Capstone Course Sponsors

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

Detroit, Michigan

Seattle, Washington & Detroit, Michigan

Palo Alto, California

Grand Rapids, Michigan

Lansing, Michigan

Plymouth, Michigan

Okemos, Michigan

Midland, Michigan

Chicago, Illinois

Dearborn, Michigan

Detroit, Michigan

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, Rock Family of 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.

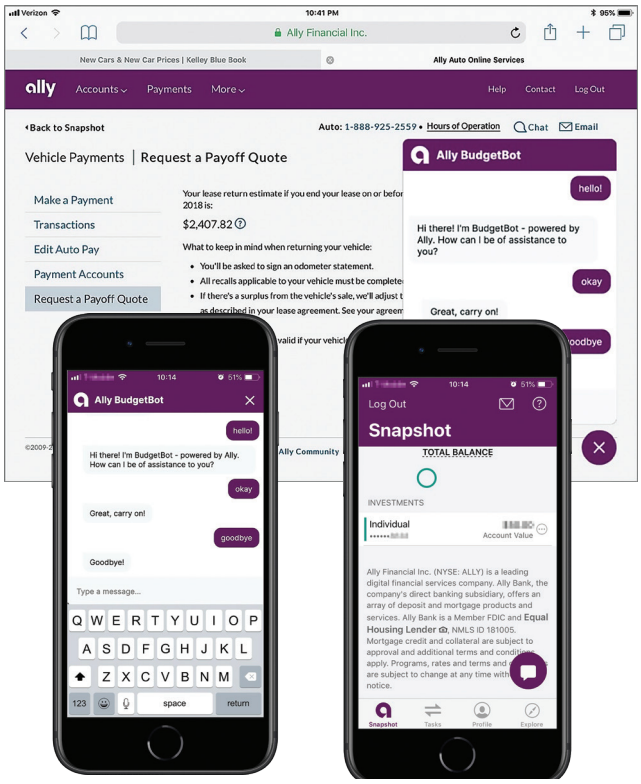
Our Digital Avatar Assistant is a cutting-edge AI assistant that provides Ally customers with real-time communication relating to their accounts, as well as custom-tailored financial advice.

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.



Michigan State University
Team Members (left to right)

Akhil Arora
Ann Arbor, Michigan

Nate Wood
Novi, Michigan

Xunran Zhou
Wuhan, Hubei, China

Zach Arnold
Farmington Hills, Michigan

Ally
Project Sponsors

Jared Allmond
Detroit, Michigan

Dzmitry Dubarav
Detroit, Michigan

Dan Lemont
Detroit, Michigan

Harish Naik
Detroit, Michigan

Susan Nord
Detroit, Michigan

Arvy Rajasekaran
Detroit, Michigan

Kevin Werner
Detroit, Michigan

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.

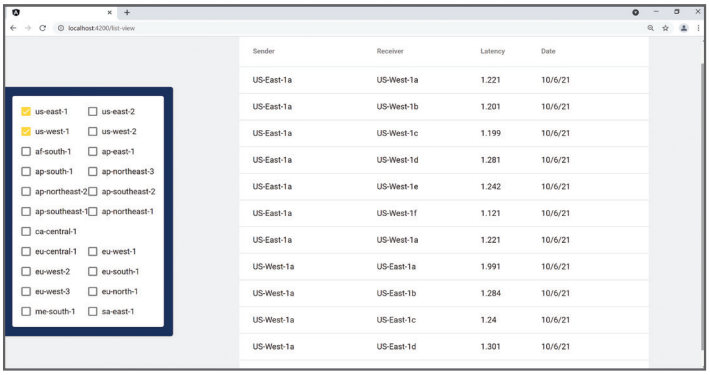
Distributed applications are spread across multiple servers, which need to communicate with each other for the application to function. This communication can take a significant amount of time, and minimizing the delay can lead to a better user experience. Choosing which AZs to use to minimize this delay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

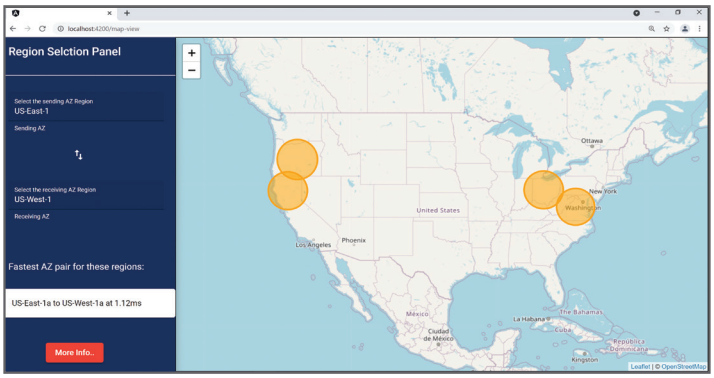
Our AWSome Availability Zones web application continuously and automatically measures the delay between Availability Zones, allowing Amazon Web Services customers to easily choose the fastest Availability Zones for their application, saving them time and money.

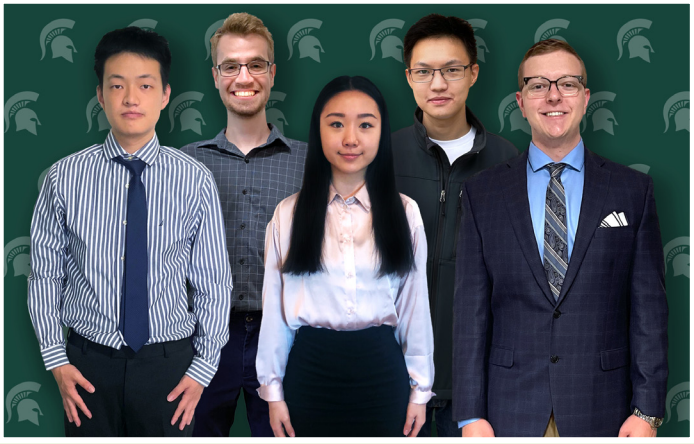
AWSome Availability Zones provides customers with an easy-to-understand visualization of the delay between Availability Zones using an interactive map with a familiar look and feel.

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.







Michigan State University
Team Members (left to right)

Wynton Huang
Ann Arbor, Michigan

Jamison Heiner
Plymouth, Michigan

Iris Kim
Shanghai, Shanghai, China

Jung Chak
Taipei, Taiwan, Taiwan

Jake Hood
DeWitt, Michigan

Amazon
Project Sponsors

Jennifer Beer
Detroit, Michigan

Jeremy Fry
Detroit, Michigan

Garret Gaw
Detroit, Michigan

Derek Gebhard
Detroit, Michigan

Erik Kamman
Detroit, Michigan

Tyler Rozwadowski
Detroit, Michigan

William Tanner
Detroit, Michigan

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.

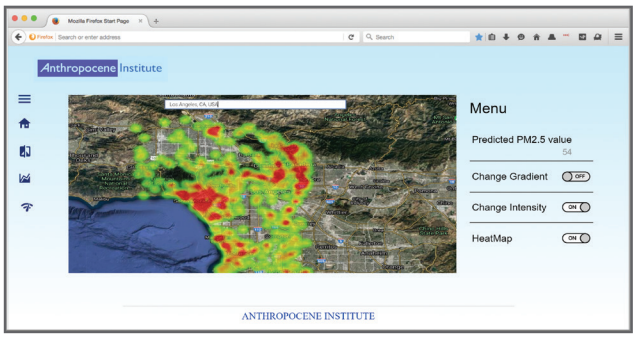
The Anthropocene Institute has turned its attention towards air pollution in hopes of researching the effect that air quality has on premature deaths and health complications, such as increased asthma, infant mortality and lung cancer.

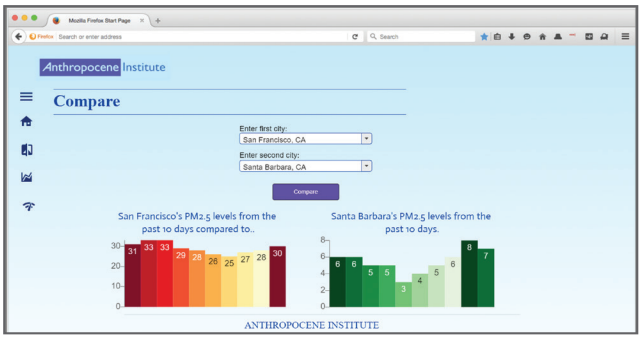
Our Air Pollution Health Outcomes Forecasting Tool is an intuitive web dashboard that provides the public with a detailed analysis of the air quality in their area, as well as the potential resulting health effects. Users visit our dashboard and are presented with a map view of the United States and 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.





Anthropocene Institute

Michigan State University
Team Members (left to right)

Lukas Richters
Farmington Hills, Michigan

Tate Bond
Grand Rapids, Michigan

Lindsey Boivin
Novi, Michigan

Hannah Francisco
Buffalo, New York

Zhendong Liu
Hefei, Anhui, China

Anthropocene Institute 1
Project Sponsors

Micha Brown
Palo Alto, California

Richard Chan
Palo Alto, California

Jason Gwo
Palo Alto, California

Michiya Hibino
Palo Alto, California

Richard Lee
Palo Alto, California

Frank Ling
Palo Alto, California

Carl Page
Palo Alto, California

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.

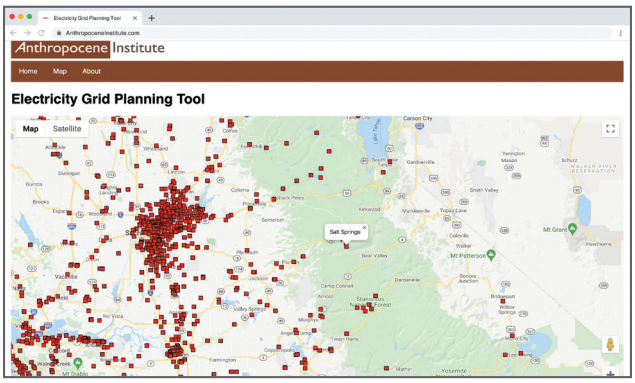
The Anthropocene Institute is interested in the possibility of Small Modular Reactors (SMRs) as a viable option for new sources of power generation in comparison to coal and gas plants that have significantly worse emissions that affect the atmosphere.

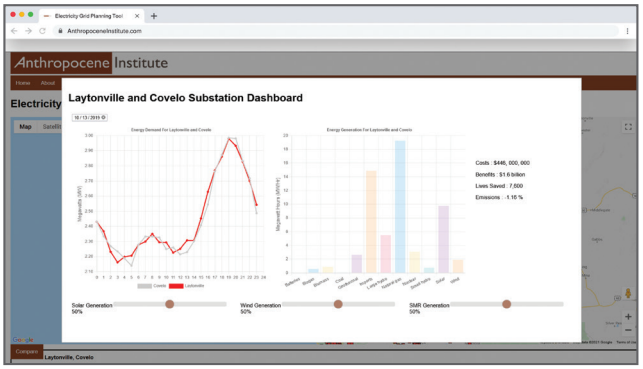
SMRs, however, must be placed properly in power substations based on power generation, power outage occurrence rates, and power consumption demands. Traditionally this would be done entirely by hand, which is time-consuming, error prone, and makes it hard to quickly compare multiple placements.

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.





Anthropocene Institute

Michigan State University
Team Members (left to right)

Tyler Smith
Charlotte, Michigan

Amanuel Engeda
East Lansing, Michigan

Nafisa Lenseni
Canton, Michigan

Nic Weller
Jackson, Michigan

Hunter Paul
Rochester, Michigan

Anthropocene Institute 2
Project Sponsors

Richard Chan
Palo Alto, California

Jason Gwo
Palo Alto, California

Frank Ling
Palo Alto, California

Carl Page
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.

