MICHIGAN STATE UNIVERSITY COLLEGE OF ENGINEERING **FALL 2021**

DESIGN DAY

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 2021.

Amazon employees use leadership principles every day to guide our decision making, 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
Director
Selling Partner Experience
Amazon Detroit

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Continued on next page

Table of Contents: December 2021

Welcome from the Dean

Design Day is one of our premier undergraduate academic events of the semester. Now in our 27th year, Design Day highlights the creativity and ingenuity of our Spartan engineers.

We are pleased to once again welcome you to our in-person Design Day! This term our senior capstone design classes will be showcasing their projects in the hallways on all three floors of the Engineering Building. A few of the classes will also be giving project presentations. As you read about their projects in this booklet, you will see that our MSU engineers are ready to lead, create and innovate.

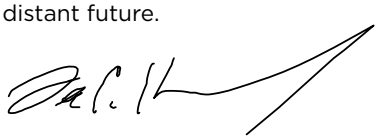
We are pleased to acknowledge Amazon as our Design Day Executive Partner Sponsor and Rocket Companies as our Design Day Directing Partner Sponsor. Our Design Day Supporting Partner Sponsors include Anthropocene Institute, Delta Dental of Michigan, Ohio and Indiana, MSU Federal Credit Union, the Michigan State University Foundation, TechSmith and Urban Science. We thank our sponsors for their generosity and their ongoing commitment to Design Day, especially during these challenging times.

As you explore the contents of this Design Day booklet, you will see that our students are an incredible group of talented young people who share a common enthusiasm for engineering. What they have accomplished during the challenges of a global pandemic, with all the associated changes in how they interact with themselves and sponsors, and how they meet the requirements of each project is inspiring.

Starting in their first semester, the freshmen in our Cornerstone and Residential Experience for Spartan Engineers programs learn about the importance of engineering and the positive impact that engineers make on society and the world around them. Our students innovate, communicate and perform at the highest levels in an increasingly global and demanding world.

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

We are confident that our full traditional in-person Design Day will continue again in the not too distant future.



Dr. Leo Kempel
Dean of the College of Engineering
Dennis P. Nyquist Endowed Professor of Electromagnetics
Michigan State University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EGR 100 Introduction to Engineering Design

Dr. Jenahvive Morgan
Course Instructor

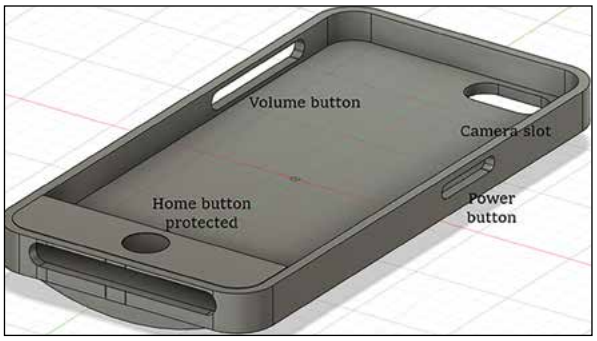
Course Project

EGR 100, Introduction to Engineering Design, is a college-level course required of all incoming first-year engineering students. It is an integral part of the CoRe (Cornerstone and Residential) Experience. The course introduces students to the engineering profession and the engineering design process through team-based, interdisciplinary design projects and assignments. There are 890 students enrolled in EGR 100 this semester.

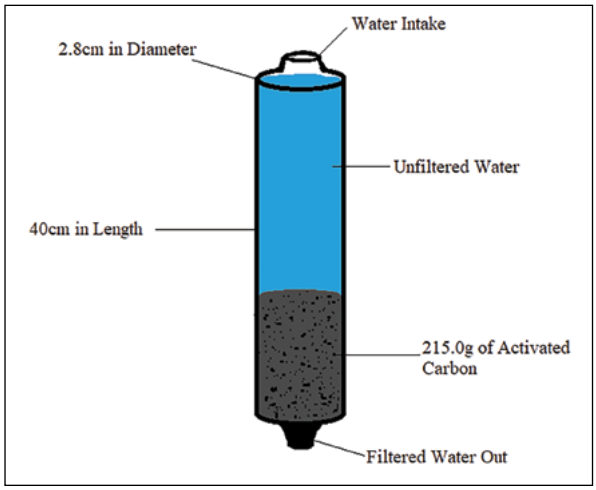
For the final course project, the student teams selected from seven project types: (i) Create a Phone App, (ii) 3D Printing CAD Drawing, (iii) Design a Mini Solar Car, (iv) Water Filtration System Design, (v) Create an Arduino LED Circuit, (vi) Design of a Heat Exchanger, and (vii) Costa Rica Community Designs.

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

Spring 2021 EGR 100 Project Designs



3D Printing CAD Drawing Project: Student Phone Case Design



Water Filtration Design Project: Student Water Filtration System Design

Inspiring students.

Transforming our community.

And providing opportunities for young adults to

dream big.

Delta Dental of Michigan is proud to support the Michigan State University College of Engineering's Design Day.

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Building Community

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

From cash back Visa Credit Cards to relocation loans, we have the financial resources you need to make your goals a reality.

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Anthropocene Institute

The Capstone Projects

Mr. Anthony Ingle
Teaching Specialist

Faculty Advisors:
Professors Dickenson, Engle, Haider, Hashsham, Ingle and Li


Dickinson


Engle


Haider


Hashsham


Ingle


Li

PRESENTATION SCHEDULES

Time	Team	Room 2205
8:00 a.m.	Team 1-SPETHE	Second Floor Room 2205
9:20 a.m.	Team 2-Mitten Made Engineering	Second Floor Room 2205
10:40 a.m.	Team 3-E.Z.P. Engineering	Second Floor Room 2205

Time	Team	Room 2245
9:20 a.m.	Team 4-Spartan Solutions Engineering	Second Floor Room 2245
10:40 a.m.	Team 5-SSD Engineering Inc.	Second Floor Room 2245

Time	Team	Room 2320
8:00 a.m.	Team 6-Star Industries	Second Floor Room 2320
9:20 a.m.	Team 7-Dogwater Design, Inc.	Second Floor Room 2320

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.

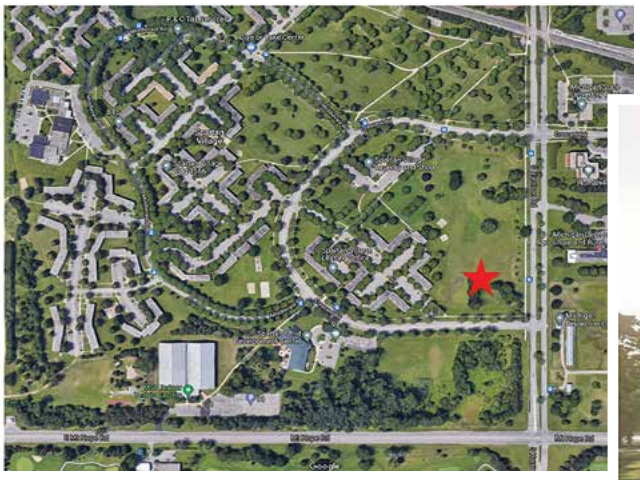
Each team is responsible for developing a design that addresses environmental, hydrological, pavement, structural, and transportation issues for the project. A student project manager coordinates each team. Design reports are judged by the faculty; progress reports and the oral presentations are judged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

CE 495 SENIOR DESIGN IN CIVIL & ENVIRONMENTAL ENGINEERING

TechSmith New World Headquarters

Michigan State University continues to implement its vision of redeveloping the 140-acre Spartan Village into a technology and innovation campus. Recently Michigan's governor and the MSU president were among others who announced the construction of a new headquarters for Techsmith, a software development company previously located nearby. The new 62,500 square-foot headquarters is being developed in partnership with the MSU Foundation on approximately 5 acres of land at the corner of South Crescent and Harrison Road.

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



Aerial photograph of site location

Architectural rendering of proposed building
- $15 million capital investment
- 330+ employees and student interns

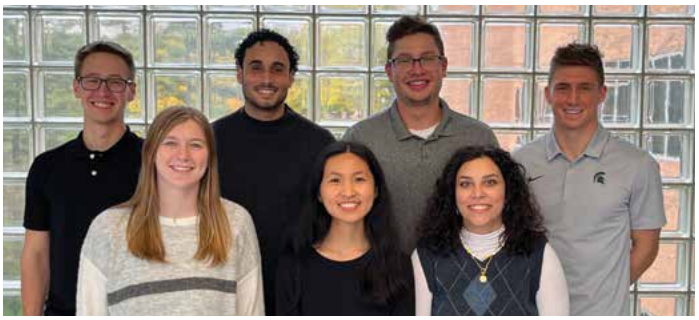
- 62,500-square-foot, two-story building
- Located on 5 acres of land in Spartan Village
- Groundbreaking was in June 2021 and completion by June 2022

Team 1: SPETHE
Left to right: Mathew Howland (PM), Reilly O'Connor (T), Garrett Pline (S), Devin Moses (P), Rebeca Fernandez de Cordova (E), Alison Duda (E), Lauren Kaltz (H)

Team 2: Mitten Made Engineering
Left to right: Patrick Dempsey (T), Kayla Siemen (E), Emily Loftis (H), Conner Earles (PM), Ashuman Gupta (S), Joseph Beattie (P)

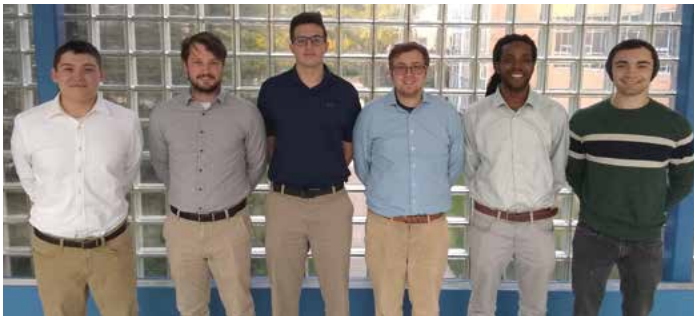
Team 3: E.Z.P Engineering
Left to right: Paige Luft (P), Peter Galer (PM), Emily Culver (S), Patrick Dickerson (H), Elizabeth Kerby (E), Zachary Ruddick (T)

Team 4: Spartan Solutions Engineering
Left to right: Brady Muldoon (P), Matthew Schwager (S), Luke Stagg (E), Sam Tyson (PM), Myles Overall (T), Calley McPherson (H), James Karvonen (E)



Team 5: SSD Engineering Inc.
Left to right: Jimmy Chadwick (P), Abby Jensen (E), Donte Richard (E), Tina Wang (S), Jeff Rockwell (T), Sara Nevedal (H), Elliott Ryan (PM)

Team 6: Star Industries
Left to right: John Thompson (S), Justin Stark (PM), Nicholas Holly (T), Parker LaGrow (P), Ryan Brown (E). Pictured inset, top to bottom: Jac Stelly (E), Blayne Libby (H)



Team 7: Dogwater Design, Inc.
Left to right: Hunter Lee (E), Matthew Boileau (PM), Rodrigo Azevedo (T), Zachary Gentry (H), Soyinka (Mike) Brown (S), Troy Dawdy (P)
Not pictured: Harrison Sochor (E)

KEY TO TEAM ROLES

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

CE 495 SENIOR DESIGN IN CIVIL & ENVIRONMENTAL ENGINEERING

PROFESSIONAL SEMINAR SPEAKERS

Michele Buckler, P.E.
Daimler Automotive Group

Mark Dubay, P.E.
Michigan Department of Transportation

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

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

Leanne Panduren, P.E.
Rowe Professional Services

Robert Rayl, P.E.
RS Engineering LLC

Charles Rolfe, P.E.
OHM Advisors

Jon Stratz, P.E.
Michigan Department of Transportation

Dan Thome, P.E.
Nicholson

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

Brad Wieferich, P.E.
Michigan Department of Transportation

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.

Jill Bauer, P.E.
Rowe Professional Services

Erik Carlson, P.E.
Michigan Department of Transportation

Dan Christian, P.E.
Tetra Tech MPS

Jim Corsiglia, P.E., S.E.
Harley Ellis Devereaux

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

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

Mike Ellis, P.E.
Barr Engineering Co.

David Hayden
DLZ

Josh Heinze, P.E.
OpenSpace

Matt Junak, P.E.
HTNB

Lauren Roller, P.E., S.E.
Harley Ellis Devereaux

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

Steven Sorensen, P.E.
PEA Group

Kevin Staley, P.E.
PEA Group

Stephen Subu
Consumers Energy

Phillip Vogelsang, P.E.
AECOM

ENGINEERING AT

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We're always on the lookout for software engineers who are passionate about technology, who care about the work they do and the people they work with. People who aren't put off by a wild idea (in fact, they crave other perspectives) and love working with a team.

From Quality Assurance to Software Development, TechSmith Engineers get the chance to work on multiple software products, in a variety of languages, and on different operating systems (Windows, Mac, iOS, and Android, plus Cloud products)

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TechSmith offers excellent health, dental and vision coverage for employees and their dependents. We also offer long-term and short-term disability coverage and life insurance at no cost.

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TechSmithies get generous paid time off (about 18 days the first year), with more days off added the longer you're here. You also get a paid day off for your birthday, in addition to the major holidays, and a paid day off each year to volunteer for a cause you love.

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TechSmith supports a portion of loan repayment and pays ⅔ of any tuition and books for qualified classes taken by full-time employees to improve their job skills, up to $5,250 per year.

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Profit Sharing
TechSmith offers quarterly and annual bonuses to full-time employees based on company profitability and increase in sales from the previous year for the same period.

Explore open positions and submit your application at techsmith.com/careers.

Capstone Course Sponsors

We thank the following companies for their generous support of the computer science capstone course.

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Plymouth, Michigan

Okemos, Michigan

Midland, Michigan

Chicago, Illinois

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Zeeland, Michigan

Littleton, Colorado

Frederick, Maryland

Grand Rapids, Michigan

Redmond, Washington

Mountain View, California

East Lansing, Michigan

Detroit, Michigan

Detroit, Michigan

Auburn Hills, Michigan

Okemos, Michigan

Chicago, Illinois

Detroit, Michigan

Royal Oak, Michigan

Auburn Hills, Michigan

Benton Harbor, Michigan

The Capstone Projects

Dr. Wayne Dyksen
Professor of Computer Science and Engineering

James Mariani

Luke Sperling

Instructors

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, Atomic Object, Auto-Owners Insurance, Bosch, Delta Dental of Michigan, Ohio and Indiana, Dow, Evolutio, Ford Motor Company, General Motors, Google, Herman Miller, Lockheed Martin Space, Malleable Minds, Meijer, Microsoft, Mozilla, MSU Federal Credit Union, PwC, The Rocket Companies, Stellantis, TechSmith, United Airlines, Urban Science, Vectorform, Volkswagen, and Whirlpool.

Ally Financial
Digital Avatar Assistant

Ally Financial is a financial services company based in Detroit, Michigan, operating as one of the largest car finance companies in the United States. Ally has amassed an immense customer base, financing cars for over 4 million people and having 2 million depositors. Ally also offers online banking and online trading, bolstering the services they provide for their customers.

Ally is a strictly digital company, offering no physical locations for customers. Because of this, Ally has been innovating the online service field since their founding. As artificial intelligence (AI) has advanced, Ally has been exploring inventive methods of digital customer service rooted in AI.

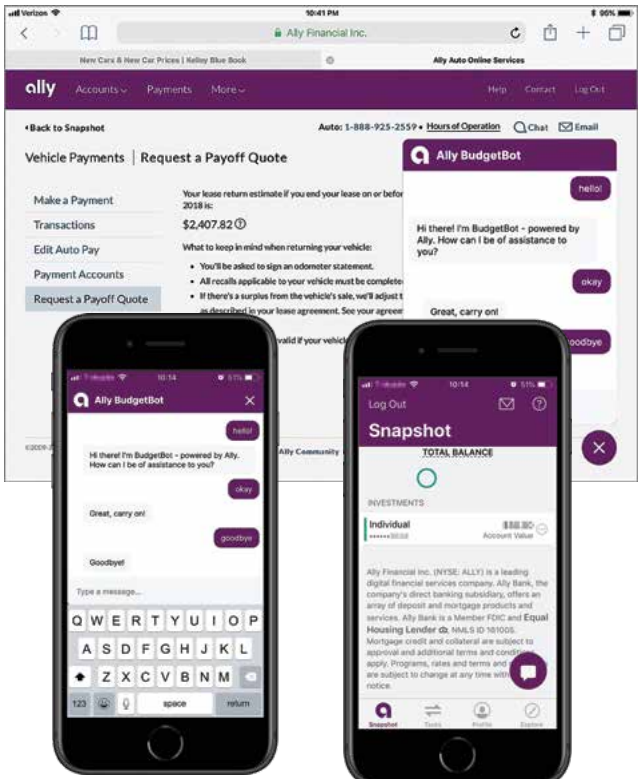
Our Digital Avatar Assistant is a cutting-edge AI assistant that provides Ally customers with real-time communication relating to their accounts, as well as custom-tailored financial advice.

Customers interact with our assistant through a chatbot interface embedded in Ally's website. Users ask questions by typing or speaking with the assistant about a wide array of topics, including account information, budgeting, spending analysis, etc.

To provide a lifelike experience, our assistant reacts with animated movement and facial expressions depending on context, mimicking a conversation with a human.

We use machine learning, natural language processing, and AI to analyze customer spending and budgeting habits to provide user-specific financial advice. Our Digital Avatar Assistant keeps track of user spending and provides reminders and warnings if the user is in danger of not meeting their spending goals.

The Digital Avatar Assistant is developed using Rasa. Our application uses Amazon EC2 for machine learning, Amazon S3 for model storage, DynamoDB for conversation storage, and a combination of Amazon Transcribe and Amazon Polly for conversational functionality. The user interface is built with React.



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Amazon
Amazon Web Services: AWSome Availability Zones

Founded in Bellevue, Washington in 1994, Amazon is a Fortune 500 company that provides a variety of services to customers as the world's largest online retailer and cloud services provider.

Customers using Amazon's cloud platform, Amazon Web Services (AWS), can choose to break their application up into many parts, each hosted in a different location (called an Availability Zone, or AZ). Such redundancy helps prevent service outages for customers.

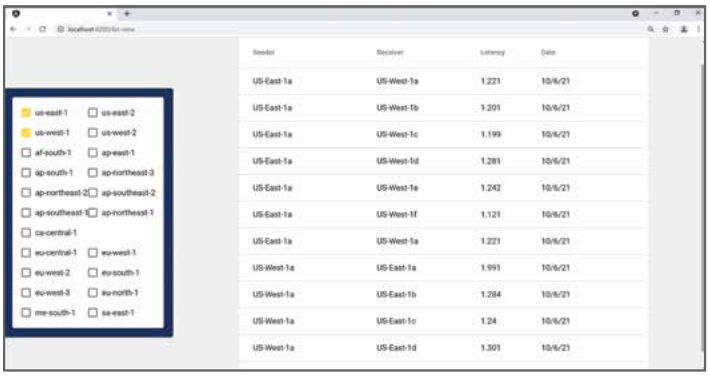
Distributed applications are spread across multiple servers, which need to communicate with each other for the application to function. This communication can take a significant amount of time, and minimizing the delay can lead to a better user experience. Choosing which AZs to use to minimize this delay traditionally requires extensive manual testing.

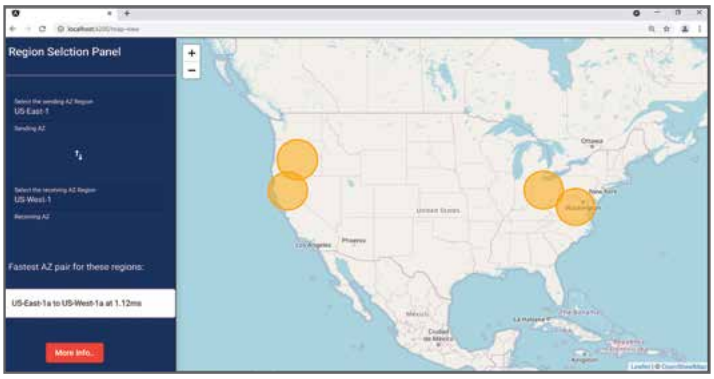
Our AWSome Availability Zones web application continuously and automatically measures the delay between Availability Zones, allowing Amazon Web Services customers to easily choose the fastest Availability Zones for their application, saving them time and money.

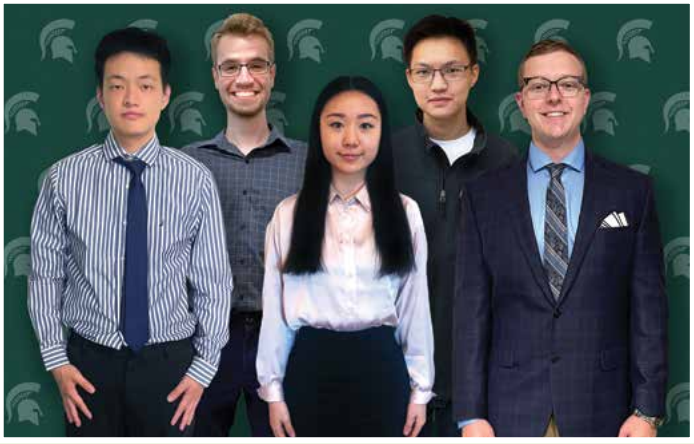
AWSome Availability Zones provides customers with an easy-to-understand visualization of the delay between Availability Zones using an interactive map with a familiar look and feel.

Experienced Amazon Web Services customers can opt to use our AWSome Availability Zones system to explore more detailed views of the network latency data, allowing them to answer specific questions they have, quickly and seamlessly.

Our software's front end is built using Angular, and its back end uses Amazon Web Services Elastic Compute Cloud (EC2) instances to measure network latency between Availability Zones, which it stores in DynamoDB.







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Anthropocene Institute
Air Pollution Health Outcomes Forecasting Tool

The Anthropocene Institute is an organization that partners with researchers, governments, experts and investors to address one of humanity's most pressing concerns, climate change. The organization provides support to projects related to clean energy, anti-pollution efforts and climate innovation and brings down any political or financial barriers they may experience.

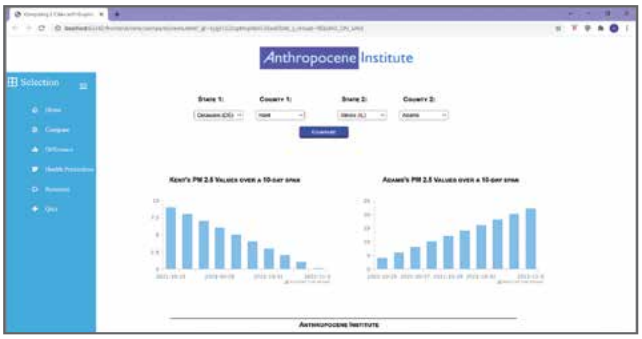
The Anthropocene Institute has turned its attention towards air pollution in hopes of researching the effect that air quality has on premature deaths and health complications, such as increased asthma, infant mortality and lung cancer.

Our Air Pollution Health Outcomes Forecasting Tool is an intuitive web dashboard that provides the public with a detailed analysis of the air quality in their area, as well as the potential resulting health effects. Users visit our dashboard and are presented with a map view of the United States and a set of filters. These filters allow the user to pick a particular address or region to learn more about the air quality in that location.

We use state-of-the-art machine learning techniques to make predictions about air quality for every location in the United States. Whenever a request for air quality information is made we use historical air quality data as well as up-to-the-hour live air quality readings from sensors around the country to make accurate predictions on the current air quality in any given location.

Our tool is used by a wide variety of people, including people trying to find a safe and healthy place to live, as well as policymakers trying to determine areas in need of assistance.

The front end is developed with HTML, CSS and JavaScript. Our software is served via a Python Flask back end which communicates data from our scikit-learn machine learning models. Our live data is retrieved from Purple Air Sensors.



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Anthropocene Institute
Electricity Grid Planning Tool

The Anthropocene Institute is a non-governmental organization with the mission of utilizing science and technology to address the planet's needs. It drives and facilitates innovation in clean energy to address the urgency of climate change. The Institute also supports start-ups and universities to develop emerging and disruptive energy technologies that are clean, safe and reliable.

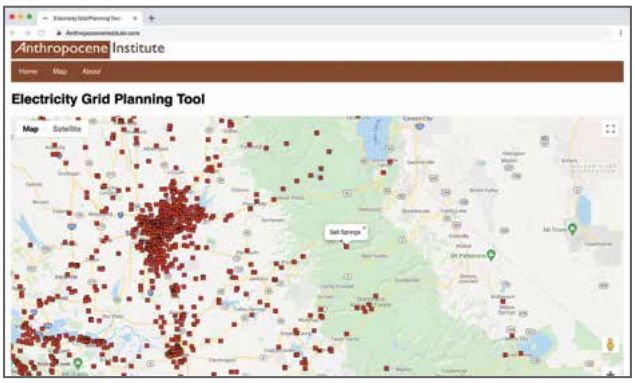
The Anthropocene Institute is interested in the possibility of Small Modular Reactors (SMRs) as a viable option for new sources of power generation in comparison to coal and gas plants that have significantly worse emissions that affect the atmosphere.

