li Lab@IQ

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**ECE 480 | 10:50 a.m.** Engineering Building, 2nd Floor | Room 2250

# PoliMOVE-MSU

## Development of Scaled Autonomous Race Car Platform with Matched Data Pipeline

PoliMOVE-MSU is a team that competes in the Indy Autonomous Challenge (IAC). IAC organizes racing competitions among 17 universities from around the world to program fully autonomous racecars and compete in a series of events at iconic tracks. PoliMOVE-MSU had secured a top spot in the newest IAC competition. Our team is tasked with developing a 1/10th scale autonomous vehicle capable of navigating a track without human intervention. A major focus is developing a reactive vehicle that can optimize its speed, accuracy, and navigation. The result will be a high-speed scalable platform that mirrors real-world F1 vehicle development with a data-driven testing environment.

The requirements for this project are to create a scaled autonomous race car that follows the F1/10th style of build given a specific budget. The vehicle testing environment must be created to mimic a track. The vehicle must be scaled from an F1 car, with a vehicle reaching speeds of 20 mph to mimic the average top speed of 200 mph on an F1 car. The software side of the project is to implement robust data logging, processing, and storage to mimic the full-scale vehicle's system, and it needs to be ROS-functional for command line operations.

Multiple sensors will be used for this project, which include LIDAR, IMU, and mounted cameras. A LIDAR unit plots the surrounding area of the vehicle by projecting light to create a map of obstacles. An IMU measures the current orientation and velocity which will be used to self-regulate position. A mounted camera can track the visibility of the vehicle in relation to its obstacles, which can work with LIDAR to track obstacles and match both views to get a complete map of its surroundings.

### Michigan State University

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### PoliMOVE-MSU

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### Project Facilitator

**Dr. Edward Gebara**

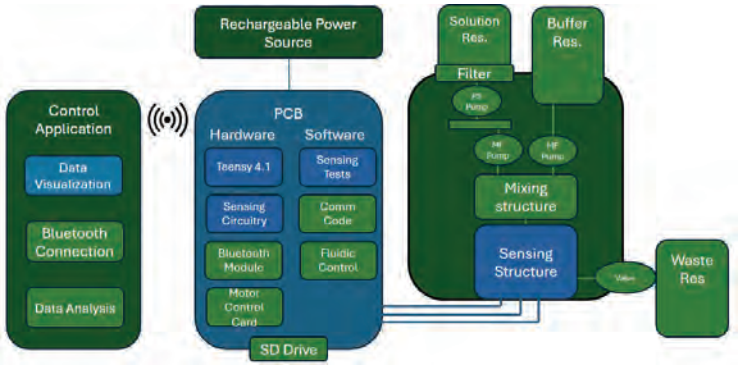
# Michigan Translational Research and Commercialization (MTRAC) Innovation Hub; Fraunhofer USA

## Development of a Field-Use Heavy Metal MicroFluidic Test Platform

This project, Development of a Field-Use Heavy Metal Microfluidic Test Platform, is to create a portable, low-cost electrochemical sensing system for detecting heavy metals in water and soil samples. The project utilizes novel carbon fiber electrodes and a low-cost custom potentiostat developed by Fraunhofer USA and the MSU Microtechnology Lab in a fully integrated sensing system intended for in-situ monitoring of water and soil samples from agricultural operations. Existing commercial solutions are expensive and designed for laboratory conditions, making them poorly suited to real-time, on-site monitoring.

The system developed by our team incorporates an automated microfluidic sample processing structure, a Bluetooth enabled control PCB, and a control mobile application to enhance system usability and testing efficiency. The new system enables remote control and monitoring and enhanced data analysis through the addition of the Bluetooth hardware and software to the potentiostat PCB, along with the dedicated control and monitoring mobile application. These improvements—along with the new monolithic sample preparation structure and controls—also enable streamlined, automated sample preparation to improve ease of use and robustness of tests.

By introducing these capabilities, our team capitalizes on the new electrode technology to make a more robust, efficient, and cost-effective sensing system compared to traditional laboratory-based heavy metal testing methods. In doing so, our project makes these measurements more accessible for researchers and environmental agencies, lowering barriers to monitor these compounds and protect human health through our agriculture systems.

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### Michigan Translational Research and Commercialization Innovation Hub & Fraunhofer USA

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**ECE 480 | 11:50 a.m.** Engineering Building, 2nd Floor | Room 2250

# MSU Smart Microsystems Lab

## 3D Path Mapping for Autonomous Robots

Effective navigation and mapping in unknown environments is a significant challenge, especially in underground drainage pipe systems where traditional localization tools like GPS are unavailable. At Michigan State University's Smart Microsystems Lab, our team is developing a SLAM-based robot to autonomously explore and map underground drainage networks. This intelligent pipe inspection and water monitoring system will provide farmers with a 3D reconstruction of their drainage infrastructure, helping to optimize water management for improved soil health and crop yield.

Drainage pipes play a crucial role in preventing waterlogging and maintaining sustainable agricultural practices, yet their layouts often remain undocumented after installation. Our goal is to deploy a wheeled robot equipped with a magnetometer and other sensors to traverse these networks, collect data, and generate an accurate 3D map of our environment.

Our project consists of four key components. First, our robot must integrate a LiDAR sensor and be capable of running SLAM (Simultaneous Localization and Mapping) algorithms to create real-time maps of its environment. Second, we are developing autonomous navigation algorithms that enable the robot to avoid collisions, make intelligent path decisions, and fully explore unknown pipe systems. Third, we are designing a graphical user interface (GUI) to visualize the mapped networks, making them accessible for analysis and maintenance. Finally, we are constructing a test pipeline with varied paths and elevations to rigorously evaluate our system's capabilities.

By implementing this advanced mapping technology, we aim to provide an essential tool for precision agriculture, enabling farmers to manage their drainage systems more effectively and sustainably.


Department of Electrical and Computer Engineering
MICHIGAN STATE UNIVERSITY


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**Smart Microsystems Lab**
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**Project Facilitator**

**Dr. Mauro Ettorre**

# MSU Nondestructive Evaluation Laboratory (NDEL)

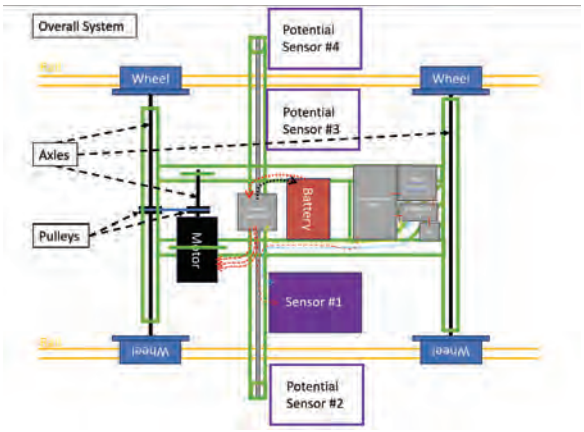
## Unmanned Ground Drone for Rail Structural Health Management and Nondestructive Evaluation

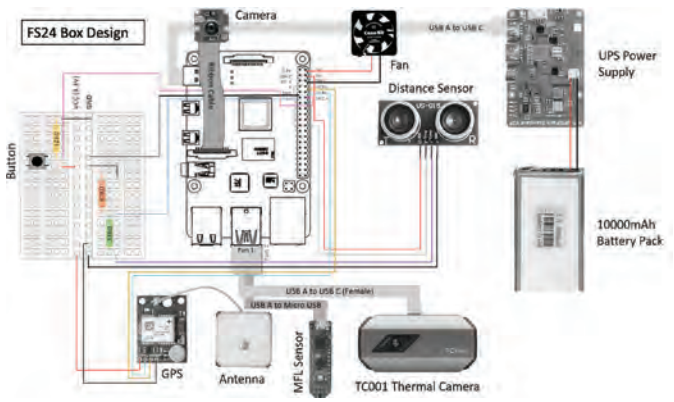
Nondestructive evaluation (NDE) provides safe, efficient, and reliable methods for assessing critical infrastructure. By employing a ground drone, inspections can be conducted with precision and stability along a predictable route. This approach improves the efficiency of inspection and contributes to enhanced infrastructure safety.

The primary objective of this project is to design and build a custom Unmanned Ground Vehicle (UGV) for NDE of railway infrastructure. While previous work focused on using aerial drones to inspect hard-to-reach structures, our project shifts the focus to an unmanned, rail-adapted ground drone. This transition enables close-up, and continuous inspections of railway tracks and associated infrastructure.

Building on the work of a previous capstone team, a key component of our project is the integration of a sensor box. Instead of utilizing an aerial platform, the sensor box will be mounted on the ground-based drone to capture close-up, low-resolution video data for detecting structural issues in rail systems. By adopting this ground-based approach, the aim of the project is to enhance the effectiveness of railway inspections, particularly for aging and critical infrastructure.

The wheeled drone is powered by a ~ 60-watt motor, delivering torque to the wheels through a geared sprocket system. The motor also serves as the braking mechanism by reversing the current, eliminating the need for additional mechanical brakes. The frame features an H-shaped design, integrating all essential components, including the battery, sensors, and control boards, within the rails for a compact and efficient layout. The chassis is constructed using a combination of wood for cost efficiency and aluminum in key areas to ensure structural rigidity.

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### MSU Nondestructive Evaluation Lab

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**Zebadiah Miles**
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### Project Facilitator

**Dr. William Harokopus**

# Design Day Fall 2024 Awards


## First Place Award

**Team Fraunhofer USA, Center Midwest**
"Low-Cost Inkjet Printer for Selective Diamond Growth"

Left to right: Noah Sanders, Pritham Kura, Andrew Barton, Tuan Nguyen, Mate Narh


## Second Place Award

**Team MSU Broadband Access Wireless Communications Lab**
"Systems for Managing Security Attacks on Machine Learning Systems"

Left to right: Blake Morris, Faris Sweis, Rashed Alumalla, Mathieu Chapaton


## Third Place Award

**Team Texas Instruments:**
"SEE Radiation Effects Validation Platform with Mechanical Positioner"

Left to right: Michael Charlton, Aaron Elkin, Marcelo da Paz Leal, Rafael Gonzalez Zuniga, Colin Watkins


## Fourth Place Award

**Team MSU Smart Microsystems Lab**
"Automated Phosphate Sensing System"

Left to right: Remy Van Wert, Georgia Bolek, Sebastian Spaenle, Gabrielle Price, Brendan Mack

# dreamBIG

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# ME 412 Heat Transfer Laboratory

**Yuping Wang**
**Academic Specialist**
**Department of Mechanical Engineering**

## A Study of Two-Phase Heat Transfer Devices

Heat transfer devices involving phase change are known to be highly effective and thus have been widely employed for thermal management in various industries such as aerospace, electronics, agriculture, and manufacturing. For this project, students are expected to understand two-phase heat transfer devices through two parts of work. First, each team is to design, build, and test a simple heat pipe to demonstrate its operation and effectiveness in heat removal. The design objective is to remove heat from a liter of boiling water, achieving a larger temperature drop. The second part of the project is for each team to conduct a review of heat pipes or other two-phase heat transfer devices that are currently in use, exploring their types, applications, performance, challenges, etc. On the testing day, each team will have 15 minutes to set up, demonstrate/test, and disassemble their device. A test station with liquid cooling will be provided, as well as a vacuum pump. In addition, students will also prepare a PowerPoint slide show for the audience to explain the design decisions, fabrication, operations and thermal analysis of their device.