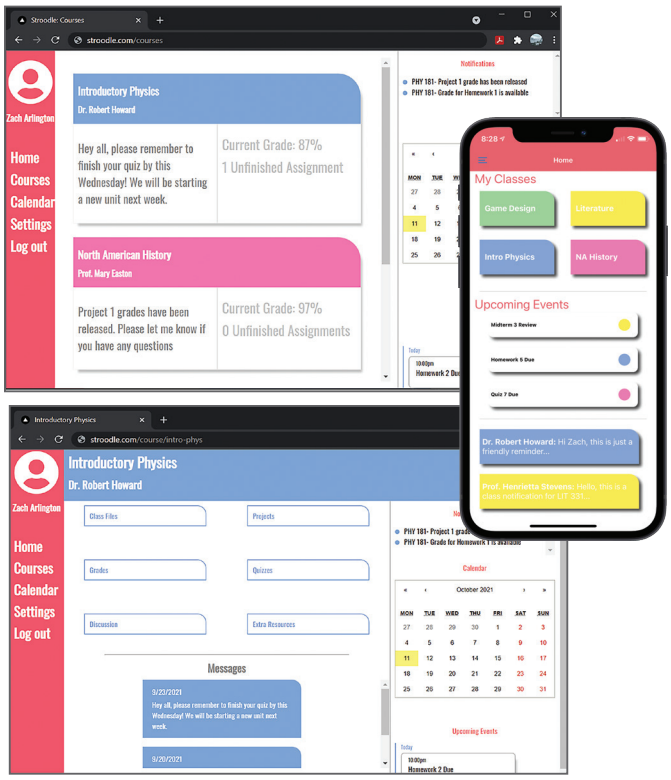
Students are provided a dashboard with a summary of important information for all their enrolled courses. They can access individual course pages to interact with material prepared by the instructor.

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.



ATOMIC OBJECT

Michigan State University
Team Members (left to right)

Jake Bosio
West Grove, Pennsylvania

Shachi Joshi
Rochester Hills, Michigan

Sean Ohare
Farmington Hills, Michigan

Gabrie Italia
Shelby Township, Michigan

Atomic Object
Project Sponsors

Micah Alles
Grand Rapids, Michigan

Jonah Bailey
Ann Arbor, Michigan

Dylan Goings
Ann Arbor, Michigan

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.

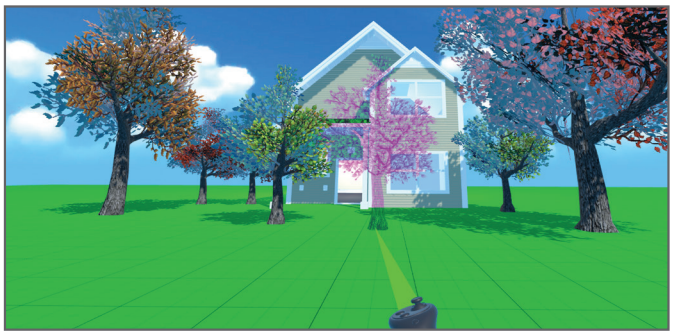
Our Yard Wars: Weathering the Storm project is a virtual reality application where storms are simulated on virtual residences. Any damage caused by the storms is viewable in real time and in first person. This data is gathered, stored and displayed on an external website for analysis.

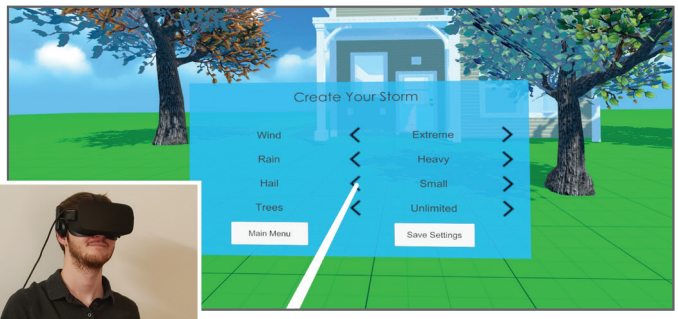
Users start by selecting the difficulty for the simulation, which changes the severity of the weather and number of trees that can be placed. Then, the user is tasked with placing trees around the property in order to replicate an existing or planned residence. Once they have finished placing trees,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





Auto-Owners INSURANCE

Michigan State University
Team Members (left to right)

Carolus Huang
Xiamen, Fujian, China

Graham Cornish
Charlotte, Michigan

Brandon Byiringiro
Okemos, Michigan

John Reichenbach
Shelby Township, Michigan

Auto-Owners
Project Sponsors

Tony Dean
Lansing, Michigan

Ross Hacker
Lansing, Michigan

Scott Lake
Lansing, Michigan

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.

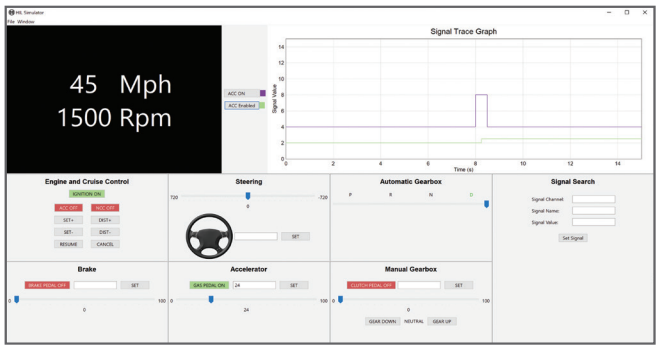
Our software allows the user to perform basic vehicle maneuvers and operations such as steering, braking, accelerating and more. The main functionality of our software system is adaptive cruise control (ACC), which users may engage and adjust at will.

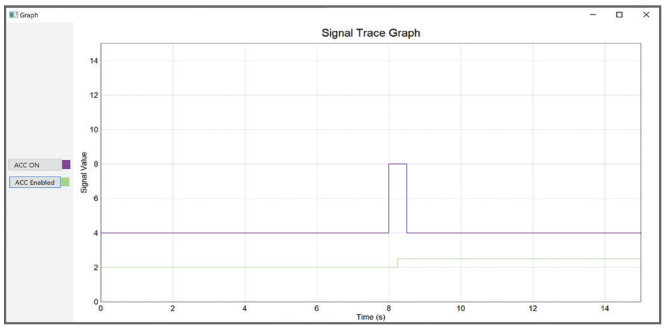
The user interface is designed to allow anyone with driving experience to control the simulation with ease. A graph is displayable to show the signals being sent to and from the PEAK hardware with their corresponding values.

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.





BOSCH
Invented for life

Michigan State University
Team Members (left to right)

Justin Armstrong
Burton, Michigan

Luke Monroe
Brighton, Michigan

Aditya Raj
Bokaro, Jharkhand, India

Christian Zawisza
Ann Arbor, Michigan

Alan Wagner
Westfield, New Jersey

Bosch
Project Sponsors

Steve Koski
Plymouth, Michigan

Matt Lee
Plymouth, Michigan

Troy McCormick
Plymouth, Michigan

John Notorgiacomo
Plymouth, Michigan

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.

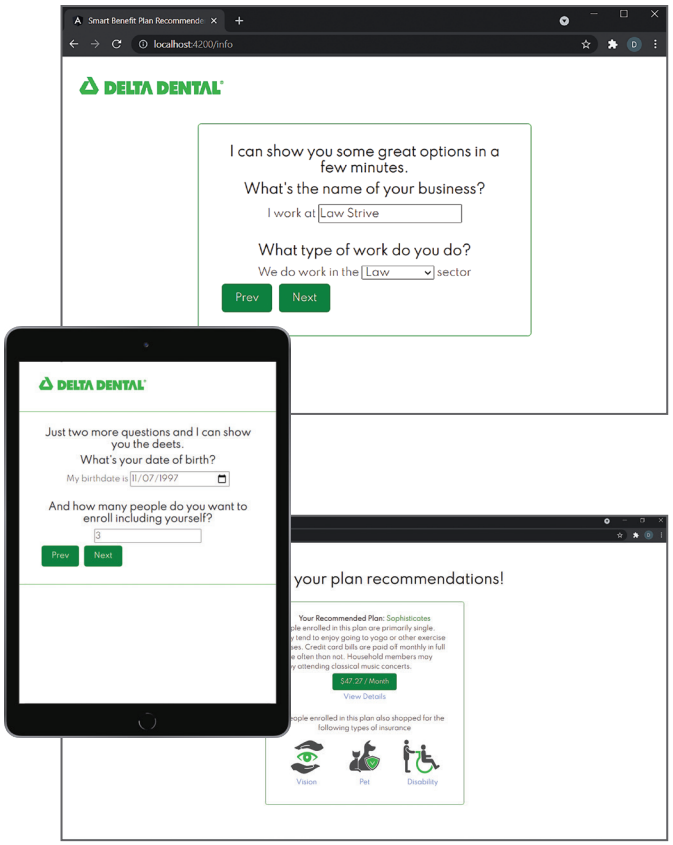
Delta Dental takes pride in tailoring benefit plans to their customers' needs, whether they are a small business, a family or an individual. Before recommending the ideal benefit plan to a customer, Delta Dental underwriters must aggregate data from several sources and use their significant domain knowledge 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.

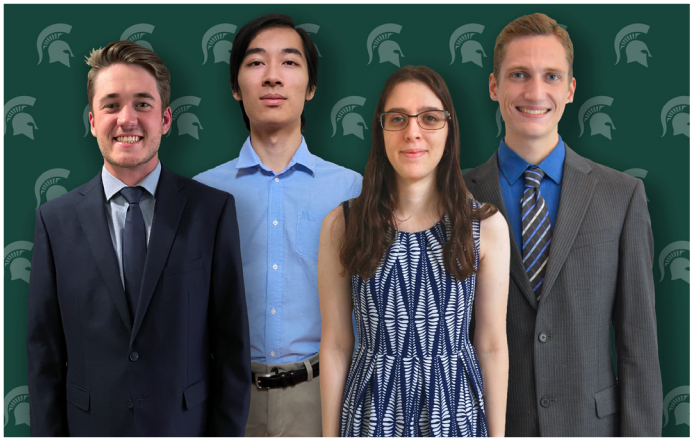
Our Recommender Engine uses advanced machine learning algorithms to divide customers into groups that share many similarities. Each group is assigned an ideal benefit plan and when the system is given new data, it can easily provide a recommendation by mapping the new data to a group and its respective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



Michigan State University
Team Members (left to right)

Nicholas Lenaghan
Dearborn, Michigan

Derek Nguyen
Ann Arbor, Michigan

Nicole Keller
Sterling Heights, Michigan

Arden Knoll
Okemos, Michigan

Delta Dental Data Science
Project Sponsors

Mukundan Agaram
Okemos, Michigan

Shikha Mohindra
Okemos, Michigan

Ayush Singh
Okemos, Michigan

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.