SMRs, however, must be placed properly in power substations based on power generation, power outage occurrence rates, and power consumption demands. Traditionally this would be done entirely by hand, which is time-consuming, error prone, and makes it hard to quickly compare multiple placements.

Our Electricity Grid Planning Tool is a web dashboard that uses machine learning to automatically simulate SMR power generation and SMR placement. Our tool uses historical energy consumption data to accurately predict the costs and benefits of placing an SMR at a particular power substation.

Our web application provides an easy-to-use interface used by electricity grid planners seeking to better understand the cost and benefits for deploying SMRs. Users simply view specific substations, and our application provides them with statistics and recommendations relating to the cost-benefits analysis of deploying a SMR in that area. Users can also easily compare two locations to make an informed decision without wasting time with manual calculations.

The machine learning models were developed in Python with scikit-learn. The user interface is built on JavaScript, CSS and HTML with an Apache web server and Google Maps API.



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Anthropocene Institute 2
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Palo Alto, California

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Palo Alto, California

Atomic Object
Stroodle: Learning Management System

Operating for over 20 years, Atomic Object is a software design and development consultancy based out of the Midwest cities of Ann Arbor, Grand Rapids and Chicago. Atomic Object has worked with over 175 clients and created over 250 applications across different industries, from tech startups to Fortune 500 companies.

Learning management systems are utilized by many educational institutions to administer, track and deliver course materials and student work. Popular offerings provide many features to manage and engage in course activities but fail to deliver them in a simple and intuitive application.

Our Stroodle: Learning Management System provides tools for students and instructors alike to participate in online courses while streamlining the user experience.

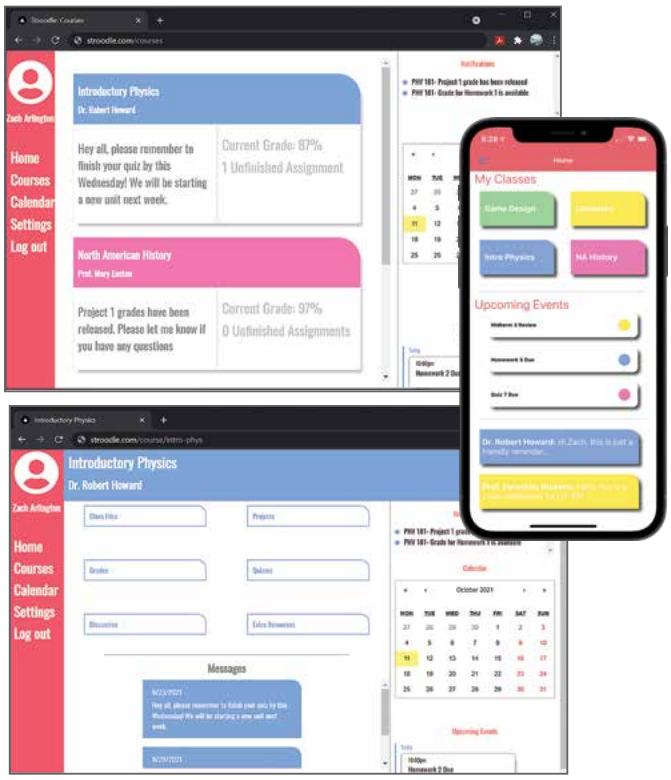
Students are provided a dashboard with a summary of important information for all their enrolled courses. They can access individual course pages to interact with material prepared by the instructor.

Instructors manage their course by uploading documents, such as reading materials or assignments, for their students to view. They can also organize upcoming events and deadlines for their students on the course calendar.

Easy quiz creation is supported to assess students. The results of these quizzes are available in a student's gradebook along with scores of other graded assignments. Students are sent push notifications when instructors send out announcements.

Our software supports all the key features of learning management systems without any of the confusing aspects, streamlining course management and decreasing wasted time.

The Stroodle front end is built using ReactJS and React Native. The back end is built using Node.js and Express.js, which communicates with a PostgreSQL database.



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Auto-Owners Insurance
Yard Wars: Weathering the Storm

Auto-Owners Insurance is a Fortune 500 company headquartered in Lansing, Michigan with over 48,000 licensed insurance agents. Auto-Owners provides automotive, home, life, and business insurance to nearly 3 million placeholders in 26 states.

As an insurance company, it is important for Auto-Owners agents to be able to gather and analyze data regarding causes for claims. This helps them better anticipate which clients could be at risk of property damage and may need to submit a claim in the future.

Our Yard Wars: Weathering the Storm project is a virtual reality application where storms are simulated on virtual residences. Any damage caused by the storms is viewable in real time and in first person. This data is gathered, stored and displayed on an external website for analysis.

Users start by selecting the difficulty for the simulation, which changes the severity of the weather and number of trees that can be placed. Then, the user is tasked with placing trees around the property in order to replicate an existing or planned residence. Once they have finished placing trees, the storm simulation begins.

As the storm progresses, trees can fall and possibly cause damage to the home. Data about the simulation, including fallen trees and any damage caused, is sent to an external database for viewing and analysis on the website by Auto-Owners agents.

Our Yard Wars is an engaging game that provides Auto-Owners agents with useful information, assisting them with providing high quality service.

Our virtual reality software is developed in Unity and written in C#. We use a MySQL database to manage the data from the simulation, and it is communicated using PHP to the website, which is hosted on the same server.

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Bosch
Hardware in the Loop (HIL) Vehicle Simulator

Bosch is a global engineering and technology company with roughly 395,000 employees worldwide. Founded in Germany in 1886, Bosch is the world's leading supplier of automotive components.

Currently, Bosch uses a Hardware in the Loop Vehicle Simulator to correct errors with their software and perform tests. This system connects to specific hardware to simulate a vehicle on the road. This hardware, however, is quite costly and therefore only two systems are available to all Bosch engineers in North America. To resolve this, Bosch selected the PEAK PCAN USB Pro FD as a low-cost replacement for the previous hardware.

Our Hardware in the Loop system reimplements the core functionality of Bosch's previous system on the PCAN hardware.

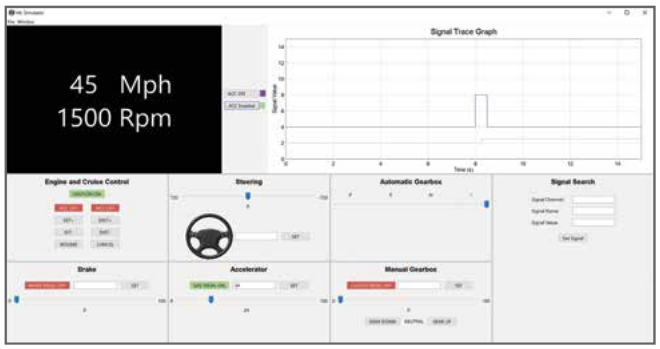
Our software allows the user to perform basic vehicle maneuvers and operations such as steering, braking, accelerating and more. The main functionality of our software system is adaptive cruise control (ACC), which users may engage and adjust at will.

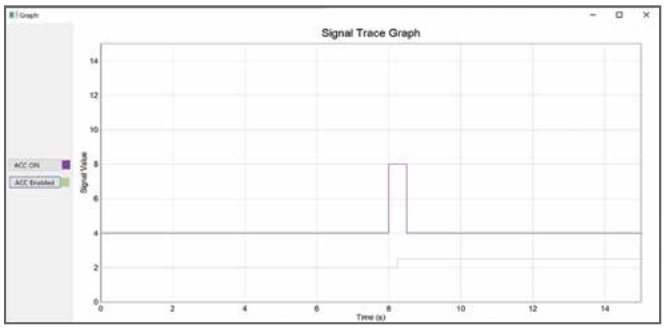
The user interface is designed to allow anyone with driving experience to control the simulation with ease. A graph is displayable to show the signals being sent to and from the PEAK hardware with their corresponding values.

Above the controls for the vehicle is the dashboard. This displays the same basic information found in a real car including the current speed, rpm, fuel level and more.

Our software implements the same functionalities as the previous vehicle simulator but runs on much cheaper hardware, cutting costs and allowing more systems to be used concurrently.

The entire software system is written in Python 3. The front end is built using the open-source toolkit wxPython, while communication with the hardware is done using PCAN Basic API.





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Delta Dental of Michigan, Ohio and Indiana
Smart Benefit Plan Recommender Engine

Delta Dental is an insurance company that provides dental coverage to more than 80 million Americans, spanning across all 50 states, making them the largest dental care provider in the nation.

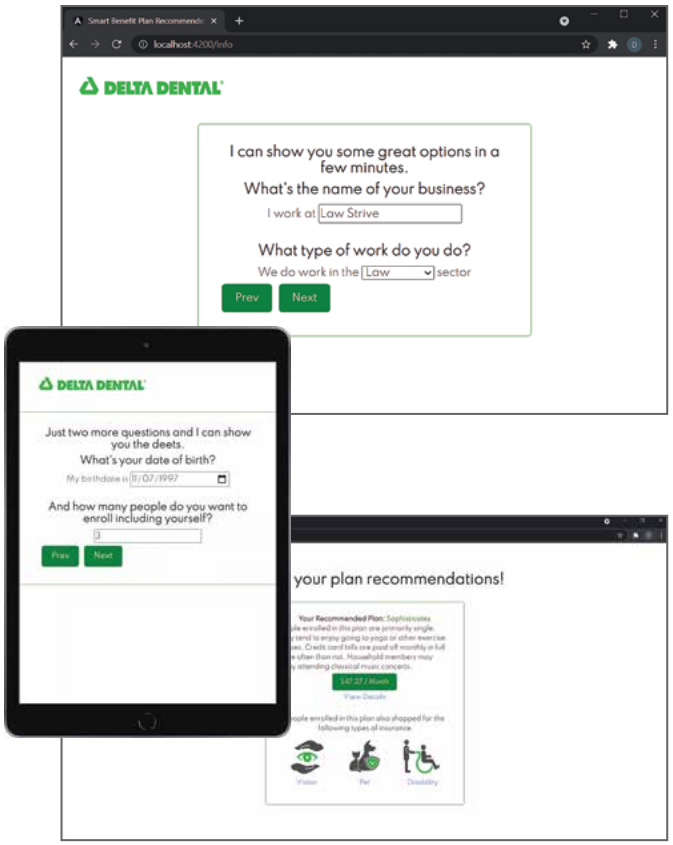
Delta Dental takes pride in tailoring benefit plans to their customers' needs, whether they are a small business, a family or an individual. Before recommending the ideal benefit plan to a customer, Delta Dental underwriters must aggregate data from several sources and use their significant domain knowledge to properly recommend a benefit plan. Creating personalized dental plans for each customer takes a significant amount of time, as there are many factors that need to be considered.

Our Smart Benefit Plan Recommender Engine aids underwriters by automatically matching new customers with benefit plans that are used by similar customers, with no input from an underwriter. Potential customers use our website to answer a series of carefully crafted questions that are used to recommend a benefit plan.

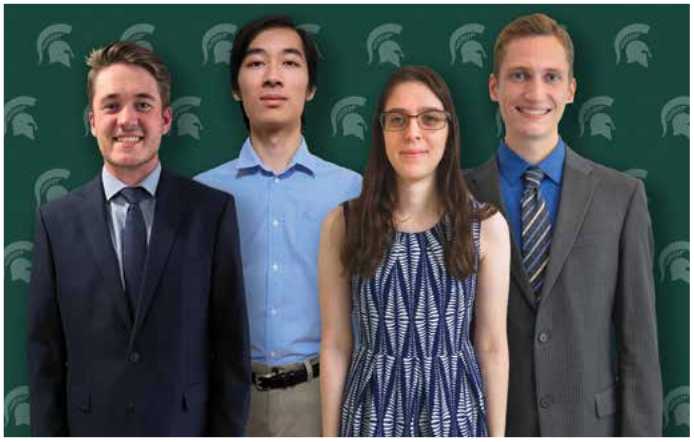
Our Recommender Engine uses advanced machine learning algorithms to divide customers into groups that share many similarities. Each group is assigned an ideal benefit plan and when the system is given new data, it can easily provide a recommendation by mapping the new data to a group and its respective benefit plan.

Our system makes the insurance shopping experience less stressful for customers by allowing users to input their information through an easy-to-use interface and providing immediate benefit plan recommendations and links to help them enroll in the plan.

The front end of our system is written using Angular, while the back end is written in Python. The data is stored in a Snowflake database, and the clustering models were developed in Jupyter Notebook using the pandas and scikit-learn libraries.



DELTA DENTAL®



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Delta Dental of Michigan, Ohio and Indiana
Microsoft Excel Data Extractor/Modeler

Serving more than 80 million Americans, Delta Dental is America's leading provider of dental insurance. To provide quality service, the company must host and leverage complicated data.

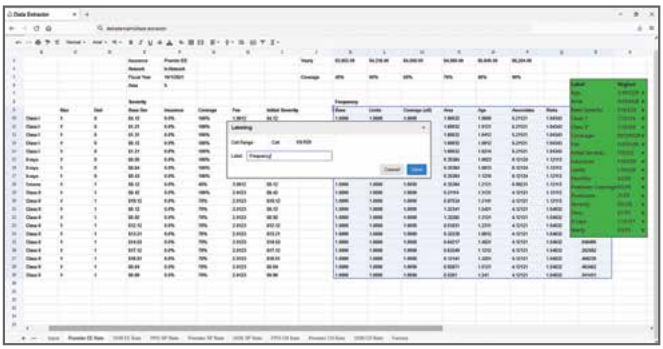
Delta Dental maintains a significant number of sophisticated Excel spreadsheets for various purposes. Comprehending these spreadsheets requires significant industry expertise. Furthermore, extracting the industry knowledge from the spreadsheets to use in other applications often requires the development of computer programs designed specifically for a single workbook, which is both tedious and costly.

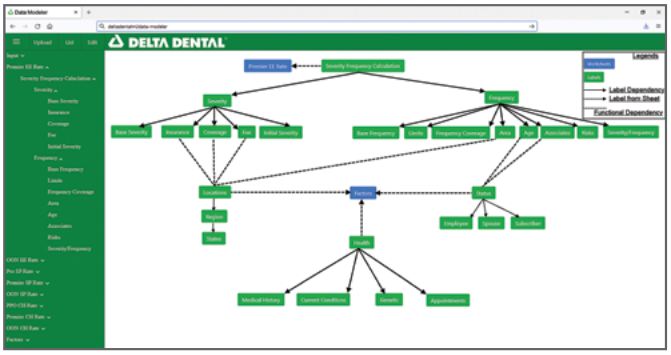
Our Microsoft Excel Data Extractor/Modeler is a web-based tool that removes the need for developing single-use computer programs for extracting Excel data. Our system imports existing Excel workbooks and, with minimal user input, can extract the relevant information as well as the data hierarchies present in an Excel spreadsheet.

Our web interface is designed to look and feel similar to Excel, but with specialized functionality that allows users to formally define data hierarchies and dependencies. These hierarchies can then be visualized to understand the structure of an Excel spreadsheet, as well as to reformat an existing Excel spreadsheet into an easier-to-understand form.

The web application and resulting data visualizations and formatting help enhance employee comprehension of complex spreadsheets and add extensibility to the existing data. Our tool removes the need for development of single-use programs, saving valuable time for Delta Dental employees.

Users can access the Data Extractor/Modeler through a web application that uses JavaScript and TypeScript within the MEAN stack framework. We use X-SpreadSheet for our user interface and ExcelJS to extract the data and formulas from Excel workbooks.





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The Dow Chemical Company
Virtual Computer Service Enhancements

Headquartered in Midland, Michigan, Dow is a world leader in the innovation, creation, and distribution of specialty chemicals, advanced materials, and plastics.

As a large company with over 35,000 employees worldwide, Dow provides its employees with a service called Dow Virtual Computer, which is a virtual machine array. These virtual machines grant access to anyone with Dow credentials and a device with internet connection to a physical Dow work computer without the use of a VPN.

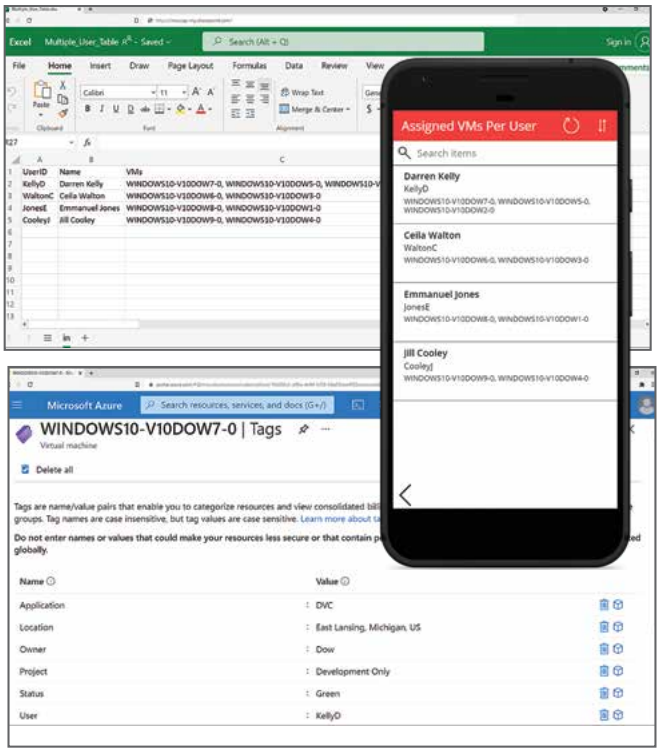
Currently, Dow has a personal structure for assigning virtual machines to their employees and clients on Microsoft Azure. This means that each user has access to their own virtual machine.

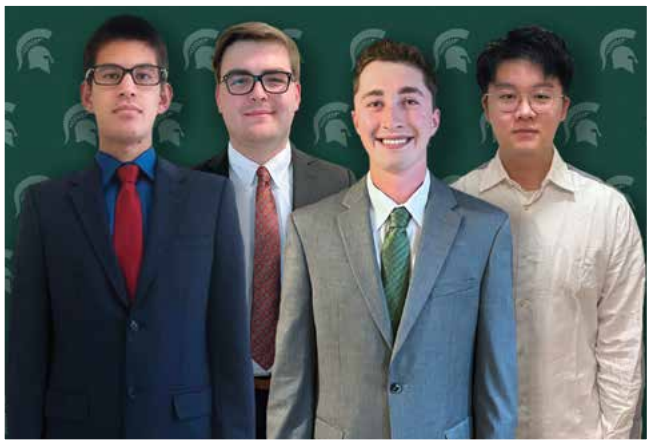
Dow is moving to a non-persistent state, meaning a single virtual machine's resources can support multiple users, cutting down the required number of virtual machines running and therefore saving money. In order to do this, there are many manual processes that need to be managed.

Our Virtual Computer Service Enhancements software automates the previously manual processes associated with the transition to a non-persistent state by tagging user information, such as Dow identification number and login location, on each virtual machine. These tags help Dow with their billing process and the location assignment of the virtual machines.

Along with the automated tagging, our software generates weekly reports of users with multiple virtual machines. Dow's support teams use this data in their transition to a non-persistent state.

Our automation process is built within the Microsoft Azure Cloud Computing Platform and runs through Azure Automation Runbooks using PowerShell. The generated reports can be viewed through our mobile Microsoft Power App.





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Evolutio
ERP Kids: Wildlife Conservation

Evolutio is a group of technology professionals that provides elegant solutions for complex business problems by leveraging technology in novel ways. Evolutio has partnered with the non-profit group Elephants, Rhinos and People (ERP) to give back to the global community through a variety of programs.

ERP is continually educating the world about wildlife preservation through its various charities and social outreach. Part of their goals for educating includes reaching children in the 6-13- year-old age demographic.

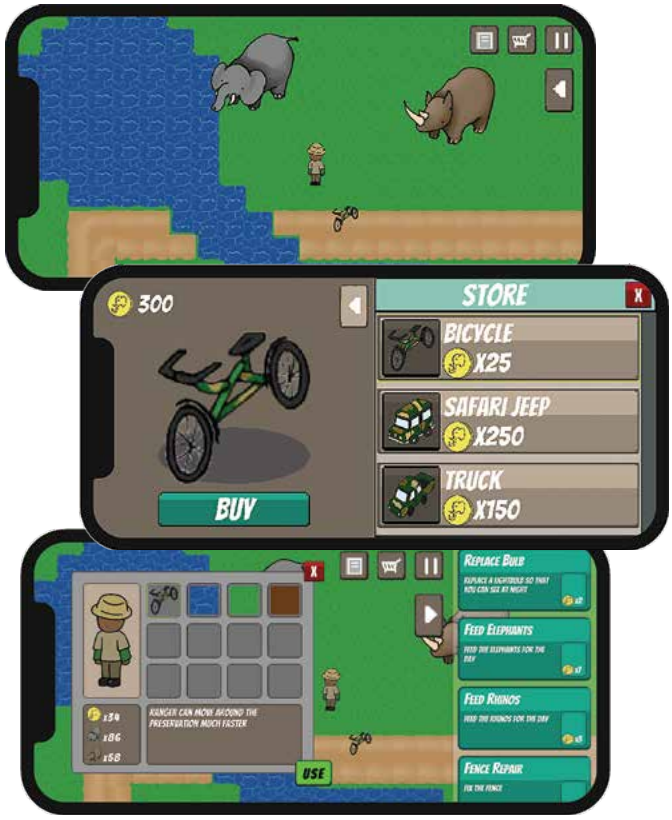
ERP Kids: Wildlife Conservation is a top-down role-playing game that allows the player to live as a wildlife ranger on the Dinokeng Reserve in South Africa. The game is offered on all mobile devices and designed to teach elementary and middle school children about the efforts of wildlife conservation rangers.

The game is divided into days and nights, in which the player has different tasks to complete based on the time of day. The player moves their character around an expansive two-dimensional map modeled after the Dinokeng Reserve in South Africa. The game provides the player with fun mini games to simulate tasks that would be completed by real rangers.

During the days, the player cares for animals, raises funds, and secures the reservation. During the nights, the player tracks animals and scares away poachers. The player progresses through the game's narrative by completing tasks and improving the reservation.

The game informs the player of the importance of protecting wildlife and how this work is accomplished. The player also learns about the daily lives of rangers, the dangers faced by animals on reservations, and the ways in which people can help them.

Our game is developed using the Unity game engine and the C# programming language. Xcode and Unity are used to export the game to the iOS App Store and Google Play Store, respectively.



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Ford Motor Company
Crowd-Sourced EV Emergency Recharge

Ford Motor Company is a multinational automotive manufacturer headquartered in Dearborn, Michigan, with operations in over 125 countries and a worldwide workforce of 186,000 employees. Ford designs and manufactures a full line of cars, trucks, SUVs and electric vehicles under both the Ford and Lincoln brands.

Electric vehicles have recently experienced significant growth in popularity and technical advancement in the automobile industry. A common concern of consumers who are hesitant to switch from a gas-powered vehicle to an electric vehicle is the possibility of running out of charge with no recharge station nearby.

Our Crowd-Sourced EV Emergency Recharge mobile application provides a platform for owners of electric vehicles to request assistance from other electric vehicle owners in the area if they run out of charge while driving.

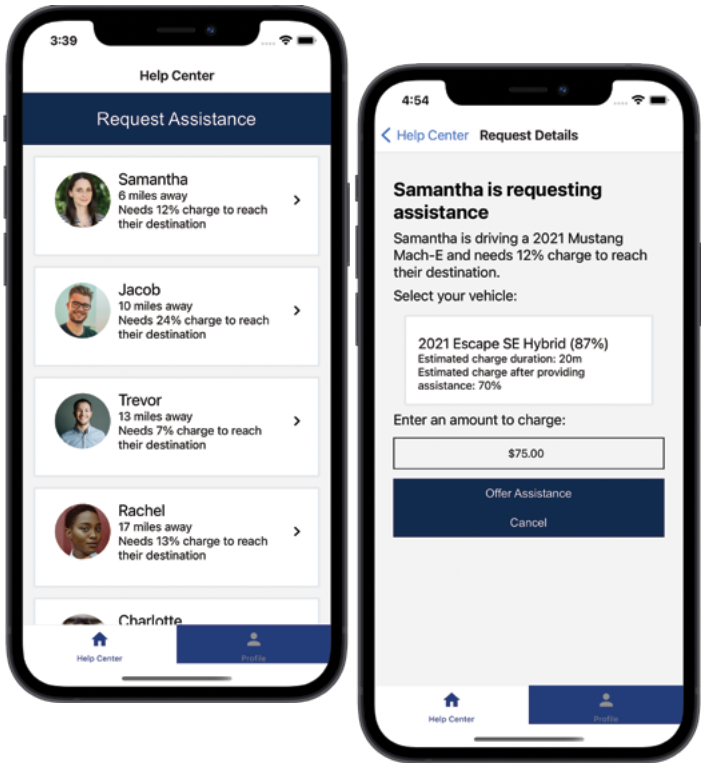
After logging in to the application, a user is greeted by a Help Center screen, from which the user can submit an assistance request or view the open requests in their area.