## Competition Schedule

| Time | Station | Team Members |
|---|---|---|
| 8:00 | A | Joe Dreon, Hunter Hendricks, Ethan Kowalik, Robin Lynskey |
| | B | Robert Dessy, Sydney Dillon, Abigail Makowski, Avery Powell |
| 8:15 | A | Roman Grimes, Ahmed Hamadah, Damon McConnell, Joey Sorgi |
| | B | Amelia Conatser, Brenna Marsin, Adam Martin, Anna Smith, Corey Smith |
| 8:30 | A | Robert Crouse, Sean Flynn, Anthony Gibbons, Gabe Guter |
| | B | Ava Boley, Keegan Bretschneider, Tyler Hedden, Ella Kruschka |
| 8:45 | A | Jordan Goik, Cole Jeffery, Ava Lam, Chase Montour, Joshua Wasmund |
| | B | Carson Chao, Miles Hayes, Maxwell Joyce, Angela Wegrecki |
| 9:00 | A | Ian Burke, Joey Karr, Tyler Noel, Abe Shamakh |
| | B | Max Cheney, Blake Christiansen, Jacob Keegan, Nathaniel Mcneilly |
| 9:15 | A | Kyle Deichmann, Ming Huang, Kurt Kehren, Connor Youngman |
| | B | Eric Glodich, Brandon Hineman, Nathan Huynh, Nicholas Zuo |
| 9:30 | A | Rishabh Ainapurapu, Navid Hasan, David Stegehuis, Alex Szumko |
| | B | Mitchell Fitzsimons, Mitchell Moran, Jacob Rhue, Eric Rymkiewicz |
| 9:45 | A | Ahmed Alsaegh, Logan Doud, Ryden Khamo, Mohammad Waleed Bin Munir |
| | B | Ashok Kamma, Jahnavi Movva, Fatima Sharief, Arslan Umair |
| 10:00 | A | Dalton Dobyns, Yulianna Duran, Hanna Stabler, Jared Throne |
| | B | Therese Gordon, Mansoor Makki, Nick Rogowski, Hemanth Surapaneni |
| 10:15 | A | Shawn Defina, Ashley Donbrock, Nathan Guseman, Kaan Ulasan, Emerson Voss |
| | B | Dominic Bednar, Max Godin, Veronica Sellin, Lauren Spott, Abbey Yager |
| 10:30 | A | Kaitlyn Heffelbower, Genna Lebster, Elizabeth Ligi, Emily Ligi, Charlotte Neu |
| | B | M M Tanvir Hassan, Sterling Mims, Liam Rich, Hekmat Saif |
| 10:45 | A | Amos Amigon, Devin Bentley, Noureldin Darrag, Zachary Wyrick |
| | B | Max Cheng, Jack Fisher, Rishi Rao, Connor Whitaker |
| 11:00 | A | Batu Akgun, Owen Heilman, Nico Quirante, Robert Stowe |
| | B | Ethan Darnall, Jesse Ernest, Abhirup Pusty, Nathan Tenfelde |
| 11:15 | A | Zachary Buchanan, Ollie Horswill, Owen Tarter, Kolby Wagoner, Nathan Young |
| | B | Justin Chang, Jenna Clark, Claire Jacka, Jacob Kern |

# ME 470 Mechanical Design & Manufacturing II

**Michael Lavagnino**
**Academic Specialist**
**Department of**
**Mechanical Engineering**

**Nevzat Bircan Buğdaycı**
**Assistant Professor**
**Department of**
**Mechanical Engineering**

## March Madness Mechanized Mini-Basketball Launcher

The goal in this project is to design, build, and test a mechanism that will launch mini-basketballs into buckets that are 48, 64, and 120 inches away and 14.5, 21, and 28.5 inches in height. The mechanism may utilize either hand power or a motor and will incorporate a linkage system with the option of gears and cam-follower systems. The system performance will be assessed by both minimizing the design weight and maximizing the mechanism's shooting percentage and ability to make shots in each basket. Students will utilize materials and manufacturing capabilities from the Manufacturing Teaching Laboratory as well as premade components.

## Competition Schedule

| Time | Team | Station | Team Members |
|---|---|---|---|
| 8:00 | 1 | A | Cole Cousino, Tanvir Hassan, Jacob Waligora |
| | 1 | B | Sean Britt, Nathan Guseman, Caleb Montpas, Kaniz Promee, Abe Shamakh |
| 8:15 | 2 | A | Alvaro Anaenugwu, Adam Laubach, Dayton Long, Daniel Montes |
| | 2 | B | Mohammed Alshagri, Aidan Krambeck, Cam Giang Ly, Nitin Niranjan |
| 8:30 | 3 | A | Brandon Davies, Kage Fox-Sanchez, Ashok Kamma, Francis Wong |
| | 3 | B | Luke Etheridge, Ronza Michael, Jahnavi Movva, Abhirup Pusty, Rishi Rao |
| 8:45 | 4 | A | Ethan Kowalik, Robin Lynskey, Kaan Ulasan, Isaac Zondag |
| | 4 | B | Logan Doud, Jett Edson, Luke McIntyre, Zachary Skilliter, Rishi Vyas |
| 9:00 | 5 | A | Emilio Albarenque, Dylan Lanthier, Evan Misajlovski, Michael Stakits |
| | 5 | B | Joey Campbell, Liam Herbert, Derrick Lin, Liam Rich |
| 9:15 | 6 | A | Lorenzo Amicucci, Alessandro LoRe, Alexander Luerssen |
| | 6 | B | Josh Bergdolt, Ian Doherty, Roman Grimes, Anton Samanic, Parth Singh |
| 9:30 | 7 | A | Colson Currie, Dylan Hammis, Cole Mahaffy, Andrew Wirth |
| 9:45 | 8 | A | Jordan Goik, Brett Kramer, Ryan Pung, Charles Wejroch |
| | 8 | B | Julian D'Souza, Brady Johnson, Maxwell Joyce, John McGivern, Joey Sorgi |
| 10:00 | 9 | A | Daniel Davis, Nick Meyer, Norman Stokes, Nathan Tessmer |
| | 9 | B | Drew Christy, Nicholas Johnston, Gabriel Lipps, Kenyon Neal, Aarav Thakkar |
| 10:15 | 10 | A | Jacob Kern, Brandon Nguyen, Sujal Soni, Jacob Veit |
| | 10 | B | Nathan Grooters, Ana Konjevic, Ella Kruschka, Joshua Wasmund |
| 10:30 | 11 | A | Megan Broughal, Jenna Clark, Hunter Hendricks, Ethan Weisblatt |
| 10:45 | 12 | A | Justin Chang, Rathin Jaikol, Krithika Mahesh, Eric Rymkiewicz, Srinidhi Swaminathan |
| | 13 | B | Connor Dunn, Courtney Easton, Finn Jarvis, Brody Stack |
| 11:00 | 14 | A | Trayza Haido, Ava Lam, Abbey Michaels, Emma Munro |
| | 15 | B | Alex Carter, Ahmed Hamadah, Damon McConnell, Andrew Nguyen, Kyle O'Connor |

# ME 478 Product Development

**Haseung Chung**
**Associate Professor**
**of Mechanical Engineering**

## Design and Demonstrate a Transportation System

The objective is to develop a system which can transport a 157g rectangular piece straight and fast.

### The requirements of the system are the following:

1. The system must travel at least 10m.
2. There is no restriction in design and size, but the possible potential energy must be prepared on-site only by the motor (a pre-prepared energy source such as compressed air or gas cannot be used).
3. If needed, the LEGO Mindstorms can be provided additionally.

### Evaluation criteria:

1. The designed transportation system must travel in a straight line up to 10m. The deviation can be evaluated by the value (e.g., angle or distance) from the straight line in the end point.
2. The amount of time the system takes to travel 10m will be recorded and reflected on the grade.
3. Each team can have three chances and the evaluation will be based on the best trial.

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

| Team | Team Members |
|---|---|
| Group 1 | David Benkes-Toth, Jack Dumais, Gabe Guter, Larissa Tacaoca Honda |
| Group 2 | Alessandro Cabrera, Joe Dumais, Ryden Khamo, Emerson Voss |
| Group 3 | Robert Crouse, Sean Flynn, Nick Opolka |
| Group 4 | Robert Dessy, Anthony Gibbons, Kody Simmons |
| Group 5 | Manbir Cadha, Mariam Farran, Eric Rymkiewicz, Fatima Sharief |
| Group 6 | Max Cheng, Elizabeth Grant, Sujal Soni, Connor Whitaker |
| Group 7 | Brian Cheladyn, Adam Martin, Stephen Moussiaux, Andrew Wirth |
| Group 8 | Max Fried, Daniel Krahn, Robin Lynskey, Leonardo Provenzola |
| Group 9 | Lauren Hassenzahl, Alexander Le, Brock Strebeck, Nathan Young |
| Group 10 | Eli Carey, Kylie Keller, Evan Misajlovski, Hanna Stabler |

## ME 497
## Biomechanical Design

**Dr. Tamara Reid Bush**
**Professor and Associate Dean for Inclusion and Diversity**

## MKT 420
## Biomechanical Design

**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 and MSU's Entrepreneurship Program. 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 ideas.

| Team | Team Members | Product Name and Description |
|---|---|---|
| 01 | Amelia Conatser, Jamelyn Forist, Sydney Runyon, Nicole Stensen | **Safe Step:** A portable, adjustable cane that molds to stair height to assist in walking up stairs. |
| 02 | Brandon Hineman, Kennedy Kullman, Adriana Massimilla, Charlotte Neu, Eshani Shedge | **Chair Vader:** May the Force Lift You: This seat boost helps elderly and disabled individuals rise effortlessly from chairs, enhancing mobility, reducing strain, and minimizing injury risk for more convenient and efficient standing. |
| 03 | Samantha Chin, Drew Christy, Nathan Huynh, Daniel Krahn, Ian Twigg | **StepFlex:** Enables users to go up and down the stairs safely while reducing physical stress on joints. |
| 04 | Gunnar Carroll, Joey Fracassi, Liam Herbert, Ryden Khamo, Gavin Killmaster | **TerraCane:** The all-terrain cane/walking stick anyone can use anywhere in snow, rain or shine. |
| 05 | Joey Campbell, Grant Chesley, Aronor Chisholm, Kyle O'Connor, Gabriel Estrada, Ederick Plantegenest | **Bench Buddy:** A mechanism that moves biomechanically with the bar ensuring proper force distribution and reducing shoulder strain in both eccentric and concentric phases. |
| 06 | Connor Dunn, Claire Jacka, Jacob Kern, Emma Powell, Lily Skaryd, Robbie Smith | **Grocery Gurney:** A collapsible lightweight cart so you can directly push your groceries into the back of your car. |
| 07 | Joe Bonahoom, Trayza Haido, Abbey Michaels, Jonathan Pataq | **Dishter:** A mechanical dishwasher that helps, is more sustainable, and cost efficient. |
| 08 | Taden Brandel, Andrew Iaquaniello, Evan Misajlovski, Blake Nowak, Norman Stokes, Grace Teichman | **ReachPro:** This is an extendable reaching aid that will assist in grabbing a cereal box from a high shelf. |
| 09 | Aaron Backos, Dominic Bednar, Lauren Briggs, Nathan Downie, Aida Soltanian, Lauren Spott | **Cinch Assist:** A device used to aid in the process of pumping gas for individuals with arthritis or other motor issues that make squeezing something difficult. |
| 10 | Colin Koot, Jack Phillips, Rachel Schenck, Macey Spevacek, Abbey Yager, Michael Zontini | **SafeSlice:** A safe and effective food-cutting tool for people with limited hand motor skills. |
| 11 | Jillian Carosella, Ming Huang, Emma Littell, Kyler Spike, Eric Winston | **Study Buddy:** The Study Buddy is an easily usable and storable bedside table used for schoolwork, or just a simple spot on which to place everyday items. |

# The Capstone Projects

**Dr. William Resh**
**Professor of Mechanical Engineering**

**Faculty Advisors:** Seungik Baek, André Bénard, Haseung Chung, Yang Guo, Norbert Mueller, Indrek Wichman


Baek


Bénard


Chung


Guo


Mueller


Wichman

### Presentation Schedule – Engineering Building, Room 1202

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:00 a.m. | Toyota Motor North America Research and Development | Lift Mechanism for Personal Mobility Aid |
| 8:30 a.m. | Consumers Energy | Green Hydrogen Powered by Hydroelectricity |
| 9:00 a.m. | Kautex Textron | Material Cost-Benefit in Electric Vehicles |
| 9:30 a.m. | Munters Corporation | Design of Farm Building Test Pods for Product Validation |
| 10:00 a.m. | Munters Corporation | Mobile Test Container for Improved Product Validation |
| 10:30 a.m. | Magliner, Inc. | Magliner Hand Truck Nose Plate Redesign |
| 11:00 a.m. | BONWRx | Redesign Biomedical Injector |

## ME 481 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 U.S. government agencies.

We gratefully acknowledge the participation support of this semester's project sponsors: *BONWRx, Cobra AERO, Consumers Energy, General Motors, Jetfire Power, LLC, Kautex Textron, Magliner, Inc., Michigan AgrAbility, Michigan Nut & Fruit Growers Association, MSU Adaptive Sports & Recreation Club, MSU Anaerobic Digestion Research and Education Center, MSU Baja Racing, MSU Bikes Service Center, MSU Broad Art Museum, MSU College of Engineering, MSU Department of Mechanical Engineering, MSU Department of Theatre, MSU IMPART Alliance, MSU Rocketry Team, MSU Solar Racing Team, MSU Student Life & Engagement, Munters Corporation, NASA Psyche Mission, Pratt Miller, and Toyota Motor North America Research and Development.*

# Toyota Motor North America Research and Development

## Lift Mechanism for Personal Mobility Aid

Toyota Motor North America Research and Development (TMNA R&D) has been a leader in automotive innovation for over 50 years. The company is dedicated to advancing vehicle design, development, and mobility solutions that enhance customer experience. More recently, TMNA R&D has a new vision to include mobility solutions that improve accessibility for individuals with mobility challenges. They plan to achieve this vision by offering customers a more effective, sustainable, and affordable way to transport mobility devices.

