DESIGN DAY

COMPUTER SCIENCE AND ENGINEERING

ELECTRICAL ENGINEERING

CIVIL ENGINEERING

APPLIED ENGINEERING SCIENCES

BIOSYSTEMS AND AGRICULTURAL ENGINEERING

MECHANICAL ENGINEERING

MATERIALS SCIENCE

CHEMICAL ENGINEERING

MICHIGAN STATE
UNIVERSITY

amazon

Executive Partner Sponsor

We at Amazon are honored to partner with the College of Engineering and Michigan State University to highlight the amazing work of MSU Students for Design Day 2023.

Amazon employees use Leadership Principles every day to guide our decisionmaking, problem solving and discussing new ideas. We see those leadership principles integrated in the projects from this year's Design Day. Projects are Customer Obsessed as they work backwards from the customer to solve what is really needed. Students worked hard to Invent and Simplify on behalf of customers, trying new and different experiments before finding the best simplified solution. All students Delivered Results in their projects to showcase solutions for Design Day and we are excited for them to continue to see success.

Amazon has witnessed innovation, creativity and solution-focused ideas from previous Design Days and we know this one is no different. MSU students worked relentlessly to solve real world problems using their skills and knowledge acquired while in the College of Engineering at MSU. These skills will help propel them into the workforce where they will be our future engineers, leaders, innovators, entrepreneurs and outstanding co-workers.

Congratulations and best of luck to all the students, faculty and staff who helped make this year's Design Day a success for MSU and all its partners. We at Amazon are proud to be included and look forward to working with these students in corporate jobs.

Amazon is always looking to hire and develop the best. If you are interested in joining our team please visit amazon.jobs

Sincerely,
Garret Gaw
Vice President
Selling Partner Experience

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MICHIGAN STATE UNIVERSITY COLLEGE OF ENGINEERING SPRING 2024

DESIGN DAY

Look for Spring Design Day projects coming in April 2024!

Welcome from the Dean

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

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

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

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

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

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

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

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

Dr. Leo Kempel
Dean of the College of Engineering
Professor of Electrical and Computer Engineering
Michigan State University

AMAZON DETROIT
INTERNSHIP PROGRAM
Jr. Software Dev Engineer

Are you passionate about innovation and developer experience at scale? Are you interested in working on an amazing team that is building new experiences from the ground up? Amazon is seeking excellent student programmers to work in an internship program located in Detroit.

QUALIFICATIONS

✔ College Student

✔ Ability to work 16 hours a week

✔ Graduate date Spring 2025 or later

✔ Solid knowledge of JAVA or equivalent

✔ Networking knowledge

✔ Advanced programming classes completed at University

More information email us
jrdeveloperprogram@amazon.com

amazon

Design Day Events Schedule:
Friday, December 8, 2023

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					
EGR 100 Presentations			2nd Floor 2300 Hallway 8:30 a.m. – 11:30 a.m.				
ME 412 Competition		1st Floor Room 1252 8:00 a.m. - 11:30 a.m.					
ME 470 Competition		1st Floor Room 1345 8:00 a.m. - 11:45 a.m.					

CAPSTONE COURSES							
CSE, ECE and ME Posters		ME Posters: 1st Floor 1300/1200 Hallway 8:00 a.m. - Noon ECE Posters: 2nd Floor 2200 Hallway 8:00 a.m. - Noon CSE Posters: 3rd Floor 3200/3300 Hallway 8:00 a.m. - Noon					
CE 495 Project Presentations		1st Floor Rooms 1225, 1230, 1234 8:00 a.m. - Noon					
ECE 480 Project Presentations	2nd Floor Rooms 2205 7:20 a.m. - 12:40 p.m.						
ME 481 Project Presentations		1st Floor Rooms 1202, 1220 & 1300 8:00 a.m. - Noon					

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.	

1st Floor Engineering

ME 470
Rm 1345
Auditorium

West Lobby

Engineering Student Organizations

ME 481 Rm 1300

ME 481 Rm 1202

ME 481 1300 Hallway

1300 Hallway:
Capstone Posters: ME 481

1200 Hallway:
Capstone Posters: ME 481

ME 481 1200 Hallway

ME 481 Rm 1220

CE 495 Rm 1230

ME 412 Rm 1252

CE 495 Rm 1225

CE 495 Rm 1234

to Anthony

2nd Floor Engineering

K-12 2400

2300 Hallway:
EGR 100

ECE 480
Presentations
Rm 2205

2200 Hallway:
Capstone Posters: ECE

K-12 2245

K-12 Rm 2250

Overview

Color Legend:

- CEE
- CSE
- ME
- ECE
- Joint/Other
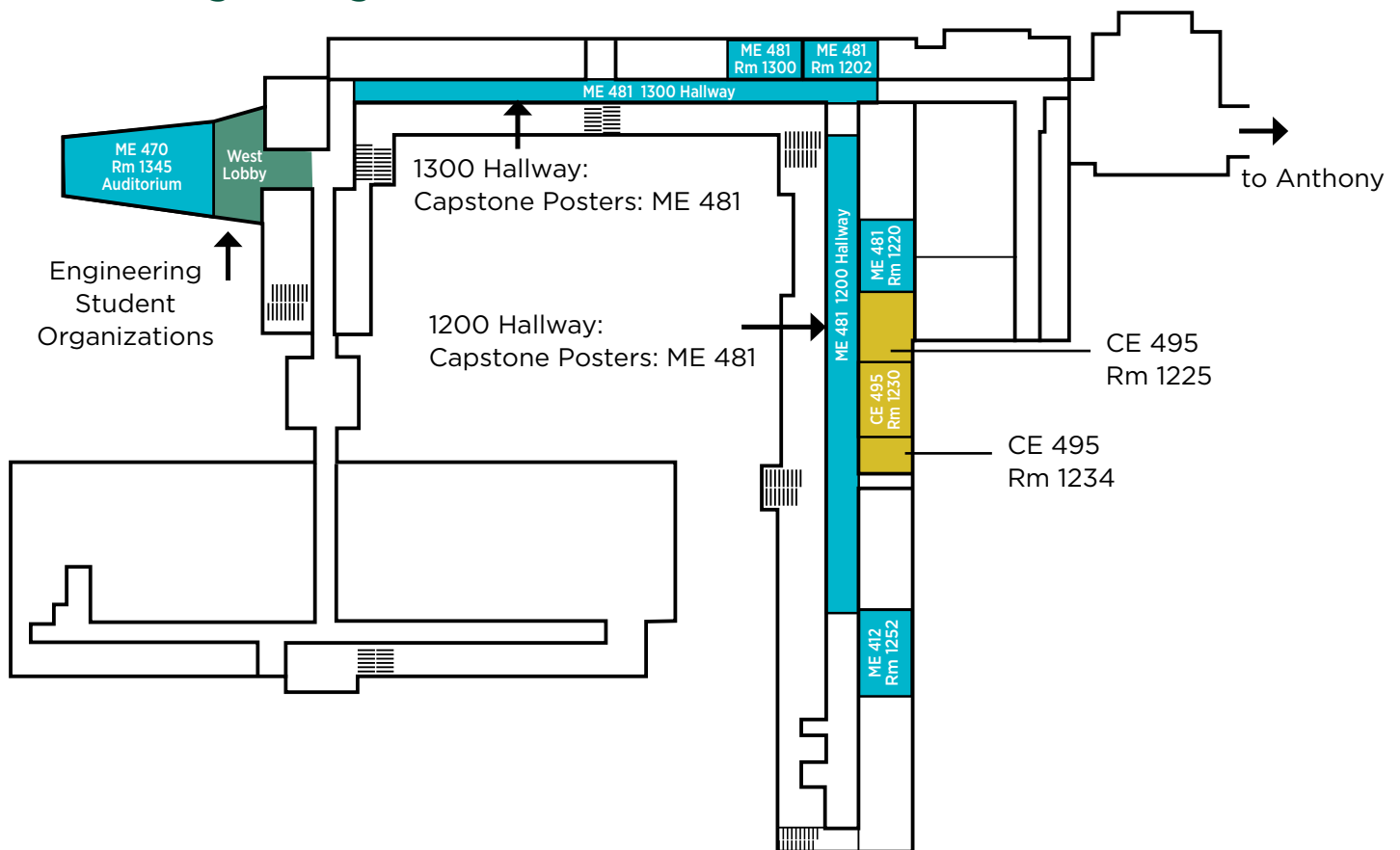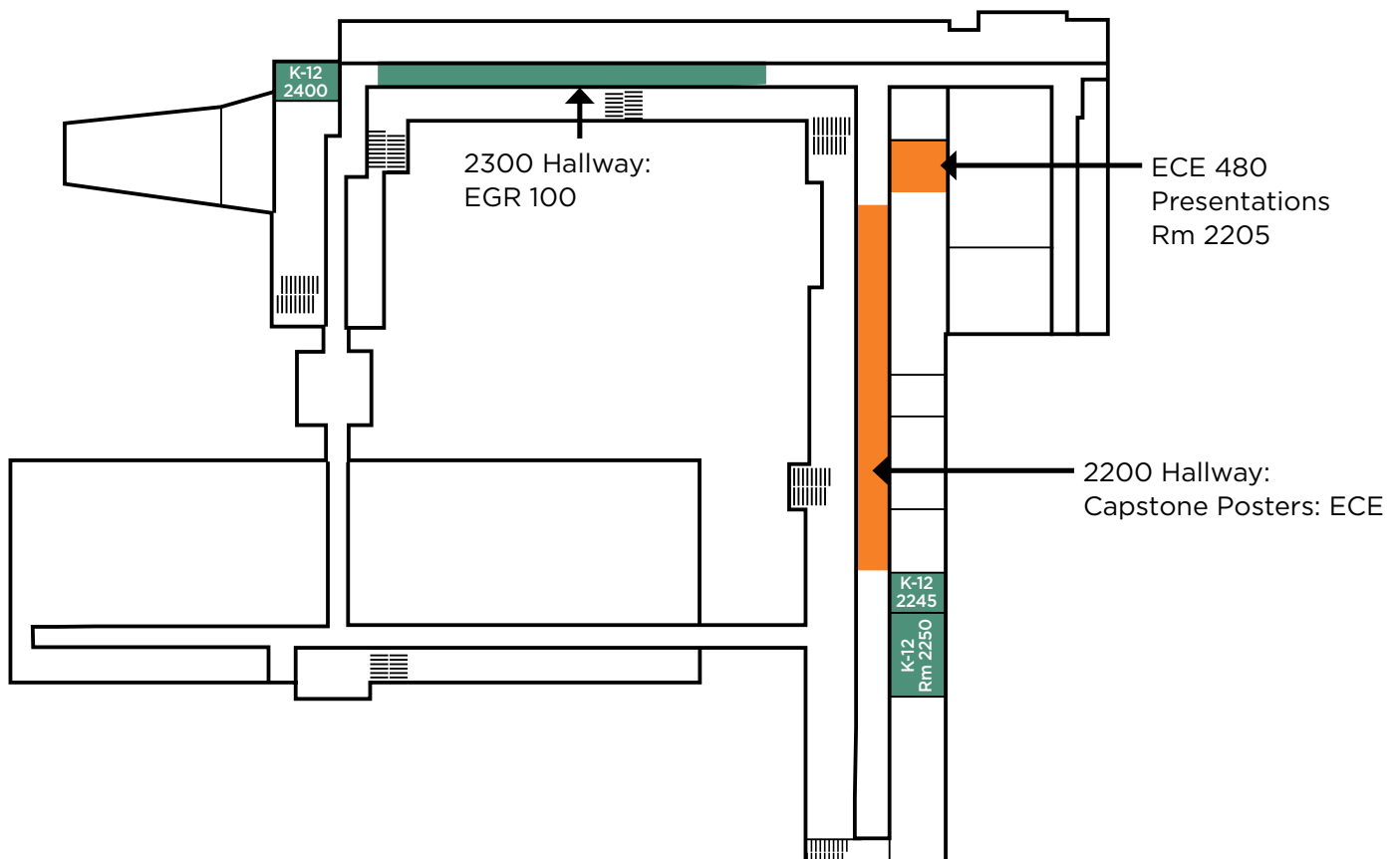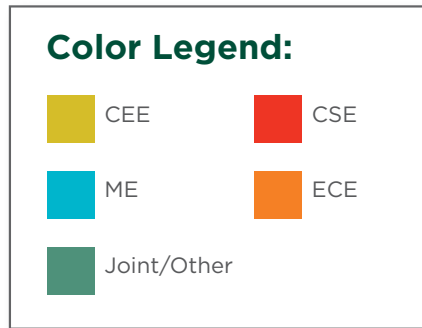
Design Day Floor Plans of the MSU Engineering Building

ENGINEERING

ANTHONY

Rm 1279

Rm 1281

MEAT LAB

DAIRY

ENGINEERING

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

N
NW NE
W E
SW SE
S

3rd Floor Engineering

3300 Hallway:
Capstone Posters: CSE 498

3200 Hallway:
Capstone Posters: CSE 498
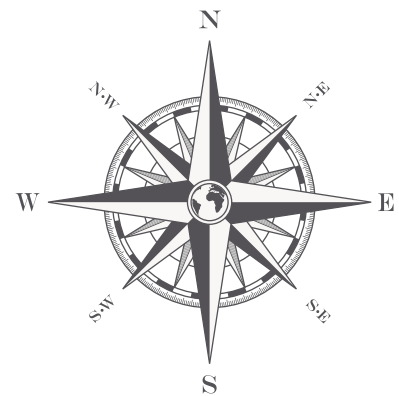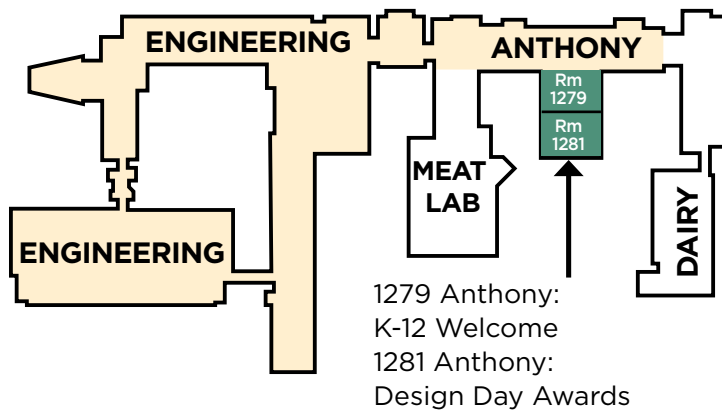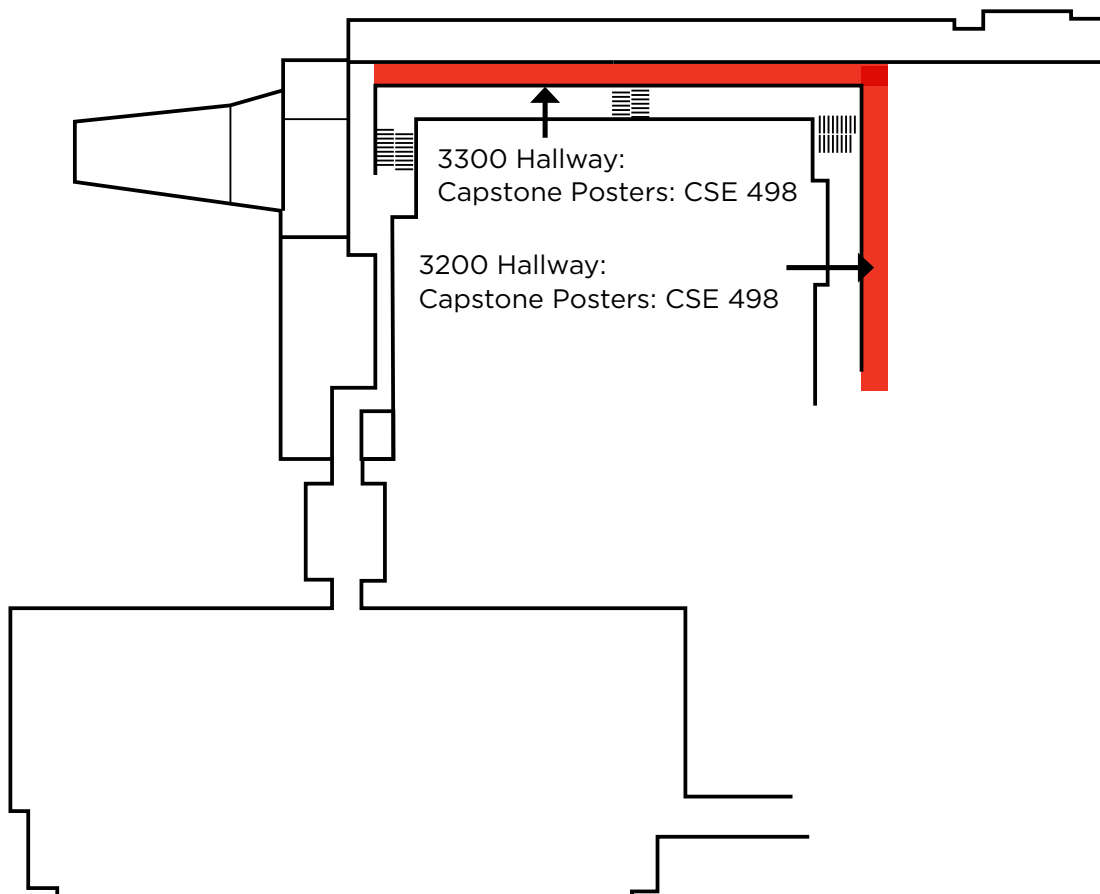
High School Innovation & Creativity Day

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

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

The following schools and groups will be participating in this Fall's Design Day events: Detroit Area Precollege Engineering Program (DAPCEP), Innovation Central High School (ICHS), Macomb Math Science Technology Center (MMSTC), 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.

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

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

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

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.
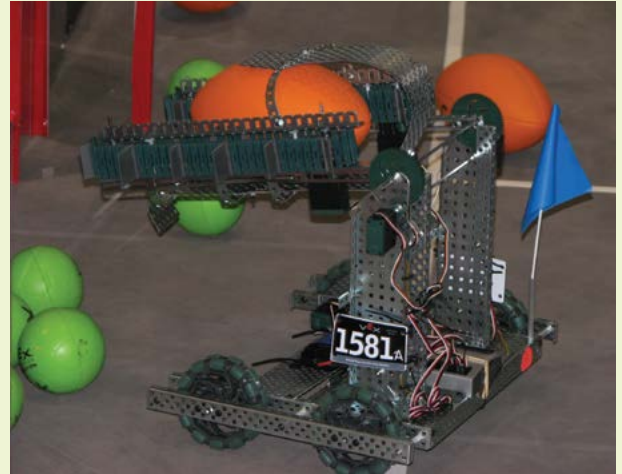
INTERDISCIPLINARY ENGINEERING BUILD

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.
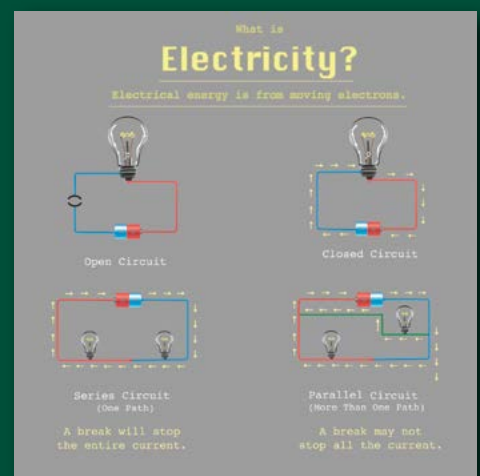
The K12 Awards: Spring 2023

EGR 100 Art Installation
Odrey Barreto, Mina Park, Drake Reid, Farham Razin

EGR 100 Iron Man LED
Kathryn Czewski, Spencer Spray, Elena Ristoski,
Sahana Balaji, Aleida Contreras

EGR 100 LED Phone Case
Evan Fioritto, Arya Amiri

K'Nex Bridge Build
Women in Engineering — Julia and Brynn

VEX Robotics
DAPCEP – Robichaud HS — Sia and Raniyah

Congratulations to All of Our Spring 2023 Award Winners!

Roosevelt®

simple. seamless. smart.

Roosevelt is the first technology solution to deliver a simple, seamless, and smart platform to run your business. Roosevelt's industry-leading claims processing capabilities will transform the way you operate, allowing you to focus exclusively on your customers and growing your business.

The Culture

Established & Empowering

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**.

EGR 100 Introduction to Engineering Design

Dr. Jenahvive Morgan
Course Instructor

Fall 2023 EGR 100 Project Designs

Adafruit Gemma LED Circuit: Student Design

Course Project

EGR 100, Introduction to Engineering Design, is a college-level course required of all incoming first-year engineering students. It is an integral part of the CoRe (Cornerstone and Residential) Experience. The course introduces students to the engineering profession and the engineering design process through team-based, interdisciplinary design projects and assignments. There are 1129 students enrolled in EGR 100 this semester.

For the final course project, the student teams selected from eight project types: (i) Create a Phone App, (ii) 3D Printing CAD Drawing, (iii) Design a Mini Solar Car, (iv) Water Filtration System Design, (v) Mini Golf Design Project, (vi) Design a Robot, and (vii) CoRe Industry-Sponsored Projects. CoRe Industry-Sponsored Projects involved collaborations with Eli Lilly on Drug Manufacturing Requirements.

3D Printing CAD Drawing Project: Student Phone Case Design

The Capstone Projects

Dr. Anthony Ingle
Teaching Specialist

Faculty Advisors: Professors Cetin, Haider, Ingle, Kumar, Li, Lussenden, Zockaie

Cetin   Haider   Ingle   Kumar   Li   Lussenden   Zockaie

Presentation Schedule Room 1225

Time	Team	Room 1225
8:00 a.m.	Team 1-Red Cedar Civils	First Floor Room 1225
9:20 a.m.	Team 2-NOV8 Engineering	First Floor Room 1225
10:40 a.m.	Team 3-Peak Engineering Company	First Floor Room 1225

Presentation Schedule Room 1230

Time	Team	Room 1230
9:20 a.m.	Team 4-Red Cedar LLC	First Floor Room 1230
10:40 a.m.	Team 5-True North Engineering Company	First Floor Room 1230

Presentation Schedule Room 1234

Time	Team	Room 1234
8:00 a.m.	Team 6-MMCG	First Floor Room 1234
9:20 a.m.	Team 7-MiOH Engineering and Consulting	First Floor Room 1234
10:40 a.m.	Team 8-J.B. MARCS	First Floor Room 1234

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

Consumers Energy New Lansing Operations Center

Consumers Energy is relocating their existing Lansing service center for gas and electric operations to a proposed site located at the southeast corner of Canal Road and Billwood Highway in Windsor Township, Michigan. The new facility will include office space for staff and work crews with an estimate of over 200 employees. Additionally, the new site includes critical warehouse storage space for materials and tools used in the maintenance, repair, and construction of gas and electric utility distribution lines. Exterior covered storage is required for operational vehicles and equipment, while additional indoor space is required for shop fabrication and repair work as well as heavy equipment repairs and maintenance.

The existing 78-acre site is mostly undeveloped and once housed a few small residential structures. The above ground portions of these former structures were previously demolished, and their foundations remain. The southern portion of the site contains large areas where development will be restricted due to the location of wetlands. Site development requirements include: a truck well and loading dock; fenced secure material and vehicle storage areas; new paved parking; storage yard; water detention; and solar power generation array.

Consumers Energy
Count on Us®
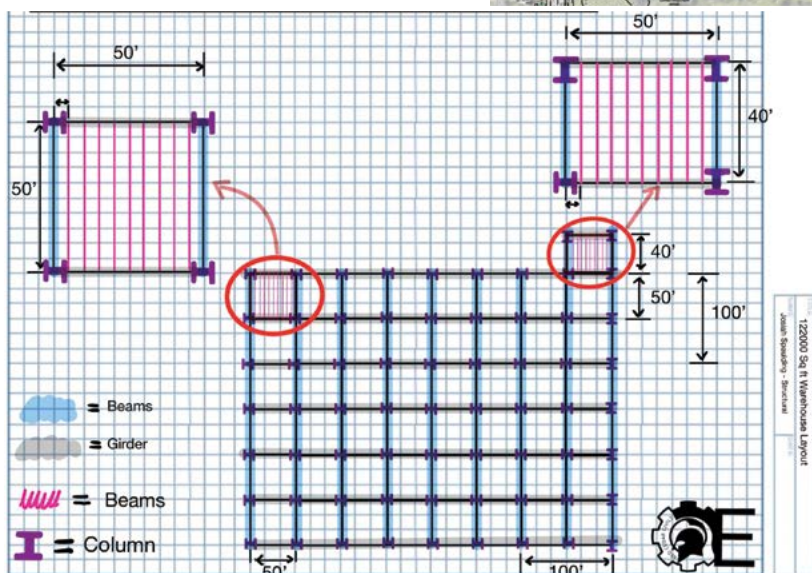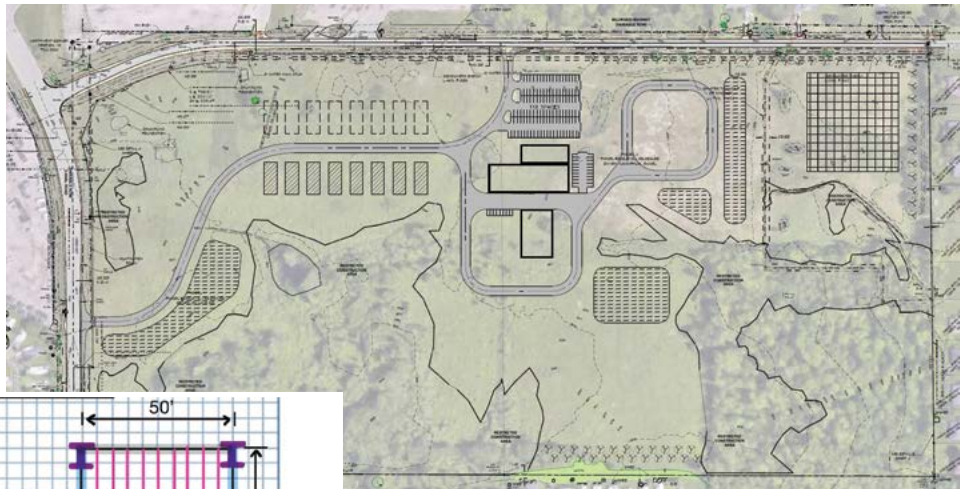
Team 1: Red Cedar Civils
Back row, Left to right: Callum Ovens (H), David Elrite (G), Chris Conkling (E) Front row, Left to right: Vito Cicinelli (H), Josiah Spaulding (S), Marina Amore (PM), Carsen Cuthbert (P), Sam Hine (T)

Team 2: NOV8 Engineering
Back row, Left to right: Zachary Ahmed (S), Austin Detweiler (T), Jacob Anderson (G), Shawn Grant (G), Alec Beson (E) Front row, Left to right: Kelina Evans (P), Dennell Adkins (PM), Therese Diakovasiliou (H)
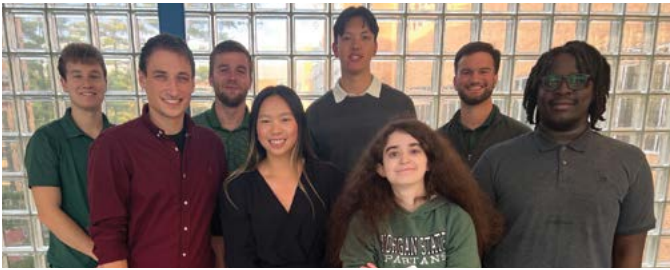
Team 3: Peak Engineering Company
Back row, Left to right: Rian O'Connor (S), Connor Stepkoski (G), JJ Ringling (H), Jackson Frendo (PM) Front row, Left to right: Benjamin Telfor (P), Emily Edwards (E), Alyssa Lifschitz (T), Freddy Kulang (T)

Team 4: Red Cedar LLC
Left to right: Alex Morley (H), Miriam Riviera (P), Kevin Sachs (E), Angelina Suchoski (T), Bobby Armstrong (S), Alexzandria Furchi (PM), Jake Pozar (G)

Team 5: True North Engineering Consulting
Left to right: Jackson Hotchkiss (E), Logan McCall (P), Eric Winston (T), Jesse Lewter (PM), Connor Rankin (G), Max Barnes (S), Madison Green (H)

Team 6: MMCG
Left to right: Heng Zhang (E), Nathan Liu (S), Camryn Cork (H), Joey Kaminski (G), Lucy DeSmet (PM), Charlotte Leblanc (T), Lucas Thompson (P)

Team 7: MiOH Engineering Consulting
Left to right: Andrea Ritenburgh (E), Carleen Parimucha (G), Grayson Kelly (H), Kyndal Boles (S), David Warnock (PM), Braden Lake (T), Zachray Tinsley (P)

Team 8: J.B. MARCS
Left to right: Andrew Wallace (E), James Morrison (P), Rehan Saharan (T), Carson Cornish (G), Mitch Strunk (S), Brita Goren (H), Spencer Kamenoff (PM)

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

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.
RS Engineering LLC

Chuck Rolfe, P.E.
OHM Advisors

Kristen Schuster, P.E.
Michigan Department of Transportation

Alex Sherman, 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.

