MICHIGAN STATE UNIVERSITY COLLEGE OF ENGINEERING **FALL 2024**

DESIGN DAY

MICHIGAN STATE UNIVERSITY

Anthropocene Institute

Executive Patron Sponsor

Anthropocene Institute Congratulates MSU Design Day Participants

The Anthropocene Institute is honored to once again access Michigan State University's skills for projects we consider critical for Earth's comfort and stability. MSU ranks very high in relevancy and efficiency. It's both broad, deep, and diverse intellectually and culturally. While many academics get lost in the weeds of arcana, at MSU, controlling the weeds both literally and figuratively, is a matter of pride.

In addressing critical infrastructure and supply chain decisions, engineers' expertise is vital, whether the focus is on national security, climate change, or public health and prosperity. It is essential that we cultivate awareness of emerging technologies and their potential benefits. We need most, what business people like to call "stuff that does not even exist."

Ever since human beings learned to control fire and cook, our external digestive system has forced us to continue improving our technology. There is no standing still. Today we don't need to combust anything — new nuclear and renewables can meet all our energy needs. When the energy industry says "We can't afford that. It's too cheap!", not enough of us organize and push back. Ending combustion air pollution also will prevent about 1/6th of all human deaths.

Engineering provides the mindset necessary to tackle our most pressing existential challenges. Yet, the voices of engineers must be amplified in conversations about the future of our society. While we have made strides in including diverse ethnic and cultural voices among stakeholders, it is also crucial to ensure that engineers and scientists have the leading role in policy decisions that shape our resources and environment. The influence of lawyers is disproportionate. Administrative law judges often re-litigate based on pleadings from powerful lawyers, overruling reality-based solutions from engineering and science.

Lawyers excel at preventing negative outcomes, bankers at scaling profitable solutions, and governments at redistributing wealth. However, it is engineers who specialize in creating new wealth through innovation and technology. We can foster a more peaceful and equitable world by making energy more affordable, and we must unite to advocate for this vital change.

We can live without war and revolution resulting from declining economic prospects. One of the most progressive things we can do for people is make energy cheaper. Note there isn't an advocacy organization for that, and the energy industry resists it. Engineers must demand our seat at the table, to envision and build solutions that new technology makes possible.

Ever since I was a kid, I have appreciated MSU's engineering acumen, demonstrated at the annual Engineering Open House. My father Dr. Carl V. Page helped found the MSU Department of Computer Science. He was a provocative scholar exploring AI long before it worked well, grappling with philosophy of thought. What is logic? How do we model reality? Who and what learns or adapts? He inspired many to learn to build a better world.

Today's engineers need to make Spaceship Earth shipshape. How stable and comfortable can we afford to make it? How many redundant life support systems do we need for a safety margin, given everyone is on the same boat?

An exponential problem demands an exponential solution. What absorbs CO2 and methane and grows exponentially? Ocean plankton is one! Let's find out if we can nudge that along by carefully evaluating the potential with the best science and learn how to responsibly control it.

Misguided world governments attempt to mitigate the worst consequences of a foreseeable climate disaster. Some advocate for "sustainability", but you can't sustain a collapse! The fearful call for a slowdown: "Stop the world, I want to get off!" **The brave find ways to change direction, and accelerate.**

Temperature records, broken year after year, show that it's too late for net-zero. Instead net-negative tools must be built in the time available. Thanks to your work we will clearly analyze and share one powerful but complex new tool in this effort. That way we may reduce humanity's footprint on nature without demanding unpopular sacrifices of quality of life. Cheaper clean energy can generate new wealth and prosperity, and help decouple our industrial material needs from Earth's complex ecosystems.

Why argue over which prophecies to believe about Earth's future habitability? Instead build a working thermostat to keep our Spaceship Earth comfortable and beautiful even if we fail to understand everything.

Congratulations on your successes and accomplishments to date. Keep moving forward, focus on abundance rather than austerity and big problems, like climate and prosperity, over little ones. Your Design Day projects showcase that you are up to the task.

Sincerely,

Carl B. Page
President, Anthropocene Institute

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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 70 capstone teams and 600 seniors from all 10 of the College's academic programs.

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

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

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 pm 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

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Anthropocene Institute

Design Day Events Schedule:
Friday, December 6, 2024

EVENTS	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	Noon	1 p.m.
Engineering Student Organizations		1st Floor Lobby 8:00 a.m. – Noon					
ME 412 Competition		1st Floor Room 1252 8:00 a.m. - 11:45 a.m.					
ME 470 Competition		1st Floor Room 1345 8:00 a.m. - 11:45 a.m.					

CAPSTONE COURSES							
CSE Posters		3rd Floor 3200/3300 Hallway 8:00 a.m. - Noon					
ECE Posters		2nd Floor 2300 Hallway 8:00 a.m. - Noon					
ME Posters		1st Floor 1200/1300 Hallway 8:00 a.m. - Noon					
CE 495 Project Presentations		3rd Floor Rooms 3400 & 3540 8:00 a.m. - Noon					
ECE 480 Project Presentations	2nd Floor Room 2320 7:00 a.m. - 12:40 p.m.						
ME 481 Project Presentations		1st Floor Rooms 1202, 1220 & 1300 8:00 a.m. - 11:30					

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

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

To stay up to date w/Careers in Engineering:
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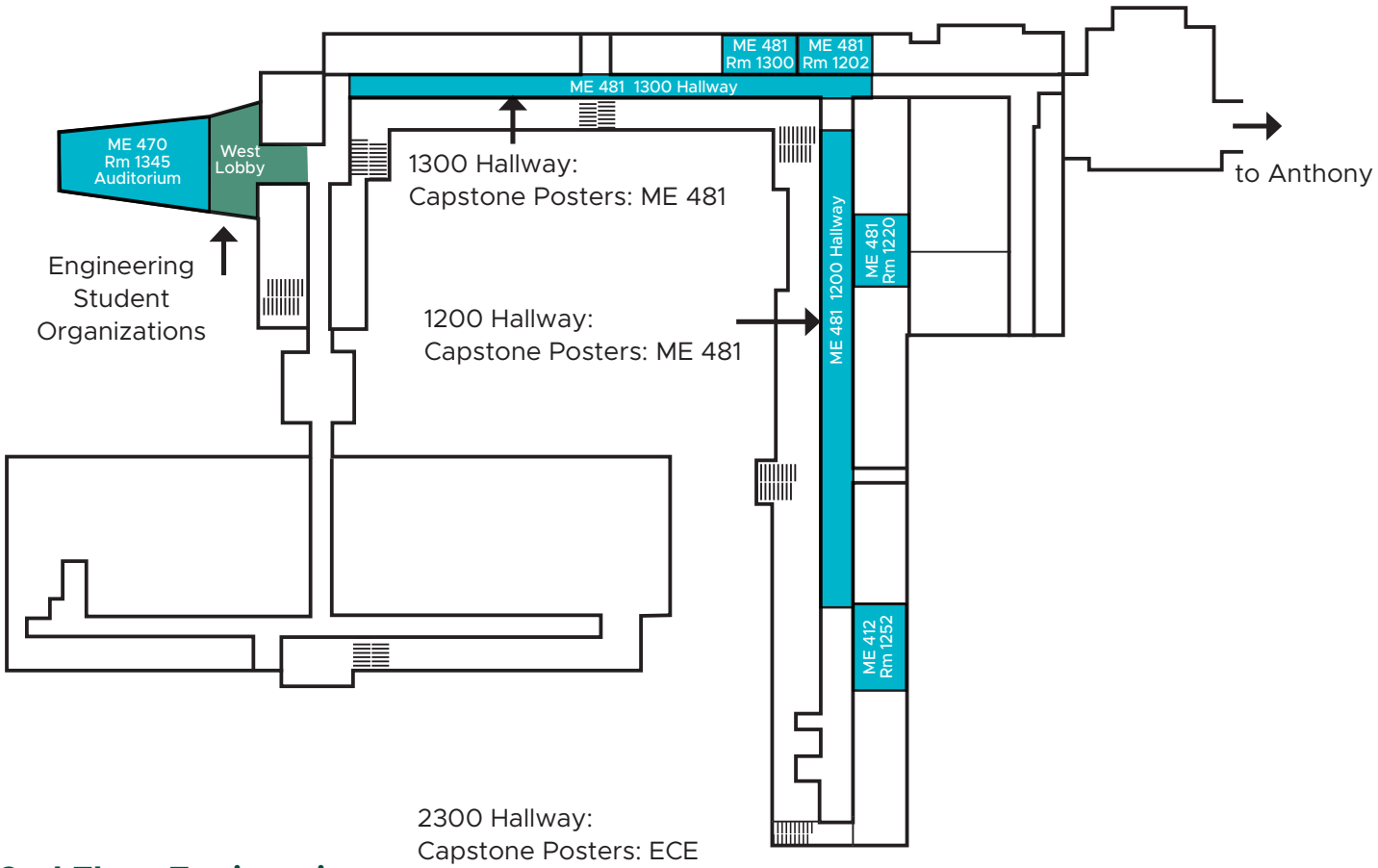
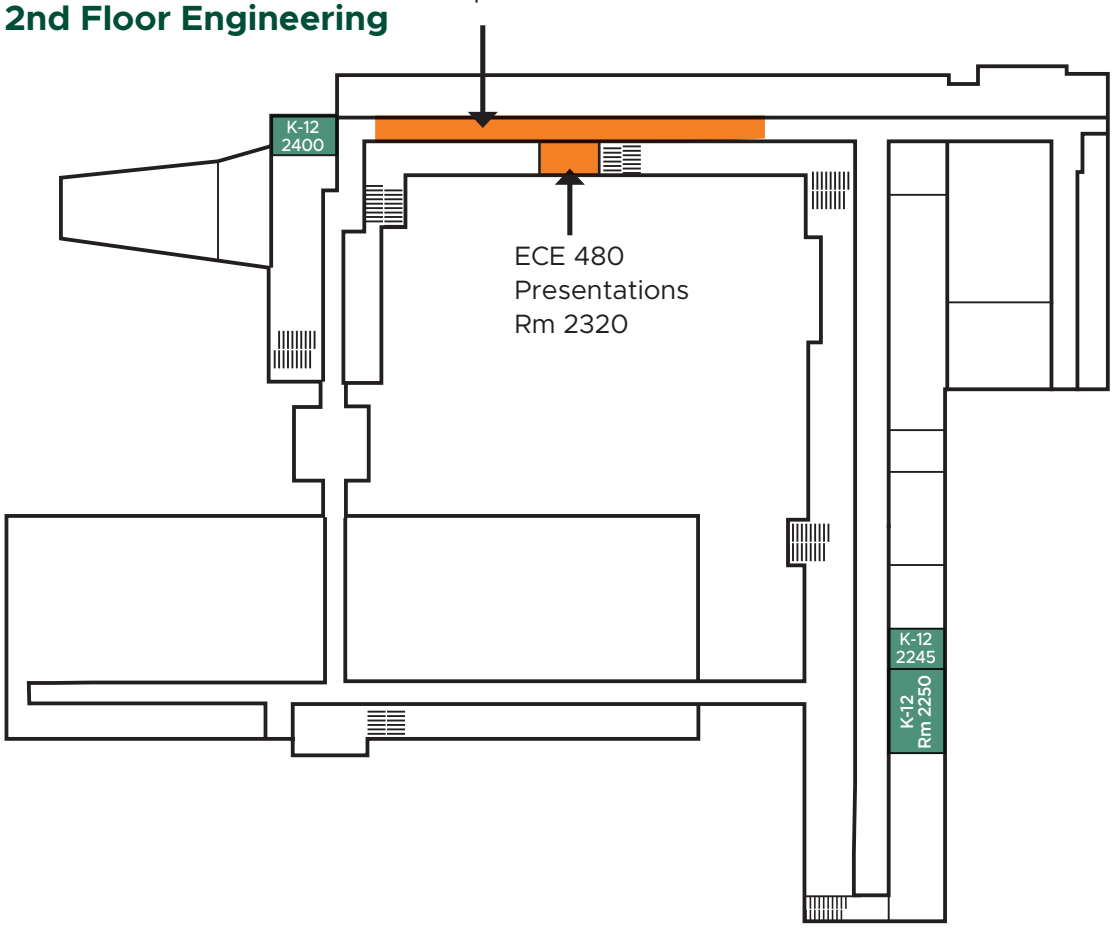
1st Floor Engineering



2nd Floor Engineering

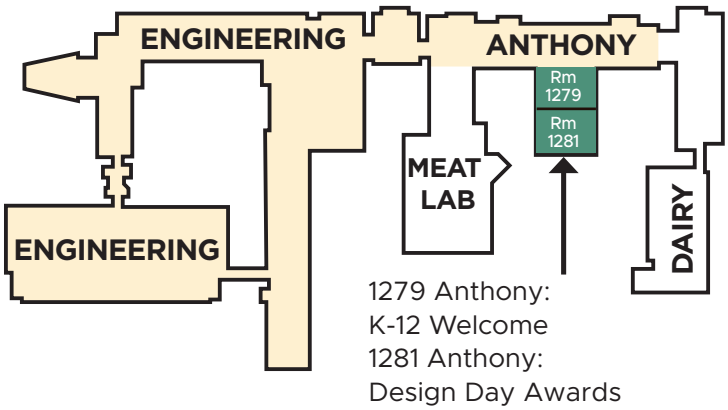


Overview

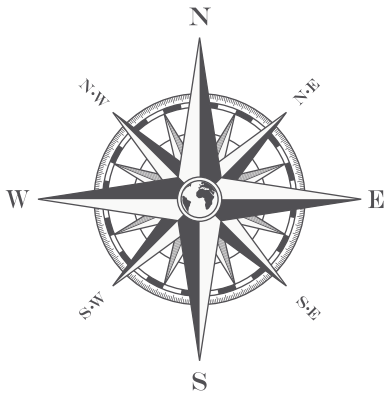
Color Legend:

- CE
- CSE
- ME
- ECE
- Joint/Other

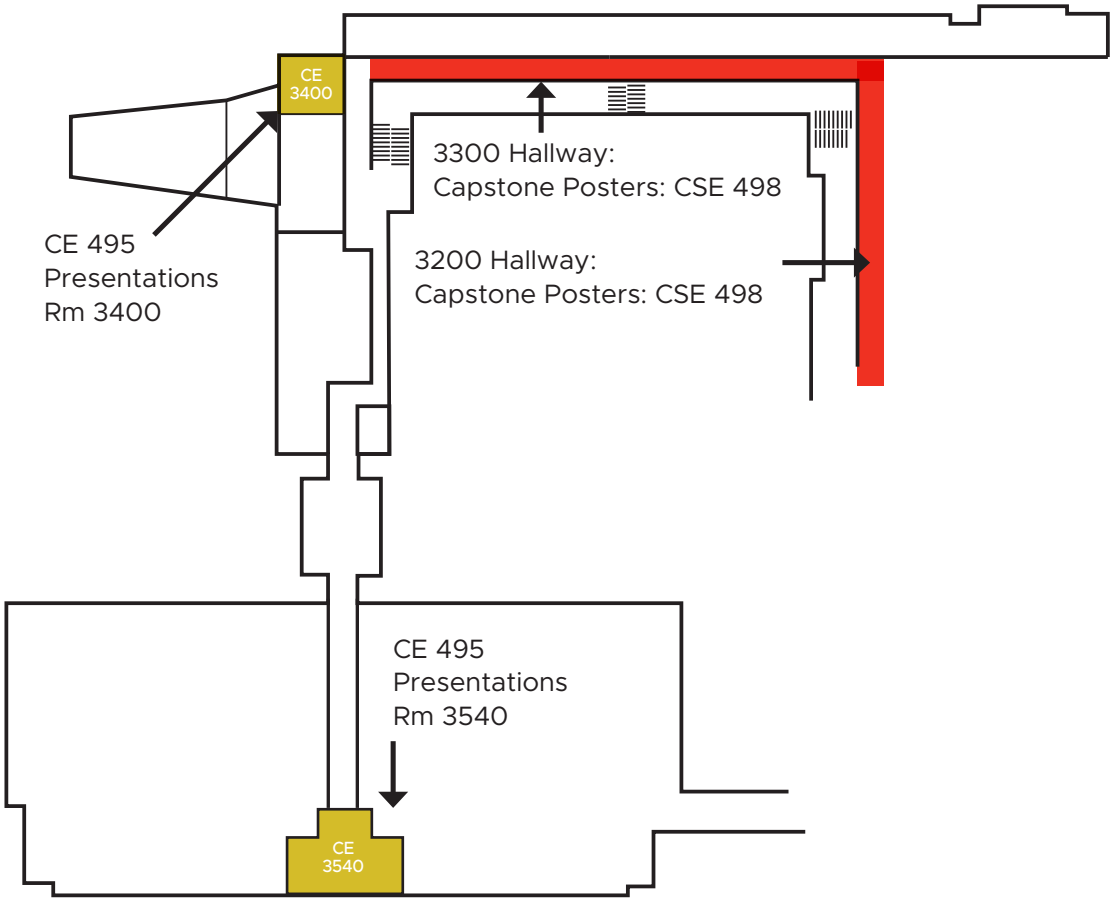
Design Day Floor Plans of the MSU Engineering Building



1279 Anthony:
K-12 Welcome
1281 Anthony:
Design Day Awards



3rd Floor Engineering



High School Innovation & Creativity Day

The following schools and groups will be participating in this Fall's Design Day events: East Lansing High School (ELHS), Innovation Central High School (ICHS), Oakland Schools Technical Campus Northwest (OSTC), and Women in Engineering (WIE).

Magna International is one of the world's largest suppliers in the automotive space and a proud sponsor of MSU's Design Day High School Innovation & Creativity Day.

MAGNA

	1279 Anthony Hall Auditorium: Check-in for all schools	K'NEX Bridge Team Build Room 2250	VEX Robotics Room 2400	Project Viewing	LED Labyrinth Competition Room 2245
8:00–8:15	Check in for all schools				
8:15–8:30	Welcome & procedures – Drew Kim, Assistant to Dean, and Luis Donado, Assistant Director				
8:40–9:30		ELHS	OSTC	ICHS	WIE
9:35–10:20		OSTC	ICHS	WIE	ELHS
10:25-11:10		ICHS	WIE	ELHS	OSTC
11:15-12:00		WIE	ELHS	OSTC	ICHS
12:15–12:30	Awards Ceremony, 1345 Engineering Building				

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MEMBERS OF THE ORGANIZING COMMITTEE FOR HIGH SCHOOL INNOVATION & CREATIVITY DAY FALL 2024

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

Sabrina Auden
K-12 Outreach

Dean Buggia
Instructor and Technology Teacher, Okemos High School

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

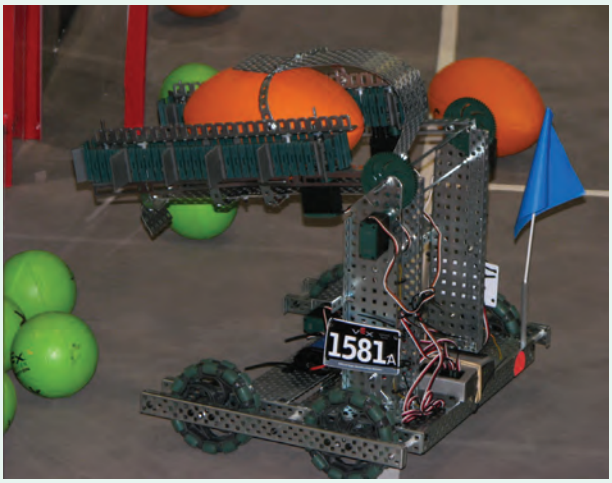
Pahoua Nguyen
Logistics Coordinator/ Office Manager

Bige Unluturk
Assistant Professor, Electrical and Computer Engineering

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

VEX ROBOTICS

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



INTERDISCIPLINARY ENGINEERING BUILD

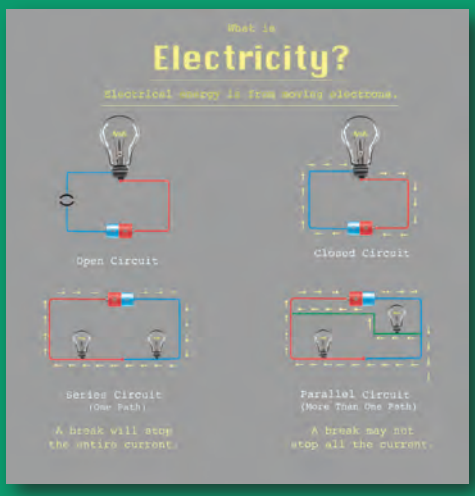
In this build you and your team will be integrating practices from multiple fields of engineering to build and evaluate a support system. Support systems can range from simple beams to intricate bridges composed of gussets, trusses, cables, etc. These types of systems are used throughout Civil, Mechanical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

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

LED LABYRINTH COMPETITION

The circuit activity at Design Day provides students with an opportunity to manipulate the path of the electrical current in a circuit by switches. Using basic principles of circuits and parallel/ series connection concepts, student groups will turn on and off switches to direct current in a premade electrical circuit with LEDs indicating each active branch.

Since an LED allows the current to pass through in only one direction, students should identify the different paths they create by activating different branches, which might be connected in series or in parallel. The event will be scored by how many LEDs can be turned on without breaking the closed circuit.



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

The Work

Challenging, Growth-centric Atmosphere

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

Your Career

Investing in Development

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

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

The Capstone Projects

Dr. Anthony Ingle
Teaching Specialist

Faculty Advisors: Professors Engle, Haider, Hashsham, Ingle, Kumar, Kutay, Li


Engle


Haider


Hashsham


Ingle


Kumar


Kutay


Li

Presentation Schedule Room 3400

Time	Team	Room 3400
8:00 a.m.	Team 3 - Great Lakes Strategies	Third Floor Room 3400
9:20 a.m.	Team 4 - Red Cedar Design Group	Third Floor Room 3400
10:40 a.m.	Team 5 - MoTown Design & Engineering	Third Floor Room 3400

Presentation Schedule Room 3540

Time	Team	Room 3540
8:00 a.m.	Team 1 - Spartan Civil Innovations	Third Floor Room 3540
9:20 a.m.	Team 2 - Red Cedar Engineering Group	Third Floor Room 3540

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 design and construction teams to better understand the project. This included a site visit in early September, soon after construction of the foundation system was initiated.

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 are not 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 spots and enabling 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.

Architectural rendering of the new building looking north.

CEE students tour the construction site during caisson installation.

HENRY FORD HEALTH + MICHIGAN STATE UNIVERSITY Health Sciences

Team 1: Spartan Civil Innovations

Left to right: Arik Marvin (S), Gabriel Bialek (H), Noah Long (G), Matthew Thelen (PM), Rudy Zelich (T), Armando Ramirez (P), Olivia Portner (E)

Team 2: Red Cedar Engineering Group

Left to right: Shane Williams (S), Reese Worden (G), Dane Herczeg (T), Daniel Gubrud (E), Reegan Kelly (H), Ricardo Ochoa (P), Owen Woods (PM)

Team 3: Great Lakes Strategies

Left to right: Malia Huss (G), Dylan Strawn (PM), Ian Schaffer (P), Jeryn Farr (S), Ibrahim Huwio (T), Taylor Siitari (E), Allison Kelly (H)

Team 4: Red Cedar Design Group

Left to right: Micah Bouman (H), Nicole Hengesbach (S), Isle Roggenbuck (P), Michael Burns (E), Masha Kochubievsky (PM), Abbygail Shuster (G), Hoky Ngoulla (T)

Team 5: MoTown Design & Engineering

Left to right: Logan Phillips (G), Chloé DuBois (H), Terry Harris (P), Alyssa Magyar (PM), Drew Bohl (S), Ralph Aguilar (T), Caiden Hughey (E)

KEY TO TEAM ROLES

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

CE 495 SENIOR DESIGN IN CIVIL & ENVIRONMENTAL ENGINEERING

PROFESSIONAL SEMINAR SPEAKERS

Talia Bellil, P.E.
Michigan Department of Transportation

Michele Buckler, P.E.
Diamler Automotive Group

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

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

Steve Minton, P.E.
Michigan Department of Transportation

Leanne Panduren, P.E.
Rowe Professional Services

Robert Rayl, P.E.
Clark Dietz, Inc.

Chuck Rolfe, P.E.
OHM Advisors

Kristen Schuster, P.E.
Michigan Department of Transportation

Dan Thome, P.E.
Nicholson Construction

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

PROFESSIONAL EVALUATORS

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

Juan Alcantar, P.E.
Michigan Dept. of Transportation

Michele Buckler, P.E.
Diamler Automotive Group

Dan Christian, P.E.
Tetra Tech MPS

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

Jordan Doddie, P.E.
HNTB

Andrew Dykstra, P.E.
Barr Engineering Co.

Jason Early, P.E.
HNTB

David Hayden, P.E.
DLZ

Cole Moody, P.E.
HNTB

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

Lauren Roller, P.E.
Harley Ellis Devereaux

Brandon Simon, P.E.
Progressive AE

Steve Sorensen, P.E.
PEA Group

Michael Thelen, P.E.
Consumers Energy

Design Day Awards Spring 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, Thompson, Carr & Huber, Inc. (FTC&H) and Barr Engineering Co.

Rolla C. Carpenter Senior Design Award Winners, Spring 2024

Team 6: Spartan Associates

Left to right: Dana LeFevre, Colin Edwards, Sarah George, Andrew Carter, Olivia Hagan, Ryan Soto, Laura Hershauer

Computer Science and Engineering

Capstone Course Sponsors

We thank the following companies for their generous support.

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Detroit, Michigan

VECTRA
San Jose, California

Auburn Hills, Michigan

Whirlpool
Benton Harbor, Michigan

WK Kellogg Co
Battle Creek, Michigan

The Capstone Projects

Dr. Wayne Dyksen
Professor of Computer Science and Engineering

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CSE 498 Collaborative Design

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

During the capstone experience, students

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

Our clients are local, regional, and national including Ally Financial, Amazon, Anthropocene Institute, Auto-Owners Insurance, Bosch, Dow Chemical, General Motors, Google, HAP, Henry Ford Innovations, Kohl's, Launch, Magna, Meijer, Microsoft, Mozilla, MSU Federal Credit Union, Roosevelt Innovations, RPM, Stryker, TechSmith, Union Pacific, United Airlines, Urban Science, Vectra AI, Volkswagen, Whirlpool, and WK Kellogg Co.

AbbVie
Image Analysis Tool for Biphasic Solutions

Headquartered in North Chicago, Illinois, AbbVie is a Fortune 500 biopharmaceutical company dedicated to advancing healthcare through innovative research and the development of lifesaving treatments.

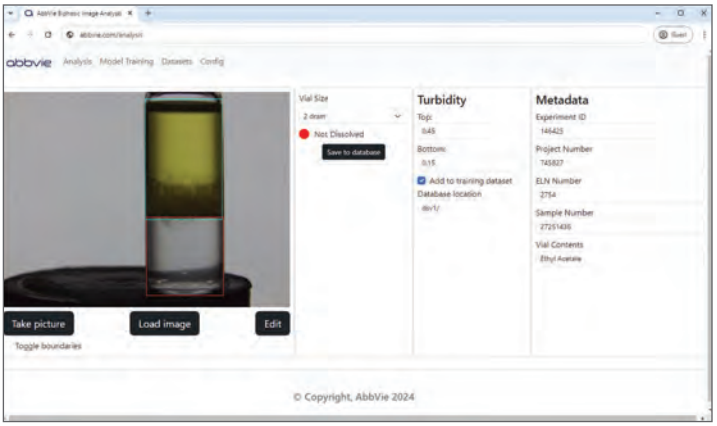
AbbVie researchers often work with special liquids that separate into two layers, called biphasic solutions. Measuring properties of biphasic solutions, such as phase boundaries (where two layers meet) and how layers are blended, is a manual process that limits high-throughput experimentation. The time this process takes inhibits AbbVie's mission of providing quality healthcare.