Users submitting a request can input information pertaining to their vehicle, current location, and destination. The application notifies nearby users that a new request has been submitted.

Users wishing to aid stranded drivers can select a help request from the screen, view details, and select a price for which the user is willing to charge up the stranded driver's car. Once the offer is accepted, the user is provided with the location, vehicle, and license plate information required to fulfill the request safely.

Our system addresses the concerns of potential customers, increasing sales and improving the reputation of electric vehicles.

Our mobile application is compatible with both iOS and Android. The front end is built with React Native and the back end is built using Swift and Java.



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General Motors
Enhanced MISP User Interface

General Motors is an American multinational automotive company headquartered in Detroit, Michigan. GM is ranked 22nd on the Fortune 500 for total revenue and is the largest automobile manufacturer headquartered in the United States. For more than a quarter of a century, GM has integrated their OnStar in-vehicle safety and security service into millions of vehicles to become the most connected automaker in the world, with more than 22 million members.

Real-time, open-source threat intelligence is imperative in mitigating the risk of successful cyberattacks against an organization. The threat landscape is ever evolving. Consequently, GM's security analysts need up-to-date information on all threats to ensure the organization's safety.

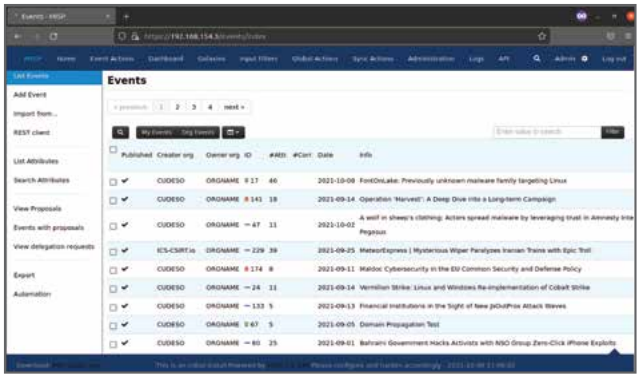
The Malware Information Sharing Platform (MISP) is an open-source sharing platform dedicated to sharing threat intelligence. However, MISP's user interface lacks several features, making it not very user-friendly or customizable.

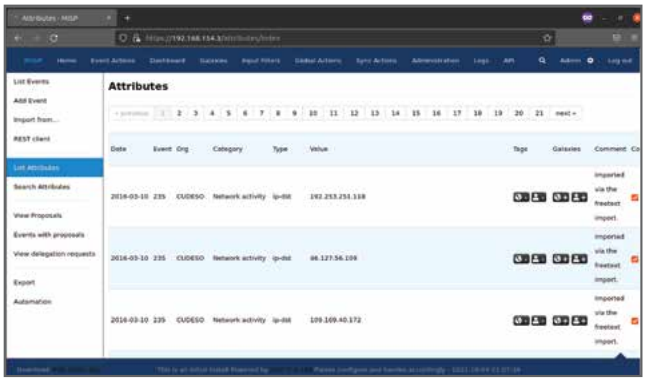
Our Enhanced MISP User Interface provides for more customization within the MISP application and enriches existing functionalities.

The enhanced interface enables the removal and reordering of columns within the malware tables. Improved sorting functionality and search query filtering allow for more in-depth results from searches. The user interface boasts a more refined and intuitive design as well.

Using our software, GM cybersecurity analysts are able to create a version of MISP that is tailored to their specific needs and is easier to use, saving time and increasing productivity.

The front end of our software is developed using Bootstrap, a web application framework that utilizes CSS, JS, and HTML. Our back-end software functionality is implemented using PHP.





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Herman Miller
Live Platform CAD Ingestion

With over 100 years of experience, Herman Miller is a globally recognized provider of furnishings and related technologies and services. Headquartered in Zeeland, Michigan, Herman Miller has been innovating new ways to design and analyze the places people work, learn and live.

Herman Miller has created Live Platform, a service which allows users to visualize and analyze their workspaces. Live Platform uses sensors placed on furniture to monitor occupancy and usage of different areas in the space. Live Platform previously used simple images to display workspace floorplans, which resulted in a loss of important data.

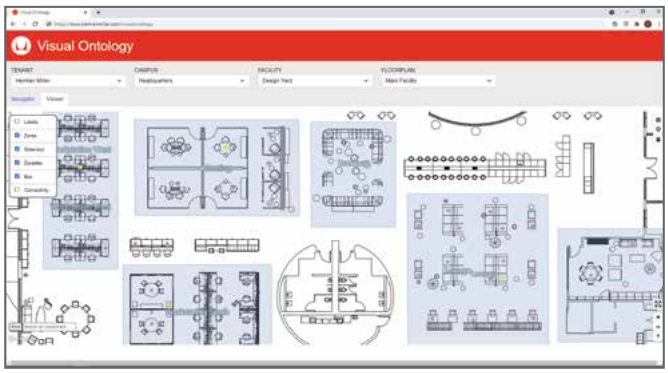
Our Live Platform CAD Ingestion software allows Herman Miller administrators to use computer-aided design (CAD) files to display these floorplans.

Our software allows for the supplying of sensor positions and the checking of hardware constraints. An algorithm is used to convert CAD files into a format readable by our web application.

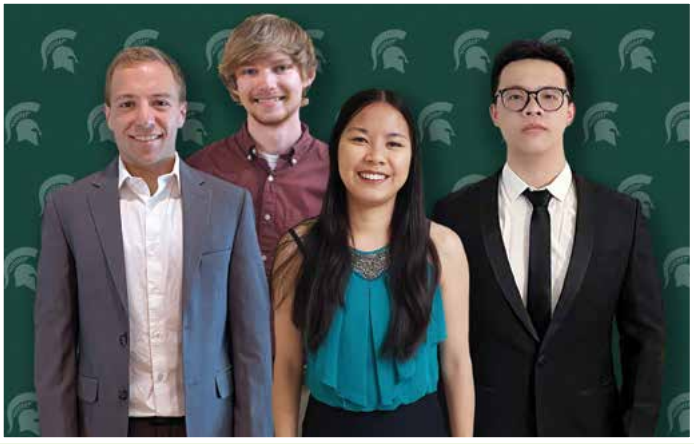
The web application displays information on all floorplans. Each floorplan has a tenant owner, name, and is part of a campus and facility. Administrators can filter floorplans based on their attributes. The navigator tab allows for the finding and editing of floorplans displayed by the filter. Floorplans can also be added and removed. The viewer tab displays the layout of the selected floorplan. Users can toggle various floorplan information, such as sensor locations.

Our system automates the process of ingesting CAD files with sensor data into the Live Platform service, saving Herman Miller administrators time and increasing productivity.

The front end of the web application uses React, Redux and Bootstrap. The back end uses Node.js and Amazon Web Services, including Lambda, Simple Storage Service, and DynamoDB.



HermanMiller



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Lockheed Martin Space
SmartSat™ Satellite App Store

Lockheed Martin Space, headquartered in Denver, Colorado, is one of the largest space defense contractors in the world, employing over sixteen thousand people that develop an impressive range of products from satellites to space probes to missile defense systems.

Currently, Lockheed Martin Space is revolutionizing the way new software is written, tested and deployed to their diverse range of satellites through their SmartSat system. SmartSat provides a standardized format for software applications.

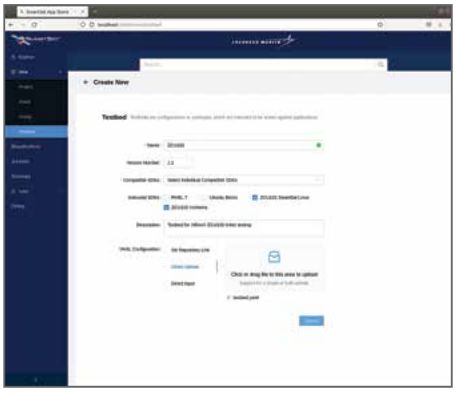
Lockheed Martin Space's satellites can vary in a few key ways, specifically when it comes to computational hardware, software development kits, and operating systems. Because of this, certain satellites are incompatible with some specialized software.

Our SmartSat Satellite App Store is a web-based marketplace for browsing, uploading, and installing mission-ready applications to live satellites. The SmartSat App Store also includes rigorous software testing that automatically determines what software is compatible with which satellites.

Every new application uploaded to our app store is put through our automated compatibility testing to assess the Lockheed Martin satellites on which the software can be deployed. The test results are sent back to the App Store and displayed for application developers, saving them many hours of rigorous testing.

To ensure reliability, our App Store runs every new piece of software against every possible target hardware on real, physical devices. The ability to test on real hardware instead of simulation offers peace of mind to Lockheed Martin engineers.

The SmartSat Satellite App Store uses SmartSat Defined Services to perform the automated testing on the target hardware. SmartSat Satellites access these services through built-in file servers linked with the Flask back end. The front end of the SmartSat Satellite App Store is built with React.



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Malleable Minds
Review Aggregator for Educational Programs

Malleable Minds is an emerging startup, building the world's most extensive collection of PreK-12 programs from the arts to the sciences so students can further develop academic, interpersonal, and communication skills.

The internet allows individuals across the globe to gain access to educational opportunities they previously could not. Despite this, children's educational programs are scattered across the web. This disorganization makes it difficult to make a custom education plan for a child. There is a need for a centralized way to explore and compare educational programs.

Malleable Minds' flagship program is a review aggregator that allows for easy browsing and comparison of PreK-12 educational programs. Parents and educators use the site to create and read reviews of these programs, offering the user a centralized platform for exploring educational programs online.

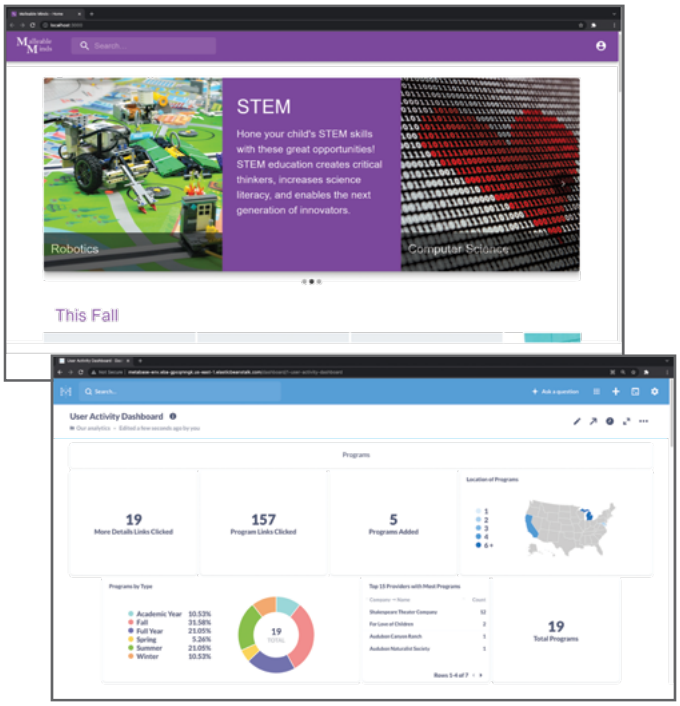
Our Review Aggregator for Educational Programs project builds many features on top of the existing review aggregator website and improves site performance.

The site's users benefit from several new additions. Our recommendation engine provides the user with tailored suggestions for new educational programs based on their interests. Parents can track their children's progress towards developing new skills with the new skill system. Additionally, users are awarded different statuses based on their contributions to the site.

Malleable Minds administrators can view usage statistics on the activity dashboard and use this information to improve the site.

Our enhanced site is faster, more efficient and includes new features that enrich the user experience.

Our software uses React on the front end and Python on the back end. We host our software on Amazon Web Services, and our user activity dashboards are stored on Metabase.



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Meijer
mHealthy: Healthy Eating Application

With over 250 supercenters, Meijer is one of the largest retailers in the United States based on 2020 revenue according to the National Retail Federation. Meijer offers a vast array of products ranging from home goods and furniture to pharmaceutical needs and groceries. They strive to assist shoppers to take care of the health and wellness of themselves and their families.

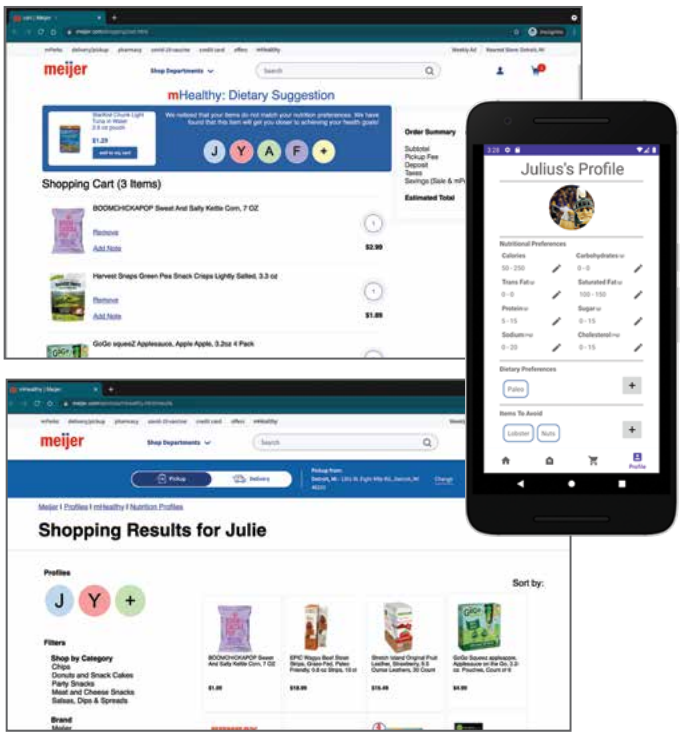
Many shoppers want to make healthy decisions when shopping but feel overwhelmed trying to do so. Finding healthy replacements can be a daunting task and may discourage shoppers from learning about healthier options or better diets. Educating shoppers and improving their experience is imperative to establishing lifelong customers.

Our mHealthy: Healthy Eating Application guides shoppers with nutritional advice according to their selected dietetic preferences. Several unique profiles can be created to allow shoppers to curate their shopping experience for family, friends and special events.

In a shopping session, a single profile is enabled to filter products that are accustomed to the shopper's personalized preferences. As items are added into the cart, the application reviews these items and recommends additional products that better suit the shopper's dietary preferences. Shoppers ultimately benefit from an easier and more informative shopping experience.

Our application encourages shoppers to eat healthy and provides an easy-to-use interface. Health-conscious shoppers are more likely to visit a Meijer supercenter thanks to our intuitive application.

Our mHealthy: Healthy Eating Application is both a web and a mobile application. The website is written using PHP, HTML, CSS and JavaScript, while the mobile application uses Java, Kotlin, XML and Android SDKs. SQL is used to manage and store the data.



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Microsoft
Feedback Prompt for Ratings in Google Play Store

Microsoft is a multinational and industry-leading technology company best known for developing numerous operating systems, software, and online computing service platforms. Microsoft's Intune Company Portal is a data and device management system that is used by tens of thousands of companies worldwide and requires individual employees to install its app on their devices.

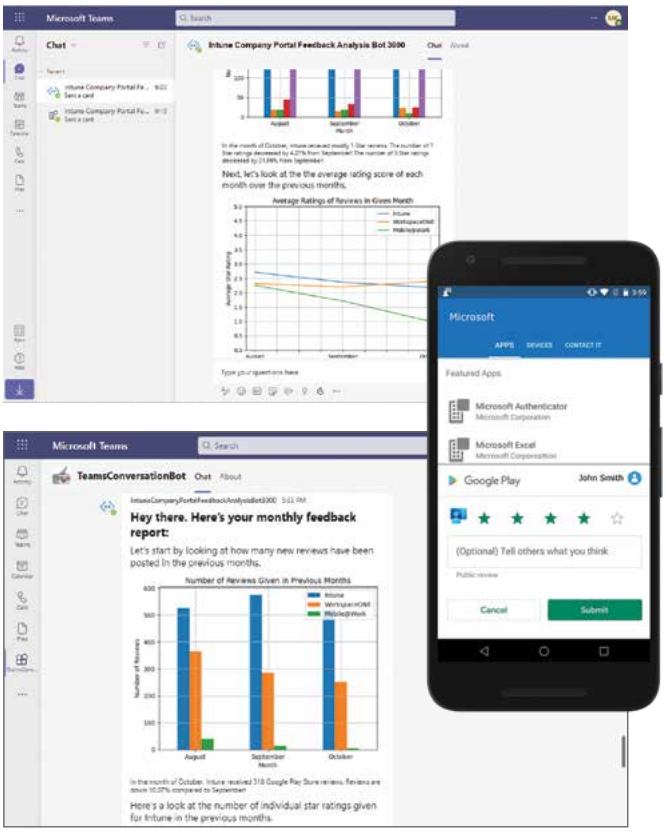
User feedback about Intune Company Portal provides insight that developers can use to create and maintain a premium user experience. However, collecting and analyzing reviews is a tedious and time-consuming task, requiring manually searching dozens of review websites and plotting the data.

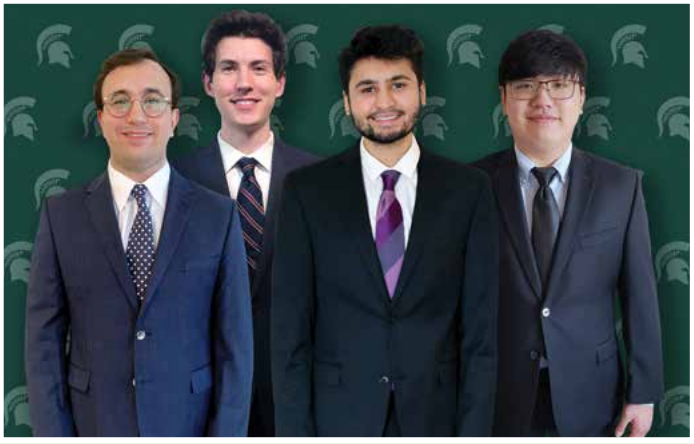
Our Feedback Prompt for Ratings in the Google Play Store system improves the overall review collection and analysis through an easy-to-use in-app review prompt for users, and automated review collection and analysis for Microsoft engineers.

To facilitate easier and more representative review collection, we integrate an automated in-app review prompt that actively promotes user feedback for the Intune application on Android. Our system removes the need for users to navigate to the Play Store and makes leaving a review quick and easy.

Our system employs a suite of web scrapers that search the internet for reviews of Intune and saves them for future analysis. We use natural language processing and machine learning to search for patterns in user reviews that might signify any bugs or issues and to determine sentiment towards the app. The results of the analysis are sent to Microsoft engineers using a Microsoft Teams Bot that delivers monthly analysis.

The front end uses the Microsoft Bot Framework and Android Studio for the in-app prompt. The back end consists of a SQL Server database hosted on Azure. The analysis pipeline is hosted on Azure and utilizes Node.js web scrapers and Python scripts.





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Mozilla Corporation
Improve High Contrast Mode for Firefox

Mozilla is a global, not-for-profit organization dedicated to improving the World Wide Web. They have an international community of developers who contribute to open-source software.

Mozilla's most popular open-source project is Firefox, with over 210 million monthly active users. Mozilla's goal as a company is to promote an open and inclusive internet. Part of this is making sure Firefox is usable by as many people as possible.

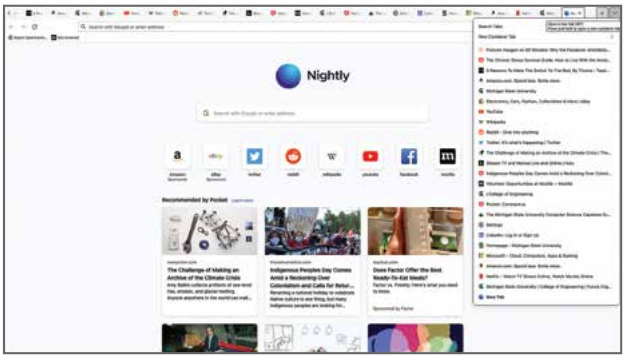
To achieve this goal, Firefox offers high contrast mode, which is a huge part of making the browser as accessible as possible. High contrast mode improves the visibility of Firefox's user interface by changing the colors in order to maximize contrast. This is important as it allows people with visual impairments to be able to receive the entire Firefox experience.

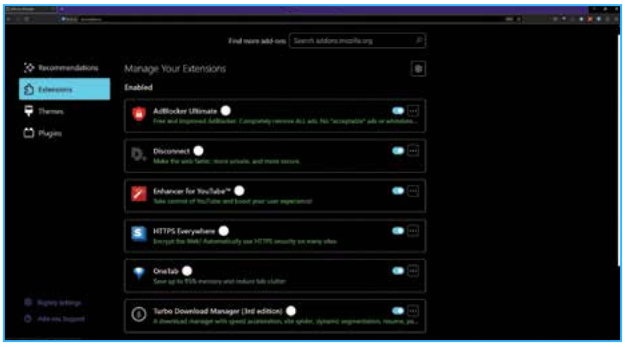
While the high contrast mode currently in Firefox is an essential feature for making the browser more accessible, there is still more that can be done to make high contrast mode even better. Specifically, high contrast mode does not perfectly cover the entirety of Firefox's user interface. This leads to confusion among users with visual impairments and an overall non-optimal user experience.

Our Improve High Contrast Mode project focuses on fixing many of these smaller issues to greatly improve the user experience of high contrast mode inside of Firefox. Our additions include things such as adding outlines to tab buttons, improving icon visibility and adjusting button colors to improve contrast.

In the screenshots to the right, one can see various pages of the Firefox browser using our Improve High Contrast Mode for Firefox project.

To implement our fixes, we edit and improve the already existing CSS, JavaScript, and HTML of Firefox. Additionally, some of our edits are written in C++.





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MSU Federal Credit Union

Spaving: Giving based on Spending Habits

Founded in East Lansing in 1937, MSUFCU, also known as the MSU Federal Credit Union, provides various financial services to students, faculty, and staff at Michigan State University. With 21 branches, over 300,000 members, more than $6 billion in assets, and nearly 900 employees, it is the largest university-based credit union in the world.

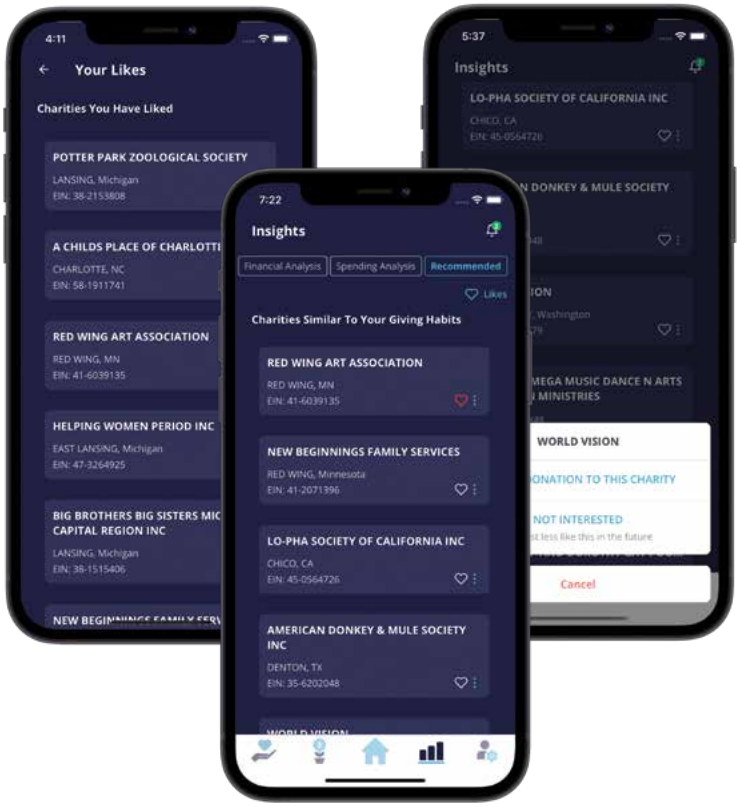
MSUFCU provides a variety of financial education resources to its customers to ensure they are making the best monetary decisions possible. One of these resources, acquired by MSUFCU's Credit Union Service Reseda Group, is a banking app known as Spave. Spave is a mobile application that allows users to donate a small amount to chosen charities every time they make a transaction.

Our Spaving: Giving based on Spending Habits project enhances the Spave mobile application with a recommender engine, providing users with recommendations for which charities the user should consider donating to, as well as alerting them to these recommendations.

Our most significant addition to this mobile app is a new recommendations page where the user can see the various suggested charities. These recommendations range from simple comparisons to other users, to recommending charities they may enjoy donating to based on how they spend their money.