Sam Baushke, P.E.
Geosyntec

Daniel Bomzer, P.E.
Abonmarche

Michele Buckler, P.E.
Diamler Automotive Group

Erik Carlson, P.E.
Michigan Dept. of Transportation

Dan Christian, P.E.
Tetra Tech MPS

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

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

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

Jordan Doddie, P.E.
HNTB

Max Drenth, P.E.
Carnaghi Structural Consulting

Andrew Dykstra, P.E.
Barr Engineering Co.

Adam Gerlach, P.E.
C2AE

Jordan Hankin
Hubbell, Roth & Clark

David Hayden, P.E.
DLZ

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

Mario Quagliata, PE
Colliers Engineering & Design

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

Brandon Simon, P.E.
Progressive AE

Steve Sorensen, P.E.
PEA Group

Michael Thelen, P.E.
Consumers Energy

Chris Zull, P.E.
Progressive AE

Design Day Awards Spring 2023

Rolla C. Carpenter Senior Design Award

The Rolla C. Carpenter Senior Design Award ($700 and plaques) 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 2023

Team 7: East Lansing Consultants

Left to Right: Kobe Ferguson, Maxwell Julien, Matt Keyes, Joe Dec, Jax Plumert, Jade Arundell

Capstone Course Sponsors

We thank the following companies for their generous support.

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Detroit, Michigan & Charlotte, North Carolina

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Detroit, Michigan & Seattle, Washington

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Palo Alto, California

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Detroit, Michigan

Kellanova
Battle Creek, Michigan

KOHL'S
Menomonee Falls, Wisconsin

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MAGNA
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Grand Rapids, Michigan

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East Lansing, Michigan

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Okemos, Michigan

RPM
Royal Oak, Michigan

stryker
Kalamazoo, Michigan

TechSmith
East Lansing, Michigan

UNION PACIFIC
Louisville, Colorado & Omaha, Nebraska

UNITED
Chicago, Illinois

URBAN SCIENCE
Detroit, Michigan

UWM UNITED WHOLESALE MORTGAGE
Pontiac, Michigan

VECTRA
San Jose, California

VW
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

James Mariani
Professor of Instruction

Tommy Hojnicki   **Griffin Klevering**   **Luke Sperling**

Graduate Teaching Assistants

CSE 498 Collaborative Design

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

During the capstone experience, students

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

Our clients are local, regional, and national including Ally Financial, Amazon, Anthropocene Institute, Auto-Owners Insurance, Bosch, Dow, DRIVEN-4, Evolutio, General Motors, Google, HAP, Kellanova, Kohl's, Lockheed Martin Space, Magna, Meijer, Microsoft, Moii.AI, Mozilla, MSU Federal Credit Union, Roosevelt Innovations, RPM, Stryker, TechSmith, Union Pacific, United Airlines, Urban Science, UWM, Vectorform, Vectra AI, Volkswagen, Whirlpool, and WK Kellogg Co.

Ally Financial
Money Moves: Ally Financial Education Platform

Headquartered in Detroit, Michigan, Ally Financial is one of the top 25 financial holding companies in the United States and is a leader in digital financial services. Ally provides financial products for consumers, businesses, automotive dealers, and corporate clients in their commitment to continuously meet and exceed the needs of their clients by constantly changing and evolving the methods they use to help.

To achieve this goal, Ally looks to not only assist their clients in improving their finances, but also to improve their financial knowledge. Assisting customers and businesses with their financial situations can be complicated, as occasionally a customer is not well versed on a particular aspect of finance.

Our Money Moves application teaches customers about the various financial topics and services Ally provides, which ensures that they feel more confident with their finances afterward. This, in turn, saves money for the customer and improves Ally's image.

Money Moves supports profile creation tailored to a customer's interests and experiences, which our software uses to recommend various courses. Users select a course and are taken through content consisting of text, images, and videos. Each medium educates the customer on a current topic. Upon completion, users are quizzed and rewarded with coins based on their performance. With these coins, users can progress through levels. As users level up, they are recommended more difficult courses and unlock specialized financial tools such as interest and loan calculators.

Our software educates customers on many financial topics, saving them money and improving Ally's brand image.

Our application is written in HTML, CSS, and JavaScript, and utilizes the React framework. The application interacts with Express, Docker, and MySQL to gather and store user data, and utilizes Amazon Web Services for infrastructure.
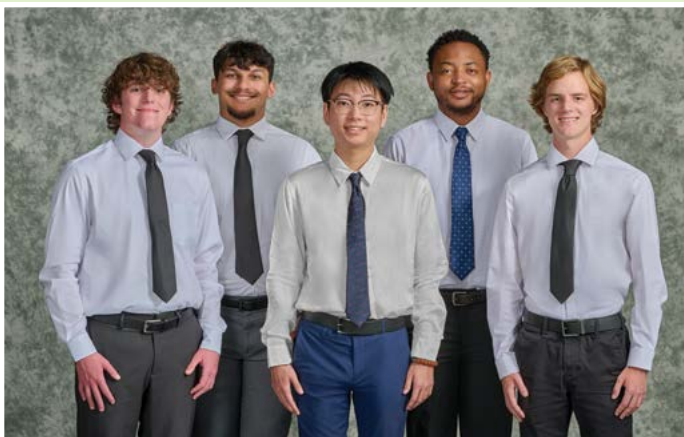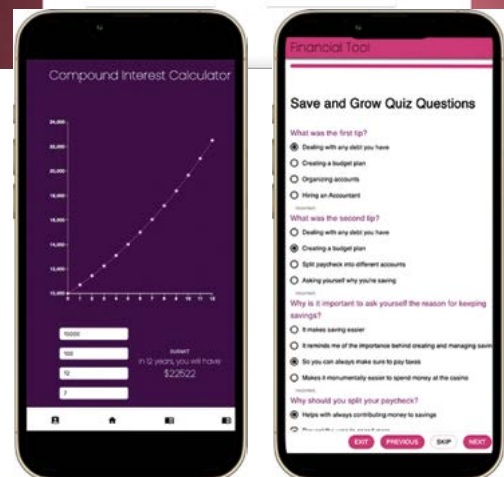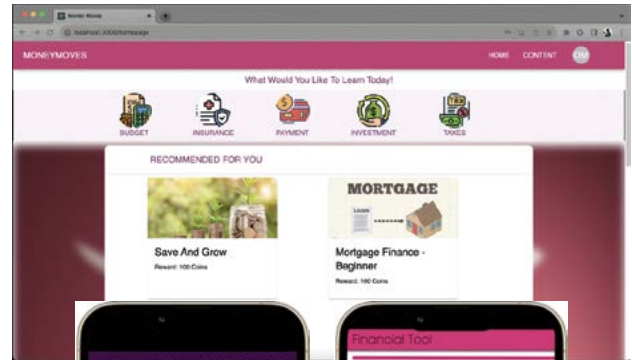
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Amazon
Email Improvement Tool

Amazon, founded by Jeff Bezos in 1994, is the world's largest online retailer, operating in over 50 countries around the world. The multinational technology company focuses on e-commerce, cloud computing and digital streaming. Amazon insists on the highest standards and focuses on earning their customers' trust.

As a part of maintaining these qualities, Amazon oversees thousands of emails that are sent daily to sellers worldwide. This task can be time consuming and complex when managing thousands of Amazon teams and millions of lines of code.

Our Email Improvement Tool is a web application that utilizes machine learning to analyze and provide feedback on uploaded emails. The analysis page of our application, shown on the right, enables Amazon content creators to view generated feedback in an easy and efficient manner. Topics of analysis include empathy, clarity, categorization, summarization and duplicate detection.

Organized by topic, each tab provides a quick preview of the feedback with a detailed description available under each dropdown. These descriptions consist of suggestions, confidence scores and ratings based off the analysis to be viewed by the user.

The duplicate detection feature provides a faster way for content creators to find similar previously written emails during the writing process. The summarization feature creates a quick overview of email content to make analyzing emails easier than ever.

Our system assists users in writing effective and clear emails, improving communication and efficiency at Amazon.

Our web infrastructure is built with a React framework and Amazon Web Services to create a responsive and scalable environment. We also use AWS Amplify, API Gateway, Lambda, DynamoDB and Simple Storage Service to minimize unnecessary overhead. Amazon SageMaker and Amazon Comprehend are used to provide the machine learning solutions.
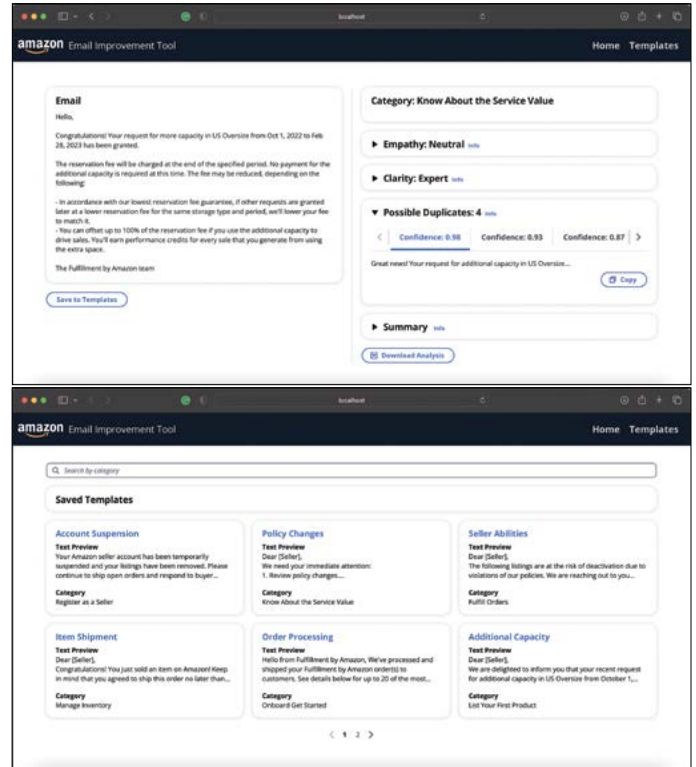
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Anthropocene Institute
Machine Learning for Optimization of Carbon Removal

The Anthropocene Institute is an organization founded by Carl Page in 2012 and is focused on making the Earth sustainable by knowing and investing in the right technology. They partner with entrepreneurs, investors, governments, nonprofits, and universities to foster science, influence policy, promote clean, sustainable energy, and more.

As climate change has become a more serious issue over time, it has become increasingly beneficial for companies and organizations to invest in lowering their carbon footprint. For example, one fourth of Fortune 500 companies have pledged to be carbon neutral by 2030. Investing in carbon removal technology is hard enough for the world's biggest companies, but smaller organizations often don't have the time or resources to effectively do so.

Our Machine Learning for Optimization of Carbon Removal tool is a website used by government agencies, private companies, entrepreneurs, investors, and the public to become informed and to help them make investment decisions.

Our website displays fully interactive and responsive heatmaps for three major carbon capture technologies on their own web pages: kelp farms, reforestation, and direct air capture.

On each page, users are greeted with a heatmap that displays how cost effective it is to implement the specific carbon removal technology for each state and county in the United States.

Users can select other relevant metrics to overlay onto the heatmap, such as the potential number of trees that could be planted in each county. These metrics assist users in selecting the most effective way to maximize carbon removal and minimize costs.

The website is developed as a web application which uses a React framework and utilizes Python machine learning libraries, publicly available data, and the Mapbox JavaScript API to generate the heatmaps.
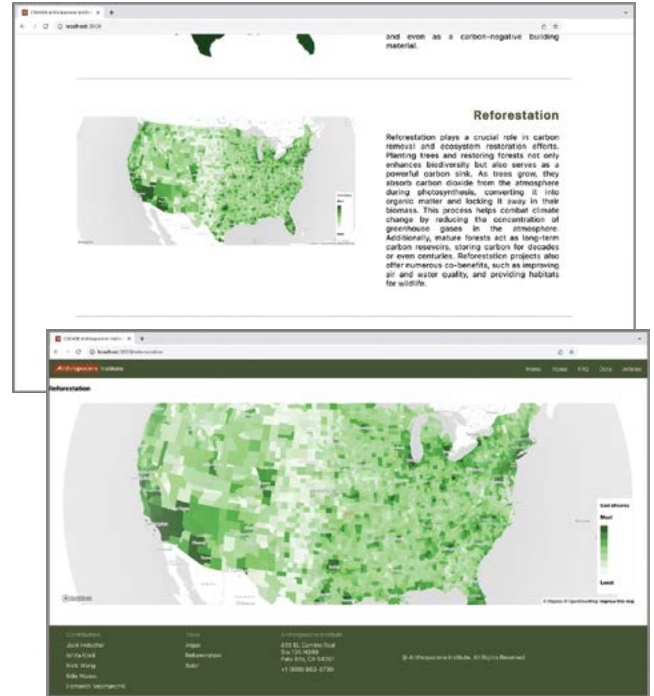
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Auto-Owners Insurance
Help Me See!

Founded in 1916, Auto-Owners Insurance is a Fortune 500 company employing more than 4,700 associates to provide nearly 5.6 million insurance policies across 26 states. Auto-Owners Insurance has been headquartered in Lansing, Michigan for over 100 years.

One of Auto-Owners insurance offerings is home coverage. Making a claim relating to home coverage represents a significant expense for both the company and policyholders. To minimize these claims, Auto-Owners wants a way to provide homeowners with understandable and comprehensive insurance and loss prevention information for common at-risk items.

Our Help Me See! application utilizes the HoloLens 2, an advanced mixed reality headset (shown on the right), and augmented reality to inform homeowners of the insurance information surrounding common household objects.

Users select from two modes, overlay and object detection. In overlay mode, policyholders choose from a variety of common objects, such as refrigerators, toasters, and fire extinguishers. The selected object appears in holographic form in front of the user to be moved and placed within the virtual space. When a user presses the information button on the object, the loss prevention and insurance information appear next to the object.

In object detection mode, the application captures an image to analyze for insured objects that a homeowner has in their home. Detected objects have the same information button seen in the overlay mode. The insurance information can then be displayed for the given object in a similar manner to overlay mode, this time with existing objects.

Help Me See! is built in Unity and written in C#. The object detection mode utilizes Azure AI services to detect and track real world objects.
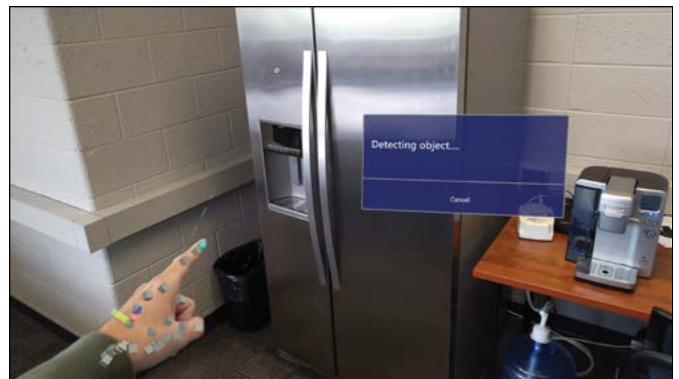
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Bosch
Trailering Safety Tool Using Computer Vision

Bosch, founded in 1886 by Robert Bosch in Stuttgart, Germany, is a leading global provider of technology. Bosch employs over 400,000 associates worldwide to produce automotive components, industrial products, and IoT software.

Bosch is a leading developer of vehicular safety technology and software. While some of Bosch's products are dedicated to driving vehicles without trailers, there is also a major need for safety solutions for trailering. If a trailer is not properly hitched to a vehicle, the trailer could detach while on the road, causing an accident. Thus, a trailer must be continually checked if it is still properly hitched to the vehicle to maintain driver safety.

Our Trailering Safety Tool combats this problem by providing users with a clear and simple way to check if their trailer has been connected correctly and that the trailer connection is maintained during a drive.

Our software tool analyzes an image or video and determines if the components of a successful connection are present. All components are presented to the user in a simple application, with boxes surrounding each hitching component for easy identification.

Users can see a checklist of all necessary components for a successful connection, and whether all parts are present in the image or current frame of the video. The dashboard also displays whether the connection is correct or failed.

This application is used by Bosch to clearly determine if a trailer is connected correctly in a quick and intuitive manner. Our software is also used to continuously check the connection during driving. Our tool assists Bosch to further develop and create software to make trailering safer for consumers.

Our Trailering Safety Tool utilizes Python for our front-end interface, PyTorch for our back-end machine learning model, and the entire tool is containerized using Docker.
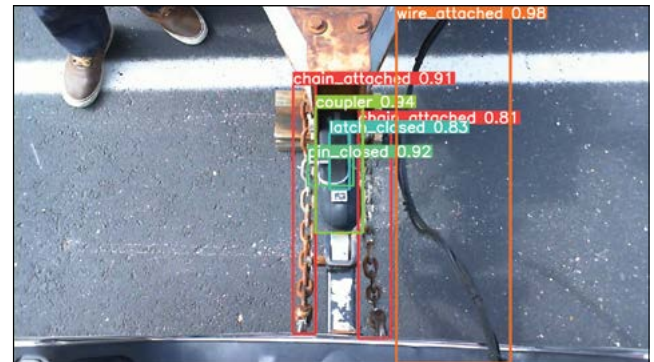
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DRIVEN-4
DRIVEN-4 Connect Update and Upgrade

D RIVEN-4, based in Saint Joseph, Michigan, specializes in providing strategies and technology solutions for delivering traditional and connected products and services to clients in the areas of Product Lifecycle Management (PLM), connected product development, connected operations, cloud services, and cybersecurity. Currently, DRIVEN-4 leverages PTC's ThingWorx and Digi's Remote Manager for remote device management and monitoring.

As they expand, DRIVEN-4 continues to develop their own Internet of Things (IoT) devices with onboard sensors for gathering device data. Hosting and storing data from these IoT devices requires a versatile, yet cost-effective, solution for users to take control of their data.

Our DRIVEN-4 Connect Update and Upgrade tool improves DRIVEN-4's data storage and hosting with a streamlined web application where manufacturers and users can manage devices as well as analyze data transmissions.

Users within an organization manage their IoT devices' operation over the internet and can visualize their IoT device data quickly and easily using our intuitive web application.

Administrators of an organization are responsible for adding or removing users, tracking user activity, uploading firmware to selected boards, making payments with a credit card, and constructing custom tables for any organization device selected.

Using our software platform, DRIVEN-4 employees, as well as their customers, enjoy improved efficiency and cost when dealing with managing IoT devices.

Our application's front end uses HTML, CSS, and JavaScript, while the back end is implemented with Flask, MySQL, and SQLAlchemy. An FTP server makes the connection between the MySQL databases and the IoT boards.
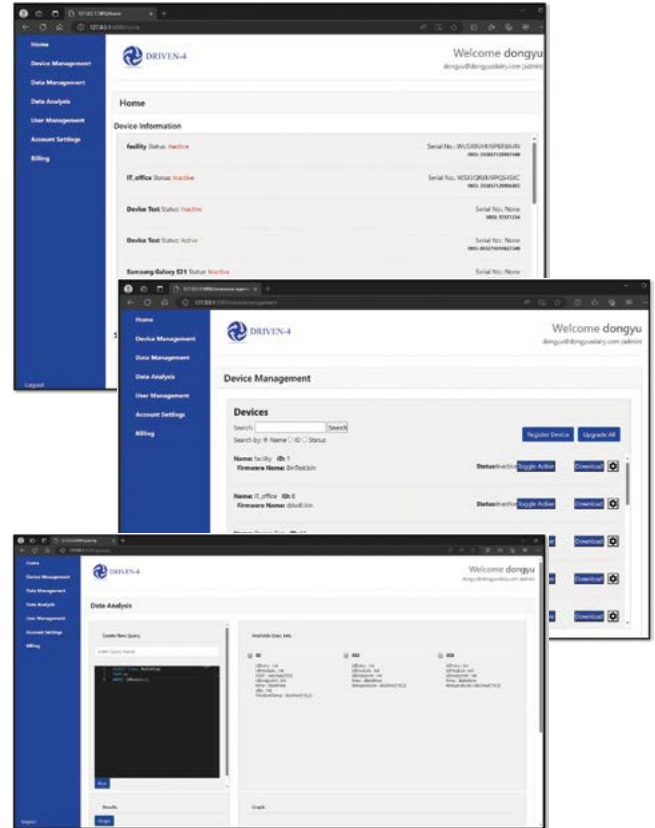
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Evolutio
Evo Observability Platform

Headquartered in Chicago, Illinois, Evolutio is a software solutions company dedicated to bringing visibility, simplicity, and usability to a client's complex enterprise platforms. They provide the necessary solutions through four specialized practices: observability, security, data science and analytics, and automation.

As applications grow increasingly complex, locating issues becomes more and more difficult. Engineering teams are looking to switch to low-cost alternatives for effective application performance monitoring. Evolutio sees an opportunity to further improve and add to existing observability software.

Our Evo Observability Platform is a robust and scalable tool that leverages cost-effective observability tools. Our platform assists developers and system administrators in monitoring the performance of applications in real time and provides extensive visibility into the behavior of each application.

Users can select an application and visualize its performance on our easy-to-read dashboard. The dashboard displays metric information and statistics about the application, such as the average elapsed time for a response and the number of accumulated errors.

Our dashboard offers robust tools, such as an intuitive dependency map to visualize an application's internal flow, an alert notification system that informs users of performance deviations, and a log of application errors to quickly diagnose software issues.

Engineers use our system to improve their efficiency and accuracy while monitoring complex software systems, saving significant time and money.

Our software is built on Python and Flask. Our front end uses ReactJS. The back end uses OpenTelemetry for data collection, Apache Kafka for data streaming, and Apache Druid as the database. We use Kubernetes for containerization, Amazon Web Services for infrastructure hosting, and Harness for continuous integration.
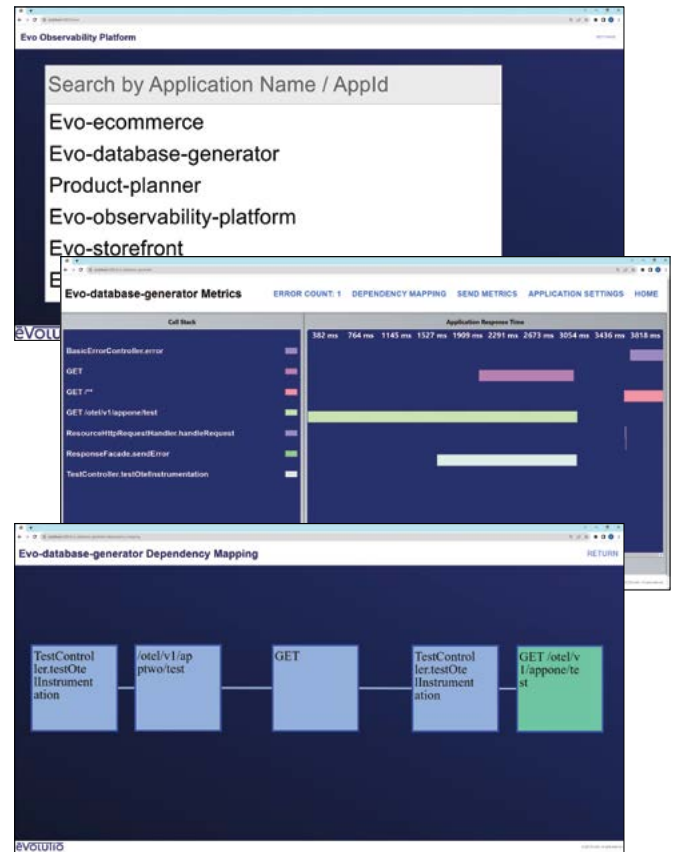
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General Motors
Application Lifecycle Framework 2.0

General Motors (GM) is an automotive company based in Detroit, Michigan. They are the largest automotive manufacturer in the United States and one of the largest automotive companies in the world.

As one of the largest automakers, GM produces a lot of software that needs to be reviewed, deployed and managed. This process needs to be tracked, validated and delivered to relevant engineers. Additionally, GM has many engineering standards that must be met during deployment.