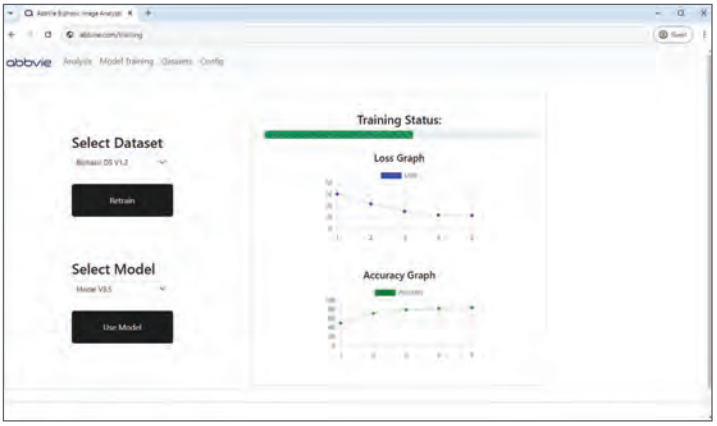
Our Image Analysis Tool automates this process by using a deep learning model to acquire metrics from images of biphasic solutions that AbbVie's chemists need to make critical decisions. First, a robotic arm positions each vial for the camera, capturing high-resolution images which are then processed by the model. Solution properties are located and displayed to the user for quick and accurate insights into the composition of the biphasic solution. Chemists save the image with its associated information, such as sample number or the chemicals used.

Our software also includes a model training feature, enabling researchers to adapt the model to specific chemicals and environments. This ensures that the model is as robust as possible, leading to the most precise and realistic results.

To support the model training feature, the application also supports the saving of images to a database. This enables users to create new datasets that can be used to train models. It also enables users to revert the software to use previous versions of the model depending on the current use scenario.

Flask, a Python webserver, constructs the back-end interface which applies the model to the acquired data. The front-end framework, Angular, enables users to view model results with ease.





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Ally Financial
Agentic Collaborator

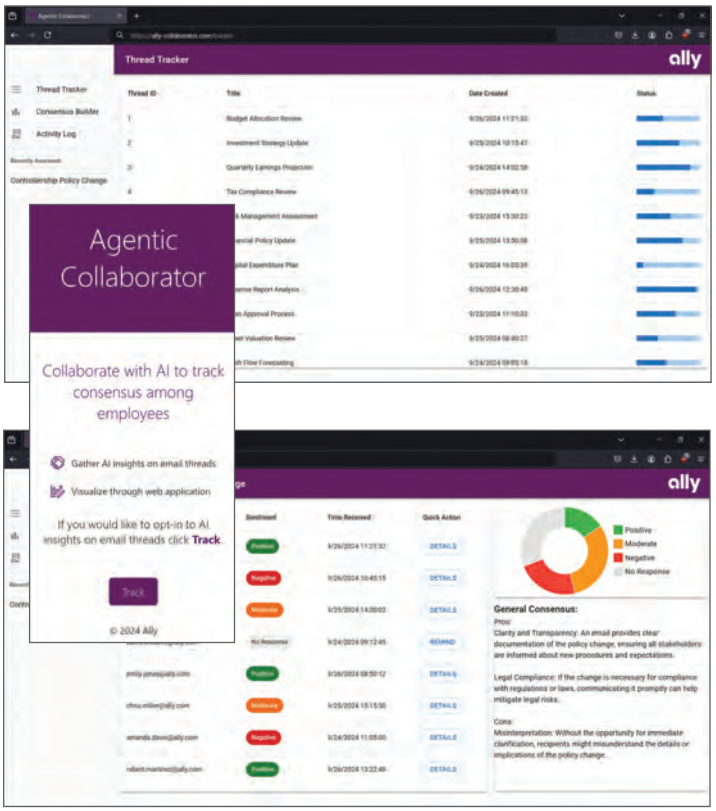
Ally Financial, headquartered in Detroit, Michigan is a leading entity in the U.S. financial services industry, known for its focus on digital banking and auto financing. The company serves approximately 11 million customers through a full range of online banking services. Being the nation's largest online-only bank, Ally is at the forefront of revolutionizing financial interactions through technology.

Ally Financial employees handle hundreds of emails daily using Microsoft Outlook, but large threads with multiple collaborators make it difficult to track employee sentiment. The process of analyzing email responses is time-consuming, as employees must sift through large email chains to ensure nothing is overlooked. Hence, there is a growing need for technological solutions that can streamline this process, saving employees time and energy.

Our Agentic Collaborator is an artificial intelligence-powered solution created to enhance sentiment analysis and improve decision-making for Ally projects. The collaborator enables employees to monitor multiple decisions simultaneously, providing an overview of stakeholder responses in an easy-to-read dashboard.

Ally internal users are provided with an Outlook widget to flag email chains for monitoring. A summary of the thread responses is displayed on the web application where users can track the sentiment of email chains and who has responded. Quick actions, such as sending reminders to non-responsive stakeholders and opening email instances, make it easier to track project progress.

Our software utilizes a Microsoft Outlook add-in and a web application to deliver a powerful email analysis tool. The back end is built with Python, PostgreSQL, LangChain, and the OpenAI API for parsing and summarizing emails. The front end is developed using React, supported by a Node.js environment. Python Flask is used to handle data exchange between endpoints.



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Amazon

Remediating AWS Security Gaps Using Generative AI

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

As more users continue to use Amazon Web Services (AWS), they encounter challenges in configuring and monitoring their account's security. Due to the platform's complexity and broad range of services, it is imperative that users acquire a deep understanding of Amazon's security features.

Currently, when an AWS user reviews their account security, they run a security scanning tool named Prowler. This tool generates a file with thousands of lines detailing security assessments they have passed or failed. Many users find this file difficult to understand.

Our Remediating AWS Security Gaps Using Generative AI tool streamlines the process of identifying, tracking, and fixing security issues through our interactive web application.

To use our application, users simply upload their file generated from Prowler. When users upload this report, machine learning models trained on hundreds of AWS security blogs and documentation generate easy-to-understand instructions. These instructions can be sorted by factors such as cost or danger so users can prioritize their vulnerabilities. Users also are given a security rating that provides the percentage of security vulnerabilities they have secured.

By leveraging these powerful AWS services, our tool provides users with an efficient, intuitive, and easy way to enhance their account security, ensuring peace of mind as they navigate the cloud.

Our web application is responsive due to a robust set of features provided by AWS. The front end is hosted on AWS Amplify, whilst back-end requests are managed by API Gateway, Lambda and S3.

amazon

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Anthropocene Institute
Ocean Carbon Pollution Cleanup

The Anthropocene Institute is an organization based in California, whose goal is to solve the climate crisis by 2030. They promote education about the climate, connect experts with entrepreneurs and policymakers, and invest in technologies to make the Earth abundant and sustainable for future generations.

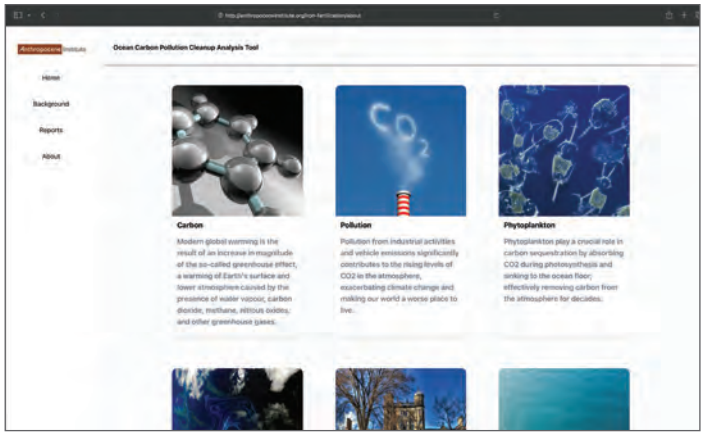
Removing excess carbon dioxide from the atmosphere is a crucial part of solving the climate crisis. Consequently, our client is partnering with the Grandparents Fund for Climate Restoration to design an ocean iron fertilization experiment. The experiment involves dispersing iron in the water to stimulate phytoplankton growth which sequesters carbon. Plankton growth is monitored by sensors mounted on ocean buoys. Usage of these sensors can be very expensive, so it is imperative that sensor locations are optimized to provide maximum ocean coverage with minimal cost.

Our Ocean Carbon Pollution Cleanup software models various buoy configurations to compare their effectiveness. Our software gives suggestions about how many sensors are required and which sensor layouts are best for recording adequate data during the experiment without going over budget.

Most existing datasets only contain a single buoy, which poses a problem for our system. To model multiple buoys from this data, older compatible datasets are combined and newer datasets are extrapolated using complex statistical methods to get estimated sensor readings for the entire experimental area.

Our software highlights the benefits of this carbon sequestration technique by visualizing the positive experimental outcomes.

The software features an appealing user interface built with the React framework. It connects to a FastAPI back end that retrieves data from a PostgreSQL database. This data is used to generate buoy configurations and create descriptive visualizations using Chart.js.



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Auto-Owners Insurance
From the Ground Up VR

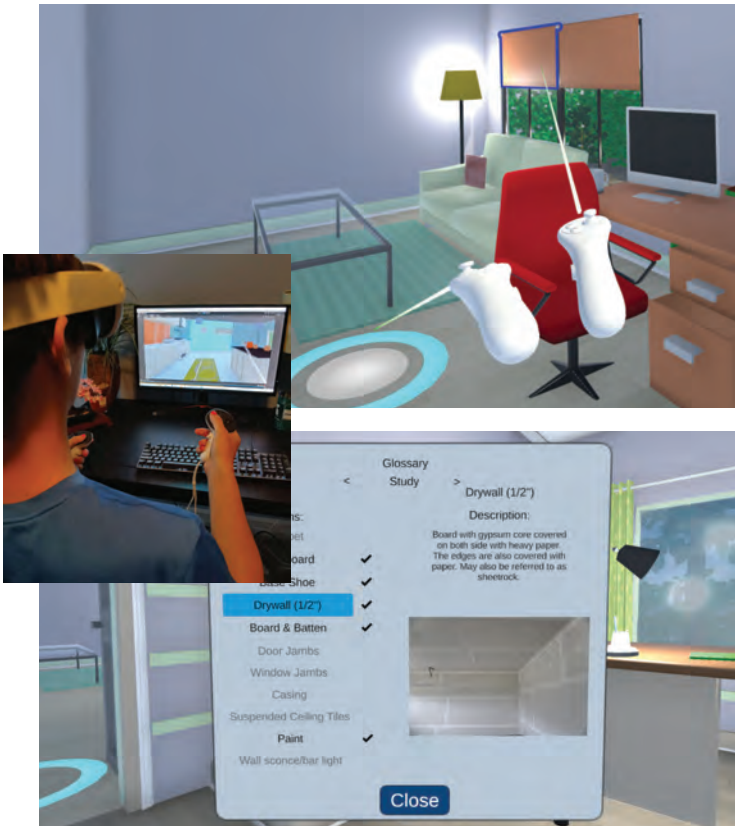
Auto-Owners Insurance is a Fortune 500 company that provides automotive, home, life, and commercial insurance to nearly 3 million policyholders in 26 states. They have been headquartered in Lansing, Michigan since 1917, and are represented by 48,000 licensed agents.

In the insurance world, training new associates is a process that can take a lot of time and manpower. There are many details about insurance that are important for employees to know. Traditional training practices are informative but lack hands-on experience and can be unengaging.

From the Ground Up VR provides an enhanced training experience through a virtual reality video game, creating a new way for property claims associates to learn and engage with Auto-Owners' policy. This software accelerates and personalizes the training process by enabling associates to navigate educational content at their own pace without the need for a human teacher.

Our software places users into a realistic virtual reality house. Associates navigate through the home and are tasked with discovering and identifying common building materials that are integrated into the environment. As the user finds items, information about relevant Auto-Owners insurance policies is displayed. After materials are collected, the game then asks the associate to use those materials to construct a home. Through these objectives, associates experience the process of building a home while also learning the basics of insurance, resulting in an informed and well-rounded employee.

The Unity game engine is used to model and represent the virtual environment. The game logic is implemented in C#, providing functionality and interactivity. The Meta Quest 3 VR headset is used by the player to access the virtual reality environment.



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DRIVEN-4
DRIVEN-4 Connect Application

DRIVEN-4 is a technology consulting firm based out of St. Joseph, Michigan. The firm's network of over 100 engineers and global partners drive solutions that have delivered over $50 million in business impact since 2017. Primary service offerings include product lifecycle management (PLM), connected product development (IoT), connected operations (IIoT) and cybersecurity.

The company's latest innovation, a programmable logic controller (PLC) known as the DRIVEN-4 Connect Module, enables customers to create customizable data streams. However, this data can take several forms, presenting a challenge as DRIVEN-4 strives to provide comprehensive services to all client needs.

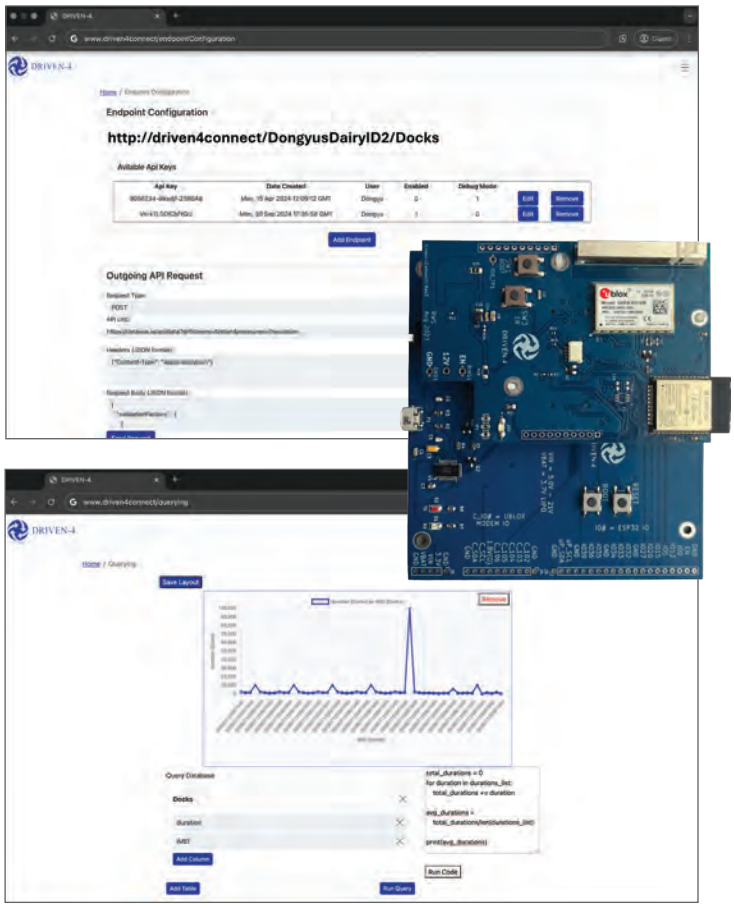
Our DRIVEN-4 Connect Application enables users to interact with their data streams from the Connect Module in a fast and easy manner. Users can manipulate data workflows and automate trivial processing stages for data analysis with only a few clicks.

Users first establish data storage capabilities by creating and editing project specifications on the web application's data modifications tab. This creates a custom database for the user.

Once a database is created, the system automatically transmits the relevant data to the database to be stored for further use.

Clients query, relay, manipulate, visualize and derive insights from collected data. The data analysis and querying pages of the Connect Application display all available databases and associated tables. Clients select desired data sources and create custom scripted instructions on how to analyze relevant information. DRIVEN-4 also provides common scripts to make client data analysis easy, along with tutorial resources to ease onboarding.

The DRIVEN-4 Connect Application is powered by the Flask framework. Data is hosted in a MySQL database and accessed via SQLAlchemy. The analysis is conducted using Python scripts.



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General Motors
Recycling Identification System

General Motors (GM) is a multinational car manufacturer headquartered in Detroit, Michigan. They are at the forefront of innovation when it comes to car manufacturing as well as being industry leaders in sustainability.

To recycle plastics in their facilities, GM must identify what type of plastic has been discarded. While this can be easier for standardized plastics used in the production line, miscellaneous plastics that are not as easily identifiable are often thrown away. GM requires a quick way to identify these miscellaneous plastics.

Our Recycling Identification System provides an improved method for managing plastics and reducing waste by ensuring accurate identification, preventing improper disposal.

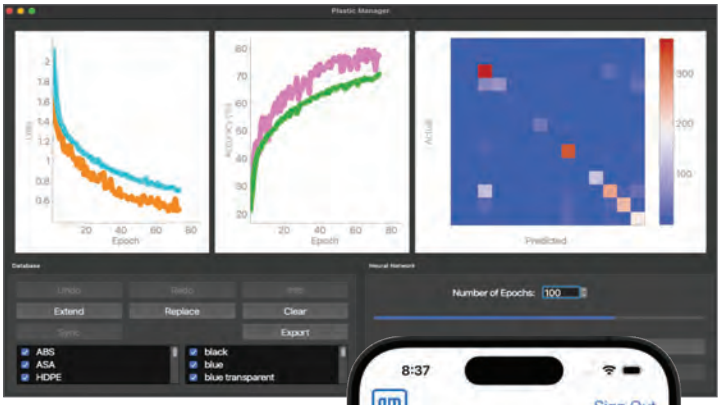
When an unidentified plastic is encountered, the plastic scanner swiftly identifies the material by scanning it and displaying the result on a connected smartphone.

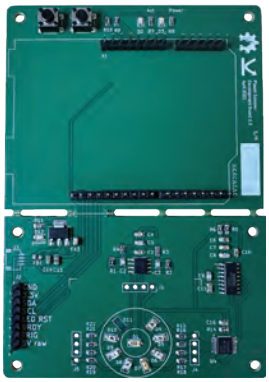
Once the plastic is confirmed, the user places it in the appropriate bin. Additionally, the app tracks all previously scanned plastics, providing a convenient reference to the correct recycling bins.

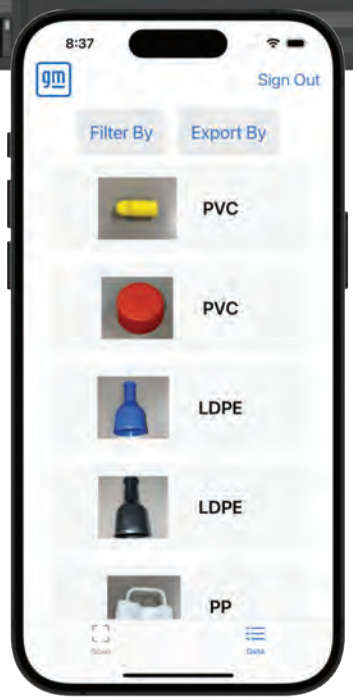
Admins can train the model further whenever new plastic types are introduced in the facilities. This ensures accuracy is maintained when an employee is scanning unknown plastics in the bins. Composite plastics are supported seamlessly and automatically with our robust model.

Our system quickly and accurately identifies plastics for efficient recycling, reducing waste and carbon footprint.

Our Recycling Identification System is built with a handheld scanner integrated with an Arduino microcontroller. The scanner utilizes a feed-forward neural network, and the mobile app, developed using React Native, uses a SQL database to save and display the plastic data.







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General Motors
Remote Wildlife Habitat Monitoring System

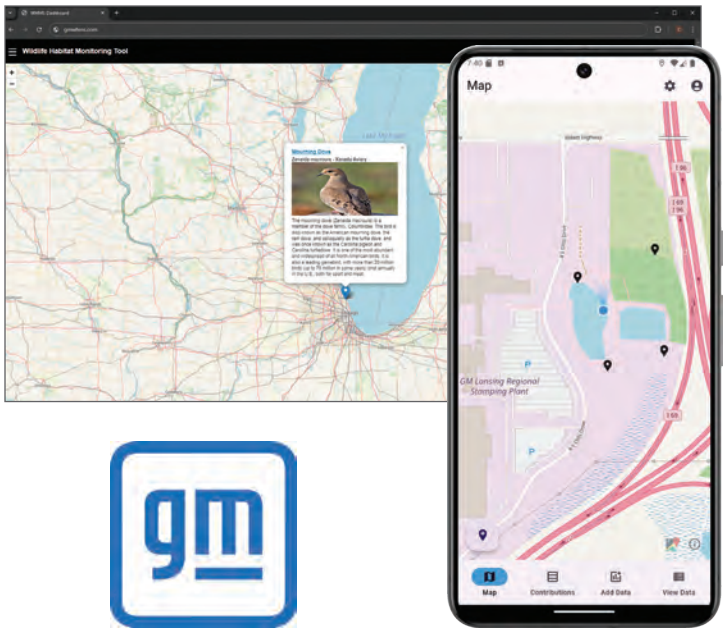
General Motors (GM) is a leading automotive company headquartered in Detroit, Michigan. GM produces and markets well-known vehicle brands including Buick, Chevrolet, GMC, and Cadillac. With many bold and innovative initiatives, including global carbon neutrality by 2040, GM is dedicated to sustainability and environmental protection for all.

GM has established 17 wildlife habitat facilities across the U.S., each spanning many acres. These habitats serve as sanctuaries for local wildlife, especially species of concern. Monitoring habitats and collecting wildlife data is essential for general analysis and habitat certification but it is very time-consuming for environmental engineers, diverting them from their other duties.

Our Remote Wildlife Habitat Monitoring System enables GM employees to access and analyze wildlife data directly from their computers and mobile devices. The system centralizes existing biodiversity data, automatically collecting real-time data using existing GM monitoring hardware and cloud-based data storage. Data is presented in an easy-to-understand format through graphs and charts for comprehensive analysis.

The system also includes an interactive map where users can record, share, and view wildlife sightings, updating the database in real time. This feature fosters a collaborative approach to habitat monitoring, making it simpler and more efficient for experts and laypeople alike.

The Habitat Monitoring System is comprised of a web application developed using Flask, which leverages Python on the back end and HTML, CSS and JavaScript on the front end. It is also available as a mobile application for both Android and iOS platforms, developed using Flutter for optimal cross-platform performance. MongoDB, hosted on a Linux server, supports the database needs of both the web and mobile applications.



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HAP
Healthcare Payer Price Transparency

HAP is a Detroit-based healthcare insurer that strives to offer quality healthcare plans and innovation to their customers. With a workforce of more than 1,000 employees, HAP provides insurance solutions for just over 400,000 members across Michigan with 50,000 healthcare provider partners.

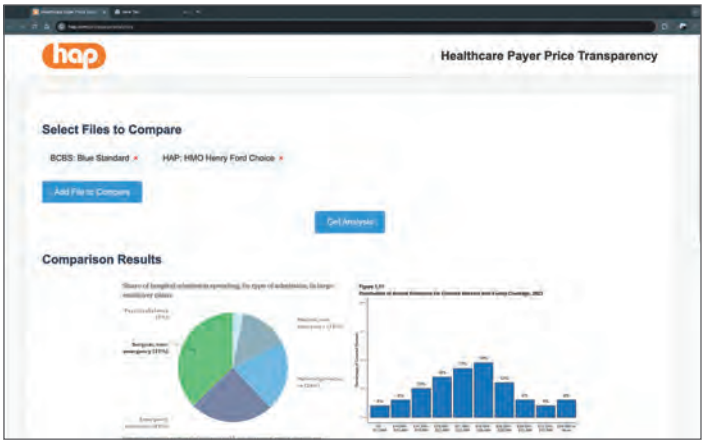
Modern healthcare providers face a competitive field. Since 2021, the Centers for Medicare and Medicaid Services has required healthcare and health insurance companies to publish their rates in standardized, machine-readable files. With this, large amounts of previously unknown data are now being published to the public, which creates a new avenue for data analysis.

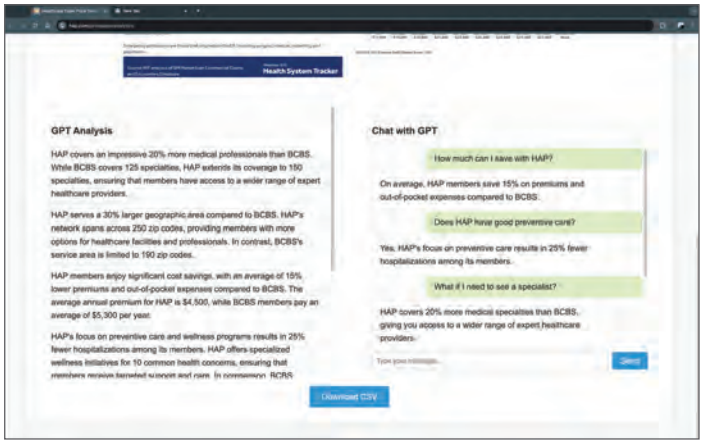
Our Healthcare Payer Price Transparency tool uses these machine-readable files to provide business insights that were previously difficult to assess. The application leverages modern artificial intelligence with big data analysis to draw conclusions about healthcare plans such as plan coverage, covered providers, and costs to both the company and customer.

The Healthcare Payer Price Transparency web application stores files that contain information about healthcare rates from both HAP and external competitors. Users select which files they are interested in analyzing and have the option of uploading new files. The application reads the files and creates data visualizations that make it easy for the user to draw conclusions.

If the user has further questions about the files or data, they can begin a conversation with our AI chatbot that provides quick analysis of anything that interests the user.

The front end of the web application is built using industry standard HTML and CSS. For our back end, we leveraged Parquet files to store large quantities of data in smaller pieces. Python is used to manipulate data to produce insights. ChatGPT API is used for generative artificial intelligence.





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Henry Ford Innovations
Modernizing Robotic Surgery Education

Henry Ford Health is one of the nation's largest and most respected healthcare providers located in Detroit, Michigan. At Henry Ford Health, medical professionals and expert researchers collaborate to develop and adopt new healthcare technologies. The partnership made between Henry Ford Health Innovations and Michigan State University advances medical education and improves patient well-being.

Many modern surgical techniques involve the use of some robotic components. Modern learners have an advantage in robotic operation due to the proliferation of technology in recent years. Modern students achieve high proficiency in robotic operation faster than previous generations, and therefore the training systems for robotic surgery tools need to be updated.

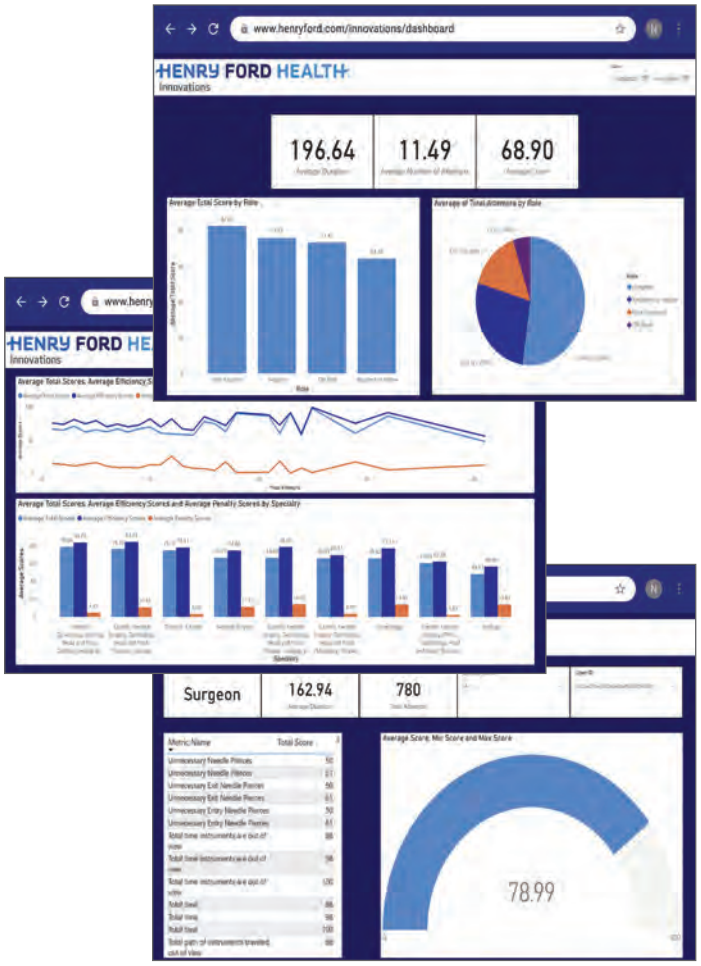
Currently, each completed training run requires a review from an expert-level provider, costing the healthcare system money and costing surgeons time.