The goal of this project was to "Develop a mobility transport accessory advertised, sold, serviced, financed, and available to all Toyota/Lexus customers." [Gabriel Marciano]. More specifically, this project focused on improving the design of a lift mechanism for personal mobility aids, ensuring that individuals using powered wheelchairs or similar devices could safely and easily transport their equipment. The team worked on refining an initial prototype, which featured a lift and platform system attached to a trailer hitch. Enhancements included the development of a mechanism that allowed the mobility aid to be deployed from the towing position to either side, based on user preference, while also incorporating adjustable ground-level height. The final design aimed to create a user-friendly and efficient mobility accessory that could potentially be offered as a Toyota dealership accessory in the future.


TOYOTA

**Michigan State University**
***Team Members*** (left to right)

**Blake Christiansen**
Lansing, Michigan

**Alex Goolsby**
Novi, Michigan

**Ryden Khamo**
Sterling Heights, Michigan

**Maxwell Cheney**
Milford, Michigan

**Jacob Keegan**
Plymouth, Michigan

**Toyota Motor North American Research and Development**
***Project Sponsors***

**Gabriel Marciano**
Plano, Texas

**Todd Muck**
Saline, Michigan

**Becky Ward**
Saline, Michigan

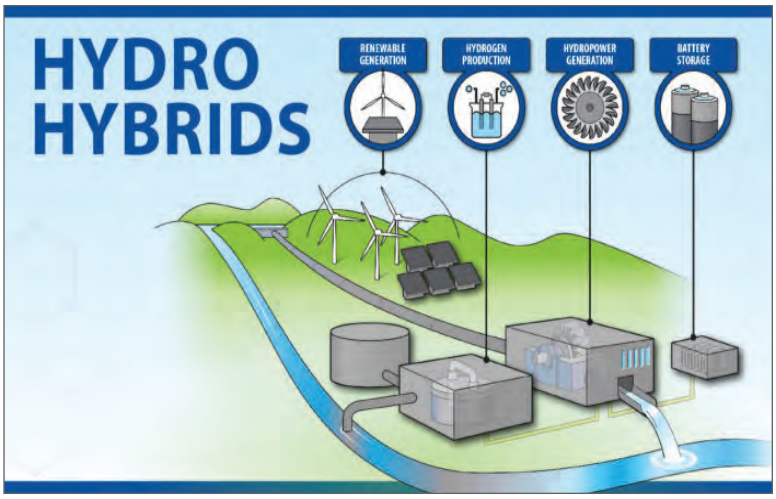
**ME Faculty Advisor**

**Dr. Norbert Mueller**

# Consumers Energy
## Green Hydrogen Powered by Hydroelectricity

Consumers Energy is an investor-owned utility that provides natural gas and electricity to 6.7 million Michigan residents. As part of its commitment to achieving Net Zero carbon emissions—by 2040 in the electric sector and by 2050 in the natural gas sector—Consumers Energy is transitioning away from coal-fired power plants and investing in renewable energy. The company operates 13 hydroelectric plants, including the Hardy Dam, which has been providing clean and reliable energy for over a century.

This project assessed the feasibility of utilizing Hardy Dam's hydroelectric power to produce green hydrogen for hard-to-abate industries such as heavy-duty transportation, cement manufacturing, and steel production. The team evaluated electrolyzer technologies, analyzed power availability, and examined hydrogen storage options, including underground salt caverns. Additionally, a high-level siting assessment and cost estimation were conducted. The results provided insights into the potential for reducing carbon emissions and supporting industrial customers in Michigan with their clean energy goals.




Consumers Energy
Count on Us

**Michigan State University**
***Team Members*** (left to right)

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Rawalpindi, Pakistan

**Mansoor Makki**
Dubai, United Arab Emirates

**Rishabh Ainapurapu**
Dubai, United Arab Emirates

**Hussain Ashkanani**
Dubai, United Arab Emirates

**Jack Jackson**
Rochester Hills, Michigan

**Consumers Energy**
***Project Sponsor***

**DeVon A. Washington**
Jackson, Michigan

**ME Faculty Advisor**

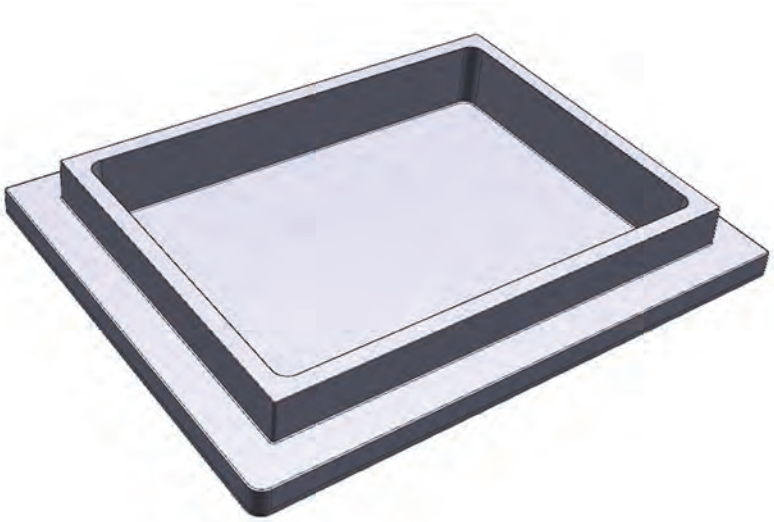
**Dr. André Bénard**

# Kautex Textron
## Material Cost-Benefit in Electric Vehicles

Kautex Textron, a subsidiary of Textron Inc., is a global leader in automotive and industrial solutions, specializing in lightweight thermoplastic fuel systems, battery enclosures, and cleaning systems for autonomous vehicles. With over 5,000 employees and operations in more than 13 countries, Kautex has developed innovative technologies for automotive applications, including advanced composite materials used in electric vehicle (EV) components. Kautex is committed to advancing the use of composites in EV battery pack enclosures and underbody protection, ensuring high performance, cost efficiency, and sustainability. Their extensive research and validation facilities across the U.S., Canada, Europe, and Asia reinforce their ability to develop cutting-edge automotive solutions.

Our project focused on evaluating the cost and performance of various composite materials for potential use in Electric Vehicle (EV) applications, particularly in battery enclosures and underbody protection. The team conducted a comparative analysis of various glass-reinforced compression and injection molded grades of polypropylene (PP) and polyamide (PA), utilizing Computer-Aided Engineering (CAE) simulations to assess mechanical performance under specific load conditions to record peak impactor force load and deflection. By analyzing impact resistance and cost efficiency, we provided Kautex with data-driven insights to optimize material selection for future EV component designs.

The project also included a visit to Windsor, Ontario in late February to observe the manufacturing processes of Kautex's products, which further informed our analysis of various material types.



KAUTEX
A Textron Company

**Michigan State University**
***Team Members*** (left to right)

**Claire Jacka**
Birmingham, Alabama

**Sydney Dillon**
Saline, Michigan

**Noah Rockensuess**
Buffalo, New York

**Abigail Makowski**
Ann Arbor, Michigan

**Avery Powell**
DeWitt, Michigan

**Kautex Textron**
***Project Sponsor***

**Matthew Detrich**
Troy, Michigan

**ME Faculty Advisor**

**Dr. Haseung Chung**

# Munters Corporation

## Design of Farm Building Test Pods for Product Testing

Munters has been a global leader in climate control since it was founded in 1955. Today, Munters operates in over 30 countries providing climate solutions for many industries ranging from food production to data center cooling. FoodTech is Munters' agricultural sector, which focuses on energy efficient climate systems for chickens, cows, swine, and greenhouses. Did you know the effects of 15 minutes without proper climate regulation would be fatal for a chicken farm because of the extreme amount of heat they produce? This goes to show how essential Munters' products are for livestock health and production.

Our project focuses on streamlining the validation process for various Munters' products. The current validation process takes upwards of nine months due to the limitations of current test barns and weather restrictions. With our design, Munters can expedite this process, enabling it to get products on the market and into farms faster than ever. Our design features an innovative testing facility assessing performance and endurance on various fan sizes. Equipped with advanced control capabilities for air temperature, density, humidity and pressure, this facility will enable Munters to simulate a wide range of environmental conditions from its home base. Our design emphasizes feasibility, adaptability, and flexibility, ensuring that it can seamlessly meet current needs while accommodating future requirements. This system will aid Munters' product development engineers for years to come.

### Michigan State University

***Team Members*** (left to right)

**Joe Dreon**
Oakland Township, Michigan

**Amelia Conatser**
Ann Arbor, Michigan

**Adam Martin**
Rochester, Michigan

**Anna Smith**
Frankenmuth, Michigan

**Chase Montour**
Oakland Township, Michigan

### Munters Corporation

***Project Sponsors***

**Thomas Mohr**
Lansing, Michigan

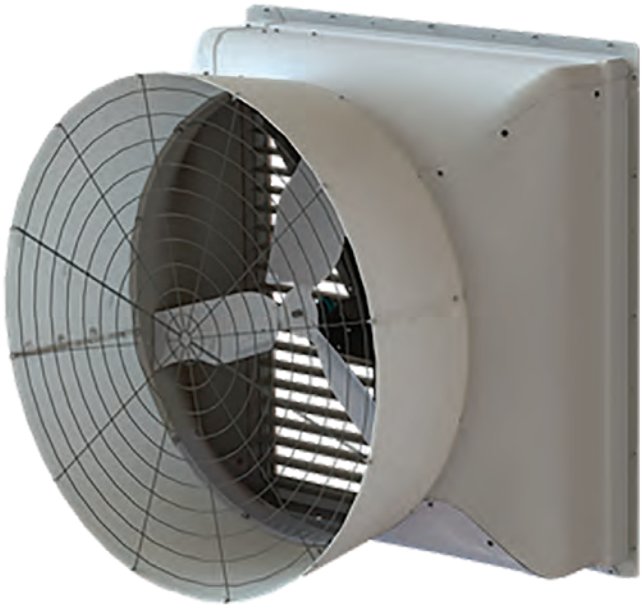
**Tyler Quirk**
Lansing, Michigan

### ME Faculty Advisor

**Dr. Yang Guo**

# Munters Corporation

## Mobile Test Container for Improved Product Validation



Munters Lansing is a global leader in agriculture building ventilation. It specializes in designing, manufacturing, and validating industrial fans and shutters. Munters' products cover the dairy, chicken, and green house spaces. Ventilation includes barn air extraction, fresh air intakes, humidity, and temperature control. Munters strives to enhance the security of consumer operations and production quality through innovative and efficient products, while minimizing the consumption of vital resources like energy and water.