Our GM Application Lifecycle Framework 2.0 provides a better system for managing the workflow of application distribution requests within the company.

Application teams submit requests for software distribution through several forms, which dynamically update based on the use scenario. Once a software distribution request has been submitted, our system analyzes the content of the request and customizes the approval process automatically based on the context of the request.

The system automates much of the validation of requests, ensuring correct information is always submitted. This previously lengthy process now seamlessly catches any input errors as soon as they occur.

Administrators can also view site logs to verify that the process is correct and to get a top-down view of the workflow. Information about each request, such as date and status, is easily viewed and managed.

Our software automatically tracks and validates software deployment requests thereby improving productivity, reducing error rate, and saving time.

Our front end is an Angular application. The back end is built with Java Spring Boot running on an Apache Tomcat server. Our database utilizes MariaDB.

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HAP
Leveraging OpenAI for Business Analytics

HAP is a leading not-for-profit health insurance provider headquartered in Detroit, Michigan. Since 1956, HAP has been enhancing the well-being of the communities they serve by offering quality healthcare plans and innovating to meet the ever-evolving needs of their customer base.

In the rapidly changing digital landscape, HAP recognizes the power of artificial intelligence (AI), especially through OpenAI's advancements. Utilizing AI, HAP strives to improve their website's user experience, make information more accessible, refine health plan choices, and gain deeper insights into customer interactions.

Our Leveraging OpenAI for Business Analytics tool is a web application composed of three unique tools to address these goals.

Our chatbot tool enhances the user experience on HAP.org by quickly answering users' questions clearly and efficiently. It provides real-time data based on HAP.org content, making it easier for users to find the information they seek without the need to navigate through multiple web pages.

Next, the plan selector tool provides a personalized approach to the health plan selection process. By analyzing responses from a customer-completed survey, the selector tool matches users to the health plan that most closely aligns with their individual needs.

Lastly, the call summarization tool takes detailed call transcripts, extracts key phrases, and determines a call's purpose. This enables HAP to quickly understand the reason behind calls, helping them continually adapt to meet customer needs.

The front end of the web application was created using the ReactJS framework along with HTML and CSS. The back end leverages DynamoDB and S3 for data storage, LangChain for information processing, and Python Flask, all of which interact with OpenAI. The application is containerized with Docker and hosted on Google Cloud.
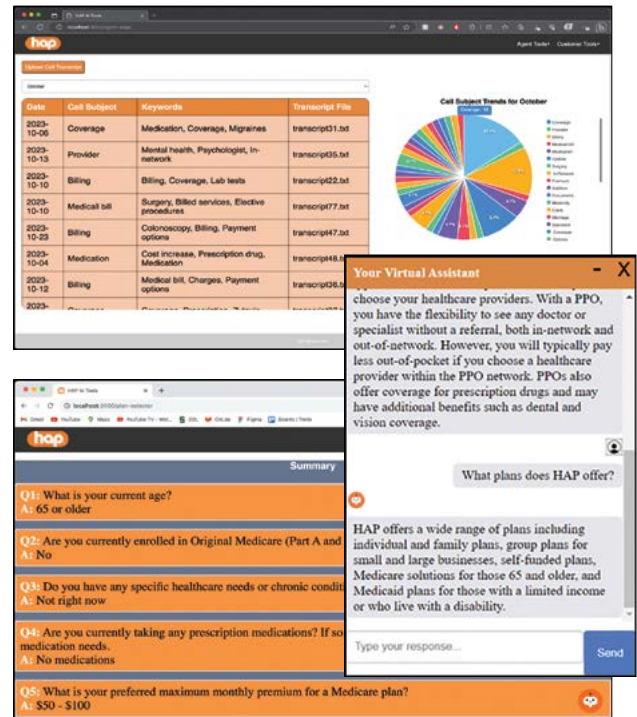
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Kellanova
Global Business Services Process Intelligence

With iconic, world-class brands, Kellanova is a leading company in global snacking, international cereal and noodles, plant-based foods and North American frozen breakfast. Launched in late 2023, Kellanova is building on the strong brand equity and legacy created over the previous 117 years as the Kellogg Company.

Kellanova's Global Business Services plays a pivotal role in the company's operations, streamlining processes through automation and improving overall performance. Their current process relies on manual data entry via Excel for handling customer returns, overages, shortages and damages (OSD). Kellanova recognizes the need to modernize these operations to enhance the customer experience and internal efficiency.

Our Global Business Services Process Intelligence application provides a comprehensive solution to address the existing challenges in customer returns processing at Kellanova.

Our application is an innovative tool that empowers internal Kellanova employees and claims processors to report and track OSD incidents effectively, ensuring swift resolution and improved supply chain efficiency. Processors can submit OSD claim forms, view all submitted claims in an organized fashion and interact with a dashboard to view statistics and visualizations of claim data, all in one central location.

Our software ensures the delivery of the highest quality products and service to Kellanova's customers while providing an environment where employees are equipped with the tools they need to succeed.

The front end of the OSD claim process uses Microsoft Teams as an integrated application developed through Microsoft Power Apps. The Power App connects to Amazon's Relational Database Service which hosts our SQL tables that contain the claims data.
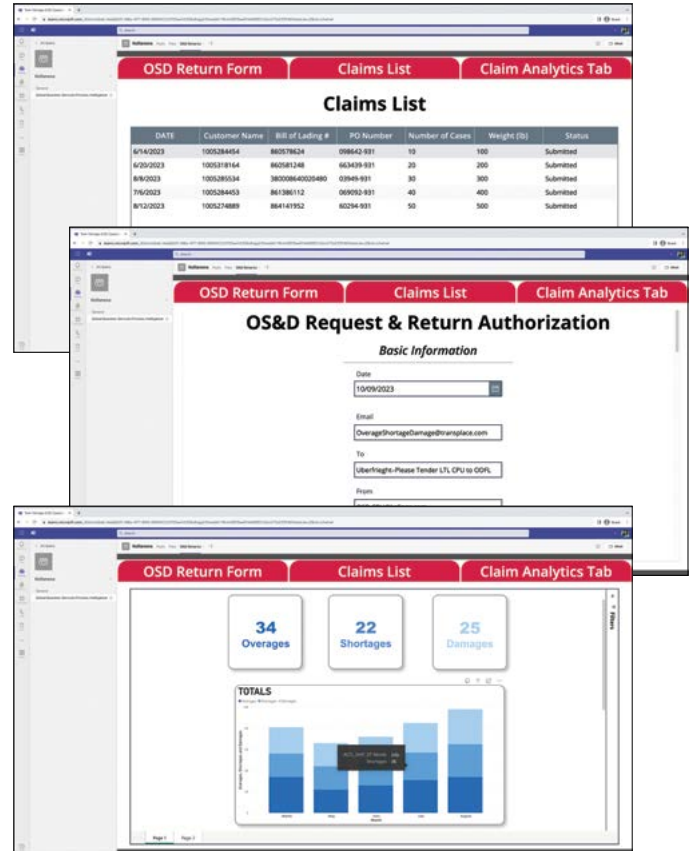
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Kohl's
Infinity Gauntlet

With over 1,100 brick and mortar stores and locations in every US state save for Hawaii, Kohl's stands as a leader in retail. In addition to their physical locations, Kohl's has invested heavily into the online world, where they are highly vertically integrated, running much of their development in house.

Kohl's developers are constantly creating new applications for the company, both consumer-facing products such as apps or promotions and business-oriented tools for other teams within Kohl's.

As Kohl's has expanded their digital capabilities, their usage of cloud service providers to host their online offerings has increased. With the plethora of hosting options available such as Google Cloud Platform or Amazon Web Services, learning the ins and outs of each can be a challenge.

If a developer needs to switch providers due to a unique feature or getting better rates on a competing provider, it can take considerable time to learn how to use the new system.

Our Infinity Gauntlet simplifies the process of creating a project with a new cloud service provider. Just as Thanos' Infinity Gauntlet united the Infinity Stones, our Infinity Gauntlet unites all the cloud service providers onto one platform.

Instead of having to learn the intricacies of each cloud service platform, Kohl's developers use our website to create and host servers on any platform from one convenient location. Our software is designed to be as simple as possible with the most common setting pre-configured to enable faster and easier development.

Our project speeds up the challenging process of setting up cloud platforms, saving time and resources for Kohl's engineers.

The front-end website and forms are created with Backstage, which then calls upon Terraform to create and manage the cloud service providers.
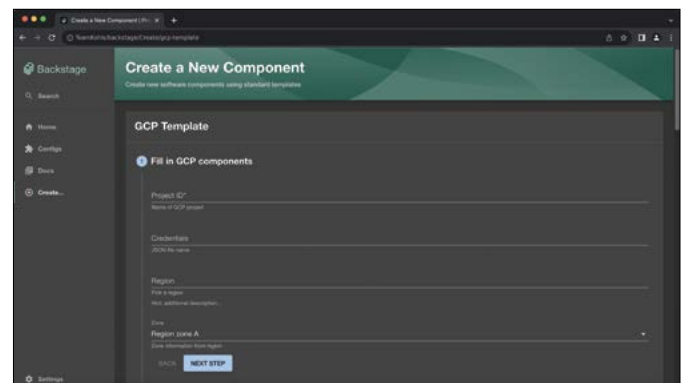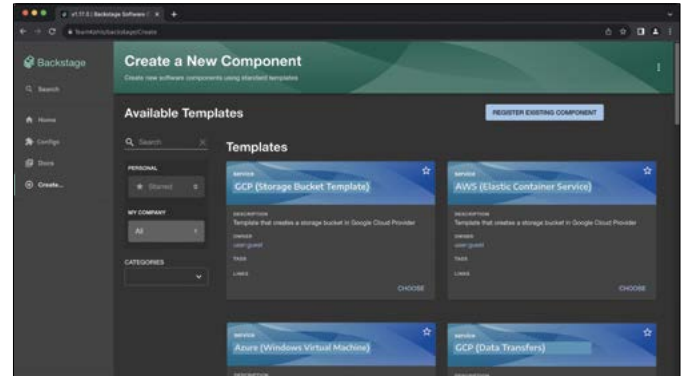
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Lockheed Martin Space
SmartSat™ Heterogenous Computing in Space

Lockheed Martin Space, a division of Lockheed Martin, is one of the largest companies in the aerospace, military support, security, and technologies industry. They work with government and commercial customers to create breakthrough technologies to discover more of space and defend the U.S. and its allies.

Lockheed Martin satellites continuously collect data during space missions. Historically, satellites have offloaded all major data processing functions to ground resources due to computing limitations of in-flight hardware.

With the recent advancements in radiation resistant processing devices, satellites now offer additional processing power in orbit. Lockheed Martin developed the SmartSat™ software infrastructure to facilitate development of satellite flight software and leverage new capabilities in satellite hardware. SmartSat satellites have an open system architecture with significant in-orbit re-programmability, meaning they can be used for a variety of diverse missions.

Our SmartSat Heterogeneous Computing in Space system makes it easier for mission applications to utilize the full power of diverse processing devices in flight. Our system enables faster data processing by enabling algorithms to be run on many types of processing devices to ensure optimal execution. Our software makes real-time decisions on how to best distribute many unique applications across the computing systems available on the satellite.

Our Heterogeneous Computing in Space platform enables efficient computation onboard satellites, consequently improving the efficiency, and reduces the cost for Lockheed Martin.

Our back-end system is built using Lockheed Martin's SmartSat SDK. The application uses AMD Vitis and SYCL to run accelerators on available hardware. The software is built and tested on the Xilinx ZCU102 multiprocessor system on a chip (MPSoC).
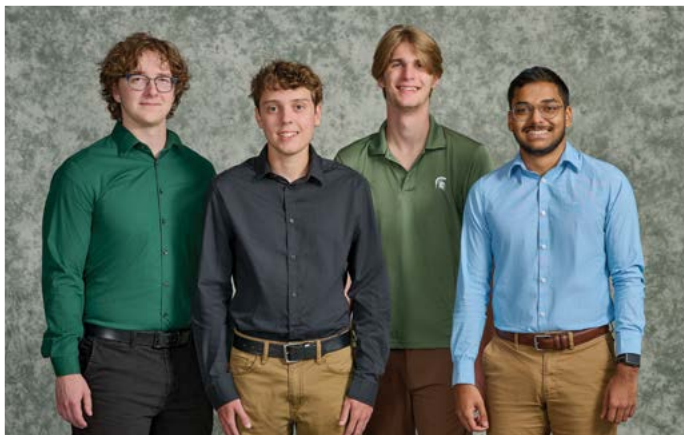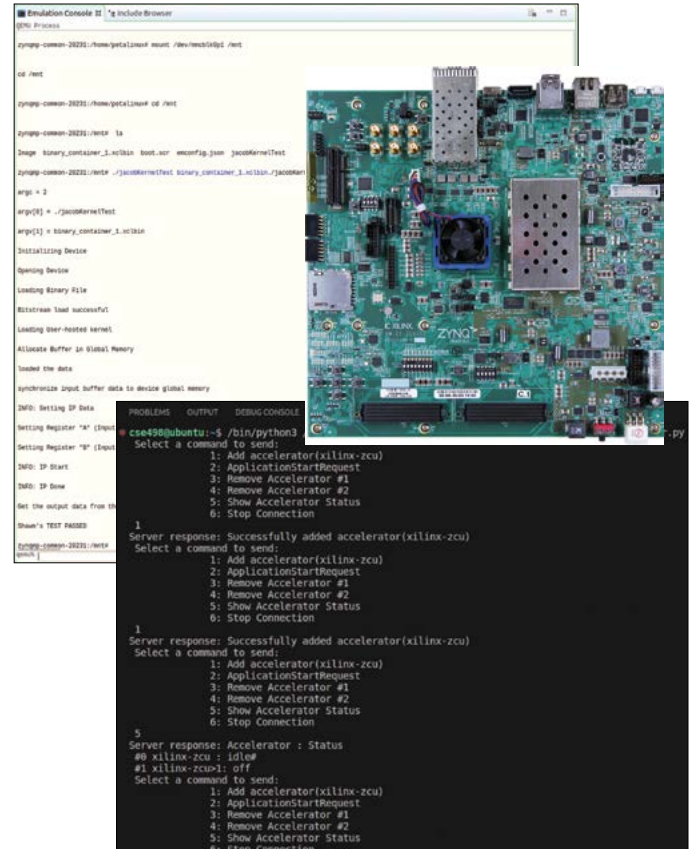
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Magna International
Composable 3D Model for a Manufacturing Plant

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

In the fast-paced world of manufacturing, gaining real-time insights into the intricate operations of a factory has long been a formidable challenge for floor managers. Understanding the status of machines, monitoring inventory levels, and optimizing plant layouts can be a daunting task.

Our Composable 3D Model for a Manufacturing Plant system solves this problem for Magna, using an innovative web interface that models Magna's manufacturing plants in an intuitive 3D representation, shown on the right. Our tool transforms how floor managers oversee their manufacturing facilities, prioritizing convenience and efficiency.

Our platform provides a precise 3D representation of the entire manufacturing plant, with every machine and storage unit accurately placed, each tagged with the real-time status of the asset.

Floor managers access real-time insights throughout the factory to monitor efficiency and productivity remotely. By selecting any machine or storage unit, users instantly retrieve critical data such as operational status and storage capacity.

Our tool allows Magna's floor managers to easily customize the layout of their plant, view the operation's status, and quickly identify issues and weaknesses.

Our system utilizes CesiumJS, which enables factories to be displayed, updated, and traversed by users. Factories and all of their assets are encoded in GeoJSON. Saving and loading factory layouts are done using Node.js API calls to a MongoDB database.
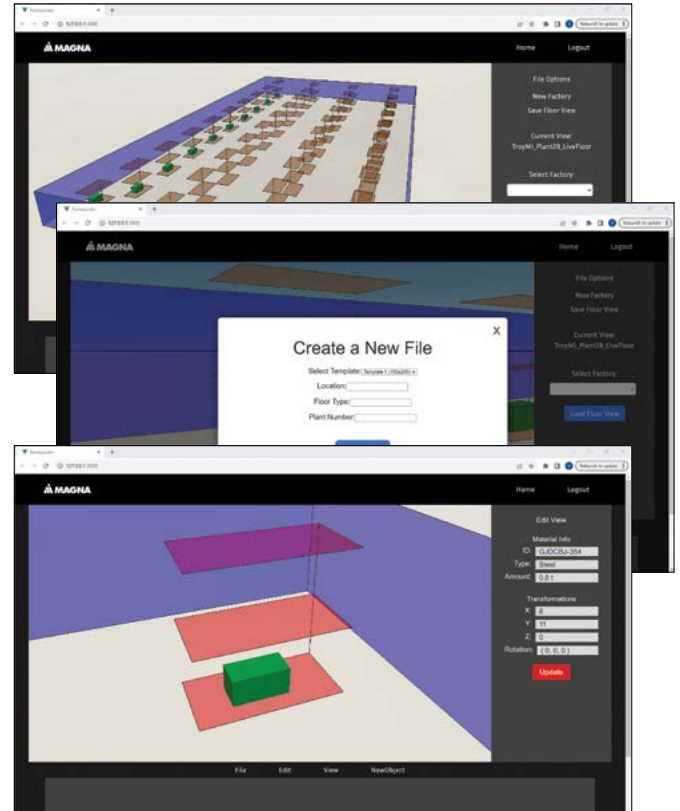
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Meijer
Enhanced Shopping Experience Using AI

Meijer is one of the country's largest supercenter chains, providing high-quality groceries and merchandise to over 265 locations throughout six midwestern states. Meijer is dedicated to elevating the customer experience in all of its stores. One of the ways that Meijer connects to its customers is through its expanding mPerks rewards program.

Serving as a grocer to many of its customers, Meijer would like to provide mPerks users with a tool to provide new and interesting meal ideas for customers to improve their shopping and dining experience.

Our Enhanced Shopping Experience Using AI system tackles this problem and provides users with suggested recipes, all while considering their various dietary restrictions and preferences.

As customers plan their next meal, they use their mPerks account to inform our system of their dietary restrictions and allergies. Our web app is expansive to be as inclusive as possible for a wide variety of shoppers. Customers also provide their meal preferences, such as breakfast, lunch, dinner or dessert.

Unique recipes are then generated using advanced artificial intelligence (AI), taking into consideration information such as a customer's shopping history, their dietary restrictions, and many other factors. Each recipe is presented to the user, who then decides to add the necessary ingredients to their shopping list or ask for a new recipe idea.

Our system improves the shopping experience for Meijer customers and enables shoppers to explore new foods and ideas.

Delivering a user-friendly and seamless experience is made possible through Next.js as our front-end technology. Our front end is able to swiftly and securely communicate with our Azure SQL database. All recipe generation is done utilizing GPT-4 from OpenAI.
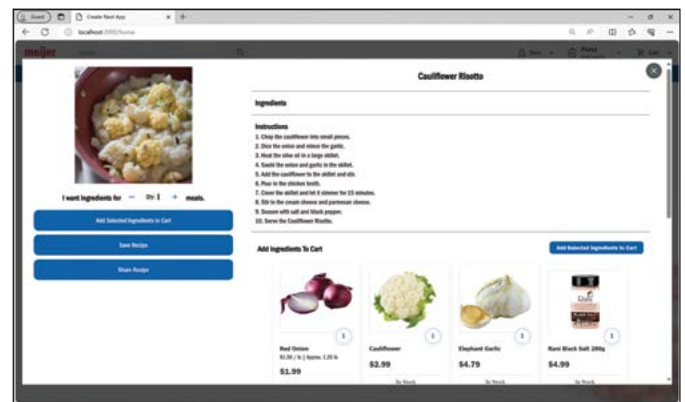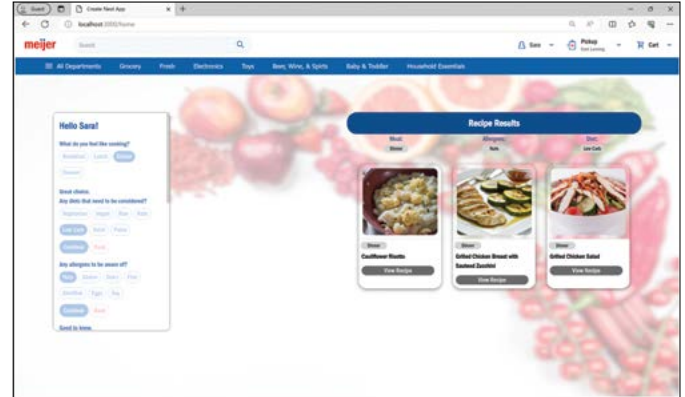
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Michigan State University
clUML: A Browser-Based UML Editor

The Department of Computer Science and Engineering at Michigan State University provides world-renowned courses for over 2,000 students in computer science-related fields. These courses utilize several custom-made software applications developed in-house to facilitate student learning.

One of the skills that all computer science students must learn is the creation and usage of UML diagrams. Such models aid in the visualization of the connectivity between individual components in software systems. Students can make a more informed plan when developing the software structure and easily communicate that structure to other programmers using UML diagrams.

Students currently utilize a third-party program, Visual Paradigm, to create UML diagrams in their classes. Our clUML: Browser-Based UML Editor removes the department's dependency on third-party software.

Based on Cirsim, a university-developed circuit diagramming tool, our system provides students an approach to creating UML diagrams in a familiar format.

Our software features a palette of tools for adding UML components to a central diagram, as shown on the right. Components can be edited and moved directly on the diagram using a mouse or a touchscreen. Connections between classes are easily drawn and edited for placement and multiplicity.

Several quality of life features, such as saved states and diagram sanity checking, enable students to quickly and easily design UML diagrams, saving time and resources for students and instructors alike.

Our software runs on all modern internet browsers, utilizing Node.js/JavaScript, HTML, and Sass/CSS. Our software employs many JavaScript packages, such as DOMPurify for sanitizing user input and Jasmine and Karma for testing.
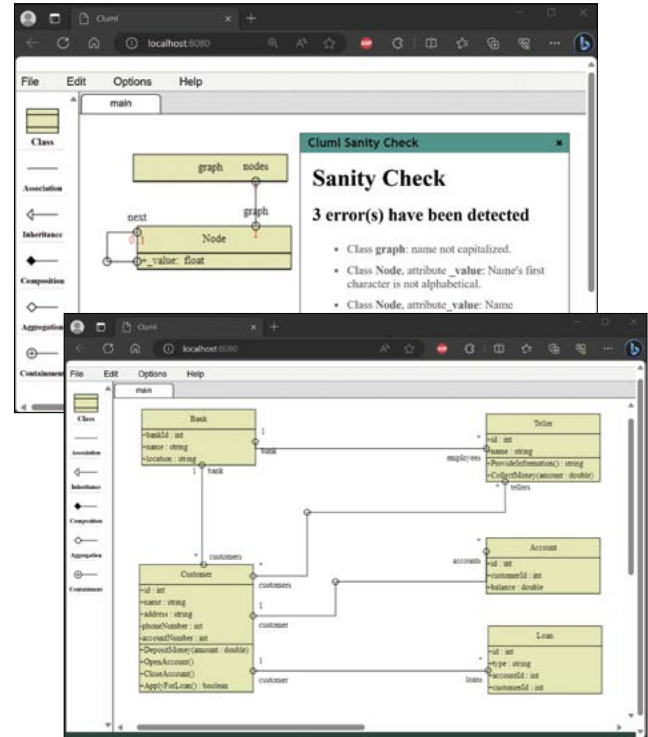
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Moii.AI
Small Object Detection Using CCTV Cameras

Moii.AI is a multinational MSU-born startup founded in 2019 in Troy, Michigan and Chennai, India. Moii.AI leverages state-of-the-art artificial intelligence technologies to provide actionable analytics and enhance security through real-time video feed analysis.

Current CCTV systems require camera feeds to be constantly monitored for small objects, introducing a constant need for labor and the possibility of human error. Due to this, Moii.AI is advancing its capabilities to detect small objects, particularly firearms, to better serve client security needs and support unsupervised surveillance.

Our Small Object Detection Using CCTV Cameras system provides users with a method to detect weapons automatically through a web application and a small object detector created with machine learning. To access the detector's capabilities, clients input their CCTV camera details on the web application.

The weapons detector continuously scans live incoming camera footage for potential threats. When a firearm is detected, the system generates a marked video snippet, highlighting the weapon with a bounding box, and triggers an alert. Our solution prioritizes safety and security by promptly alerting clients through SMS or email, enabling timely interventions.

The web application centralizes the management of CCTV cameras and provides clients with a platform to monitor and manage threats. Additionally, the web application includes a testing feature that lets clients upload images or videos containing firearms, providing an easy method for them to explore the capabilities of the small object detector without facing an actual threat.

The system features a ReactJS-based web application deployed on Firebase. The small object detection model, which handles the gun detection, is trained with PyTorch and SAHI method and is hosted on Google Cloud Platform. A FastAPI interfaces with this model and coordinates with Firebase to relay predictions.
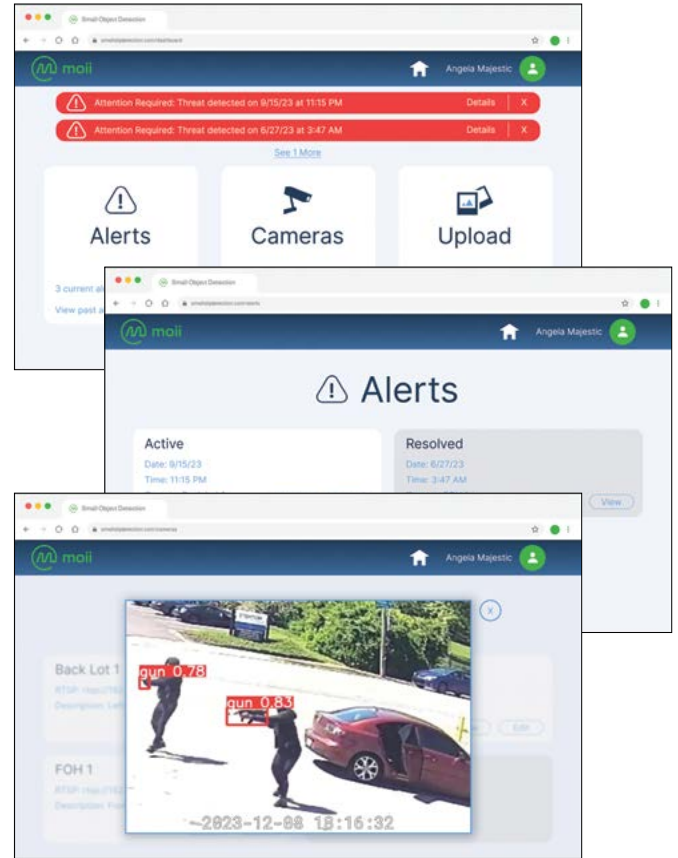
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MSU Federal Credit Union
Digital Banking Car App

Established in 1937, Michigan State University Federal Credit Union (MSUFCU) is an esteemed American credit union. Its ascension to prominence can be attributed to the cultivation of robust affiliations, an unwavering commitment to fostering financial literacy, and active community engagement. As a result, MSUFCU has emerged as the preferred choice for university students, faculty members, and esteemed alumni.