Our Modernizing Robotic Surgery Education system reduces how many trials it takes a modern learner to gain expert-level status for each educational task. This reduces training time for learners and saves valuable time for surgeons who review the training.

Using statistical analysis and machine learning technology on robotic surgery training data, our dashboard displays visuals that find the most effective training modules and predict success rates of residents based on metrics collected from the robotic surgery console.

Our system identifies redundancies in the robotic training program, reducing training time and saving money.

Scikit-learn is used to identify the most important metrics that indicate success for surgeons as they complete various training tasks. The dashboard is developed by importing this data into Microsoft PowerBI.



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Henry Ford Innovations

MSU-HFH Research Synergy Vanguard Portal (RSVP)

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 (MSU), HFH bridges the gap between clinical needs and academic expertise across both institutions.

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) solves this by providing a platform that automatically suggests potential collaborators. Our system analyzes user expertise and interests to recommend ideal partners, fostering interdisciplinary connections that might not occur otherwise.

Our portal integrates data from HFH and MSU and enables researchers and clinicians at both institutions to find research collaborators with a simple and intuitive keyword search.

With our profiles connection page, users manage their own detailed profiles, highlighting their expertise, interests and the resources that they have available. This facilitates direct communication, enabling users to connect, share ideas, and initiate collaborative projects seamlessly.

Our system connects MSU and HFH researchers and clinicians, improving collaboration and reducing time spent searching.

Our portal is built using a ReactJS front end for a dynamic user interface 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.

HENRY FORD HEALTH®
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Kohl's

Governance of Expense in Kohl's Cloud Operations

Kohl's, founded in 1962 by Maxwell Kohl, is a leading omnichannel retailer with over 1,100 stores across 49 states. Offering a wide range of apparel, home goods, and lifestyle products, Kohl's is committed to using cutting-edge technology to enhance customer experiences and optimize its vast operations. As part of this effort, Kohl's leverages the Google Cloud Platform (GCP) to manage over 7,000 cloud-based projects.

Despite GCP's powerful infrastructure, the scale and complexity of Kohl's operations poses challenges in monitoring costs, managing resources, and ensuring overall cloud efficiency. Existing tools are not equipped to handle the high volume and complexity of data, which makes it difficult for Kohl's to gain real-time insights into their cloud performance.

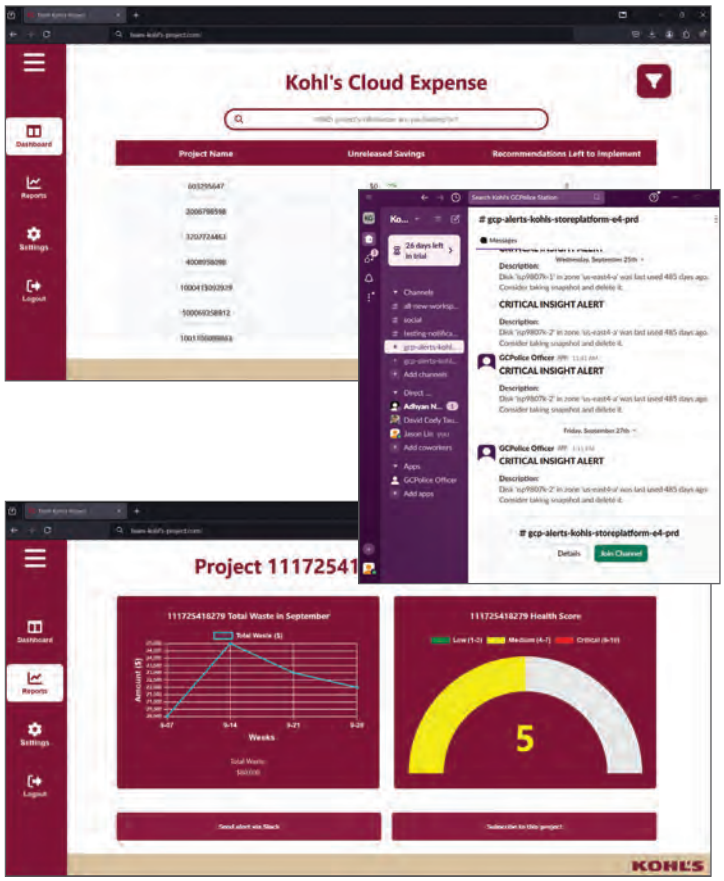
To address these challenges, our Governance of Expense in Kohl's Cloud Operations platform provides real-time monitoring and actionable insights into GCP data.

Our platform provides comprehensive visibility into cloud project expenses, showcasing potential cost-saving opportunities for each. Detailed instructions on how to reduce costs are listed in an easy-to-understand way so users can cut costs effortlessly.

Our software also features visual graphs for historical data, tracking trends in resource usage over time, helping stakeholders identify inefficiencies and optimize cloud operations.

Finally, the platform sends automated alerts to key stakeholders through Slack, helping employees make informed decisions in a timely manner on cost management, resource utilization, and security improvements.

Our system is fully dockerized and hosted on GCP powered by Kubernetes. On the back end, data is pulled from Big Query database and processed through a Python Flask server. This is displayed on the front end via a ReactJS web interface.



KOHL'S

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Launch by NTT DATA
Spatial IoT Control using Apple Vision Pro

Launch by NTT Data is a global digital business that helps their clients to strategize, ship and scale digital experiences. They have developed innovative solutions for brands such as Ford, Epic Games, and Adidas.

As virtual and augmented reality technology matures and becomes more usable, virtual experiences continue to have an ever-increasing role in how we go about our daily lives. As a leader in creating innovative digital experiences, Launch explores how new devices like the Apple Vision Pro can be used to enable users to interact with their environment, specifically to control smart devices in their homes.

To this end, our Spatial IoT Control using Apple Vision Pro is a visionOS and iOS application that controls home appliances like plugs, lights and other appliances through a sleek and seamless interface.

Our software recognizes and tracks devices in the user's view. When a device has been identified, a pop-up appears over it that the user can interact with to change the state of the device. For example, when a smart lamp enters the view of the Vision Pro, a toggle switch view is displayed above the lamp, which turns the lamp on and off when selected.

Our software enables actions involving other smart home appliances using various hand gestures recognizable by the Vision Pro, including sliding, pinching, and twisting.

In addition, IoT devices can be controlled via iPhone using our iOS application, which has the same features and functionality as the visionOS app. This provides more flexibility in how users can control their home appliances.

Both applications are written in Swift. Interaction with tracked objects is enabled through the RealityKit and ARKit frameworks, and devices are controlled via HTTP and MQTT protocols.

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Magna

Offline-Ready Mobile App for Delivery Optimization

Magna International is a leading global automotive supplier, focusing on delivering value to their customers through innovative processes and world class manufacturing. Magna New Mobility wing is committed to solving the complex challenges involved in the development of advanced mobility solutions.

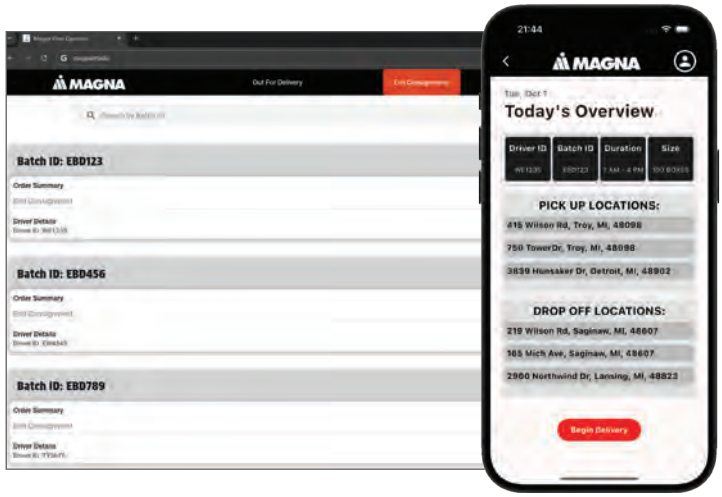
Delivery drivers often face challenges with network connectivity and efficient route planning. This can impact their ability to complete deliveries in a timely manner. Similarly, fleet operators who oversee deliveries need real-time updates into the progress of deliveries to ensure everything runs smoothly.

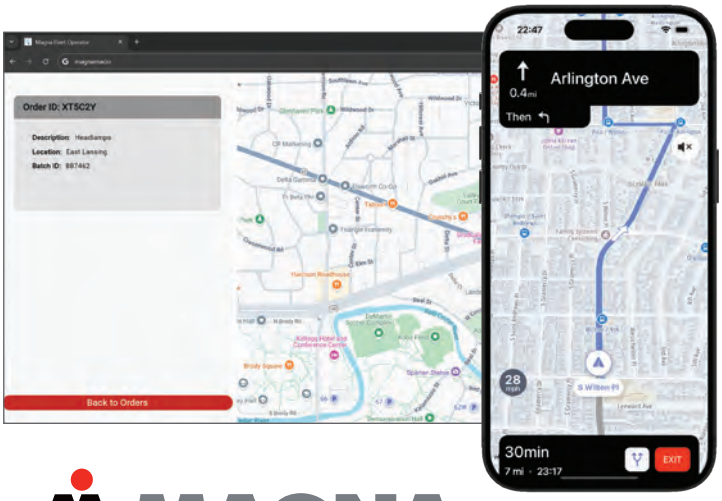
Our Mobile App for Delivery Optimization enhances the efficiency of delivery operations by providing an application that works in areas with poor network connectivity. It optimizes drivers' delivery routes, managing multiple consignments, and tracking their progress in real time. The mobile application leverages artificial intelligence to batch orders based on pickup and drop-off locations, while accommodating for configurable truck sizes.

Our system enables drivers to access the navigation system even if they are not connected to a network, ensuring the delivery process is not hindered by the loss of a network connection.

For fleet operators, the web dashboard provides a comprehensive view of the progress of deliveries. The dashboard displays real-time locations of the drivers and status of each order. This web application offers options for operators to intervene in a delivery if necessary, such as manually editing a consignment.

The front end is implemented in Flutter separately for both mobile and web applications. The back end encompasses route computation using NextBillion.ai and Node.js. Moreover, remote and local data storage is synchronized between both platforms using MongoDB.





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Magna

Test-Driven Development for Embedded Software

Founded in 1957, Magna is a leading global manufacturer in automotive parts, providing innovative products and services to nearly every automaker worldwide. As an industry leader, Magna has significantly advanced vehicle safety and technology through systems such as advanced driver assistance, blind-spot detection, and lane departure warnings.

One of the most innovative areas in the automotive industry today is autonomous driving systems, and Magna is at the forefront of this technology. To ensure the reliability of these systems, it is crucial that vehicles' vision cameras are thoroughly tested.

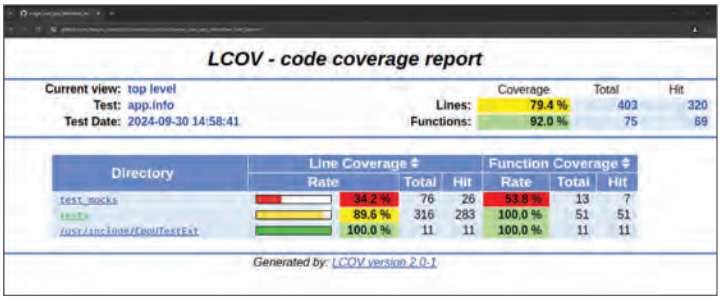
Managing and testing the software behind vision cameras is not an industry standard due to the difficulties of testing hardware dependent code. Regardless, a test-driven approach can avoid critical errors, reduce the time required to diagnose errors, and increase code quality.

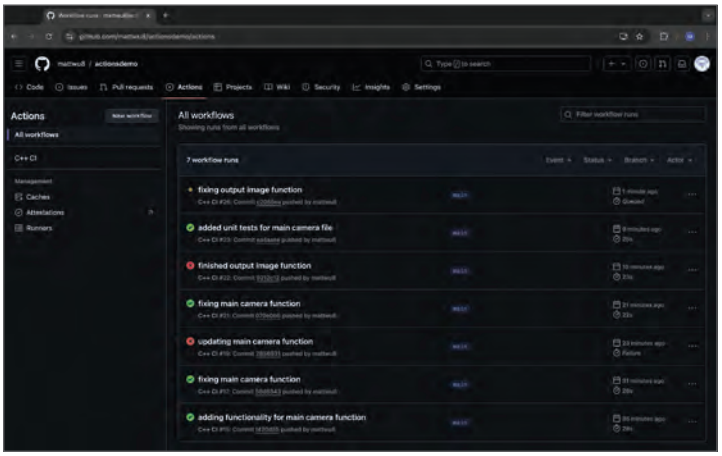
Our Test-Driven Development for Embedded Software platform introduces test-driven development to Magna's existing surround view camera system and creates an automated testing process for a continuous integration and development pipeline.

Whenever a Magna employee publishes code to their GitHub repository, our platform runs a series of tests on the published code. Our tests fully probe the code base for any new errors that may have been introduced. This ensures the updates do not negatively impact other parts of the system.

Users are also able to analyze the percentage of the code tested to ensure that the platform has full coverage of the code base.

The test cases are written in the C++ language, using the CppUTest framework. The code is tested automatically whenever a push is made to GitHub, using the workflow automation platform GitHub Actions. Our workflow also uses LCOV and Python scripts to collect and display test metrics.





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Magna
Visualizing Neural Network Gradients

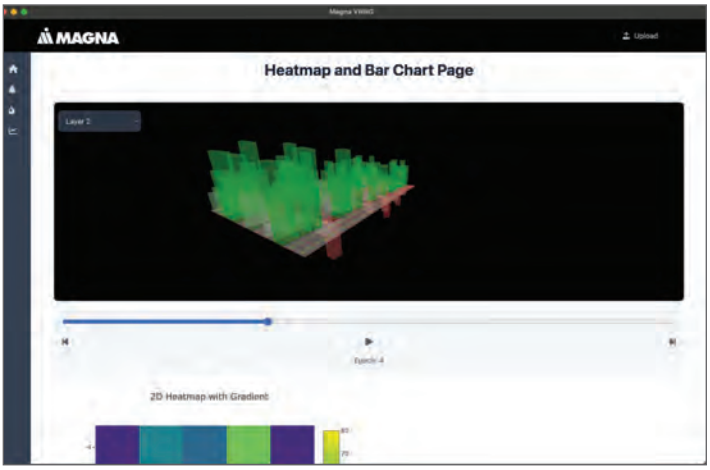
Founded in 1957, Magna has established itself as the largest automotive supplier in North America. With over 60 years of experience supplying components and systems to manufacturers worldwide, Magna is a visionary leader, driving the evolution of the automotive industry.

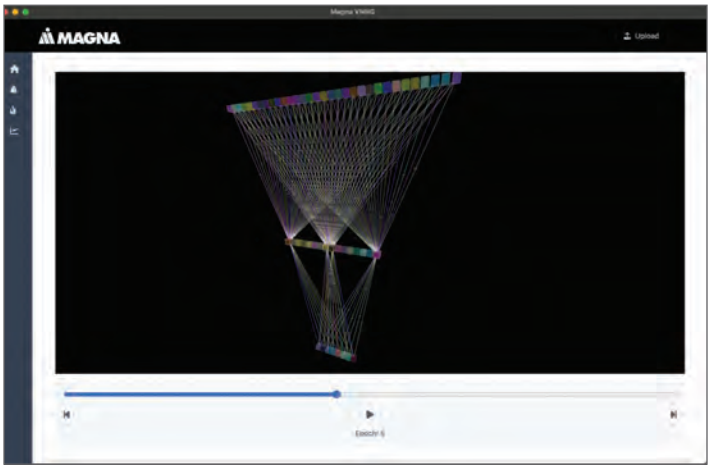
In the ever-evolving world of artificial intelligence, understanding how neural networks learn has been a complex challenge for engineers. Monitoring model performance, diagnosing issues, and optimizing architectures can be a daunting task, especially when working with large-scale networks.

Our Visualizing Neural Network Gradients software solves this problem for Magna, offering an innovative two-part solution: a logger, and a visualization tool. The logger seamlessly integrates into engineers' existing machine learning pipelines, collecting data in real time. The visualization tool offers an interactive interface that provides an intuitive representation of the model's learning process, revolutionizing how engineers analyze their networks, placing an emphasis on convenience and actionable insight.

Our platform provides detailed 2D and 3D visualizations of the neural network structure, with each layer and gradient dynamically visualized to reflect performance metrics like gradient flow and magnitude. Engineers can monitor performance in real time and identify potential issues with the network, such as vanishing or exploding gradients, enabling more efficient troubleshooting and model optimization.

Built using Electron, our platform leverages Three.js for 3D visualization, creating a fully immersive environment. The Python-based logger supports two widely used machine learning frameworks, PyTorch and TensorFlow, recording gradient and network data in HDF5 files that smoothly integrate with the visualization tool for real-time analysis.





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World Feature Generation for ADAS Simulation

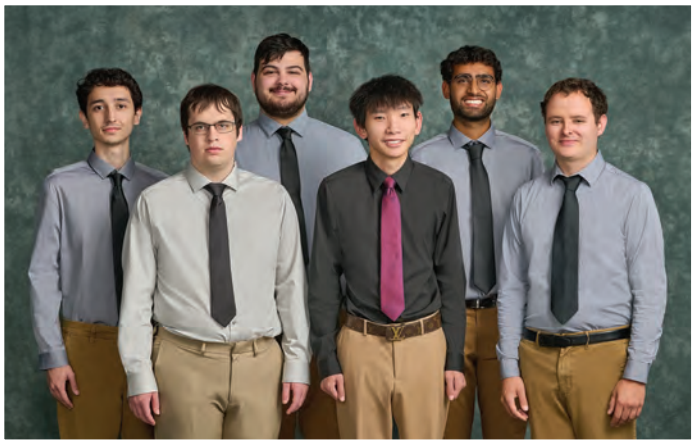
Headquartered in Aurora, Ontario, Magna is one of the world's largest automotive suppliers that designs, develops, and manufactures automotive systems, assemblies and components. Magna provides services for major automakers across vehicle development, engineering, and manufacturing.

Currently, a major focus for Magna is to expand products relevant to self-driving vehicles. Unfortunately, testing these systems is quite difficult. Simulators are often used to ease this difficulty, but these simulations require hand-created environments for virtual vehicles to navigate and take hours to create.

Our World Feature Generation for Advanced Driver Assistance Systems Simulation streamlines the process by procedurally generating environments in Unreal Engine 4. Road layouts are generated from real-world street map data. These are preprocessed to apply modifications such as variable numbers of lanes. They are then imported to Unreal Engine where the maps are created before a postprocess scrubs over them and applies parameters such as weather, debris, and visibility. Individual world features are then randomized with additional parameters. This enables more fine-grained variation, such as a stop sign that has bent due to impact with a car, or a flickering streetlamp.

Our software enables further detailed alterations in an easy-to-access manner through an intuitive UI present in Unreal Engine. This trims down the time and manpower required to simulate edge cases while also enabling minute adjustments. This transforms hours of work into as little as the click of a button.

Our tool utilizes Unreal Engine in cooperation with several other technologies: Carla built from source, a program for importing sensors and actors to test self-driving car software; OpenStreetMap, which provides detailed road data from around the world; and Blender for asset modification.



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Meijer

Increasing Awareness of Meijer-Branded Products

Meijer is a prominent Midwest supercenter chain headquartered in Grand Rapids, Michigan, with over 250 stores across six states. Meijer is committed to offering value and quality through its 18 in-house brands.

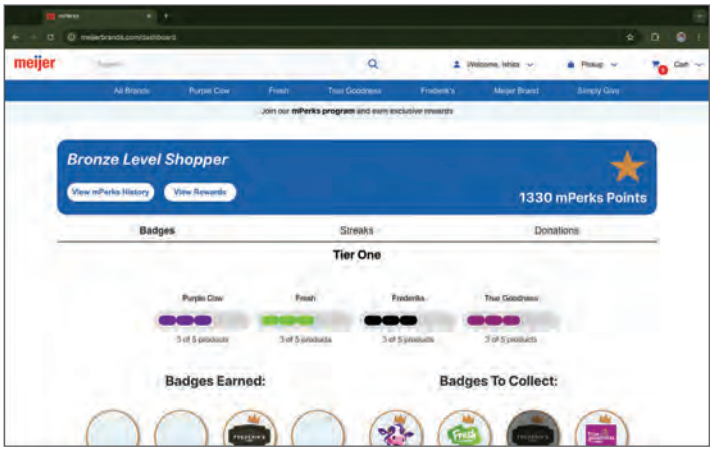
With consumers having several options to choose from when selecting a grocery store, it is important for Meijer to foster their brand and provide incentives for people to continue shopping at their stores. Our project, Increasing Awareness of Meijer-Branded Projects, is a web application that achieves this goal by promoting Meijer-branded products and business practices.

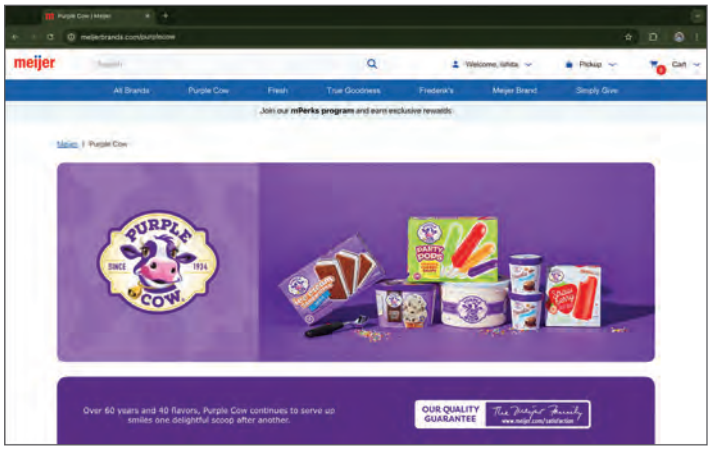
The core of the website is the integration of product purchases and donations. When customers purchase three Meijer-branded products, Meijer donates the value of the highest priced item in the customer's cart to one of the many food pantries it supports through its 'Simply Give' donation program.

The web application also incorporates gamified rewards through the rebranded mPerks program. A personalized mPerks dashboard tracks every customer's order history, rewarding them with coupons as they accrue points and surpass specific point thresholds. Customers earn badges for milestones like 'first timer' for their first purchase and 'century' when their order history exceeds 100 dollars.

The dashboard features two meters: a shopping streak meter that tracks consecutive weeks shopping at Meijer, rewarding the customer with coupons as their streak increases, and a donation impact meter showing total donations made on behalf of the customer's purchases.

The front end of the system used ReactJS. The back end utilizes C# and .NET, while the entire platform is hosted on Microsoft Azure. Data is managed through Microsoft SQL Server, and Power BI dashboards provide real-time analytics for tracking engagement.





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Michigan State University
Robotic Job Coaching

The Department of Computer Science and Engineering (CSE) is one of the largest academic units at Michigan State University. The department is home to 20 laboratories equipped with cutting-edge technologies that enable research in a wide spectrum of topics. The department leverages its impressive research capabilities in collaboration with other departments in areas of robotics, mechatronics, special education, psychology and more.

The CSE department hosts many research professionals from various fields who are collaborating to develop an innovative system for workplace training. Job coaching is a powerful tool for supporting the employment of individuals with disabilities, especially cognitive and behavioral disabilities. Existing methods of job coaching face several issues. On-site job coaching faces limitations because a coach must be physically present.

Our Robotic Job Coaching system solves many problems with modern job coaching techniques. Job coaches can now oversee many clients simultaneously and remotely. Coaches connect in a teleconference call with any one of their clients instantly using a queue system. Importantly, job coaches control a robotic arm to empower better teaching. The arm holds an iPad, which is running our application, and thus the coach can change their view of the work area at will.

Our system extends the influence of job coaches beyond in-person training to efficient remote conferencing. Unlike traditional conference software, our solution gives coaches the ability to manipulate their point of view, increasing effectiveness of coaching.

The front end of our application uses the SwiftUI framework. The back-end server uses the Flask web framework. The application communicates to the back-end server over the WebSocket protocol. The server initiates a peer-to-peer connection over WebRTC between the client and coach users.

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MSU Federal Credit Union
Branch Pickup Lockers

MSU Federal Credit Union (MSUFCU) has been serving Michigan State University and the greater Lansing area for over 84 years. MSUFCU strives to help its local communities thrive and achieve financial freedom.

MSUFCU members are currently restricted by traditional operating hours when they need to pick up essential items such as debit cards or important documents. MSUFCU is looking to introduce a more efficient, self-service solution that provides members with flexibility and convenience.

Our Branch Pickup Lockers system is a mobile application that enhances the customer experience by providing convenient access to banking items outside regular branch hours. Customers can request these items and securely retrieve them at any time using a One Time Passcode (OTP).

Users select the items they need and choose the most convenient branch for pickup through the MSUFCU app. Once the user arrives at the selected branch, they can request a unique six-digit OTP from their app. This code grants immediate access to the locker containing the requested items.

Employees can easily manage requests and unlock lockers through a responsive web application that notifies members when their order is ready to be retrieved.

Members can easily track the status of their order and retrieve items whenever they are ready. This system improves operational efficiency for MSUFCU and offers members flexibility.

The front ends for the web, iOS and Android apps are developed using Vue.js, Swift and Java respectively. These communicate with a back-end API written in Python Flask and store data in a PostgreSQL database. The smart lockers are controlled through a Raspberry Pi, which communicates with the system to manage the locks using 12V relay modules and magnetic locks.

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Roosevelt Innovations

Intelligent Benefits Parser and Knowledge Assistant

Roosevelt Innovations, a subsidiary of Delta Dental of Michigan, develops software for insurance processing. Based in Okemos, Michigan, they support over 23 million customers with their reliable software platforms. With years of experience, Roosevelt helps health and dental insurers streamline group rate calculations and claims processing.

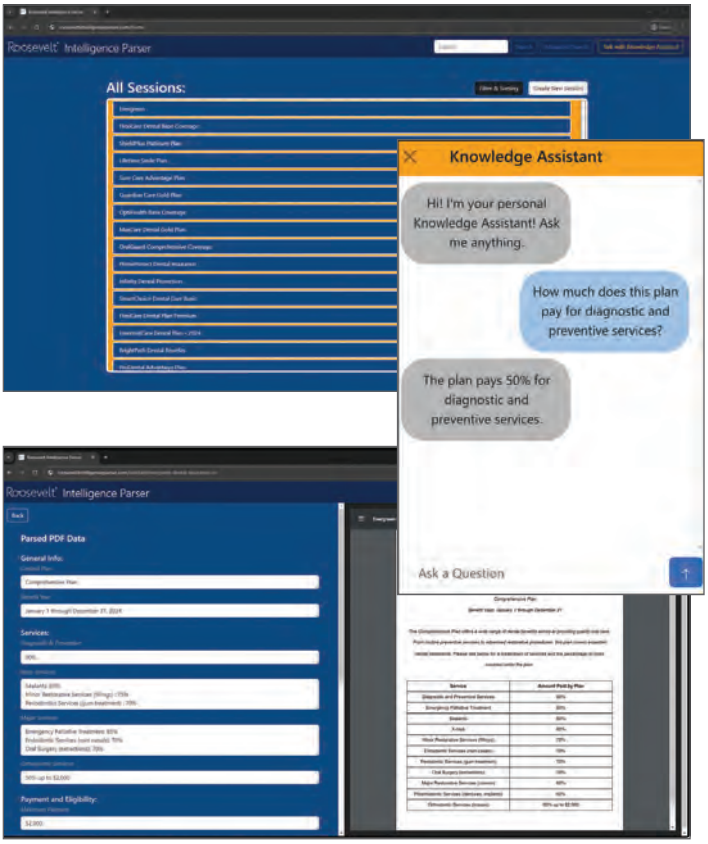
When a new business user transfers data to Roosevelt's applications, they must translate the terminology of their insurance to a standardized format that the Roosevelt platform uses. This is a time-consuming process, since the files containing insurance information are lengthy and differ in formatting depending on the insurance company. During this process, the user often has to read and reference this insurance file multiple times to extract all of the required information.

