The Capstone Experience

From Students...to Professionals

COMPUTER SCIENCE AND ENGINEERING 2024-2025

MICHIGAN STATE UNIVERSITY

Auto-Owners INSURANCE

The Capstone Experience

CSE 498, Collaborative Design

Dr. Wayne Dyksen
Professor of Computer Science and Engineering

James Mariani
Professor of Instruction

The Capstone Experience provides the educational capstone for all students majoring in computer science at Michigan State University. Teams of students build software projects for corporate clients.

During the Capstone Experience, students

- design, develop, debug, document, and deliver a software project for a corporate client,
- work in a team environment,
- develop written and oral communication skills,
- become proficient with software development tools and environments, and
- consider issues of professionalism and ethics.
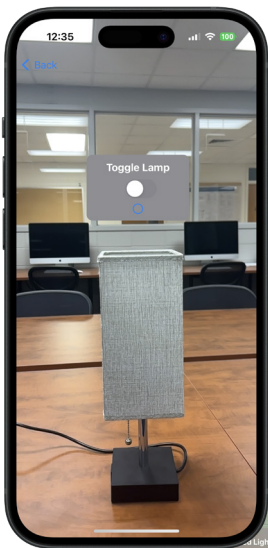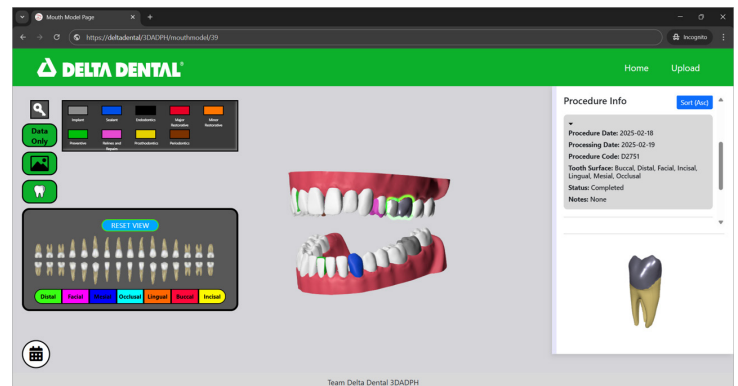
Corporate clients are local, regional, and national including Ally, Amazon, Anthropocene Institute, Auto-Owners Insurance, Corewell Health, Delta Dental, Dow Chemical, General Motors, Google, HAP, Kohl's, Lockheed Martin Space, Magna, McKesson, Meijer, Microsoft, MillerKnoll, Mozilla, MSU Federal Credit Union, NetJets, RPM, Stryker, TechSmith, United Airlines, Union Pacific, Urban Science, UWM, Vectra AI, Volkswagen, Whirlpool, and WK Kellogg Co.