MSUFCU offers members a seamless and secure means to undertake a multitude of financial transactions, ranging from checking transactions to transferring funds to other members, through their internal Member2Member system, all accessible at the touch of a finger.

Due to legislative changes enacted by Michigan in 2023, the physical use of mobile electronic devices while operating a vehicle is illegal. Our Digital Banking Car App is an innovative extension of MSUFCU's current mobile application.

Our application runs on a vehicle's infotainment system, enabling members to safely, intuitively, and quickly perform banking actions while operating a vehicle.

The application gives users the ability to perform actions within their banking application safely. Through voice-controlled technology, members talk to the system through digital assistants to transfer funds, view recent transactions, find nearby loyalties, and locate nearby MSUFCU branch locations.

The software enhances the member experience by delivering a seamlessly secure digital banking interface that caters to their dynamic and on-the-go lifestyles.

The front end of our Android application is written in Kotlin using Java to communicate with the back end. The back end uses a PHP framework that communicates with a SQL database that is hosted on an MSU CSE server.

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Roosevelt Innovations
Predictive Claims Scoring

Roosevelt Innovations, LLC is a software company and subsidiary of Delta Dental, the nation's leading dental insurance provider. Roosevelt Innovations offers end-to-end solutions with industry-leading claims processing capabilities that have saved $972 million in treatment costs for over 23 million members.

Reviewing insurance claims for signs of fraud, waste, and abuse (FWA) is a tedious and time-consuming process. To enhance the claims assessment process and optimize resource allocation, our Predictive Claims Scoring system uses machine learning techniques to provide business and data analysts a preliminary score representing the likelihood of a claim containing FWA.

Business analysts reviewing claims leverage our system to search for specific claim identification numbers. Users are directed to a webpage displaying the specific claim's FWA likelihood score and the attributes of the claim that were most influential to the score. For a broader search, a full history of claims and their scores are listed underneath the search bar, providing quick and easy access to valuable information.

Our software provides data analysts with intuitive graphs that show patterns and trends in insurance claim scoring, seen on the right. Charts and graphs update as new claims with scores are entered into the system. Analysts track claim denials over time and between attribute groups, enabling them to make connections and inferences quickly and efficiently.

Identifying patterns in denied claims enhances the business analysts' workflow and improves the overall effectiveness of the claims assessment process.

Our system's website is written in HTML/CSS and uses FastAPI to interact with the Snowflake database. Dashboards within our software are built in Tableau. Our machine learning model uses the scikit-learn library in Python.
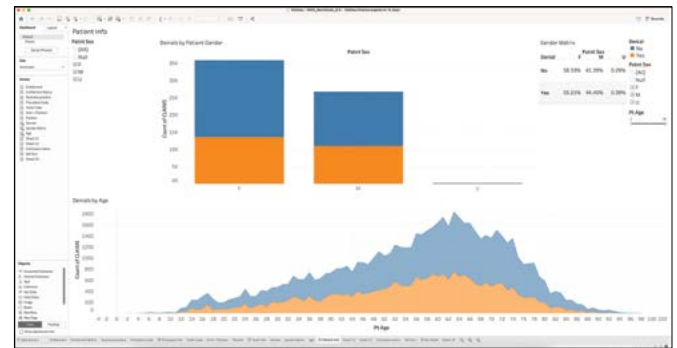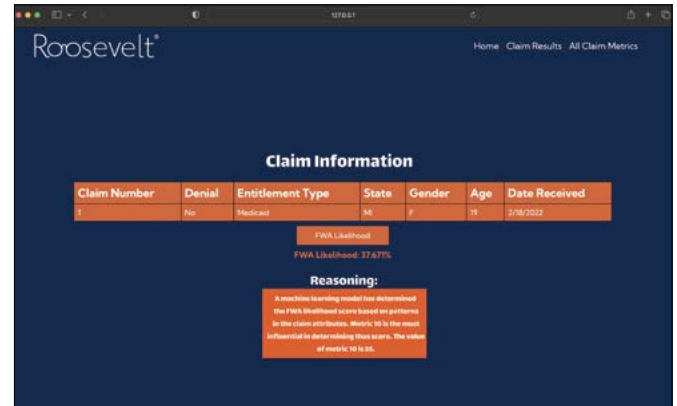
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Roosevelt Innovations
Universal Guided Web Editor

Roosevelt Innovations, headquartered in Okemos, Michigan, is a software solutions company owned by Delta Dental. With over 50 years of experience and innovative automated claims processing capabilities, Roosevelt has achieved an industry-leading 96% auto-adjunction rate and enabled a total treatment cost savings of $972 million. Altogether, Roosevelt has over 23 million users across its platforms and offers their services to insurance companies across the country.

At Roosevelt Innovations, insurance experts need to create and edit business rules that govern the automated claims processing system. However, development can be time-consuming for users without a technical background, often requiring additional training and resources.

Our Universal Guided Web Editor assists anyone working on claims in creating business rules in a streamlined and easy-to-use process.

Users first select a particular rule-framework. The complicated and technically confusing framework is then interpreted into an intuitive layout in the web editor (shown on the right) for users to input their rule specifications and variables in plain English.

This self-guided tool empowers businesses to create rules without the involvement of technical team members. Dropdowns and other selectable options improve the speed and ease of rule creation.

Our software improves quality and reduces errors in the work environment, increasing productivity.

Our application's front end is constructed with Angular, a web application framework and Bootstrap 4. The interpretation of the rule framework is done by ANTLR 4, a powerful parser generator that produces parsers for processing structured text, using a visitor approach to traverse the generated abstract syntax tree.
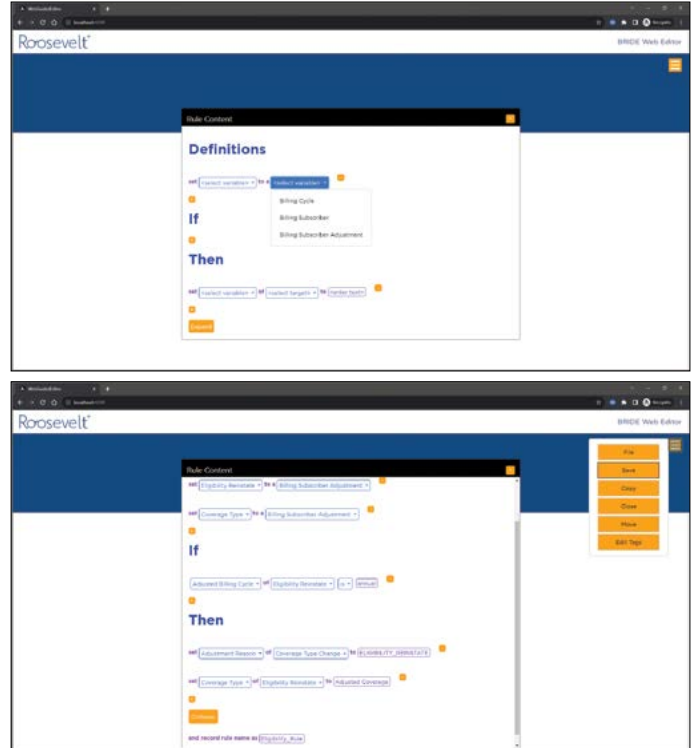
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RPM
AI-Based Chat Service

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. RPM services 30 countries and transports over 60,000 vehicles per month.

Serving as an end-to-end transportation provider, RPM requires a considerable amount of effort to manage drivers' and customers' inquiries. To address the needs of the drivers and customers, RPM requires 24/7 on-call representatives. This leads to high operational costs and potential gaps in customer service quality. Therefore, RPM wants to maximize the utility of carrier representatives while reducing costs and improving drivers' satisfaction.

Our AI-based Chat Service mimics a customer service representative by instantly answering carrier inquiries. The AI chat service has access to a multitude of frequently asked questions as well as instant access to all of RPM's shipment data.

The chat maintains a natural human language interaction, such that the driver feels as if they are talking to a real human. The AI chat service is knowledgeable and able to assist in most situations.

If the chat reaches a point that a carrier representative is needed, it seamlessly transfers a user to an on-call representative. Transferring the user's chat transcript to the representative improves the speed and quality of the customer service experience.

Our software intelligently serves customers, reducing the need for dedicated customer service workers, saving time and money.

Our AI-based chat is a back-end service that can be integrated into any platform. Our service utilizes Python Flask as well as OpenAI, Turvo and Microsoft .NET. The chat service is hosted entirely on Python Flask. OpenAI's API is used for natural language processing while Turvo's API is used to pull data from RPM's .NET database.
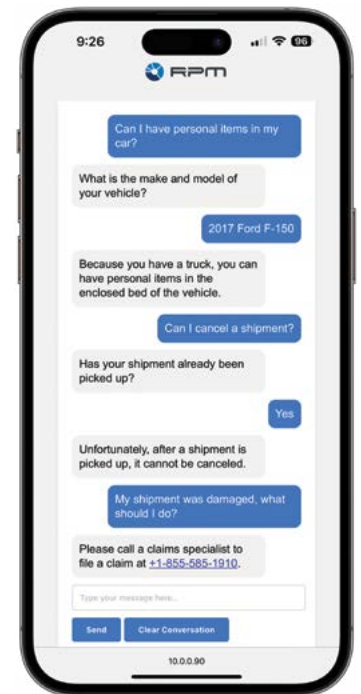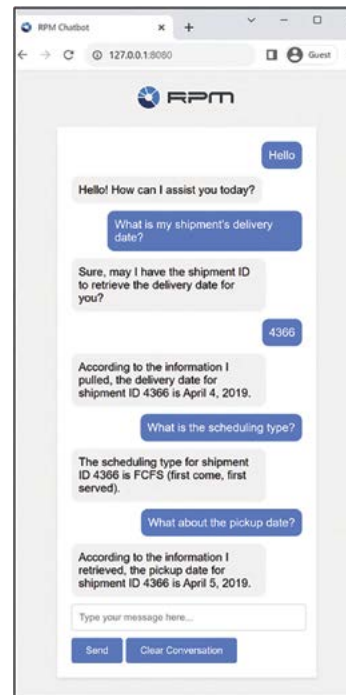
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Stryker
Electronic Data Interchange (EDI) Dashboard

Stryker is a Fortune 500 company that provides world class medical equipment to hospitals worldwide. From surgical equipment to neurotechnology, Stryker operates in over 75 countries and impacts more than 130 million patients annually.

Due to its size, Stryker faces the intricate challenge of overseeing a vast supply chain. As a serial acquisition company, Stryker frequently integrates software systems from acquired companies, known as Enterprise Resource Planning (ERP) systems. These new ERP systems are used to manage the products, purchase orders, and employees of the acquired company. To facilitate the many different systems, Stryker requires a centralized software platform that helps display and analyze the ERP transactions.

Our Electronic Data Interchange (EDI) Dashboard provides a web application to monitor the various ERP transactions inherited by Stryker's acquisitions.

Upon launching our web application, users are provided a comprehensive table containing an overview of all ERP transaction records. Employees use our advanced sorting, searching, filtering, and exporting capabilities to quickly and efficiently analyze ERP transaction data. Anomalies or transactions of interest are quickly identified using our system.

Our system provides holistic analyses of all transactions, highlighting key trends and metrics, improving the efficiency and accuracy of Stryker's integration efforts. The system also provides scheduled email alerts to help users receive data that needs to be monitored at regular intervals.

The app's back end uses Flask, hosted on Azure App Service. Data for each transaction is stored in Azure SQL Server. We utilize jQuery's DataTables to display tabular information and Power BI to display dynamic graphs.
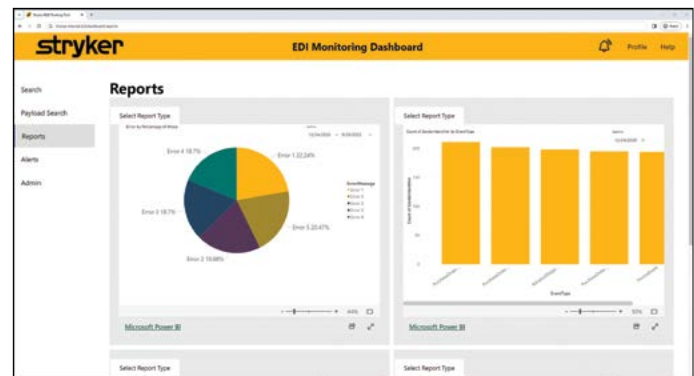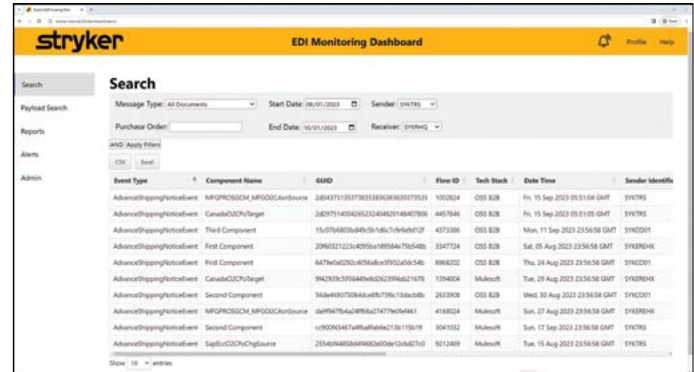
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TechSmith
ACE: Automated Content Editor

TechSmith is a global leader in media recording and editing software, driven by a mission to empower their 73 million worldwide users to share knowledge and information visually. TechSmith's flagship products, Camtasia and Snagit, provide unmatched solutions for creating videos quickly and precisely.

TechSmith continuously innovates and paves the way for users to seamlessly share knowledge and create compelling content. While videos have become the quintessential medium for knowledge transfer, the intricacy and steep learning curve behind video creation often poses a barrier for content creators to translate their vision into a great video.

Our ACE: Automated Content Editor simplifies video editing by enabling users to edit videos using everyday language. This is achieved via a web application built around an artificial intelligence (AI) driven editing approach.

Unlike traditional video editors, ACE features a chat panel, shown on the right, through which all editing tasks are delegated. Users simply express their desired editing needs to the AI-powered conversational assistant which interprets their intent, automatically executes the corresponding editing actions, and continues to chat with the user to achieve their desired outcomes.

Users only need to be able to describe the video they want to create, and our software does all of the heavy lifting for them, reducing the barrier to entry for beginning video editors.

By eliminating the inherent complexities and challenges of video editing, ACE enables users to center their attention on the creative and innovative expression of content and information delivery.

Our web application, hosted on Microsoft Azure, leverages React for front-end development and Flask for back-end operations. OpenAI's large language model GPT-3.5 interprets the user intent while directing FFmpeg to implement the exact media edits.
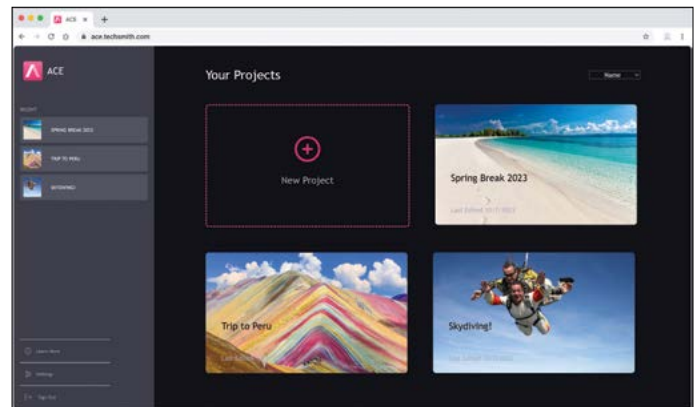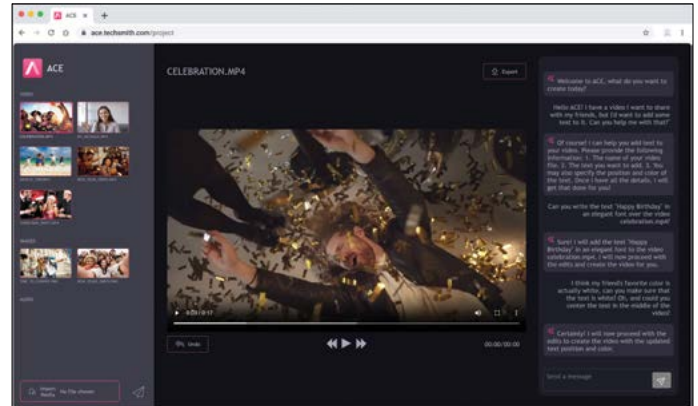
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Union Pacific
Railroad Switch Alignment Training

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 32,500 miles of track in 23 western states, Union Pacific boasts an impressive lineup of over 8,000 locomotives and a team of over 30,000 employees.

Switches are a core component of railroads that direct the movement of a train. Correctly identifying switch alignment is crucial to ensuring the transportation of resources the country relies on. A misaligned switch — if not identified and corrected — can lead to delays and damages and can pose a danger to personnel.

Our Railroad Switch Alignment Training software consists of courses that train employees to identify the alignment of railroad switches quickly and accurately. Employees get the necessary experience and training in a safe environment.

During a course, a prerecorded video taken from the front of a locomotive plays. As a switch approaches, the user interface displays inputs corresponding to switch identification. The user indicates the alignment of the switch, and the software gives audio-visual feedback to indicate whether the response was correct.

The training software teaches personnel to better identify rail switches in a real-world setting. Each course of the training is its own program, giving management more control over exactly what content employees should complete. Upon completion of a course, feedback is given and a score is reported to Union Pacific's learning management system. The software is also highly configurable, supporting custom course creation without having to write a line of code.

Our software is developed in Unity 3D and programmed with C#. It follows the SCORM standard for eLearning courses. The software is configured using JSON files and pulls videos from a database to generate a course in real time.
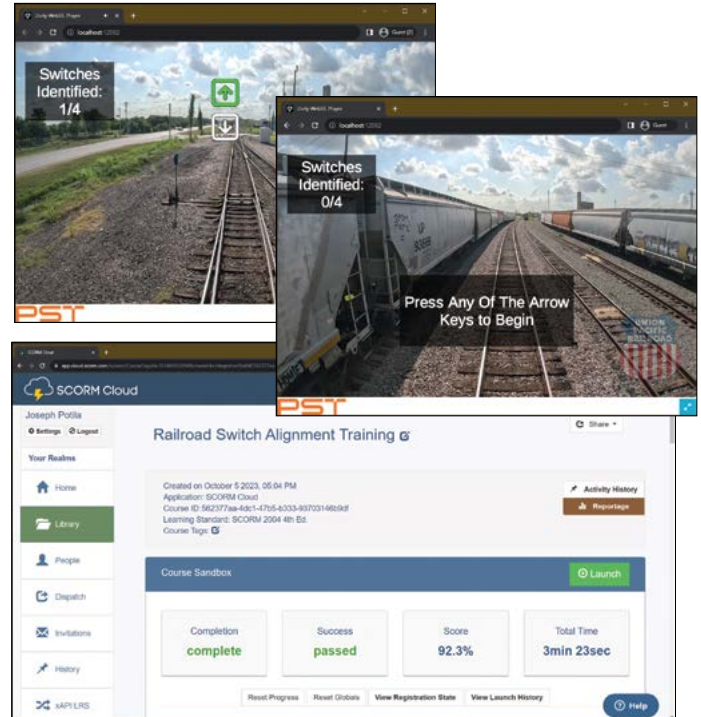
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United Airlines
Audit Automation Tool

United Airlines is one of America's foremost airlines, headquartered in Chicago, Illinois, serving over 100 million passengers annually. Utilizing a substantial fleet of more than 850 aircraft, United Airlines strives to hold themselves to the highest standards of safety and reliability for their passengers.

To maintain their remarkable fleet, ongoing maintenance is essential, and United Airlines has established a network of vendors dedicated to preserving the fitness of its planes. These suppliers perform repairs and part replacements while undergoing regular inspections by auditors from United Airlines, ensuring strict adherence to industry best practices. The current auditing process demands a substantial amount of labor hours, incurring significant financial expenditures for the company.

Our Audit Automation Tool streamlines this process for auditors by diminishing the disparities in auditing practices through the utilization of artificial intelligence (AI).

Our software automatically scans uploaded vendor manuals that auditors use to complete an audit. Through the application, auditors have the ability to upload vendor manuals and industry regulations. The system then compares the documents to ensure that the vendor manuals are in compliance with the provided regulations.

United Airlines auditors use our tool to quickly parse and analyze vendor manuals and regulations documents that can be hundreds of pages each. Our system automates large portions of the auditing process, increasing efficiency and saving time.

The application's user interface is constructed using React and interacts with the back-end model developed in Python. This communication occurs via a Flask API while the historical data is stored on a DynamoDB database. The front end and back end, along with the database, are all hosted on Amazon Web Services.
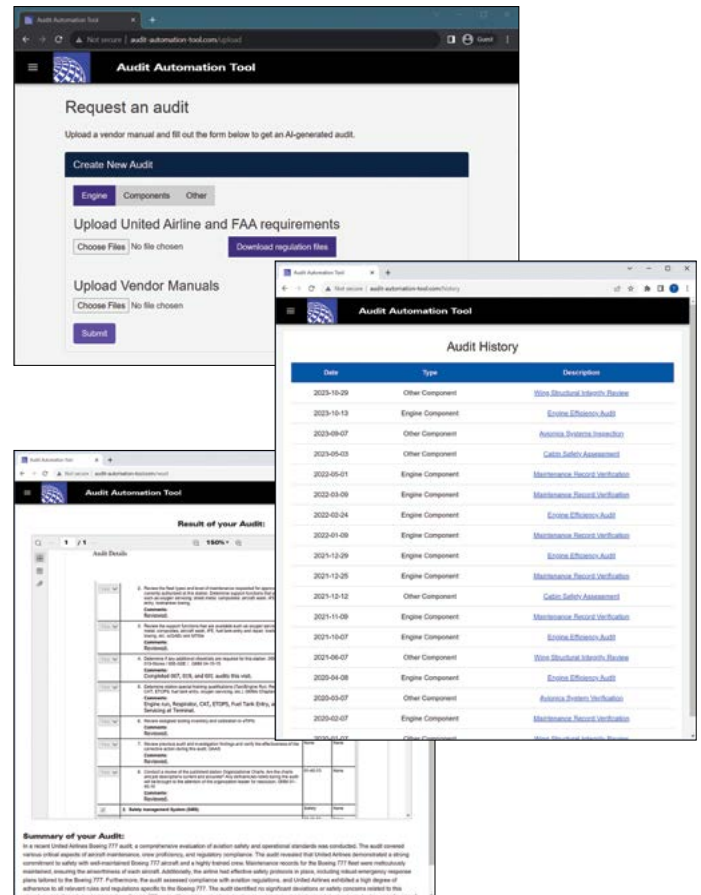
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Urban Science
Synthetic Media

Founded in 1977 and headquartered in Detroit, Urban Science is a leading global data-driven consulting firm that specializes in providing insights and solutions for the automotive industry. With a track record of serving major automakers worldwide, they utilize data and business science to address market challenges and drive success for their clients.

Due to the increasing intricacy of data in modern industries, clients and field staff are encountering the challenge of drawing meaningful conclusions from wide ranges of statistics. In the past, Urban Science hired firms to generate informative content to educate clients of the results of data analytics. This, however, came at a high cost. Recent advancements in artificial intelligence (AI) create a new avenue for Urban Science to inform clients of analytic results with minimal cost.

Our Synthetic Media web extension mitigates the challenge of complex data analysis by generating a virtual avatar that clearly explains the analysis in an easy to understand and friendly way.

Our web extension displays a wide array of charts and graphs to visually illustrate data trends and changes. Each chart comes equipped with an AI-generated explanation, which is easily accessible with just the click of a button. The generated explanation is given in a text format or via our virtual avatar, which explains the chart with auditory and visual elements for any user that prefers a more human element in their learning experience.

Utilizing our generated explanations, clients can extract meanings and trends that may have been invisible before. The Synthetic Media web extension makes data driven decision-making easier and faster than ever before.

The front end of our user dashboard is written in HTML, CSS, Chart.js, and Angular. The back end is built with FastAPI and Firebase Firestore database in Python.

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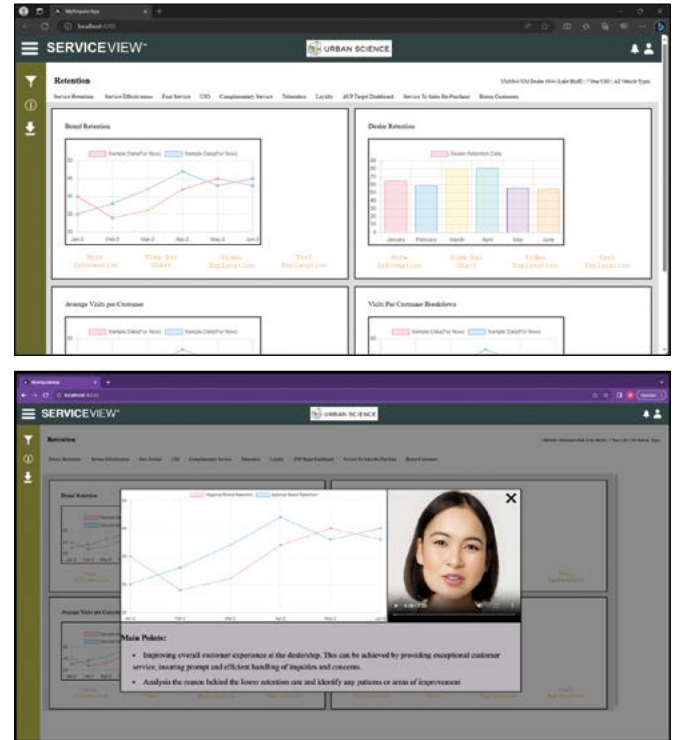
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UWM
Change Insights Datamart and Risk Assessment

Headquartered in Pontiac, Michigan, United Wholesale Mortgage provides mortgage products and services to mortgage brokers all over the country and is currently the top wholesale and mortgage lender in the United States.