Our Intelligent Benefits Parser and Knowledge Assistant software solves this problem through a web application that automatically extracts important insurance information from insurance benefit documents.

The extracted information is stored and displayed in fields on a validation page. Users on the validation page review and adjust the data to align with Roosevelt Innovations' standardized format. The software includes storage and organization for many PDFs, enabling users to work within many different sessions.

The application is also equipped with a knowledge assistant chatbot. The knowledge assistant provides relevant, context-specific answers when asked about the content within an insurance document.

Our system's front end is built using the Angular framework. The back end utilizes FastAPI. All data for our application is stored on MongoDB Atlas. The knowledge assistant runs on the OpenAI API.



Roosevelt
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RPM
Automated VIN Integration for RPM Logistics

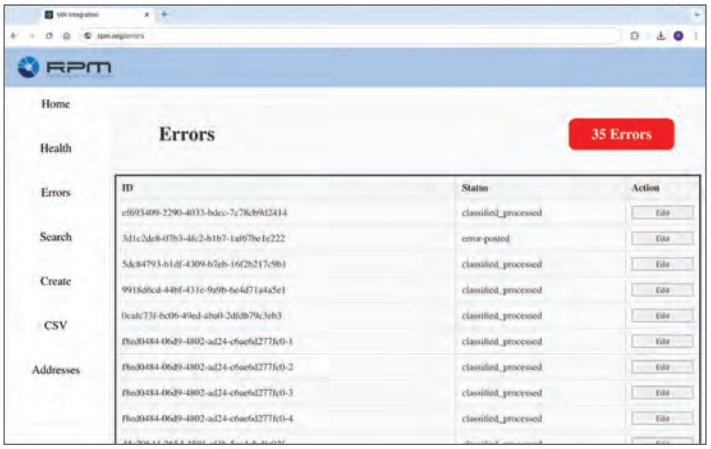
RPM is an international logistics and supply chain solutions company based in Royal Oak, Michigan. RPM specializes in freight transportation and vehicle logistics across North America and Europe. As a non-asset logistics company, RPM invests heavily in modern technologies and automation solutions.

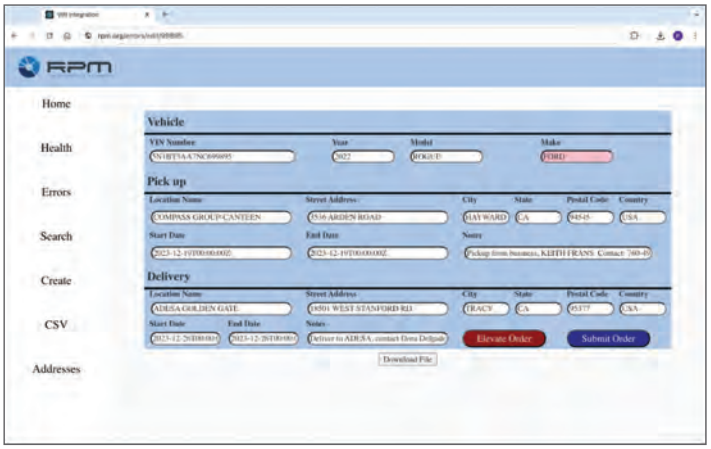
RPM uses an internal whiteboard to display and process orders that come in as email attachments. This is a time-intensive process that requires employees to manually hunt down orders. To reduce human involvement, RPM wants to automate incoming order emails and significantly minimize manually processed orders.

Our Automated VIN Integration Software achieves this by automating vehicle order types processed by email. The software receives incoming email orders, classifies the attachments and extracts details for order creation. Our AI models analyze text and CSV files, providing manual order creation for additional file types. Our software improves error detection by using external tools and common data input patterns for order validation.

The software visualizes order statistics and customized metrics tailored to the customer or specific date ranges, enabling improved customer insight. Brokers can access the software on RPM's internal company apps platform for simple integration into current processes. Our software provides automated support to RPM brokers, minimizing overhead costs and significantly reducing order processing time.

The React front end and Flask back end are containerized using Docker and hosted on Azure hosting services. Our software uses Python and JavaScript, in addition to various Azure services. Utilizing Azure functions and HTTP triggers, the software classifies and uploads documents. OpenAI's API extracts text and returns a structured JSON output. After error checking, the JSON formatted order is posted to the RPM order API from Flask.





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Stryker
Surgical OR Instruments and Needle Tracking

Stryker is a Fortune 500 company that provides world class medical technologies to hospitals worldwide. From surgical equipment to neurotechnology, Stryker impacts over 150 million patients annually across more than 75 countries.

Millions of surgical procedures are performed each year. Throughout each procedure, safety is critical to ensure the best outcome for the patient. The impact of retained surgical items is a major safety concern. Nearly 12 times daily, retained surgical items occur in the USA. Retained surgical items lead to financial strain, malpractice allegations, and threaten a patient's wellbeing.

Our Surgical OR Instruments and Needle Tracking iOS app uses real-time tracking and verification checkpoints to improve accuracy and efficiency of tracking instruments within the operating room (OR).

When opening the app, the surgical operating room schedule is displayed. From there, the user may select a procedure to begin tracking. Once selected, the user is directed to pre-check, where initial scans of surgical tools are taken for automated tracking in addition to manual verification. During active surgery, a live feed and the use state of surgical tools is shown. A final post-check is enabled to verify all instruments and needles are accounted for.

Users view, update, and add surgical procedures with corresponding tool catalogs. If circumstances require, tool catalogs may be updated mid-procedure as well. Status logs from completed operations are also available for audit and analytical purposes.

Our app aligns with Stryker's mission to make healthcare better by saving surgical personnel time, minimizing error and decreasing retained surgical items.

The app's front end uses Swift, SwiftUI and UIKit. CoreML integrates our YOLO model and PyTorch. Node.js and Express.js are used to run the back end. The data is hosted on an Ubuntu Server.

stryker

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TechSmith
Video Insight and Knowledge Interface (VIKI)

Founded in 1987, TechSmith is the global leader in screen recording and screen capture technologies. TechSmith creates software that empowers people to produce extraordinary videos and images. TechSmith's software products, notably Camtasia and Snagit, have over 65 million users across 222 countries.

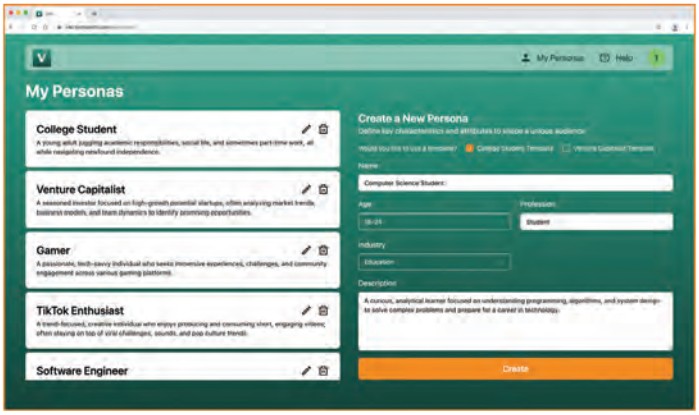
In the modern world of short form content, social media, and hyper-personalized content everywhere, reaching your intended audience is crucial. Unfortunately, tailoring videos for specific audiences is very difficult for beginners. Furthermore, making sure videos are clear, concise, and entertaining is hard without receiving outside opinions. There is currently not much guidance and recommendation built into the editing platforms.

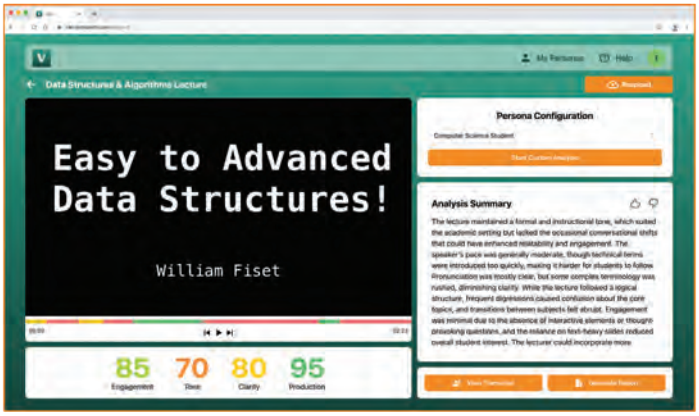
Our Video Insight and Knowledge Interface (VIKI) web application enables video creators to upload videos and receive tailored feedback based on custom AI audience members.

Users create AI reviewers and detail unique characteristics of each persona. For example, a professor uploads a video to VIKI and creates a student persona to give constructive feedback specifically tailored to videos in a university setting. There is no limit to the personas that can be created, ensuring any video can be properly tailored to any audience.

This feedback is based on multiple metrics such as tone, clarity, pace, content, etc. A final engagement score is also provided along with recommendations for improvement. VIKI has an integrated interactive timeline that is segmented into sections, where each section has feedback on the different metrics. This enables users to pinpoint exact moments where their video could be improved.

The front end of VIKI is built using ReactJS while our back end is built with FastAPI. Our web application is hosted using Microsoft Azure. VIKI uses OpenAI and Hugging Face models, and Azure AI Video Indexer to provide feedback.





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Union Pacific
Virtual Reality Inspection Training

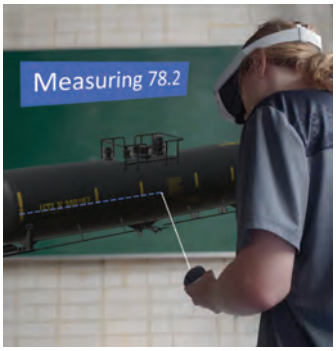
Union Pacific has been building America for more than 160 years. Founded July 1, 1862, they are one of the largest railroad companies in the United States. With over 32,693 miles of track in 23 western states, Union Pacific boasts an impressive lineup of over 7,154 locomotives and a team of over 32,973 employees.

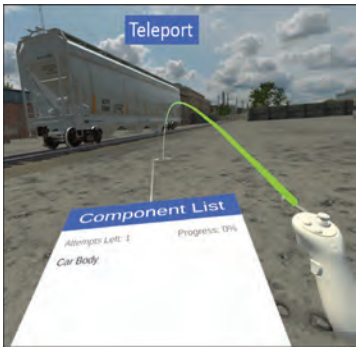
Identifying defective or faulty equipment is a safety-critical task performed by all Union Pacific engineers. However, it is challenging to train employees to perform this task as defective equipment is either repaired or discarded. A remote and easily available solution is needed to train engineers on how to inspect railroad equipment.

Our Virtual Reality Inspection Training system modernizes Union Pacific's training by converting existing training modules into a virtual reality (VR) format, creating an engaging and immersive environment for railcar inspection. Employees practice inspections in a hands-on manner, significantly improving both safety measures and operational efficiency. By shifting traditional training into a virtual space, workers receive more interactive experiences while gaining immediate feedback on their performance.

Our solution handles user interaction across different platforms, such as the Meta Quest 3 headset and an online learning management system (LMS). Each training session generates a unique PIN, which manages a user's details and tracks their progress. With the LMS integration, scores are automatically recorded and stored, simplifying the overall process.

The back end of the system, using Java and Spring Boot, connects to a PostgreSQL database, while the React-based interface handles the user experience and course setup. The VR headset communicates with the back end to access necessary data and submit completed course results, ensuring smooth interaction between all components.





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Urban Science

Predicting Automotive Sales Using Generative AI

Urban Science is a leading global consulting firm headquartered in Detroit, Michigan that has provided tailored insights and solutions for the automotive industry worldwide since 1977. They leverage data and business science to help clients increase market share, improve profitability, and enhance customer satisfaction.

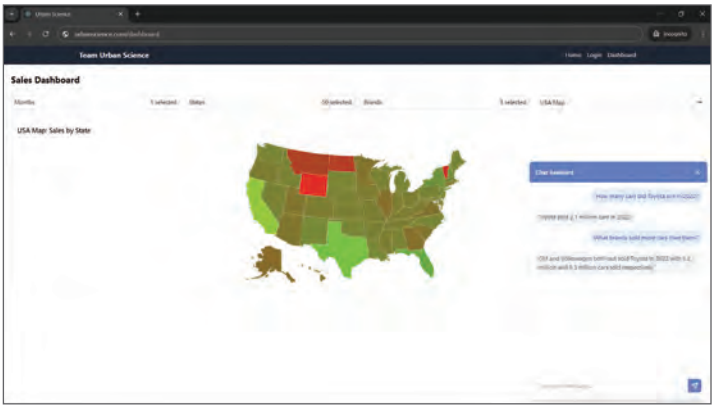
Automotive companies rely on Urban Science to make effective and efficient insights based on rapidly updating statistics. This helps them to increase their profitability in the competitive automotive industry. Urban Science is called upon to help these automotive dealers make decisions and strategize, but with constant data changes it can be difficult and time-consuming to give each company personal recommendations.

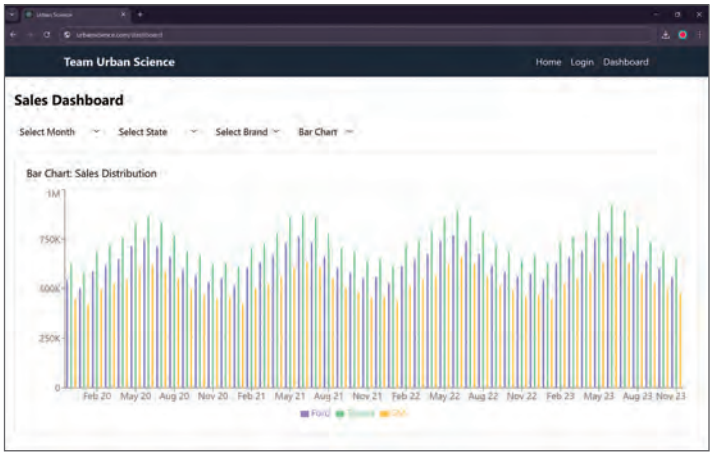
Our Predicting Automotive Sales Using Generative AI web application uses generative artificial intelligence to give recommendations to dealers based on automotive sales predictions, delivering analytics faster and easier than ever.

The Insight Portal web application interface has multiple data analysis pages. Users select options from four categories: brand, state, date and model, and receive a display of unique data pertaining to the options selected. Users also interact with the artificial intelligence model in the form of a chatbot to gain insights from the data on the fly.

The application displays data unique to automotive dealers statewide in several different forms, including traditional charts and graphs, and also an intuitive heat map. The application uses sales predictions data to create recommendations via our artificial intelligence model, encouraging improvement in profitability, market share, and customer satisfaction.

Our web application is built using React and Tailwind for the front end, MySQL for data storage, and C# and .NET framework for the back end. The software utilizes Azure cloud services for hosting.





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Vectra AI
AI Cyberattack Early Warning System

Vectra AI, founded in 2011, is an industry leader in cybersecurity and artificial intelligence. One of the many highlights of Vectra AI is that they successfully utilize artificial intelligence to detect complex cyberattacks before they occur. Additionally, they can do so without decrypting their client's sensitive information. Vectra AI serves clients in 113 countries and is on the CRN Security 100, as well as the Forbes AI 50 List.

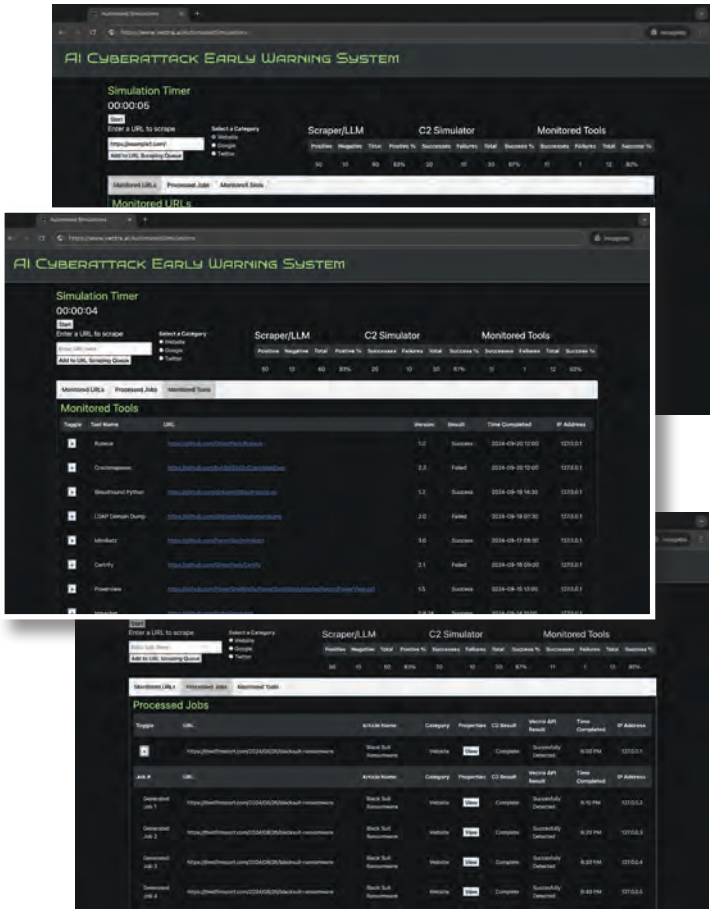
Vectra AI has a system that simulates cyberattacks before they occur. This state-of-the-art simulator replicates complex attacks when given valid parameters. However, Vectra AI needs to spend dozens of manhours to extrapolate data about new cyberattacks from online articles and reports to accomplish this.

To remedy this problem, advancements to Vectra AI's system must be made. That is where our AI Cyberattack Early Warning System comes in. Utilizing large language models, we gather parameters from credible cyberattack reports, relevant threat intel resources, and other URLs gathered by trusted engineers.

With this data, the AI Cyberattack Early Warning System then runs simulations using Vectra AI's C2 Simulator, as well as other common cyberattack tools. From there, this data is stored in Vectra's database and is presented back to users in a user-friendly interface.

Our system predicts and identifies impending attacks before they happen, based solely on web traffic data. Vectra AI can then stop the attack before sensitive data is compromised.

The AI Cyberattack Early Warning System is a local web application that uses a Flask framework for the UI, Playwright as a webscraper to gather information from articles, Gemini as a large language model to extrapolate the configurations, and MySQL as the database where all valid new information is stored. Rubeus, and Mimikatz are used as additional cyberattack tools.



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Volkswagen Group of America
Safe Journey AI

Volkswagen Group of America, a subsidiary of the global Volkswagen Group, continues to lead in automotive innovation and sustainable transportation. Volkswagen operates in over 140 markets with production in 12 countries.

Drivers often face various external risks during their journeys, including areas with unpredictable weather, crime, and traffic hazards, all of which can compromise their safety.

Safe Journey AI addresses these concerns by using intelligent routing features to enhance driver safety. Our software is powered by artificial intelligence, dynamically updating route recommendations based on real-time safety ratings.

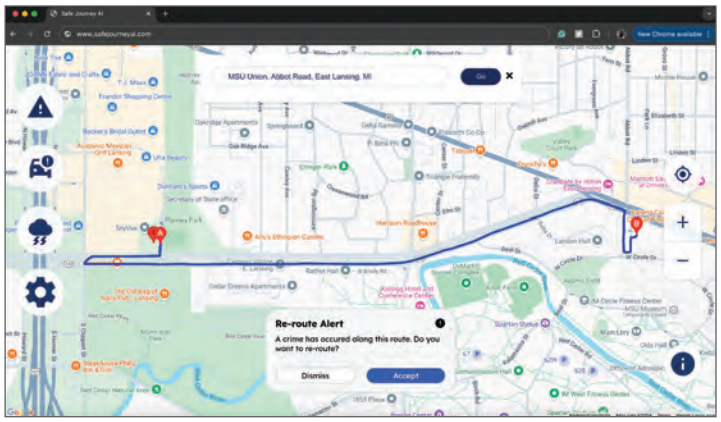
Drivers are provided with continuous updates on the safest paths, avoiding high-risk areas and offering alternative routes when necessary. The system provides suggestions for safe parking and refueling options, ensuring a secure journey from start to finish. Drivers can set their own safety preferences for a more customized experience.

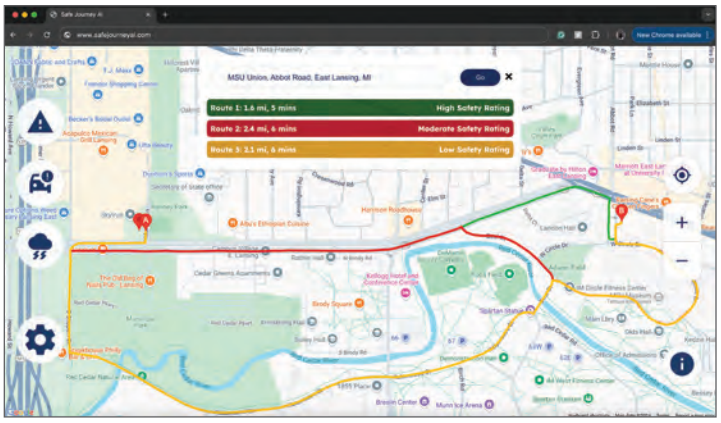
The system is integrated directly into Volkswagen's in-car navigation system, offering an easy-to-use interface that keeps drivers informed without distracting them.

Our platform offers real-time updates while on the road and gives drivers unparalleled control through intuitive and adjustable safety settings, helping drivers stay safe without distractions.

Safe Journey AI offers a reliable approach to route planning, aligning with Volkswagen's focus on safer and smarter transportation solutions.

Our software leverages React for the front end, Quart for the back end, and Google Cloud Platform for scalable hosting. Machine learning models built with TensorFlow process vast amounts of crime and weather data, providing accurate and dynamic safety ratings for use in routing suggestions.





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Whirlpool Corporation
Cooking GPS

Whirlpool Corporation, headquartered in Benton Harbor, Michigan, is a global home appliance manufacturer with approximately $19 billion in annual sales, 55 manufacturing and research centers, and 59,000 employees. Whirlpool's mission is to improve satisfaction and engagement with their home appliances.

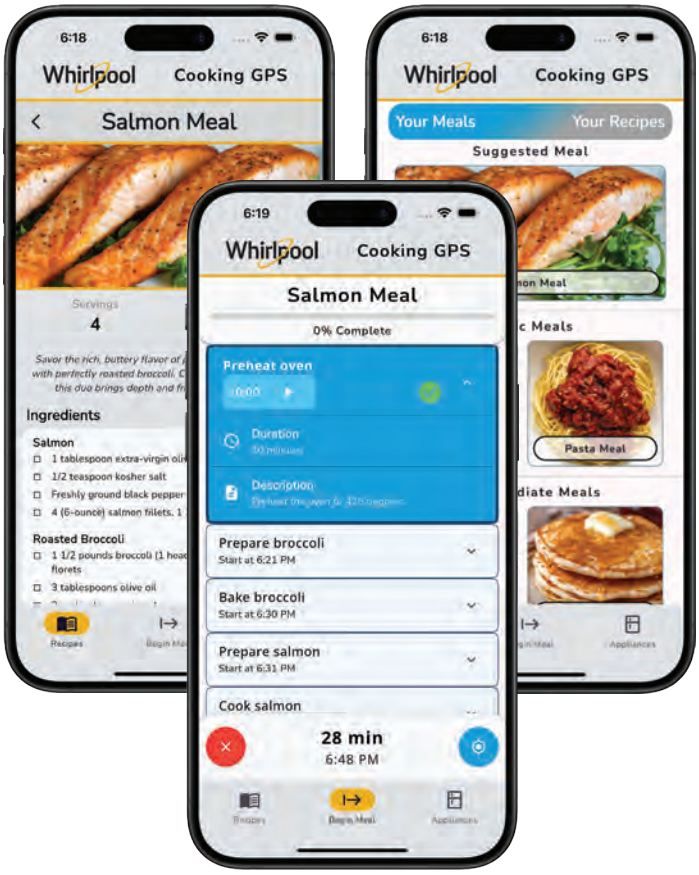
Kitchen appliance technology has advanced significantly over the last decade. However, the consumer experience and interaction has stayed relatively stagnant. The responsibility and effort to prepare a meal at home falls entirely on a home cook, often with very little assistance.

Our Cooking GPS alleviates the mental stress involved with meal coordination. The mobile application enables users to choose from pre-curated meals or incorporate singular recipes into a customized meal. When the user is ready to start the cooking process, the software compiles all preparation steps into a single easy-to-follow instruction list that accounts for time and efficiency.

Once meal preparation begins, the user is taken to a screen that displays all cooking steps ordered by start time. The current step is highlighted, displaying specific preparation instructions and necessary ingredients. In addition, a progress bar and estimated completion time is shown to communicate preparation progress. Once a step is completed, the user dismisses it. Completed steps are available to view by scrolling up on the meal preparation screen.

The Cooking GPS system is fully integrated into Whirlpool appliances, displaying steps in progress with relevant information such as timers, oven cycles, and stovetop burner temperatures.

The front ends for the Cooking GPS mobile application and smart appliance application are built using the Flutter framework. The back end consists of a Flask server connected to our job-shop algorithm and a WebSocket server to facilitate communication between the mobile application and appliance application.



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WK Kellogg Co

Cereal Industry Analysis Tool Using Generative AI

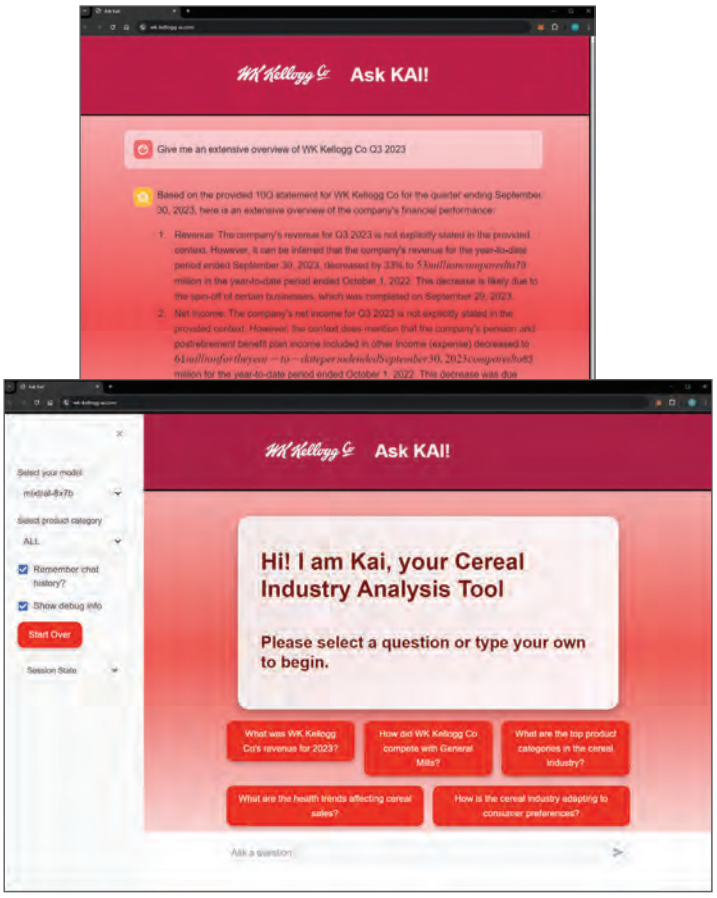
WK Kellogg Co, home to some of the world's most iconic cereal brands, is one of the largest food manufacturing companies in the nation. Headquartered in Battle Creek, Michigan, WK Kellogg has grown into a major player in the food industry, thanks to its global reach and ability to adapt to shifting consumer demands.