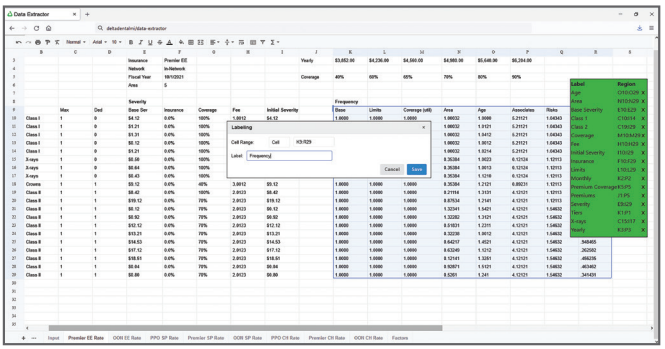
Delta Dental maintains a significant number of sophisticated Excel spreadsheets for various purposes. Comprehending these spreadsheets requires significant industry expertise. Furthermore, extracting the industry knowledge from the spreadsheets to use in other applications often requires the development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

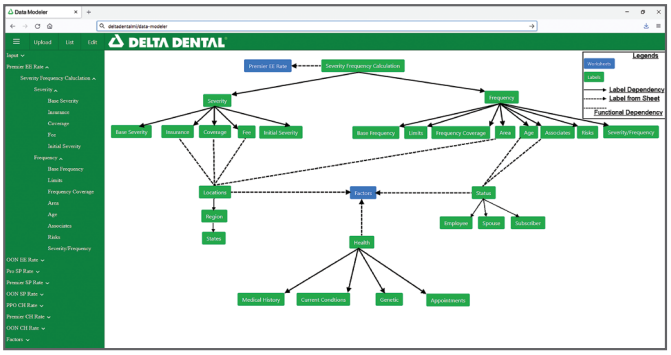
Our Microsoft Excel Data Extractor/Modeler is a web-based tool that removes the need for developing single-use computer programs for extracting Excel data. Our system imports existing Excel workbooks and, with minimal user input, can extract the relevant information as well as the data hierarchies present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





DELTA DENTAL®

Michigan State University
Team Members (left to right)

Ethan Bransdorfer
Harrison, Michigan

Xochitl Weiss
Okemos, Michigan

Morgan Mundell
Brighton, Michigan

Peter Ro
Northridge, California

Delta Dental Knowledge Science
Project Sponsors

Mukundan Agaram
Okemos, Michigan

Jacob Ernst
Okemos, Michigan

Chang (Charlie) Liu
Okemos, Michigan

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.

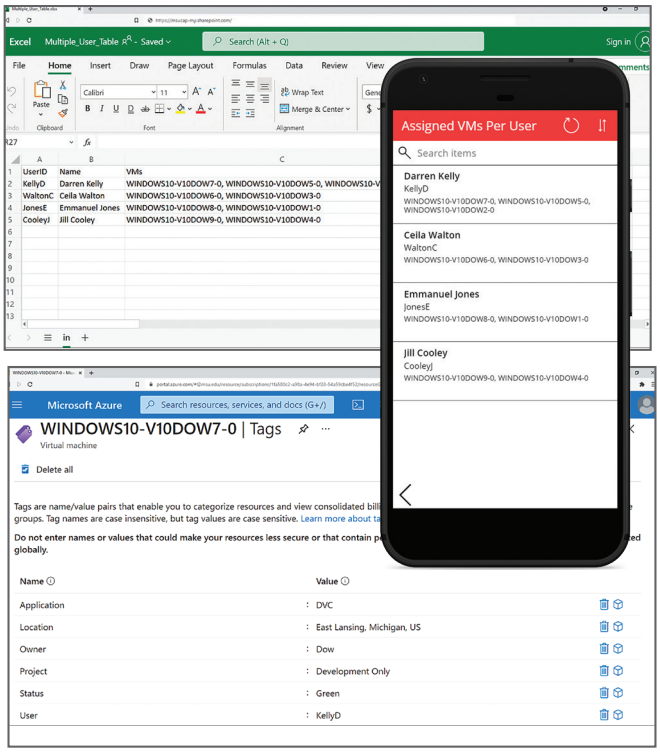
Currently, Dow has a personal structure for assigning virtual machines to their employees and clients on Microsoft Azure. This means that each user has access to their own virtual machine.

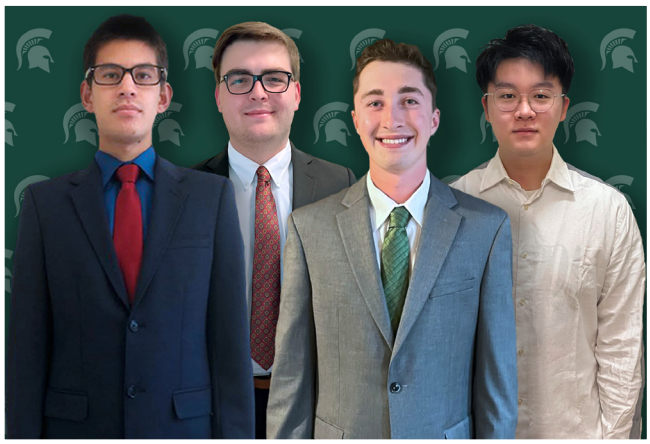
Dow is moving to a non-persistent state, meaning a single virtual machine's resources can support multiple users, cutting down the required number of virtual machines running and therefore saving money. In order to do this, there are many manual processes that need to be managed.

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.





Michigan State University
Team Members (left to right)

Arvid Brunsell
West Bloomfield, Michigan

Mark Kistler
Troy, Michigan

Patrick Doyle
Manitou Beach, Michigan

Junnan Fu
Shenzhen, Guangdong, China

Dow
Project Sponsors

Jeff Ngafua
Midland, Michigan

Jeff VanDusen
Midland, Michigan

Scott Way
Midland, Michigan

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.

Michigan State University
Team Members (left to right)

Lindsey Murrell
Brighton, Michigan

Jonathan Skidmore
West Bloomfield, Michigan

Joe Daprai
Lake Orion, Michigan

Gabe Sanborn
Ludington, Michigan

Jennifer Sageman
Rockford, Michigan

Evolutio
Project Sponsors

Jordan Cobe
Lansing, Michigan

Bob Dyksen
St. Louis, Missouri

Devin Stonecypher
Fremont, California

Adam Ties
Indianapolis, Indiana

Laura Vetter
Chicago, Illinois

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.

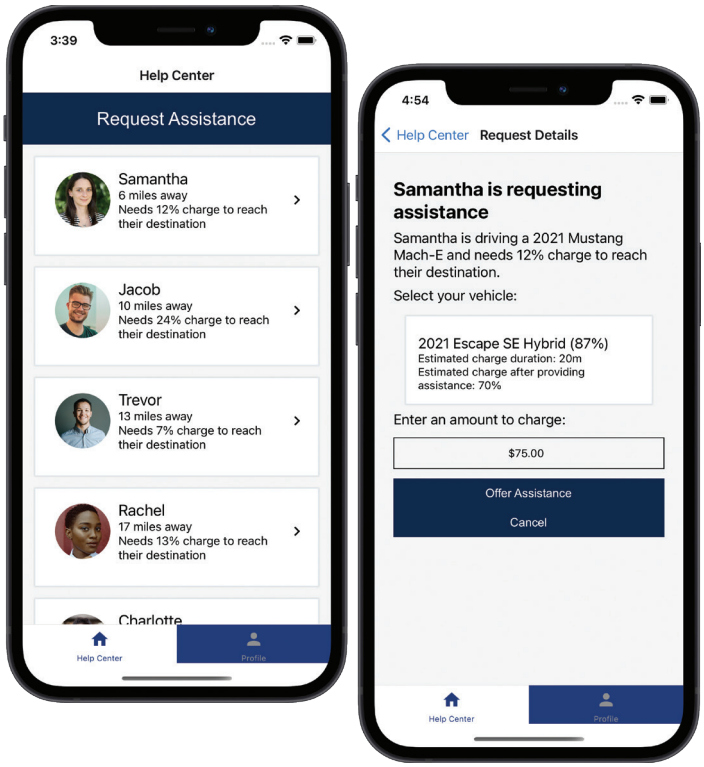
After logging in to the application, a user is greeted by a Help Center screen, from which the user can submit an assistance request or view the open requests in their area.

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.



Michigan State University
Team Members (left to right)

Chris Beeman
Grosse Pointe Woods, Michigan

Bridget Bussey
St. Clair Shores, Michigan

Alec Rotter
Livonia, Michigan

Shiyu Li
Zhengzhou, Henan, China

Ford
Project Sponsors

Moaaz Elsayed
Dearborn, Michigan

Adam Haas
Dearborn, Michigan

Keith Nash
Dearborn, Michigan

Tres Shepard
Palo Alto, California

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.

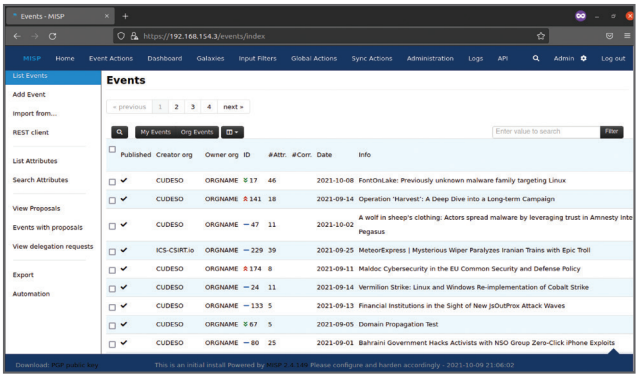
The Malware Information Sharing Platform (MISP) is an open-source sharing platform dedicated to sharing threat intelligence. However, MISP's user interface lacks several features, making it not very user-friendly or customizable.

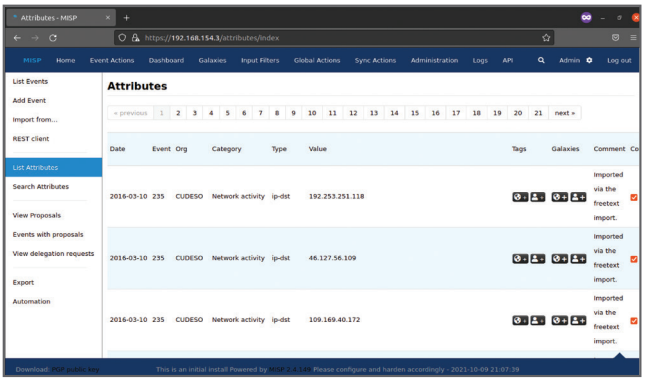
Our Enhanced MISP User Interface provides for more customization within the MISP application and enriches existing functionalities.

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.





Michigan State University
Team Members (left to right)

Jordyn Rosario
West Bloomfield, Michigan

Alex Richards
Novi, Michigan

Marven Nadhum
Karrada, Baghdad, Iraq

Jake Rizkallah
Northville, Michigan

Noah Anderson
Dearborn, Michigan

GM
Project Sponsors

Vinny Hoxha
Warren, Michigan

Fred Killeen
Warren, Michigan

Wade Kirschner
Warren, Michigan

Lesa Ludwig
Warren, Michigan

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.

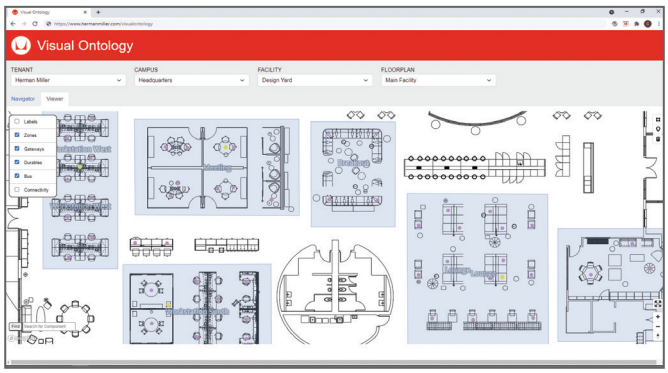
Our Live Platform CAD Ingestion software allows Herman Miller administrators to use computer-aided design (CAD) files to display these floorplans.