The scope of this project was to design a 53' container to test their industrial products. The intent of this project was to establish an environment that wasn't limited by weather conditions or validation time, allowing for continuous durability testing throughout the year. The "validation" container design included features such as the ability to mount extraction fans on the vertical walls, maintenance of the optimal pressure difference to ensure the fans work under a load, and the incorporation of the electrical distribution and control systems. A key requirement for this container was that it must remain stationary at a fixed location during testing. It also had to be capable of being packed for transport between test sites while remaining fully compliant with DOT regulations.


**Michigan State University**
***Team Members*** (left to right)

**Ian Burke**
Ortonville, Michigan

**Matthew Luxhoj**
Rockford, Michigan

**Joey Karr**
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**Zachary Wyrick**
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**Ethan Darnall**
Beverly Hills, Michigan

**Munters Corporation**
***Project Sponsors***

**Mark Farone**
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**Thomas Mohr**
Lansing, Michigan

**Tyler Quirk**
Lansing, Michigan

**ME Faculty Advisor**

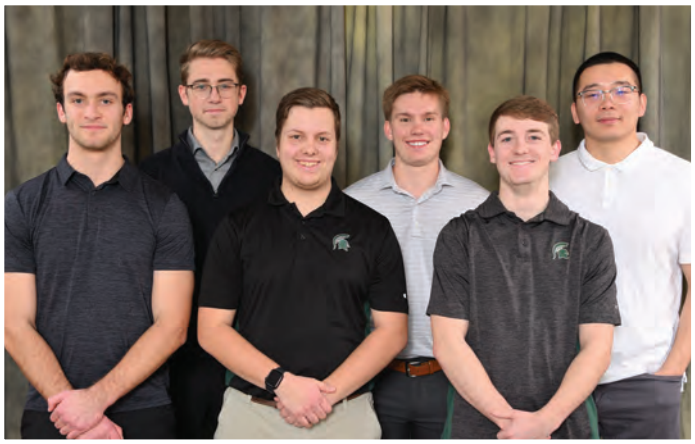
**Dr. Yang Guo**

# Magliner, Inc.
## Magliner Hand Truck Nose Plate Redesign

Magliner, Inc. is one of the leaders in route distribution services and the manufacturing of aluminum hand trucks in the U.S. Founded in Standish, Michigan in 1947, Magliner has been committed to making the transportation of materials easy and safe. Its goal is to build products that customers can trust, and through the innovation and dedication of its team it ensures each one of its products upholds the "Made by Magliner" promise. Magliner is driven by the needs of its customers, and it will continue to make the process of moving products safer and more efficient for years to come.

Delivery drivers across the country use hand trucks to "stab" cases or packages to lift and transport them. The problem with this process is that drivers face a variety of environments and significant differences in packaging. Current hand trucks may work well on wood and tile floors but poor on asphalt, or they can easily stab cardboard but not plastic wrap. Our team was tasked to redesign the hand truck nose plate and create one that works well in all circumstances in addition to being easily serviced. This new nose plate reduces the effort needed to stab any load of products while working on any surface. Our design keeps the products stable while the operator is moving and easily enables them to remove the load. Furthermore, the new nose plate can be easily serviced, or even replaced, if it gets damaged during everyday use.


MAGLINER®



### Michigan State University
***Team Members*** (left to right)

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Haslett, Michigan

**Devin Bentley**
Paw Paw, Michigan

**Tyler Noel**
Canton, Michigan

**Kolby Wagoner**
Coldwater, Michigan

**Judson Wise**
Auburn, Michigan

**Ming Huang**
Lacrosse, Wisconsin

### Magliner, Inc.
***Project Sponsors***

**Greg Ecker**
Standish, Michigan

**Andrew Lehman**
Standish, Michigan

### ME Faculty Advisor

**Dr. Indrek Wichman**

# BONWRx
## Redesign Biomedical Injector

BONWRx, based in Lansing, Michigan, specializes in developing and manufacturing medical devices for spinal and nervous system treatments, including alternatives for vertebral augmentation procedures. The company offers a safer alternative to PMMA, a commonly used acrylic in bone cements with potential health risks, by using a proprietary elastomer. This biocompatible elastomer acts as a shock absorber for the spine, treating vertebral fractures that can lead to severe spinal deformity, back pain, immobility, and reduced quality of life. BONWRx's mission is to alleviate these issues and reduce the need for additional medical procedures.

Our team was tasked with redesigning the VK100 system to enhance the dispensing handle's usability and ergonomics. The redesign is to improve ease-of-use for medical professionals across specialties, while providing greater control during procedures. The new device uses a twisting motion to apply pressure (replacing the previous squeezing motion) and includes a release to stop elastomer flow when necessary. The new device ensures medical staff working long hours could perform their duties safely, comfortably, and effectively.


BONWRX

**Michigan State University**
***Team Members*** (left to right)

**Joshua Machuca-Gonzalez**
Jackson, Wyoming

**Hanna Stabler**
Chandler, Arizona

**Shawn DeFina**
Fenton, Michigan

**Ashley Donbrock**
Portland, Michigan

**Nathan Zavsza**
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**BONWRx**
***Project Sponsors***

**Ralph Carmichael**
Lansing, Michigan

**Rose Carmichael**
Lansing, Michigan

**ME Faculty Advisor**

**Dr. Seungik Baek**

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# The Capstone Projects

**Dr. William Resh**
**Professor of Mechanical Engineering**

**Faculty Advisors:** Ranjan Mukherjee, Siva Nadimpalli, Galit Pelled, Elisa Toulson, Junlin Yuan, Guoming Zhu


Mukherjee


Nadimpalli


Pelled


Toulson


Yuan


Zhu

### Presentation Schedule – Engineering Building, Room 1220

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:00 a.m. | MSU IMPART Alliance | System for Loading, Securing, and Unloading of Direct Care Worker Training Equipment |
| 8:30 a.m. | MSU IMPART Alliance | DCW Offsite Training Equipment Organization Carts |
| 9:00 a.m. | MSU IMPART Alliance | Development of Portable Storage Cart |
| 9:30 a.m. | Michigan AgrAbility | Rolling Kneeler Cart Drivetrain |
| 10:00 a.m. | MSU Department of Theatre | Portable Wood Hardness Tester |
| 10:30 a.m. | MSU Adaptive Sports & Recreation Club | Three-Wheel Drive System for Scooter (Continuation) |
| 11:00 a.m. | MSU Department of Theatre | Adjustable Dust Collector Arm |
| 11:30 a.m. | MSU College of Engineering | Human-Robot Collaborative Object Transport System |

# 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: *Rebecca Anthony, Seungik Baek, André Bénard, Haseung Chung, Gary Cloud, Brian Feeny, Yang Guo, Farhad Jaberi, Lik Chuan Lee, Ricardo Mejia, Hamidreza Modares, Norbert Mueller, Ranjan Mukherjee, Siva Nadimpalli, Ahmed Naguib, Galit Pelled, Thomas Pence, Harold Schock, Elisa Toulson, Indrek Wichman, Neil Wright, Junlin Yuan, Mohsen Zayernouri, and Guoming Zhu.*

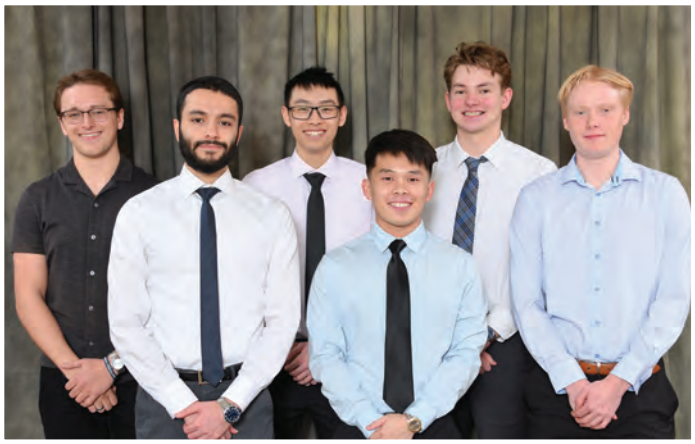
# MSU IMPART Alliance

## System for Loading, Securing, and Unloading of Direct Care Worker Training Equipment

The IMPART Alliance initiative is an MSU-led program to train and support Michigan's in-home Direct Care Workers (DCWs). Many Michiganders and their families care for their loved ones with the help and skills of DCWs; however, there is currently an urgent shortage of well-trained DCWs. IMPART Alliance strives to bridge the gap in DCW retention and recruitment by developing training curriculum and models, establishing effective protocols and procedures, providing professional training, and collating a database of DCWs based in Michigan. As part of the IMPART Alliance's training program, its staff transport an assortment of training aids and other equipment to various locations around the state.

Our team's project was to design a system that enabled IMPART Alliance staff to safely and easily load, transport, and unload four to five carts of equipment onto and from a cargo van provided by the MSU Motor Pool. To modify the carts as needed to fit into the van, we consulted with two other student teams tasked with the design and organization of the carts. An exterior commercial lift gate was installed onto the back of a Ford Transit van to lift and lower the carts, as the largest cart weighed nearly 150lbs. Inside the van, two sets of tracks attached to the floor guide the wheels of the carts and prevent lateral movement while the van was in motion. D-ring hardpoints are also present inside the van and provide attachment points for straps to further secure the carts. By working with the IMPART Alliance, the MSU Motor Pool, and the teams working on other aspects incorporated in this project, we were able to design an effective system that accommodates any IMPART Alliance staff who would operate it and enable them to safely carry out their training.

*MSU IMPART Alliance through a grant received by the Michigan Department of Health and Human Services using American Rescue Plan Act/Home and Community Based Services Project funds.*



**Michigan State University**
***Team Members*** (left to right)

**Cole Jeffery**
Chicago, Illinois

**Mohammad Alqaryouti**
East Lansing, Michigan

**Maxwell Cheng**
West Bloomfield, Michigan

**Alexander Le**
Caledonia, Michigan

**Sterling Mims**
Okemos, Michigan

**Kyle Taormina**
Macomb, Michigan

**MSU IMPART Alliance**
***Project Sponsor***

**William Resh**
East Lansing, Michigan

**ME Faculty Advisor**

**Dr. Galit Pelled**

# MSU IMPART Alliance

## DCW Offsite Training Equipment Organization Carts

IMPART Alliance is a dedicated organization focused on improving the training and support of Direct Care Workers (DCW) who provide essential care for individuals in need. The organization works to enhance workforce development, training programs, and industry standards to ensure quality care. Through various initiatives, IMPART Alliance has aimed to make DCW training more efficient, accessible, and effective by addressing challenges such as resource organization and training logistics.

Our project focused on developing an improved system for organizing and transporting training equipment for DCW at offsite locations. We designed and built fully functional prototype carts and container systems to efficiently store and transport training materials, ensuring quick setup for different training modules. The project involved organizing materials into consumable, maintainable, and durable items while creating a tracking system to monitor inventory and maintenance needs. By optimizing storage solutions and enhancing mobility, our work contributed to a more structured and accessible training process, ultimately supporting the effectiveness of DCW education and workforce development.