WK Kellogg currently operates in the competitive global food market in over 180 countries. Operating at such a large scale, it is important for the company to stay up to date on current business and market trends.

Our Cereal Industry Analysis Tool Using Generative AI automates data analysis through a web application. The website enables analysts and financial professionals to extract valuable insights regarding WK Kellogg and their competitors. This information can then be used by the company to assist in making business decisions and developing strategies to enhance the WK Kellogg brand.

WK Kellogg employees navigate to the web application and select a large language model to perform analysis on the large amount of stored data. Users then pose questions to our intelligent chatbot to gain valuable insights into business performance. Users can ask questions about industry shifts, market trends, business strategies, and more. The chatbot provides detailed responses throughout the conversation, empowering users to make informed business decisions.

The platform uses public datasets stored in Snowflake, which serves as the primary data warehouse. SQL commands interact with the Snowflake database and extract information from stored files. Streamlit, a Python framework, powers the front end of the web application. The application enables user interaction via a chatbot, which leverages large language models for generating detailed responses.



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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 spring 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 TechSmith
Enhanced Video Assistant (EVA)

Carter Salna, Chirag Rudrangi, Sriram Seelamneni
Kyle Nowak, Albert Cho, Emmett Barrett
Presented by Julie Wilkinson 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 MillerKnoll
Product Lifecycle Tracing System

Felix Liang, Mohammad Zaman, David Xiong
Ashley Jarria, Keshav Babu
Presented by Ben Maxim of MSU Federal Credit Union

Spring 2024

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 GM
Recovery of Lost and Stolen IT Assets

Hunter Jones, Joel Marshall, Jemin Han
Seth Youngstrom, Auden Garrard
Presented by Tony Lambert 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 Vectra AI
Hybrid Cyberattack Simulator

Henry Barton, Andrew Talbott, Campbell Robertson
Alisha Brenholt, Nathan Motzny
Presented by E.J. Dyksen of Amazon

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The Capstone Projects

Dr. Subir Biswas
Professor of Electrical and Computer Engineering

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Baryshev


Chahal


Chakrapani


Ettorre


Gebara


Harokopus


Karpenko


Li


McGough


Miller


Morris


Nanzer


Purcell


Ren


Traganitis

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, résumés, evaluations, posters, web pages, and oral presentations.

ECE 480 Electrical and Computer Engineering

Presentation Schedule – Engineering Building, Room 2320

Time	Team Sponsor	Project Title
7:00 a.m.	Valtech Mobility	Traffic Control System with Radar for Speed Detection
7:20 a.m.	Fraunhofer USA, Michigan	Low-Cost Inkjet Printer for Selective Diamond Growth
7:40 a.m.	MSU Facility for Rare Isotope Beams	Ion Beam Quadrupole Moment Calibration System using 4-Wire Coupling
8:00 a.m.	MSU Solar Racing Team	Intelligent Battery Test System for Solar Racing Cars
8:20 a.m.	MSU IPF Building Performance Services	Automated Prediction System for Utility Meter Calibration Drift
8:40 a.m.	Texas Instruments	SEE Radiation Effects Validation Platform with Mechanical Positioner
9:00 a.m.	Texas Instruments	Smart Software Controlled System for Foam Dart Launcher
9:20 a.m.	MSU D-CYPHER and NeEWS Laboratories	Interactive Robot System with LLM Integration
9:40 a.m.	Break	
10:00 a.m.	GenoPalate Inc.	App System for Rendering Color-Coded Food Scores
10:20 a.m.	MSU Broadband Access Wireless Communications Lab	Systems for Managing Security Attacks on Machine Learning Systems
10:40 a.m.	MSU PUMA Lab	High Power Amplifier System for Acoustic Testing of Rail Tracks
11:00 a.m.	MSU Nondestructive Evaluation Lab	Aerial Drone for Structural Health Management and Nondestructive Evaluation
11:20 a.m.	MSU UNLUTURK LAB	Macro-Scale Molecular Communication System via a Wind Tunnel
11:40 a.m.	MSU Smart Microsystems Lab	Automated Phosphate Sensing System
12:00 p.m.	MSU Solar Racing Team	Vehicle Controller System for Solar Car
12:20 p.m.	Electromagnetics Research Group	V2X Wireless Communication Security using X-band Phased Array

The ECE Project Facilitators who supervised ECE 480 teams this semester are: Sergey Baryshev, Premjeet Chahal, Sunil Chakrapani, Mauro Ettorre, Edward Gebara, William Harokopus, Oleksii Karpenko, Tongtong Li, Robert McGough, Nicholas Miller, Daniel Morris, Jeffrey Nanzer, Erin Purcell, Jian Ren, and Panagiotis Traganitis

We gratefully acknowledge the support of this semester's project sponsors: Electromagnetics Research Group, Fraunhofer USA, Michigan, GenoPalate Inc., MSU Broadband Access Wireless Communications Lab, MSU D-CYPHER and NeEWS Laboratories, MSU Facility for Rare Isotope Beams, MSU IPF Building Performance Services, MSU Nondestructive Evaluation Lab, MSU PUMA Lab, MSU Smart Microsystems Lab, MSU Solar Racing Team, MSU UNLUTURK LAB, Texas Instruments, Valtech Mobility.

Valtech Mobility

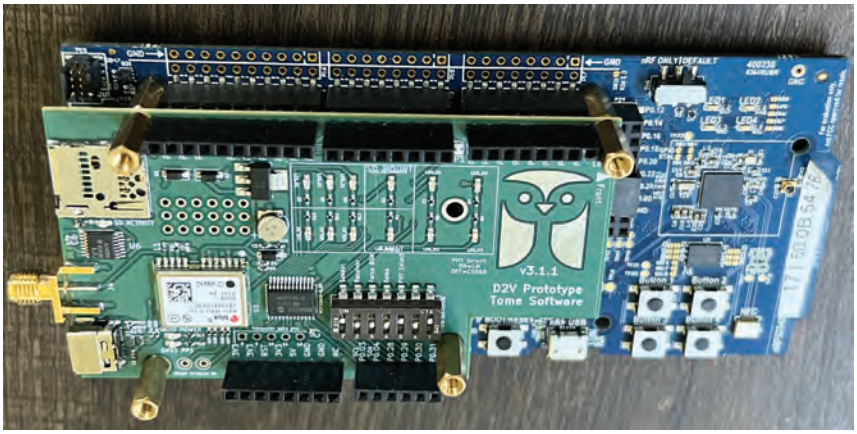
Traffic Control System with Radar for Speed Detection

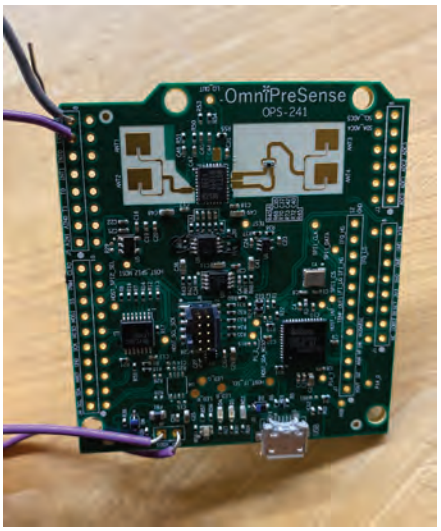
In 2022, 801 motorists and pedestrians lost their lives in roadside work zone accidents, highlighting the urgent need for improved traffic monitoring to enhance safety. This project aims to develop a cost-effective, scalable system to track vehicle speeds in work zones using Valtech Mobility's Hardware Development Kit (HDK).

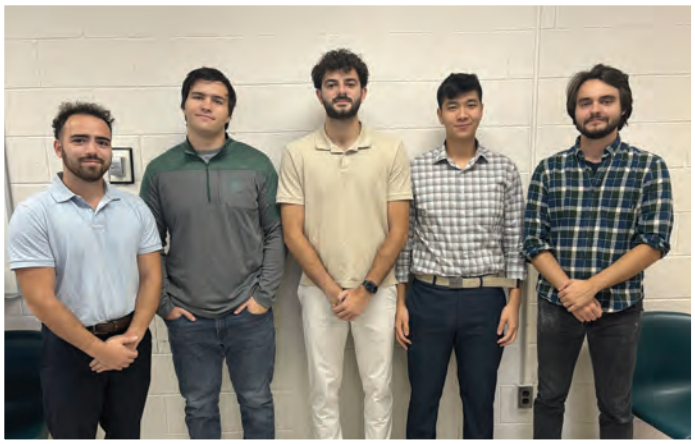
Valtech Mobility, a joint venture between Valtech and the Volkswagen Group, is a leader in connected car technologies and traffic management solutions.

Our project will integrate radar speed-tracking into the HDK over a standard serial bus to accurately measure vehicle speeds. In addition, we will explore using Bluetooth-enabled HDKs to track vehicles by detecting unique MAC addresses and calculating their speed based on timestamp comparisons over a set distance.

By combining radar precision with Bluetooth connectivity, our project provides a comprehensive and flexible solution for monitoring traffic in work zones. The system can be seamlessly integrated into existing infrastructure, enhancing safety for both workers and motorists.







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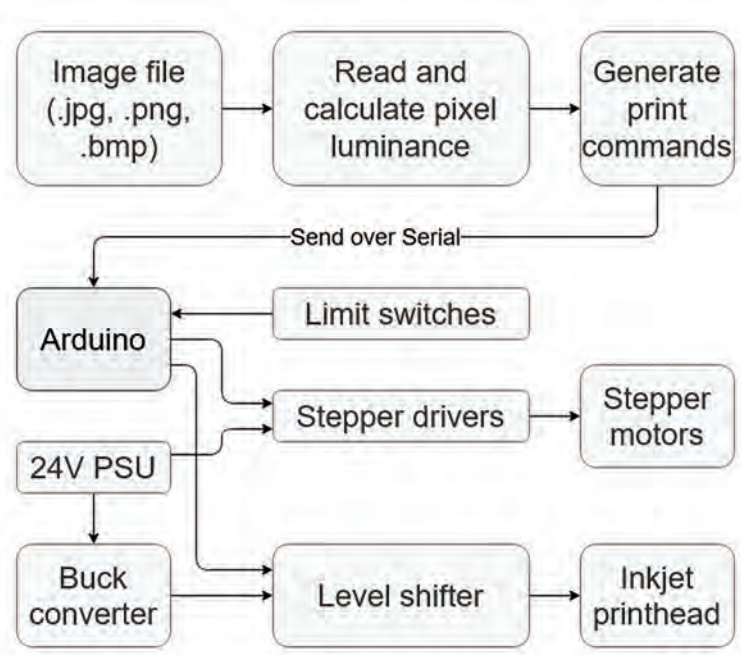
Low-Cost Inkjet Printer for Selective Diamond Growth

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. These electrical properties, as well as its mechanical hardness and resistance to temperature changes and corrosion, lead to diamond becoming an increasingly important material in electronic components. As electronics are designed to function at higher frequencies and in hostile environments, diamond-based chips are needed in larger quantities at lower costs.

Manufacturing diamond-based chips is often done through the long and expensive process of diamond lithography, where a crystal is grown in a lab and cut to size for use. Diamond crystals grown this way may warp the chips as the mechanical crystal structure is extremely rigid.

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 software for autonomous dual axis movement and solution dispensing. Images generated from CAD software will be processed and compiled into commands, then sent to an Arduino that controls the printer motors and inkjet printhead.



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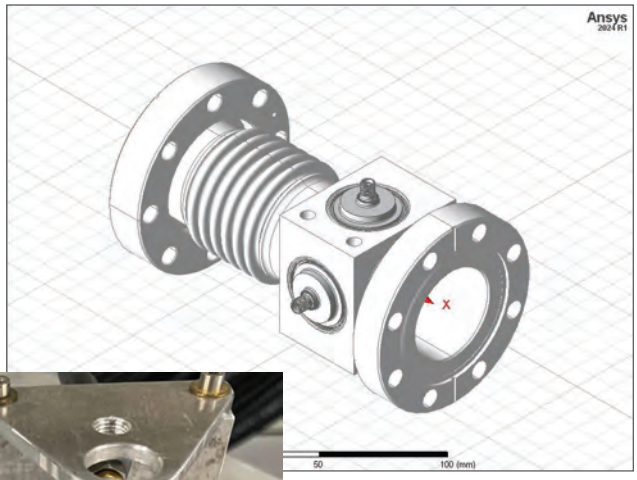
MSU Facility for Rare Isotope Beams
Ion Beam Quadrupole Moment Calibration System using 4-Wire Coupling

Facility for Rare Isotope Beams (FRIB) is a facility on Michigan State University's campus with a powerful isotope accelerator. The accelerator generates high-intensity beams of stable atomic nuclei and propels them to high velocities causing collisions that produce rare isotopes. Safely transporting these beams includes transporting the beam through various components. This is a non-interceptive diagnostic, meaning that the beam characteristics are not changed by this transportation. Dipole and quadrupole movements are crucial for steering an ion beam, as external electric fields are used to guide the polarized beam in different directions. The advantage of using a quadrupole moment for directing an ion beam is that it can be manipulated in both horizontal and vertical directions. A quadrupole moment is the next step of analysis at FRIB. A 4-button Beam Position Monitor (BPM) can be used to analyze this quadrupole moment. Currently, a 1-wire system models this system accurately instead of using the actual beam. An impedance has been calculated for this 1-wire system and circuit boards have already been fabricated. This circuit couples with a 50 Ω output from a Vector Network Analyzer (VNA). This means that the load, or in this case, circuit, should have an impedance of 50 Ω. Since the VNA input matches the circuit impedance, it can be stated that this system exhibits impedance matching. Therefore, a modulating input travels through the wire system, then through an initial impedance matching circuit board. After the signal (AC current) passes through this board, the signal goes through the BPM and another identical impedance matching board before it meets a 50 Ω termination.

The goal for this project is to have a working PCBA and VNA setup with a matching impedance for the 4-wire setup. Ideally, an RF splitter and attenuator circuit would be used for further analysis of this 4-wire system.



FACILITY FOR
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at Michigan State University

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MSU Solar Racing Team

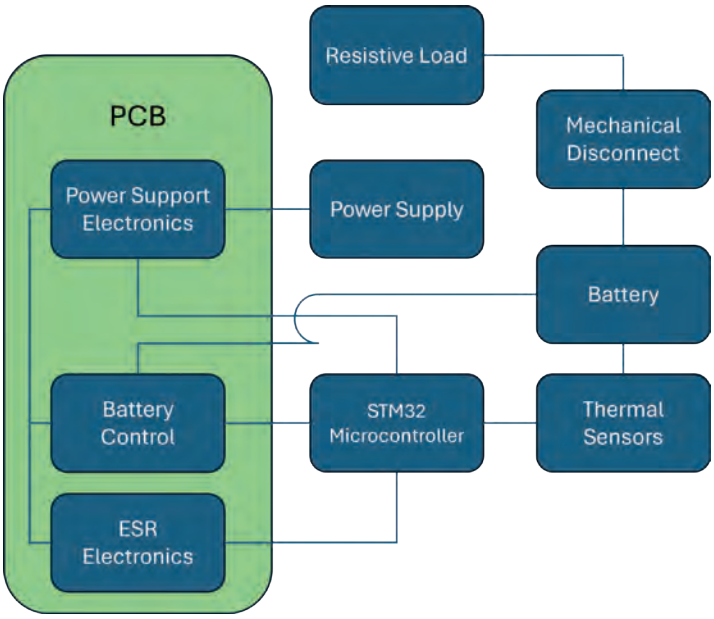
Intelligent Battery Test System for Solar Racing Cars

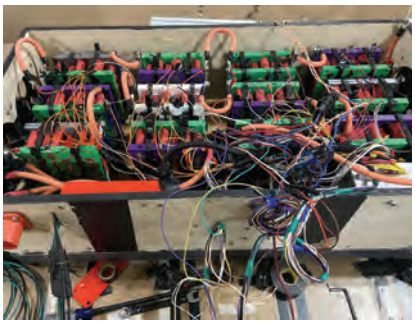
The Michigan State Solar Racing team designs, builds, and tests solar powered cars. These solar powered cars are designed with a cross-country race in mind, where the car must travel thousands of miles over the course of a few weeks while being completely powered by the sun and street legal.

The solar powered vehicles created by the Solar Racing Team require a large rechargeable battery pack. This battery pack is rated for 155V and 50A. It is created from hundreds of 3.6V lithium-ion battery cells. These cells are connected in separate modules and come together to form the complete battery pack. This battery must be tested to ensure safety and to maximize efficiency.

The goal of this project is to create an intelligent test system to test the vehicle battery at the individual battery cell, module, and pack level. This system must be able to test the capacity of the battery, the internal resistance of the battery, and perform stress tests to test the maximum current of the battery. This system must be able to communicate to and from a PC with user-friendly software. This software can be used to run the various tests and display data as requested by the Solar Racing Team.

This system will be implemented by the creation of a PCB using Altium Circuit Designer. This PCB will contain the required electronics for the capacity tests along with the stress tests. It will be controlled with an STM32 microcontroller development board as requested by the team. The PCB will connect to the battery at either the cell, module, or pack level and run tests as desired by the users. Separate electronics must be used for the high voltage pack vs. the low voltage capacity tests.





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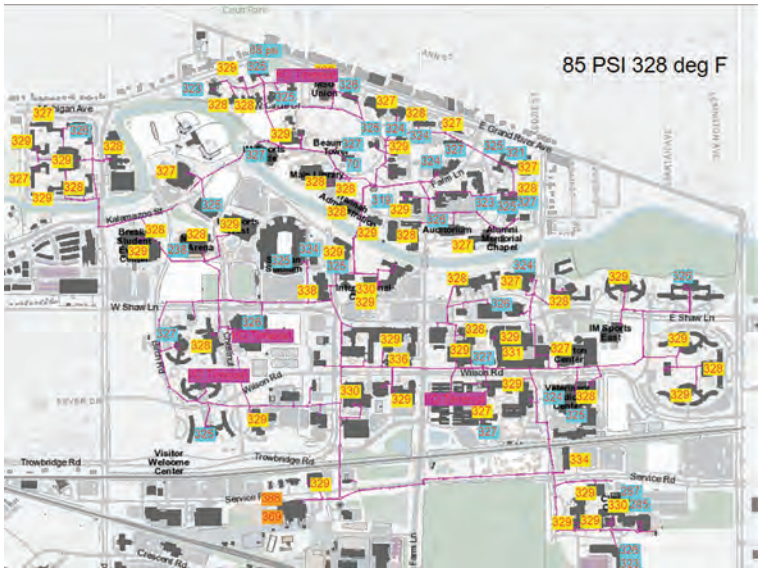
MSU IPF Building Performance Services
Automated Prediction System for Utility Meter Calibration Drift

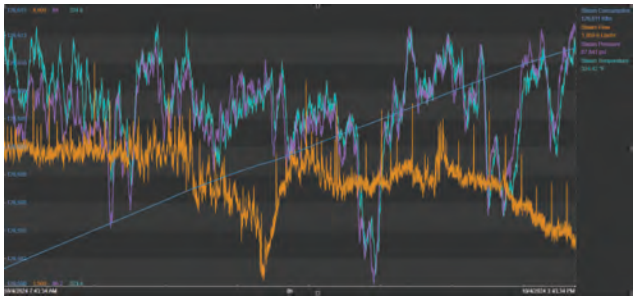
Michigan State University Infrastructure Planning and Facilities (MSU IPF) is responsible for planning, building, and maintaining the physical environment of the campus. With about 5,467 acres of property and 24.5 million square feet of buildings, there is a continuous need of accurate and reliable data to efficiently monitor and save energy usage costs. This includes electricity, steam, water, and natural gas.

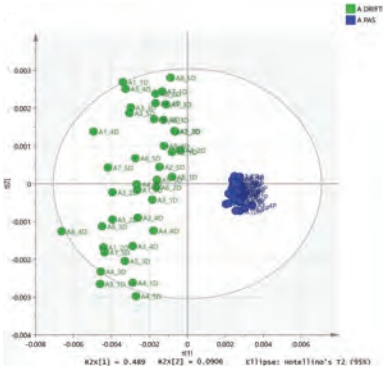
Currently, identifying drift in these meters is a reactive process, based on data collected up to a month before analysis. Additionally, the system is a manual process requiring labor time to complete. This can lead to delayed identification of inaccuracies, inefficient use of labor, and potential errors in utility tracking.

The goal of this project is to create a workflow that will make possible the automated prediction and identification of drift on various IPF utility meters.

We will be using Sartorius Simca, a multivariate data analysis software, to draw conclusions from the historical metering data. The system will enable early detection of metering anomalies and proactive recalibration of meters.







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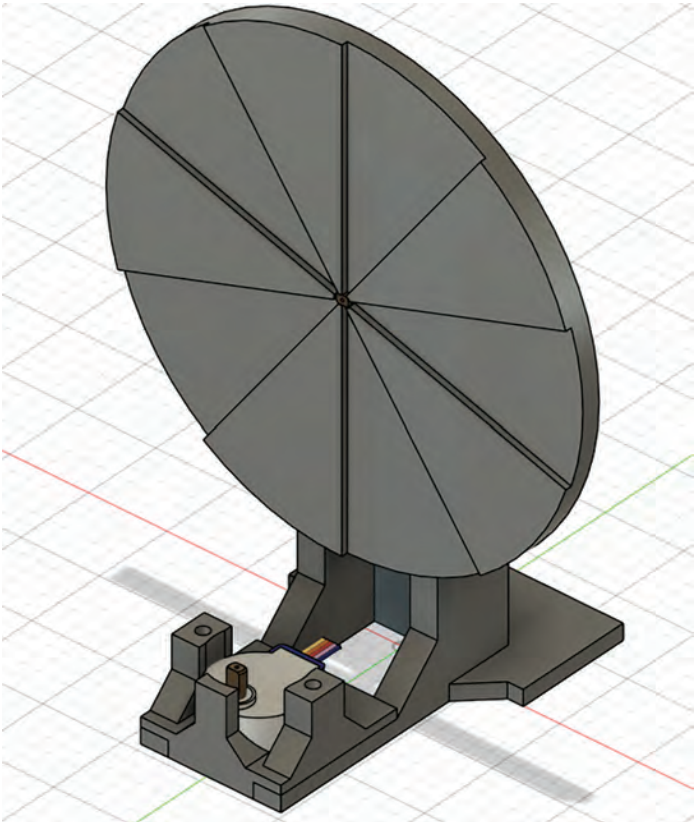
Texas Instruments
SEE Radiation Effects Validation Platform with Mechanical Positioner

Currently, Radiation Engineers (REs) are required to evaluate power electronic products at Michigan State University Facility for Rare Isotope Beams (FRIB). Oftentimes, numerous products need to be evaluated, which requires following detailed instructions, time-consuming intervention due to the switching of product hardware after each test, and having to wait for radiation to dissipate in the testing chamber, not to mention the limited availability of the Linear Particle Accelerator itself. Engineers come from all over the country to perform tests in an environment that, if not careful, can be rather dangerous due to the radiation. Additionally, considering FRIB's limited schedule, customers need to use their time as efficiently as possible. Texas Instruments provided relevant information that shows that using the Linear Particle Accelerator costs approximately $2,500 per hour. Manually changing each device individually takes 30 to 40 minutes, and with an average of ten devices tested per session, would mean that without any automation $15,000 would be wasted.

For this reason, our project aims to design and automate the hardware connection of the Device Under Test (DUT) to the instrumentation during Single Event Effects (SEE) radiation testing of space-grade power electronic products at the Michigan State University FRIB facility. The hardware automation will facilitate the precise positioning of Integrated Circuits (ICs) in front of the beamline while also automating the connection changeover of instrumentation, thus enabling REs to evaluate many products without requiring the manual, time-consuming intervention of switching product hardware after disabling the SEE heavy ion beam line. Ultimately, the implementation of this system will increase efficiency while decreasing the use of resources and reducing expenses for Texas Instruments.



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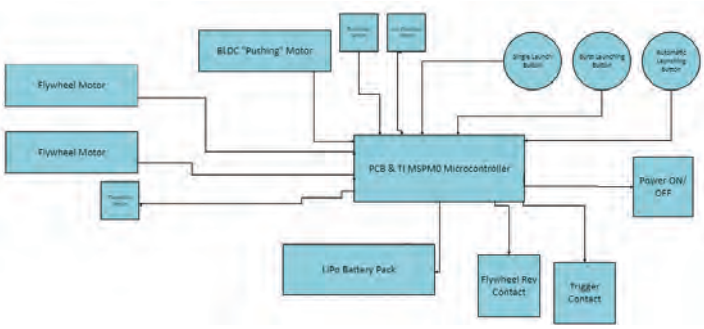
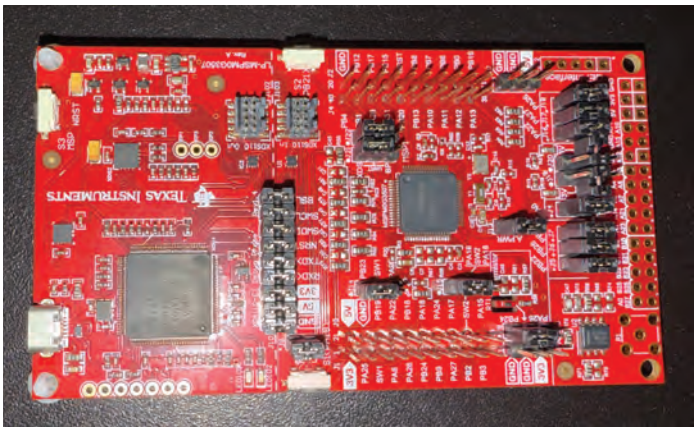
Smart Software Controlled System for Foam Dart Launcher



Texas Instruments (TI) is a global leader in analog and embedded processing technologies with a mission to make electronics more efficient, affordable, and innovative. With expertise in microcontrollers, sensors, and integrated circuits, TI is at the forefront of advancements in sensing, control, and processing. As a project sponsor, TI provides state-of-the-art components and technical support to drive the development of this Smart Software Controlled Foam Dart Launcher, enabling the practical application of their technologies in a hands-on engineering project.

The Smart Software Controlled Foam Dart Launcher project aims to create a high-performance dart launcher that integrates TI's advanced hardware to enhance accuracy, safety, and efficiency. At the heart of the launcher is a brushless motor-controlled flywheel, which enables precise propulsion of foam darts. TI microcontrollers and sensors are embedded to enable key features like jam detection and thermal monitoring, ensuring smooth operation and preventing mechanical issues. These components work together to deliver real-time feedback and efficient power management throughout the launcher's operation.



To maximize user control and flexibility, a custom software interface is designed to calibrate, monitor, and control the launcher's various settings. Users can adjust parameters such as number of darts and modes while the system processes input data from sensors and hardware components for optimal performance. TI's embedded systems allow for seamless communication between the hardware and software, making the device easy to operate and ensuring that it meets the highest standards of functionality and safety.

This dynamic design emphasizes both safety and user experience, making the launcher an interactive and reliable device, with TI's embedded technologies providing the essential control and connectivity between components.