Users can like or dislike recommendations to influence what is recommended to them. Recommended charities can be clicked on to present the user with further information regarding the selected charity.

Our front-end additions to Spave are built using Android Studio, Xcode, React Native and Typescript while the back end utilizes Express.js, Node.js, machine learning and Amazon Web Services.



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PwC
Collaboration Bot for Microsoft Teams

PwC is a global leader in professional services, from tax and audit to technology and strategy consulting. PwC is a partnership of firms, consisting of over 250,000 employees operating under one brand, making it one of the largest professional services networks in the world.

Collaboration with clients is key to PwC's business, and as such, their clients want to use newer and more ubiquitous technologies, such as Microsoft Teams and OneDrive.

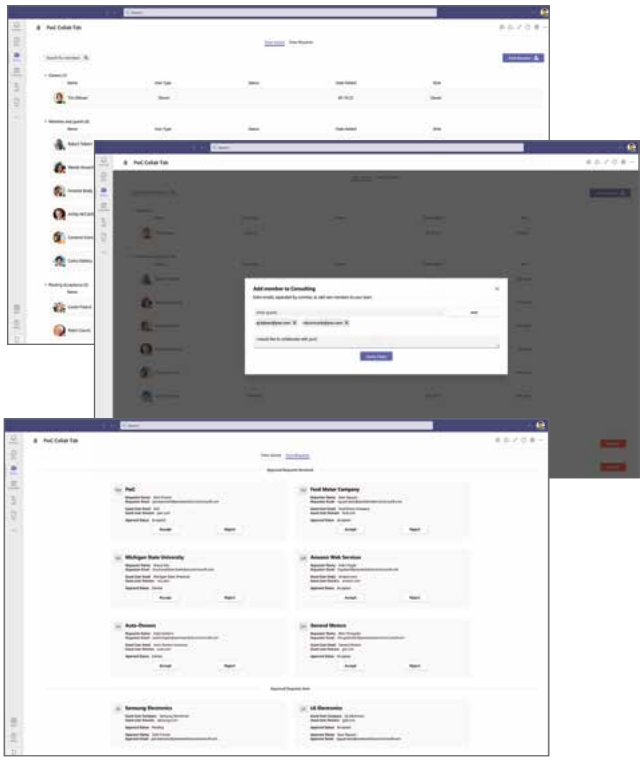
Currently, collaboration requires external users to be invited into the PwC Microsoft environment and given access to Microsoft Teams and OneDrive securely. This requires significant work from an IT administrator who has to manually set this up, and in some cases seek out and get approval from the PwC clients. The entire process takes a significant amount of time and energy that could be better spent elsewhere.

Our Collaboration Bot for Microsoft Teams allows PwC employees to establish collaborative partnerships with external companies within the Microsoft environment with little to no work from an IT administrator.

Our software provides an easy-to-use interface within Microsoft Teams that allows PwC employees to easily send bulk invitations to external collaborators without having to manually approve each user and grant them access privileges.

Once invitations have been sent to external clients, our bot automates the entire approval process in the background, allowing PwC employees and IT administrators to spend their time on more significant issues.

The front end of our Collaboration Bot for Microsoft Teams is built using Node.js and ReactJS, which communicates with Microsoft Azure Active Directory and an Azure Database via Microsoft Graph API calls.



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The Rocket Companies
ROCKY: Team Challenge Application

The Rocket Companies are made up of 15 publicly traded companies involved in many different industries, including mortgages, fintech, real estate, automotive and more. They employ over 26,000 team members and are committed to providing the best team member experience they can.

More and more companies are taking strides to improve the mental and physical wellbeing of their team members. Our ROCKY: Team Challenge Application improves the team member experience by promoting wellness with a fun and interactive web application.

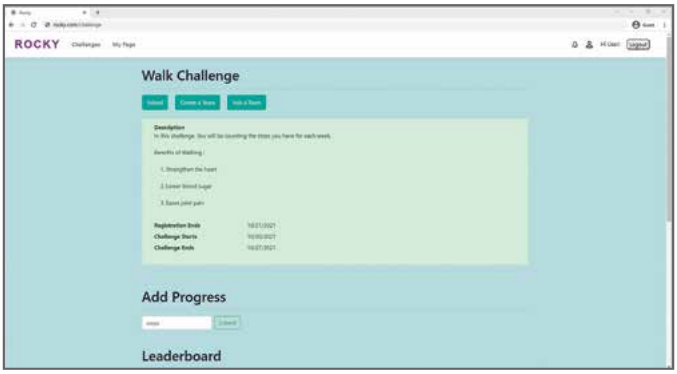
ROCKY provides a platform for Rocket team members to compete in challenges against other team members to promote wellbeing, community and productivity. Challenges can measure any number of attributes such as steps walked, hours volunteered, and loans closed.

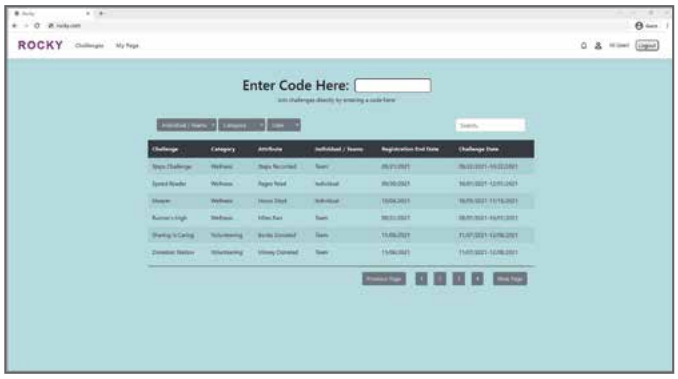
Challenges can be created as either team or individual challenges. To join a team challenge, team members can create a team, join an already existing team, or enter the challenge as free agents, who are assigned to teams at the start of the challenge. Team members who create a team can send invites out to other team members to join their team.

The challenges page has a list of all active challenges a team member can join and details about the challenges. This list can be filtered by the category of the challenge, the attribute being measured, or whether it is a team or individual challenge.

The user's home page contains information about the challenges that user is currently participating in as well as any pending invitations to join a team challenge.

The front-end user interface of ROCKY is built in Angular. The back-end data is stored in an Amazon Aurora database with a .NET Core RESTful API to query the database.





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Stellantis
Interactive Digital Assistant

Stellantis is a leading global automaker and a mobility provider headquartered in Amsterdam with operations in nearly 30 countries and a worldwide workforce of over 300,000 employees. Stellantis is guided by a clear mission: to provide freedom of movement through distinctive, appealing, affordable, and sustainable mobility solutions.

In today's fast-paced world with responsibilities spanning multiple projects, staying up to date with the latest information is critical for Stellantis employees to make timely decisions and reassess priorities.

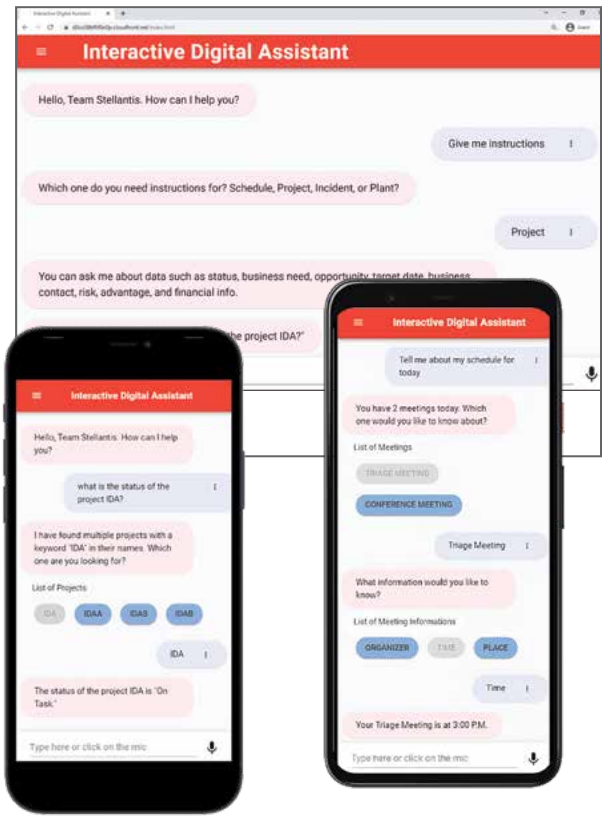
Our Interactive Digital Assistant is a web-based chatbot that allows Stellantis employees to ask general form questions in a life-like conversation about a wide variety of topics, including project statuses, issues or incidents, business applications, process contacts, etc. in a timely manner.

Our Interactive Digital Assistant first asks general questions of the employee to ensure they have the proper credentials to access the documents in which they are interested. Once the user's identity has been confirmed, the user can ask any question they want.

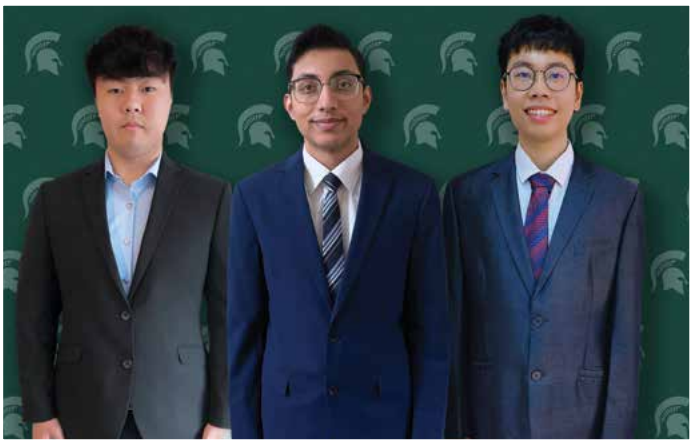
Once a question has been received, our natural language processing algorithms parse the request and search multiple documents for the correct answer. Our Interactive Digital Assistant can provide answers to questions in less than a second, whereas manually searching all the relevant documents would take from minutes up to hours.

Our Interactive Digital Assistant helps employees find crucial information quickly, allowing them to spend their valuable time focusing on more important tasks.

Our front end is developed in CSS, HTML, JavaScript, and PHP. Our system utilizes the AWS Cloud Platform with Python. Our APIs are hosted by Google Cloud Platform and Drive IT.



STELLANTIS



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TechSmith
Snagit Template Creator

Headquartered in Okemos, Michigan, TechSmith is a software company that develops screenshotting, screencast and video editing software. TechSmith's products have over 73 million users worldwide. Snagit, one of the company's flagship products, is a simple, but powerful screen capture and recording software that allows a user to quickly capture their screen, add additional content, and easily share with others.

Templates in Snagit are designs users can download to more easily create graphics instead of starting from scratch. Currently, Snagit templates can only be created using internal TechSmith tools, making it a challenge for partners or savvy customers to create their own templates.

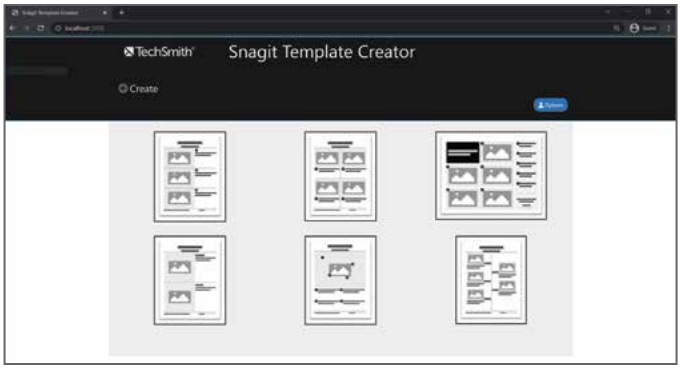
Our TechSmith Snagit Template Creator platform provides a solution to this problem through an intuitive web application that allows users to easily create, download and share Snagit templates with others.

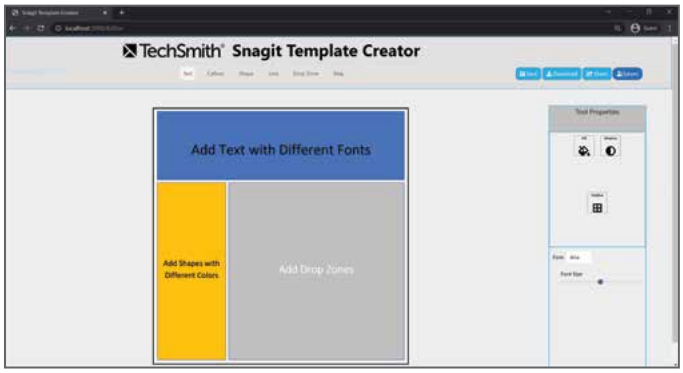
TechSmith Snagit Template Creator allows users to customize templates through a variety of graphics objects including drop zones, shapes and lines. Once the creation of a template is complete, users can download it, share it with colleagues or save it within the web application for later viewing and use.

When a user downloads a template, they can import the template into Snagit, where it can be utilized just like existing pre-defined Snagit templates.

The additional creative power and flexibility our system provides greatly enhances the Snagit experience and makes Snagit a more attractive option for those looking for a graphical editor.

TechSmith Snagit Template Creator uses Microsoft Azure for data storage and sign-in. The front end is built using ReactJS, and the back end is built using .NET Core.





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United Airlines
Gate Hazard Geo-Mapping

United Airlines, Inc. is a leading American airline headquartered in Chicago, Illinois. In 2019, United and United Express operated more than 1.7 million flights carrying more than 162 million customers to their destinations safely.

Safety is United Airlines' highest priority at every airport. A major component of that commitment to safety is being aware of the hazards faced by aircraft and operations staff at each gate.

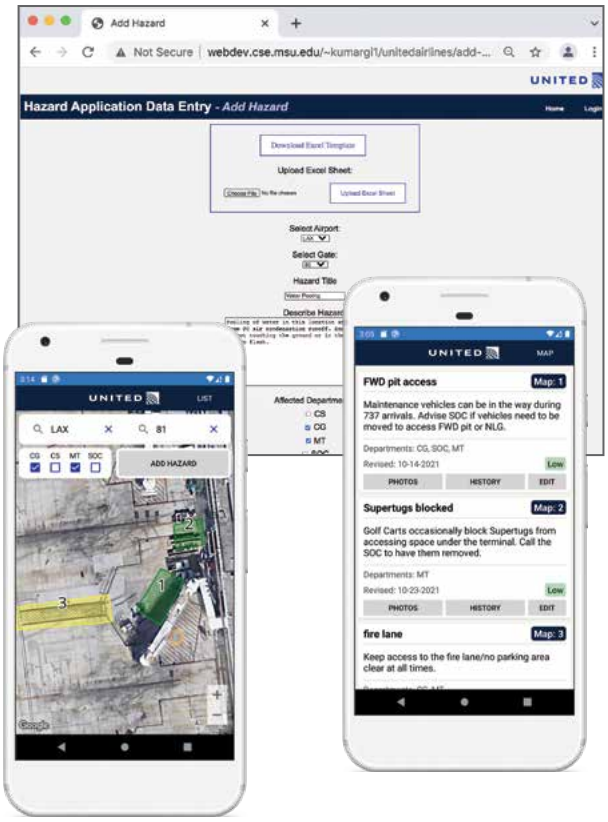
United Airlines Safety & Compliance staff record data on the hazards faced at each airport gate. This information is then referenced by employees when they begin working at the gate to ensure both their own safety, and the safety of their aircraft during operation. United Airlines is exploring ways to further standardize this process and make the information more accessible.

Our Gate Hazard Geo-Mapping software allows staff to enter observed hazards into their mobile device, and automatically generates GPS placement data, as well as an interactive map visualization to allow seamless cataloging and sharing of gate-specific hazard information.

When United Airlines staff identify a hazard, they can open our application and select an airport and gate. They then mark the area where the hazard exists, record a title, description, the level of risk the hazard poses, and which departments should be aware of the hazard.

When other United Airlines employees visit a gate to work, they use our application to quickly familiarize themselves with the hazards at the gate to ensure they are adhering to the strict safety protocols.

The website front end is written in HTML, JavaScript, and CSS. The back end consists of a MySQL database and PHP code for both the API and data processing. The Android and iOS application is written in C# utilizing Xamarin for cross-platform development.



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United Airlines
QA Audit Center

United Airlines is a major American airline company headquartered in Chicago, Illinois. Every day, United Airlines unites the world using the most comprehensive domestic and international network routes possible. This network connection requires United Airlines to hold themselves to the highest standards in safety and reliability, promote trust, and ensure flights are on schedule.

Within United Airlines, the Technical Operations Quality Assurance division plays a vital role in meeting United Airlines' shared goals of efficiency, reliability, and safety.

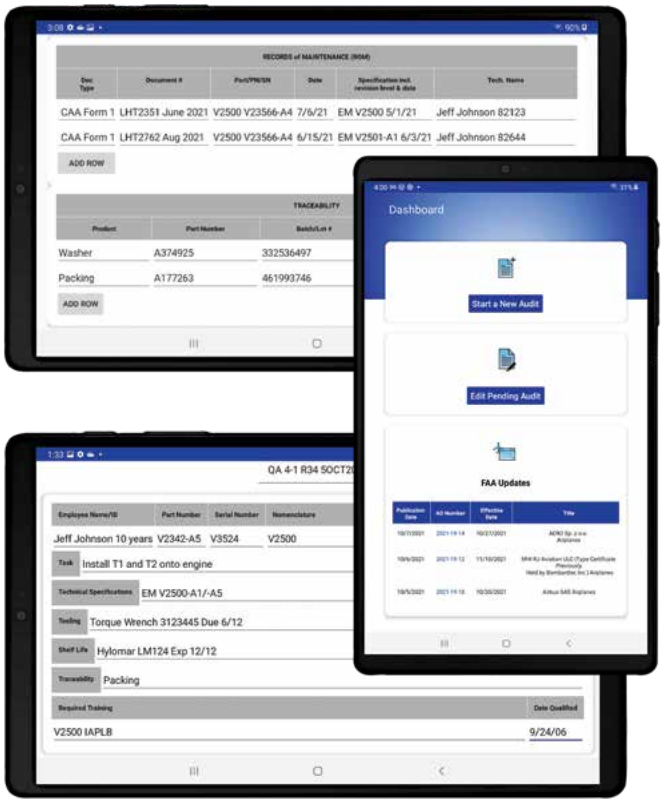
To accomplish this, the United Airlines Quality Assurance team conducts live audits to ensure all equipment and services are maintained according to Federal Aviation Association (FAA) standards. Current audits require handwritten documents that are hard to keep track of and difficult to share.

Our Quality Assurance Audit Center Platform serves off-wing quality assurance auditors and provides them with a solution to have electronic access to audit documentation on their mobile devices. Our system converts a currently paper-and-pencil audit process to completely digital.

Our system recreates digital versions of forms used by auditors, which facilitates easier saving, editing, and submission of audit documentation. Additionally, our mobile applications allow real-time access to the camera to easily photograph and attach evidence to audit forms.

The time of auditors is valuable, and our system allows them to perform their duties in an efficient manner that reduces errors.

The front end of our application is written in Java for Android integration. The back end is hosted on Google Firebase. PHP performs government website scraping and stores updated data on the SQL Database hosted on the Michigan State University server.



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Urban Science
Independent Repair Facility (IRF) Insights

Urban Science is a global data-driven company headquartered in Detroit that has provided tailored insights and solutions for the automotive industry since 1977. As a global company that has served every major automaker, Urban Science analyzes the market to pinpoint issues and propel success for their clients.

One of the most profitable components of automotive business is aftersales, the parts and services sold after a car is purchased. Independent Repair Facilities (IRFs) vastly outnumber dealers, dominating the aftersales sector. Without comprehensive information on IRFs, dealers miss an opportunity to increase customer retention and grow service revenue.

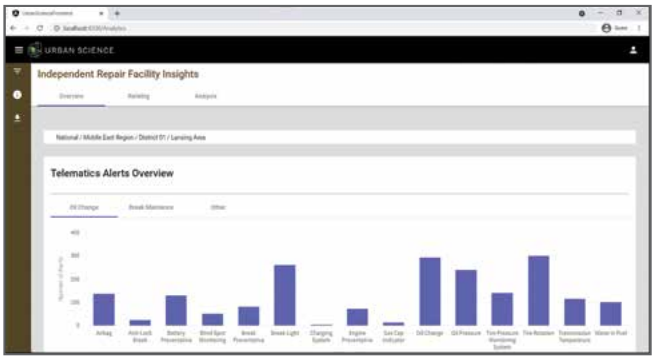
Our Independent Repair Facility Insights web application alleviates this gap of market knowledge through leveraging telematics data. Telematics systems in vehicles monitor a wide range of information including vehicle location, engine diagnostics and vehicle activity.

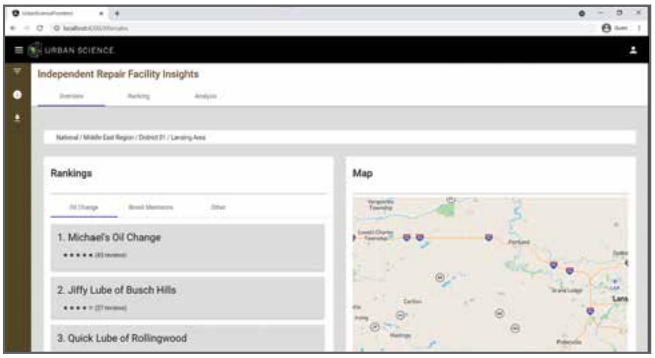
Using the telematics data, users are notified of what IRFs customers are selecting over the dealership for aftersales. This information is displayed on our web application and provides dealers with information such as IRF rankings and analysis on top- performing IRFs in their area of responsibility.

Users gain insights into the competitive landscape of aftersales through data visualizations and an interactive map. Leveraging clustering analysis and natural language processing, tailored solutions are generated for each dealer.

Our software enables the user to efficiently survey telematics data, explore critical components of IRFs, and utilize our data-driven solutions to better compete with IRFs and increase sales.

Our application is built using Angular, Typescript, HTML and CSS. The back end uses ASP.NET Core 5.0 APIs written in C# and is connected to an Azure SQL Database.





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Vectorform
Smart Auto-Time Logging

Founded in 1999, Vectorform is headquartered in Detroit with seven offices across the globe. It is a company designed to help organizations move from an idea to an invention with digital products and hardware solutions. They combine a variety of technologies such as the Internet of Things, augmented or virtual reality, and other emergent systems to develop solutions for their clients.

Employees at Vectorform work on multiple projects at a given time using various tools and software development platforms. Keeping accurate totals of time spent on a given billable project is extremely important to both the company and their clients. Entering time statements manually is time-consuming and error-prone. Previous automatic time tracking systems fail to properly distinguish between different projects within one program.

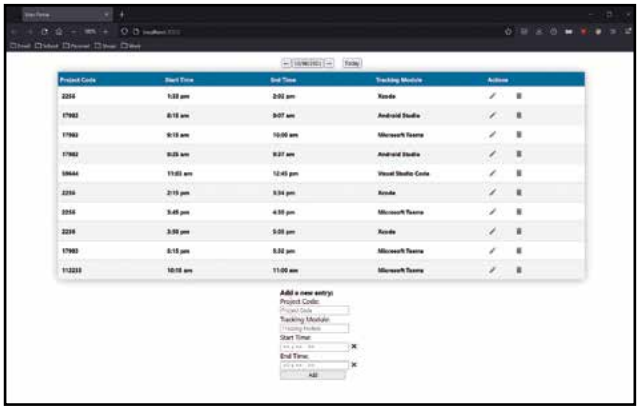
Our Smart Auto-Time Logging system solves this issue by generating accurate and reliable time statements for software development and communications.

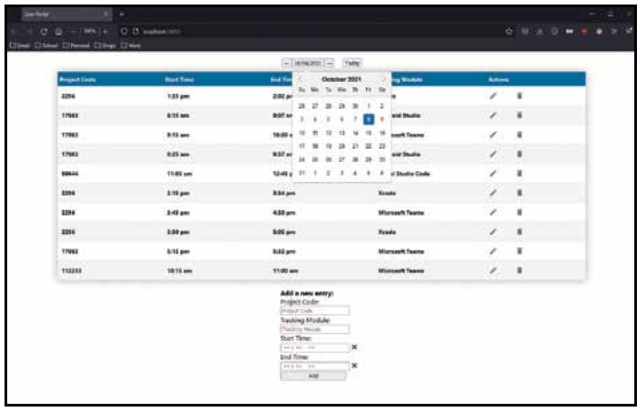
Users start the program before beginning their workday. The system generates accurate time statements throughout the workday by monitoring the programs in operation on the user's computer and associating them to a project billing code through smart analysis.

Time statements are viewed through a web application to be confirmed before being sent to Vectorform's billing department.

Our system automates the time-tracking process, eliminating the need for Vectorform employees to do it by hand, saving time and increasing the accuracy of the billing process.

The front end of our Smart Auto-Time Logging system is built using ReactJS, while the back end is implemented using C#. Both sides of the program interface with an SQLite database through the use of Node.js.