IMPART ALLIANCE
MICHIGAN STATE UNIVERSITY

*MSU IMPART Alliance through a grant received by the Michigan Department of Health and Human Services using American Rescue Plan Act/Home and Community Based Services Project funds.*

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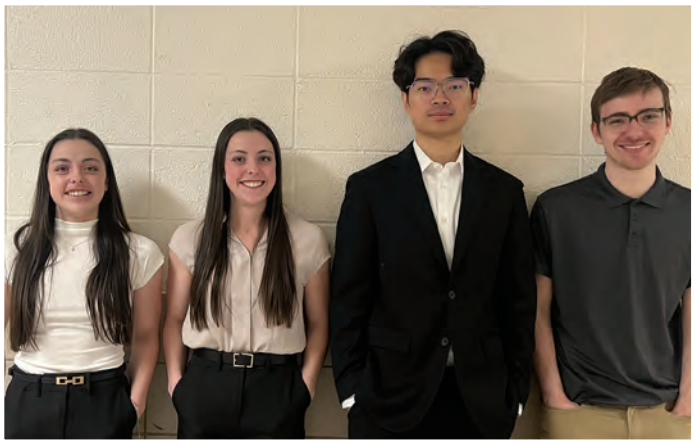
# MSU IMPART Alliance
## Development of Portable Storage Cart

Affordable, high-quality healthcare is crucial for everyone. Though this is the case, many families find it difficult to receive this level of care at a reasonable cost. The MSU IMPART Alliance is dedicated to addressing this challenge and finding a solution. Its mission is to teach and build a skilled workforce of direct care workers to support families and individuals who would benefit from this type of care. The IMPART Alliance has multiple training programs available in order to help combat the increasing need for direct care workers in Michigan. One of these programs is an in-person training program that utilizes medical mannikins. In order to make this available in different areas, the IMPART Alliance needs an easy way of transporting this equipment throughout Michigan. This is where storage carts become a key role in carrying the necessary training equipment such as medical beds, side rails, a mannikin, etc. to the different training locations.

Our team was tasked with further developing a portable storage cart that would transport a medical mannikin as well as a bed and any other necessary equipment being employed for training. We worked with two other groups to make transporting this equipment as seamless as possible from packing and loading onto a vehicle, to setup/breakdown. A prototype for this cart and bed was previously built and we focused on the attachment of bed rails with the intent of making the process of getting up and out of the bed easier for patients. In addition, we focused on making sure that a single person could easily take apart/put together this cart as well as improving the mobility of this cart in various environments by making design changes to the wheels.

*MSU IMPART Alliance through a grant received by the Michigan Department of Health and Human Services using American Rescue Plan Act/Home and Community Based Services Project funds.*



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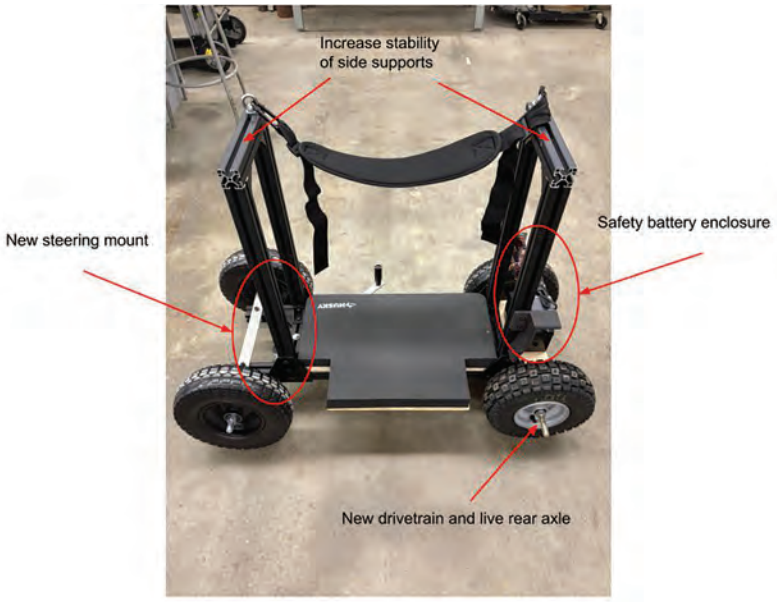
# Michigan AgrAbility
## Rolling Kneeler Cart Drivetrain

Michigan AgrAbility provides critical assistance to enable people in the agricultural industry with an injury, illness, or disability to continue working. We are funded by the USDA through Michigan State University Extension and Easterseals MORC. Kami is a lavender farmer in Michigan with a disorder causing her foot bones to break. She contacted AgrAbility for assistance to relieve foot strain while pruning, weeding, and harvesting lavender. A previous capstone group designed a kneeling roller and at the end of the semester installed an electric drive motor.

The Kneeler Cart with chest strap enabled Kami to kneel with hand supports, as well as to lean forward while rolling along rows where she plants, harvests, prunes, and weeds a given crop. Working stooped over or kneeling and crawling is impossible for workers with back and lower extremity impairments who grow low fruits and vegetables. It requires good balance and strong legs to kneel and stand up unaided, along with eliminating the risk of falling. Rolling work seats help some farmers complete ground level tasks without crawling, but they must bend far over, straining their backs to reach the ground. Kami was unable to freely roll the cart from one place to another, so a neutral mechanism was implemented in order to achieve this. On top of the neutral addition, the Kneeler Cart has an improved drivetrain, which turns both wheels simultaneously via a live rear axle. A new steering mount is also included in this design upgrade so that turning the cart is more accessible and far easier. In order to make this a permanent design, the side supports, and overall stability of the cart were improved to make it far more robust, while still keeping it easy to recreate by future users.

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**Michigan AgrAbility**
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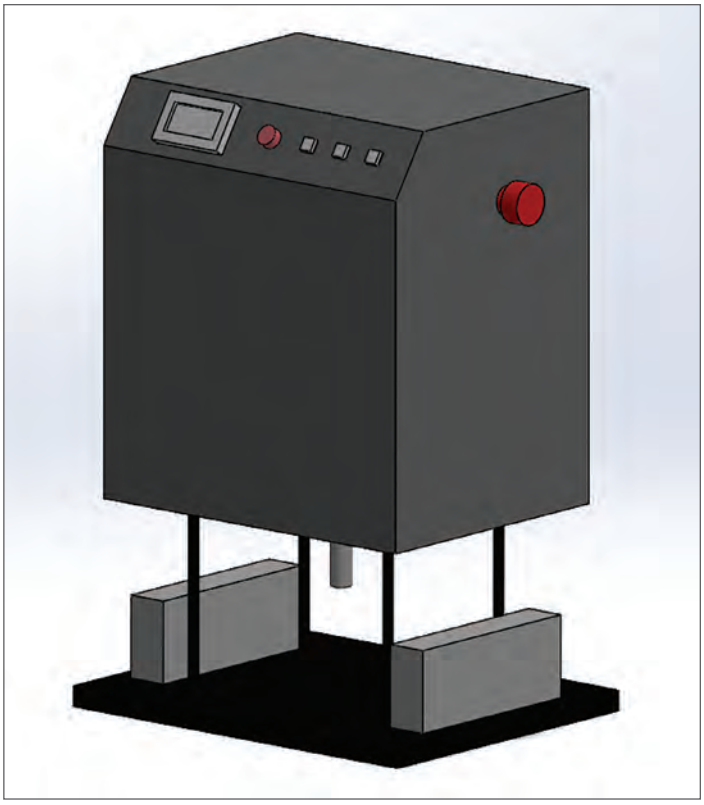
# MSU Department of Theatre
## Portable Wood Hardness Tester

Bringing a production to life requires more than just vision - it demands craftsmanship, precision, and the right materials. The MSU Theatre Department Scene Shop crafts immersive scenic environments using wood, metal, and composites to create sets that captivate audiences. However, not all materials perform the same under the varying demands of live theatre. Choosing the right wood for a set piece means balancing strength, weight, and artistic finish. To enhance the selection process, we worked to develop a compact, portable, and digital hardness tester, enabling us to assess the strength of various materials before incorporating them into scene designs.

This project builds upon a previous capstone team's work, which developed an initial mechanism to measure the force required to break, bend, or deform materials. The core structure was in place; however, the electronics needed additional programming and rewiring, while certain mechanical aspects required reworking. Our goal was to refine and redesign this device into a user-friendly tool for measuring hardness with precision. Integrating this technology into set design operations will optimize material selection, improve structural integrity, and enhance the efficiency of scene construction. This project is to provide a valuable tool for faculty and students in set construction, while also offering potential applications in theatre, film, and other industries that depend on wood hardness assessment.



Department of Theatre
MICHIGAN STATE UNIVERSITY

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**Dr. Guoming Zhu**

# MSU Adaptive Sports & Recreation Club

## Three-Wheel Drive System for Scooter (Continuation)

MSU Adaptive Sports and Recreation Club is an inclusive club at MSU that promotes health, wellness, and teamwork through sports for individuals with physical disabilities. Piotr Pasik was inspired to start the program after seeing a lack of physical activity opportunities on campus for individuals with disabilities, and the club launched in 2014. Athletes have the opportunity to play a variety of sports in this club including boccia ball, wheelchair hockey, wheelchair rugby, hand-cycling, table tennis, and wheelchair tennis. Through the use of sports, the club strives to improve the physical health of its athletes as well as eliminate the societal stereotypes about disabilities.

This project is a continuation of a mobility scooter to provide Piotr (and many others who have cerebral palsy) with reliable transportation every day. The current two-wheel drive system performs well throughout most of the calendar year. However, once the winter weather starts, it is increasingly difficult to navigate the sidewalks, particularly with heavy snow fall. Implementing a synchronized three-wheel drive system would help to solve this problem. Currently, the front motor is burnt out and does not provide any help in the motion of the scooter. Implementing a new motor that synchs with the back wheel powertrain would provide much more torque, ensuring that Piotr can navigate the snow with no issues. In addition to this, engineering a new braking system will help in the winter months as well, because it is harder to brake on snow and ice.

Michigan State University
Adaptive Sports & Recreation Club
Est. 2014

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**Keegan Bretschneider**
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### MSU Adaptive Sports and Recreation Club
***Project Sponsor***

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### ME Faculty Advisor

**Dr. Guoming Zhu**

# MSU Department of Theatre
## Adjustable Dust Collector Arm

The Michigan State University Department of Theatre is where excitement and intrigue are created through shows; including operas, plays, and other entertainment. Here is where many students and alumni, as well as other members of the community, can come to see new attention-grabbing creations through theatre. One of the most important aspects of putting these plays together is the creation of the scenery; this is how the audience is immersed into the stories they come to see. The scenery tells as much of the story as the characters and must be made with precision and care. This is the role of the MSU Department of Theatre Scene Shop faculty. They have the task of planning the many aspects that go into how the scenery is built, altered, and moved. The construction process warrants the use of a large number of raw materials and power tools, which continuously develop dust particulates that clutter their workspace and make it hard to continue their efforts.

Our team was tasked with the development of an adjustable dust collecting apparatus that could span large work areas, enabling the technical team to effortlessly collect the unwanted dust and debris from their work area. The system was integrated into the preexisting duct to provide a centralized waste receptacle. The designed arm enables any user to easily maneuver, position, and operate the dust collection system of the shop without having to bear the weight of the full system. It was designed as an overhead arm that enables the user to keep their hands on the workpiece while also keeping the system out of their path to maximize an efficient workflow.

Department of Theatre
MICHIGAN STATE UNIVERSITY

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**Marc White**
East Lansing, Michigan

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**Dr. Junlin Yuan**

# MSU Department of Mechanical Engineering

## Human-Robot Collaborative Object Transport System

The Michigan State University Department of Mechanical Engineering has sponsored this project. The Human-Robot Collaborative Object Transport System is designed to improve coordinated transport of objects using AgileX LIMO robots controlled by human operators. The system integrates vibrotactile feedback vests, which will enable human operators to control the robots through shoulder movements while receiving real-time guidance.

Department of Mechanical Engineering
MICHIGAN STATE UNIVERSITY

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**Dr. Ranjan Mukherjee**

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# CAN YOU SPOT THE DIFFERENCE?