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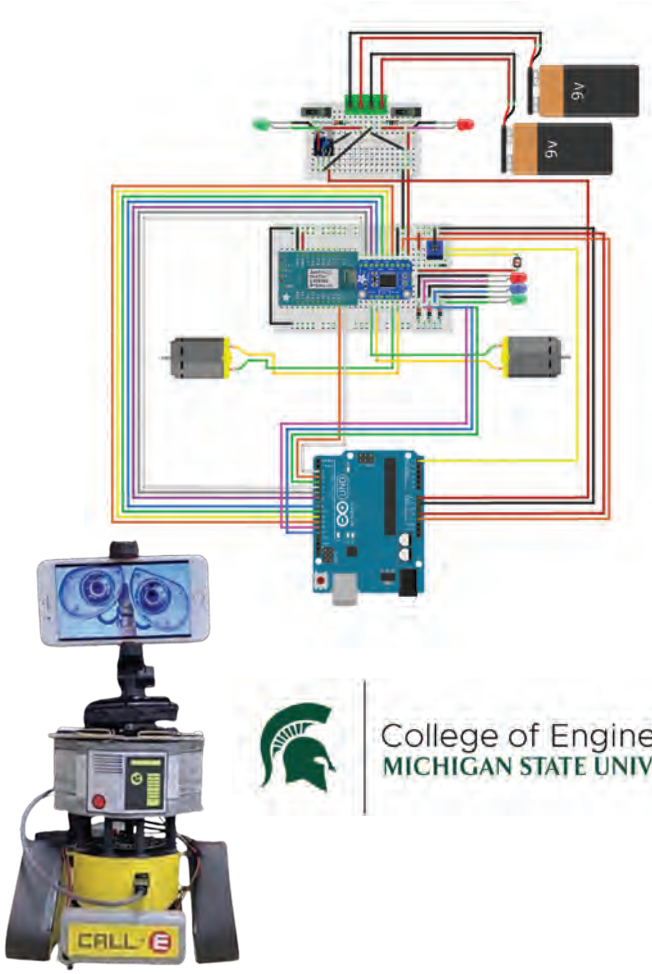
MSU D-CYPHER and NeEWS Laboratories
Interactive Robot System with LLM Integration

Michigan State University's D-CYPHER lab, led by Vaibhav Srivastava, and the NeEWS laboratories, led by Subir Biswas, focus on advancing technology through cutting-edge research in various fields, innovating solutions to enhance human interaction with automated systems.

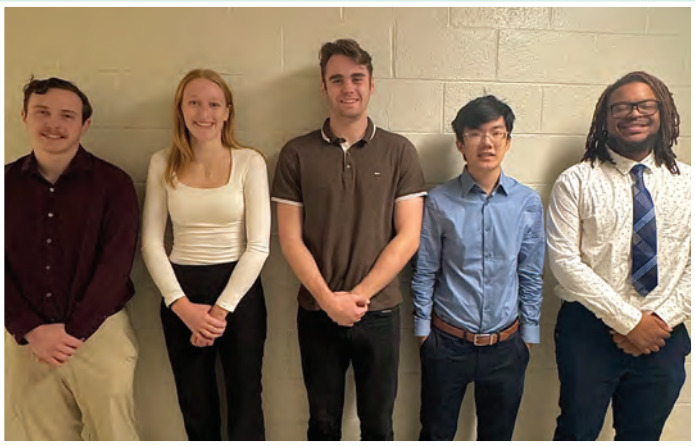
The Interactive Robot System project, sponsored by Michigan State's D-CYPHER and NeEWS laboratories, aims to revolutionize remote collaboration by integrating advanced AI capabilities into an existing sound-activated robot named "Call-E." This initiative focuses on improving communication dynamics during virtual meetings, ensuring participants can engage more effectively.

Building on a previous mobile robot design that utilized a microphone array for sound localization to identify and approach active speakers, this project introduces Generative Pre-trained Transformer (GPT) technology. The enhanced system will not only enable the robot to follow conversations but also analyze the dialogue in real time, offering insights into participant engagement and group dynamics.

By integrating GPT functionalities, the robot facilitates smoother conversations by notifying participants when they need to speak up or give space for others to contribute. It will also improve the flow of communication outside of a meeting through the reports and overviews it generates after a meeting is complete, enabling absent participants to catch up on what they missed or simply to refresh the memory of those who were in it. Automating meeting reports with GPT can minimize human error and potentially recall key aspects of a meeting more accurately than relying on memory, especially when compared to manual notetaking and meeting report creation.



College of Engineering
MICHIGAN STATE UNIVERSITY



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GenoPalate Inc.

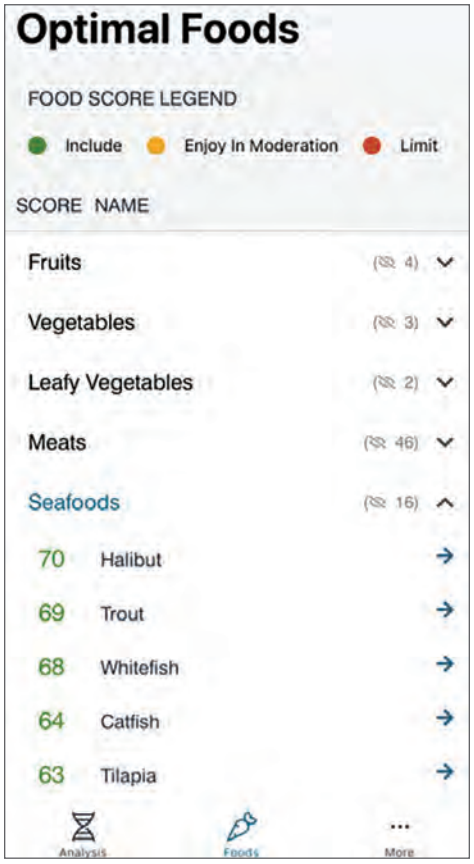
App System for Rendering Color-Coded Food Scores

GenoPalate is a nutritional support service that utilizes the unique genetic DNA of the customer to generate a personalized nutritional report. The customer sends in their DNA via a saliva sample to GenoPalate's lab where it is analyzed and used to generate the report that helps the customer understand what foods and nutrients their body processes best based on their genetic code. From here the customer can utilize the GenoPalate app to better understand their report in an interactive way.

The GenoPalate app is a great tool for the customer to understand and use the data from their genetic report to live a healthier lifestyle. The current "optimal foods" page works by providing food scores based on the customer's DNA report and the nutritional facts about common foods. This gives the customer an excellent way to determine what foods will help (or harm) their nutritional goals. Although this "optimal foods" page is an excellent way for customers to find foods, improvements to the page can be made to provide a better customer experience.

The focus of this project will be to upgrade and update the optimal foods page by providing a filtering and sorting mechanism to better find foods. The filtering mechanism will be a way to filter out what foods are shown based on details such as type, individual properties, and customer-selected ranges of nutrients and vitamins. The sorting mechanism will be a way to list the foods in various ways such as alphabetically, by score, by category, or by other nutritional properties.

For this project we will be utilizing React Native, the food algorithms and data provided by GenoPalate, and the current GenoPalate app to add the desired sorting and filtering mechanisms to the page.



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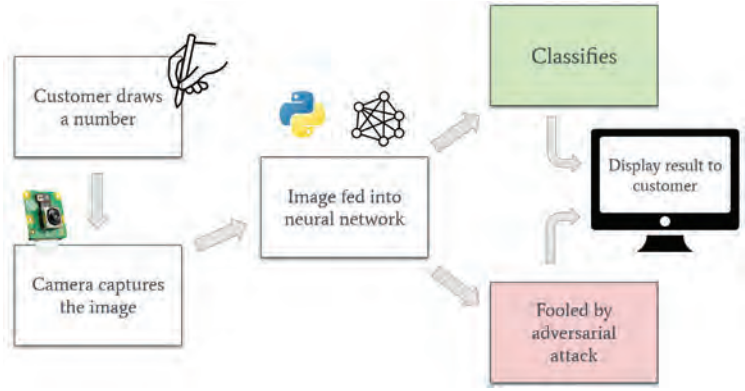
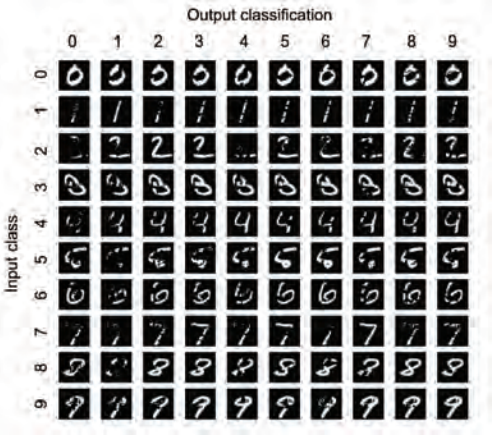
MSU Broadband Access Wireless Communications Lab

Systems for Managing Security Attacks on Machine Learning Systems

Large neural networks, recast as deep neural networks (DNNs) in the mid-2000s, altered the machine learning landscape by outperforming other approaches in many tasks. This increasing use of deep learning is creating incentives for adversaries to manipulate DNNs so as to force misclassification of inputs. This is when an attacker uses adversarial samples, an input crafted to cause learning algorithms to misclassify. Novel algorithms that can produce samples that are correctly classified by humans while being misclassified by a DNN, have been introduced in the past. This is possible by the algorithms maintaining a low modification average of input features per sample. This project's goal is to utilize Theano to build and train a deep learning model to classify these handwritten digits, then further explore these vulnerabilities in deep learning models through adversarial attacks.

This project will demonstrate how small, imperceptible changes in input data can fool machine learning models while remaining unaltered to the human eye. To do so it will implement adversarial attacks on neural networks using either an original dataset or a premade dataset like MNIST, a collection of handwritten digits (0-9). The basis of this work is rooted in the research paper 'The Limitations of Deep Learning in Adversarial Settings' in which they formalize and discuss the space of adversaries against DNNs. In this research paper they evaluate the vulnerability of different sample classes, defining a hardness measure, which will be used in this project to better measure, evaluate, and compare the difficulty of altering specific source-target class pairs.





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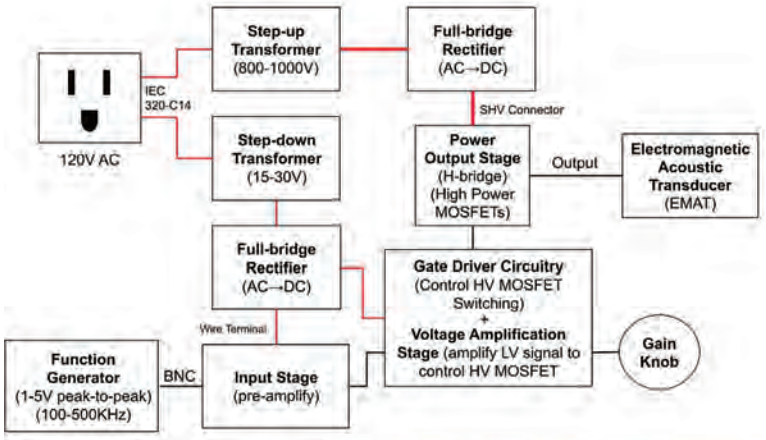
MSU PUMA Lab

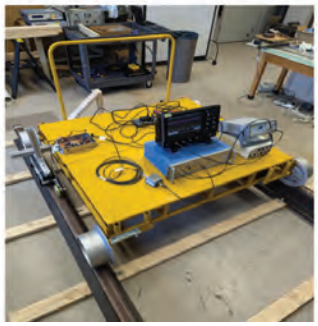
High Power Amplifier System for Acoustic Testing of Rail Tracks

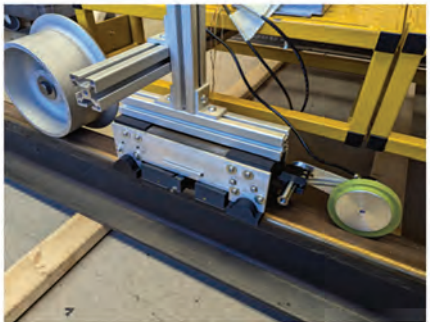
The PUMA Lab, which is a part of the Nondestructive Evaluation Lab, specializes in physical ultrasonic testing especially for structural evaluation. This line of work inspired the creation of the "High Power Amplifier Fabrication for Acoustic Testing of Rail Tracks" project. The main goal in this project is to create a high-power amplifier capable of generating 1500A peaks while also not exceeding +/- 70V. Additionally, we require a 4-cycle tone burst in the output, which will be used to excite our Electromagnetic Acoustic Transducer (EMAT) and be used for structural evaluation of railroad tracks.

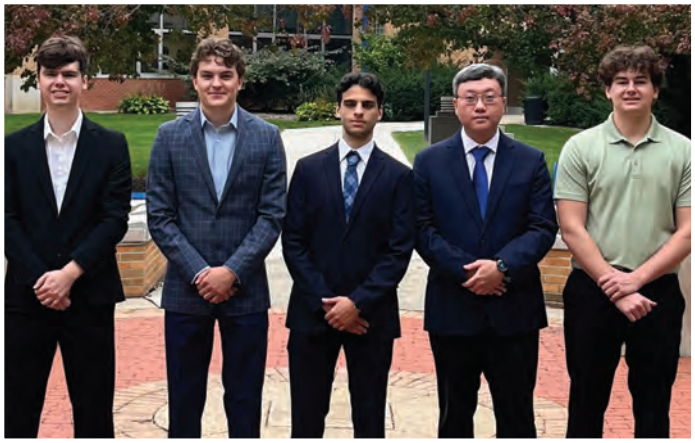
Our team will aim to utilize Eagle to design a compact PCB containing our amplifier and driver circuits while meeting the specified requirements. To initially test the functionality of our board we will make use of QSPICE to simulate our circuit. Eventually, when our design passes our desired simulation results, we will go onto breadboard testing along with implementing our cooling solution. We will repeat the same cooling solution with our fabricated PCB.

With our PCB possessing the capability of exciting our EMAT, we will be able to analyze the ultrasonic waves that are sent through portions of the rail track and returned. By examining any differences in wavelength, we will be able to determine if there are any faults in the tracks.









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MSU Nondestructive Evaluation Lab

Aerial Drone for Structural Health Management and Nondestructive Evaluation

Aerial nondestructive evaluation (NDE) has the potential to provide safe, efficient, and reliable evaluation methods for critical infrastructure. Vast benefits to workplace safety and the public may be realized when a drone is used to expand the scope of an evaluation or provide inspections for formerly inaccessible infrastructure.

While the use of commercial drones may be cost-effective for larger organizations, the goal of this project is to improve access to drone-based evaluation by developing a low-cost, fit-for-purpose drone for infrastructure inspection. This durable and economical solution would enable a user to swap out technology to explore additional evaluation techniques while avoiding the costly consequences of a commercial drone malfunction or accident.

This project entails the adaptation of a roughly $70 drone received from MSU's Physical Ultrasonics, Microscopy, and Acoustics (PUMA) Lab equipped with brushless motors, electric speed controllers, and a KK Multicopter flight controller on a hexacopter frame with an integrated power distribution board. The drone's capabilities will be continuously expanded by first integrating and mounting a camera and infrared (IR) sensor to collect and write close-up video and IR data to an onboard SD card via a lightweight Raspberry Pi, and cleaning and processing the data post-flight.

In iteratively improving this minimum viable product, adding functionality tailored to the end user while testing the possible capabilities of a low-cost drone, this project presents a route for new users to explore aerial nondestructive evaluation without costly buy-in and commitment. Subsequently, the use of drone-based infrastructure evaluation may be accessible to a broader range of consumers, providing invaluable benefit to the public by ensuring the safe and continuous operation of critical infrastructure.

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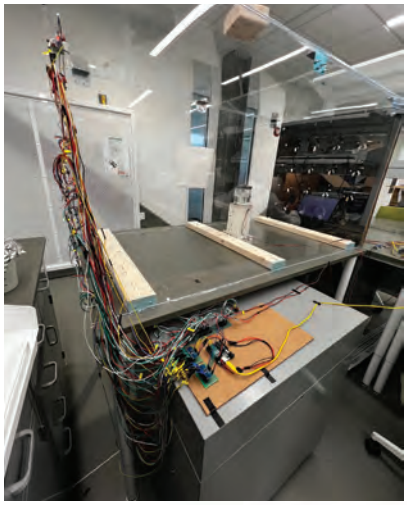
MSU UNLUTURK LAB

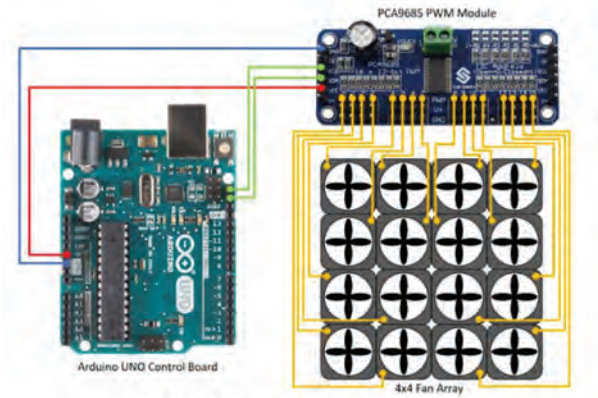
Macro-Scale Molecular Communication System via a Wind Tunnel



Molecular communication is an innovative bio-inspired communication technology that involves the transfer of information through the exchange of molecules. This method shows promise for interconnecting electrical devices at the macroscale, interfacing with biological cells for biomedical applications. In molecular communication channels, information is encoded in the concentration of molecules. The molecules then diffuse through the environment to reach the receiver.

Previous studies have explored molecular communication channels utilizing the diffusion-convection process. The process focuses on noise sources and channel performance metrics, such as capacity, data rate, and bit error rate under various conditions. These molecular communication channel setups typically include wind-tunnel-like fan arrays for directional airflow, alcohol atomizers to transmit molecules, and sensor arrays as receivers. However, challenges such as maintaining steady airflow, accurately controlling fan speeds, and ensuring precise molecule detection have been present in these experiments.

The team looks to further characterize the macroscale communication channel by conducting various tests, such as adjusting fan speeds and directions, transmission molecule amounts, transmitter-receiver distance, and transmitter duration. Turbulent airflow will be introduced by controlling the existing fans, adding a new one to the side of the channel, and fan gratings. The microcontroller boards that control the fans, sensors, and atomizers will be upgraded to a more capable, singular board, and the communication circuitry for the sensors will be improved. A detection algorithm will be developed to interpret received signals, along with a novel modulation program to increase data rate, while reducing bit error rate.



Layout 2: PWM Extension Module

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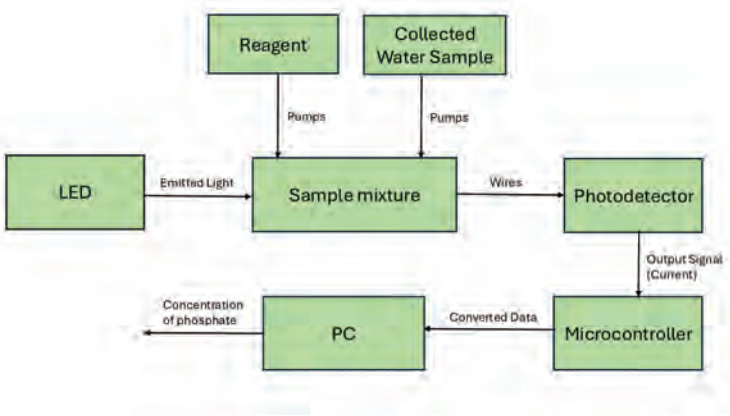
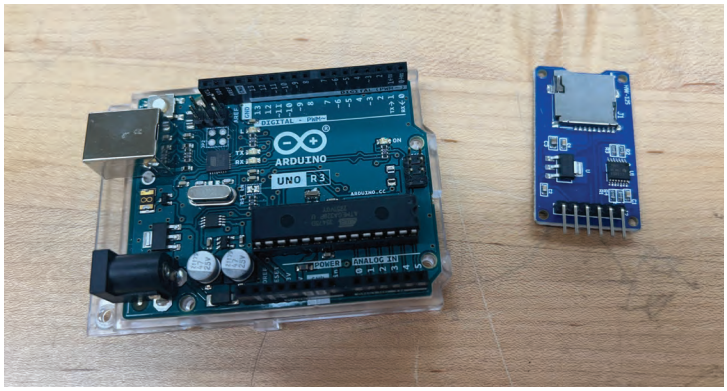
MSU Smart Microsystems Lab
Automated Phosphate Sensing System

The goal of this project is to design an automated phosphate sensing system for agricultural practices, which is crucial in mitigating the harmful effects of excessive phosphate runoff into rivers. High phosphate levels cause rapid algae growth, which depletes dissolved oxygen (DO) in the water, leading to aquatic ecosystem collapse. While phosphorus is essential for wildlife and vegetation, elevated concentrations reduce DO, threatening marine life and contaminating drinking water sources. Reducing phosphate levels helps protect marine ecosystems and maintain water quality.

This system is comprised of three main components. The first is the development of an automated dispensing mechanism that accurately combines reagents with phosphate present in water samples, ensuring precise mixing and consistent delivery for each test cycle. The second component involves photodetection, utilizing a sensor such as a photodiode or phototransistor to capture the signal produced when phosphate reacts with the reagent. The third component is data analysis, where the photodetection signal is processed to determine the phosphate concentration in the water.

To ensure system efficiency, particularly in real-time phosphate monitoring, extensive testing is conducted across various phosphate concentrations and reagent mixtures. This identifies the ideal reagent composition that produces a detectable color change at a specific wavelength, which is then measured by the photodiode. The reagent is dispensed incrementally until the correct wavelengths are detected. The goal is to create a robust system capable of providing continuous data on phosphate concentrations, enabling timely interventions to prevent ecological damage.





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MSU Solar Racing Team

Vehicle Controller System for Solar Car

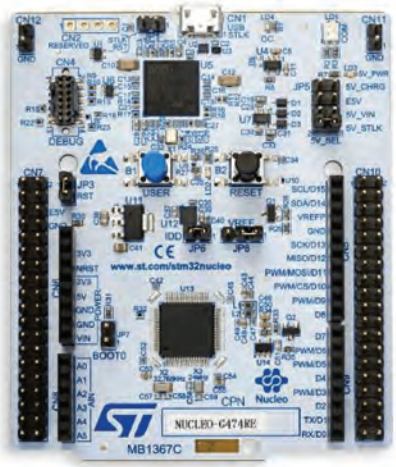
The MSU Solar Car Racing team started 24 years ago, competing in both the American Solar Challenge (ASC) and Formula Sun Grand Prix (FSGP). They are a racing team that is designing a single occupant port canopy four-wheel solar car. The current vehicle, codenamed Cynisca, was taken to the 2024 competition but was kept from competing due to incomplete and poor designs.

Currently, one of the poor designs hindering the team from competing is being caused by the data buses on the vehicle being overloaded, causing data to be lost. The overloaded buses are due to only having two CAN nodes and using the slower CAN 2.0 protocol, as opposed to the faster FDCAN protocol. There is also no GPS system or data storage system.

This means if the car loses power due to a fault state, there isn't any way to view what the fault was after the vehicle shuts down as the information is not stored.

The goals for us are to centralize the CAN system with support for three lines, control vehicle lights while adhering to regulations, add a GPS system to be able to track the car, and an SD card to monitor the car's systems by logging necessary information.

Our design will consist of an enclosed PCB, with a mounted STM32 Nucleo Development Board for all processing needs. The board must be able to communicate with the solar car via CAN to toggle the lights (headlights, turn signals, hazards, brakes, etc.). These lights must comply with all ASC and FSGP competition racing regulations. There also must be support for three FDCAN lines. Using the FDCAN lines, the board must properly route all relevant signals to their respective systems without error. The PCB must include a GPS module to deliver useful tracking information for the team, as well as an SD card for data logging even after power is removed from the vehicle.



MSU SOLAR RACING TEAM

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Zoltan Kovacs
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Shane Liu
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MSU Solar Racing Team
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East Lansing, Michigan

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Dr. Jeffrey Nanzer

Electromagnetics Research Group

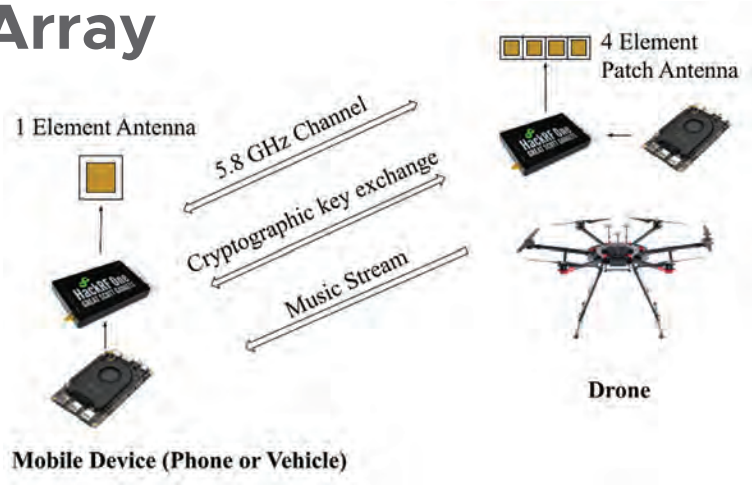
V2X Wireless Communication Security using X-band Phased Array

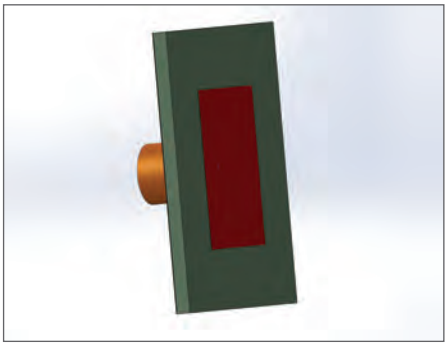
With the increasing development of autonomous vehicles and smart transportation systems, Vehicle-to-Everything (V2X) communication has become a critical element in ensuring the safety, reliability, and efficiency of connected vehicle ecosystems. However, ensuring that V2X communications are secure and resistant to eavesdropping or unintentional interferences poses a significant challenge.

To address these issues that are associated with V2X communications security, the team is designing a custom phased antenna array to achieve directional modulation techniques through phase vector synthesis and spatial amplitude dynamics, while ensuring that the system is lightweight and inexpensive to implement. In addition, Software-Defined Radio (SDR) technology is used in conjunction with AES and RSA to transmit encrypted data with directional modulation techniques serving to enhance the overall security of the system by adding an additional physical layer of security.

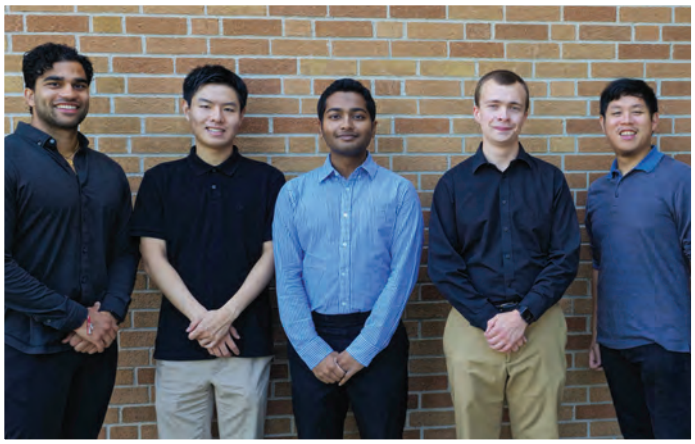
To demonstrate the practical application of this technology, the phased array system will be integrated with a drone and will communicate with a stationary ground receiver. This design will implement multiple key parts such as a handshake protocol for initial connection, beamforming to detect the receiver node, and encrypted music streaming for secure communications.