Vectorform

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Volkswagen Group of America
Car-Net® DriveView Social Competition App

Volkswagen Group of America is the North American operation headquarters and subsidiary of the Volkswagen Group, which facilitates the U.S. operations of many brands of vehicles.

Car-Net was introduced by Volkswagen in 2013 with features that allow Volkswagen owners to easily access their vehicle with a mobile device, along with other features designed to improve the driving experience.

With nearly 5.25 million accidents per year in the United States, finding ways to encourage safe driving habits is an ongoing challenge. There is a need to encourage drivers to drive safely.

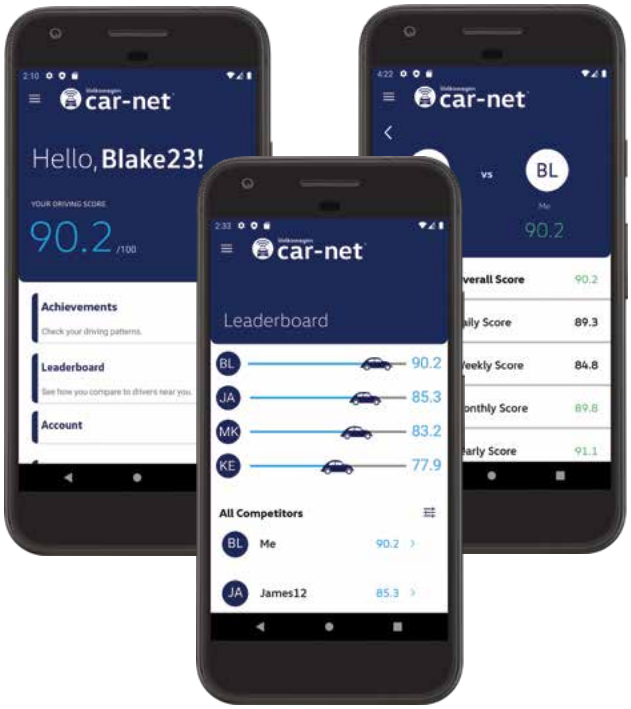
Our Car-Net DriveView Social Competition App is a social media mobile application that allows users to compete against each other by driving safely. Users who drive the safest are placed at the top of the leaderboards for other users to view.

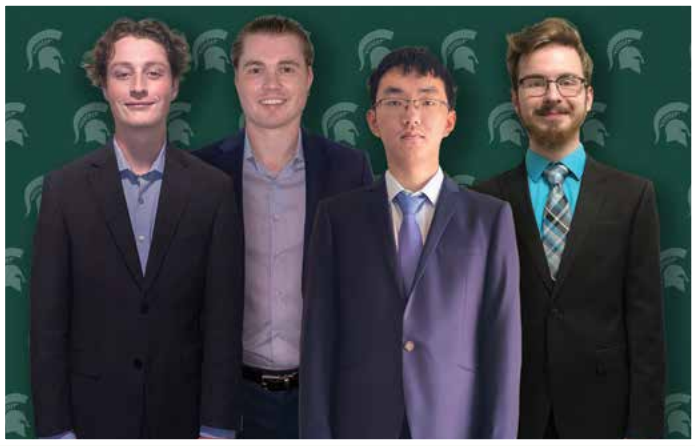
Drivers achieve these safety scores by completing objectives relating to safe driving. With our application, users track their driving achievements by simply using their vehicle. A user's safety score is calculated using these achievements as well as vehicle data.

To promote competition between users, leaderboards allow users to track how well they are doing compared to other drivers in their region.

Our application also allows users to filter who they are competing against. These filters include an overall distance driven by other drivers, other users' overall safety scores and a radius of other drivers near them. In addition to those filters, users may also check how they stack up based on the current day, week, month or year to see how they have progressed against other users.

Our Android application is written in Java and uses Firebase for user authentication. The back end is written in Python with Flask libraries to communicate with the app through HTTP messages.





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Whirlpool Corporation
AI Recipe Converter

Whirlpool Corporation, headquartered in Benton Harbor, Michigan, is the world's leading major home appliance company with approximately $20 billion in annual sales and 75,000 employees. Whirlpool's goal is to improve home life through the production of a variety of home appliances.

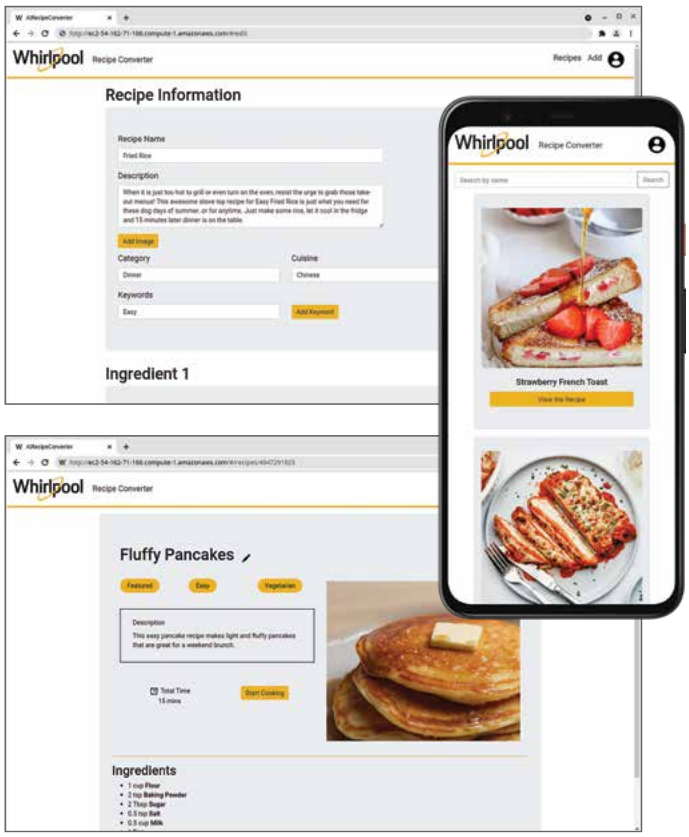
To this end, Whirlpool provides smart cooktops that automatically set the temperature and timers according to recipe instructions. Recipes must be formatted in a specific way to be used by these devices. Previously, it was the task of Whirlpool's food scientists to convert recipes into the specialized format. However, manually converting these recipes is time-consuming.

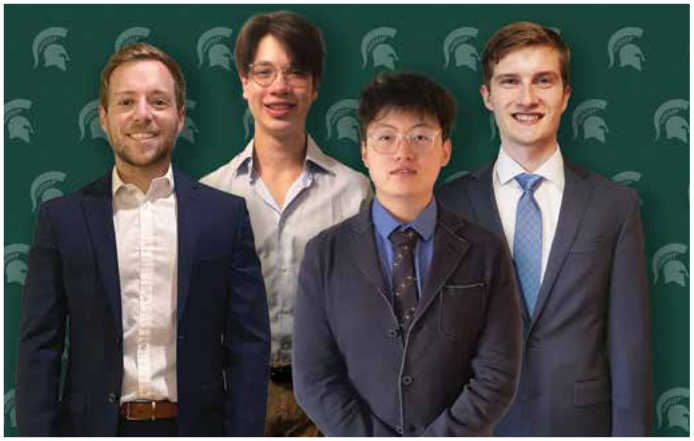
Our AI Recipe Converter assists Whirlpool food scientists in this task by automatically converting recipes on cooking websites into the machine-understandable format. Using natural language processing, information such as ingredients, cooking temperatures, and cook times are extracted from recipes. The final automatically-generated recipe can be viewed on our web dashboard and exported to a Whirlpool smart cooktop.

Food scientists at Whirlpool upload a set of recipe URLs to our web application. These recipes are then converted by our software into the specialized format. Food scientists can then verify that the recipes have been converted correctly and make edits to the recipe. Finally, they can view all of their previously converted recipes.

The AI Recipe Converter saves Whirlpool time and accelerates the growth of their automated recipes library, ultimately alleviating the burden on food scientists and creating a better customer experience.

Our front-end web application is built with AngularJS while our back end utilizes MongoDB, Node.js, and Python. All components of the application are hosted on Amazon Web Services.





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Design Day Awards

CSE 498, Collaborative Design, is the senior capstone course for students majoring in computer science. Teams of students design, develop and deliver a significant software system for corporate clients. The CSE capstone teams compete for four prestigious awards. Here are the winners from the spring of 2021.

Auto-Owners Insurance Exposition Award

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

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

Team Learning A-Z
Definition Station Word Matching Game

Sydney Hickmott, Yirong Bao, Jess McCoy, Clare Kinery
Presented by Tony Dean, Ross Hacker and Scott Lake

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 Anthropocene Institute
Siting of Water Turbines for Power Generation

Charles Ye, Ben Robbins, Lindsay Guare, Ahmed Alutairi, Andrew Rebits
Presented by April Clobes and Ben Maxim

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

TechSmith Screencast Award

TechSmith®

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

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

Team Herman Miller
Scout 2.0: Dynamic Data Visualization for Dealers

Marc Colucci, Pooja Panguru, Albert Asta
Presented by Wendy Hamilton, Tony Lambert and David Norris

Amazon Sigma Award

amazon

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

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

Team TechSmith
TechSmith Answers

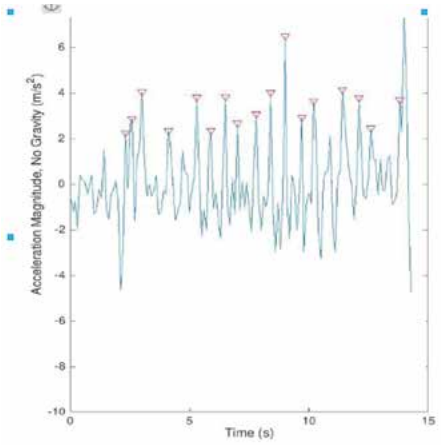
Zhehao Zhou, Spencer Novick, Rachel Allen
Presented by Garret Gaw and Derek Gebhard

Introduction to Electrical and Computer Engineering

Dr. Dean M. Aslam
Professor of Electrical and Computer Engineering

Problem statement

ECE 101 is an elective course introducing freshman students to Electrical and Computer Engineering through a series of unique/innovative **online hands-on flipped laboratory experiments** linked to Smartphone and research-oriented teaching approaches. The experiments include (a) MATLAB Mobile on Smartphone: Import and Plot Data from Built-in Smartphone-Sensors, (b) Study Ohm's Law Using Simulation Apps, (c) Create Smartphone App Using MIT's App Inventor or similar software for iPhone, (d) Built-in Smartphone-Sensors: Plotting Angular Velocity and Device Orientation by MATLAB Mobile, and (e) Other Smartphone sensors.



Acceleration Data From Smartphone: Counting Steps

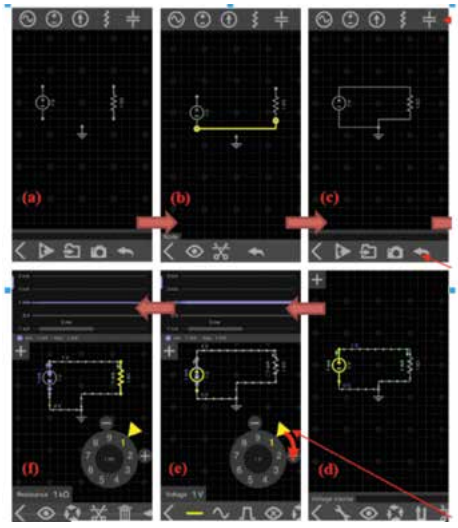
MATLAB Drive > Published > countingsteps.m

```
clear m;
m=mobiledev;
m
m.AccelerationSensorEnabled=1;
m
m.Logging=1;
T =timer('TimerFcn',@(~,~)disp('15
seconds done.'),'StartDelay',15);
start(T);
wait(T);
m.Logging=0;
[a,t]=accellog(m);
plot(t,a);
legend('X','Y','Z');
xlabel('Relative time(s)');
ylabel('Acceleration(m/s.^2)');
x=a(:,1);
y=a(:,2);
z=a(:,3);
mag=sqrt(sum(x.^2+y.^2+z.^2,2));
plot(t,mag);
xlabel('Time(s)');
ylabel('Acceleration(m/s.^2)');
magNoG=mag-mean(mag);
plot(t,magNoG);
xlabel('Time(s)');
ylabel('Acceleration(m/s.^2)');
minPeakHeight=std(magNoG);
```

C-Code

Graduate Student Assistant:
Mohammed Alshammari

Team Members	Project Title
Team #1: Matt Coury Colin Crawford Ndiaga Diouf Alex Robb	*Remote Control Car Using Smartphone*
Team #2: Jacob Graybeal Cheikhe Ndiaye Qinghao Shen	*Game App Using Smartphone*
Team #3: Ethan Grant Joel Martinez Daniel Pawar Terrell Thurman	*LED Blink Morse Code App Using Smartphone*
Team #4: Jim Allen Andrew Bastian Brett Dennis Marcus Pytel	*Blink LEDs Using Smartphone App*



Ohm's Law Simulation

The Capstone Projects

Dr. Subir Biswas
Professor of Electrical and Computer Engineering

Dr. Satish Udpa
Professor of Electrical and Computer Engineering

Faculty Advisors: John Albrecht, Dean Aslam, Sunil Chakrapani, Tim Hogan, Tongtong Li, Nihar Mahapatra, Daniel Morris, Jian Ren, Lalita Udpa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Aslam

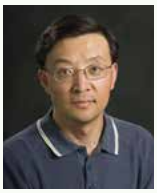

Chakrapani


Hogan


Li


Mahapatra


Morris


Ren


Udpa

Presentation Schedule – Engineering Building, Room 2243

Time	Team Sponsor	Project Title
8:00 a.m.	bpower	Battery Charing Monitoring and Billing
8:20 a.m.	MSU RCPD	SCATIR Switch for People with ALS
8:40 a.m.	Tecnix	Wind Turbine & Environmental Monitoring System
9:00 a.m.	Texas Instruments	Remote mmWave Radar Data Capture System
9:20 a.m.	MSU ECE Department	Aerial Vehicle Localization using AprilTags
9:40 a.m.	MSU ECE Department	High Resolution Object Triangulation
10:00 a.m.	Axia Institute	Smart Recycling B.I.N. using RFID-based Technology
10:20 a.m.	MSU College of Engineering/MSU IPF/DTE Energy	HVAC Occupancy Sensor System in Commercial Spaces
10:40 a.m.	MSU ECE Department	App for Personalized Cancer Symptom Management
11:00 a.m.	MSU ECE Department	Diaper Condition Monitoring System
11:20 a.m.	MSU College of Engineering	Aerial Perching Mechanism

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; and
- Requiring each student to complete four individual hardware/software laboratory assignments.

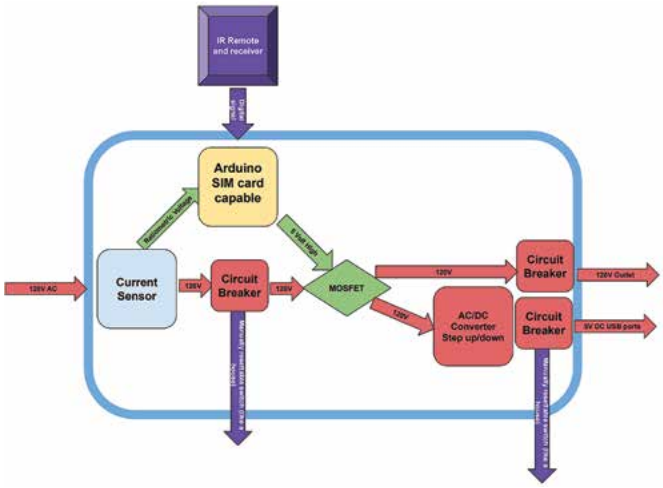
Team sponsors are local and national, including Axia Institute, bpower, MSU College of Engineering, DTE Energy, MSU Department of Electrical & Computer Engineering, MSU Infrastructure Planning and Facilities, MSU Resource Center for Persons with Disabilities, Tecnix, and Texas Instruments. Thank you to each of these team sponsors.

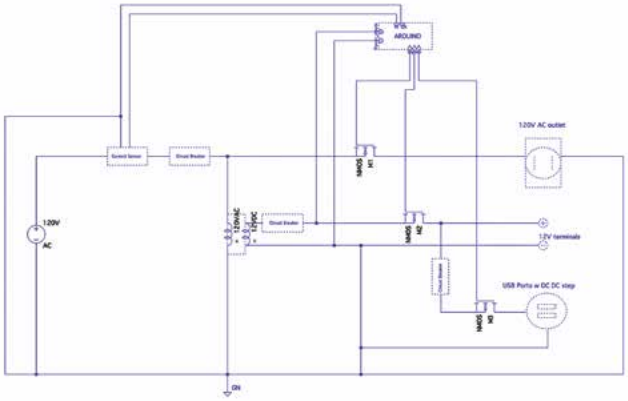
bpower
Battery Charging Monitoring and Billing

Energy Wells promises to deliver an energy dispersion marketplace to provide electricity to near-grid and off-grid households to combat inaccessibility to reliable electrical grid infrastructure in developing countries. A pilot project is scheduled for Cameroon in 2022.

Currently only 55% of the Cameroon population has access to the electrical grid, with only 17% in rural areas. Like the recent issue with the electrical grid in Texas, reliability is also an issue with the Cameroon electrical grid.

By creating a marketplace for the sale of electricity to charge batteries, the Energy Wells marketplace will allow innovation for any energy source available in rural areas (solar, wind, hydro, electrical grid, CNG, H2, biofuel or traditional gas or diesel) to receive payment for individuals or households to charge a variety of different batteries for reliable, off-grid electricity.





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MSU RCPD
SCATIR Switch for People with ALS

The MSU Self-Calibrating Auditory Tone Infrared (SCATIR) switch is a switch which is an assistive input device for people with amyotrophic lateral sclerosis (ALS). People with ALS progressively lose function and strength in their extremities and eventually end up quadriplegic, or paralyzed. This makes it hard to communicate and operate many types of devices.

The MSU SCATIR switch is a device that has a sensor mounted on glasses that can detect facial movements, such as an eye blink, eyebrow movement, and other facial movements. Since the facial muscles are one of the last muscle groups to retain movement and function, this sensor and attached circuitry allow the user to send a signal to connected peripheral devices. This can be used to send computer "left-click" events to a laptop or tablet running assistive communication software.

This combination of devices can allow a person with limited movement due to ALS to type manually or choose between a list of commonly used words.

RCPD
Maximizing Ability & Opportunity

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MSU Resource Center for Persons with Disabilities
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Tecnix
Wind Turbine and Environmental Monitoring System

Tecnix is a Tanzanian wind turbine company that started out just 10 years ago when an entrepreneur saw an opportunity to utilize the wind power in his community. Tecnix wind turbines are unique due to their size (7.5kw) and their local production, which includes a custom motor stator and rotor. Recently Tecnix was purchased by Justin Heath, a Kenyan entrepreneur and businessman who wants to take the company to the next level. Tecnix's goal is to provide sustainable green energy in its community for an affordable cost.

A crucial component to company success is accurate data analytics from both existing and new turbines to be installed. Tecnix asked our team to understand the design of their current data logger prototype and then focus on troubleshooting its issues to get it functioning properly. Once this has been achieved Tecnix requires that the data logger function so that the reported data is digestible.

Another desire of Tecnix is to store all data on a cloud database and present it on a Tecnix website/mobile app for easy access for both the company and its customers. Tecnix suggests that the team bases the user interface of the website off a specific example.

Additionally, a goal of Tecnix is to reduce the number of required parts and/or component cost. Our team plans to write a cost part report to optimize the opportunities for part cost reduction. Our team's final goal is to create a PCB of the data logger to reduce cost and optimize the data logger efficiency.

TECNIX WIND POWER

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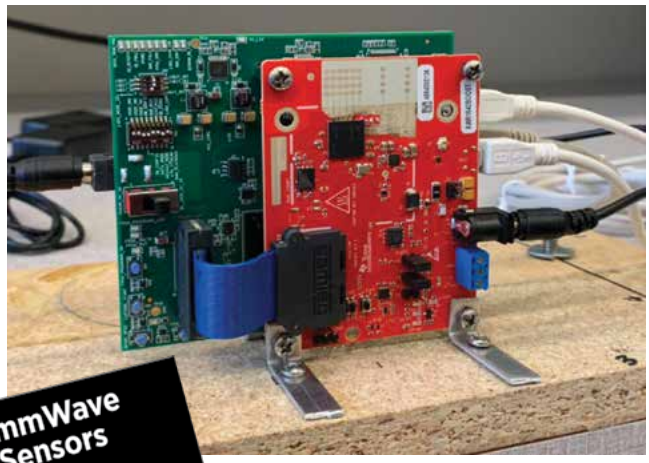
Texas Instruments
Remote mmWave Radar Data Capture System (WIFI)

Texas Instruments Incorporated (TI) is an American technology company headquartered in Dallas, Texas that designs and manufactures semiconductors and various integrated circuits, which it sells to electronics designers and manufacturers globally. The company's focus is on developing analog chips and embedded processors.

Currently, mmWave data collection requires people to collect data in person. Some data needs to be collected from different locations. It is difficult for people to travel between different places and bring a heavy computer. This project is to develop a solution that can be used to reduce the effort for end-users intending to collect radar data. For this project, we capture data from a Texas Instruments mmWave Radar unit and an accompanying camera. By collecting from the radar and the camera, we will enable new algorithm development and in particular machine learning applications.

Our design is based on a core of boards developed by Texas Instruments for the purpose of radar data collection. The UART stream, raw analog radar data, and camera data need to be obtained simultaneously and reported via a wireless network connection. In addition the device must be able to record data and video locally with a runtime of 1 hour.



beaglebone

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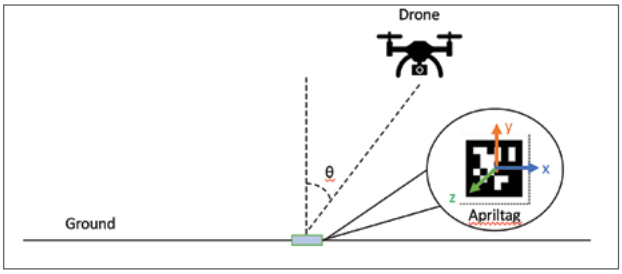
MSU Department of Electrical & Computer Engineering
Aerial Vehicle Localization using AprilTags

The objective of this project is to develop an integrated localization and flight controller for aerial drones in indoor environments. Standard flight controllers require access to GPS, which is not readily available indoors, so these flight controllers cannot be immediately used.

Our localization will be done by using AprilTags which will allow a camera on the drone to recognize the location and orientation of the tags and, if the camera is able to detect at least two AprilTags, then the drone will have the data to calculate its general location. AprilTags are similar to regular QR codes. The main difference from QR codes is that AprilTags don't hold as much information. This allows AprilTags to be detected by lower quality cameras but also allows them to be more reliable and robust.

This project will use drones that have been developed/used by previous design groups and the localization system will be deployed and tested in the Spartan Village Gymnasium.



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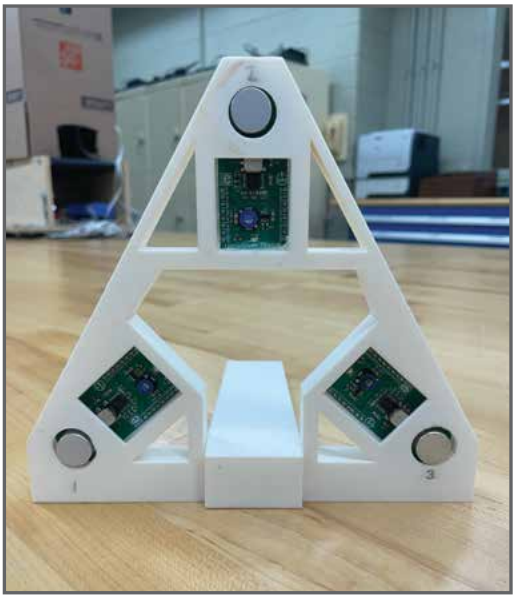
MSU Department of Electrical & Computer Engineering
High Resolution Object Triangulation

Object triangulation has become a vital part of many systems found within the automotive field, robotics, and many other fields. Object triangulation has been used in car backup detection systems, robotic production lines, tank fluid level detection, and several other applications. As these fields continue to develop, the need for better and more precise object triangulation has increased.

This project is to utilize transducers found on chips to transmit and receive a signal of a small object in a precise way. These transducers are controlled by a python code and mounted on a 3D printed working surface area, which can be moved to wherever it may be needed. The code connects with the sensors and takes measurements through them via ultra-sonic detection. The sensors are able to triangulate an object's position within a three-dimensional plane, as well as communicate with each other to more accurately calculate the object's position.