Project Sponsors Fall 2024

abbvie
North Chicago, Illinois

ally
Detroit, Michigan

amazon
Detroit, Michigan & Seattle, Washington

Anthropocene Institute
Palo Alto, California

Auto-Owners INSURANCE
Lansing, Michigan

DRIVEN-4
St. Joseph, Michigan

gm
Detroit, Michigan

hap
Detroit, Michigan

HENRY FORD HEALTH Innovations
Detroit, Michigan

KOHL'S
Menomonee Falls, Wisconsin

Launch by NTT DATA
Troy, Michigan

MAGNA
Troy, Michigan & Aurora, Ontario, Canada

meijer
Grand Rapids, Michigan

MICHIGAN STATE UNIVERSITY Founded 1855
East Lansing, Michigan

msufcu
East Lansing, Michigan

Roosevelt simple. seamless. smart.
Okemos, Michigan

RPM
Royal Oak, Michigan

stryker
Kalamazoo, Michigan

TechSmith®
East Lansing, Michigan

UNION PACIFIC
Louisville, Colorado & Omaha, Nebraska

URBAN SCIENCE
Detroit, Michigan

VECTRA®
San Jose, California

VW
Auburn Hills, Michigan

Whirlpool
Benton Harbor, Michigan

WK Kellogg Co
Battle Creek, Michigan

AbbVie
Image Analysis Tool for Biphasic Solutions

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

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

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

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

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

Flask, a Python webserver, constructs the back-end interface which applies the model to the acquired data. The front-end framework, Angular, enables users to view model results with ease.
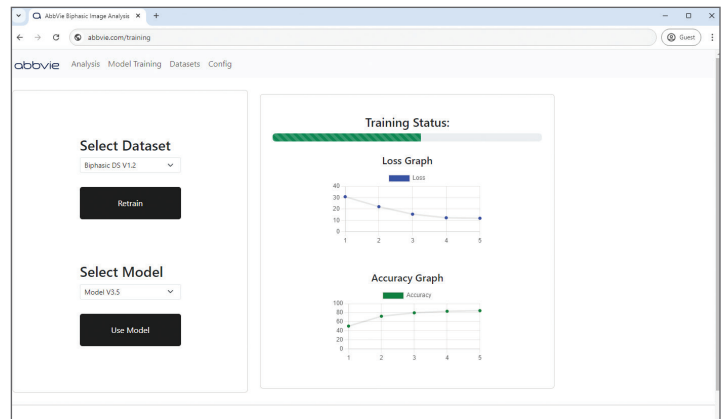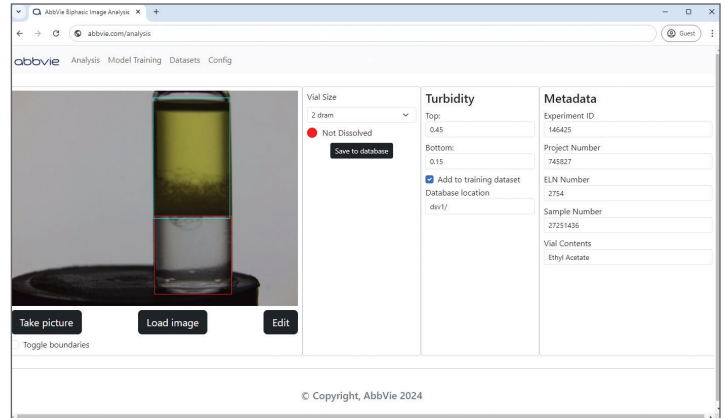
Michigan State University
Team Members (left to right)

Noel Vazquez
Round Lake Beach, Illinois

Alex Chirillo
Northville, Michigan

Henry Murdock
Ann Arbor, Michigan

Joe Cook
Birmingham, Michigan

Chirag Solanki
Grand Rapids, Michigan

Colton Leslie
Ortonville, Michigan

AbbVie
Project Sponsors

Ryan Chung
North Chicago, Illinois

Mike Dennis
North Chicago, Illinois

Ruben Quintero
North Chicago, Illinois

Daniel Tao
North Chicago, Illinois

Ally Financial
Agentic Collaborator

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

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

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

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

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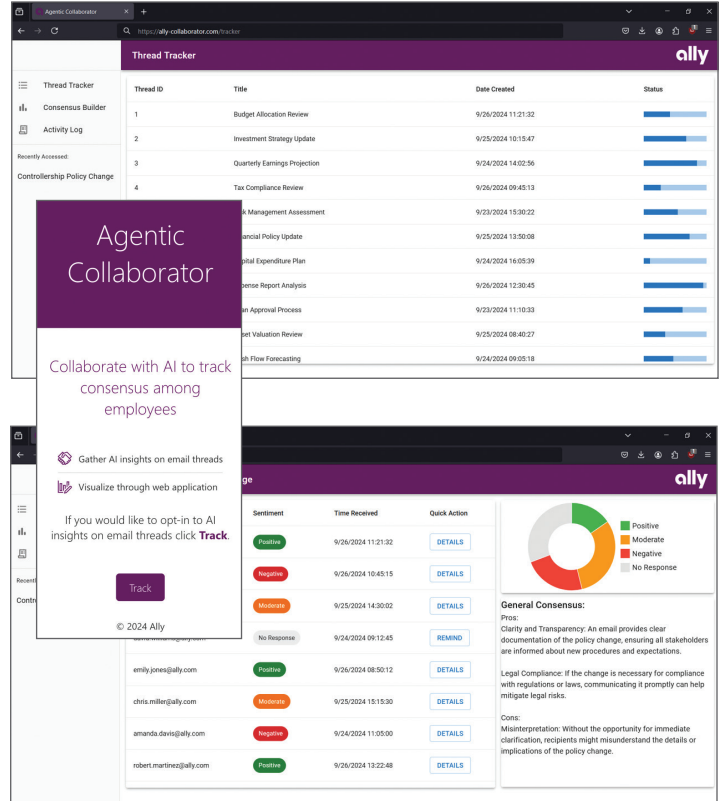
Michigan State University
Team Members (left to right)