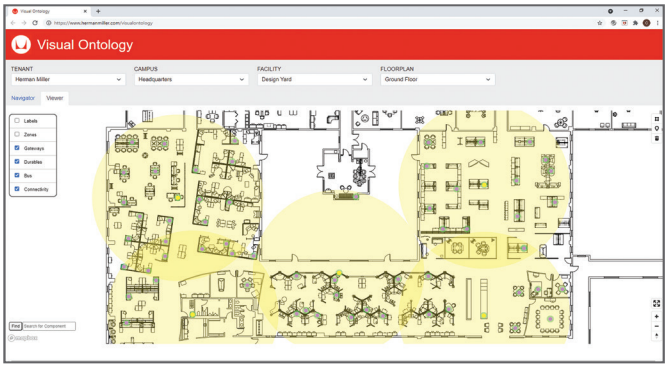
Our software allows for the supplying of sensor positions and the checking of hardware constraints. An algorithm is used to convert CAD files into a format readable by our web application.

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.

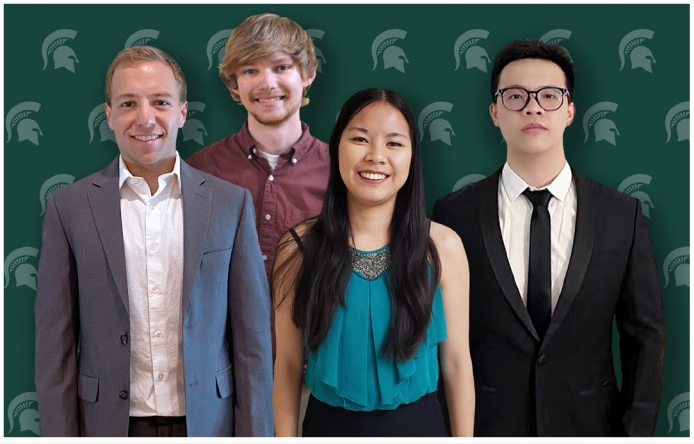
Our system automates the process of ingesting CAD files with sensor data into the Live Platform service, saving Herman Miller administrators time and increasing productivity.

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



Michigan State University
Team Members (left to right)

Connor Lang
Grand Rapids, Michigan

Greg Szczerba
Grand Blanc, Michigan

Meigan Starr
Cheyenne, Wyoming

Xingzhi Mei
Shanghai, Shanghai, China

Herman Miller
Project Sponsors

Mark Buikema
Zeeland, Michigan

Jonathan Hunsberger
Zeeland, Michigan

Jeff Kurburski
Zeeland, Michigan

Tony Pearce
Zeeland, Michigan

Harvey Schaefer
Zeeland, Michigan

Jess Troup
Zeeland, Michigan

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.

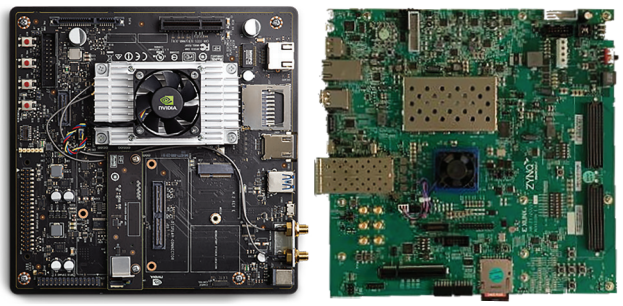
Lockheed Martin Space's satellites can vary in a few key ways, specifically when it comes to computational hardware, software development kits, and operating systems. Because of this, certain satellites are incompatible with some specialized software.

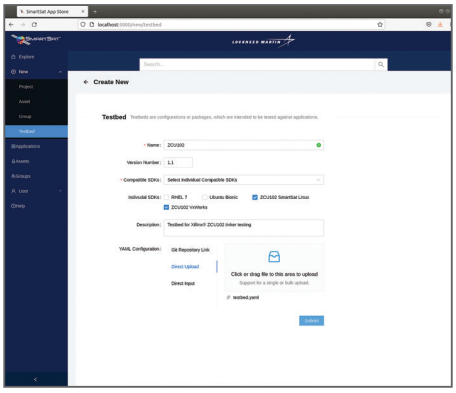
Our SmartSat Satellite App Store is a web-based marketplace for browsing, uploading, and installing mission-ready applications to live satellites. The SmartSat App Store also includes rigorous software testing that automatically determines what software is compatible with which satellites.

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.





LOCKHEED MARTIN

Michigan State University
Team Members (left to right)

Matt Heilman
Waterford, Michigan

Aidan Delfuoco
Ann Arbor, Michigan

Will Teasley
Rochester, Michigan

Colin Williams
Troy, Michigan

Valentino Dore
Detroit, Michigan

Lockheed Martin Space
Project Sponsors

Josh Davidson
Littleton, Colorado

Brandon Hearn
Littleton, Colorado

Adam Johnson
Littleton, Colorado

Tony Miller
Littleton, Colorado

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.

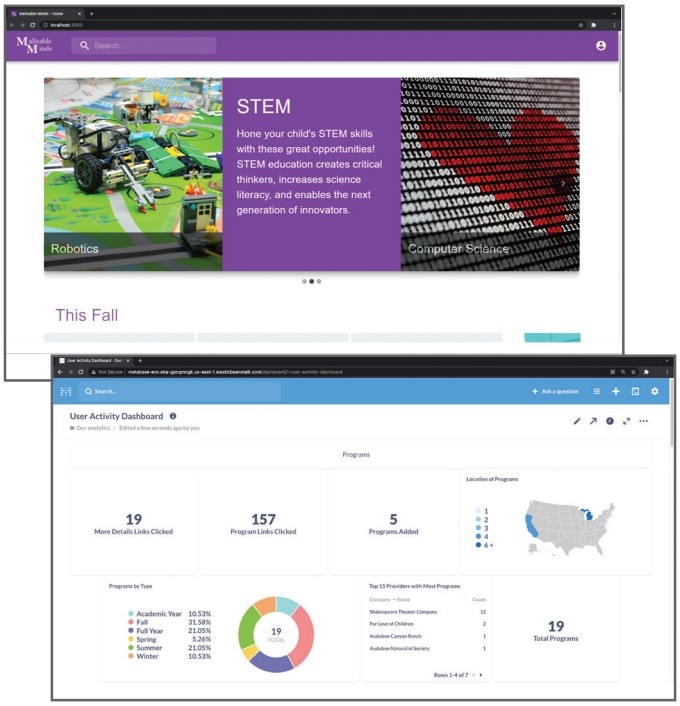
Our Review Aggregator for Educational Programs project builds many features on top of the existing review aggregator website and improves site performance.

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.



Malleable Minds

Michigan State University
Team Members (left to right)

Matthew Ladouceur
Orchard Lake, Michigan

Neil Potdukhe
Novi, Michigan

Shanrui Zhang
Qiqihaer, Heilongjiang, China

Jack Belding
Rochester, Michigan

Malleable Minds
Project Sponsors

Ripple Goyal
Los Angeles, California

Cathalina Juarez
Frederick, Maryland

James Pita
Frederick, Maryland

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.

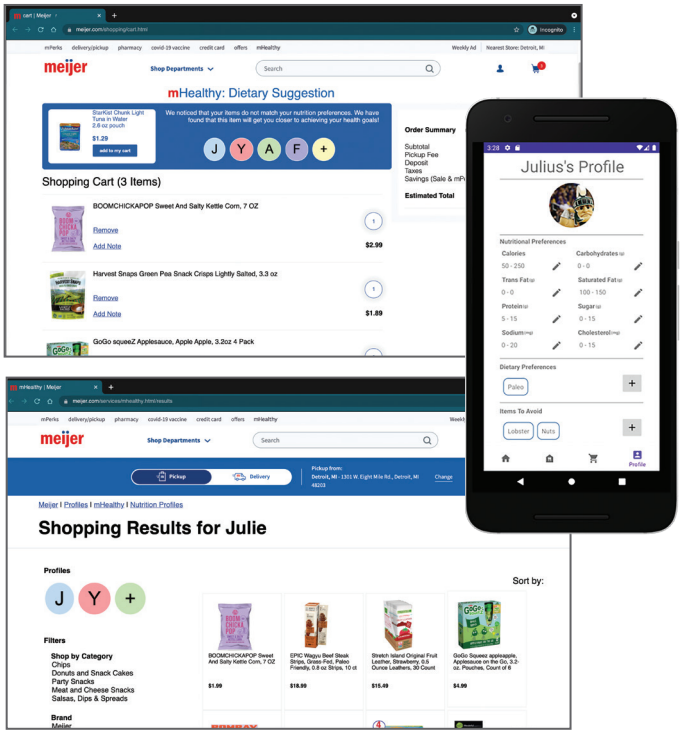
Many shoppers want to make healthy decisions when shopping but feel overwhelmed trying to do so. Finding healthy replacements can be a daunting task and may discourage shoppers from learning about healthier options or better diets. Educating shoppers and improving their experience is imperative to establishing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



meijer®

Michigan State University
Team Members (left to right)

Yiteng Zhang
Dongying, Shandong, China

Amy Puidokas
Grand Blanc, Michigan

Filip Matovski
Shelby Township, Michigan

Julius Eillya
Sterling Heights, Michigan

Meijer
Project Sponsors

Vinod Alahari
Grand Rapids, Michigan

Bill Baer
Grand Rapids, Michigan

Chirag Ghimire
Grand Rapids, Michigan

Phil Kane
Grand Rapids, Michigan

Chris Laske
Grand Rapids, Michigan

Terry Ledbetter
Grand Rapids, Michigan

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.

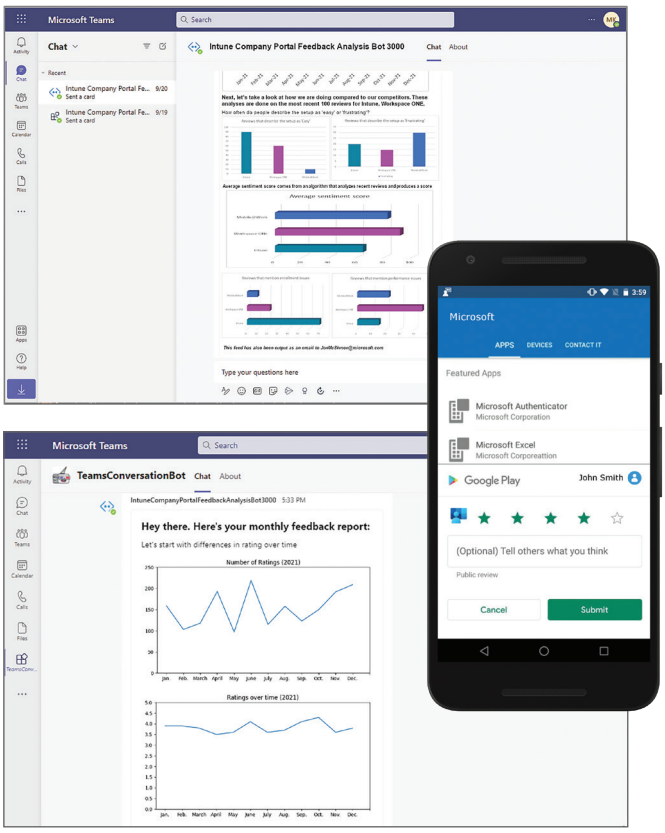
User feedback about Intune Company Portal provides insight that developers can use to create and maintain a premium user experience. However, collecting and analyzing reviews is a tedious and time-consuming task, requiring manually searching dozens of review websites and plotting the data.

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.