In a large IT organization such as UWM, there are thousands of software changes and custom software solutions built every year. These changes produce valuable data about how certain software changes can affect the overall development cycle and other production risks. However, the data associated with these changes is spread across multiple different systems and is ineffective in this state.

Our Change Insights Datamart and Risk Assessment tool assists team leaders at UWM to proactively mitigate any potential production risks throughout the development cycle and monitor their team's performance.

In our tool, data related to software changes is aggregated from various sources into one cohesive IT Datamart. This creates a single view of all IT operations within UWM, making it easier than ever to analyze data at a glance.

Our predictive model leverages data from the IT Datamart to collect crucial insights which may correlate to deployment risks such as net changes to a file, associated incident reports, and which team is contributing the corresponding changes. Following collection and analyzation, the model determines the level of risk associated with each software change.

Our IT Datamart includes data from Bitbucket, Jira, Harness, Octopus, and ServiceNow. Python scripts are utilized for cleaning the CSV files. The model is implemented in Azure Machine Learning Studio. Azure Blob Storage is used to import data into Power BI from the model for front-end representation.
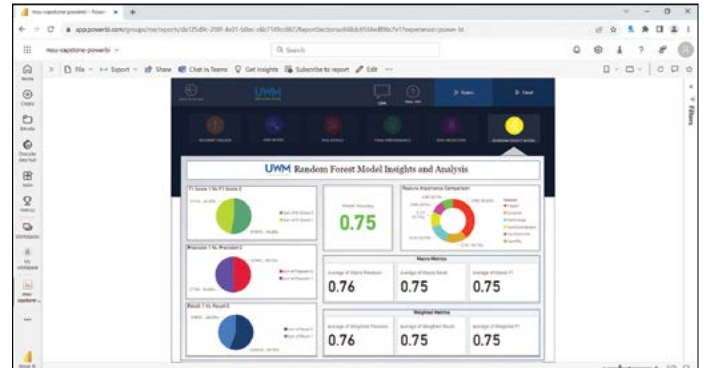
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Vectra AI
Malware Command and Control Channel Simulator

Vectra AI is a leader in the cybersecurity field, harnessing the power of artificial intelligence (AI) to provide clients with state-of-the-art threat detection and real-time response across all domains of enterprise systems. With over a decade of experience, Vectra AI provides security for enterprises in 113 countries. Along with winning Security Customer Champion at the 2023 Microsoft Excellence Awards, Vectra AI can be found on the Forbes AI 50 List and the CRN Security 100.

Ransomware attacks cost companies $20 billion in 2021, a figure that is expected to rise to $256 billion by 2031. This makes Vectra AI's service increasingly crucial and the effectiveness of their AI models of the utmost importance. A common technique utilized by attackers is to take control of a victim's computer and command it remotely, known as a command and control channel (C2).

Our Malware Command and Control Channel Simulator generates configurable C2 channels through an application set. Users configure the channel in a web interface where they select different features to customize the channel behavior. This enables Vectra AI to generate network activity, simulating real-world behaviors that would be present in the event of a command and control attack.

Hackers use a variety of methods to disguise their presence, making the customization of the channels an important aspect to mimic diverse behavior.

The simulation data our application generates is used to train AI threat detection models used in the software that Vectra AI sells to its clients, increasing the effectiveness of Vectra AI's security service.

Our server is hosted on Amazon Web Services in an EC2 instance, and our entire application set is written in Python. Our server communication with the client is achieved over multiple protocols (TCP, UDP, HTTP, HTTPS).
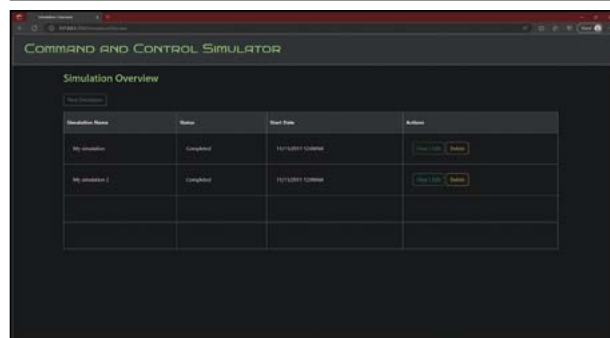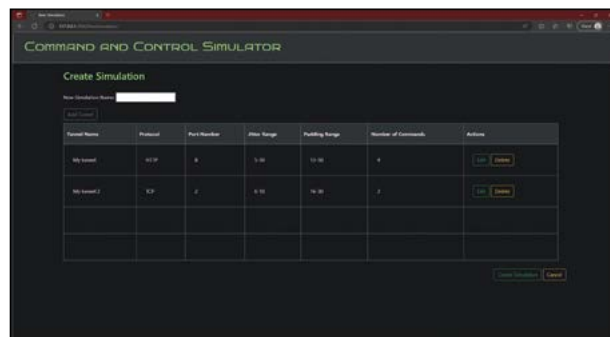
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Volkswagen Group of America
Volkswagen Shopping App with Augmented Reality

Volkswagen Group of America is the North American subsidiary of the Volkswagen Group, a global leader in automobile manufacturing. Delivering over 570,000 full-electric vehicles in 2022, VW is also at the forefront of sustainable transportation.

Currently, the car-buying process is time-consuming and sometimes inconvenient, requiring customers to physically visit dealerships to view any vehicles they might purchase.

Our Volkswagen Shopping App with Augmented Reality offers a unique solution to this process. It empowers customers to explore and personalize Volkswagen vehicles from the comfort of their homes and on the go.

Within the application, users select a vehicle from a catalog of Volkswagen's latest models and customize the vehicle with an array of exterior body paints and accessories. These customizations can be saved to be viewed and edited later.

Our software detects and highlights surfaces where the user's vehicle can be placed. Once a location is selected, our application displays a high-quality 3D model. It is life-sized, making it easy to envision owning the vehicle.

Users can also view the car's virtual interior. While imagining themselves behind the wheel, they can tap to honk the horn or look around to get a feel for the interior.

Our innovative approach to window shopping streamlines the car-buying process by providing an immersive user experience. This informs VW customers and aids in decision-making as they search for their newest Volkswagen vehicle.

Our Volkswagen Shopping App with Augmented Reality is available exclusively on iOS devices. It is developed in Swift using Xcode and leverages ARKit, RealityKit and SceneKit for AR. Our system uses API calls to AWS for database communication.

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Whirlpool Corporation
DeepOven: Volume and Quantity Estimation in Cooking

Whirlpool Corporation, a fortune 500 company headquartered in Benton Harbor, Michigan, is the world's leading home appliance company with over 50 manufacturing and research centers. Whirlpool is in constant pursuit of improving life at home through their reliable appliances.

In this spirit, Whirlpool is working to make cooking more accessible to all through the development of a smart oven. An oven of this nature provides users with insight and instruction to improve the result of the dish.

Our DeepOven system contributes to the larger Whirlpool smart oven goal by estimating volume and quantity of food inside a Whirlpool smart oven. Through a camera inside their oven, users see a livestream of their food cooking and leverage the camera and our tool to improve their cooking experience.

Connecting to the oven brings the user to the livestream view from inside the oven. Using either a frame from the livestream or a pre-captured image, the user initiates our system, which uses advanced machine learning to automatically determine the oven's rack level, the food quantity, and the total estimated volume of the food in the oven.

Our system produces a 3D reconstruction of the food in the oven, accompanied with the original image and any statistics and data determined by our software. Whirlpool uses this data to improve the performance of their smart ovens, enabling them to better estimate the cooking time required in many scenarios.

The web application is built with React as the front end and utilizes Flask and Python for the back end. Food quantity detection is achieved with a custom trained YOLOv8 instance segmentation model. A convolutional neural network (CNN) model determines the rack level, and a differentiable volumetric rendering model calculates the volume and creates the 3D image of the food.
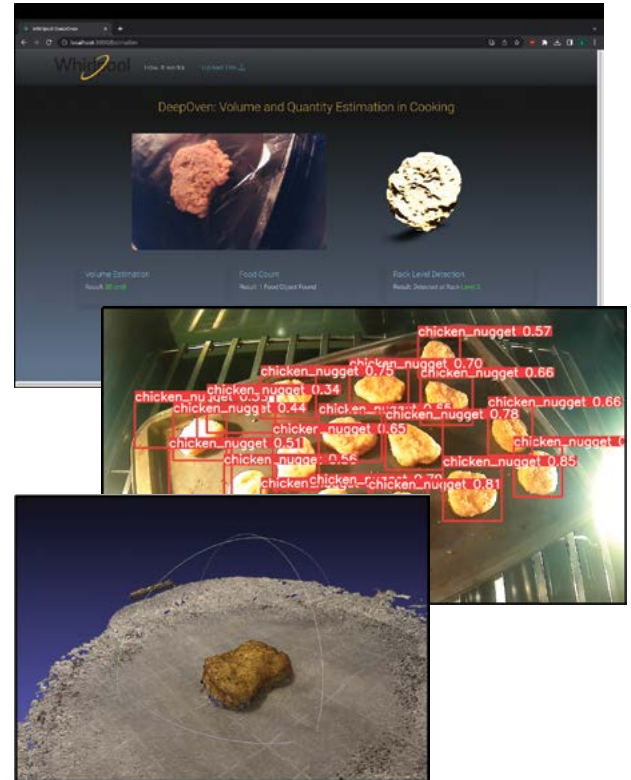
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WK Kellogg Co
Global Business Services Process Intelligence

WK Kellogg Co, home of the world's most memorable cereal brands, is one of the largest food manufacturing companies in the nation. Located in Battle Creek, Michigan, WK Kellogg Co was created recently as a spinoff of Kellogg's.

Supply chain manufacturing is the backbone of WK Kellogg Co's iconic brand. After spinning off as the leading manufacturer of ready-to-eat cereal, WK Kellogg Co is charted to achieve aggressive margin improvements by improving their internal software to meet the demands of their new enterprise.

Our Global Business Services Process Intelligence website is accessible to plant employees and supports them in performing their day-to-day tasks.

A major concern of WK Kellogg Co leadership is the discontinuation of the data integration software they currently use. Our website replaces this system and connects multiple data centers together, offering a smooth flow of data. Using our website, employees can compare live data and customize it according to their needs.

Our website offers the option of charting data by simply clicking on the specified row in the table, providing a wider array of options to study and analyze the data. These features support WK Kellogg Co's mission of creating greater strategic focus and operational flexibility.

Our Global Business Services Process Intelligence website is supporting WK Kellogg Co in this transition period by not only replacing the current tool, but improving upon it.

Our Global Business Services Process Intelligence website is developed using HTML CSS and JavaScript for a modern, friendly, and easy-to-use user interface. The data is stored in an SQL Database and Flask used in Python connects the front end and back end smoothly.
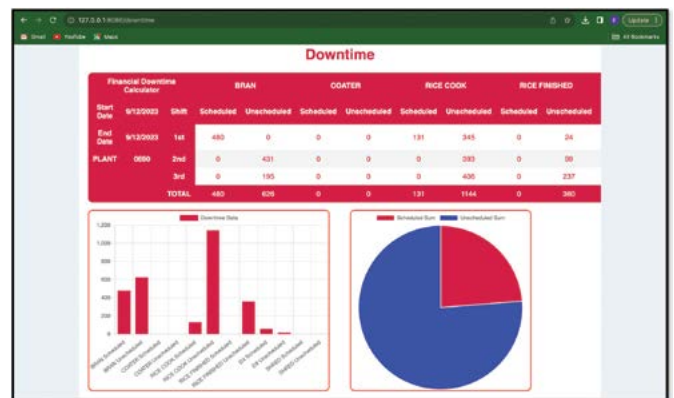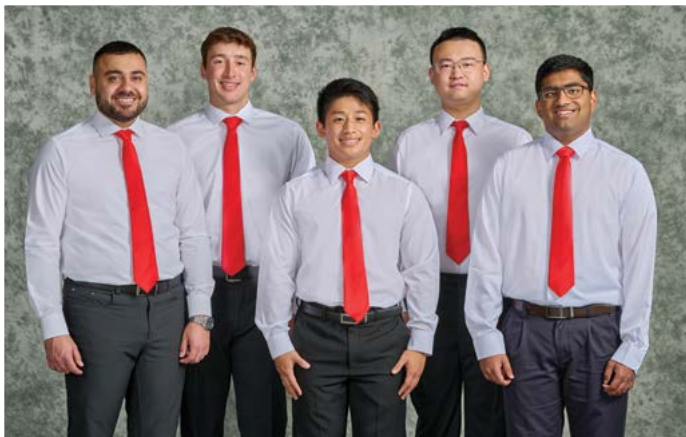
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Design Day Awards

CSE 498, Collaborative Design, is the senior capstone course for students majoring in computer science. Teams of students design, develop and deliver a significant software system for corporate clients. The CSE capstone teams compete for four prestigious awards. Here are the winners from the fall of 2023.

Auto-Owners Insurance Exposition Award

CSE 498 capstone teams present their projects on Design Day in a variety of ways. Teams create and set up an exhibit where they demonstrate their software systems and answer questions from Design Day attendees 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 Michigan State University Linguistics
Build-an-App for Humanities Researchers

Shiyu Yan, Daniel Magaway, Albert Crooks IV
Hemkesh Agrawal, Tess Coleman
Presented by Ross Hacker of Auto-Owners

MSU Federal Credit Union Praxis Award

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

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

Team Moii
Image Similarity System

Ethan Yang, Joseph Pallipadan, Hunter Samoy
Alex Day, Thalia Sakowicz, Michael Yin
Presented by Ben Maxim of MSUFCU

Spring 2023

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 Whirlpool
SmartCook: Smart App for Induction Cooktop Cooking

Alexis Tochiki, Ziming Qiu, Ashu Acharya
Clarence Nanamori, Preston Harrell, Daniel Nguyen
Presented by Wendy Hamilton of TechSmith

Amazon Sigma Award

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

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

Team TechSmith
CAVE: Collaborative Audio/Video Editor

Faran Meshinchi, Marco Suriano, Kyle Wagner
Wenrui Li, Craig Smith, Rachel Townson
Presented by E.J. Dyksen and Garret Gaw of Amazon

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The Capstone Projects

Dr. Subir Biswas
Professor of Electrical and
Computer Engineering

Project Facilitators: Mohammed Ben-Idris, Sunil Chakrapani, Yiming Deng, Shanelle Foster, Matthew Hodek, Tongtong Li, Nihar Mahapatra, Robert McGough, Daniel Morris, Jeffrey Nanzer, Hayder Radha, Jian Ren, Nelson Sepúlveda, and Panagiotis Traganitis

Ben-Idris	Chakrapani	Deng	Foster	Hodek	Li	Mahapatra

McGough	Morris	Nanzer	Radha	Ren	Sepúlveda	Traganitis
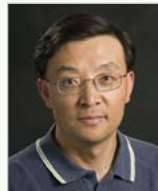
ECE 480 Senior Design

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.

Presentation Schedule – Engineering Building, Room 2205

Time	Team Sponsor	Project Title
7:20 a.m.	MSU College of Music	Instrumented System for Playing Music for Visually Impaired
7:40 a.m.	Fraunhofer USA	Wireless Sensing and Fluidic Control System for Microfluidic-Electrochemical Sensing
8:00 a.m.	MSU Bikes Service Center	Bike Green Box: A Micro-Mobility Data Collection System
8:20 a.m.	MSU Solar Racing Team	Versatile Power Supply for Solar Racing Cars
8:40 a.m.	MSU Solar Racing Team	Solar Car Battery Management System
9:00 a.m.	MSU ECE Department	Hardware-in-the-Loop Fire Simulator System
9:20 a.m.	MSU IPF Building Performance Services/Sartorius	Building-specific Energy Modeling for MSU Campus
9:40 a.m.	MSU ECE Department	Sound-Activated Interactive Robot System
10:00 a.m.	Break	
10:20 a.m.	MSU Resource Center for Persons with Disabilities	Alert System for the Visually Impaired to Detect Electric Scooters
10:40 a.m.	MSU Resource Center for Persons with Disabilities	Augmented Reality Glasses for Live Visual Assist
11:00 a.m.	MSU Resource Center for Persons with Disabilities	Sound Identification System for People with Hearing Impairment
11:20 a.m.	MSU ECE Department	Autonomous Shopping Robotic System
11:40 a.m.	Valtech Inc.	Pedestrian Crossing Awareness Service for Road Intersection Safety
12:00 p.m.	MSU Facility for Rare Isotope Beams (FRIB)	Camera-based Rotational Speed Detection System
12:20 p.m	Texas Instruments	Slope Measurement System with Radar

The ECE Project Facilitators who supervised ECE 480 teams this semester are: Mohammed Ben-Idris, Sunil Chakrapani, Yiming Deng, Shanelle Foster, Matthew Hodek, Tongtong Li, Nihar Mahapatra, Robert McGough, Daniel Morris, Jeffrey Nanzer, Hayder Radha, Jian Ren, Nelson Sepúlveda, and Panagiotis Tragnaitis.

We gratefully acknowledge the support of this semester's project sponsors: Fraunhofer USA, MSU Bikes Service Center, MSU College of Music, MSU Electrical and Computer Engineering Department, MSU Facility for Rare Isotope Beams, MSU IPF Building Performance Services, MSU Resource Center for Persons with Disabilities, MSU Solar Racing Team, Texas Instruments, and Valtech Inc.

MSU College of Music
Instrumented System for Playing Music for Visually Impaired

The Michigan State University College of Music has been developing a new approach to notated music that will enable visually impaired persons to experience music as it was written by composers. The project is meant to offer a three-dimensional, tactile alternative to standard music notation while overcoming the innate limitations of Braille music notation. This project will decrease barriers of entry into classical music for non-sighted individuals and create a new way to learn music. The final product will be an instrumented "sound sensitized" board with recessed staff lines, movable 3D notes, and a computer system that will play the notes as they are placed on the board.

The device will be built with a Raspberry Pi 4 and a Raspberry Pi camera. The camera will capture images of the notes placed on the board and send the pictures to the microcontroller for processing. The embedded software will then standardize, quantize, and white-balance the images for a more accurate analysis and a shorter processing time. The Raspberry Pi will scan the image of the board for the 3D notes placed onto the staff lines and determine the pitch, length, and order of the notes. The device will then output the notes as one continuous audio sample. The sound output will mimic the sound of an electric keyboard and will accurately reflect the notes placed on the board by the user.

In order to improve the device's user-interface for non-sighted users, the device will be designed to fit in a simple box/case and require minimal setup. Furthermore, the case will be easily portable and will be powered by an embedded, rechargeable battery pack.
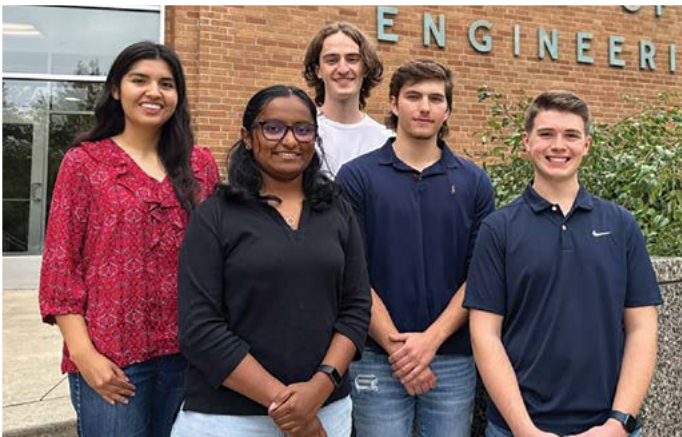
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Fraunhofer USA
Wireless Sensing and Fluidic Control System for Microfluidic-Electrochemical Sensing

Fraunhofer USA is a research organization in East Lansing, Michigan that specializes in diamond and coatings technologies. These technologies are employed in several ways in the development of electrodes for electrochemistry utilization. The electrochemical uses of these electrodes include testing water samples for possible contaminants using small sample sizes, which is the purpose of the microfluidic control system. Because other testing methods often require expensive equipment or access to a lab, our goal was to create a reusable, rapid, and cost-effective water testing system.

Our team will take an Arduino-controlled potentiostat and microfluidic pumping system and integrate a wireless communication system to "cut the cord" allowing for remote control operation. The team will use previous semesters' designs for both the pump and potentiostat and integrate it into a single control user interface.

The demonstrator object will involve 3D printed fluidic flow path, the ability to select between two different fluids stored in separate refillable reservoirs, wireless communication control with a range of 100 ft, real-time data visualization and control of collected data and integration of a new electrophysiology recording circuit.

Initial Block Diagram Concept
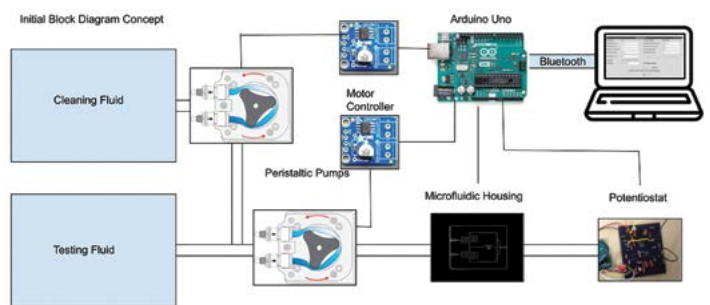
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MSU Bikes Service Center
Bike Green Box: A Micro-Mobility Data Collection System

MSU Bikes was formed in the spring of 2003 with the purpose of promoting biking as a healthier and more sustainable form of transportation than the use of vehicles. It was initially run by volunteers but has now received funding from MSU to open a full-service shop on Farm Lane.

Because MSU's student population is very large, there is also a high volume of people riding bikes, electric scooters, and many other forms of micro-mobile transportation to travel around campus. Unfortunately, this results in a considerable number of small, yet preventable, accidents involving riders getting into dangerous situations with pedestrians and motorists. To help reduce the total number of bicycle-related accidents around campus, our team is working with the current manager of MSU Bikes, Tim Potter, to develop a device that will hopefully aid in both detecting and preventing further incidents from occurring.

The MSU Bikes Green Box is a powerful, yet portable, device that can be mounted to a bicycle. It enables the rider to collect useful metrics like average speed, location, distance traveled, etc. The device consists of a PCB with an ARM Cortex M0 microcontroller, as well as other circuitry and modules. Developing the PCB from scratch helps keep everything in one place and consistent across the device. The team also wanted to minimize the packaging of the device to make it more compact and comfortable for the rider. The data is collected via a mobile application through Bluetooth connectivity, allowing for a more streamlined and efficient way of viewing important rider telemetry.

With the efforts of the team and the coordination of MSU Bikes, we hope that our device can provide a much safer environment for cyclists traveling around campus, while also helping highlight the accident hotspots to detect potentially dangerous situations before they happen.

Block Diagram of System
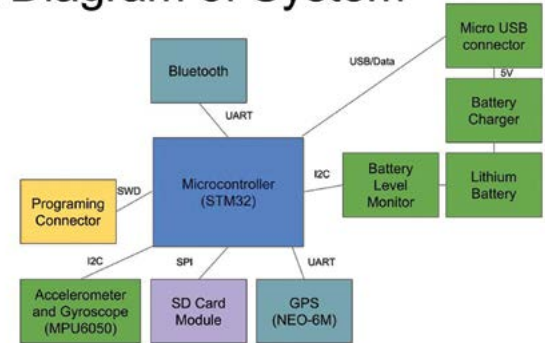
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MSU Solar Racing Team
Versatile Power Supply for Solar Racing Cars

The MSU Solar Racing Team is a student run organization at Michigan State University that participates in yearly racing competitions with other schools. To successfully compete, the MSU Solar Racing Team needs various equipment. The MSU Solar Racing Team currently has a prototype of their solar car, which is made of multiple electrical systems. Each system requires testing and troubleshooting under conditions that a typical benchtop power supply cannot support.

A power supply is a common component used for experiments and for testing other electronic components. A power supply provides a stable and adjustable source of electrical power for testing, prototyping, and troubleshooting electronic circuits. Power supplies have been used since the 1920s and were revolutionized in the 1950s when semiconductor transistors were used. Presently, modern-day power supplies have LCD or LED screens that display voltage and current.

The main objective of this project is to extend the modern-day power supply by designing a custom power supply to suit the MSU Solar Racing Team's needs, especially in situations where a typical benchtop power supply is not applicable.
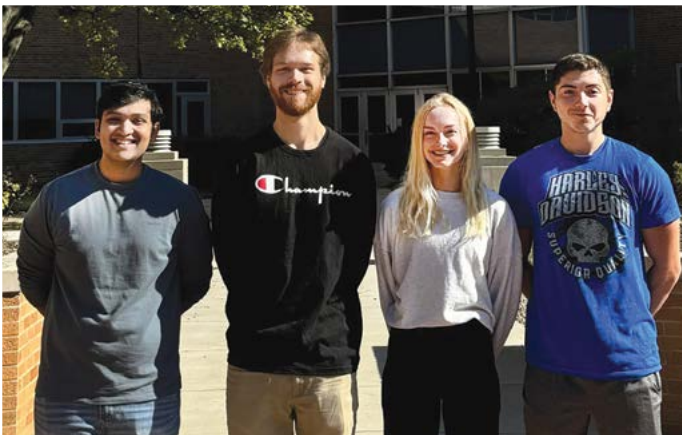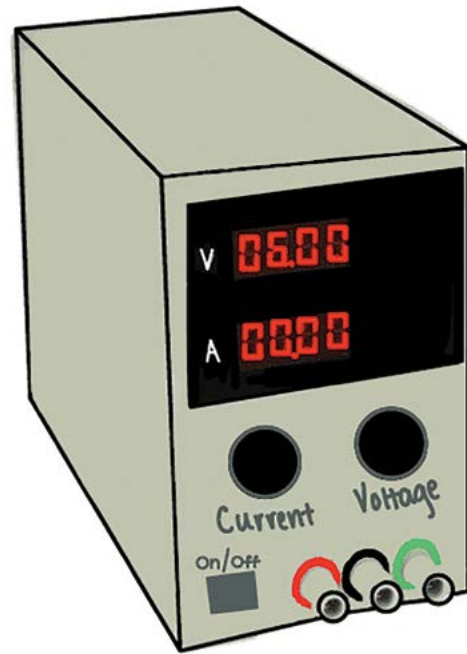
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MSU Solar Racing Team
Solar Car Battery Management System

The objective of our project is the development of a Battery Management System, commonly referred to as a BMS, for the Michigan State Solar Racing Team. Throughout previous years, the team has utilized the BMS to implement passive cell balancing. However, one of the key objectives in this initiative is to enhance the BMS to encompass active cell balancing, thereby enabling the sponsor to maximize its advantages.