To evaluate the final design, the Bit Error Ratio (BER) will be measured to ensure that it is low when the drone and ground systems are broadside to ensure that only the desired recipient is able to receive the data, and the playback of the audio stream enables for an auditory check that the data is correctly transmitted without any serious degradation.





emrg
Electromagnetics Research Group
Michigan State University



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Electromagnetics Research Group
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Jacob Randall
Novi, Michigan

Project Facilitator

Dr. Premjeet Chahal

Design Day Spring 2024 Awards

First Place Award — 1

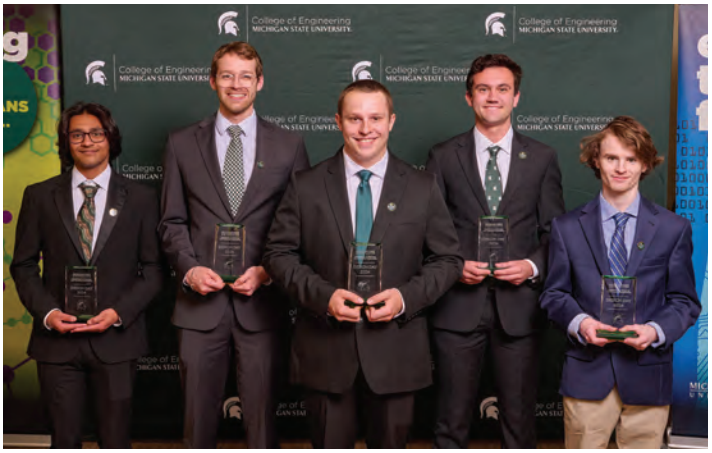
Team MSU College of Music
"Feel the Music"

Left to right: Maria Scannel, Andrew Morgan, Spenser Lafferty, Jason Shell, Jason Ahn

First Place Award — 2

Team MSU D-CYPHER Lab
"Design of Hardware-in-the-Loop Fire Simulator"

Left to right: Najiha Jaigirdar, Doriana Vuljaj, Nick Fedewa, Alayna Schumaker



Second Place Award — 1

Team MSU Department of Electrical and Computer Engineering
"24W DC-DC Converter"

Left to right: Manan Patel, Ben Schuchart, Ben Torok, Jake Cabana, Douglas Bombard

Second Place Award — 2

Team Fraunhofer USA
"The Design and Fabrication of an Inkjet Printer for Selective Diamond Growth"

Left to right: Ruiqi Lu, Joey Lopez, Herminee Orzech, Andrei Bodea, Morgan Gates, Scott Risdon

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ME 412 Heat Transfer Laboratory

Yuping Wang
Academic Specialist
Department of Mechanical Engineering

Review and Practice on Electronics Cooling

Electronic devices, whether tiny microprocessors or large LED display panels, can be found in almost all areas of modern technology, and in each application, thermal management always presents a challenge. The heat generated during the device operation needs to be dissipated effectively to prevent overheating, and hence to maintain an optimal and stable performance and extend the lifespan of the system as well. For this project, students are expected to understand the importance and common methods used for electronics cooling. Each student team is to design, build, analyze, and test a heat transfer device that aims to enhance cooling from an electrically heated plate (simulating an electronic device). A box fan is available to provide airflow within a specified range. The objective of the design is to minimize the operating temperature of the plate when 20W of power is supplied. A second part of the project is for each team to choose and review a specific electronics cooling unit or conduct a general review on various cooling solutions for electronic systems. On the testing day, each team will have 15 minutes to set up, demonstrate/test, and dissemble their device. In addition, they will also prepare a PowerPoint slide show for the audience to explain their design decisions, fabrication, operations and thermal analysis of their device.

Competition Schedule

Time	Station	Team Members
8:00	A	Hannah Crist, Stephanie Glaspie, Jordyn Porter, Aida Soltanian, Larissa Tacaoca Honda
	B	Julio Dam, Elizabeth Grant, Jacob Greca, Kylie Keller
8:15	A	Mariam Farran, Matthew Luxhoj, Vanessa Mendez-Valencia, Will Stamatakos
	B	Joe Dumais, Easton Knott, Luke Naughton, Logan Trierweiler
8:30	A	Jacob Ervin, Andrew Iaquaniello, Connor Mackenzie, Kaden Swierkos
	B	Shivam Pandey, Uma Pentakota, Garrett Westphall, Judson Wise
8:45	A	Eric Dutkiewicz, Arinc Kuloglu, Yash Patil, Noah Rocktensuess
	B	Sydney Bush, Ryan Harth, Jared Zammit, Rachel Zubrzycki
9:00	A	Blake Bur, Brian Cheladyn, Ben Kruk, Kieran Velasquez
	B	Wenhao Jin, Daniel Krahn, Joshua Picciano, Cameron Tsivitse
9:15	A	Sydney Agius, Brendan Cruz, Ryan Gioffreda, Jp Nelson
	B	Mallory Brooks, Deleena Fajou, Ari Mustafaraj, Nick Opolka
9:30	A	Malachi Locke, Ihsan Murtadho, Reeddhiman Rhythm, Paddy Toole
	B	Mohammed Al Abri, Hussain Ashkanani, Ryan Bilsky, Gunnar Carroll
9:45	A	Eli Carey, Max Fried, Kody Simmons, Justin Tyack
	B	Manbir Chadha, Ian Ladd, Saransh Mehta, Aditya Varma
10:00	A	Parker Bentley, Sean Britt, Jake Dumais, Haley Dyer
	B	Luca Boson, Anthony Demaio, Alex Goolsby, Gerrid Rutledge
10:15	A	Jackson Larkin, Cade Smith, Kyle Taormina, Jeremy Wall
	B	Eathan Bentley, Max Doty, Josh Machuca-Gonzalez, Nathan Zavsza
10:30	A	Philip Bereznicki, Joey Harwood, Payson Kotel, Matthew Russell
	B	David Benkes-Toth, Chad Fowler, Alexander Le, Brock Strebeck
10:45	A	Huseyin Canoglu, Berk Demirci, Jash Modi, Ava Shumaker
	B	Ryan Cornellier, Kenneth Gordon, Emma Luzbetak, Monica Roberts
11:00	A	Jack Jackson, Chase Marcath, Miko Parkinson, Deyuan Wang
	B	John Burroughs, Lucy Kiloustian, Lizzie Kooistra, Jacob Rubino
11:15	A	Aaron Dawson, Kennedy Kullman, Dylan Miron, Austin Pier
	B	Gavin Lahousse, Elizabeth Milne, Stephen Moussiaux, Ethan Newman
11:30	A	Chris Definis, Nathan Downie, Nick Mercer, Matthew Osborn
	B	Zachary Colo, Liam Cooney, Stephan Freitag, Logan Nicks

ME 470 Mechanical Design & Manufacturing II

Michael Lavagnino
Academic Specialist
Department of Mechanical Engineering

High Mechanical Advantage Mechanism

The goal in this project is to design, build, and test a mechanism that will produce the highest mechanical advantage. Mechanical advantage is the ratio of output force to input force. Each team will use a one-pound weight as an input force to their mechanism and try to maximize the output force per mechanism weight. The mechanism 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 the ability of the mechanism to multiply the input force. 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	Ava Boley, Ian Burke, Blake Christiansen, Ryden Khamo, Francis Wong
	1	B	Alexander Le, Sterling Mims, Ari Mustafaraj, Connor Whitaker
8:15	2	A	Max Cheney, Claire Jacka, Mike McGowan, Nick Mercer
	2	B	Manbir Chadha, Yulianna Duran, Fatima Sharief, Emerson Voss
8:30	3	A	Mohammad Alqaryouti, Ethan Darnall, Kurt Kehren, Blake Nowak, Ryan Zink
	3	B	Duncan Donley, Renee Kinsler, Ethan Koss, Daniel Krahn, Owen Tarter
8:45	4	A	Keegan Bretschneider, Sydney Dillon, Ming Huang, Abigail Makowski
	4	B	Batu Akgun, Philip Bereznicki, Robert Stowe, Nicholas Zuo
9:00	5	A	Devin Bentley, Joe Dreon, Navid Hasan, Tyler Hedden, Adam Martin
	5	B	Noureldin Darrag, Matthew Luxhoj, Tyler Noel, Alex Szumko, Larissa Tacaoca Honda
9:15	6	A	Luca Boson, Brandon Hineman, Nick Rogowski, Arslan Umair
	6	B	Mariam Farran, Eric Glodich, Avery Powell, Noah Rockensuess
9:30	7	A	Jackson Larkin, Elizabeth Ligi, Emily Ligi, Veronica Sellin
	7	B	Matthew Osborn, Daniel Pawar, Nathan Tenfelde, Garrett Westphall
9:45	8	A	Miles Hayes, Vinay Rao, Kolby Wagoner, Judson Wise
	8	B	Mallory Brooks, Jack Jackson, Wenhao Jin, Chase Marcath
10:00	9	A	Nathan Huynh, Angela Wegrecki, Rachel Zubrzycki
	9	B	Stephanie Glaspie, Joey Karr, Jacob Keegan, Justin Tyack, Connor Youngerman
10:15	10	A	Genna Lebster, Charlotte Neu, Jordyn Porter
	10	B	Zachary Buchanan, Jesse Ernest, Ollie Horswill, Nathaniel Mcneilly
10:30	11	A	Max Fried, Elizabeth Grant, Kaitlyn Heffelbower, Kennedy Kullman, Joshua Picciano, Kody Simmons
	11	B	Egemen Keskin, Leonardo Provenzola, Nathan Young
10:45	12	A	Shawn Defina, Ashley Donbrock, John Machuca-Gonzalez, Corey Smith, Nathan Zavsza
	12	B	Jacob Ervin, Sean Flynn, Andrew Iaquaniello, Jp Nelson
11:00	13	A	Amelia Conatser, Cole Jeffery, Anna Smith, Hanna Stabler, Abbey Yager
	13	B	Jake Dumais, Joe Dumais, Nick Opolka, Zachary Wyrick
11:15	14	A	Huseyin Canoglu, Max Cheng, Arinc Kuloglu, Kyle Taormina
	14	B	Kyle Deichmann, Jack Fisher, Jash Modi, Mohammad Waleed Bin Munir
11:30	15	A	Eli Carey, Anthony Gibbons, Gabe Guter, Kylie Keller, Cade Smith

The Capstone Projects

Dr. William Resh
Professor of Mechanical Engineering

Faculty Advisors: Rebecca Anthony, Giles Brereton, Abraham Engeda, Tong Gao, Thomas Pence


Anthony


Brereton


Engeda


Gao


Pence

Presentation Schedule – Engineering Building, Room 1202

Time	Team Sponsor	Project Title
8:00 a.m.	Eaton Aerospace Test Facility	Dual Driven Intensifier
8:30 a.m.	Eaton Aerospace Test Facility	Liquid Cooling System Steady-State Design Tool
9:00 a.m.	MSU Broad Art Museum	Collapsible Art Transport Bin
9:30 a.m.	General Motors	Analytical Jounce Shock Model
10:00 a.m.	KLA Corporation	Server Characterization Test Bench
10:30 a.m.	KLA Corporation	Optical Table Cleaning Device
11:00 a.m.	NASA/Arizona State University	Future Power Solutions for Exploring Hypothesized Surfaces

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:

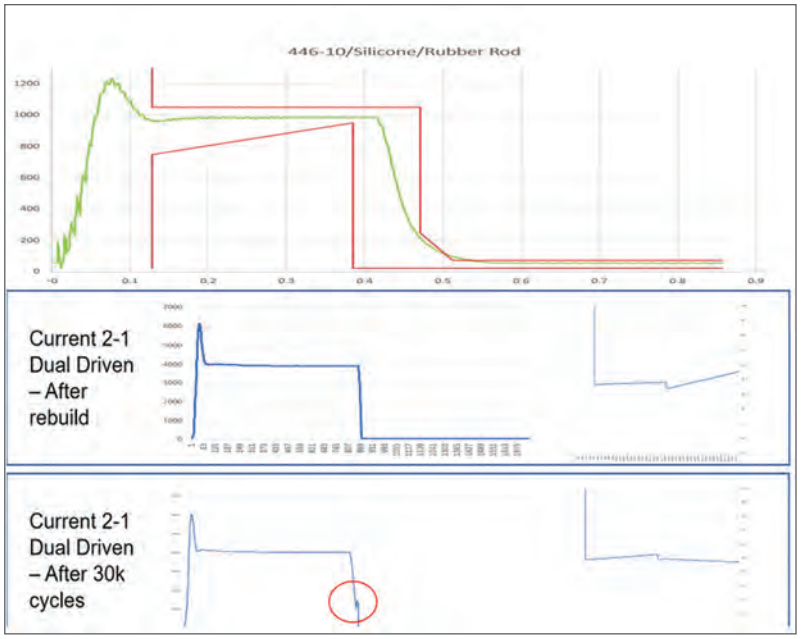
- Use the technical expertise, communication skills, and teaming methodologies they have learned throughout their mechanical engineering curriculum, together with their creativity, to solve real world problems
- Collaborate with practicing engineers to address problems sponsored by industry
- Develop 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: ATESTEO North America Inc., Eaton Aerospace Test Facility, General Motors, KLA Corporation, Magna International, Michigan AgrAbility, MSU Adaptive Sports & Recreation Club, MSU Bikes Service Center, MSU Broad Art Museum, MSU Department of Theatre, MSU IMPART Alliance, NASA/ Arizona State University, Robert Bosch LLC, and Village of Alanson.

Eaton Aerospace Test Facility
Dual Driven Intensifier

Eaton Corporation is a power management company that helps provide solutions through electrical, aerospace, hydraulic and vehicle products and service. Eaton Aerospace specializes in the development of aerospace products and technologies used in commercial, military, and business aviation. The Jackson Test Lab is fundamental in the testing of Eaton's conveyance product line, providing top-of-the-line assessment through analysis of pressure, temperature, motion, and vibration data obtained during testing.

Eaton has a servo valve that operates an intensifier on a 2:1 ratio, which was used for applying pressure. The servo valve has two sides, sides a and b, which operate individually applying pressure. Because of this, when the pressure is lowered, the pistons lack the force to lower the pressure effectively on side b. The pressure over time can be seen in the figures to the right. Our goal was to create a dual-driven intensifier by utilizing the unused port on side b to drive both sides at the same time. This increases the control over lower pressures and increases the number of cycles the intensifier can run.



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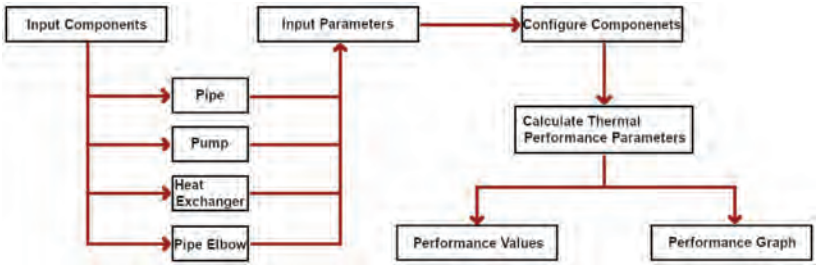
Dr. Giles Brereton

Eaton Aerospace Test Facility

Liquid Cooling System Steady-State Design Tool

Eaton Corporation is a global power management company that provides products and services across diverse industries, including aerospace, automotive, and industrial markets. Eaton is known for its innovative solutions in thermal management systems, providing critical cooling technologies for advanced electrical and mechanical components. These systems ensure that high-performance equipment in industries such as aerospace remain operational at safe temperatures, preventing overheating, and maintaining safety standards.

For this project, our team developed a Liquid Cooling System Steady-State Design Tool to streamline and optimize the thermal management process. The tool was designed to calculate and predict steady-state performance metrics, such as temperature, pressure, and flow rate, across various components in a liquid cooling system. Using object-oriented programming integrated with MATLAB, the tool enables engineers to evaluate the performance of system architectures, facilitating component sizing decisions. This innovative tool will enable Eaton to enhance the design and efficiency of thermal management systems, reducing computational complexity while improving overall system optimization.



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MSU Broad Art Museum
Collapsible Art Transport Bin

The Broad Art Museum connects Michigan State University with the Greater Lansing Area. With over 20,000 square feet of gallery space, the Broad centers itself upon contemporary art that encourages engagement about current issues and events locally as well as globally. It features local, national, and international artists with a rotating collection of artwork on display as well as a permanent collection of over 10,000 works. The Broad prides itself on telling stories and perspectives through art with a focus on diverse communities. It guides important conversations with co-creation and co-learning to address implicit bias, systematic racism, and social inequalities. Within its walls you can find yourself surrounded by support, community, and representative art.

For this project, our group was tasked with designing and fabricating an advanced-level collapsible art transport bin with a convertible interior and vibration minimization qualities. Transport bins are frequently used to carefully move fragile and/or heavy works of art within the Broad Art Museum. Due to this, the bin needed to maximize vibration dampening while traveling across cement floors and a variety of elevation changes. The bin also needed to be collapsible and modular to enable for convenient storage and easy assembly. These goals were expected to be met, while keeping the integrity of the design to keep the artwork safe and secure.

MSU BROAD ART MUSEUM

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MSU Broad Art Museum
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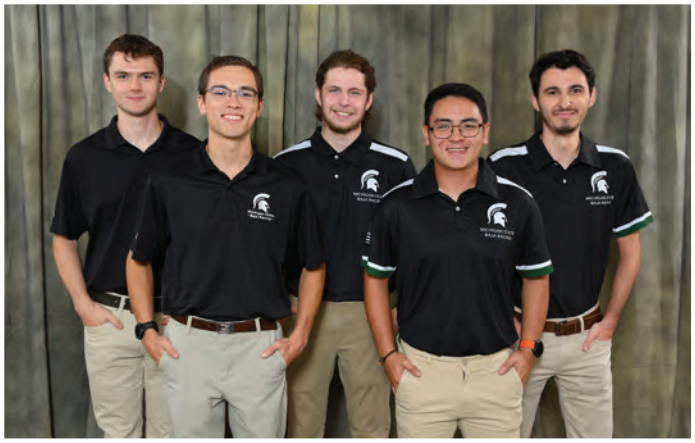
General Motors
Analytical Jounce Shock Model

General Motors (GM) is an American multinational automotive corporation headquartered in Detroit, Michigan. Founded in 1908, it is one of the largest automakers in the world. GM designs, manufactures, and sells vehicles under various brands, including Chevrolet, GMC, Cadillac, and Buick. The company has a global presence, with operations in numerous countries and a wide range of vehicles from electric cars to trucks and SUVs. In recent years, GM has been focusing on electric vehicle (EV) technology, autonomous driving, and sustainability initiatives to lead in the future of mobility.

A jounce shock is a kind of secondary shock that is sometimes employed in automobiles to enhance vehicle ride and handling characteristics. Most commonly seen in offroad vehicles, jounce shocks enable the primary shocks to focus on providing a softer response over smaller obstacles while enabling the system as a whole to still be able to withstand large impacts such as jumps. Our team was tasked with creating an analytical jounce shock model. This model is based upon the actual physics behind the operation of a jounce shock whereas previous iterations of this model employed approximations of a jounce shock. With our model we simulate the fluid dynamics that enable the shock to function. Calculating the fluid dynamics of the shock as a function of user-defined properties enables designers to quickly be able to see how differently tuned jounce shocks will behave in a future system. Our parametric model of a jounce shock is a useful tool in early vehicle development, where physical testing hardware is currently lacking, but designers need to be able to make decisions regarding the sizing of a jounce shock.



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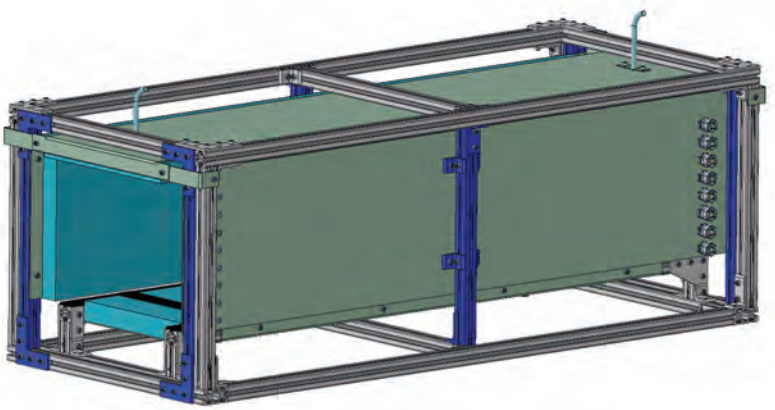
KLA Corporation
Server Characterization Test Bench

KLA is a leading provider of advanced process control and enabling solutions specifically designed for the manufacturing of wafers, reticles, integrated circuits, packaging, and printed circuit boards. Their comprehensive approach to semiconductor process control encompasses every stage, from initial research and development to final large-scale manufacturing. By leveraging innovative technologies and extensive expertise, KLA ensures that manufacturers can optimize their processes, enhance product quality, and improve overall efficiency. This commitment to excellence positions KLA at the forefront of the semiconductor industry, driving advancements that meet the evolving demands of modern electronics production.

Our team was tasked with designing a test bench that can reliably and accurately record metrics from servers of varying sizes that KLA purchased from third party vendors. By recording the mass flux and heat transfer rates at many points along the server, we can better characterize the heat flow and energy usage at any given point, enabling KLA to better design the rest of its systems with the knowledge provided using our test bench. We used CFD for thermal verification of the model we proposed to ensure that the insulation and other irregularities that were designed into the interior of the test bench did not impact its accurate recording capabilities. These irregularities were the holes and channels placed in the foam insulation, which enables power cords and sensors to reach the test bench.



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KLA Corporation
Optical Table Cleaning Device

KLA is an industry leader in creating the most advanced process control systems in the world. KLA creates the equipment necessary for measuring and inspecting critical parameters and defects in the world of semiconductors. They enable semiconductor manufacturers the ability to see the quality and efficiency of their fabricating process. To be able to detect these defects, KLA tools must operate on a scale of sub 100 nm. Because an average piece of dust is around 500 nm, many KLA tools operate in a class 100 cleanroom, which means there must be less than 100 particles per cubic foot.

Some of the many pieces of lab equipment that KLA utilizes are highly stabilized optical mounting tables. These tables have a grid of mounting holes that are spaced out every inch, which in most cases is over 2,000 holes. This table must then be cleaned to operate in a class 100 cleanroom. The current cleaning process consists of wiping each hole with a swab dipped in isopropyl alcohol, which takes a considerable amount of time and manpower to clean the entirety of the table. In this project our team worked to create a handheld device that could clean multiple mounting holes at once and speed up the cleaning time of the optical tables, while still achieving a class 100 cleanroom status.

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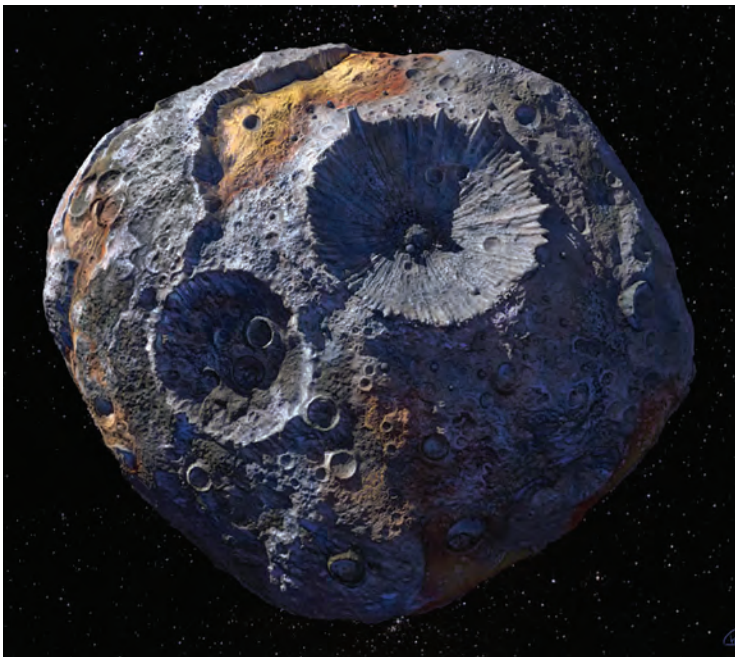
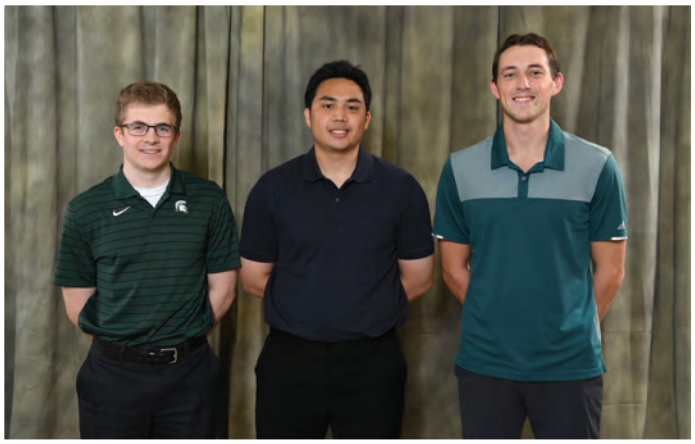
NASA/Arizona State University
Future Power Solutions for Exploring Hypothesized Surfaces

NASA has launched a spacecraft to the asteroid Psyche, which is scheduled to arrive in 2029. It will orbit the asteroid to study the origins of its metal composition. The Psyche asteroid is unique because NASA believes it is made of a mixture of metals (mostly iron and nickel) as well as silicate. This means Psyche could be a remnant of a former planetesimal core and could provide a glimpse into how the Earth was formed.

Arizona State University and Michigan State University have teamed up to design and propose a future power solution that could enhance the study opportunities if NASA ever decided to study the surface of Psyche. This opportunity provides many challenges when deciding on a power solution, as the terrain, temperature, gravity and length of day all need to be taken into account. Our team has decided to design an alternative energy system on the surface of Psyche that will be able to provide power to future NASA missions and will be able to explore the surface of the asteroid. The team understands the many constraints that a project like this presents but is excited for the opportunity to work with NASA and ASU on such an exciting project.





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NASA/Arizona State University
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Dr. Abraham Engeda

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TechSmith has long been partnered with the East Lansing community over it's 35+ years in operation. As of 2022, TechSmith has called Michigan State University's campus our home. By working at our brand new, state of the art headquarters, or using our flexible hybrid work benefit, you'll be able to continue the tradition of excellence beyond your years at MSU and into your career at TechSmith Corporation.

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The Capstone Projects

Dr. William Resh
Professor of Mechanical Engineering

Faculty Advisors: Haseung Chung, Lik-Chuan Lee, Zhaojian Li, Himanshu Sahasrabudhe


Chung


Lee


Li


Sahasrabudhe

Presentation Schedule – Engineering Building, Room 1220

Time	Team Sponsor	Project Title
8:00 a.m.	Magna International	Magna mLCV Enclosure Design
8:30 a.m.	NASA/Arizona State University	ASU NASA Robotic Explorer
9:00 a.m.	NASA/Arizona State University	Modification of Heritage Scientific Instrumentation
9:30 a.m.	Michigan AgrAbility	Rolling Kneeler Cart with Chest Strap
10:00 a.m.	MSU Department of Theatre	Portable Wood Strength Tester
10:30 a.m.	ATESTEO North America Inc.	North America Test Cell Modeling for Future Vision

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, Giles Brereton, Haseung Chung, Abraham Engeda, Tong Gao, Lik-Chuan Lee, Zhaojian Li, Ricardo Mejia, Norbert Mueller, Siva Nadimpalli, Galit Pelled, Thomas Pence, Himanshu Sahasrabudhe, Elisa Toulson, and Mohsen Zayernouri.