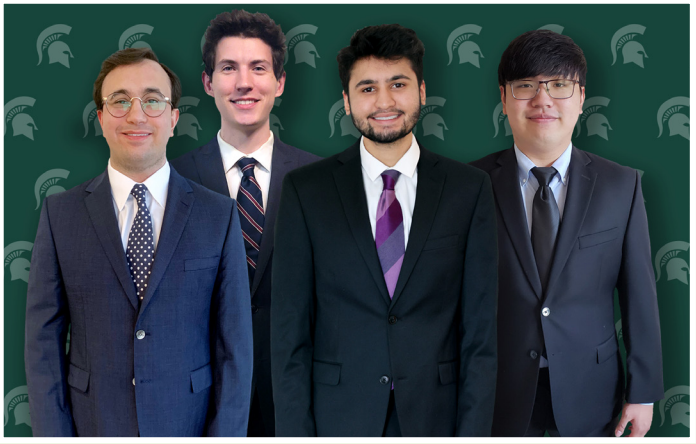
To facilitate easier and more representative review collection, we integrate an automated in-app review prompt that actively promotes user feedback for the Intune application on Android. Our system removes the need for users to navigate to the Play Store and makes leaving a review quick and easy.

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.



Microsoft



Michigan State University
Team Members (left to right)

Jordan Hybki
Sydney, New South Wales, Australia

Justin Hollinshead
Canton, Michigan

Moeez Khan
Freeland, Michigan

Karn Jongnarangsin
Ypsilanti, Michigan

Microsoft
Project Sponsors

Katie Fairbrother
Cambridge, Massachusetts

Scott Sawyer
Cambridge, Massachusetts

Kurt Seippel
Atlanta, Georgia

Abby Starr
Cambridge, Massachusetts

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.

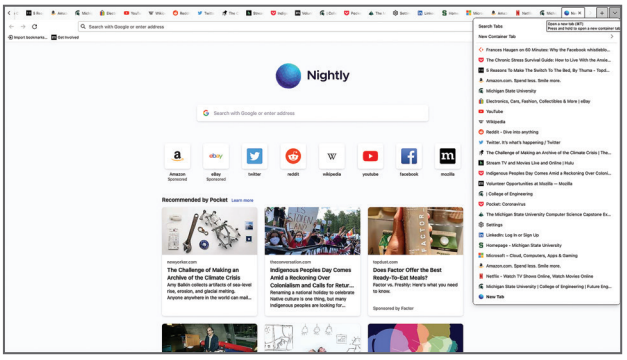
To achieve this goal, Firefox offers high contrast mode, which is a huge part of making the browser as accessible as possible. High contrast mode improves the visibility of Firefox's user interface by changing the colors in order to maximize contrast. This is important as it allows people with visual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

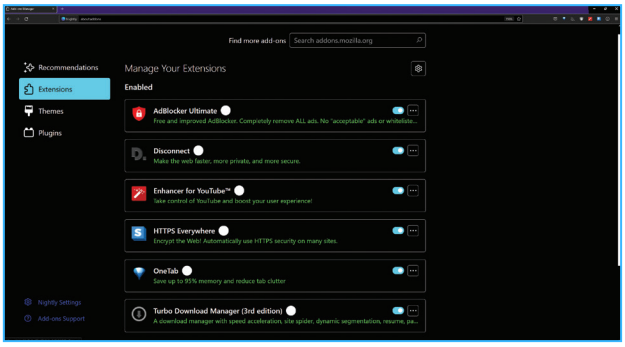
While the high contrast mode currently in Firefox is an essential feature for making the browser more accessible, there is still more that can be done to make high contrast mode even better. Specifically, high contrast mode does not perfectly cover the entirety of Firefox's user interface. This leads 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++.





Firefox Browser

Michigan State University
Team Members (left to right)

Jack Ying
Wuhan, Hubei, China

Shaoting Huang
Beijing, Beijing, China

Danielle Lamoureux
Northville, Michigan

Avi Pasula
Okemos, Michigan

Noah Pesta
Clarkston, Michigan

Mozilla
Project Sponsors

Molly Howell
Portland, Oregon

Gijs Kruitbosch
Hinckley, Leicestershire, UK

Philip Luk
Mountain View, California

Micah Tigley
Toronto, Ontario, Canada

Jared Wein
Burton, Michigan

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.

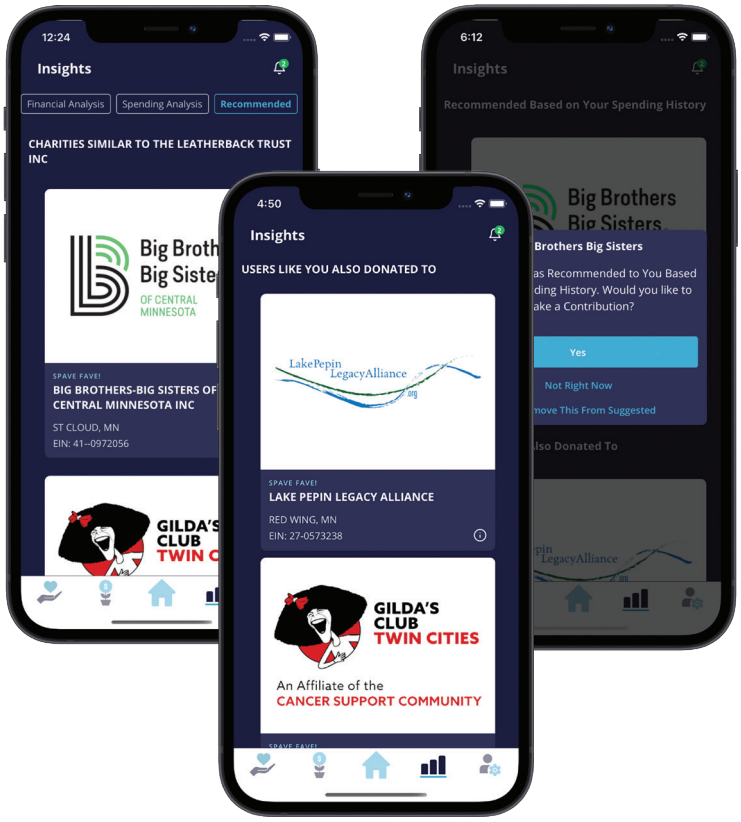
MSUFCU provides a variety of financial education resources to its customers to ensure they are making the best monetary decisions possible. One of these resources, acquired by MSUFCU's Credit Union Service Reseda Group, is a banking app known as Spave. Spave is a mobile application that allows users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



msufcu

Michigan State University
Team Members (left to right)

Ethan Colbert
South Lyon, Michigan

Nick Aaltonen
Canton, Michigan

Ning Wang
Wuxi, Jiang Su, China

Jonathon Harkness
Midland, Michigan

MSUFCU
Project Sponsors

April Clobes
East Lansing, Michigan

Ben Maxim
East Lansing, Michigan

Liam Petraska
East Lansing, Michigan

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.

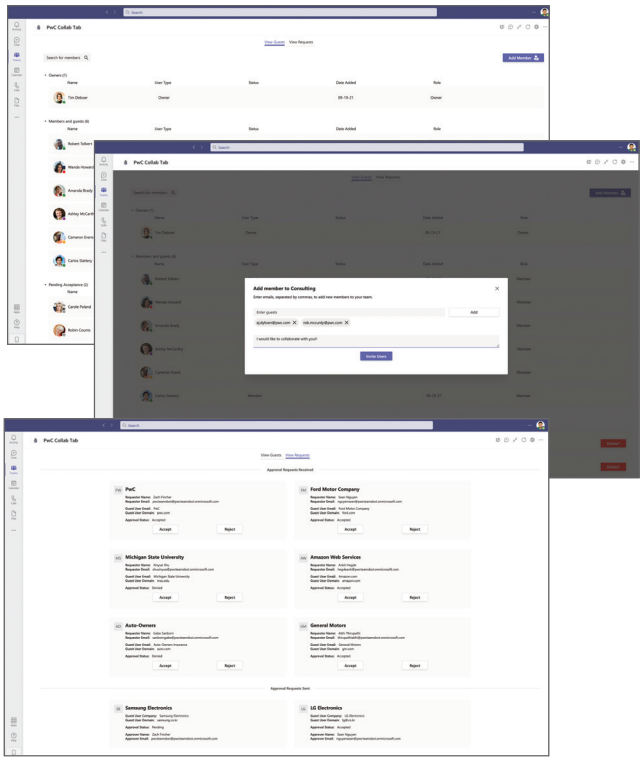
Currently, collaboration requires external users to be invited into the PwC Microsoft environment and given access to Microsoft Teams and OneDrive securely. This requires significant work from an IT administrator who has to manually set this up, and in some cases seek out and get approval from the PwC 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.



Michigan State University
Team Members (left to right)

Ankit Hegde
Lake Orion, Michigan

Sean Nguyen
Holland, Michigan

Xinyue Shu
Hengyang, Hunan, China

Zach Fincher
Elburn, Illinois

PwC
Project Sponsors

E. J. Dyksen
Okemos, Michigan

Rob McCurdy
Grand Rapids, Michigan

Rock Family of Companies
ROCKY: Team Challenge Application

The Rock Family of Companies (FOC) is made up of nearly 100 separate businesses spanning fintech, sports, entertainment, real estate, startups and more. They employ 25,000 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.

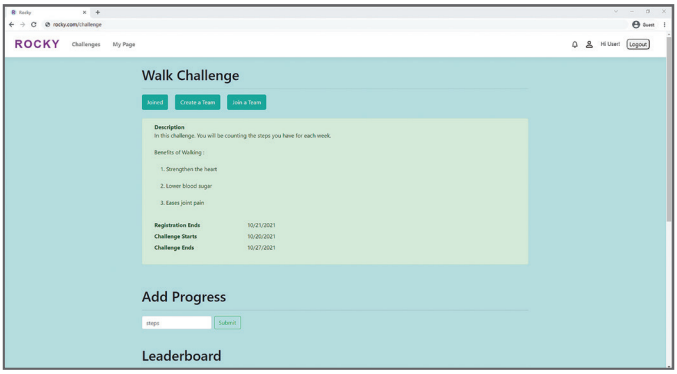
ROCKY provides a platform for Rock FOC team members to compete in challenges against other team members to promote wellbeing, community and productivity. Challenges can measure any number of attributes such as steps walked, hours volunteered, and loans closed.

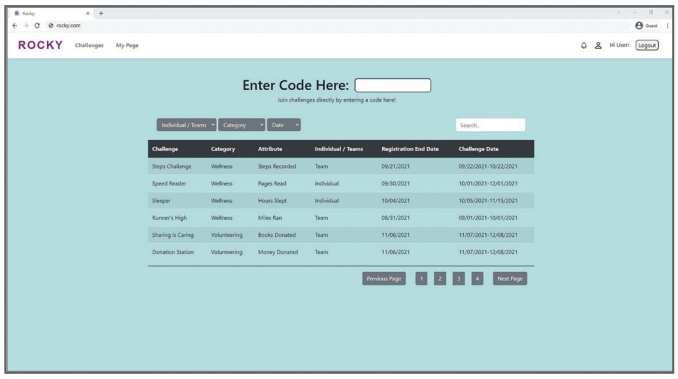
Challenges can be created as either team or individual challenges. To join a team challenge, team members can create a team, join an already existing team, or enter the challenge as free agents, who are assigned to teams at the start of the challenge. Team members who create a team can send invites out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





ROCK
Family of Companies

Michigan State University
Team Members (left to right)

Thomas Bos
Grandville, Michigan

Justin Kappler
Northville, Michigan

Huanduo Yang
Guangzhou, Guangdong, China

Kyle Terryn
Rochester, Michigan

Rock FOC
Project Sponsors

Rachel Cohen
Detroit, Michigan

Rachel Kaip
Detroit, Michigan

Rachel Knapp
Detroit, Michigan

Janet Kubiak
Detroit, Michigan

Kevin Lang
Detroit, Michigan

Bala Raparla
Detroit, Michigan

Chris Woodruff
Detroit, Michigan

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.