This project is categorized into two main components: hardware and software. The hardware facet involves designing and setting up a General-Purpose Breadboard, along with the necessary hardware components, to achieve active cell balancing. It also encompasses the capability to precisely gauge voltage and temperature within the modules, as well as monitor battery pack current. The software aspect of this initiative involves the ability to gather crucial data such as voltage, current, and temperature, and transmit this information via a Control Area Network (CAN) line. The collected measurements will be used to indicate any faults through the CAN line. Moreover, the software should be designed to support active cell balancing.

Michigan State Solar Car 2016-2022 "Aurora"
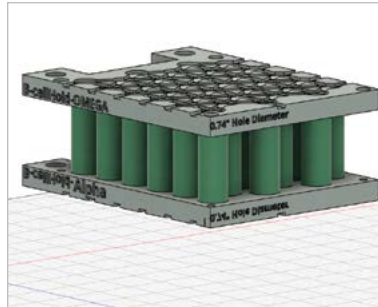
Battery Module
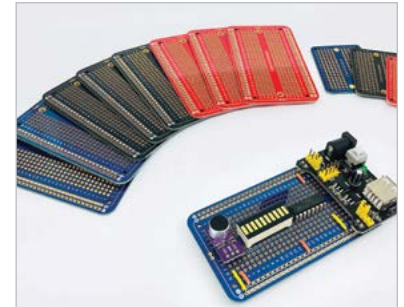
General-Purpose Breadboard
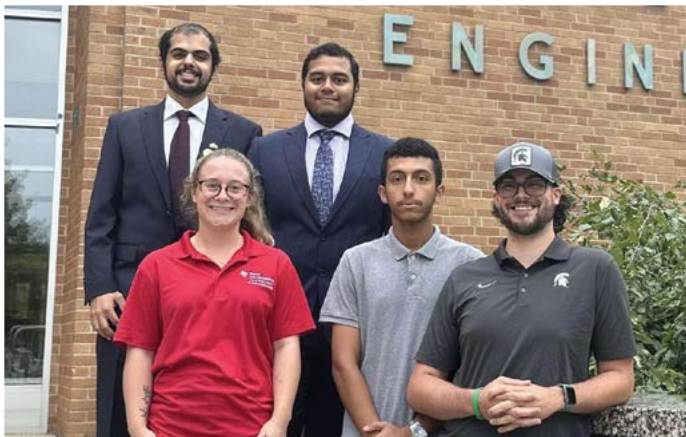
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MSU Department of Electrical and Computer Engineering
Hardware-in-the-Loop Fire Simulator System

Institutions such as the National Institute of Standards and Technology (NIST) have developed simulations which can model the response to a fire. These simulations are able to show the effect of actions taken on a fire. However, they are currently unable to communicate with real-world firefighting robots.

The main goal of this project is to create a hardware-in-the-loop fire simulation system. This system will be able to see the movements of the real-world robot and convey them into the fire simulation, then transmit response data back to the robot. For the purpose of training and monitoring the robot, it is often impossible to train in an actual fire environment due to the inherent safety issues that would cause.

This is made possible using the Fire Dynamics Simulator (FDS), a program that can create virtual scenarios with dynamic effects of fire and smoke. It also can map the location across a 2D space to enable the robot to react to its surroundings.
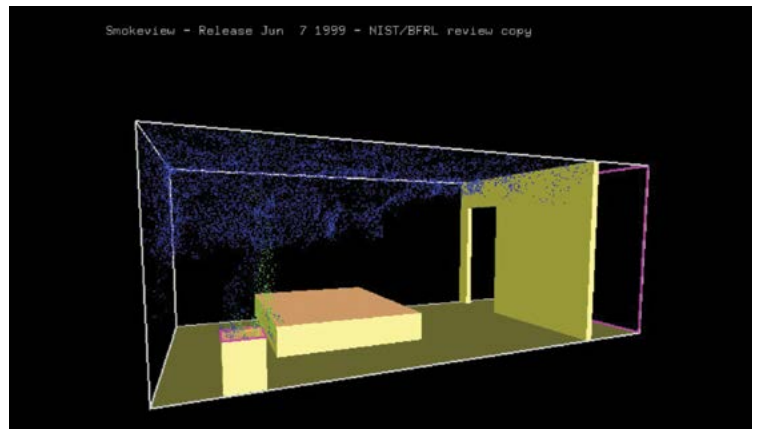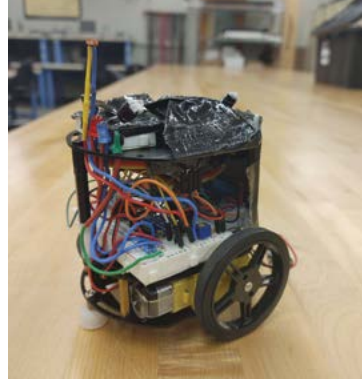
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MSU IPF Building Performance Services/Sartorius
Building-specific Energy Modeling for MSU Campus

Every day the Michigan State University Infrastructure Planning and Facilities (IPF) produces electrical energy and steam to supply buildings and facilities with power for their various systems. Each building contains systems for HVAC, Hot Water, Chilled Water, and for the Terminal Devices on each floor. These systems use the energy produced to ensure building functionality.

The goal of this project is to use data collected by MSU IPF to measure how variables such as weather and building occupancy impact these building systems, and to create an energy load profile based on building energy consumption. This profile can then be used by MSU IPF to segment energy production to accommodate building demands for energy.

This will be accomplished using software called SIMCA created by Sartorius. SIMCA is a multivariate data analysis software that can analyze large sets of data configured in a matrix and establish correlations between different variables. This is done using PCA and PLS analyses that normalize sets of data and show correlations visually.

MSU's campus contains dozens of buildings, each with varying size, age, and complexity. In order to demonstrate that this system can analyze a large range of building types, this project will cover five building system types in depth. These types will include a single system small facility, a multisystem small facility, a newer laboratory building, a residence hall, and a special building, such as an amphitheater, museum, or sports complex.

MSU Radiology: HVAC Data vs Outdoor Air Temperature

Green: Fan ON
Red: Fan OFF
Increasing Air Temperature

$to[1] \times 1.0569$ (vertical axis)
$t[1] \times 1.00862$ (horizontal axis)

Scaled proportionally to R2X, R2X[1] = 0.156, R2Xo[1] = 0.43,
Ellipse: Hotelling's T2 (95%)

SIMCA 18 - 9/28/2023 4:42:58 PM (UTC-4)
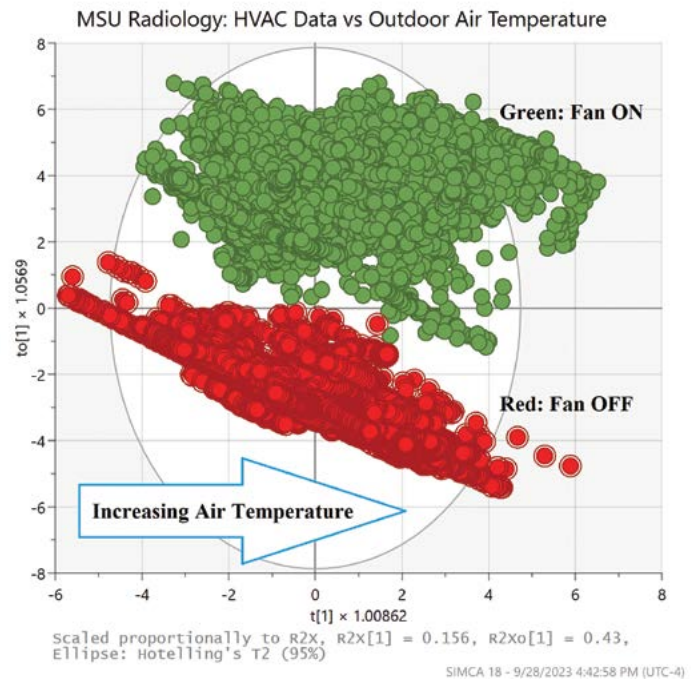
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Dr. Nelson Sepúlveda

MSU Department of Electrical and Computer Engineering
Sound-Activated Interactive Robot System

Michigan State University is a distinguished institution of higher education known for its commitment to academic excellence and pioneering research. Within the university, the College of Engineering is recognized for its innovation and scholarly rigor, embodying a tradition of scholarly pursuit, technological advancement, and societal impact.

In the contemporary workplace, the shift towards digitalization has led to an increased demand for effective remote collaboration. This demand arises from the unique challenges faced in remote industrial and collaborative settings, where clear and responsive communication is essential for safety, participation, and productivity. As organizations continue to embrace remote work arrangements and globalized partnerships, the ability to bridge geographical distances through seamless collaboration becomes not only advantageous but imperative for sustained success in a rapidly evolving professional landscape.

The objective of our project is to develop an advanced mobile robot capable of autonomously identifying and locating sound sources and approaching promptly if the sound persists. This innovation holds particular relevance in professional meetings, where seamless communication is of utmost importance.

Our proposed design incorporates a Seeed Studio ReSpeaker Mic Array to pinpoint the primary speaker's location, transmitting the data to a Raspberry Pi equipped with custom-written software to drive sound localization and movement for the robot body. This collaborative integration of hardware and software represents a new approach to enhancing remote collaboration in professional settings, with the goal of fostering more efficient and engaging digital interactions in the future.
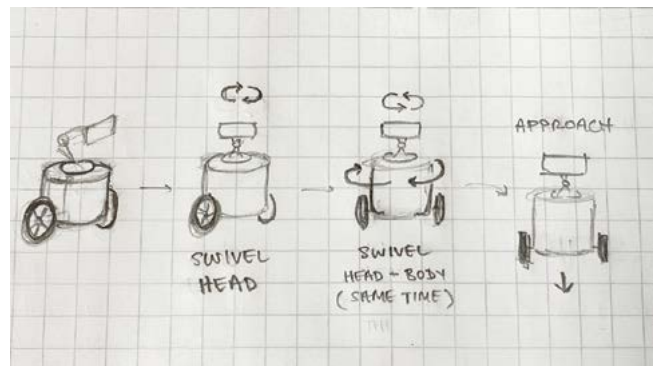
Department of Electrical and Computer Engineering
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01010111 01101001 01101100 01101100 01101001 01100001 01101101

MSU Resource Center for Persons with Disabilities
Alert System for the Visually Impaired to Detect Electric Scooters

In the 1970s, Michigan State University created the Resource Center for Persons with Disabilities (RCPD) in response to the need for equal access to a university education for all students. Since then, they have expanded their services to students with mobility and visual disabilities, as well as hearing impaired, any learning disabilities, brain injuries, psychiatric, and other chronic health conditions. MSU RCPD's mission is to lead Michigan State University in maximizing ability and opportunity for full participation by persons with disabilities.

Due to the increased use of motor scooters on campus, one of the major challenges faced by those with visual impairments is that the scooters are ultra quiet and fast, making it difficult to hear them approaching and leading to potentially dangerous outcomes. MSU RCPD has a goal of enabling the visually impaired to travel safely around campus without the fear and threat the scooters present. Because the scooters have only recently been installed on campus, there are no safety measures currently in place.

To help with their mission, our project will focus on assisting the visually impaired with the increased usage of electric scooters on the university's campus. Our goal is to provide an alert system that will effectively notify the visually impaired of scooters in a way that is conventional for campus. We also want to ensure that the environment accommodates the visually impaired rather than requiring the visually impaired to have to conform to their environment. If these scooters provide audible cues to alert them of a scooter present, the danger can be prevented. The biggest success will be for the visually impaired to have completely safe travels on campus in a way that does not burden them with making accommodations.

Resource Center for Persons with Disabilities

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MSU Resource Center for Persons with Disabilities
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MSU Resource Center for Persons with Disabilities
Augmented Reality Glasses for Live Visual Assist

Many people throughout the world suffer from varying degrees of visual impairment, making most tasks much more difficult to complete. The VUZIX AR glasses are a versatile, programmable tool that are used to assist people in both work and everyday life. These glasses can be programmed to create a visual description enabling the user to remotely share their view with a professionally trained visual interpreter, who is connected via a camera. The visual interpreter can then assist or guide the user through the task they need to complete.

The goal of this project is to develop and design a smartphone app that connects the user to a visual description software. The app must be accessible and easy to use for someone who is visually impaired. Additionally, we will create the visual description software to enable a visual describer to see through the camera on the glasses and provide an audible description to the user.

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Tyler Baird
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MSU Resource Center for Persons with Disabilities
Project Sponsor

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East Lansing, Michigan

Project Facilitator

Dr. Nihar Mahapatra

MSU Resource Center for Persons with Disabilities
Sound Identification System for People with Hearing Impairment

I ndividuals with hearing impairments frequently encounter challenges in recognizing sounds in their surroundings while struggling to identify the source or its origin.

When confronted with unfamiliar sounds, these individuals often find it challenging to determine whether the source poses any risks. Although some smartphone platforms possess the capability to detect ambient sounds and notify the user, these existing systems remain underdeveloped, displaying unreliability and limited proficiency in sound source identification.

The ultimate objective of this project is to develop a smartphone app that not only notifies users of common environmental sounds but also can identify these sounds and aid in pinpointing their source.
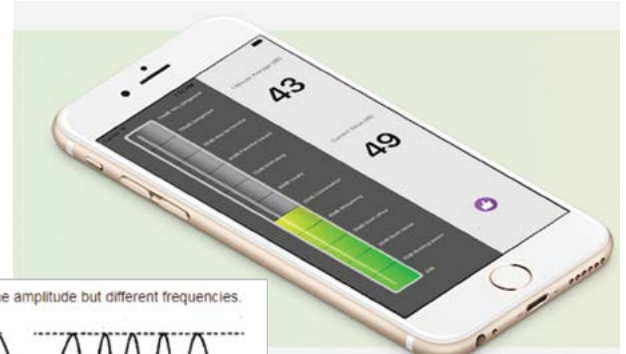
(a) Two sound waves having same amplitude but different frequencies.

(b) Two sound waves with same frequency and different amplitudes.

© Two sound waves having varying amplitudes and different wavelengths.

Resource Center for Persons with Disabilities

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MSU Resource Center for Persons with Disabilities
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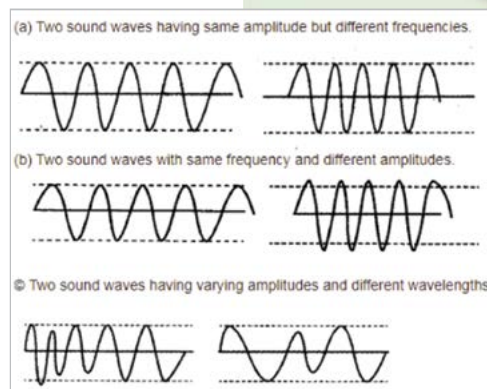
Project Facilitator

Dr. Nihar Mahapatra

MSU Department of Electrical and Computer Engineering
Autonomous Shopping Robotic System

For some people, grocery shopping can be a big hassle. Some people just don't have the time, while others may have a certain mobility disability. It may be hard to get around, carry a basket or push a cart. Our project can help people save time and create an innovative and convenient shopping experience. By developing a robot that can go through store aisles and shop, people's lives will be made easier. Using an HD camera and scanning technology, the robot is able to scan a list of items and sets out on the shopping trip. This robot navigates to the proper aisle and shelf, picks up an item in the list, and drops it in its basket. Our algorithm enables this robot to seamlessly shop by avoiding all obstacles and taking the most efficient path to get groceries.

The fundamental idea of this system is to create an autonomous robotic aperture that receives a list of items from the user, locates that object on the aisles, picks it up, and returns it to the shopper. The primary parts of this system are a robotic aperture for mobility, a sensor to differentiate between shelf products, an algorithm for interpreting the sensor's findings, as well as pathfinding to and from the shopper. It is supported by a mechanical apparatus attached to the robot to grab, hold, and drop the item. The algorithm is comprised of three major components processed within an NVIDIA Jetson Nano: the capability to accept a user-defined list of items, a pathfinding and obstacle avoidance system to efficiently find its way to the correct item, and an object detection system that interprets a QR code for recognition. The mechanical arm apparatus is a servo-controlled robotic with a 100g lifting capacity, a five-switch wired controller, multiple motors and joints providing total command and visual manipulation. The arm can be powered from an independent battery source to decrease strain on the already existing system.

Department of Electrical and Computer Engineering
MICHIGAN STATE UNIVERSITY
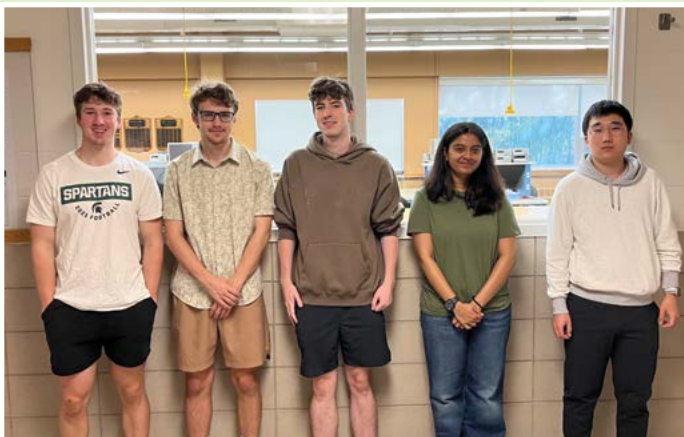
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Valtech Inc.
Pedestrian Crossing Awareness Service for Road Intersection Safety

Valtech is a global digital agency company founded in 1993 with a focus on business transformation. With expertise in technology, marketing, and experience design, Valtech helps clients anticipate future trends and connect more directly with consumers across their digital touchpoints while optimizing time-to-market and ROI.

A growing problem in our world is the safety of intersections. More pedestrians waiting to cross the road are observed on their phones and often may not notice when it is time for them to cross. This can cause confusion for drivers by making crossing intent less clear, which may cause unsafe situations. Also, there are only a small number of current technologies that can assist pedestrians with disabilities with crossing intersections.

Our project is to create a mobile application tailored to pedestrian safety. This application will be designed to assist pedestrians in navigating busy streets while alerting them to safe crossing opportunities and potential hazards. It leverages technology and data to ensure accurate, real-time information that can significantly reduce the risks pedestrians face in urban settings.

Our design objectives are focused on providing pedestrians with seamless alerts regarding changes in crossing signals. To achieve this, we plan to replicate roadside units (RSUs) using Valtech-provided Hardware Development Kits (HDKs). This will enable us to generate encoded Signal Phase and Timing (SPaT) messages, which can be effortlessly received via Bluetooth on compatible Android devices. Once received, the SPaT messages will pass through a sophisticated algorithm that will determine when there is no anticipated traffic passing through the crosswalk and will generate an appropriate safety message.

Alert: Safe to cross. 15 seconds remaining.
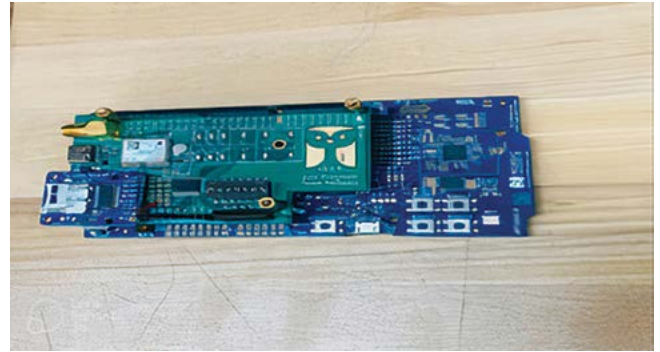
valtech_ mobility

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MSU Facility for Rare Isotope Beams
Camera-based Rotational Speed Detection System

The Facility for Rare Isotope Beams (FRIB) at MSU is home to the world's most powerful heavy-ion accelerator. This device enables physicists to produce rare isotopes and perform groundbreaking research.

A key piece of this accelerator is the carbon charge stripper. This device directs the beam through a thin carbon sheet, which in turn strips electrons off particles in the beam. This creates a higher polarity that enables the beam to reach higher speeds.

The thin piece of carbon must rotate and move up and down sinusoidally, so that the sheet does not get obliterated by the beam. Two stepper motors are used to move the carbon, but traditional methods of detecting the carbon's speed cannot be used, due to the radiation. This is where camera detection and computer vision play a role.

Currently a camera is placed near the stripper looking through a set of mirrors at the carbon sheet. This gives engineers a live feed of the carbon stripper in action.

The goal of this project is to take the video feed of the carbon stripper and calculate the RPM of the rotating sheet. This would ensure that the motors are functioning as desired and eliminate any potential downtime of the beam.

Our design will utilize optical flow algorithms together with edge detection on a portion of the charge stripper. This will enable us to obtain a vector map of the movement of the charge stripper. We can then calculate the RPM using dimensions of the device and compare our result with the RPM fed to the motors. This program will be able to continually monitor the stripper and provide feedback to engineers at the FRIB on the motors' current status.

FACILITY FOR
RARE ISOTOPE BEAMS
at Michigan State University
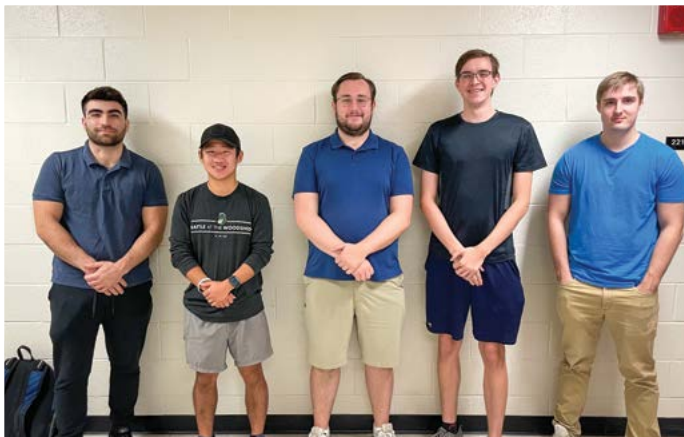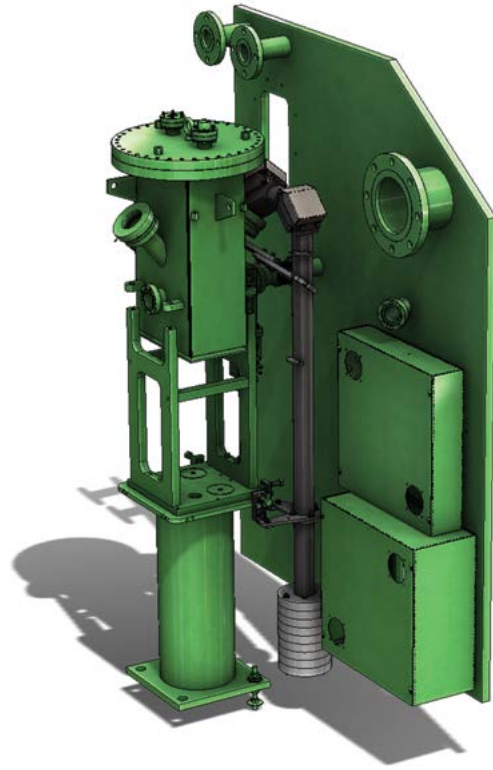
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Texas Instruments
Slope Measurement System with Radar

In the world of self-driving cars, there are many different technologies to help detect surrounding landscapes. The popularity of autonomous cars has boosted the research and development of things like light detection and ranging (lidar) and cameras to determine different varieties of roadway and objects near vehicles, such as signs, pedestrians, and other cars. However, some of these options are not reliable in certain weather conditions. Rain or fog can render these technologies ineffective, so it is necessary to find alternative solutions for these scenarios.

Radio detection and ranging (radar) is a dependable choice. Its larger wavelengths are not obstructed or disrupted by large particles in the air, and it can easily detect objects in clear view of a vehicle. An issue arises, however, when radar attempts to identify things at an irregular position, such as objects to the side of a vehicle or on the surface below it. These objects often do not reflect most of the transmitted signals back to the radar, so it makes it difficult for the radar to understand those objects' positioning.