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# The Capstone Projects

**Dr. William Resh**
**Professor of Mechanical Engineering**

**Faculty Advisors:** Gary Cloud, Farhad Jaberi, Ricardo Mejia, Thomas Pence, Mohsen Zayernouri


Cloud


Jaberi


Mejia


Pence


Zayernouri

### Presentation Schedule – Engineering Building, Room 1300

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:00 a.m. | MSU Broad Art Museum | Modular Art Transport Cart with Vibration Minimization |
| 8:30 a.m. | MSU Department of Mechanical Engineering | Chainsaw Sharpening Fixture |
| 9:00 a.m. | MSU Student Life & Engagement/MSU Anaerobic Digestion Research and Education Center | Quality Control in MSU's Food Waste Management |
| 9:30 a.m. | MSU Adaptive Sports & Recreation Club | Roller Sled Mobility – Phase Four |
| 10:00 a.m. | MSU Adaptive Sports & Recreation Club | Inclusive Sports Wheelchair |
| 10:30 a.m. | MSU Rocketry Team | Custom Filament Winder for Rocketry Tubes |
| 11:00 a.m. | Pratt Miller | Composite Battery Container for FSAE Car |

# 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.

# MSU Broad Art Museum

## Modular Art Transport Cart with Vibration Minimization

The MSU Broad Art Museum was established by Eli Broad, a Michigan State University alumnus, alongside his wife Edythe. Both lovers of the arts, they donated $26 million to the university in 2007 to build the Eli and Edythe Broad Art Museum. The 20,000-square-foot museum was opened five years later in 2012 (designed by the Pritzker Prize-winning architect Zaha Hadid) and placed perfectly on the edge of campus to face the surrounding community. The MSU Broad Art Museum boasts 10,000 works in its permanent collection, specifically focused on creating an inclusive environment by addressing implicit bias, systemic racism, and social inequalities. In addition to its permanent collection, the Broad Art Museum features local, national, and international artists through its rotating collection of exhibits.

When replacing exhibits in the museum, it is important to uphold the safe transportation of all artworks. This project is to continue the development of an advanced-level art transportation cart with a focus on developing an auxiliary A-frame top. The top must be collapsible for flat storage and easily assembled by any staff member. The modular A-frame also enables the cart to be used as an easel or display to reduce the number of times the art needs to be handled. With a strong focus on structural strength and an adjustable size to accommodate art pieces of various shapes and sizes, minimizing vibrations is also a critical consideration to eliminate potential damages during transit. The use of specific materials and structural design choices helped meet the criteria to deliver an effective prototype.

MSU BROAD ART MUSEUM

**Michigan State University**
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**Max Doty**
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**Stephanie Glaspie**
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**Dominic Bednar**
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**Emerson Voss**
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**MSU Broad Art Museum**
***Project Sponsor***

**Brian Kirchensteiner**
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**ME Faculty Advisor**

**Dr. Ricardo Mejia**

# MSU Department of Mechanical Engineering
## Chainsaw Sharpening Fixture

The Department of Mechanical Engineering at MSU strives to approach difficult problems, enabling students to strengthen their engineering skills as they seek creative, feasible solutions. They also handle a variety of challenges, with the ultimate goal of learning, creating, and problem solving. The department provides education to undergraduate and graduate students through studies in automotive, aerospace, manufacturing, robotics, medical devices/artificial organs, and renewable energy. Leading-edge research is also conducted by professors who are involved in the program at Michigan State.

Our team was tasked with developing a chainsaw mounting system, with the main goal of creating a reliable and user-friendly sharpening method. The problem with the original design was that it was considered inefficient due to the loose grip of the fixture on the guide bar. As the file is used to sharpen the teeth, the pulling force would cause the chain saw to slip. This slipping posed a risk in terms of safety as well as damaging the blade and teeth. Our goal was to create a fixture that would prohibit all movement of the chainsaw with an easy and cost-effective setup.

This project was carried out in a three-step process: design, physical creation, and analysis. This was an iterative process, with the analysis including a proper selection of material, safety, and cost. The team was successful in creating a new design for the chainsaw fixture that holds the chainsaw more firmly, enabling the sharpening of the blade without movement.

Department of Mechanical Engineering
MICHIGAN STATE UNIVERSITY


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**Jack Fisher**
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**Gunnar Carroll**
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**MSU Department of Mechanical Engineering**
***Project Sponsor***

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**Dr. Ricardo Meija**

**ME 481 | 9:00 a.m.** Engineering Building, 1st Floor | Room 1300

# MSU Student Life & Engagement/ MSU Anaerobic Digestion Research and Education Center

## Quality Control in MSU's Food Waste Management

Michigan State University takes pride in being green, both on and off the field. When it comes to food waste management, it is essential to be efficient, precise, and resourceful. For many years MSU has had a program to manage all food waste before it arrives at the consumers' table, and dealing with any leftover products. The whole operation begins in the kitchen where food that is unfit to serve (scraps, etc.) is discarded in waste bins. Those bins are then taken to the MSU Surplus Store and Recycling Center, where they are sorted to remove unfit waste, dumped into larger containers, and hauled away to be processed. Besides taking action and processing tons of food waste, MSU's Food Waste Management wants to educate both the public and workforce about the benefits of composting and correct disposal of food waste.

Despite active efforts to correctly dispose of food waste and to educate the public on proper items to dispose of, contaminants still end up in the food waste stream. Items such as kitchen utensils, latex gloves, plastic film, plastic bags, etc. can cause problems in the processing of this waste. Our project is to design a new pre-consumer quality control process to filter out unwanted materials, such as plastic and stainless steel, from the kitchen food waste bins in order to be acceptable at the campus anaerobic digester.

STUDENT LIFE & ENGAGEMENT

MICHIGAN STATE UNIVERSITY Department of Biosystems & Agricultural Engineering

ADREC


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**Student Life & Engagement/MSU Anaerobic Digestion Research and Education Center**
***Project Sponsors***

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**ME Faculty Advisor**

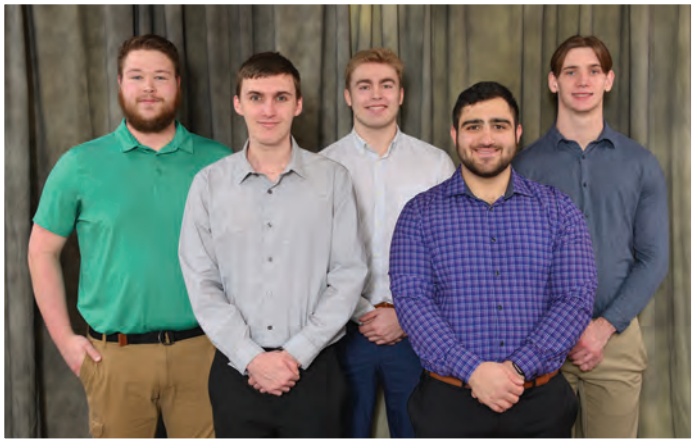
**Dr. Farhad Jaberi**

# MSU Adaptive Sports & Recreation Club
## Roller Sled Mobility – Phase Four

The MSU Adaptive Sports & Recreation Club is a Registered Student Organization established in 2014. It was created to enable adult athletes with physical disabilities to participate in a handful of different activities. The program is open to athletes and able-bodied volunteers at the university and from the surrounding area. The program helps the athletes stay active and achieve their fitness goals, while building a community of athletes and volunteers. The club helps bring the lessons obtained through sports to the athletes (like self-efficacy) while educating the volunteers about the community and eliminating cultural stereotypes.

This project is the fourth phase of modifying the existing hockey roller sleds to increase athlete mobility. While previous phases have increased user control, there is still room for improvement in terms of speed and mobility. In their original state, the roller hockey sleds were very difficult to move on the Demonstration Hall Arena surface where they are primarily used. This required athletes in the program to exert significant effort without meaningful results in terms of movement. The new design prioritizes this in order to improve game flow, but more importantly to increase the inclusion of individuals with more involved physical disabilities.

Michigan State University
Adaptive Sports & Recreation Club
Est. 2014

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Oxford, Michigan

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**Nicolas Sarafian**
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**Jon Hilton**
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**MSU Adaptive Sports & Recreation Club**
***Project Sponsor***

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East Lansing, Michigan

**ME Faculty Advisor**

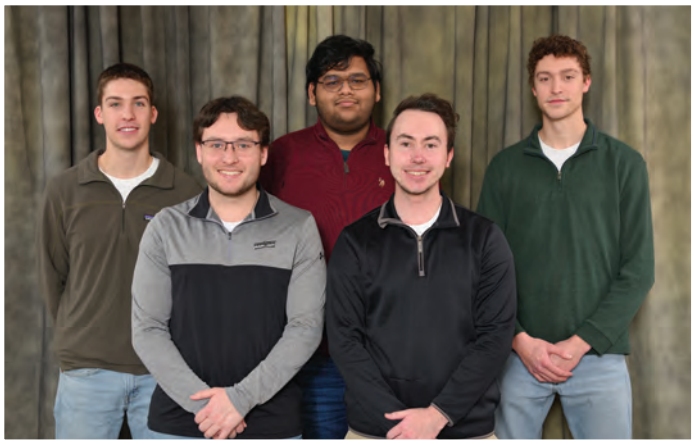
**Dr. Mohsen Zayernouri**

# MSU Adaptive Sports & Recreation Club
## Inclusive Sports Wheelchair

The Michigan State Adaptive Sports & Recreation Club, located on campus, aims to provide an inclusive space where athletes can connect and form a supportive community. Open to both athletes with physical disabilities, as well as able-bodied volunteers, the club offers a variety of sports, including wheelchair basketball, wheelchair tennis, wheelchair floorball, and more. Since its inception, the club has grown significantly, expanding from just a few recreational sport options to competing in numerous tournaments against other colleges. It hosts open gym sessions on Monday and Thursday nights, inviting anyone to join and participate. The club plays a vital role in the community by offering athletes a chance to get active, build strength, and foster friendships with others.

Since fall of 2016, the MSU Adaptive Sports & Recreation Club has been collaborating with the MSU College of Engineering to support capstone projects for senior mechanical engineering students. The main purpose of this wheelchair is to enable ambulatory individuals with disabilities impacting arm function, to participate in team sports that require the use of a wheelchair. In a previous phase, a steering system was implemented that allows the chair to use brakes on either wheel via the lever. This semester, improvements were made to the wheelchair's functionality by refining the steering system, making it easier to control and brake. Another goal was to increase compatibility with standard sport wheelchairs to simplify maintenance. This project was completed with the purpose of ease-of-use and accessibility for all people, and it was incredibly rewarding to help such an impactful group.

Michigan State University
Adaptive Sports & Recreation Club
Est. 2014



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**MSU Adaptive Sports & Recreation Club**
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**Piotr Pasik**
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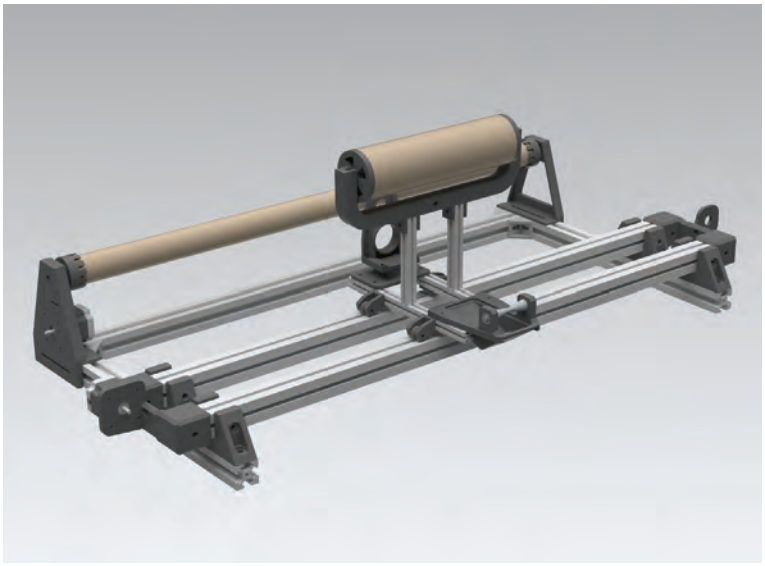
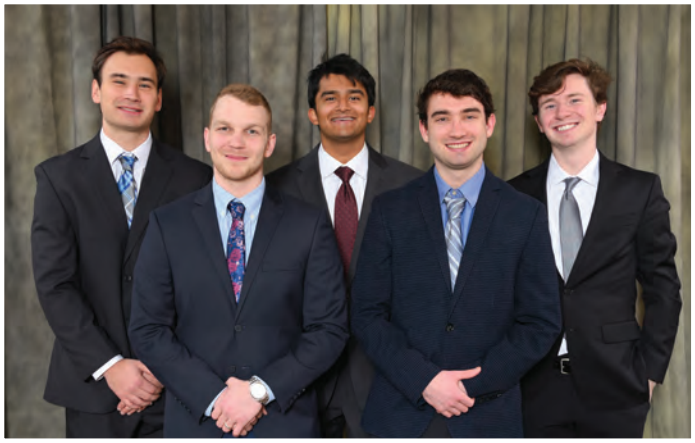
**ME Faculty Advisor**

**Dr. Mohsen Zayernouri**

# MSU Rocketry Team
## Custom Filament Winder for Rocketry Tubes

The MSU Rocketry Team is a student engineering club that builds and competes against other college teams across America in the Space Port America Cup. Rocketry currently purchases fiberglass for its body tube; and it would like to convert to a lighter, stronger composite material. The club wants to start producing its own body tubes for competition rockets to increase performance, reduce costs, and optimize current designs. To complete this task a custom-tube winder must be manufactured to allow for repeatable, precise, and variable designs. To showcase the machines capabilities, a one-foot tube with a two-inch diameter will be made, enabling tuning of production, code, and material properties. It is designed to expand to accommodate tubes up to three feet long and six inches in diameter when ready. The goal of this project is to design a machine that can create tubes at smaller scales while enabling future expansion to larger diameters and longer lengths. This will enable the team to build custom rocket body tubes in-house, eliminating the need to purchase pre-made ones. A mandrel rotates while an epoxy-coated filament is wound onto it at precise angles using a sled driven by three stepper motors. Once wound, the assembly is shrink-wrapped and heated to cure the resin, forming a solid composite structure. The machine will offer versatility, precision, and efficiency as the team works to develop stronger, lightweight components for its rockets.