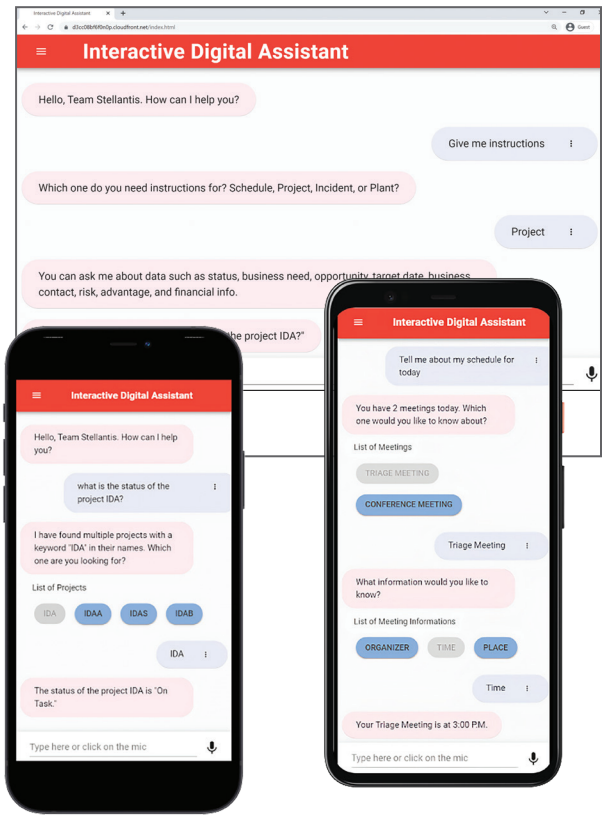
Our Interactive Digital Assistant is a web-based chatbot that allows Stellantis employees to ask general form questions in a life-like conversation about a wide variety of topics, including project statuses, issues or incidents, business applications, process contacts, etc. in a timely manner.

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.



Michigan State University
Team Members (left to right)

Seoungwoo Hong
Ann Arbor, Michigan

Shaheer Hasan
Shelby Township, Michigan

Jinrong Liang
Foshan, Guangdong, China

Stellantis
Project Sponsors

Martin Bally
Auburn Hills, Michigan

Punnaiah Cherukuri
Auburn Hills, Michigan

Sachin Kerkar
Auburn Hills, Michigan

David Swartz
Auburn Hills, Michigan

Karen Wrobel
Auburn Hills, Michigan

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.

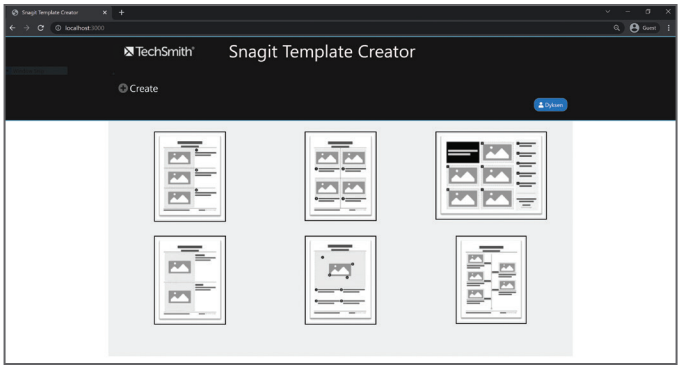
Our TechSmith Snagit Template Creator platform provides a solution to this problem through an intuitive web application that allows users to easily create, download and share Snagit templates with others.

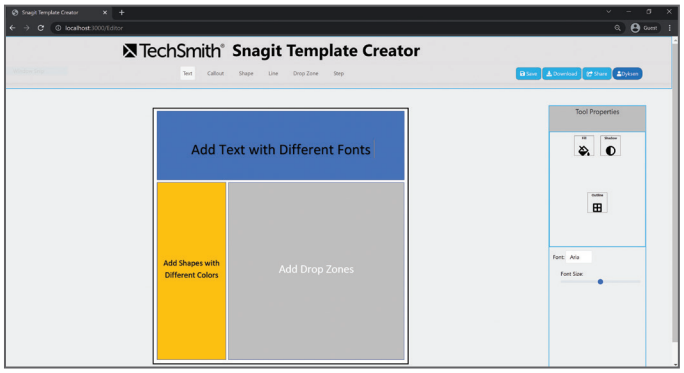
TechSmith Snagit Template Creator allows users to customize templates through a variety of graphics objects including drop zones, shapes and lines. Once the creation of a template is complete, users can download it, share it with colleagues or save it within the web application for later viewing and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





TechSmith®

Michigan State University
Team Members (left to right)

Miaoyu Yang
Changsha, Hunan, China

Yash Anandakumar
Canton, Michigan

Heather Noonan
Houston, Texas

Dalton Lauerman
Gladstone, Michigan

Akansha Dey
Troy, Michigan

TechSmith
Project Sponsors

Mike Bell
Okemos, Michigan

Dorie Blaisdell
Okemos, Michigan

Jake Hall
Okemos, Michigan

Wendy Hamilton
Okemos, Michigan

Tony Lambert
Okemos, Michigan

Dave Norris
Okemos, Michigan

Scott Schmerer
Okemos, Michigan

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.

UNITED

Michigan State University
Team Members (left to right)

Zachary Yarost
West Bloomfield, Michigan

Mihir Bhadange
Novi, Michigan

Gitika Kumar
Novi, Michigan

Alex Brandt
Lowell, Michigan

United Airlines Airport Operations
Project Sponsors

Ken Allen
Chicago, Illinois

Adriana Carmona
Chicago, Illinois

Christine Clarida
Chicago, Illinois

John Kleberg
Chicago, Illinois

Spencer Resh
Chicago, Illinois

Moin Siddiqui
Chicago, Illinois

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.

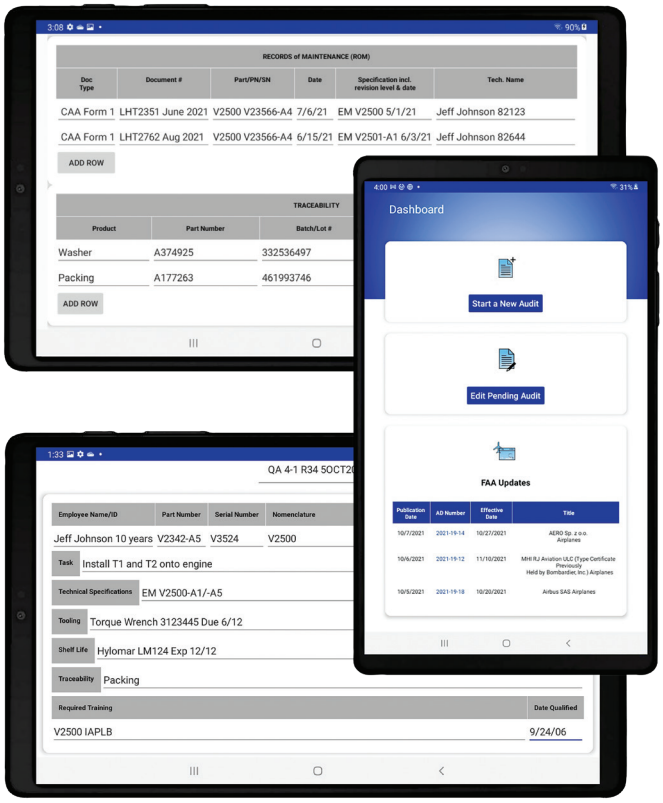
To accomplish this, the United Airlines Quality Assurance team conducts live audits to ensure all equipment and services are maintained according to Federal Aviation Association (FAA) standards. Current audits require handwritten documents that are hard to keep track of and difficult to share.

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.



Michigan State University
Team Members (left to right)

Elizabeth Stevens
Macomb, Michigan

Adeboye Adegbenro Jr.
Sterling Heights, Michigan

Anika Patel
Canton, Michigan

Xuefeng Sun
Beijing, Beijing, China

United Airlines Quality Assurance
Project Sponsors

Amadou Anne
San Francisco, California

Kaley Pon
San Francisco, California

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.

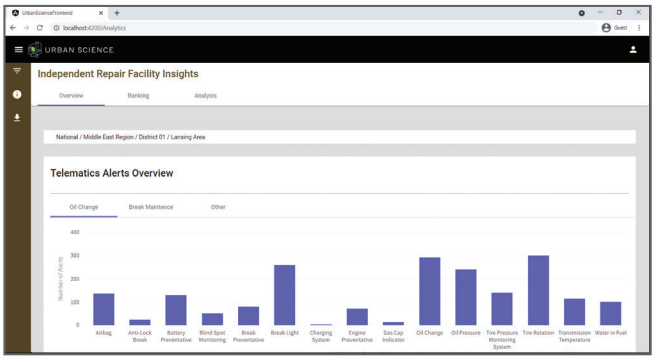
Our Independent Repair Facility Insights web application alleviates this gap of market knowledge through leveraging telematics data. Telematics systems in vehicles monitor a wide range of information including vehicle location, engine diagnostics and vehicle activity.

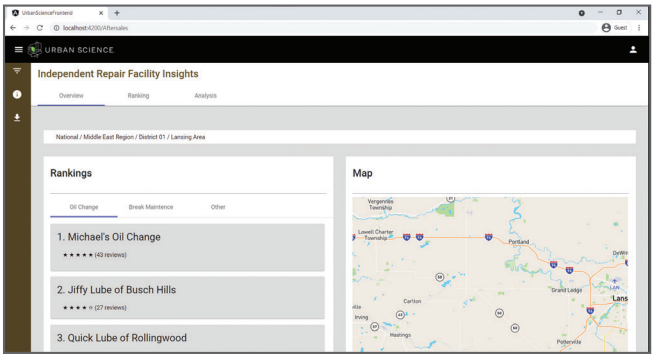
Using the telematics data, users are notified of what IRFs customers are selecting over the dealership for aftersales. This information is displayed on our web application and provides dealers with information such as IRF rankings and analysis on top- performing IRFs in their area of responsibility.

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.





URBAN SCIENCE™

Michigan State University
Team Members (left to right)

Zhi Li
Shenzhen, Guangdong, China

Gyungrok Lee
Seoul, Seoul, Korea

Victoria Cao
Rochester, Michigan

Juston Ko
Weston, Connecticut

Urban Science
Project Sponsors

Robert Buttery
Detroit, Michigan

Mike DeRiso
Detroit, Michigan

Elizabeth Klee
Detroit, Michigan

Timothy Scogin
Detroit, Michigan

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.

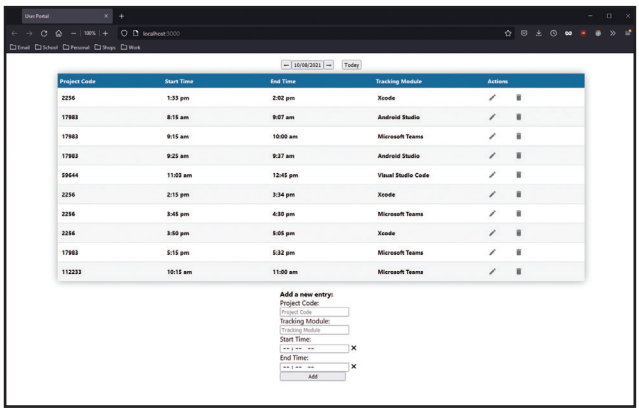
Our Smart Auto-Time Logging system solves this issue by generating accurate and reliable time statements for software development and communications.