The focus of this project is to tackle the above challenge. Using Texas Instruments (TI) radar transceivers, it is our job to identify the slope of a declined plane. We will position a vehicle-model on a horizontal slope immediately facing towards a declined plane. The design will focus on positioning the radars on the model in a way that will optimize the amount of received signals sent to the plane. This means the radars will be placed near orthogonally with respect to the slope at slightly different angles in order to capture a full range from 0 to 90 degrees. We will send relevant processed data from the radars to an Arduino, which will run our trigonometric algorithms to calculate the angle. Several intervals between 0 and 90 degrees will be tested to achieve an accurate reading of +/-10% degrees.
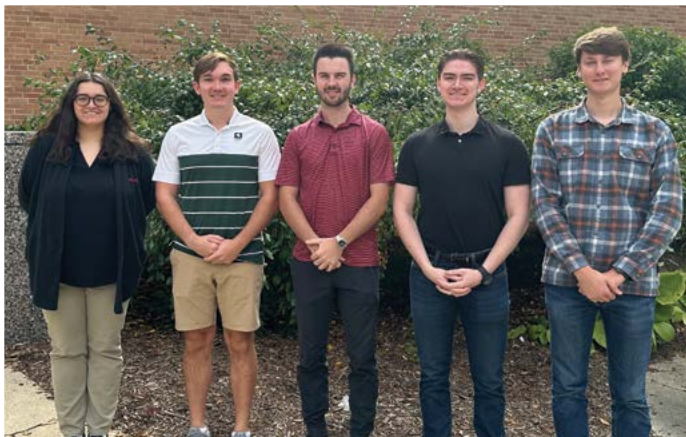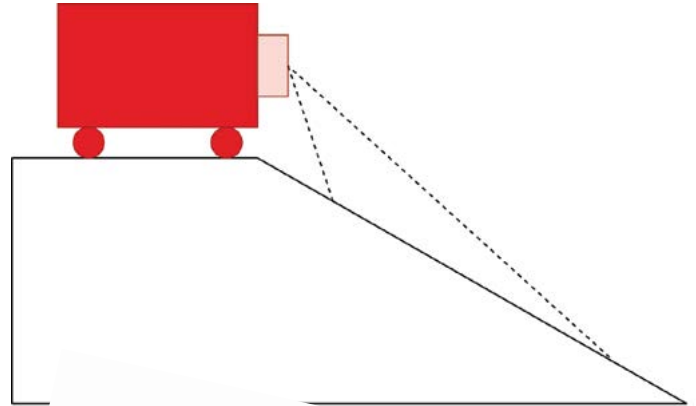
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Texas Instruments
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Anil Mani
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Project Facilitator

Dr. Yiming Deng

Design Day Awards

ECE 410

Left to right: Kyle Neid, Keaton Mulcahy, Maximus Sese

First Place Award — 1

Team Nondestructive Evaluation Laboratory/NSF
"Robotic Arm Object Reconstruction for NDE"

Left to right: Andy Fondaw, Max Verboncoeur,
Gabby Lovett, Franklin Lopez, Sean Elworth

First Place Award — 2

Team MSU Bikes Service Center
"MSU Bikes Green Box"

Left to right: Kyle Heslop, Collin Faeth, Victor Faletti,
Andrew Merriman, Jake Ryba, Karson Mientkiewicz

Second Place Award — 1

Team MSU Department of Electrical & Computer Engineering
"Wirelessly Powered Backup Camera"

Left to right: John Slivka, Prince Funwie, Francis Kasmikha, Michael Scruggs, Fuad Sabit, John Hanna

Second Place Award — 2

Team Great Lakes Crystal Technologies
"Measuring Diamond NV Center Charged States"

Left to right: Mijan Ahmadnizam, Ryan Kunkel, Derek Luzano, Adesh Gondara, Maximus Sese

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ME 412 Heat Transfer Laboratory

Yuping Wang
Academic Specialist
Department of Mechanical Engineering

Heat Recovery Study with TEG

A large amount of usable energy can be found in the exhaust discharge from power plants, engines, and many industrial processes. Capturing some of the otherwise wasted energy through a heat recovery unit would improve the efficiency of the overall system and have favorable environmental effects as well. Among the various heat recovery system designs, a TEG (thermoelectric generator), a compact solid-state device, has been widely used in many applications such as in automobiles. For this project, students are expected to understand the use of TEG in a waste heat recovery process. Each student team is tasked with designing, building, analyzing, and testing a heat transfer device creating a temperature difference on the two sides of the TEG modules. Hot air supplies through a heat gun, simulating the hot exhaust gas, is to be used on the hot side of TEG. The objective of the design is to create a sufficient temperature difference for the TEG module to power a small fan. A second part of the project is for each team to choose a specific heat recovery unit and conduct a review of it. On the testing day, each team will have 15 minutes to set up, demonstrate/test, and disassemble their device. In addition, they will also prepare a PowerPoint slide show or video clip 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	Reagan Ferschweiler, Emily Holman, Sam Rohrer, Jeffrey Zhou
	B	Brendan Foster, Antonina Klatka, Luke Lemont, Luke Schmidt
8:15	A	Hunter Arnett, Cody Bartos, Abby Pankey, Nic Stoller
	B	Aaron McDowell, Matthew Mozariwskyj, Jacob Smith, Daniel Staal
8:30	A	Yusuf Abbas, Citizen Kim, Dayton Kullman, Garrett Martin
	B	Jack Bajcz, Jonathon DeFrense, Michael DuFrense, Josh Heibeck
8:45	A	Elia Al Abdullatif, Michael Maser, Nicholas Nastovski, Tyler Wysocki
	B	Jenni Aubin, Ellie Clark, Tommy Erickson, Nick Sarafian
9:00	A	Stefan Bellman, Danny Drennan, Drew Goodman, Jason Li
	B	Jordan Arnold, Matt Fular, Charles Mercer, Sarah Walrath
9:15	A	Owen Garber, Owen Korff, Adolfo Lopez, Vedi Patel
	B	Brandon Gonzalez, Branton Guri, Tori Morgan, Marianna Osentoski
9:30	A	Matthew Ajlouny, Ryan Geisler, Nelson Ladomer, Maya Patel
	B	Graham Bailey, Nico Boehlert-Somohano, Jacob Bruck, Angel Perez
9:45	A	Alex Johnson, Adam Peckens, Catherine Schenone, Kenny Yue
	B	Nicole Gibbons, Manuel Hudecek, Jalen King, Anita Patel
10:00	A	Sampath Eaty, Luke Honer, Ben Roraff, Andrew Tabaka
	B	Haley Denton, Sydney Kelly, Kory Knickerbocker, Aidan Svoboda
10:15	A	James Fordyce, Taylor Page, Ben Van Hove, Trent Warren
	B	Elise Delikat, Jack Feistritzer, Raed Mohammed, Courtney Smith
10:30	A	Kylie Carbary, Nolan Hoffman, Alex Rodriguez, John Salloum
	B	Abel Barraza, Alexander Choma, Logan Roeser-Nordling, Brandon Tsivitse
10:45	A	Mitchell Bjorne, Wil Jozwiak, Ryan Leinweber, Aditya Swarnkar, Gavin Watthayu
	B	Ryan Bolio, Alex Figa, Henry Kantzes, David Twomley
11:00	A	Alexander Arnold, Josh Bennett, Luke Roethemeyer, Carter Stefanovski, Ben Walters
	B	Jackson Rayer, Michael Romzek, Arron Stebic, Tate Virkus
11:15	A	Mitchell Carroll, Amjid Khogali-Watson, Hunter Staton, Brendan Zwiernik
	B	Adi Agaram, Luke Aman, Lochlann Dunlavey, Jake Gilman, Charlie Meilinger

ME 470 Mechanical Design & Manufacturing II

Michael Lavagnino
Academic Specialist
Department of Mechanical Engineering

U. S. Steel

Cereal Shaker Horizontal Motion Conveyor

The goal in this project is to design, build, and test a small-scale horizontal motion conveyor system to transport cereal during processing. The design scope includes (1) the drive mechanism, (2) the pan, (3) the supports, and (4) all associated hardware. The system performance will be assessed by (1) minimizing the design mass, (2) the volume of cereal moved 3.5 feet in one minute, and (3) the lowest variance in distribution of the cereal. Students will utilize materials and manufacturing capabilities from the Manufacturing Teaching Laboratory, steel pans donated by U.S. Steel, as well as premade components.

Competition Schedule

Time	Team	Station	Team Members
8:00	1	A	Connor Casey, Andrew Ferguson, Ronak Patel, John Young, Hoahua Zhang
	1	B	Noah Benson, Drew Goodman, Alex Johnson, Brad Kolinski, Arjun Patel, Ben Roraff
8:15	2	A	Matthew Ajlouny, Olivia Lyle, Anissa Sant, Ethan Smydra, Gavin Watthayu
	2	B	Mason Dalrymple, Ben Delduca, Jake Gilman, Charlie Meilinger, Evan Rushbrook
8:30	3	A	Colin Boulard, Aidan Dobbie, Jonathon Fudala, Branton Guri, Manav Shah
	3	B	Ali Lewis, David Mueller, Michael Romzek, Katelyn Szafranski, Ben Van Hove
8:45	4	A	Evan Hampel, Ryan Qualley, Noah Roux, Catherine Schenone
	4	B	Gabriel Birchmeier, Austin Crawford, Sammy Dickow, Adolfo Lopez, Gina Sapiano
9:00	5	A	Carter Beck, Mitchell Carroll, Elan Krakoff, Maggie Le, Ben Lemke, Michael Taylor
	5	B	Karem Algarash, Ian Calandrino, Tyler Doral, Cameron Hesano, Jacob Kunka
9:15	6	A	Megan Fazio, Emilia Jakuc, Jeremy Kloss, Brandon Kortum, Sam Rohrer
	6	B	Atharva Burande, Elise Delikat, Ryan Leinweber, Eric Luo, Enido Shyti
9:30	7	A	Ben Arkles, Ari Bozann, Panzer Che, Kyle Pahl, Patrick Ryan
	7	B	Drew Darin, Mason Koudelka, Nicholas Malcolm, Sara Moscone, Ethan Wise
9:45	8	A	Angelo Bartolome, Tanaka Chonyera, Zach Hetfield, Nick McCarthy, Tyra Treadway
	8	B	Ryan Cornellier, Danny Drennan, Alex Miciuda, Keegan Sclabassi, Jacob Smith
10:00	9	A	Adi Agaram, Dylan Jones, Garrett Puehler, Sara Purdue, Hunter Reif
	9	B	Matthew Bush, Daniel Erfani Zachi Yazd, Joe Hamouda, Lucas Henricks, Luke Muller
10:15	10	A	Elia Al Abdullatif, Ryan Geisler, Logan Jacobson, Nicholas Nastovski, Christian Takla
	10	B	Owen Korff, Austin Pier, Matthew Russell, Kevin Schultz, Aditya Varma
10:30	11	A	Qasem Alobaydan, Deniz Farmaka, Abdallah Hamad, Fallou Mbengue
	11	B	Keya Baxi, Alexa Garavaglia, Justin Gauthier, Brenden Shelby, Will Stamatakos
10:45	12	A	Matthew Celini, Eric Dutkiewicz, Harshil Jain, Aisyah Mahira, Abby Pankey
	12	B	Alayna Celestini, Bradley Haskin, Gabe Johnson, Miles Peters, Kenny Yue
11:00	13	A	Noah Iung, Pahul Kahlon, Antonina Klatka, Selena Vidojevski, Poom Wichitrakanlikit
	13	B	James Fordyce, Colin Graf, Taylor Page, Maya Patel, Jacob Stabler
11:15	14	A	Bennett Guensche, Amanda Jeffers, Kate Nolan, Brandon Roux, Daniel Staal
	14	B	Shahab Khorasanizadeh, Lauren Osiwala, Jon Paul, Elizabeth Sharkevich, Andrew Tabaka
11:30	15	A	Sean Blanchard, Nicole Burcon, Justin Schmitz, Aditya Swarnkar, Aditya Tarle

The Capstone Projects

Dr. William Resh
Professor of Mechanical Engineering

Faculty Advisors: Rebecca Anthony, Seungik Baek, Andre Benard, Brian Feeny, Norbert Mueller, Galit Pelled, Thomas Pence
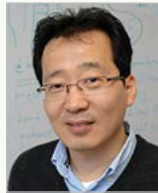
| Anthony | Baek | Benard | Feeny | Mueller | Pelled | Pence |

Presentation Schedule – Engineering Building, Room 1202

Time	Team Sponsor	Project Title
8:00 a.m.	Wheels on Rails, LLC	Rail Biking Assist
8:30 a.m.	Wheels on Rails, LLC	Propulsion Assist Wheels on Rails
9:00 a.m.	Alro Steel	Plasma Processing Center, Material Handling Cart
9:30 a.m.	Gerdau	Ergonomic Risk Reduction/Handling Large Paper Rolls
10:00 a.m.	Peckham, Inc.	Robotic Garment Packaging Design
10:30 a.m.	Peckham, Inc.	Thread/Trim Cutoff Safety System: Silk Production Line
11:00 a.m.	Village of Alanson	Hand-Propelled Ferry to Sanctuary Island Park

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 US government agencies.

We gratefully acknowledge the participation support of this semester's project sponsors: Adventures in Training with a Purpose, Alro Steel, Gerdau, Magna International, MSU Adaptive Sports & Recreation Club, MSU Department of Mechanical Engineering, MSU Department of Theatre, MSU Rocketry Club, Munters FoodTech, Peckham, Inc., Robert Bosch LLC, Village of Alanson, and Wheels on Rails, LLC.

Wheels on Rails, LLC
Rail Biking Assist

Wheels on Rails is an exhilarating outdoor experience in Traverse City, Michigan. It offers one-of-a-kind tours that utilize custom-made exclusive pedal-powered rail bikes. The tours take place on out-of-service rail lines where the rail bikes are run through the woods of southern Traverse City. The company was founded by Macie Hefron. Her love for the outdoors, cycling, and railroads led to her rail biking.

After the first season, it was determined that more assistance was needed for the 1.75-grade incline on the tour's return route. The focus of this project was to design a motor/throttle system for the existing rail bikes to navigate the 1.75 railroad grade on a six-mile route with a 198 ft elevation gain, ensuring passenger safety and ease of battery replacement. The potential design needed to have an extended battery life to cover the first half of the six-mile route (one hour) and accommodate the existing four-seater rail bike design with a maximum system weight of 1200 lbs. For long-term use, the final design had to be efficient, while prioritizing the safety and comfort of the rail bike passengers. Additionally, the team was tasked with designing a frame to attach the motor to the rail bike utilizing 3D modeling software as well as curating a bill of materials for the final design.

Michigan State University
Team Members
(left to right)

Courtney Smith
Brighton, Michigan

Thaslimur Rahman
Hamtramck, Michigan

Raed Mohammed
Farmington Hills, Michigan

Muad Hassan
Hamtramck, Michigan

Jack Feistritzer
Grand Rapids, Michigan

Wheels on Rails, LLC
Project Sponsor

Macie Hefron
Traverse City, Michigan

ME Faculty Advisor

Dr. Norbert Mueller

Wheels on Rails, LLC
Propulsion Assist Wheels on Rails

Wheels on Rails is an outdoor rail bike company that specializes in providing tours on out-of-service railroad lines in Traverse City, Michigan. After receiving assistance from previous Michigan State University mechanical engineering capstone groups on chassis design and assembly, they have returned with the next task of propulsion assistance. The objective was to modify the current rail bike models by designing them with the addition of a motor. Currently, the rail bikes are strictly pedal-powered. This creates potential issues for customers when some inclines are encountered on the tour. Wheels on Rails wants to make the tours fun for all customers without causing unenjoyable physical exertion to overcome these inclines. The addition of a motor/pedal assist to the rail bikes will allow Wheels on Rails to improve the customer experience.

This was a design-intensive project consisting of integrating a combustion engine onto the rail bike to deliver extra torque to the rear axle. The engine is required to supply enough power to push multiple rail bikes up a 1.75 grade incline for at least six miles. A throttle was included so that the user can control the speed of the rail bike. It was also important to have a clutch system so that the user is able to toggle the assistance of the engine for different parts of the railroad.

This project was conducted using computer-aided design to replicate Wheels on Rails rail bikes and to model the assembly of our recommended motor, along with the external systems such as throttle, clutch, and gearing integrated into the rail bike.

Michigan State University
Team Members
(left to right)

Richmond Zhang
Fowlerville, Michigan

Jacob Bruck
West Bloomfield, Michigan

Nicolas Boehlert Somohano
Okemos, Michigan

Graham Bailey
Bay City, Michigan

Joseph Lambert
Troy, Michigan

Wheels on Rails, LLC
Project Sponsor

Macie Hefron
Traverse City, Michigan

ME Faculty Advisor

Dr. Rebecca Anthony

Alro Steel
Plasma Processing Center, Material Handling Cart

Alro Steel is a distributor of metals, industrial supplies, and plastics. Founded in 1948 by two brothers, Alvin and Robert Glick, Alro Steel started in a small garage in Jackson, Michigan. Now, with over 75 locations in 15 states, it is one of America's premier distributors in North America. Specifically, the Lansing Branch has the highest concentration of plasma burning capacity in the Midwest. Alro offers cut-to-size metals and plastics with next day delivery to over 50,000 customers, selling a broad inventory of products under a variety of company names such as Alro Steel, Alro Metals, Alro Metals Outlet, Alro Industrial Supply, and Alro Plastics. No matter how large or small the company is, Alro Steel's main focus is on exceeding expectations and building relationships with all customers.

The objective of this project was to improve the processing efficiencies at the primary plasma burning location in Lansing, Michigan. They wanted to increase efficiency and productivity by improving its specific material handling carts, which are used to transport semi-finished parts to additional processing stations. One of the main issues with the older models was that some of the workers preferred to use the overhead crane to transport the material, slowing down productivity and becoming a higher safety risk. Another issue was if a load was too heavy to push, a device called a "Tugger" would need to be used to move the cart, which is not the preference of many of the workers. Our main focus was on redesigning the material handling cart to hold a desired load, be able to move with ease, and improve productivity, all while listening to the workers' feedback and suggestions.

Michigan State University
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(left to right)

Aaron McDowell
Mason, Michigan

Brendan Foster
Saline, Michigan

Logan Roeser-Nordling
Ann Arbor, Michigan

Nathan Wright
Grand Rapids, Michigan

Dan Mo
Farmington Hills, Michigan

Alro Steel
Project Sponsor

Joel Major
Lansing, Michigan

ME Faculty Advisor

Dr. Andre Benard

Gerdau
Ergonomic Risk Reduction/Handling Large Paper Rolls

Gerdau is an industry-leading global steel manufacturing company with locations throughout the Americas. They specialize in the manufacturing and fabrication of steel from scrap metal and ore into specialty steel products for automotive, firearms, agricultural, construction, kitchen appliances, and energy industries, amongst others. The Jackson steel mill specializes in the finishing steps of the steel bar processing, utilizing methods such as chamfering straightening, heat treating and turning of specialty bar products.

Many of Gerdau's customer's request that Gerdau wrap its finished steel bars with corrosive-resistant paper before shipment. The paper arrives at the Jackson mill stacked as paper rolls in pallets. From the pallets, the paper rolls need to be moved to caddy stations and placed so that the paper can be dispensed onto the finished steel products. This project was to design and implement a mechanism that can more ergonomically lift the paper rolls and relieve the steel mill workers of the repetitive and physical strain of manually lifting the paper rolls. This also eliminates the possibility of injuries caused by manually lifting these heavy rolls so that the paper can be dispensed onto the finished steel products. The design had to be capable of lifting the paper rolls, most of which were over 100 pounds. The design also had to be applicable to multiple different caddy stations at the Jackson mill with a transportation component to move the paper rolls without the need for the workers to lift them.

Michigan State University
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Williamston, Michigan

Brandon Tsivitse
Rochester, Michigan

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Kylie Carbary
South Lyon, Michigan

Abel Barazza
Melvindale, Michigan

Gerdau
Project Sponsor

Erin Whiting
Jackson, Michigan

ME Faculty Advisor

Dr. Galit Pelled

Peckham, Inc.
Robotic Garment Packaging Design

Peckham, Inc. is a nonprofit vocational rehabilitation organization that intertwines business and human services and values quality, diversity, and performance. With a mission to maximize human potential, Peckham provides opportunities aimed at fostering independence and self-sufficiency among individuals with disabilities. In the manufacturing realm, especially in garment manufacturing, Peckham has leaned on manual labor for operational processes, ensuring product quality and precision. Every client and employee at Peckham brings forth a unique story of overcoming adversity, and the organization has consistently exceeded customer expectations by delivering high-quality performance and globally competitive products, actualizing potential.

Our project set forth a strategic initiative to bolster Peckham's operational efficiency within the garment manufacturing sector, specifically targeting the pack-out or end-of-line process. We crafted a phase one design proposal that seamlessly integrates innovative robotics and automation technologies into Peckham, Inc.'s existing processes. The focal point of our phase one design proposal was to ensure that the integration of automation not only amplified throughput but also promoted employee development and safety. This methodology was devised to ensure alignment with Peckham, Inc.'s core values, thereby enabling Peckham to continue to deliver on its potential and uphold its commitment to quality and performance.

Michigan State University
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Cody Bartos
Plymouth, Michigan

Brandon Gonzalez
Wixom, Michigan

Dexter Lynch
Beal City, Michigan

Nathan Kowalski
Mount Prospect, Illinois

Peckham, Inc.
Project Sponsor

Rockey Myall
Lansing, Michigan

ME Faculty Advisor

Dr. Thomas Pence

Peckham, Inc.
Thread/Trim Cutoff Safety System: Silk Production Line

Peckham, Inc. is a nonprofit rehabilitation organization that was established in 1976. One of its goals is to supply equipment that is designed with the latest technology. It provides training in order to optimize human performance for people aiming to gain skills such as career planning and consultation that enables them to be confident in their ability to be self-sufficient on the path towards excellency. The program also includes a manufacturing division that designs and produces high-performance clothing and gear for the military in large quantities by turning rolls of fabric and cutting a variety of components to be delivered.

Our team was focused on improving the safety aspect of the sewing department at Peckham, Inc. The problem that the factory faces is the excessive amounts of threads accumulating on the floor and around the operator that may cause a slip hazard and decrease the efficiency of the operators, as they have to take time out of their work to clean up the debris. We designed two prototypes that tackled the issues for the different sewing machines that Peckham, Inc. uses. The mechanism's main principle is the Venturi effect. This is achieved by having a compressed air supply attached to the wand. The first design created is a handheld wand that the operator can use freely, and the second design is a stationary vacuum that sucks in the threads before they reach the floor.

Michigan State University
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Orchard Lake, Michigan

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Chesterfield, Michigan

Faisal Alsuhaimi
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Peckham, Inc.
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Dan Stevens
Lansing, Michigan

ME Faculty Advisor

Dr. Seungik Baek

Village of Alanson
Hand-Propelled Ferry to Sanctuary Island Park

Alanson, Michigan is a quaint town located at the top of the state's lower peninsula. Situated on the banks of the Crooked River, the village has a rich history dating back to its founding during the Michigan lumber boom. It served as a transportation rest stop through the peak of rail travel and is one of the westernmost stops of Michigan's Inland Route. In more recent times, Alanson has become a common place for tourist travel due to its many attractions, including the world's smallest swing bridge, the village museum curated by the Inland Water Route Society, and the many recreational activities available on Sanctuary Island Park. The town's island is located directly adjacent to the Crooked River and stands as an object of pride for the village. Originally donated by local resident Derry Williams as a memorial to his wife and son, Sanctuary Island features a pier, a gazebo, and a system of boardwalks traversing the park that have been contributed by other members of the community over the years.

Despite Sanctuary Island itself being a point of honor for the town, the method by which people can enter the park has not been. The hand-propelled ferry constructed to cross the stream encircling the island is currently inoperable. After the original system of underwater chains became unreliable and expensive to maintain, a private citizen devised a cable propulsion system for the ferry. Though an improvement, the second design did not operate smoothly or consistently. By the summer of 2023, the ferry was in a state of disrepair and the island was not accessible. The Village of Alanson tasked our team with designing a reliable, safe, and serviceable hand-propelled mechanism with the hopes of having Sanctuary Island accessible in time for next spring's tourist season. Additionally, our solution had to meet a variety of operational constraints, such as allowing small watercraft to cross the stream and working with the existing infrastructure.

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Hunter Arnett
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Village of Alanson
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The Capstone Projects

Dr. William Resh
Professor of Mechanical Engineering

Faculty Advisors: Zhaojian Li, Siva Nadimpalli, Thomas Pence, Neil Wright, Mohsen Zayernouri, Guoming Zhu
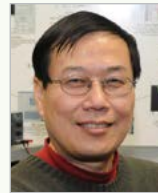
Li   Nadimpalli   Pence   Wright   Zayernouri   Zhu

Presentation Schedule – Engineering Building, Room 1220

Time	Team Sponsor	Project Title
8:00 a.m.	Adventures in Training with a Purpose	Directed Steps: Ambulation Aid Enhancements
8:30 a.m.	Adventures in Training with a Purpose	Ambulation Aid Design
9:00 a.m.	Magna International	Micro-Mobility Concept Design
9:30 a.m.	Magna International	Micro-Mobility Concept Design
10:00 a.m.	Robert Bosch LLC	Fuel Cell Anode Recirculation Test Stand
10:30 a.m.	MSU Adaptive Sports & Recreation Club	Increasing Hockey Sled Mobility – Phase V
11:00 a.m.	MSU Adaptive Sports & Recreation Club	Inclusive Sports Wheelchair

Mechanical Engineering Design Program

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

The ME faculty who supervised ME 481 design teams this semester are: Rebecca Anthony, Seungik Baek, Andre Benard, Haseung Chung, Brian Feeny, Farhad Jaberi, Patrick Kwon, Zhaojian Li, Ricardo Mejia-Alvarez, Norbert Mueller, Siva Nadimpalli, Ahmed Naguib, Galit Pelled, Thomas Pence, Sara Roccabianca, Harold Schock, Elisa Toulson, Neil Wright, Mohsen Zayernouri, and Guoming Zhu.

Adventures in Training with a Purpose
Directed Steps: Ambulation Aid Enhancements

Adventures in Training with a Purpose (ATP), established in 2015, emerged with a powerful mission: to address health and mobility challenges that underserved communities face, where access to proper paid rehabilitation resources is often limited. Operating as a registered nonprofit organization under 501(c)(3) status, ATP envisions a world where individuals are not confined by the constraints of their health. Representing an uncharted journey filled with meaning and enlightenment while training empowers individuals to strengthen both their mental and physical capabilities, and provides them newfound freedom of movement. ATP's dedicated journey is all about breaking barriers and unlocking human potential in the pursuit of a healthier and more equitable society.

Our team's primary objective was the development of an innovative design to enhance the functionality of conventional crutch tips, which have remained largely unchanged for centuries. This innovative design prioritizes the use of forward momentum and mobility in individuals' movements. Presently, traditional crutch tip designs offer limited advantages in terms of reducing the effort required for crutch usage. Our groundbreaking approach not only instills user confidence but also places a strong emphasis on safety and improved mobility. Our mission entailed designing a crutch tip that would inspire patients to confidently take the next step of their rehabilitation journey.

Michigan State University
Team Members
(left to right)

Miles Grimes
Chesapeake, Virginia

Amjid Khogali-Watson
Lansing, Michigan

Zach Maccoux
Northville, Michigan

Longfei Bao
Taiyuan, China

Anita Patel
Canton, Michigan

Adventures in Training with a Purpose
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Wexford, Pennsylvania

Jon Kolb
Wexford, Pennsylvania

ME Faculty Advisor

Dr. Zhaojian Li

Adventures in Training with a Purpose
Ambulation Aid Design

Adventures in Training with a Purpose (ATP) is a nonprofit organization dedicated to enhancing the quality of life for individuals in need through physical training. Their support extends to various groups, such as amputees and veterans. They employ functional movement training techniques, integrating strength and aerobic exercises with elements of balance and movement patterns. This approach enhances an individual's stability and balance. ATP firmly believes that regardless of a person's disability, it should never limit his/her ability to live life to its fullest potential.

For this project, our assignment was to enhance an existing crutches design. The initial design provided to us lacked sturdiness and user-friendliness, falling short of ATP's desired standards. Additionally, we were tasked with refining the spring mechanism inside the crutches. The crutch was composed of three main components: the handle, the middle section, and the foot, with the spring located in the middle portion. In the previous design, it was unable to generate sufficient energy for the user to lift off and use the crutches efficiently which was a significant challenge the spring faced. We successfully tackled this issue by implementing a stronger spring, ensuring it could provide the necessary support for users weighing between 100-120 lbs. This approach enabled us to tailor the spring and mechanism precisely, which enhanced user comfort and efficiency. We then collaborated with another group that worked on a separate part of the crutch and made sure that both designs fit into one cohesive crutch. By adapting our design to fit harmoniously with the other components, and improving the overall spring in the middle section, the overall crutch design was significantly improved.