The system is able to accurately detect an object's position within real time. The transducers are wired to a computer system which displays the recorded data in real time. This data is displayed in a graphical user interface, which conveys the object's exact position within the defined space. The system is able to be powered by a 12V car battery, which allows for it to be easily implemented in a vehicle if needed. A similar system can then be implemented in various industries in order to increase safety and performance, as better and more precise object triangulation allows for less accidents and promotes increased efficiency for the system. Additionally, this system can be used to virtually map the environment of the measured area.



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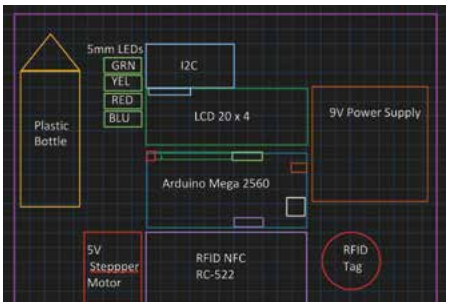
Axia Institute
Smart Recycling B.I.N. using RFID-based Technology

The goal of this project is to design and create a smart recycling platform that can count & collect RFID-based bottles. RFID is an acronym for "radio frequency identification," which uses a reader and tags to relay information from the tags to the reader via radio frequencies. Bottles that are tagged with RFID stickers allow them to be scanned by the recycling unit's RFID reader. The RFID reader can scan and then display the number of bottles counted in real time (as seen in the top image to the right), which signals the trap door mechanism to open allowing for easy access to the recycling bin when the bottle is accepted.

Our team chose to use Arduino because of its relatively low pricing of RFID readers and because it was the easiest to implement for the system's needs. Arduino Mega was chosen as the microcontroller of the project because of its larger array of pins and ports to maximize the recycling bin's unique features such as buzzer sounds, LED lighting, LCD display compatibility, and of course RFID scanning (bottom image).

The long-term scope of this project is to have these smart recycling bins to be able to connect to an Android application that displays information about specific recycling units such as the number of bottles it has collected in a specific period of time, the location of other bins, and the most popular units in an area. The second long-term goal is to collaborate with bottle companies that can include RFID tags on their products right out of the factory and have these stickers relay information about the product, such as the life of the product from the factory all the way to its expiration date. Though these steps are out of the scope of this semester's project, we have nonetheless dubbed our project the Smart Recycling B.I.N. (Biodegradable Interfacing Network) to convey the extent of this project's potential.



The Axia Institute:
Delivering Value Chain Solutions®
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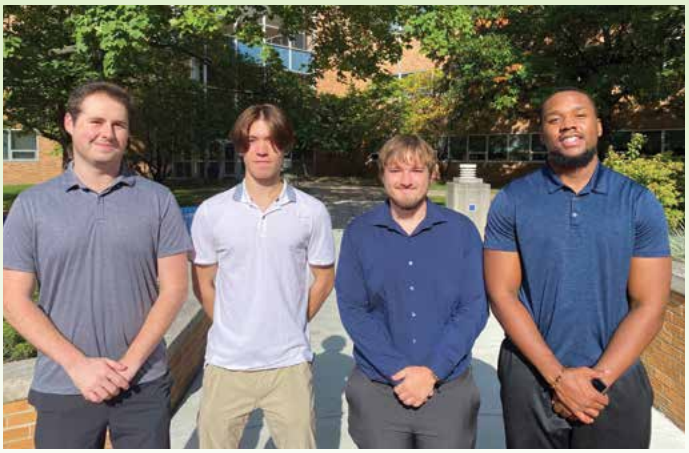

Michigan State University
Team Members
(left to right)

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Dr. Prem Chahal

MSU College of Engineering/MSU IPF/DTE Energy
HVAC Occupancy Sensor System in Commercial Spaces

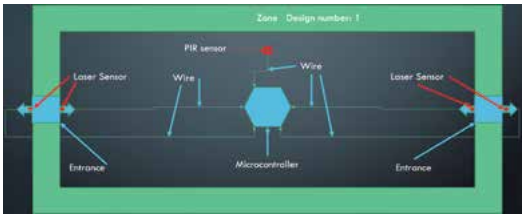
Since its establishment in 1903, DTE Energy has been working to create a smarter, cleaner, and safer energy future. One way to accomplish this is by hosting the E-Challenge 5.

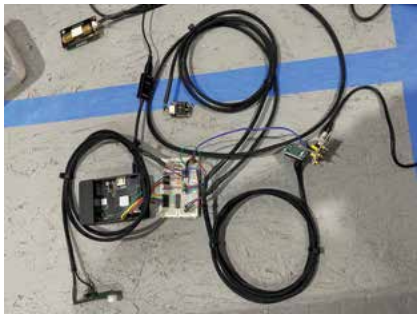
The goal of the challenge is to create an Energy Conservation Measure (ECM) that is not already commercialized in Michigan. Our system works to reduce energy conservation in commercial buildings through the use of occupancy sensors connected to a Variable Air Volume (VAV) based Heating, Ventilation, and Air Conditioning (HVAC) system.

The ECM our team created has an energy savings payback of 1-8 years for electric savings measures and 1 year for gas savings measures. The system was created to be adaptable to all commercial buildings without large changes in cost and payback measures.

To achieve the ECM goals, the system consists of two laser sensors at each entrance to a room, with one being located in each side of the entrance as shown in the diagram. All entrance sensors will collaborate to count the number of occupants entering and leaving the room. With this count, our system will be able to tell if the room is occupied or not. Along with the laser sensors, the system also includes Passive Infra-Red (PIR) sensors. PIR sensors have the ability to check movement, which can be used for occupancy detection. If the room is indicated as unoccupied from both the laser sensors and the PIR sensors for a predetermined idle time, the system will go into savings mode and allow a +/- 2°F difference to the target temperature. If the PIR sensors detect movement or if the occupancy counter is not zero, the system will exit the savings mode and the idle timer will be restarted. This allows the ECM to have a dual check system and conserve energy in unoccupied rooms.

Due to the system having an exact occupancy count, the recommended CO_2 set point can be calculated and used by the HVAC system, to follow the Guideline 36 recommendations.





MICHIGAN STATE UNIVERSITY
Infrastructure Planning and Facilities

DTE Energy

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MSU Department of Electrical & Computer Engineering

App for Personalized Cancer Symptom Management

Two of the most debilitating symptoms of cancer include sleep/wake disturbance and fatigue occurring during chemotherapy. This is due to the disruptions in circadian rhythm caused by chemotherapy that is required to treat certain cases of cancer. Circadian rhythm is the natural internal process that regulates sleep cycles. Light is one of the biggest factors in regulating circadian rhythm, and our project is to create a smartphone application that assists in bright light therapy by adhering to a strict schedule in an effort to better manage sleep/wake disturbance and fatigue.

Our app is customized to help older patients monitor and adhere to prescribed light therapy sessions. The app also has notifications to remind patients of scheduled therapy sessions. The patient will receive an initial reminder and if they do not respond after ten minutes, they will receive a second reminder. If no response is received after another ten minutes, a final alert will be sent. Apart from the therapy reminders, the app also facilitates the recording of sleep, wake, and nap times.

Their levels of fatigue are also recorded, which efficiently replaces the need to use paper and pencil logs.

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Project Facilitator

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MSU Department of Electrical & Computer Engineering
Diaper Condition Monitoring System

The first disposable diapers were created in Sweden in the 1940s. Since then, disposable diapers have become a commonality in all developed countries and most developing countries.

A diaper monitoring device is a system that uses a mobile app to notify parents or caretakers when a baby's diaper has been soiled. This system can be a reusable sensor that is placed on the diaper, or it can be a disposable sensor that is implemented into the build of the diaper.

Having a device that can let parents know their baby's diaper needs changing can improve the baby's comfort and well-being by preventing health issues, such as skin irritation, rashes, and possible bladder infections, all due to infrequent changes. For the user's benefit, this system reduces the amount of time spent checking a baby's diaper.

Our team has been developing a cost-efficient design for a disposable sensor. This sensor uses an RFID tag that can send a signal to a reader once it is soiled. This reader is programmed to be compatible with both IOS and Android.

Diaper's absorbent core contains conductive material that can activate RFID when wet.

RFID reader is implemented into diaper. Once activated, RFID sends a signal to the reader.

Reader communicates with the RFID. When RFID is activated, reader is programmed to send an alert via a mobile app.

App is compatible with IOS and Android.

College of Engineering
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MSU Department of Electrical & Computer Engineering
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Project Facilitator

Dr. Lalita Udpa

MSU College of Engineering
Aerial Perching Mechanism

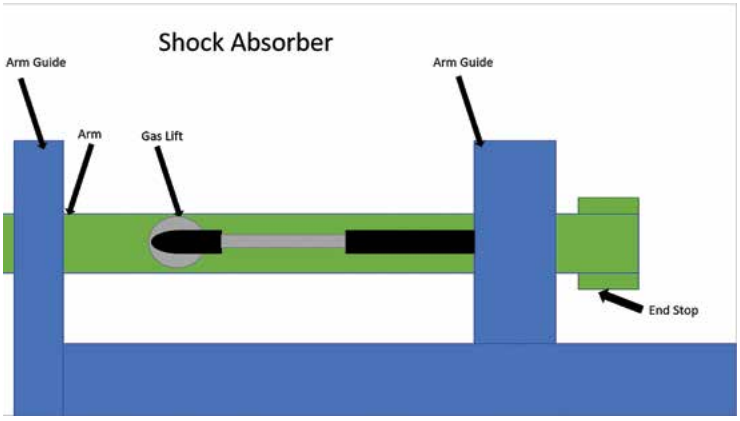
The objective of this project is to develop an aerial perching mechanism that allows an aerial drone to attach to a surface and collect ultrasonic measurements for non-destructive evaluation. Several designs for aerial perching have been introduced.

This project explores mechanisms for aerial perching on a smooth wall, adopts a mechanism, implements it on an aerial drone frame, and demonstrates perching behavior. Possible mechanisms include:

1. Attaching legs (similar to a spider robot) to the drone, using the drone to stick to the wall, and using friction at the contact of the legs and wall to ensure the drone doesn't slide on the wall.
2. Using a suction vacuum cup with a micro vacuum pump to attach/remove the drone to/from the wall. This design will be similar to the one described above.

The team will design the perching mechanism, design a joystick-based remote controller for the system, interface it via WiFi, and demonstrate the overall system.

To best match the requirements of the sponsor, the vacuum suction cup is the connecting mechanism used in the final version of this design.



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Vaibhav Srivastava
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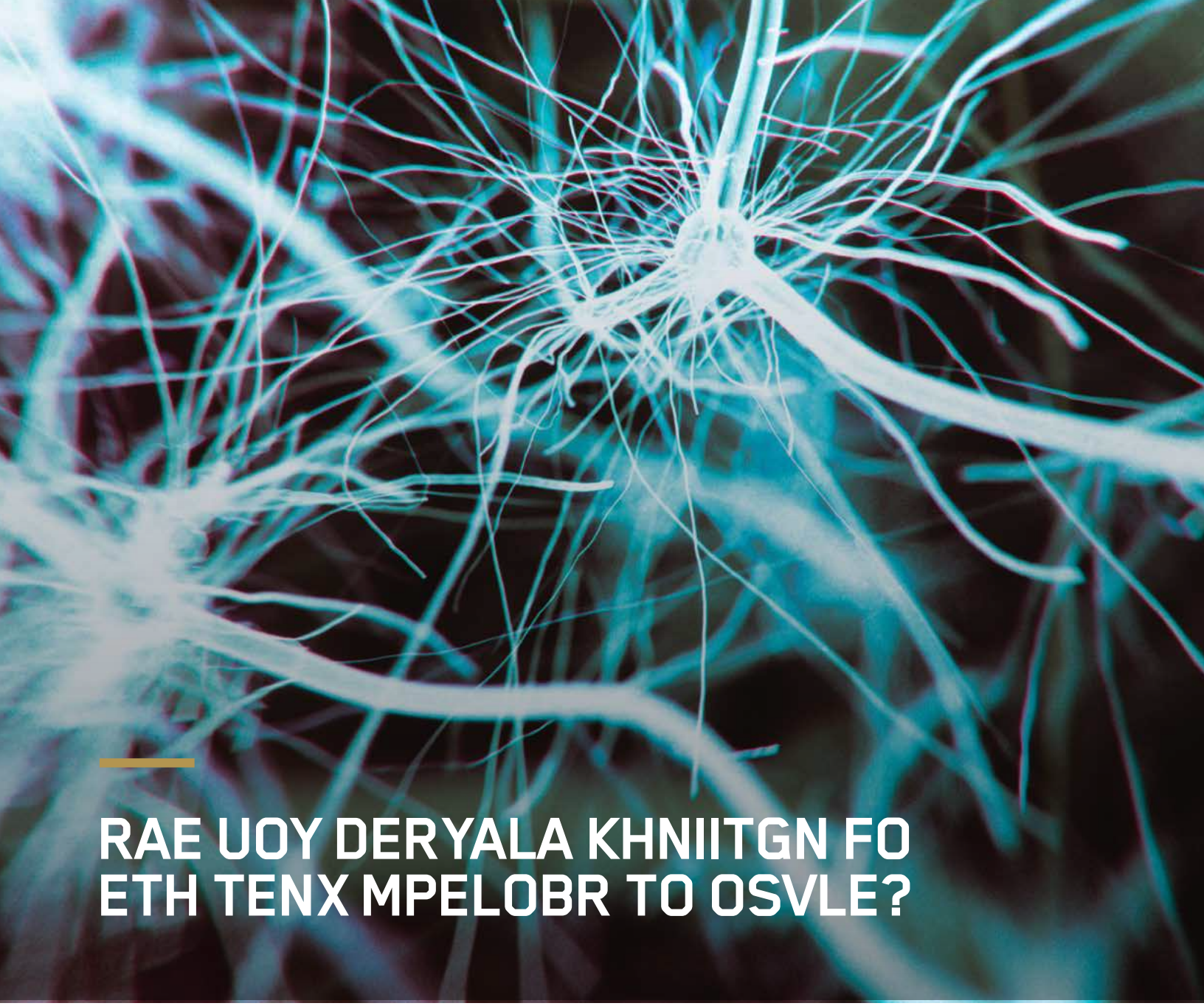

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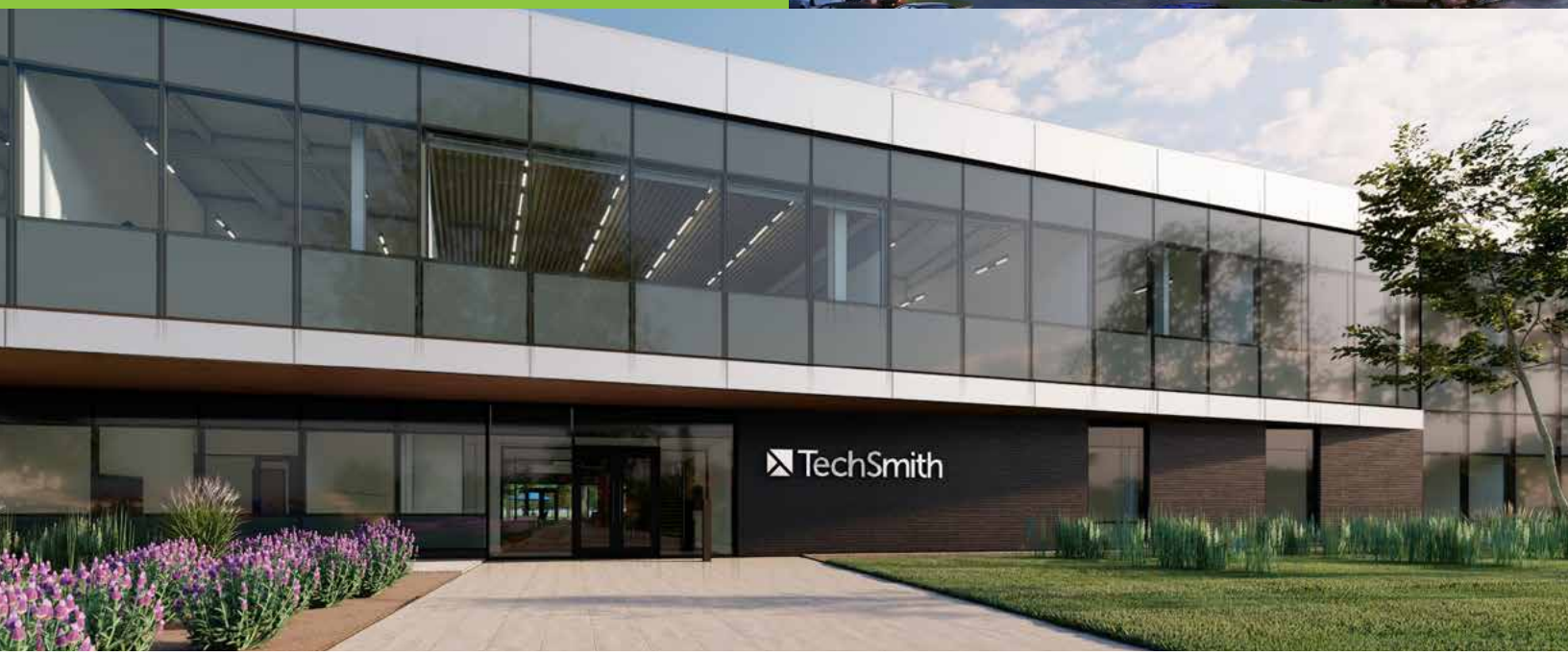
FOUNDATION



Driving an Innovation Ecosystem

The Michigan State University Foundation is a nationally recognized 501(c)(3) nonprofit research Foundation dedicated to advancing education and research. Our mission is to serve Michigan State University and provide solutions to the specific needs of our partners. In addition to our venture creation activity including $30M in venture funds, we're proud to be working with TechSmith and McLaren Greater Lansing to drive the development of innovation communities and state-of-the-art facilities for greater collaboration with Michigan State.

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PRE-SEED FUND III

MSU INNOVATION NETWORK

ME 412 Heat Transfer Laboratory

Yuping Wang
Academic Specialist
Department of Mechanical Engineering

Understanding Heat Exchangers

Heat exchangers are common. They are found in homes, cars, factories, and they take on a variety of designs and sizes, from simple tubular to compact plate to many other innovative structures. Students in heat transfer laboratory this year are to study the heat exchangers as their design project. They are expected to understand heat exchanger operations and applications through two parts of work. For the major part, each team will build a simple heat exchanger based on their own design, and then evaluate its performance through lab testing and thermal analysis. The objective of the design is to provide sufficient cooling to a hot water stream. For the secondary part, each team will choose a specific type of heat exchanger of their interest, conduct a review on its design, application, performance, as well as its existing experimental/computational works. A testing station, with instrumentations for flow rate and temperature measurements, is available for teams to test their device. On the presentation day, each team will prepare a power-point slide show or a video clip to explain the design decisions, fabrication, thermal analysis and testing results of their heat exchanger.

Competition Schedule

Team 1
Fritz Hittner
Jared Koekkoek
Andrew McNamara
Garrett Novak

Team 2
Sebastian Bosoc
Oriol Canellas Salles
Jake Frelich
Mitch Leblanc

Team 3
Andrew Hall
Lehomm Pickard
Race Piontkowski
Emma Turkmani

Team 4
Paige Cordts
Jerica Tallman
Katharine Walters
Yu Xin Zheng

Team 5
Justin Helmer
Andrew Retzlaff
Zhihao Xu
Ryota Yoshida

Team 6
Ethan Kalkman
Kyle Patton
Karisa Rodeghiero
Marcelo Zaplain

Team 7
Jared Ludacka
Ryan Rowe
Steven Souphis

Team 8
Andrew Emery
Noah Hubbard
Kaushik Kothakonda
Mackenzie Wagner

Team 9
Andrew Debaker
Noel Dyde
Nate Farhat
Max Smith

Team 10
Ryan Knutson
Matt Schram
David Schulte
Steven Stine

Team 11
Matthew Good
Lila Ninotti
Mark Pastoria
Joshua Woodford

Team 12
Jack Beddow
Matt Greene
Colin Hachey
Elias Mackoul

Team 13
Claudia Chen
Lazerick Hill
Nelson Huynh
Allison Keller
DeShawn Schwan

Team 14
Vince Cushing
Max Kempisty
Sean Lishawa
Devon Pung

Team 15
Delano Dalfonsi
Brian Hanton
Mason Perillo
Bobby Vette

Team 16
Dan Bojanowski
Jack Sikemma
Jessica Thomas
Adam Van
Atharva Wadhokar

Team 17
Conner Curnette
Marvin Haddad
Noah Terech

Team 18
Tadiwa Chiduma
Ethan Mulder
Nathan Vigneau
Dayana Villagran

Team 19
Brandon Burlage
Cayla Coury
Kelsey Karasek
Ryan Langa

Team 20
Will Berlage
Daniel Blondell
Nick Masini
Hailey Swamy

Team 21
Peter Caruso
Olivia Dario
Suhail Turkistani
Grace Veenstra

Team 22
Rohan Challa
Drew Hubbard
Santos Lopez Jr.

Team 23
Nolan Kerwin
Jason Scott
Hammer Shalawylo
Jacob Zettle

Team 24
Chelsey Ely
Justin Kowalchik
Drew Larson
Mike Wichman

Team 25
Kylie Decker
Roman Grishin
Aaron Rakowski
Zac Seeds

Team 26
Zhemeng Fan
Aaron Humphries-Dolnick
Brad McMahon
Jiachen Qu

Team 27
Thomas Jennett
Austin Meisel
Victoria Saxton
Samar Sheikh

Team 28
Josh Bravo
Alec LeVasseur
Jimmy Provax Jr.
Justin Yan

Team 29
Srujan Gubbi
Alain Sotolongo-Carballo
Yang Xu
Tahha Zahid

ME 470 Mechanical Design & Manufacturing II

Michael Lavagnino
Academic Specialist
Department of
Mechanical Engineering

Walking Robot

For the 110th anniversary of the invention of Orange Crush soda, this semester's final design project entails designing and building an aluminum can crushing system. Students will utilize a human-powered crank slider linkage system that will be geared in sync with a cam-follower system to indent the side(s) of the can while initially being crushed. Students will be able to utilize the MTL equipment and materials, as well as utilize a $100 budget for any additional purchases. Each team will have the opportunity to crush two cans. The best designs will be ergonomically friendly (low force, comfortable to use) and crush the can to the smallest height.

Team 1A
Ryan Koschay
Nick Occhiuto
Tommy Pang
Sam Pellinen
Jax Prusakiewicz

Team 1B
Will Berlage
Emma Carduner
Ben Gaynier
Chloe Ho
Landon Luyckx

Team 2A
Ryan Knutson
Blake Mallamo
Eli Rodriguez
McKyle Stanfield
Jack Voigt

Team 2B
Ian Burress
Will Erskine
Srujan Gubbi
Elias Mackoul
Julia O'Mara

Team 3A
Ian Beshears
Olivia Dario
Hanna Gehrke
Zach Vander Stel

Team 3B
Arianna Finn
Thomas Jennett
Lila Ninotti
Vanessa Pariso
Mark Pastoria

Team 4A
Garrett Gould
Matt Simental
Youngbin Song
Akhilesh Swaminathan
Marcelo Zapiain

Team 4B
Jacob Demski
Justin Kinville
Alex Kriese
Ethan Mulder
Ricardo Paz Weber

Team 5A
Garrett Colasinski
Joseph Deschaine
Austin Lowien
Jack Rutkowski
Quentin Wade

Team 5B
Kylie Decker
John Paul Dela Cruz
Brendan MacDonald
Patrick Marchal
Willis Wuebben

Team 6A
Hunter Hansen
Aaron Humphries-Dolnick
Kace Krauss
Raj Lamport
Julie Pham

Team 6B
Brian Hanton
Nicole Kowalski
Justine Stewart
Lucas St John
Adam Van Gieson

Team 7A
Henrique Pio
Liam Ranik
Harrison Schaub
David Schulte
Connor West

Team 7B
Joe Fantin
Cody Hayse
Charley Jiang
Michael Trajkovski
Griffin Yakey

Team 8A
Jacob Grimmer
Max Kempisty
Kirk Maibach
Mason Perillo
Michael Vangel

Team 8B
Cam DePauli
Zack Friess
Zach Harrison
Jack Lambrix
Ryan Zerona

Team 9A
Ben Abdallah
Rohan Challa
John Gregor
Faizan Malik
Rhett Pimentel

Team 9B
Sean Colling
Ethan Keppy
Nick Montpas
Steven Souphis
Cooper Strebeck

Team 10A
Ha Dang
Karli Deutscher
Livia Noble
Eric Parsons
Robert Walston

Team 10B
Valerie Aten
Michael Batina
Logan Malak
Hailey Minton
Anthony Pero

Team 11A
Abdulkareem Alasmari
Renad Alhassani
Michael Bachleda
Meghan Parkinson
Eli Pickard

Team 11B
Anthony Kasiyan
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Abhyuday Rastogi
Atharva Wadhokar

Team 12A
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Samir Hussain
Jiachen Qu

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Nathan Clinger
Clarie McMillen
Zach Stroud
Trent Treppa

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Madeline Stump
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Ty Ebling
Danny Mondrusov

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Stephen Stormzand
Kengo Takenouchi

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Rahmi Khalil
Matt Stucky
Jerica Tallman

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Tanner Nurnberger
Mitchell Ruczynski
Coleson White

Team 15B
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Garrett Ruhala
Victoria Saxton
Zac Seeds
Katharine Walters

The Capstone Projects

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Professor of Mechanical Engineering

Faculty Advisors: Rebecca Anthony, Seungik Baek, Tong Gao, Michele Grimm, Manoochehr Koochesfahani, Guoming Zhu


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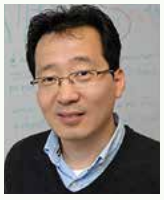
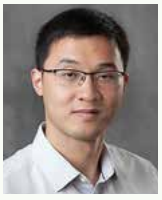
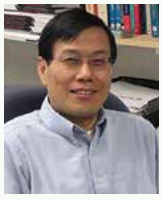

Baek


Gao


Grimm


Koochesfahani


Zhu

Presentation Schedule – Engineering Building, Room 1202

Time	Team Sponsor	Project Title
8:00 a.m.	The Center – Michigan State University	Directed Steps
8:30 a.m.	Heartwood Schoo/Ingham ISD	Adult-Sized Ride-On Recreational Mobility Car
9:00 a.m.	Heartwood Schoo/Ingham ISD	Wheelchair Customization
9:30 a.m.	Heartwood Schoo/Ingham ISD	Mechanical Pony Revisions
10:00 a.m.	Ingham ISD	In-Home Lift Device Design
10:30 a.m.	NASA/Arizona State University	Psyche Hypothesized Landing System
11:00 a.m.	Michigan AgrAbility	Hive Lifter

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 support of this semester's project sponsors: The Center-Michigan State University, Cleveland-Cliffs, Inc, Flash Steelworks, Inc, Heartwood School, Ingham ISD, Michigan AgrAbility, The Michigan Chestnut Industry, MSU Adaptive Sports and Recreation Club, MSU Department of Mechanical Engineering, MSU Department of Theatre, NASA/ASU, and Toyota.