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**Bobby Dessy**
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**MSU Rocketry Team**
***Project Sponsor***

**Patton Allison**
East Lansing, Michigan

**ME Faculty Advisor**

**Dr. Thomas Pence**

# Pratt Miller
## Composite Battery Container for FSAE Car

The MSU Formula Racing Team is a student-led organization at Michigan State University that designs, builds, and races in Formula SAE competitions nationally and internationally. Formula SAE was founded as a competition called Mini Indy in 1979. In 1981, its name was changed to Formula SAE, and a whole new journey started. It became one of the largest engineering competition series. The MSU Formula team proudly represents Michigan State University in Formula SAE competitions. MSU-FSAE is driven to push the boundaries of innovative automotive design. The MSU Formula Racing Team recently transitioned to the EV category and is focused on improving vehicle performance while promoting teamwork and competency.

For 30 years, Pratt Miller has driven innovation in racing and beyond, including the legendary Corvette Racing team. Now, with 300+ employees, it serves global clients in Motorsports, Defense, Mobility, and Innovation, and served as the technical/industrial advisor for this project.

The goal of this project was to design, build, and test a composite battery container for the MSU FSAE EV racecar that will meet the requirements of SAE electric racecar standards. The key advantage of using the new composite battery container is its lighter weight compared to the current one, thereby reducing the overall vehicle weight while maintaining high structural integrity. Our studies mainly focused on improving thermal management; making sure the cooling system was both effective and efficient; ensuring durability; and creating a light, reliable solution that integrates easily into the car's chassis. As the MSU FSAE team transitions to EV, our main objective was not only to build a battery container but also to support future improvements as the team advances.


State RACING

PRATT MILLER

**Michigan State University**
***Team Members*** (left to right)

**Jackson Larkin**
Zeeland, Michigan

**Arinc Kuloglu**
Istanbul, Turkey

**Huseyin Emir Canoglu**
Ankara, Turkey

**Nicholas Mercer**
Woburn, Massachusetts

**Gavin Lahousse**
Ann Arbor, Michigan

**Pratt Miller**
***Project Sponsor***

**Cameron Hesano**
New Hudson, Michigan

**ME Faculty Advisor**

**Dr. Gary Cloud**

# The Capstone Projects

**Dr. William Resh**
**Professor of Mechanical Engineering**

**Faculty Advisors:** Rebecca Anthony, Brian Feeny, Lik Chuan Lee, Hamidreza Modares, Ahmed Naguib, Harold Schock, Neil Wright


Anthony


Feeny


Lee


Modares


Naguib


Schock


Wright

### Presentation Schedule – Engineering Building, Room 2435

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:00 a.m. | Cobra AERO and Jetfire Power, LLC | Design of 3-Cylinder Engine Head for Aero Application |
| 8:30 a.m. | NASA Psyche Mission | Future Power Solutions for Exploring Hypothesized Surfaces |
| 9:00 a.m. | Michigan Nut & Fruit Growers Association | Sorting of Shell and Kernel Fragments of Black Walnuts |
| 9:30 a.m. | MSU Bikes Service Center | Bike Powered Prosthetic |
| 10:00 a.m. | MSU Solar Racing Team | Solar Car 3-Wheel Suspension Creation |
| 10:30 a.m. | General Motors | MSU Baja Multi-Disc Basket Clutch |
| 11:00 a.m. | MSU Baja Racing | Design and Manufacture of Custom Brake Calipers |

# 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.

# Cobra AERO and Jetfire Power, LLC

## Design of 3-Cylinder Engine Head for Aero Application

Cobra AERO is an advanced propulsion technology company that specializes in small, unmanned aircraft engines, such as drones and their related power systems. The company was established in 2012 as a branch to Cobra MOTO, using its skills of engine design and innovation to develop high-performance solutions for a variety of propulsion applications. The company initially focused on unmanned aerial vehicles (UAVs), although they have since expanded into other markets such as related controls and power electronics. They lean on partnerships with various companies such as Currawong Engineering and TWIG Power to continuously refine and deliver new propulsion systems. Cobra AERO has teamed with Jetfire Power, LLC to implement a new combustion system for their engine. The concept termed, Jetfire, is a product of Jetfire Power, LLC, which adds a pre-combustion chamber to the Cobra AERO engine, yielding a highly efficient, environmentally sustainable combustion engine.

This project was to redesign the cylinder heads for a 3-cylinder two-stroke engine to account for a rotary intake valve, as opposed to a poppet valve of previous Jetfire concepts. This will permit increased engine speeds and an aerodynamically favorable engine frontal area. The rotary valve is an integral part of the Jetfire ignition system that Cobra AERO is attempting to implement in its engine. The challenge of the rotary valve design was to conceptualize a method for adequately sealing the rotary shaft during combustion, while maintaining proper synchronization between the crankshaft and the Jetfire ignition system. Highlights will be the impact of this concept's future combustion engine technology including compact size, enhancing power density and efficiency.

### Michigan State University

***Team Members*** (left to right)

**Alex Szumko**
Ann Arbor, Michigan

**Brandon Hineman**
Macomb, Michigan

**Kennedy Kullman**
Shelby Twp., Michigan

**Nour Darrag**
Cairo, Egypt

**Joshua Picciano**
Livonia, Michigan

### Cobra AERO and Jetfire Power, LLC

***Project Sponsor***

**Harold Schock**
East Lansing, Michigan

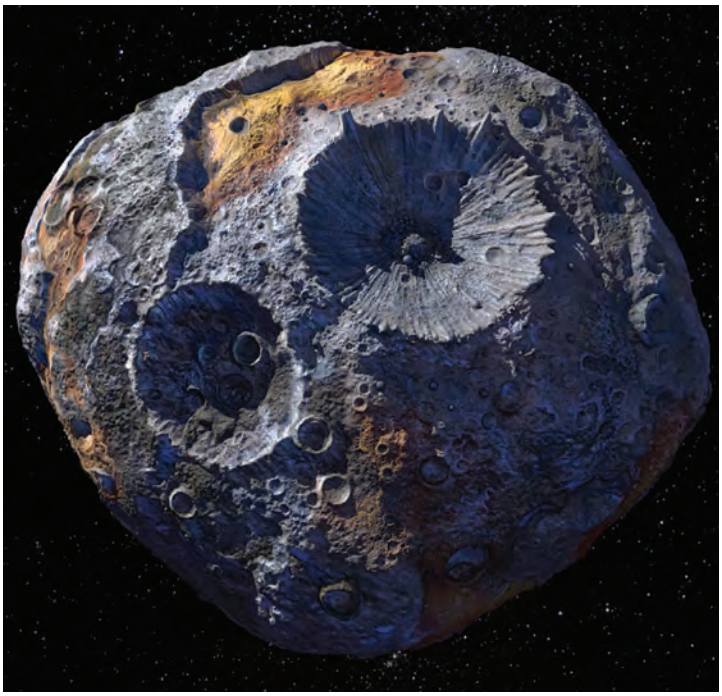
### ME Faculty Advisor

**Dr. Harold Schock**

# NASA Psyche Mission
## Future Power Solutions for Exploring Hypothesized Surfaces

NASA is continuously pushing the boundaries of extraterrestrial exploration. New endeavors are always being developed and launched, encompassing goals in many fields of science. Some teams are focused on a surface composition of a celestial body, while others intend to study the object's gravity and rotation. All missions, regardless of their scale, enable scientists to understand the galaxy better and push towards new discoveries. In recent years, one of NASA's goals has been to create the smallest spacecrafts possible. One such small spacecraft could be used in a future mission to the surface of the asteroid Psyche. This asteroid has been the focus of many collaborations between NASA and universities across the country. Student projects have focused on many aspects of the mission to Psyche, including long-term simulations, sample collection, and even game designs that feature the object.

Psyche poses a unique challenge because it is one of the few remaining classes of solar system objects that has not been explored. Unlike many other objects in the solar system, it is likely composed largely of metals and is ellipsoid in shape rather than spherical. Many of the details of Psyche's composition are still unknown. These factors make exploration challenging, because many techniques that have served other missions will not apply. NASA currently has a probe en route to Psyche, which will arrive sometime in 2029 and will orbit the asteroid to collect data. In the future, scientists and engineers may propose the launch of a second mission that would land on the asteroid's surface. Our team developed ideas for a power source for that mission. We selected a renewable energy generation method that would provide enough power for the duration of the mission and brainstormed a method for excess energy to be stored.



**Michigan State University**
***Team Members*** (left to right)

**Ari Mustafaraj**
Troy, Michigan

**Chase Marcath**
Macomb, Michigan

**Renee Kinsler**
Holland, Michigan

**Daniel Krahn**
Imlay City, Michigan

**Mallory Brooks**
Saginaw, Michigan

**NASA Psyche Mission**
***Project Sponsor***

**Cassie Bowman**
Tempe, Arizona

**ME Faculty Advisor**

**Dr. Hamidreza Modares**

**ME 481 | 9:00 a.m.** Engineering Building, 2nd Floor | Room 2435

# Michigan Nut & Fruit Growers Association

## Sorting of Shell and Kernel Fragments of Black Walnuts

Black walnut trees present an opportunity as an agroforestry food source, but their exceptionally hard shells make accessing the edible kernel difficult. The most effective way to access the edible portions is to crush open the hard walnut, which results in an intermixed assortment of highly variable sized portions of shells and edible "meats". Due to the significant overlap in fragment size, traditional sorting methods struggle to efficiently separate the edible portions from the shell.

For this project, the goal was to develop an effective and feasible small-scale system to sort black walnut shell fragments from the edible insides. Our concept is based on hardness principles: a walnut shell resists needle penetration, whereas the meat resistance is minimal. By applying a controlled force, the penetration depth or resistance determines the classification of walnut fragments. Sponsored by the Michigan Nut & Fruit Growers Association, this project presented an opportunity to apply mechanical design principles to a real-world agricultural challenge. Our project is to enhance processing efficiency, minimize waste, and support sustainable food production by creating an accessible and efficient sorting solution. The final design provides an innovative approach tailored to small-scale users who currently lack practical affordable separation methods.