Michigan State University
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(left to right)

Waabe Damboba
Grand Rapids, Michigan

Alexander Choma
Novi, Michigan

Erik Liu
Novi, Michigan

Phillip Jeon
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Jalen King
Montclair, New Jersey

Adventures in Training with a Purpose
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Wexford, Pennsylvania

Jon Kolb
Wexford, Pennsylvania

ME Faculty Advisor

Dr. Siva Nadimpalli

Magna International
Micro-Mobility Concept Design

Magna International is a global automotive supplier and manufacturer headquartered in Canada, renowned for its comprehensive range of automotive systems, components, and complete vehicle assembly solutions. With a presence in 30 countries and a strong reputation for innovation and quality, Magna is a significant contributor in the automotive industry, providing leading-edge technologies and electric vehicle components, while also offering full-service capabilities for designing, engineering, and manufacturing vehicles. Additionally, Magna is deeply committed to sustainability, actively working to reduce emissions through the development of eco-friendly technologies and advanced mobility solutions, further solidifying its pivotal role in shaping the future of the automotive field.

Our team was tasked to design and analyze a micro-mobility concept for operation in urban areas and tailored to utility workers and skilled trades as the target audience. Notably, our close collaboration with a peer design group responsible for designing other aspects of the concept for Magna ensured the optimal positioning of critical system integration points, contributing to the overall dynamic and static stability of the integrated vehicle. Moreover, our project benefited from the cooperation with a peer from the Applied Engineering Sciences Department, who conducted a comprehensive cost analysis and economic viability study for the concept.

Michigan State University
Team Members
(left to right)

Dayton Kullman
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Luke Honer
Angola, Indiana

Alex Figa
Clarkston, Michigan

David Twomley
Grosse Ile, Michigan

Ryan Bolio
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Wil Jozwiak
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Magna International
Project Sponsor

Julian Knutzen
Aurora, Ontario

ME Faculty Advisor

Dr. Neil Wright

Magna International
Micro-Mobility Concept Design

Magna International is a global automotive supplier and manufacturer headquartered in Canada, renowned for its comprehensive range of automotive systems, components, and complete vehicle assembly solutions. With a presence in 30 countries and a strong reputation for innovation and quality, Magna is a significant contributor in the automotive industry, providing leading-edge technologies and electric vehicle components, while also offering full-service capabilities for designing, engineering, and manufacturing vehicles. Additionally, Magna is deeply committed to sustainability, actively working to reduce emissions through the development of eco-friendly technologies and advanced mobility solutions, further solidifying its pivotal role in shaping the future of the automotive field.

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AI GENERATED IMAGE by DALLE-3 using prompt "electric trailer with conventional tow hitch in bike lane"

Michigan State University
Team Members
(left to right)

John Salloum
Plymouth, Michigan

Luke Lemont
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Anirudh Menon
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Jonathon Lewis
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Magna International
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Jim Quesenberry
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Dr. Neil Wright

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01001010 01101111 01101000 01101110 00000110
01010111 01101001 01101100 01101100 01101001 01100001 01101101

Robert Bosch LLC
Fuel Cell Anode Recirculation Test Stand

The Bosch Group is a leading global supplier of technology and services. Its strategic objective is to improve quality of life worldwide with connected products and solutions that are innovative and spark enthusiasm. Bosch is pursuing a vision of mobility that is sustainable, safe, and exciting using cross-functional solutions. One of the largest sectors within Bosch is mobility. In terms of revenue, Bosch is the largest automotive supplier in the world. From spark plugs to electric motors and fuel cells, Bosch has a hand in numerous sectors throughout the automotive market. This project focused on fuel cells, which are a revolutionary innovation that combines hydrogen and oxygen to create power and offer a flexible opportunity to greatly reduce the carbon footprint of both commercial and personal travel. Whereas classic internal combustion engines emit pollutants into the atmosphere, the by-products produced by fuel cell-powered vehicles are steam and water.

With this project, our goal was to measure the contribution of individual anode components to the recirculation of the anode side of the fuel cell. From this understanding, optimization of a fuel cell system could be realized, resulting in optimized utilization of hydrogen gas. Currently, one of the largest challenges to the overall life cycle of fuel cell vehicles is the requirement of production of hydrogen. The reduction of hydrogen consumption would further increase the environmental benefits of fuel cell vehicles. The main obstacles the team focused on were how to measure the flow at three different locations, which gas to use in place of the hydrogen during testing, and the packaging of the system into a standalone bench.
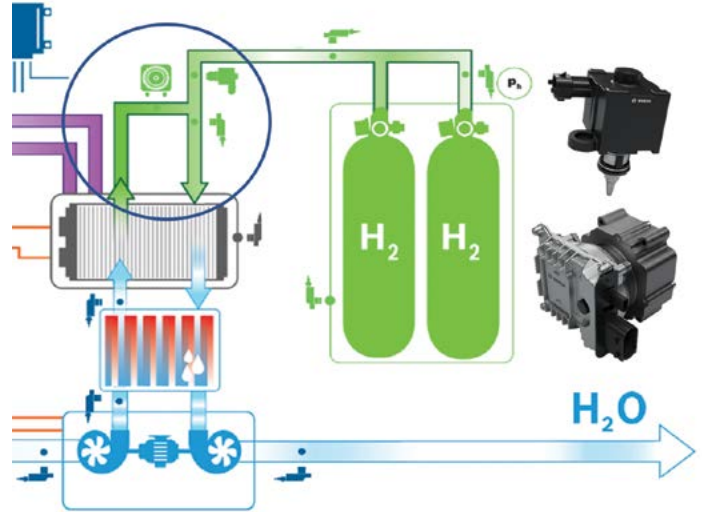
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Farmington Hills, Michigan

Jason Moll
Farmington Hills, Michigan

ME Faculty Advisor

Dr. Guoming Zhu

MSU Adaptive Sports & Recreation Club
Increasing Hockey Sled Mobility – Phase V

The purpose of the Michigan State Adaptive Sports & Recreation Club is to promote a healthy lifestyle to better physical, social, and mental health regardless of an athlete's physical ability. The club offers a wide variety of recreation activities such as seated volleyball, pickleball, goal ball, boccia ball, tandem cycling, roller hockey, and many more.

The club acquired several sleds for roller hockey, and the goal of this project is to improve the basic sled to serve a wider range of participants with varying abilities, while increasing performance, safety, and comfort. The previous phases of this project worked to improve the mobility and aesthetics of the sleds, and the comfort of the rider. Phase V focused on improving the safety for the user while maintaining the progress in the other areas achieved in the earlier phases of design.

Michigan State University
Team Members
(left to right)

Kailey Head
Monroe, Michigan

Stefan Bellman
Lake Orion, Michigan

Garrett Martin
Ann Arbor, Michigan

Angel Perez
Holland, Michigan

MSU Adaptive Sports & Recreation Club
Project Sponsor

Piotr Pasik
East Lansing, Michigan

ME Faculty Advisor

Dr. Mohsen Zayernouri

MSU Adaptive Sports & Recreation Club
Inclusive Sports Wheelchair

The Michigan State University Adaptive Sports & Recreation Club facilitates inclusive and accessible sports for individuals with physical disabilities. The program is headed by Piotr Pasik and includes sporting events in wheelchair basketball, wheelchair hockey, and wheelchair rugby. The MSU Adaptive Sports & Recreation Club is funded by grants that are put directly back into the program for new sports wheelchairs, online exercise and nutrition programs, and support for engineering projects pertaining to the club.

Our team was tasked with optimizing an inclusive sports wheelchair for an individual with limited mobility. The project is in its ninth iteration and is a continuation of previous Capstone groups' efforts. The individual has limited use of the left side of his body and the wheelchair must facilitate movement while enabling him to utilize his free hand for sport. Optimizing the sports wheelchair included using a simplistic design so that if an engineer is not present, repairs can still be made, improving the mobility of the chair, and enabling the individual to break, turn, and propel himself without limiting use of his free hand.

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MSU Adaptive Sports & Recreation Club
Project Sponsor

Piotr Pasik
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The Capstone Projects

Dr. William Resh
Professor of Mechanical Engineering

Faculty Advisors: Haseung Chung, Farhad Jaberi, Patrick Kwon, Ricardo Mejia-Alvarez, Ahmed Naguib, Sara Roccabianca, Harold Schock, Elisa Toulson

| Chung | Jaberi | Kwon | Mejia-Alvarez | Naguib | Roccabianca | Schock | Toulson |

Presentation Schedule – Engineering Building, Room 1300

Time	Team Sponsor	Project Title
8:00 a.m.	MSU Department of Theatre	Spinning Practical Drop
8:30 a.m.	MSU Department of Theatre	Retractable Sanding Dust Collector
9:00 a.m.	MSU Department of Theatre	Fairchild Theatre Rigging Grid Analysis
9:30 a.m.	MSU Adaptive Sports & Recreation Club	Sled Hockey Transfer Platform – Phase VIII
10:00 a.m.	MSU Adaptive Sports & Recreation Club	3-Wheel Drive System for Scooter – Phase III
10:30 a.m.	MSU Department of Mechanical Engineering	Hydrogen IC Engines vs Fuel Cells
11:00 a.m.	MSU Rocketry Club	Launch Tower Design, Fabrication, and Ground Support
11:30 a.m.	Munters FoodTech	Manual to Automated Shutter Assembly

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.
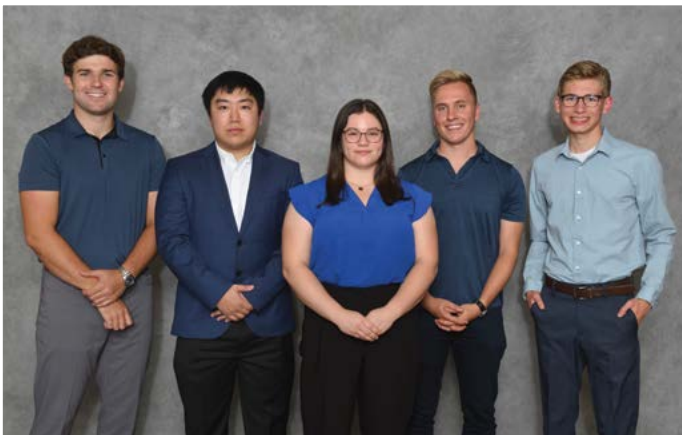
MSU Department of Theatre
Spinning Practical Drop

Michigan State University's Department of Theatre serves the community throughout the year with multiple productions for students and the community. The Theatre Department strives to challenge complacency through its productions to expand the audience's world view and create opportunities for important discussions about society. These performance spaces help stimulate the exchange of cultures and ideas, as well as create inspiration.

In theatrical productions, the "grid" serves as a crucial support structure for suspending props and backdrops. While this system facilitates the smooth raising and lowering of practical items like chandeliers, the persistent issue of spinning fixtures has been a longstanding concern, causing undue distraction for the audience. Our mission was to engineer a raising and lowering system capable of rectifying this issue, ensuring steadiness and stability in practical drops. To achieve this, we sought to minimize wire diameter, to optimize smooth operation, and reduce the number of wires to a minimum, ultimately aiming for a single point of connection to the practical drop for utmost audience focus. The safety of our system was paramount, as it operates above individuals. We designed it to bear loads of up to 25 lbs. with a high factor of safety, implementing fail-safes and mechanical stops to safeguard against any potential operator or equipment failures. Moreover, our system was crafted with sustainability and cost-effectiveness in mind, seamlessly integrating with the existing rigging infrastructure and being able to be reused in the future plays for various lighting fixtures and practical drops. Through meticulous engineering and innovative design, our raising and lowering system not only addresses these challenges but also sets a new benchmark for efficiency, safety, and audience engagement in practical drop operations. We are proud to present a solution that enhances the theatrical experience, ensuring a seamless and immersive production for all.

Department of Theatre
MICHIGAN STATE UNIVERSITY

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MSU Department of Theatre
Retractable Sanding Dust Collector

The Department of Theatre at Michigan State University strives to provide graduate and undergraduate education in all realms of performing arts by challenging tradition to create something new. Its mission is to incite, excite, and provoke action through plays and musicals. While the department connects with the spectator through action on stage, the depth of this connection is enhanced by many other aspects, including the sights, sounds, and insights into the human condition that are acknowledged through this experience. The Scene Shop plays a key role, as this is where many of the settings and inanimate pieces of the performance are brought to life. This state-of-the-art teaching laboratory opened in 2016 and has transformed the learning experiences of those working on set design and construction ever since.

For this space to function as safely, efficiently, and effectively as possible there was a need to control the debris created through some of the fabrication processes that take place at the Scene Shop. It was also of key importance that specific design restrictions were heeded. First, ease of use and convenience were considered. The final design is easy to set up and properly maintain. Spatial constraints were also in place as the amount of available physical space in the Scene Shop is extremely limited. To account for all of this and more, a collapsible enclosure was built to create an area where activities such as sanding could take place inside, while carefully minimizing the amount of space taken up. When not in use, this design retracts against a wall and takes up little to no space. In doing this, an area with negative pressure was created so that these and similar tasks could be completed inside, and the debris created could be removed from the workspace and environment. This system was set up using an existing structure within the shop to once again reduce space used. This makes for a cleaner working environment and enhances the safety of the task for the operator.

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MSU Department of Theatre
Fairchild Theatre Rigging Grid Analysis

The Michigan State University Department of Theatre puts on many shows throughout the year. The theatre program provides a courageous and self-driven creative process within and outside of current structures with a focus on using art to create a path to success. They provide personalized experiences for both undergraduate and graduate students, using technology to design new worlds and through examining the past to understand the present and influence the future. For graduate students, there is a focus on preparation for a career as a professor or administrator at major universities and colleges throughout the United States, or a career in professional theatre.

The Fairchild Theatre stage is used throughout the year for different concerts and performances, which has brought about curiosity about the grid structure above the stage and how much weight it can safely hold. We have conducted an analysis focusing on the individual beams of the grid and the load on the grid supports caused by loading on the individual members of the grid. We focused on point loads that had the highest chance of causing failure on the member. We also examined the rivets holding the beams together and determined the stress concentrations and conducted a bolt shearing analysis to determine the safety of the rivets. We focused on a process where chain motors supporting lighting and scenery are attached to a pipe that lays across multiple different beams in the grid since this is a practice used in the theatre.

Department of Theatre
MICHIGAN STATE UNIVERSITY

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

The MSU Adaptive Sports and Recreation Club was established in 2014 with the primary objective of providing students equitable access to regular physical activity, regardless of their physical mobility status. The club offers a diverse range of recreational sporting options year-round, encompassing activities such as adaptive rowing, boccia ball, and even adaptive track & field. Its unwavering commitment lies in ensuring inclusive access and active engagement for all participants. The club serves as a hub for cultivating a socially dynamic community, where both disabled athletes and able-bodied volunteers can partake in healthy activities. Before the program's establishment, the opportunity for MSU students with physical mobility disabilities to compete at the national level was difficult to obtain, but the MSU Adaptive Sports & Recreation Club now provides students with that platform. Overall, the sports club has become a destination for the Spartans of today and the future with physical disabilities.

Among the diverse array of sports offered, sled hockey stands out as an exhilarating and highly competitive team sport, tailored for those with lower-body impairments. The transfer platform enables athletes to transfer from their mobility aids to a hockey sled; however, the platform encountered safety and mobility issues. Therefore, our team's focus in the modification of the transfer platform consisted of ensuring transfer safety and independent use. Our team's redesign involved modifying the handlebars to increase rigidity during a transfer. To improve independent use, a docking mechanism to ensure stability from a hockey sled to the platform was designed. Overall, these changes are to help improve mobility of users during transfers, enabling ease of access for all.
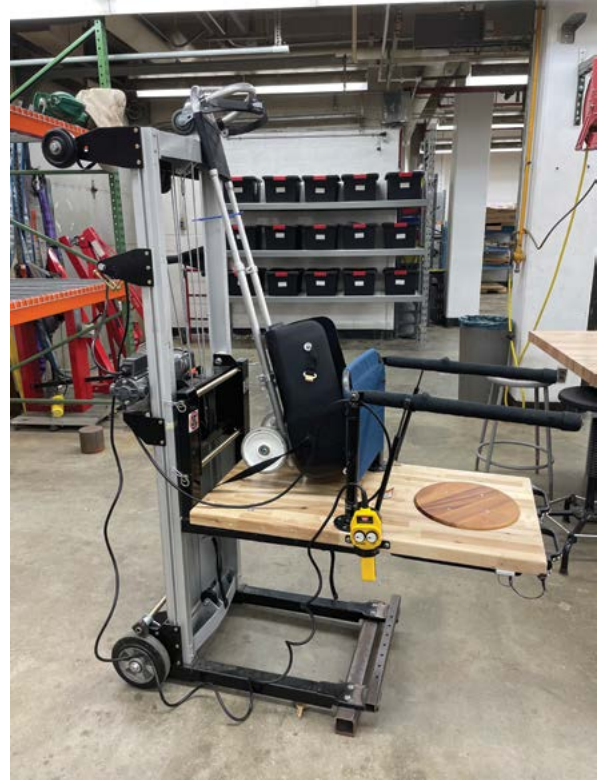
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MSU Adaptive Sports & Recreation Club
3-Wheel Drive System for Scooter – Phase III

The Michigan State University Adaptive Sports & Recreation club is committed to providing a diverse range of sporting and recreational opportunities tailored to individuals with physical disabilities. Its offerings encompass sports such as boccia ball, hand-cycling, wheelchair tennis, wheelchair floorball, wheelchair basketball, as well as adaptive variations of track & field and rowing. The club's overarching goal is to enhance the quality of life for those with physical disabilities by enabling their participation in activities that may otherwise be inaccessible to them. They achieve this by supplying all necessary sports equipment to their students and taking pride in their unwavering support for inclusion and diversity.

A major barrier to accessing adaptive sports opportunities was the lack of reliable transportation for individuals with disabilities. The EW-36, a 3-wheel mobility scooter designed to enable easy transportation for people with physical disabilities, faced challenges during winter due to its limited functionality. Our industry advisor tasked us with enhancing the scooter's winter performance by improving its structure and increasing power output to prevent it from getting stuck in the snow. The scooter's structure was not optimized for winter conditions, leading to snow buildup in the wheel wells and under the scooter near the engine. Additionally, the scooter lacked the power needed to consistently navigate through the snow. The goal of this project was to reduce the risk of getting stuck in inclement weather by optimizing the scooter's structure and increasing its power output, addressing a significant obstacle to accessing the benefits of adaptive sports.

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MSU Department of Mechanical Engineering
## Hydrogen IC Engines vs Fuel Cells

For over a century, internal combustion engines have been the heart of transportation. However, as temperatures rise and climate change becomes more evident, people are shifting their focus to different powertrain alternatives. The Michigan State University Department of Mechanical Engineering performs research in areas such as manufacturing and internal combustion engines, while also providing excellent curriculum to students. The Department of Mechanical Engineering decided to study the issue of carbon emissions for cleaner forms of transportation. One system that was considered was the hydrogen fuel cell system. This powertrain uses proton exchange membrane (PEM) fuel cells to convert hydrogen fuel into energy. Secondly, we examined a hydrogen fueled IC engine operated similarly to gasoline IC engines which uses hydrogen as fuel instead.

In each step, from mining raw materials to final product, carbon dioxide is emitted into the atmosphere. The question is, which system, from start to finish, produces the least amount of carbon dioxide. Emissions and cost for mining raw materials, transporting and refining those materials, manufacturing each component of the powertrain, producing the hydrogen fuel, and overall assembly were examined. The degradation for the powertrain components also played a key role in the decision. By looking at each system's emission data, a choice was made for which system is better.

These findings were presented in a format specified by the Michigan State University Department of Mechanical Engineering. This information will help with further research on these different transportation methods.
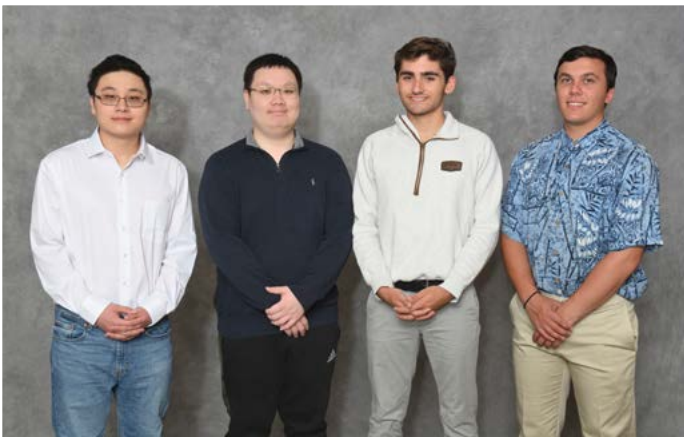
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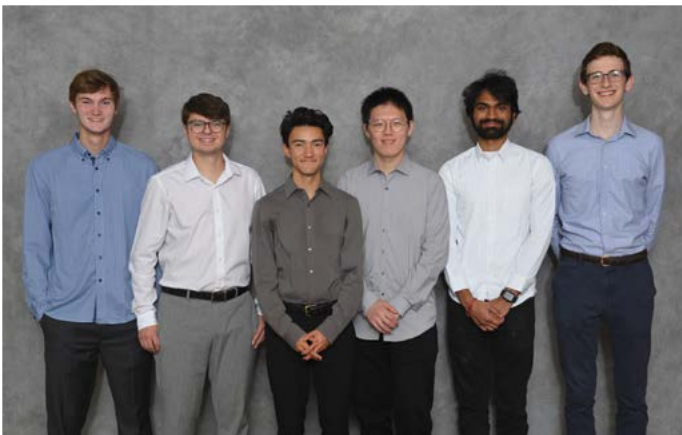East Lansing, Michigan

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MSU Rocketry Club
Launch Tower Design, Fabrication, and Ground Support

Founded in 2017, the Michigan State University Rocketry Club is an amateur rocketry group with the mission of designing, building, and launching high-powered rockets. Each summer, the MSU Rocketry Club competes in the Spaceport America Cup in Las Cruces, New Mexico, where they compete against over 150 other organizations. This past summer, MSU Rocketry competed in the 10,000 feet solid motor division, and successfully launched and recovered their rocket. For summer 2024, MSU Rocketry plans to compete with and launch a custom-made hybrid motor rocket in the 10,000 feet division.

In order to properly test and eventually launch their next rocket, MSU Rocketry required a launch stand with the necessary capabilities to accommodate a hybrid rocket. These capabilities included the ability to support the 100+ pound rocket, the ability to weigh the rocket on the stand, and the ability to be tilted at a set angle. Additionally, the launch stand needed to be tall enough to ensure the rocket reached the required speed off of the rail. It was also paramount that the launch stand was modular in design, allowing for disassembly and transport to the competition. In order to accommodate a successful launch, a launch tower with these capabilities was designed, developed, and manufactured.

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Munters FoodTech
Manual to Automated Shutter Assembly

Munters FoodTech is a global leader in climate solutions for mission-critical processes in livestock farming and greenhouses. Additionally, they offer cutting-edge software designed to control and optimize the entire food production value chain. Munsters' solutions enhance productivity while facilitating sustainable food production in environments where there are high requirements for quality, animal health, and food safety. Sustainability is an important part of Munters' business strategy and value creation.

The goal of our project was to transition the manual assembly process currently in place at Munters FoodTech into a more efficient, automated one. The completion of this project has greatly impacted the company. Not only has the automated process helped to reduce production costs, but it has also enabled the rotation of staff to other projects within the company, thereby maximizing efficiency. The fully automated assembly process has impacted the company's operations by enabling the more rapid fulfillment of work orders, which leads to increased profits and a notable reduction in production costs. With the new assembly process in place, shutters of various sizes, tailored to customers' individual specifications are now effortlessly and precisely assembled with no item-to-item variation. This transition to automation is a pivotal change in the production process. Prior to the implementation of our project, the overall assembly process had not been adjusted in approximately thirty years, apart from the addition of a robot to provide machining precision. Additionally, the project involved researching options for improving methods of the cutting of materials.
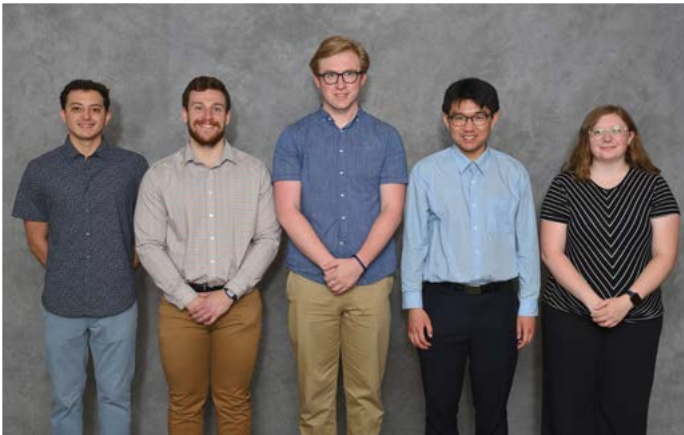
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**ME Faculty Advisor**

Dr. Ahmed Naguib

Mechanical Engineering
Design Day Awards Spring 2023

ME 481 Edison Award

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: Team Our Next Energy "Trailer Hitch Force via Strain Gage"

Left to right: Zachary Lang, Connor Witham, Nicholas Sarver, Evan Petersen, Najmi Rahim, Christian Giggy
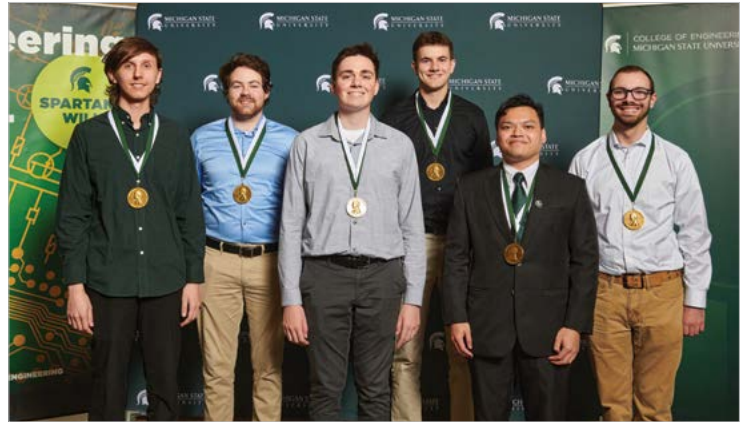
ME 481 Presentation Award

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

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

Left to right: Nicholas Coubard, Calum Walton, Olivia Reyes, Garrett Colasinski, Noah Goldman

ME 470 da Vinci Award

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

Left to right: Hunter Arnett, Matt Fular, Ethan Avery, Steven Coscino

NOTES

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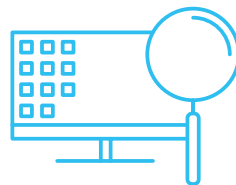**apply today at auto-owners.com**

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