The Center – Michigan State University
Directed Steps

Directed Steps is a project founded to confront health and movement issues in populations who may not have the benefit of paid rehabilitation. The program aims to improve quality of life for these individuals and aid them in achieving fulfilling and purposeful experiences. Through directed mobility training, strength and aerobic exercise sessions, as well as mentorship and mental health coaching, participants are prepared to embark on trips and adventures that give their training purpose.

Our team was tasked with prototyping a rehabilitative ambulation aid for a patient recovering from a spinal cord injury. The device is intended to assist the patient with mobility training while upright, as their injury has significantly debilitated control of their lower body. Traditional aids such as crutches or walkers do not provide the patient with a sufficient base of support, nor give enough energy return during a stride to allow the patient to effectively move forward without their feet dragging below them. The design also has to be lightweight, as the patient is still undergoing strength training of their upper body and core muscles. Through implementation of a larger base of support for additional stability, increased energy return through a compressive foot design, and a quick-release in case of falls, the team designed and built a prototype that will effectively assist the patient in their rehabilitation process, and aid them in recovering their mobility.

EXPERIENCE ENGINEERING CAREERS
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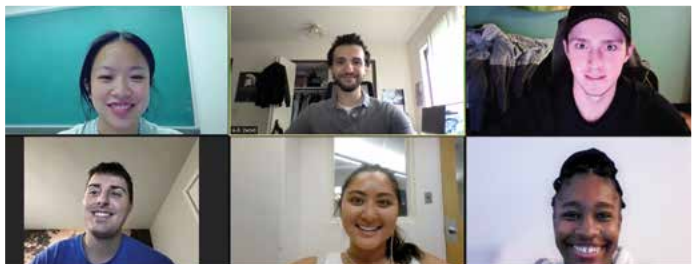

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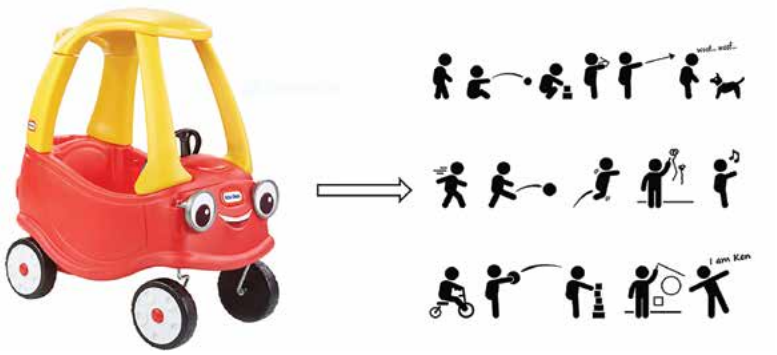
Dr. Rebecca Anthony

Heartwood Schoo/Ingham ISD
Adult-Sized Ride-On Recreational Mobility Car

Based in Mason, Michigan, Heartwood School is a center-based program that serves a wide range of students with moderate to severe cognitive impairments, severe multiple spectrum impairments, autism spectrum disorders, and physical impairments. Heartwood School is a part of the Ingham Intermediate School District and plays a vital role in ensuring that these students are able to reach their full potential while learning in an engaging environment.

Students who attend Heartwood School often deal with delayed gross motor skills development and, to aid in developing these capacities, it is necessary to undergo physical therapy sessions. At the time of commencing this project, there was a lack of products on the market that were designed for individuals above the age of five years old. Given the much wider age range of students at the school, it was necessary to identify similar products that promote gross motor skills development and to design a ride-on car that could support larger individuals.

Our team designed a recreational ride-on mobility car, inspired by products like the Little Tikes© Cozy Coupe car, that students would be able to propel with their feet and that featured a removable floorboard for students with limited functionality of their lower extremities to promote development of gross motor, academic, and social skills.



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Heartwood School/ Ingham ISD
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Dr. Michele Grimm

Heartwood School/Ingham ISD
Wheelchair Customization

Heartwood School is a center-based program in the Ingham Intermediate School District located in Mason, Michigan. Heartwood School helps students who range in age from 3 to 26 years old who have cognitive impairments, physical impairments, autism spectrum disorders, and severe multiple impairments. Their mission is for all students to reach their greatest potential. Heartwood School has partnered with the MSU College of Engineering many times to create and update equipment that students can use to participate in new experiences and build skills. This contributes to the Mobility Opportunities Via Education®/Experience model (MOVE), which is an activity-based program designed to improve an individual's mobility skills and better their health, independence, and inclusion in the community.

Many students require custom seating in their wheelchairs to provide the proper and safe support they need. The custom wheelchairs, however, can be difficult to transport as they often have many heavy or bulky components. As such, parents often use simplistic sling-style "hospital" wheelchairs for appointments, vacations, and other trips. Sling-style wheelchairs are generally lighter and easily transportable, but they do not provide ample support. This can put the student at risk for discomfort, pain, skin breakdown, and worsening deformities. Our team was tasked with creating an attachment that allows custom seats and seatbacks to be attached to sling-style wheelchairs. The attachment is designed to keep the seat secure while in use, but it is also removable so that the wheelchair can be folded and the seating can be transported separately. This allows the student and their family greater flexibility with regards to traveling without sacrificing their health, comfort, and safety.

Ingham Intermediate School District
Heartwood School

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Katianne Rausch
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Mitch LeBlanc
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Novi, Michigan

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Dr. Manoochehr Koochesfahani

Heartwood School/Ingham ISD
Mechanical Pony Revisions

Heartwood School is a local school in Mason, Michigan, serving students 3-26 years old with physical impairments, cognitive impairments, and/or autism spectrum disorders. Heartwood School utilizes the Movement Opportunities Via Education (MOVE) program to help support students gain physical mobility skills through functional activities. The goal of this program is to improve the quality of life for students by allowing them to become more independent by integrating activities that focus on developing and enhancing their motor skills. Using the Therapeutic Mechanical Pony is one enjoyable and exciting activity that can help them accomplish this.

The use of the mechanical pony is based on the principle of Hippotherapy. Hippotherapy is the form of therapy in which a therapist uses the movements of a horse to provide a sensory and motor input. The mechanical pony has never been successfully created to be both safe and durable but will hopefully be implemented in order to allow students to work on gaining strength and postural control in a fun and engaging way. The main priority for this project is to keep the machine safe. It is built with intentions for children under one hundred pounds in weight to be able to ride and use. Previous issues with this project were that it was not smooth operating and had dangerous movements. The previous designs left the pony jerky and unpredictable. The pony itself was also not stable, as it had the great possibility of tipping over. Our team developed a safe design that will function properly for this project.

Ingham Intermediate School District
Heartwood School

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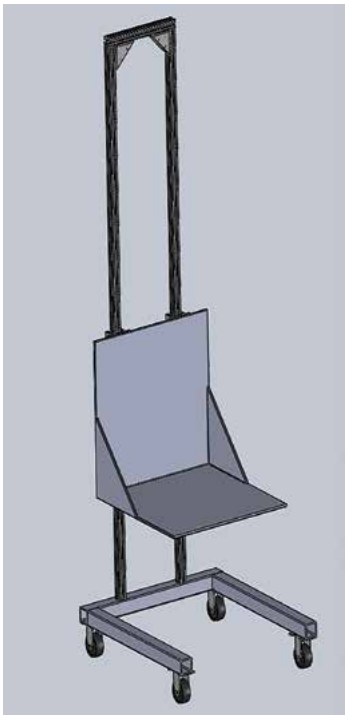
Ingham ISD
In-Home Lift Device Design

The Ingham Intermediate School District (Ingham ISD) is a school district that encompasses the greater capital area from Lansing to Stockbridge. The Ingham ISD's goal is to provide efficient education to these areas and support all learners in the service area. The Ingham ISD has worked with the Mechanical Engineering Department at Michigan State University for 3 semesters since 2020 to design a lifting device for a student from a local high school with Quadramelia or Amelia, which means they have no arms and no legs. Because they have no functional limbs, they are dependent on others for most activities.

The goal of the project was to safely lift a specific student from Ingham ISD but with the possibility of further application for other individuals with similar or different conditions. The device lifts the student from floor level with a clearance of no more than half an inch, to seated level of about 2-3 feet with the need for only one individual to assist, versus the previous system requiring two people to assist. The device is small enough to navigate around the client's house yet stable and powerful enough to provide adequate stability for safe operation. The device is self-encompassed in a way to limit the chance of injury or damage while its mechanisms are in use.



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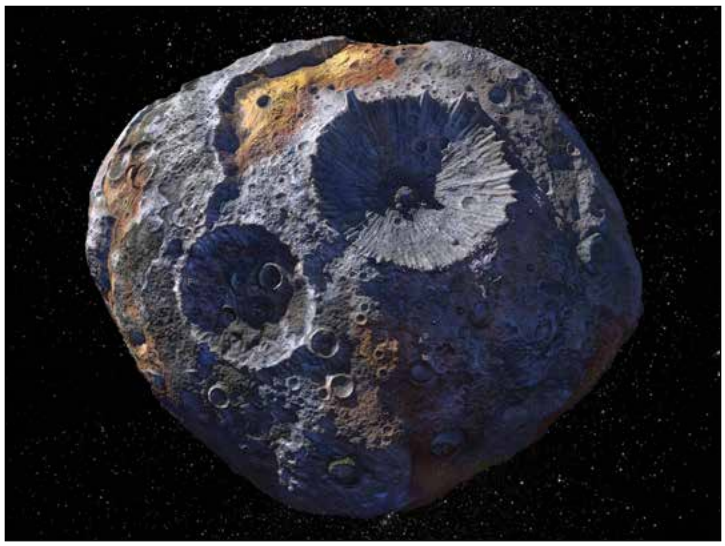
NASA/Arizona State University
Psyche Hypothesized Landing System

The National and Aeronautics Space Administration (NASA) has launched numerous missions into space. The goal of these missions is to discover new information about what exists beyond the earth's atmosphere. The NASA Psyche mission is set to launch in 2022 and arrive at the asteroid in 2026. The spacecraft will orbit the asteroid and learn about its environment. NASA and Arizona State University assigned senior projects to groups from various universities to research optimal designs for a future follow-on mission. Each assignment has a set task to accomplish on the surface of the Psyche asteroid. This project is focused on designing a future landing system for the hypothesized surfaces of the asteroid.

The landing system has to be able to safely land on a variety of surfaces that are hypothesized to be found at Psyche. These included mostly flat metallic surface, flat metallic with metal and/or rocky debris, rough/high-relief metallic and/or rocky terrain, and high-relief metallic crater walls. Furthermore, environmental factors were considered, including gravity. The lander needs to land on these surfaces at a reasonable speed. Different methods of slowing the speed and safely landing the orbiter were proposed. Various ideas were combined to create a prototype of the landing system. The landing system was tested and analyzed for the mission. Based on these results, the landing system provides a solution that could be used in future missions to Psyche.



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Michigan AgrAbility
Hive Lifter

Michigan AgrAbility is a philanthropic organization that is a partnership between Michigan State University and Easterseals Michigan in order to provide assistance to people with an injury, illness, or disability working in the agricultural industry. Michigan AgrAbility, in coordination with Heroes to Hives, has set out to assist and enable local veterans around Michigan to begin beekeeping. In order to tend to the hives, beekeepers often need to be able to lift hive body setups that can individually weigh upwards of 90 pounds. This task is not always possible for people dealing with back, leg, or arm injuries and Michigan AgrAbility is leading the cause to make sure these issues do not continue to hinder future beekeepers. With bee populations continuing to decline it is not only important to Michigan AgrAbility to reverse that trend, but also have the ability to improve the welfare of all individuals that are affected by injuries, illnesses, or disabilities.

Our team was tasked with designing a self-propelled hive lifter that allows the individual operating it to be able to lift, transport, and check their hive body setups. This project focused on building the base of the hive lifter with the ability to add a lift to the machine at a later date. The hive lifter base is designed to be able to travel through the rough conditions of the beekeeping environment using a four-wheel drive system. The base of the lift is driven by two motorized drive wheels and two steering wheels while someone operates it from behind. The base is made to be compact enough to fit in tight beekeeping setups and allow it to be easily transportable by the company or operator. Furthermore, we chose to use tubular steel for the structure in order to have the ability to hold up to 500 pounds. The team's hive lifter base will help to ensure that beekeepers with any illness, disability, or injury will be able to safely take care of their hives.

AgrAbility
easterseals MICHIGAN STATE UNIVERSITY Extension

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Presentation Schedule – Engineering Building, Room 1220

Time	Team Sponsor	Project Title
8:00 a.m.	MSU Department of Theatre	Metal Cleaner
8:30 a.m.	NASA/Arizona State University	Returning Samples of Hypothesized Surfaces
9:00 a.m.	NASA/Arizona State University	Robotic Explorer for Hypothesized Surfaces
9:30 a.m.	NASA/Arizona State University	Sampling System for Hypothesized Surfaces
10:00 a.m.	The Michigan Chestnut Industry	Chestnut Harvester
10:30 a.m.	Toyota Motor North America	Automotive Seat Component Design
11:00 a.m.	Toyota Motor North America	Battery Road Interference Protection

Mechanical Engineering Design Program

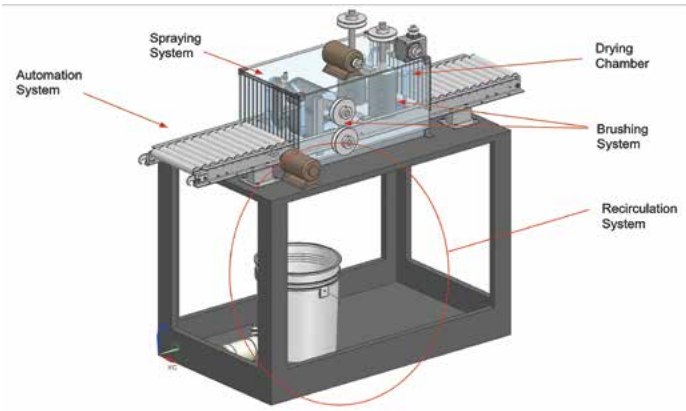
Mechanical engineers make the world move and provide the energy for it to do so. One goal of the MSU Mechanical Engineering Program is to educate engineers who are prepared to lead, create, and innovate as their professional or graduate careers evolve. The Mechanical Engineering Design Program is the 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, Ron Averill, Seungik Baek, Andre Benard, Giles Brereton, Brian Feeny, Tong Gao, Michele Grimm, Farhad Jaberi, Manoochehr Koochesfahani, Lik Chuan Lee, Ranjan Mukherjee, Ahmed Naguib, Harold Schock, Elisa Toulson, Indrek Wichman, Neil Wright, Xinran Xiao, Mohsen Zayernouri, and Guoming Zhu.

MSU Department of Theatre
Metal Cleaner

The Michigan State University Department of Theatre is located on the Michigan State University campus in East Lansing, Michigan. The department is in need of a device capable of cleaning oil from metal and preventing residue build-up. The department uses steel and aluminum for aesthetic and structural purposes. The metal must be clean for welding and painting. The current process to clean full lengths of metal (usually box or tube shapes, approximately twenty feet in length) is laborious and inefficient.

Our team was tasked with designing a metal cleaner that pulls the metal through a device while flooding it with a cleaning solution (currently a mixture of Simple Green and water) while simultaneously scrubbing the metal. The device has a reservoir to pull from and a well to recycle the fluid to reduce waste. The device is compact and portable and is able to operate on an average 115 amp outlet and 120 psi pressure. The device consists of an automation system, brushing system, spraying system, recirculation system, and drying system. The device achieves the function of cleaning and drying under the joint operation of all components.



DEPARTMENT OF THEATRE
www.theatre.msu.edu

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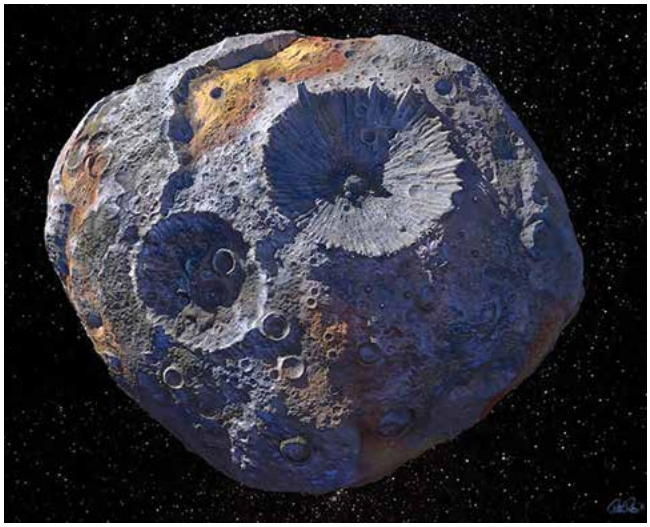
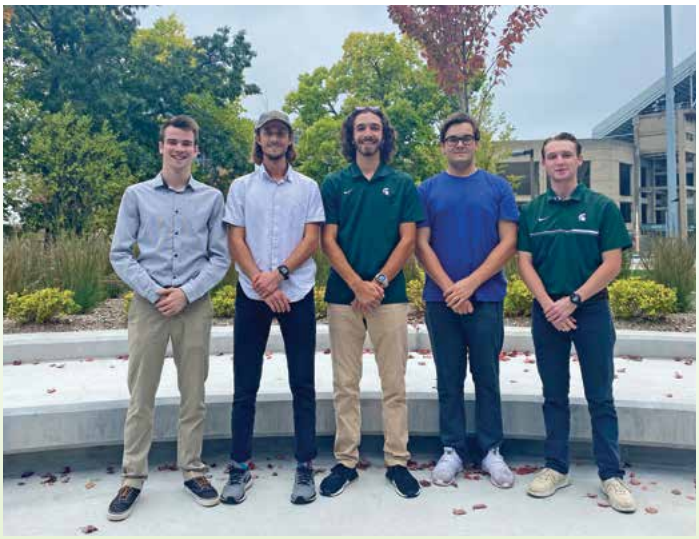
NASA/Arizona State University
Returning Samples of Hypothesized Surfaces

NASA's Psyche mission launching in August 2022 will be the first mission to a metallic asteroid rather than one of rock and ice. Within rocky, terrestrial planets such as Earth, scientists infer the presence of metallic cores, but these lie unreachable below planets' rocky mantles and crusts. Because scientists cannot see or measure Earth's core directly, Psyche offers a window to study the planetary formation patterns including collisions and accretion processes that created terrestrial planets.

Our team's goal was to return samples from the surface of Psyche, during a theoretical future mission to the asteroid following NASA's initial flyby in early 2026. This potential future mission will consist of a robotic explorer equipped with a sampling system, landing on 16-Psyche to collect and return samples of the hypothesized metallic surface to Earth. Our mission as the sample return team was to design a capsule system that would safely store and preserve 2.6 kg of material collected from the surface of 16-Psyche: managing environmental contamination from Earthly compounds and solar radiation using materials consistent with NASA material handling standards. Our return capsule is designed to store an array of cylindrical tubes holding cached samples based on material and collection location. The designed geometry of the tubes allows them to contain a variety of sample forms including fine particles, small rocks, and cores, giving the Sampling Team flexibility in the form of returnable material. Sample tubes will be filled using a fail-safe mechanism that ensures collected material will fit within the tube's diameter and do not protrude the tube's environmental seal ensuring samples are safely stored within the body of the tube. Once the sample return system has reached the designed flight weight, the capsule will be launched into orbit for docking with an orbiter for its return journey to Earth.





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NASA/Arizona State University
Robotic Explorer for Hypothesized Surfaces

The NASA Psyche mission is led by Arizona State University and is a journey to a unique metal asteroid between Mars and Jupiter, named 16 Psyche. Psyche is unique because it has a surface that is hypothesized to be made largely of nickel and iron, rather than of rock and ice. Nickel and Iron are often found in the core of terrestrial planets. For that reason, Psyche is hypothesized to be the remnants of a planetesimal's core and may provide more insight on Earth's core as well as how cores of terrestrial planets were formed. The orbiter mission is set to launch in August of 2022, and arrive at the asteroid in 2026 where it will then observe Psyche for a period of 21 months.

After the orbiter mission, it is very possible that scientists and engineers would propose a subsequent mission to actually land on the asteroid. Our project was to design a robotic explorer that would be capable of traversing the wide range of hypothesized surfaces that may be found on Psyche. Data suggest that Psyche's terrain could include flat, rough, and high-relief craters. Psyche's surface and composition, among many other constraints, presented new challenges. Our team aimed to overcome these obstacles through our robotic explorer's suspension, wheel, and propulsion system.

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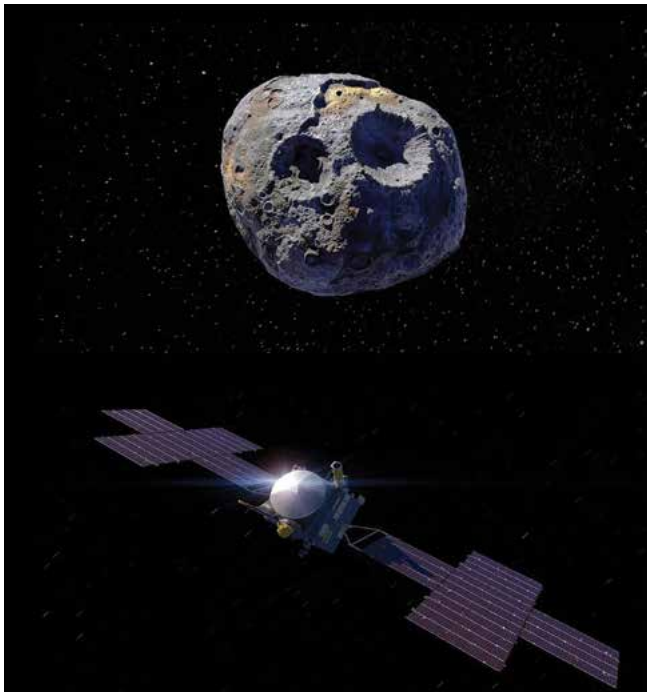
NASA/Arizona State University
Sampling System for Hypothesized Surfaces

NASA, headquartered in Washington, D.C., is an independent agency of the United States government. NASA is responsible for the civilian space program and performs research on aeronautics and space. NASA works with U.S. industries, international partners, and academia to develop new technology, which can be used by both NASA and the rest of the world to improve life for people everywhere. Our project focused on the Psyche Mission, which is currently set to orbit the metallic asteroid with hopes to expand our understanding of planetary cores. Once the orbit mission of Psyche is completed, it is possible that future scientists and engineers will want to propose a follow-up mission to land on Psyche and collect samples of the core.