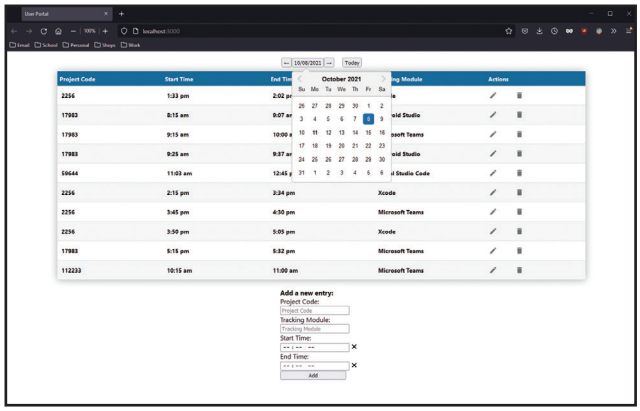
Users start the program before beginning their workday. The system generates accurate time statements throughout the workday by monitoring the programs in operation on the user's computer and associating them to a project billing code through smart analysis.

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

Michigan State University
Team Members (left to right)

Everett Case
Berrien Springs, Michigan

Jake Mitchell
Macomb, Michigan

Jianyu Deng
Lansing, Michigan

Sherwin Soroushian
Okemos, Michigan

Vectorform
Project Sponsors

Chris Cornish
Royal Oak, Michigan

Woody Floyd
Royal Oak, Michigan

Claire Lizear
Royal Oak, Michigan

Jeff Meador
Royal Oak, Michigan

Josh Parmenter
Seattle, Washington

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.

Michigan State University
Team Members (left to right)

Blake Miller
Greeley, Colorado

Evan Yokie
Novi, Michigan

Tianyu Wang
Huaian, Jiangsu, China

Riley Wagner
Freeland, Michigan

Volkswagen
Project Sponsors

Courtney Boire
Auburn Hills, Michigan

Igor Efremov
Auburn Hills, Michigan

Chelsea Smykowski
Auburn Hills, Michigan

Frank Weith
Auburn Hills, Michigan

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.

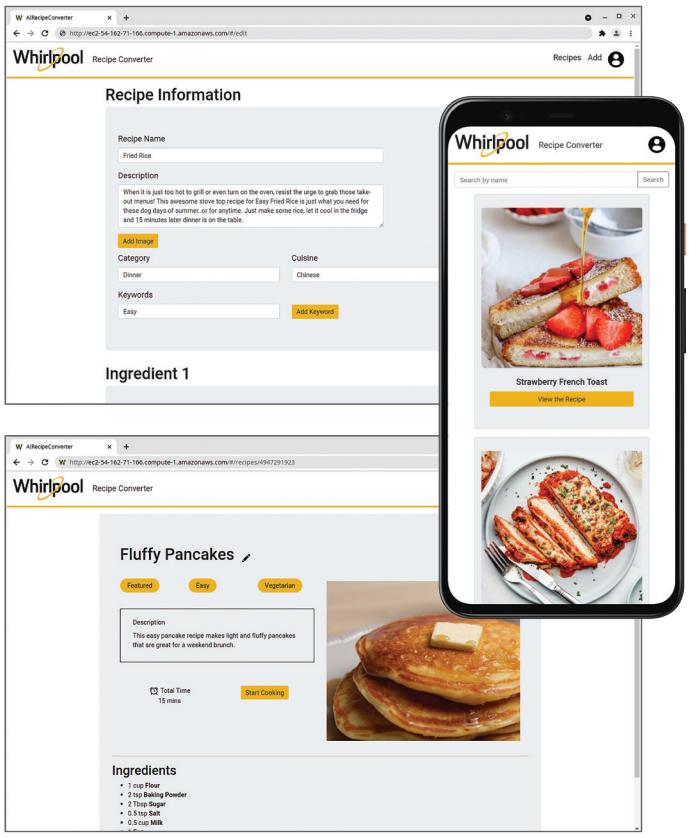
To this end, Whirlpool provides smart cooktops that automatically set the temperature and timers according to recipe instructions. Recipes must be formatted in a specific way to be used by these devices. Previously, it was the task of Whirlpool's food scientists to convert recipes into the specialized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

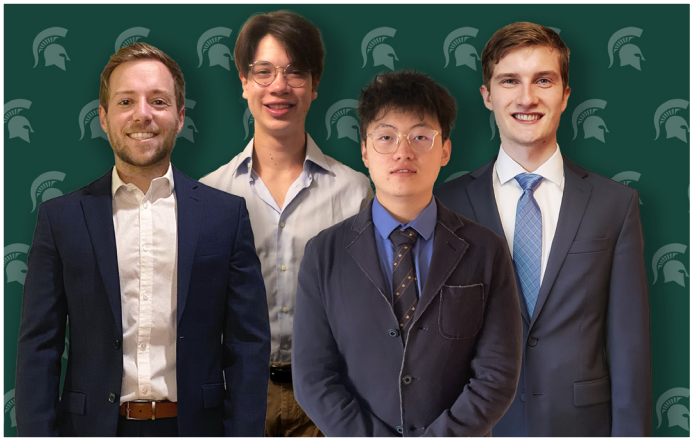
Our AI Recipe Converter assists Whirlpool food scientists in this task by automatically converting recipes on cooking websites into the machine-understandable format. Using natural language processing, information such as ingredients, cooking temperatures, and cook times are extracted from recipes. The 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.





Michigan State University
Team Members (left to right)

Cameron Lang
Grand Rapids, Michigan

Samuel Chen
Saline, Michigan

Ruitong Xu
Taizhou City, Zhejiang, China

Ryan McLean
Rochester Hills, Michigan

Whirlpool
Project Sponsors

Colleen Doyle
Benton Harbor, Michigan

Sang Jin Ko
Benton Harbor, Michigan

Jackie Li
Benton Harbor, Michigan

Phil Swanson
Benton Harbor, Michigan

Design Day Awards

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

Auto-Owners Insurance Exposition Award

Auto-Owners INSURANCE

CSE 498 capstone teams present their projects on Design Day in a variety of ways. Teams create and set up an exhibit where they demonstrate their software systems and answer questions from Design Day attendees. 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

MICHIGAN STATE UNIVERSITY FEDERAL CREDIT UNION
Building Dreams Together

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

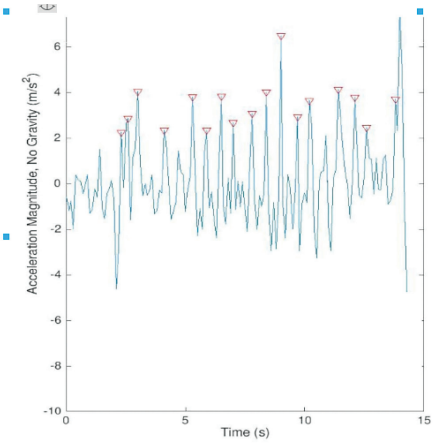
Zhehao Zhou, Spencer Novick, Rachel Allen
Presented by Garret Gaw and Derek Gebhard