**Michigan State University**
***Team Members*** (left to right)

**Larissa Tacaoca Honda**
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**Kaitlyn Heffelbower**
Woodland, Michigan

**Aida Soltanian**
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**Genna Lebster**
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**Charlotte Neu**
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**Michigan Nut & Fruit Growers Association**
***Project Sponsors***

**Dan Guyer**
East Lansing, Michigan

**Dennis Strahle**
Eagle, Michigan

**ME Faculty Advisor**

**Dr. Rebecca Anthony**

# MSU Bikes Service Center
## Bike Powered Prosthetic

The MSU Bikes Service Center's mission is to help people enjoy bicycling on campus and beyond by offering everything from new bikes, used bikes, rentals, parts, accessories, to repairs. At Michigan State University, there is an abundance of around 1,000-1,500 bikes being abandoned each year, which MSU Bikes can access. This makes them a great potential resource for parts that can be modified to function as an affordable lower limb prosthetic. Modern prosthetics, though effective, are not always a feasible option due to their high costs and complex technologies. Currently, 90% of people in third world countries who are missing limbs do not have prosthetics to help them in their daily lives. Working with the MSU Bikes Service Center, sponsor Ben Hogan, a Certified Prosthetist Orthotist at Mary Free Bed hospital and former student at MSU Bikes, has come up with the idea of utilizing many of the abandoned bikes found around the world as parts for affordable prosthetics. Ben considered many of the challenges in developing countries and wanted to find a way to produce prosthetics cheaper and more accessibly. Ben addressed these challenging factors by creating a functioning prototype made entirely from bicycle parts and wanted us to explore and refine the idea further.

Our project was to assemble another prototype using the original design of a below-the-knee prosthetic from a bike, following steps to ensure it can be made with ease. We modified the design when necessary to make it easier to produce with commonly available tools. We looked at the variability of the fit and the durability of the prosthetic under constant load. We also worked with a volunteer client to perfect the fit of the design and perform analysis on the prosthetic in a real-world environment. The goals for our design work included something more functional, lightweight, and easy to build and adjust.

**Michigan State University**
***Team Members*** (left to right)

**Sydney Bush**
Fowlerville, Michigan

**Corey Smith**
Portland, Michigan

**Abigail Yager**
Riverside, Illinois

**Brenna Marsin**
Harper Woods, Michigan

**Jordyn Porter**
Park Ridge, Illinois

**MSU Bikes Service Center**
***Project Sponsors***

**Ben Hogan**
Saginaw, Michigan

**Bill McConnell**
East Lansing, Michigan

**Tim Potter**
East Lansing, Michigan

**ME Faculty Advisor**

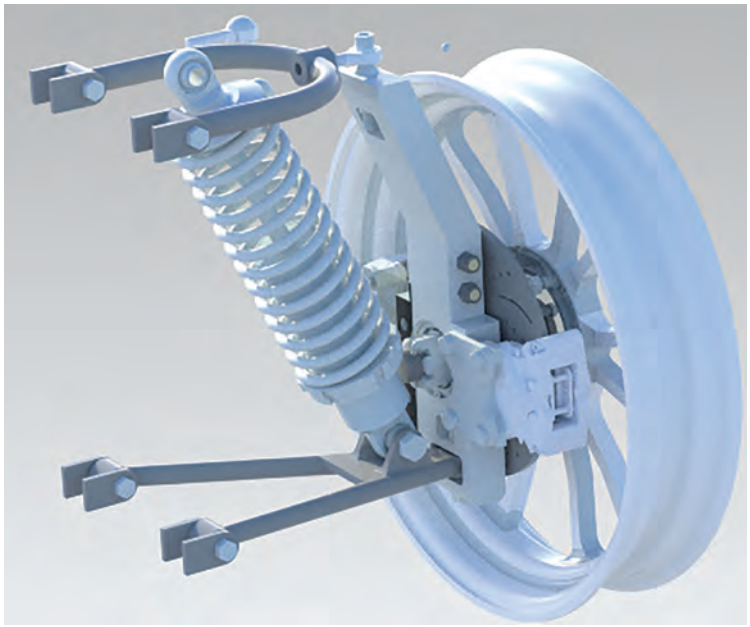
**Dr. Lik Chuan Lee**

# MSU Solar Racing Team

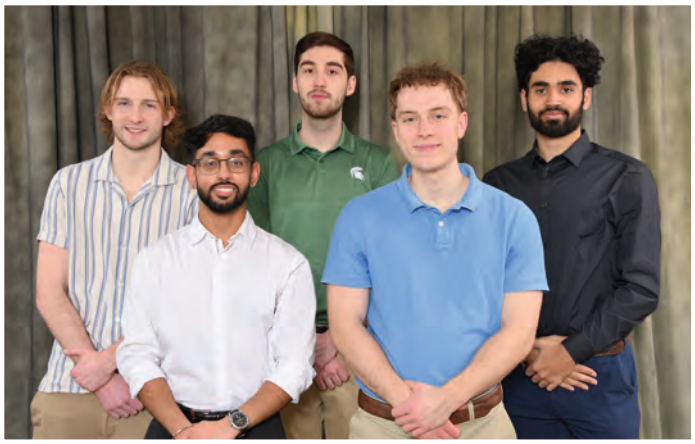
## Solar Car 3-Wheel Suspension Creation

The Michigan State University Solar Racing Team is a student-led engineering team focused on creating solar-powered race cars from scratch. Through the team, young engineers gain experience by engineering an automobile. Students design, assemble, and manufacture parts through the use of welding, milling, lathing, and other techniques, resulting in unique experiences gained by applying knowledge from their engineering courses to real-world issues. Their first solar-powered vehicle was created in 2010, and they have produced six new models since, including the most recent one called "Cynisca." This car is set to compete in the Single Occupant Vehicle class at the Formula Sun Grand Prix later this year.

This project is an exploration for the next iteration, a new three-wheel suspension setup that mainly focuses on the design of the single rear wheel suspension containing the hub motor. The suspension previously consisted of a double wishbone set of control arms on all four wheels, where the arms regulated the motion of the wheels and a coilover connected the lower control arm to the chassis to absorb bumps and improve handling. With the new single rear wheel suspension, the vehicle's weight, cost of manufacturing, and packaging space were all expected to decrease. Meanwhile, ease of machinability, handling, and reliability are expected to increase as a result of using fewer than half as many parts. This all contributes towards creating a more efficiently run and sustainably produced car.



MSU SOLAR RACING TEAM



### Michigan State University

***Team Members*** (left to right)

**Robert Stowe**
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**Manbir Chadha**
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**Egemen Keskin**
Izmir, Turkey

**Connor Whitaker**
Macomb, Michigan

**Jash Modi**
Ahmedabad, India

### MSU Solar Racing Team

***Project Sponsor***

**Rachel Schneck**
East Lansing, Michigan

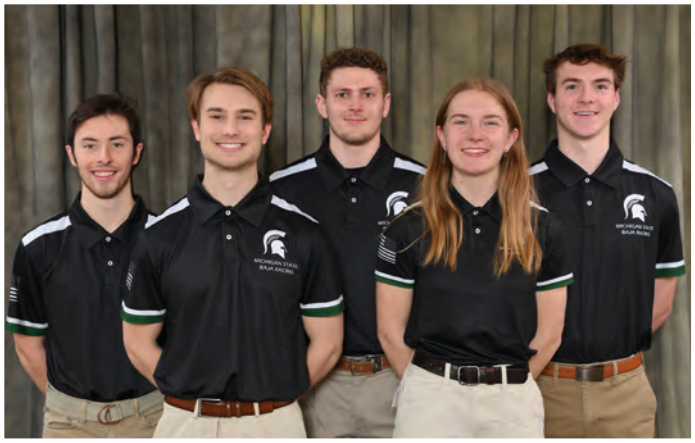
### ME Faculty Advisor

**Dr. Brian Feeny**

# General Motors
## MSU Baja Multi-Disc Basket Clutch

Founded in 1908, General Motors (GM) is a major American automotive company based in Detroit, Michigan. As one of the world's largest car manufacturers, GM produces a diverse range of vehicles under popular brands like Chevrolet, GMC, Cadillac, and Buick. With a strong global footprint, the company offers everything from electric vehicles to trucks and SUVs. In recent years, GM has increasingly focused on advancing electric vehicle technology, autonomous driving, and sustainability efforts by positioning itself at the forefront of the future of transportation. Additionally, GM has made significant investments in technology and innovation, including partnerships in the development of self-driving vehicles and smart mobility solutions. The company also places a strong emphasis on corporate social responsibility, aiming to reduce its environmental impact while enhancing the safety and efficiency of its products.

Our team designed and manufactured a multi-disc basket clutch system for Michigan State University's Baja vehicle which is a critical component commonly used in off-road vehicles. The clutch features a pack of multiple friction discs and steel plates that engage and disengage to transfer power from the engine to the front wheels, offering rapid disconnection when needed. This system not only enables the vehicle to always be in the optimal drivetrain configuration for varying terrain but also limits the forces through the chain powering the front wheels, reducing wear on key components. By providing quick, efficient power management, our design enhances both performance and durability, ensuring that the Baja vehicle can adapt to any given scenario with minimal mechanical stress.

### Michigan State University
***Team Members*** (left to right)

**Max Fried**
Farmington Hills, Michigan

**Elijah Carey**
Hemlock, Michigan

**Kody Simmons**
Midland, Michigan

**Kylie Keller**
Kentwood, Michigan

**Gabe Guter**
Gaylord, Michigan

### General Motors
***Project Sponsors***

**Evan Boyers**
Detroit, Michigan

**Thomas Dionne**
Detroit, Michigan

### ME Faculty Advisor
**Dr. Ahmed Naguib**

# MSU Baja Racing

## Design and Manufacture of Custom Brake Calipers

Baja SAE is a student-led competition where teams design, build, and test a single-seat, all-terrain vehicle. Students on the MSU Baja Racing team gain hands-on experience ranging from engineering and design to testing and competition, with students working together to meet the competition's rules. Since the 1970s, MSU Baja Racing students have dedicated long hours in both the machining shop and computer labs to develop innovative vehicles. Every year, the team travels to global competitions where over 80 teams compete in various challenges with their custom vehicles.

The goal of this project was to research, design, test, and manufacture custom brake calipers for the next MSU Baja car, while maintaining or improving braking power and packaging while also reducing the size, weight, and cost of the calipers. Prior to this project, the MSU Baja Racing team used the Wilwood PS1 Caliper. The PS1 is a lightweight, compact brake caliper made from cast aluminum with two stainless steel deep cup pistons, internal fluid passages, and a low-profile design. Despite these advantages, the size, weight, and packaging of the Wilwood PS1 Calipers cannot be customized, making them undesirable for MSU Baja. Given the extreme use case of these calipers (racing), the custom calipers were designed for easy serviceability, enabling quick replacement of the brake pad. Reliability was a top priority, as faulty brakes pose significant safety risks. Designing and manufacturing custom calipers from CNC-milled aluminum addressed these issues and achieved improvements.

State BAJA RACING

**Michigan State University**
***Team Members*** (left to right)

**Sydney Agius**
Grosse Pointe, Michigan

**Justin Tyack**
Rochester, Michigan

**Elizabeth Grant**
Northville, Michigan

**Robert Crouse**
Brighton, Michigan

**Matthew Osborn**
Milan, Michigan

**MSU Baja Racing**
***Project Sponsor***

**Phil Hill**
East Lansing, Michigan

**ME Faculty Advisor**

**Dr. Neil Wright**

# Design Day Awards Fall 2024

## ME 481 Edison Award for Best Capstone Design Project

The Edison Undergraduate Design Award is given to the ME 481 Design Team that is judged to have produced the best technical design project.

**Team Michigan AgrAbility:**
Rolling Kneeler Cart with Chest Strap

Left to right: Ryan Harth, Jack Darrow, Connor Mackenzie, Hannah Crist, Kaden Swierkos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## ME 481 Best Capstone Project Presentation Award

The ME 481 Project Presentation Award for the best presentation of a design project.

**Team MSU Department of Theatre:**
Portable Wood Strength Tester

Left to right: Deyuan Wang, Aaron Dawson, Ava Shumaker, Chris DeFinis, Miko Parkinson (not pictured)


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## ME 470 da Vinci Award (Best Mechanical Design)

The Leonardo da Vinci Award was presented to the team with the best machine design.

Left to right: Max Fried, Elizabeth Grant, Joshua Picciano, Kennedy Kullman, Kody Simmons

# NOTES

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