Our team designed a method of sample collection for future exploration. The challenges of this project were drilling in a vacuum, drilling metal, and obtaining clean samples. The lack of concrete knowledge about the asteroid Psyche's surface and properties proved to be one of the greatest challenges when designing a solution. To complete this task, our group has performed a vast amount of research, including hypothesizing the surface of Psyche, the mechanics of drilling/sample collection, properties of metals, impact of vacuum on drilling, and past drilling/sample collection missions both on Earth and in previous space missions. Along with the research performed, our group also created a CAD drawing of a drill that can be utilized to obtain samples from Psyche based on information gathered from our research. Our research was then compiled into a report for the purpose of providing NASA with a single document that explains our design decisions so that NASA can easily examine the performance and effectiveness of our suggested solution. The completion of this project will assist NASA in improving our understanding of planetary cores, including Earth's own core.



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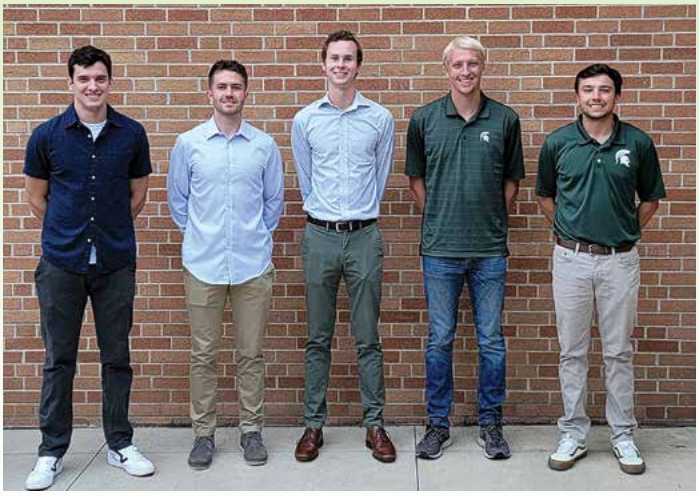
The Michigan Chestnut Industry
Chestnut Harvester

The Michigan Chestnut Industry is a growing industry focusing on bringing back the chestnut, especially in the U.S., from its decimation by blight in the early to mid-1900's as well as increasing a cultivated commercial agroforestry food product. Chestnuts represent a unique food opportunity that is healthy for both humans and the environment as a low production input commodity. However, there are significant challenges from production to processing, including harvesting, which must be done in a timely window of opportunity. Small-scale growers can harvest with minimal labor or use U-pick operations, while large-scale growers use mechanical harvesters that are expensive and require a higher level of orchard management and preparation. This leaves the need for harvesting technology that can support the more common mid-sized (3-10 acre) producers found in Michigan, which is the largest chestnut producing state in the U.S.

Our team designed and fabricated a chestnut harvesting method that is fit for medium-sized orchards and is able to deal with the large amount of variability involved. Due to the nature of the chestnuts, the device only picks them up once they have fallen off a tree, signaling they have reached maturity. This harvesting method is capable of handling the changes in terrain while picking up a large percentage of chestnuts and only a minimal amount of other debris. It is also possible to expand or automate this harvesting process for larger-scale operations.



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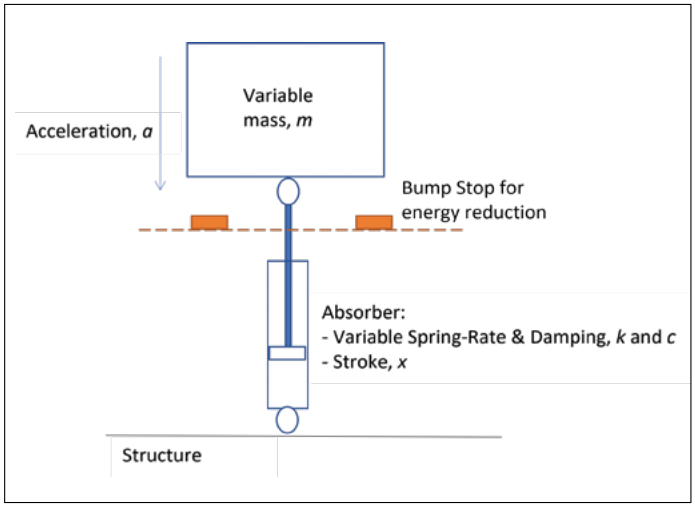
Toyota Motor North America
Automotive Seat Component Design

Toyota is Japan's largest automaker and the second largest in the world. The automotive manufacturer is the first to produce 10 million cars per year. Toyota Motor North America Research and Development Product Performance Division operates out of Ann Arbor, Michigan. The organization focuses on setting and confirming performance goals that meet and exceed customer expectations. It seeks new ideas for new projects such as for the design of a bump stop for a seating system. The purpose of a bump stop for this system is to minimize damage to the seating system as well as to ensure user safety.

Our team was tasked to develop a performance-tuning model and prototype component-level bump stop. The bump stop's main purpose is to keep the system from obtaining damage from bottoming out. Its parameters were also constrained to ensure human comfort and safety, an operational temperature range, and a large cycle durability. To complete this task, the program was composed of 3 stages. The first stage was to determine and propose an optimal deceleration and energy absorption rate for safety and comfort. The second stage included developing a universal bump-stop model which can be applied to any vehicle project using known inputs (i.e., mass, acceleration, and spring/damper characteristics) to specify the required bump-stop characteristics such as stiffness, max compression, linearity, material, quantity, and shape, as well as to show why the selected option is the best option. The universal model will help reduce development time/cost to Toyota. The last stage was to create a prototype of an optimal model for a specified vehicle that correlates to the predicted characteristics.



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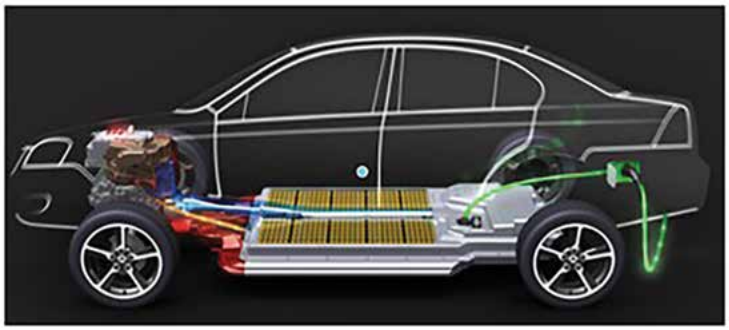
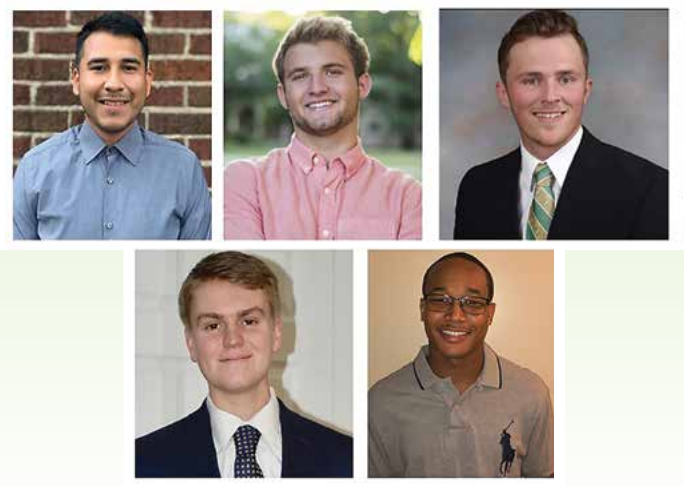
Toyota Motor North America
Battery Road Interference Protection

Toyota Motor North America, headquartered in Plano Texas, a subset of the Toyota Motor Company, Aichi, Japan, is a multinational automotive company engaged in the manufacturing and sale of motor vehicles and parts. Toyota is constantly looking for ways to build vehicles that help drivers go places reliably and safely. By 2030, it is estimated that 30% of new car sales will be electrified vehicle products. To prepare for this transition, Toyota is working on building electrified vehicles that offer consumers a combination of safety, price, and performance. The performance of these vehicles is highly dependent on the battery functions. Therefore, protecting the battery from shearing, or other various types of damage while driving across speed bumps, road constructions, and off-road areas is an essential design consideration.

Our team has been asked to create a battery case protection structure that will help protect Toyota vehicles while they are driven across all types of road conditions. The protective case is required to cover the entirety of the battery to prevent it from receiving damage due to road debris and interference. The case is fabricated of material that possesses strength to prevent fracture, while minimizing the amount of weight added to the vehicle. A successful design for this project will support the transition from the internal combustion engine and will allow suppliers and consumers to be confident that EV batteries are adequately protected.



TOYOTA



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Feeny


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Presentation Schedule – Engineering Building, Room 1300

Time	Team Sponsor	Project Title
8:00 a.m.	Flash Steelworks, Inc.	Flash Steel Shovel
8:30 a.m.	MSU Adaptive Sports & Recreation Club	Inclusive Sports Wheelchair – Phase V
9:00 a.m.	MSU Adaptive Sports & Recreation Club	Sled Hockey Transfer Platform Phase IV
9:30 a.m.	MSU Adaptive Sports & Recreation Club	Increasing Hockey Sled Mobility
10:00 a.m.	Cleveland-Cliffs, Inc.	RFID Antenna Mount
10:30 a.m.	Cleveland-Cliffs, Inc.	RFID Antenna Mount
11:00 a.m.	MSU Department of Mechanical Engineering	Actuation System for a Submerged Slender Body

Mechanical Engineering Design Program

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.

Flash Steelworks, Inc.
Flash Steel Shovel

Flash Steelworks is an R&D firm that specializes in high-strength steel. This project is based on a Flash Processed steel in which the material is heated from room temperature to 1000 degrees Celsius almost immediately and then instantly quenched at the peak temperature. This process, in turn, creates a nanoscale, iron-based metal matrix composite that has minimal carbon migration and dissolution. This technology has been applied to numerous applications such as coils and lightweight high-strength military armor plates.

Our project was to design a shovel for common applications such as gardening. Currently, much of the shovel weight comes from the shovel face itself. The team designed a shovel that utilizes this new high-strength steel in order to optimize the shovel with the goal of weight reduction. This not only includes the shovel face itself, but other aspects of the shovel that can be improved such as the shovel blade and handle connection. A rough model was constructed so that FEA analysis software can be utilized to determine a design that has maximum utility at minimal weight. The team will start with a standard shovel design and, if time permits, explore other options such as spades and additional features. The design of this shovel will hopefully provide a proprietary product for Flash Steelworks that could then be patented and sold on the market. This project will also further prove the new steel's capabilities as well as prove the vast scope of applications for this steel.

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MSU Adaptive Sports & Recreation Club
Inclusive Sports Wheelchair – Phase V

The Michigan State University Adaptive Sports & Recreation Club is a Registered Student Organization that promotes physical health, psychological wellness, and social inclusion for individuals with physical disabilities. Adaptive and wheelchair sports are the primary means of promoting these values. The club plays adaptive sports such as rowing, boccia ball, discus throw, handcycling, shotput, table tennis, track sports, and small-court wheelchair tennis. Wheelchair sports, such as full-court tennis and rugby, are also played by the Adaptive Sports & Recreation Club. Engaging in these sports allows athletes to develop a routine, set goals, and achieve those goals.

Despite the efforts of the Adaptive Sports & Recreation Club, not all athletes are able to fully participate in the sports played. Some physical disabilities, such as body asymmetry, can still exclude athletes from certain games. Solving this problem is the primary goal of the Inclusive Sports Wheelchair project. Previous phases of the project focused on improving individual facets of the existing wheelchair, namely phase IV, which produced a reliable method of propulsion. The goal of this phase of the project was to improve the braking of the existing wheelchair in a way that would leave the user's dominant arm free for use in games. This was achieved without significantly increasing the footprint of the wheelchair and without sacrificing user safety. Additionally, it was a minor goal to improve the ease of entering and exiting the wheelchair. Reliability and robustness were key factors in this phase of the Inclusive Sports Wheelchair.

Michigan State University
Adaptive Sports & Recreation Club
Est. 2014

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MSU Adaptive Sports & Recreation Club
Sled Hockey Transfer Platform Phase IV

The MSU Adaptive Sports & Recreation Club is a Registered Student Organization (RSO) at MSU. It was established as a free program that is open to adult athletes with physical disabilities, able-bodied volunteers, and academic projects personnel, who are MSU students, employees, alumni, and members of the community. The program seeks to create and continually cultivate a physically and socially accessible space where athletes with physical disabilities and able-bodied volunteers come together to establish an integrated community. The program focuses on athlete autonomy, competence, and relatedness as key facilitators in the process of acquiring self-efficacy in sports and physical activity.

The sled hockey transfer platform is an ongoing project to design an effective adaptive lift mechanism to allow athletes with limited use of lower limbs to transfer between personal mobility equipment and adaptive sports equipment. The Phase IV redesign focused on increasing safety of the transfer platform and facilitating independence of the user. This was accomplished by improving and modifying previous transfer platform design phases with an emphasis on streamlining the transfer process. Specifically, our design team concentrated on redesigning the guardrail system of the transfer platform, eliminating obstruction to motion present in previous iterations and reducing the amount of cumbersome repositioning required by users. By adapting the previous design to accommodate an alternative entry point, unnecessary motion was eliminated, guardrail placement simplified, and the stability of grab bars improved. Moving forward, it is intended that these revisions improve the user comfort, safety and independence, and maximize the usability of the transfer platform.

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MSU Adaptive Sports & Recreation Club
Increasing Hockey Sled Mobility

The MSU Adaptive Sports & Recreation Club is an organization that allows for the participation in sports and fitness for individuals who have physical disabilities. Through these sports the players can exercise their bodies and minds to lead a happy and healthy lifestyle. This club not only assists physically with exercise but mentally as well. Socially, it helps physically disabled persons by building a community around the playing of adaptive sports. New members are able to meet new people who go through similar experiences and bond with these individuals. The organization appreciates and accepts abled bodied volunteers as well. Some of the sports offered are wheelchair hockey, wheelchair basketball, and wheelchair rugby. The organization is trying to add roller sled hockey to this list of sports.

Our team was tasked to help increase the mobility of one of the roller hockey sleds with the goal of implementing this design onto all the sleds. The problem with the sled was that it could not be used on the surface of Demonstration Hall where they play the sport. This is because it took too much force to be able to move the sled. One addition to the new design was to add a new different set of wheels better suited for the sled's playing surface. Our team also made sure to add good bearings to the sled so the wheels could roll better. For stopping and stability, a wheel was added behind the chair so it would not be prone to tipping backwards. To increase the mobility of the sled, a base plate was added under the seat of the sled. This base plate utilizes four springs so that the player is able to lean one way or the other to allow for better turns. On this baseplate there also are two more wheels that act as stabilizers when leaning into turns. By implementing these designs onto the sled it allows the players to use less force to propel themselves forward and turn.

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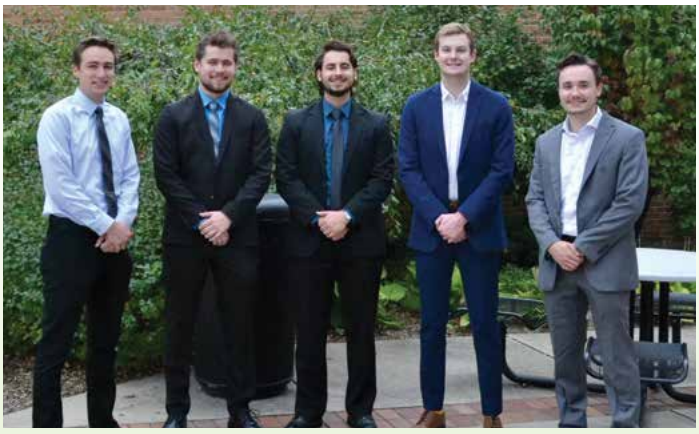

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Cleveland-Cliffs, Inc.
RFID Antenna Mount

Cleveland-Cliffs, Inc.'s facilities work year-round to reliably produce steel for many different industries nationwide. Different industry applications require the steel to be tailored to have specific dimensions and properties. In order to perform this task effectively, Cleveland-Cliffs, Inc. uses their own mines for creating the steel rolls at their production facilities. The process creates molten metal from the raw materials in a large furnace. This molten metal is cast into large slabs and then hot and cold rolled down to the desired thickness supplied by the various customers. Cleveland-Cliffs, Inc. works on many core values that help improve workplace safety, economic value, and customer satisfaction. These values hold true to the project that our team was assigned because this device will ultimately increase employee safety and decrease financial losses due to manual errors.

Currently, one of the steps in this elaborate process requires a crane operator to set specific rolls of steel onto a conveyor belt to be further processed. Since each roll is finished at different thicknesses depending on customer specifications, it is essential to run them through the mill in a specific order. Right now, each steel roll is scanned manually by a worker with a handheld scanner. Our team designed a stationary bracket to hold two RFID antennas that would scan in the steel rolls. The main objective was to reduce errors caused by the rolls not being scanned in correctly and being rolled down to incorrect thicknesses. The bracket will also reduce the risk of employee injuries at the location around the conveyor. This bracket must be removable to allow maintenance to be done on the conveyor, while at the same time be very robust in case it is hit by any steel rolls.

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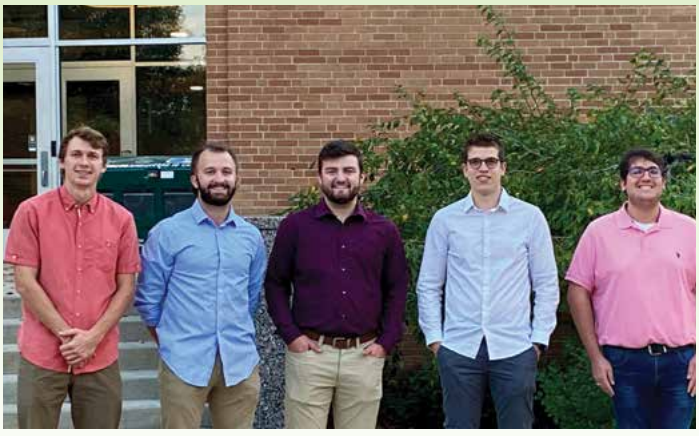

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Cleveland-Cliffs, Inc.
RFID Antenna Mount

Cleveland Cliffs, Inc. steel mill, located in Burns Harbor, Indiana, is a fully integrated steel mill that produces up to 5 million tons of raw steel annually. Being fully integrated means that the steel mill contains the entire process of manufacturing steel coils, from mining the ore pellets out of the ground, to melting the pellets down, to creating entire steel coils. Each of these steel coils weighs on average around 50,000 pounds, but some larger coils can weigh up to 80,000 pounds. Since not all steel is manufactured using the exact same process, there is some variation in the mechanical properties of the steel (like hardness, yield strength, tensile strength, etc.). These variations are extremely important to keep track of since, if there is an error and the wrong coil is sent to the wrong customer, this could potentially lead to a failure in the product, which could lead to possible injury. So, it is very important to mark which coil is which, and this marking is done using stickers with RFID tags inside of them.

Our team designed a stand that holds two of the RFID antennas that are used for scanning the RFID tags placed on the steel coils. The designed stand is robust enough to last for an extended period of time with the ability to withstand all of the conditions within the mill.

The mount was designed to be mobile and not permanently fixed to the floor panels. This was done to allow for any maintenance that the conveyor belt would require. The design for the mount also needed to be compact enough so that it would not extend too far onto the conveyor since there will be an operator who still needs to interact with the steel coils before they move on to the next manufacturing process.

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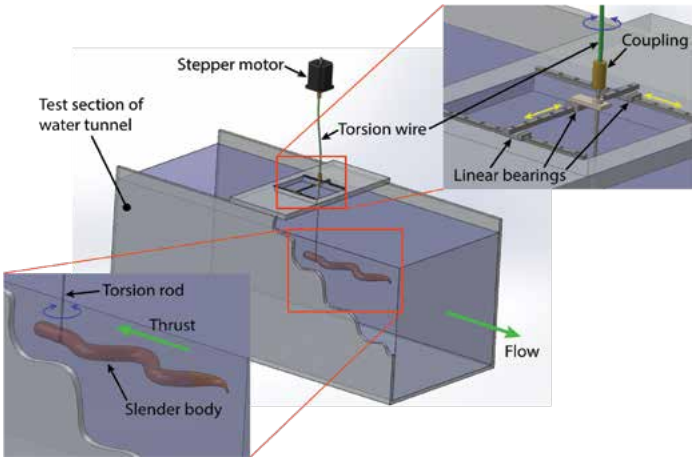
MSU Department of Mechanical Engineering
Actuation System for a Submerged Slender Body

Michigan State University is a top global research university. The Department of Mechanical Engineering is home to professors conducting leading-edge research with funding from organizations such as the National Science Foundation, Department of Energy, and the Department of Defense.

Our team designed a physical experiment to validate the computational fluid dynamics code and low-order model for fluid-structure interaction of a flexible slender body. This physical experiment required an actuation system that imparts controlled rotational oscillations to the slender body and that has two degrees of freedom of linear displacement. The oscillations make the slender body generate thrust in water. The two degrees of freedom allow displacements of the actuation system in the streamwise and spanwise directions with respect to the flow in a water tunnel. Oscillations were optimized to reach equilibrium between thrust and drag.



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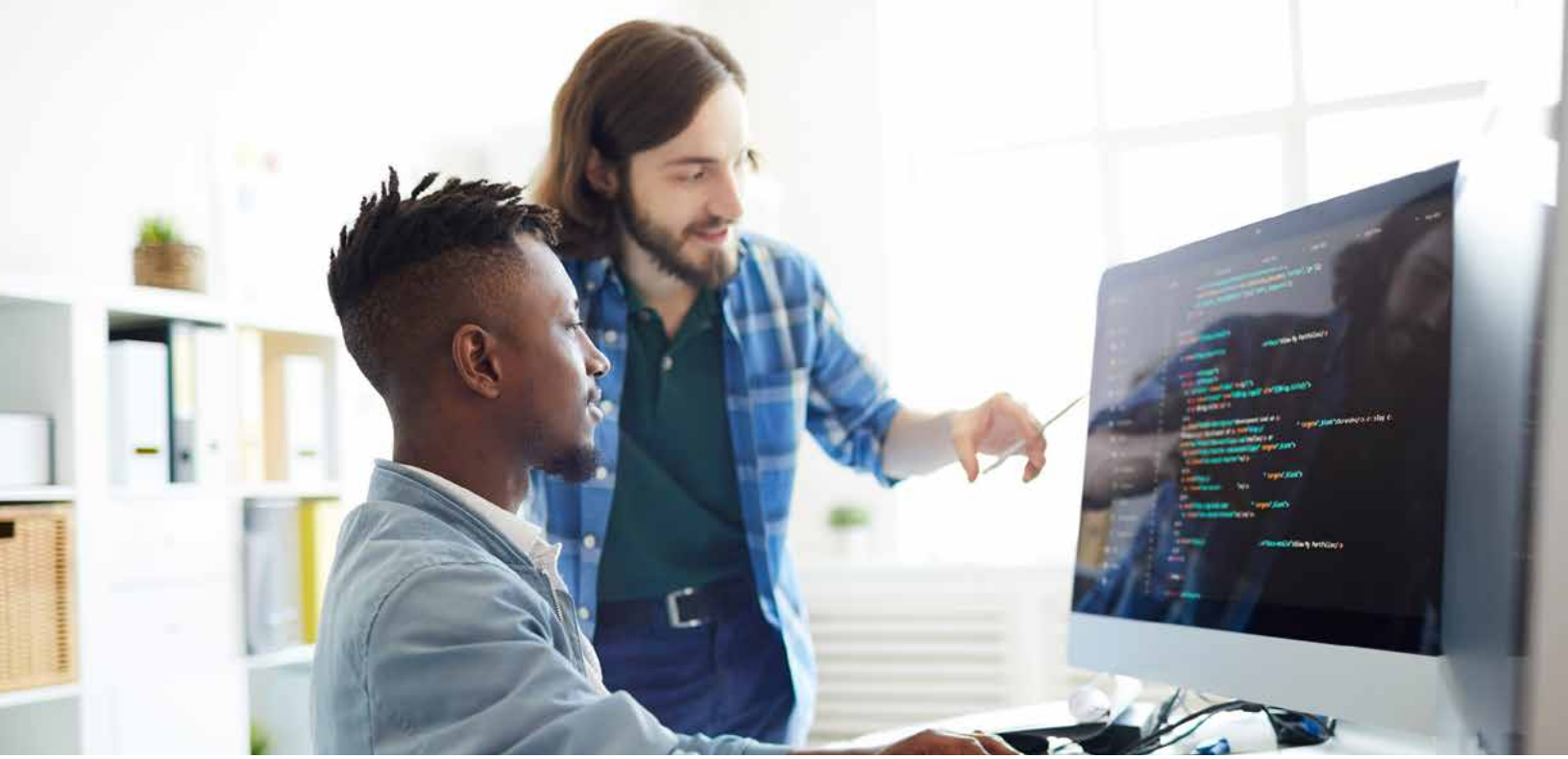

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