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

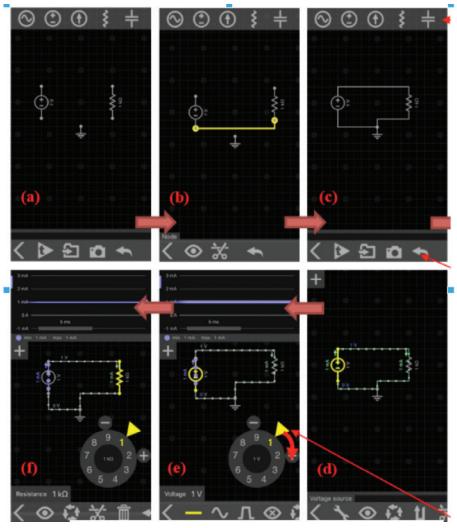
MATLAB Drive > Published > countingsteps.m

```
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

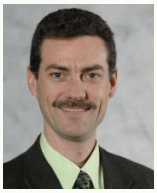
Dr. Satish Udpa
Professor of Electrical and Computer Engineering

Faculty Advisors: Albrecht, Aslam, Chakrapani, Hogan, Li, Mahapatra, Morris, Ren, Udpa


John Albrecht


Dean Aslam

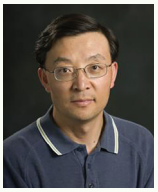

Sunil Chakrapan


Tim Hogan,


Tongtong Li


Nihar Mahapatra


Daniel Morris


Jian Ren


Lalita 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 ECE Department	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 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.

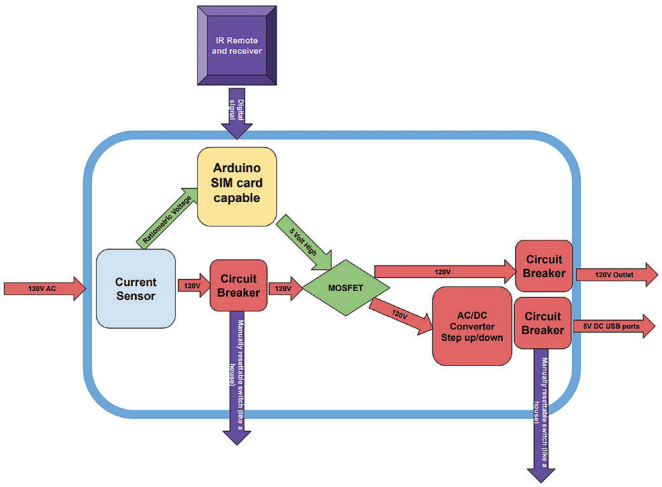
bpower
Battery Charging Monitoring And Billing

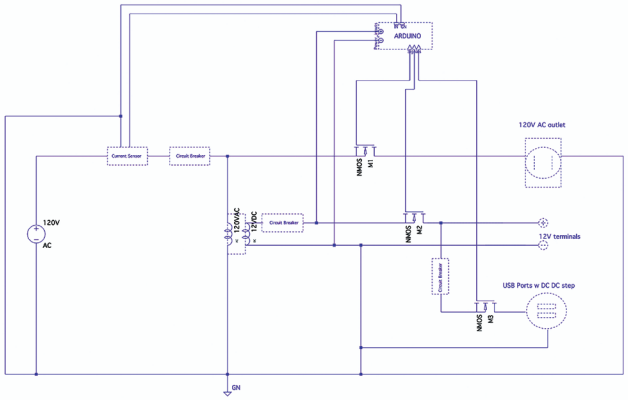
The Michigan State University's Brody Cafeteria provides roughly 1.6 million meals per year.

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.





Michigan State University
Team Members
(left to right)

Joshua Paull
Bloomfield Hills, Michigan

Aime Mafuta
Kinshasa, DRC

Yuchen Wang
Shanghai, China

Hanxiang Zhang
Zhejiang,China

Evan Miller
Allen Park, Michigan

Sohaib Farrukh
Farmington Hills, Michigan

bpower
Project Sponsor

Dave Giordano
East Lansing, Michigan

Project Facilitator

Dr. Daniel Morris

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

Michigan State University
Team Members
(left to right)

Aaron Brookhouse
Valpariso, Indiana

Diana Dalski
Battle Creek, Michigan

Deborah Kim
Rochester Hills, Michigan

MSU Resource Center for Persons with Disabilities
Project Sponsor

Stephen Blosser
East Lansing, Michigan

Project Facilitator

Dr. Nihar Mahapatra

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

Michigan State University
Team Members
(left to right)

Devin Abb
Plymouth, MI

Artan Tagani
Northville, MI

Ryan Doyle
Plymouth, Michigan

Davis Brown
Livonia, Michigan

Shadman Chowdhury
Troy, Michigan

Isabel Woelke
Canton, Michigan

Tecnix
Project Sponsors

Justin Heath
East Lansing, Michigan

Eric Tarkleson
East Lansing, Michigan

Project Facilitator

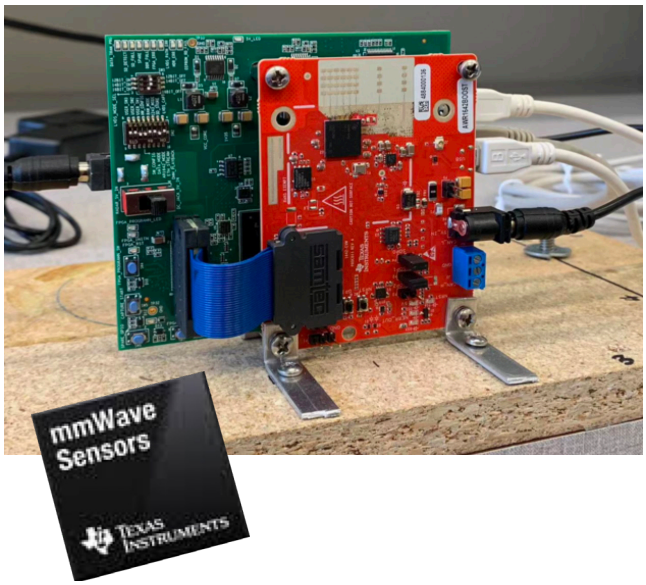
Dr. Nihar Mahapatra

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

Michigan State University
Team Members
(left to right)

Nicholas Fitzsimons
Richmond, Michigan

Cade Poland
Muskegon, Michigan

Michael Dittman
Richmond, Michigan

Ethan Kepros
Lansing, Michigan

Connor Foley
Goodrich, Michigan

Haocheng Hu
Wuxi, JiangSu

Consumers Energy
Project Sponsor

Sudharshan KN
Dallas-Fort Worth, Texas

Project Facilitator

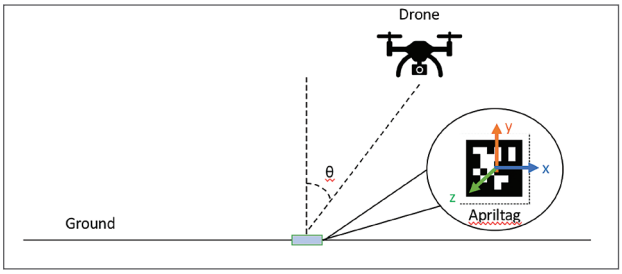
Dr. Jian Ren

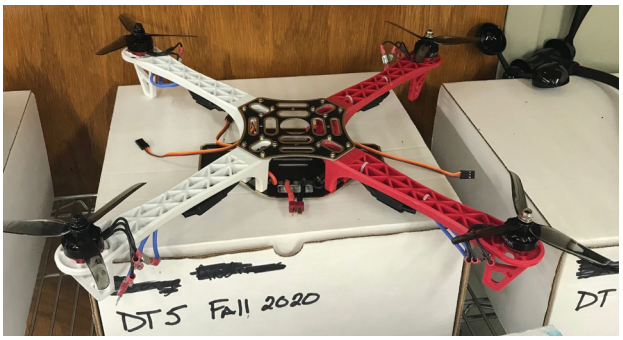
MSU Department of Electrical & Computer Engineering
Aerial Vehicle Localization using AprilTags

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.

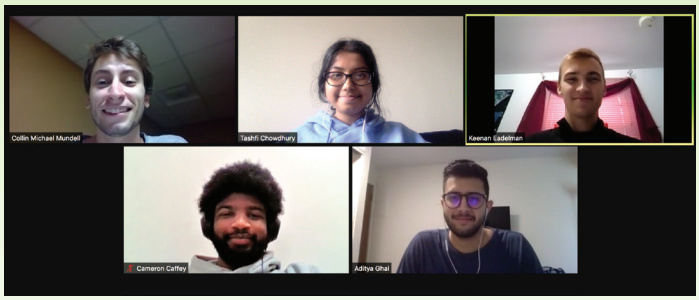
Our localization will be done by using AprilTags which will allow a camera on the drone to recognize the location and orientation of the tags and, if the camera is able to detect at least two AprilTags, then the drone will have the data to calculate its general location. AprilTags are similar to regular 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.





College of Engineering
MICHIGAN STATE UNIVERSITY



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

Collin Mundell
Brighton, Michigan

Tashfi Chowdhury
Hamtramck, Michigan

Keenan Eadelman
Rockford, Michigan

Cameron Caffey
Carbondale, Illinois

Aditya Ghai
New Delhi, India

MSU Department of Electrical & Computer Engineering
Project Sponsor

Vaibhav Srivastava
East Lansing, Michigan

Project Facilitator

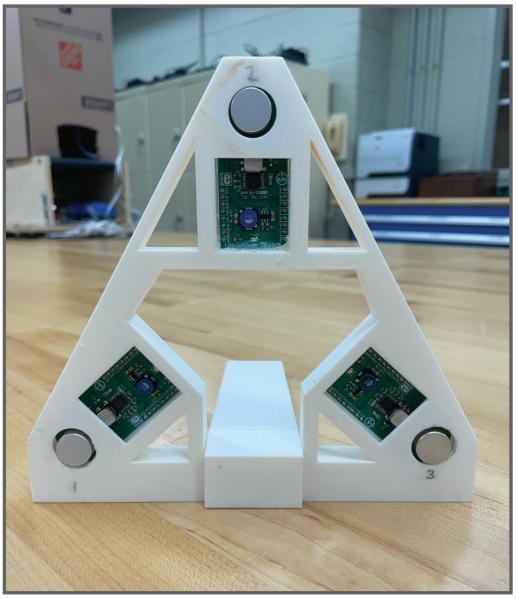
Dr. John Albrecht

MSU Department of Electrical & Computer Engineering
High Resolution Object Triangulation

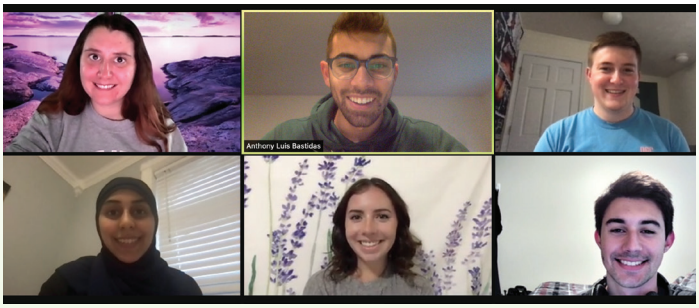
Object triangulation has become a vital part of many systems found within the automotive field, robotics, and many other fields. Object triangulation has been used in car backup detection systems, robotic production lines, tank fluid level detection, and several other applications. As these fields continue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



College of Engineering
MICHIGAN STATE UNIVERSITY



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

Madison Desormeau
Macomb, Michigan

Anthony Bastidas
Saginaw, Michigan

Ethan Laba
Rochester, Michigan

Nada Alqaderi
Detroit, Michigan

Kelsey Johnson
Grand Rapids, Michigan

Aaron Friedland
Novi, Michigan

MSU Department of Electrical & Computer Engineering
Project Sponsor

Prem Chahal
East Lansing, Michigan

Project Facilitator

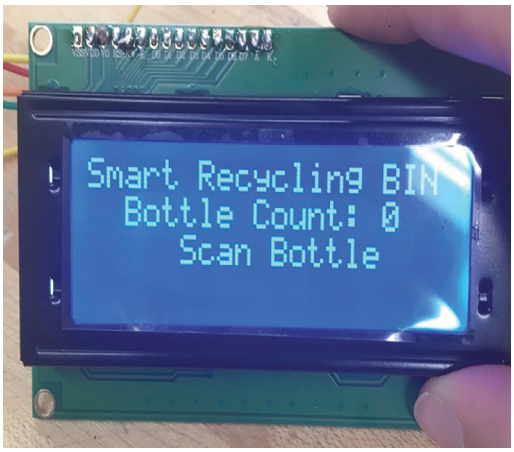
Dr. Dean Aslam

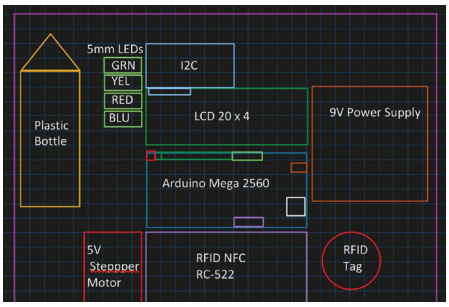
Axia Institute
Smart Recycling B.I.N. using RFID-based Technology

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.

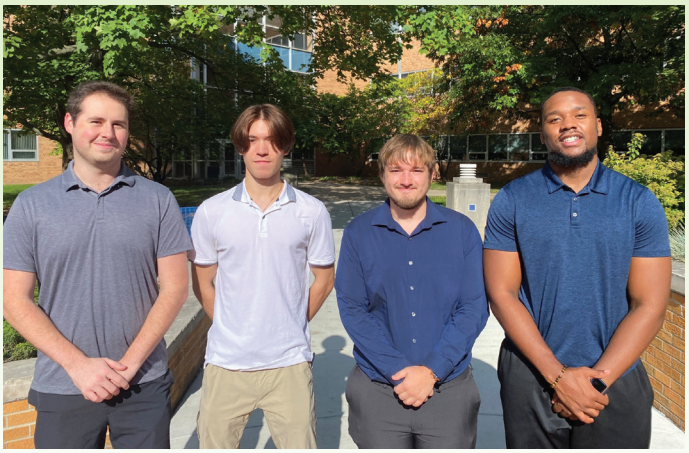
Our team chose to use Arduino because of its relatively low pricing of RFID readers and because it was the easiest to implement for the system's needs. Arduino Mega was chosen as the microcontroller of the project because of its larger array of pins and ports to maximize the recycling bin's unique features 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®
MICHIGAN STATE UNIVERSITY



Michigan State University
Team Members
(left to right)

Chase Miller
West Bloomfield, Michigan

Joseph DiVito
Bloomfield Hills, Michigan

Josh Comiska
Harrison Township, Michigan

Jamal Burton
Flint, Michigan

Axia Institute
Project Sponsor

Bahar Aliakbarian
East Lansing, Michigan

Project Facilitator

Dr. Prem Chahal

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

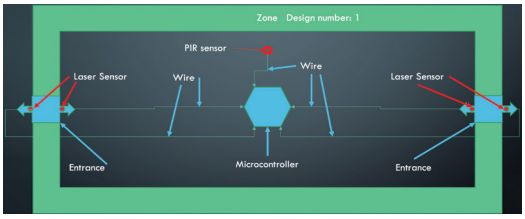
Since its establishment in 1903, DTE Energy has been working to create a smarter, cleaner, and safer energy future. One way to accomplish this is by hosting the E-Challenge 5.

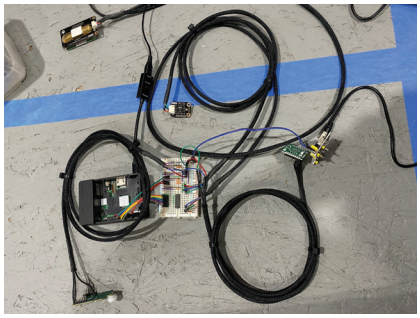
The goal of the challenge is to create an Energy Conservation Measure (ECM) that is not already commercialized in Michigan. Our system works to reduce energy conservation in commercial buildings through the use of occupancy sensors connected to a Variable Air Volume (VAV) based Heating, Ventilation,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

College of Engineering
MICHIGAN STATE UNIVERSITY

Michigan State University
Team Members
(left to right)

Troy Misialek
Arlington Heights, Illinois

Connor Rosekrans
Charlotte, Michigan

Julian Olejnik
Lake Orion, Michigan

Shannon Falter
Lake Orion, Michigan

MSU College of Engineering/MSU Infrastructure Planning and Facilities/ DTE Energy
Project Sponsor

Kristen Cetin
Okemos, Michigan

Project Facilitator

Dr. Tim Hogan