Magna International
Magna mLCV Enclosure Design

Magna is a company dedicated to improving technologies and making safe, clean vehicles to protect communities and the planet. The company is at the forefront of mobility advancements in multiple sectors including cars, bicycles, and robots. One ongoing problem is that of green transportation. In addition to pure sustainability, there are locations worldwide where cars can't go or aren't allowed due to carbon pollution, size, noise, wildlife, and other factors. In many cases, thin, cheap transportation that can carry cargo and be protected by the environment would be a solution to this car deficit. This leads to a need for cargo bikes that are protected from the environment.

The bike enclosure includes many amenities and features such as shelving, heaters, transformable designs, and handlebar designs. The most important considerations of the bike that are optimized are one m^3 of cargo space, rider safety, and protection from wind and rain. The bike design has fewer emissions related to manufacture and operation than a car as it is much smaller, battery-assisted, and lighter with less road wear. The possible market of the vehicle includes delivery services, groceries, and car-free zones. The consumers are therefore seeking a lightweight, eco-friendly vehicle that has a large carrying capacity.

Michigan State University
Team Members
(left to right)

Joey Harwood
St. Claire, Michigan

Emma Luzbetak
Lake Zurich, Illinois

Matthew Russell
Williamston, Michigan

Rachel Schenck
Ada, Michigan

Kenneth Gordon
New York City, New York

Magna International
Project Sponsors

Anirban Chakraborty
Troy, Michigan

Julian Knutzen
Aurora, Ontario

ME Faculty Advisor

Dr. Lik-Chuan Lee

NASA/Arizona State University
ASU NASA Robotic Explorer

NASA is a U.S. government agency responsible for the nation's civilian space exploration, research, and aeronautics programs. Founded in 1958, NASA has led pioneering efforts in space exploration, satellite technology, and space science, with landmark achievements including the Apollo moon landings, the Mars rovers, and contributions to the International Space Station. The agency conducts cutting-edge research in astrophysics, planetary science, and Earth observation, while also developing advanced aerospace technologies. NASA's collaborations extend globally with international space agencies and private industry to push the boundaries of human spaceflight and scientific discovery.

Our team employed an iterative design process to model and analyze a robotic exploration vehicle capable of traversing the challenging terrain of asteroid 16 Psyche. Located an average of 3.3 astronomical units from the Sun, asteroid Psyche is hypothesized to have a crater-filled surface composed of a mixture of metal and silicate. To address these complex design requirements, we developed an exploration vehicle that is lightweight, energy-efficient, compact, and reliable, ensuring its ability to successfully navigate Psyche's surface. The suspension system we designed features a unique configuration that enables the vehicle to adapt to various hypothesized terrains.

Michigan State University
Team Members
(left to right)

Zachary Colo
Macomb, Michigan

Jared Throne
Troy, Michigan

Anthony DeMaio
Muskegon, Michigan

Alessio Laura
Monroe, Washington

William Schugars
Muskegon, Michigan

NASA/Arizona State University
Project Sponsor

NASA Psyche Mission
Tempe, Arizona

ME Faculty Advisor

Dr. Zhaojian Li

NASA/Arizona State University

Modification of Heritage Scientific Instrumentation

The NASA Psyche mission was selected in 2017 with the goal of studying asteroid 16 Psyche, an M-type asteroid located in the main belt between Mars and Jupiter. Observations of this metal-rich asteroid prompted an interesting question: can it be studied as a point of comparison to the innermost core of planets such as ours, helping to overcome the impossibility of studying Earth's interior without physically reaching it? Because the Psyche mission launched in October 2023, modifications to the current mission's orbiter were impossible. However, future proposed missions to 16 Psyche would likely incorporate a lander for surface exploration.

Our team identified a prior surface-based mission with a suite of instruments that were most compelling for a scientific surface exploration of Psyche. We met with professors from the Department of Earth and Environmental Sciences at MSU to assist in determining what instruments would be most beneficial for this potential mission. Adjustments and modifications were then designed to the scientific instrument package for the greatest chance of operational and scientific success at Psyche. Other considerations included minimizing both mass and power requirements since the majority of power is projected to be solar. It will also be important to consider scientific instrumentation that will provide accurate and desired results while staying below the sponsored cost threshold.

Michigan State University

Team Members

(left to right)

Berk Demirci
Ayvalik, Turkey

Antonina Klatka
Rock Springs, Wyoming

Lizzie Kooistra
East Jordan, Michigan

Elizabeth Milne
Shelby Twp., Michigan

Ethan Newman
Macomb, Michigan

NASA/Arizona State University

Project Sponsor

NASA Psyche Mission
Tempe, Arizona

ME Faculty Advisor

Dr. Himanshu Sahasrabudhe

Michigan AgrAbility
Rolling Kneeler Cart with Chest Strap

Michigan AgrAbility supports farmers with illness, injury, or aging conditions by developing assistive solutions to help them continue to do what they love. Common conditions that impact farmers include arthritis, cancer, strength issues, and fatigue. These create challenges for farmers to continue their highly active occupations. In addition, many families face financial strain and emotional challenges with these changes. In partnership with Easterseals and MSU Extension, Michigan AgrAbility consultants work with farmers to create affordable tools and research methods that aid those in these situations.

For this project, the goal was to create a rolling kneeling cart that enabled the user to get close to the ground to pick fruits or vegetables or to weed garden rows. For many individuals, it became very difficult to continually get up and down to complete these activities on their farm. This cart made it possible again for individuals with lower back pain, persons with disabilities, or people who are getting older to continue to farm their fields. It includes a chest strap for support as the farmer leans over, and padding on the base of the cart for comfort. This cart was designed to be simple to build and was built using standard materials that enabled farmers to create this cart without a steep initial cost. Also, this design used simple machining processes and readily available materials so farmers would not need to purchase any additional machinery or customized parts. Instructions, including a bill of materials and sourcing information to build the cart, were generated for distribution alongside the prototype.

Michigan State University
Team Members
(left to right)

Kaden Swierkos
Hartland, Michigan

Jack Darrow
Hartland, Michigan

Connor Mackenzie
Armada, Michigan

Hannah Crist
Rochester Hills, Michigan

Ryan Harth
Phoenixville, Pennsylvania

Michigan AgrAbility
Project Sponsor

Ned Stoller
Grand Rapids, Michigan

ME Faculty Advisor

Dr. Himanshu Sahasrabudhe

MSU Department of Theatre
Portable Wood Strength Tester

The MSU Department of Theatre provides students of all levels a space to express creativity through portrayals of various characters. Known for their several performances throughout the year, it is rare to find a night the Wharton Center auditorium is not packed with people eagerly anticipating the scenes to follow. A crucial aspect of a successful show is set design – and that's where the MSU Department of Theatre's Scene Shop excels. The Theatre Department works closely with the Scene Shop to conceptualize set pieces of every production. The Scene Shop then takes the vision of the Theatre Department and builds sets out of wood that get used in performances. Critical to the Scene Shop's success is a lightweight, inexpensive, yet structurally sound set design, which can be set up and torn down in as little time as possible, providing the actors the maximum amount of time to prepare on set.

The goal of this design project was to develop a way for the MSU Scene Shop's skilled carpenters to test various woods for strength, ensuring the structural integrity of their sets long before anyone sets foot on stage. To do this, various factors were considered: our team needed to develop a greater understanding of the material science behind wood grain structure, moisture content, and the force application of a 3-point bending test. To develop a consistent and reliable product, an automatic system was created that returns a strength rating at the push of a button. The project features a bespoke load-cell design utilizing a stepper motor and lead screw, generating enough force to deflect and deform nearly all woods. The force value returned can be used to develop a comparative matrix of wood strength to ensure structural integrity.

Department of Theatre
MICHIGAN STATE UNIVERSITY

Michigan State University
Team Members
(left to right)

Chris DeFinis
Clarkston, Michigan

Miko Parkinson
Howell, Michigan

Ava Shumaker
Grand Blanc, Michigan

Deyuan Wang
Gaylord, Michigan

Aaron Dawson
Royal Oak, Michigan

MSU Department of Theatre
Project Sponsors

Levi Galloway
East Lansing, Michigan

DJ Selmeyer
East Lansing, Michigan

Marc White
East Lansing, Michigan

ME Faculty Advisor

Dr. Himanshu Sahasrabudhe

ATESTEO North America Inc.

North America Test Cell Modeling for Future Vision

ATESTEO North America is a world leader in drivetrain testing and engineering services, assisting automotive manufacturers in developing cutting-edge propulsion systems for passenger vehicles, commercial trucks, and off-road machinery. With expertise in internal combustion, electric, and hybrid drive systems, ATESTEO provides comprehensive testing and calibration solutions to ensure optimal performance, safety, and sustainability. In 2024, ATESTEO opened a 35,000 square-foot state-of-the-art drivetrain testing facility in East Lansing, Michigan, dedicated to eMobility applications. This facility plays a pivotal role in advancing automotive technologies by offering a wide range of services, from validation testing to the development of next-generation propulsion systems. The company's commitment to innovation makes it a key partner for manufacturers working towards a more sustainable and electrified future in the automotive industry.

Our project focused on developing accurate, to-scale CAD 3D models of 11 test cells at ATESTEO's new East Lansing facility. These test cells, each tailored to specific testing requirements, include critical equipment such as Dynamometers and other specialized instrumentation. Using SolidWorks, we meticulously recreated the spatial layouts, enabling the company to assess and optimize equipment placement, ensuring there were no spatial constraints that could affect operations. Our models also provided the flexibility to simulate different configurations, which proved instrumental for ATESTEO's planning of Phase 2 expansions. These expansions include adding new test cells for commercial vehicle drivetrains, a multiple inverter test bench, and an NVH anechoic chamber. By delivering these detailed 3D models, we helped ATESTEO streamline their operational workflow, avoid potential delays due to spatial miscalculations, and set the foundation for their facility's future growth and efficiency improvements.

ATESTEO

Michigan State University
Team Members
(left to right)

Qasem Alobaydan
Alqudaih, Saudi Arabia

Rawad Fakhreddine
Dearborn, Michigan

Fadi Saab
Dearborn, Michigan

Mohammed Alabri
Shinas, Oman

Fallou Mbengue
Ann Arbor, Michigan

ATESTEO North America Inc.
Project Sponsor

Austin Knotts
East Lansing, Michigan

ME Faculty Advisor

Dr. Haseung Chung

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The Capstone Projects

Dr. William Resh
Professor of Mechanical Engineering

Faculty Advisors: Ricardo Mejia, Norbert Mueller, Siva Nadimpalli, Galit Pelled, Elisa Toulson, Mohsen Zayernouri


Mejia


Mueller


Nadimpalli


Pelled


Toulson


Zayernouri

Presentation Schedule – Engineering Building, Room 1300

Time	Team Sponsor	Project Title
8:00 a.m.	MSU IMPART Alliance	Portable Storage Container for Medical Training Manikin
8:30 a.m.	MSU IMPART Alliance	Bed for In-Home Care
9:00 a.m.	Village of Alanson	Solar Tree Sculpture
9:30 a.m.	MSU Bikes Service Center	Kinetic Sculpture to Promote Sustainable Transportation
10:00 a.m.	Robert Bosch LLC	Thermal Model for Automotive Heating and Cooling
10:30 a.m.	MSU Adaptive Sports & Recreation Club	Sled Hockey Transfer Platform – Phase X

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 IMPART Alliance

Portable Storage Container for Medical Training Manikin

The MSU IMPART Alliance was first created in 2016 with the goal of building and supporting the direct care workforce in Michigan by introducing components of workforce development in a more standardized and efficient way. Although starting off with just one training program, the group has since expanded to provide multiple training programs through a variety of platforms. One such platform is in-person through the use of medical manikins, which enable direct care workers in training to gain hands-on experience while they are in the training program. The medical manikin will be transported throughout Michigan, particularly in rural areas where the need for such hands-on experience may be higher. Due to the transport required, this creates a need for a storage container that will hold the medical manikin among other things that may be necessary for such trainings, such as a table, side rails, and clothes for the manikin.

Our team was tasked with creating a storage container that will hold everything listed above and followed some general guidelines. These guidelines included ensuring that just one person could do the setup and teardown, that our storage container could be used in most residential settings with narrow doorways, small elevators, rough driveways, and that it would be able to fit inside a common cargo van.

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.

IMPART ALLIANCE
MICHIGAN STATE UNIVERSITY

Michigan State University
Team Members
(left to right)

David Kurylo
Howell, Michigan

Mustafa Alobaidi
Quatif, Saudi Arabia

Ryan Gioffreda
Timonium, Maryland

Therese Gordon
Poulsbo, Washington

Tori Morgan-Paiz
Stamford, Connecticut

MSU IMPART Alliance
Project Sponsor

William Resh
East Lansing, Michigan

ME Faculty Advisor

Dr. Siva Nadimpalli

MSU IMPART Alliance
Bed for In-Home Care

As we age or experience medical conditions throughout our life, many people will require long-term health support in their homes to avoid being placed in skilled care facilities. Many people have known someone in their life that has required assistance at home. Knowing traditional hospital beds offer numerous features that facilitate care, such as adjustable positions and safety mechanisms, these beds are often too large, heavy, and industrial for typical home environments. There is a growing need for specialized in-home care beds that balance the essential features of hospital beds with a more user-friendly design suitable for residential spaces, while also being offered at an affordable price for all no matter their financial circumstances. Such a bed would not only improve patient comfort and safety but also reduce the risk of injury to caregivers, making it a viable solution for home healthcare with no additional training needed.

Our team focused on successfully developing a home use bed designed to meet the needs of long-term care patients. We focused on modifying existing designs by incorporating key features from hospital beds, such as positioning readjustment and safety functionalities, but is optimized for use in smaller, home sized rooms. The design process involved many hours of extensive consultation with home caregivers and healthcare providers along with professors, ensuring that the bed designed not only improves patient comfort but also minimizes the risk of caregiver injuries. With its user-friendly design and critical safety features, the bed is now a practical solution for in-home care, offering a balance between functionality and in-home compatibility. The bed has also been designed to be affordable for the average American while not losing any of the important features needed for critical care.

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)

Jeremy Wall
Canton, Michigan

Malachi Locke
Ypsilanti, Michigan

Haley Dyer
Macomb, Michigan

Reeddhiman Baidya Rhythm
Dhaka, Bangladesh

MSU IMPART Alliance
Project Sponsor

William Resh
East Lansing, Michigan

ME Faculty Advisor

Dr. Galit Pelled

Village of Alanson
Solar Tree Sculpture

The Solar Tree Sculpture project is part of an art initiative based out of Alanson, Michigan supported by project sponsor Charles Rehmann, an MSU alumnus. The art project, which was initially abandoned, was for metal tree sculptures to be constructed for the Alanson Hillside Gardens. The trees were a class project at the Industrial Arts Institute in Onaway, Michigan, with the purpose of creating awareness of the integration of art and utility. Once the project was restarted, two large metal tree sculptures were built to be placed in a municipal park setting with the potential for more to be made. Each sculpture is about 10 ft tall and weighs over 700 lbs.

The Solar Tree Sculpture Project required the designing of a base so that the trees could be placed in a municipal park setting. An engineered base was needed to support the weight of the trees and make sure they are securely in place in the park. The trees will be placed either on the side of a hill or an undulating grassy area. Another element to the project was the integration of solar panels. Solar panels were to be added to the sculpture so that the trees were not only artistic but also functional. A special emphasis was put on the solar panel integration, the panels and mechanisms, being easily accessible so that they could be used in a residential, municipal park, or commercial setting. The solar power from the trees would be used to power kiosks, irrigation pumps, charge personal devices, or have other practical applications for use in the parks.

The Village of Alanson

Michigan State University
Team Members
(left to right)

Parker Bentley
Traverse City, Michigan

Liam Cooney
Northville, Michigan

Michael Maser
South Lyon, Michigan

Nelson Ladomer
Birmingham, Michigan

Village of Alanson
Project Sponsor

Charles Rehmann
Alanson, Michigan

ME Faculty Advisor

Dr. Mohsen Zayernouri

MSU Bikes Service Center
Kinetic Sculpture to Promote Sustainable Transportation

The MSU Bikes Service Center in East Lansing, Michigan is a bicycle repair and rental shop located on Michigan State University's campus. It offers bike repairs, tune-ups, and a rental program for students, faculty, staff, and the public, with options for daily, weekly, or semester-long rentals. The center also sells used bikes, parts, and accessories, promoting cycling as a sustainable and eco-friendly transportation option.

This project aims to address the problem of abandoned student bicycles at Michigan State University (MSU), which result in financial and environmental costs due to scrap waste. The objective is to create a kinetic sculpture from discarded bicycle parts to promote the leasing of bikes from MSU Bikes instead of purchasing low-quality bicycles. Drawing inspiration from kinetic bicycle sculptures and wind generators made from bike parts, the artwork will capture energy and be easy to maintain. The project will encourage sustainable transportation, reduce costs for both students and the university, and free up parking spaces by reducing the number of abandoned bicycles.

Michigan State University
Team Members
(left to right)

Brandon Kortum
Jackson, Wyoming

Emilia Jakuc
Shelby Twp., Michigan

Ethan Bentley
Canton, Michigan

Maya McRae
Rochester, Michigan

Simon Sajan
Royal Oak, Michigan

Tanner Zidzik
Canton, Michigan

MSU Bikes Service Center
Project Sponsors

Bill McConnell
East Lansing, Michigan

Tim Potter
East Lansing, Michigan

ME Faculty Advisor

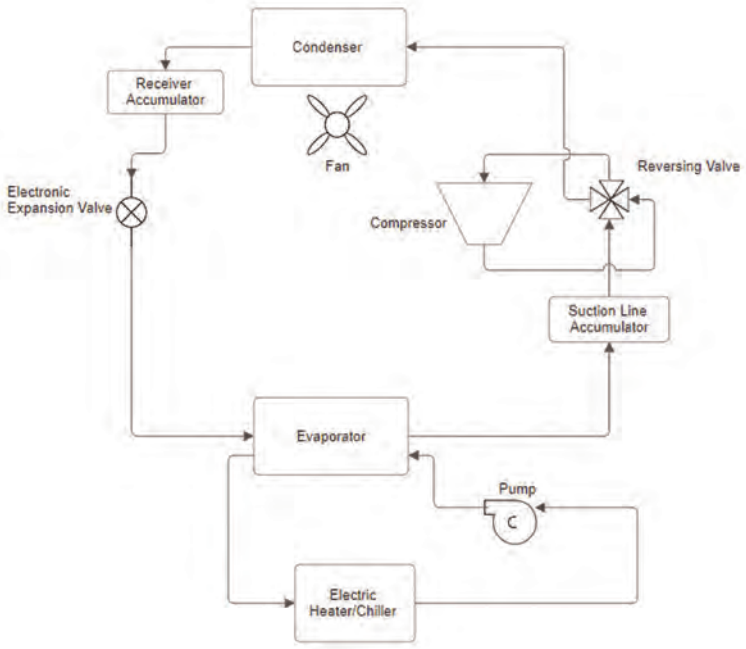
Dr. Elisa Toulson

Robert Bosch LLC

Thermal Model for Automotive Heating and Cooling

Bosch is a multinational engineering and technology company headquartered in Gerlingen, Germany. It is the world's leading supplier for internal-combustion engines, with expertise in software, controls, and services for automotive manufacturers. With the world transitioning to electrified vehicles, it is important to address the challenge that the all-electric driving range is sensitive to ambient temperatures. By focusing on the development of advanced thermal management systems, the all-electric range can be significantly improved.

The Systems Engineering team at Bosch works on advanced propulsion and thermal technologies of future vehicles in North America. To support the development of thermal system products and their testing, there was a need to create a 'virtual thermal testbench' model. Bosch engineers will utilize this model to determine the performance of the refrigeration system for various refrigerant gases and operating temperatures at steady state conditions. Our team developed a fully functional model in Simulink to represent the functionality of the refrigeration system connected to representative components of the vehicle. Using temperature targets, the model can perform heating/cooling functions as needed, while displaying critical parameters of the refrigerant and the coefficient of performance (COP).



BOSCH

Michigan State University
Team Members
(left to right)

Austin Pier
Rives Junction, Michigan

Vanessa Mendez-Valencia
Chesterfield, Michigan

Jacob Rhue
Waterford, Michigan

Yash Patil
Westland, Michigan

Robert Bosch LLC
Project Sponsor

Varun Chakrapani
Farmington Hills, Michigan

ME Faculty Advisor

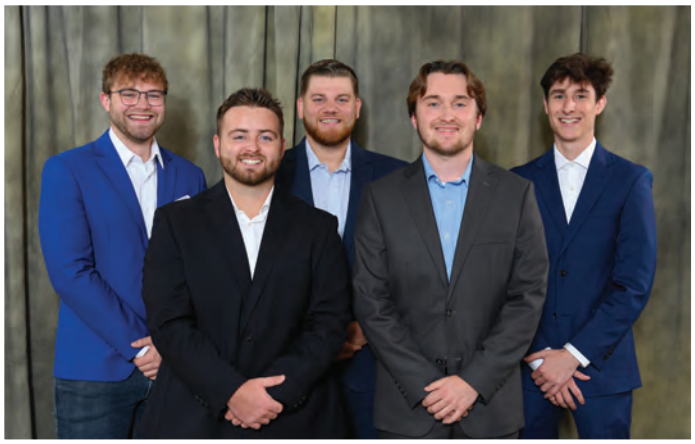
Dr. Norbert Mueller

MSU Adaptive Sports & Recreation Club
Sled Hockey Transfer Platform – Phase X

The Michigan State University Adaptive Sports & Recreation Club (RSO) is a student organization that provides student athletes with physical disabilities an open space to practice and compete in adaptive sports. The club's main goal is to promote a physical lifestyle, along with a safe social space, for adult athletes by providing a range of adaptive sports including sled hockey, adaptive track and field, adaptive rowing, bocce ball, handcycling, wheelchair basketball, wheelchair floorball, wheelchair rugby, and wheelchair tennis. Prior to the club's establishment, MSU students with disabilities had limited accessibility to adaptive sports, and recreation. This club has now become a hub for student athletes with disabilities to explore new sports, make new friends, and live an active lifestyle.

Amidst the diverse selection of sports, sled hockey, like ice hockey, has users compete in individual sleds that consist of either a blade or roller wheels to move on their respective surfaces. For the players, moving from their assistive technology to the sled can be troublesome and difficult. To make this process easier, the sled hockey transfer platform was developed. As the tenth phase of the project, our team's goal was to improve the transfer bars, enabling a more seamless shift to and from the sled. Additionally, an emphasis was put on adding more surfaces that will enable users to control their transition into the sled. Our team aimed to make the final improvements to the product, enabling it to be fully integrated into the club.

Michigan State University
Adaptive Sports & Recreation Club
Est. 2014



Michigan State University
Team Members
(left to right)

Logan Nicks
Oxford, Michigan

Logan Trierweiler
Westphalia, Michigan

Easton Knott
Macomb, Michigan

Nathan Downie
Livonia, Michigan

Ian Ladd
Ortonville, Michigan

MSU Adaptive Sports & Recreation Club
Project Sponsor

Piotr Pasik
East Lansing, Michigan

ME Faculty Advisor

Dr. Ricardo Mejia

Design Day Awards Spring 2024

ME481 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: MSU Combat Robotics Team "Combat Robotics Vehicle Design and Development"

Left to right: Ellie Clark, Ryan Prost, Ahmed Abboushi, Nicole Gibbons, Owen Korff, Ari Bozann

---

ME481 Best Capstone Project Presentation Award

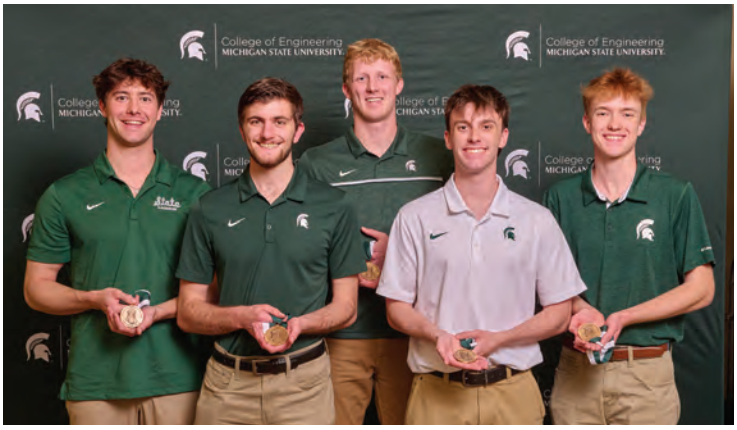
The ME 481 Project Presentation Award for the best presentation of a design project.

Team: Pratt Miller "FSAE Front Outboard Electric Motor Assembly"

Left to right: Rafael Abage, Anissa Sant, Ronak Patel, Cameron Hesano (missing: Matthew Ajlouny)

ME470 da Vinci Award (Best Mechanical Design)

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

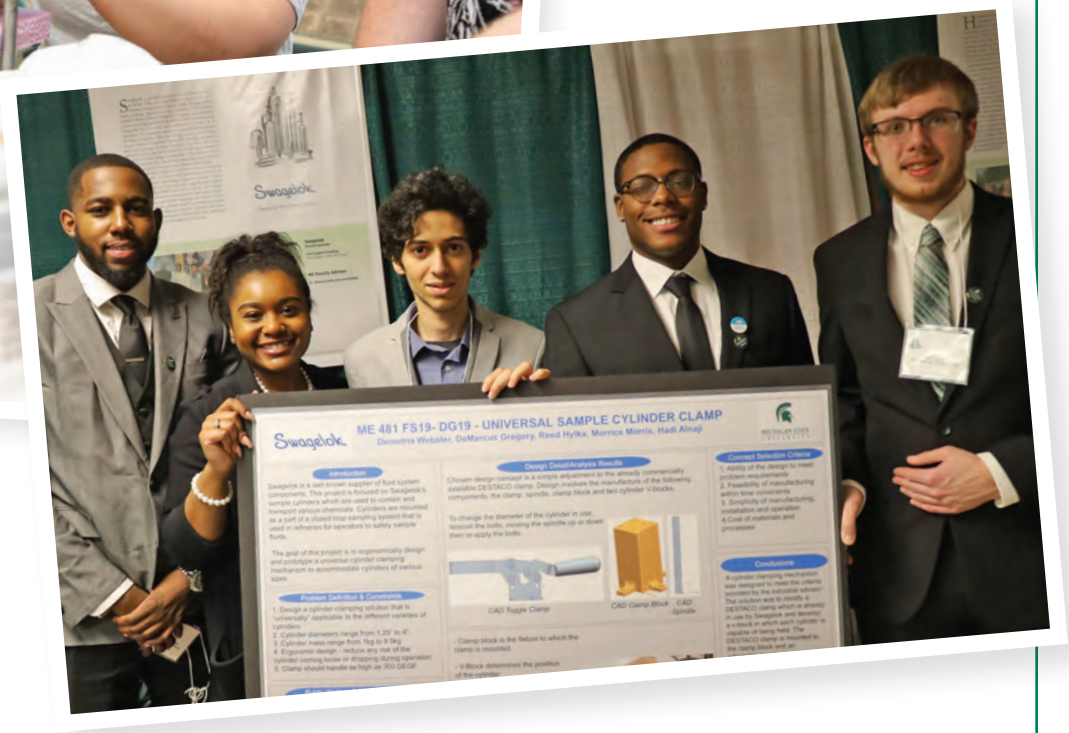


Left to right: Kieran Velasquez, Luke Naughton, Connor Mackenzie, Jack Darrow, Kaden Swierkos

MICHIGAN STATE UNIVERSITY

COLLEGE OF ENGINEERING SPRING 2024

DESIGN DAY



Look for Spring Design Day projects coming in April 2025!

NOTES

NOTES

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For information on sponsoring Design Day and design projects, contact

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MAGNA

Directing Patron Sponsor