Andrew Chen
Bloomfield Hills, Michigan

Abdullah Baqai
Islamabad, Islamabad, Pakistan

Pranta Nir Barua
Chattogram, Chattogram, Bangladesh

Alison Schlacht
Chesterfield, Michigan

Stefan Lemke
Troy, Michigan

Areeb Islam
Troy, Michigan

Ally
Project Sponsors

Divyesh Jambusaria
Detroit, Michigan

Dan Lemont
Detroit, Michigan

Jesse Podell
Detroit, Michigan

John Stoutenger
Detroit, Michigan

Amazon
Remediating AWS Security Gaps Using Generative AI

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

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

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

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

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

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

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

Michigan State University
Team Members (left to right)

Ndiaga Diouf
Eastpointe, Michigan

Valdine Pegy Tchinda Pegou
Douala, Littoral, Cameroon

Sardar Murtaza
Chittagong, Chittagong, Bangladesh

Ilyas Abdulrahman
Detroit, Michigan

Nate Mikkola
Pontiac, Michigan

Jaden Cabansag
Novi, Michigan

Amazon
Project Sponsors

Jennifer Free
Detroit, Michigan

Garret Gaw
Detroit, Michigan

Dean Schifilliti
Arlington, Virginia

Anthropocene Institute
Ocean Carbon Pollution Cleanup

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

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

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

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

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

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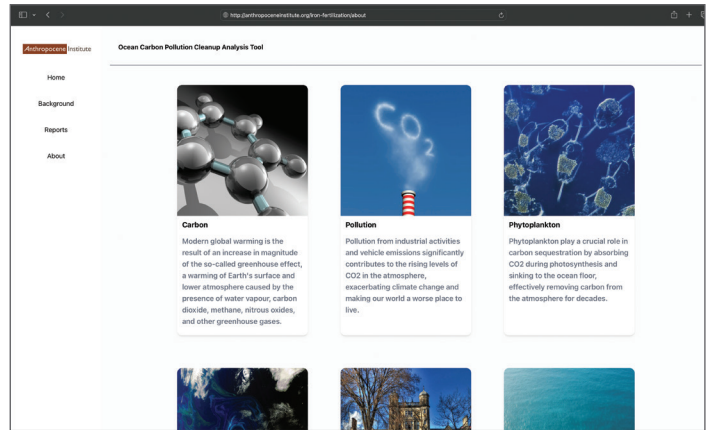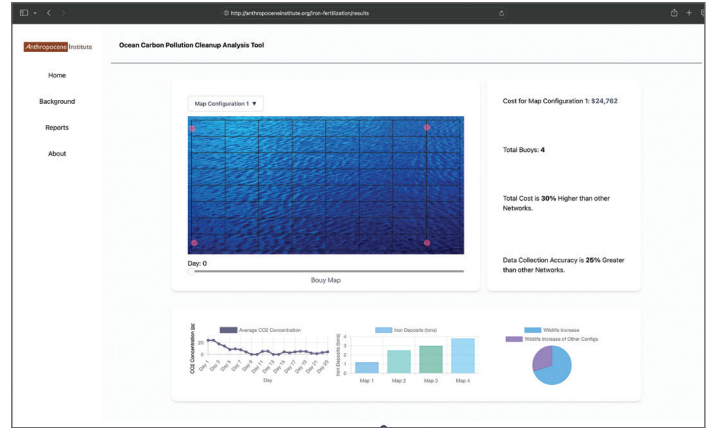
Michigan State University
Team Members (left to right)

Cam Koons
Durand, Michigan

Henry Bock
Grand Rapids, Michigan

Blake Potvin
Bloomfield Hills, Michigan

Faith Dawson
Austin, Texas

William Chasteen
Birmingham, Michigan

Nitin Polavarapu
Okemos, Michigan

Anthropocene Institute
Project Sponsors

Melinda Alankar
Denver, Colorado

Peter Fiekowsky
Los Altos, California

Frank Ling
Tokyo, Japan

Carl Page
Palo Alto, California
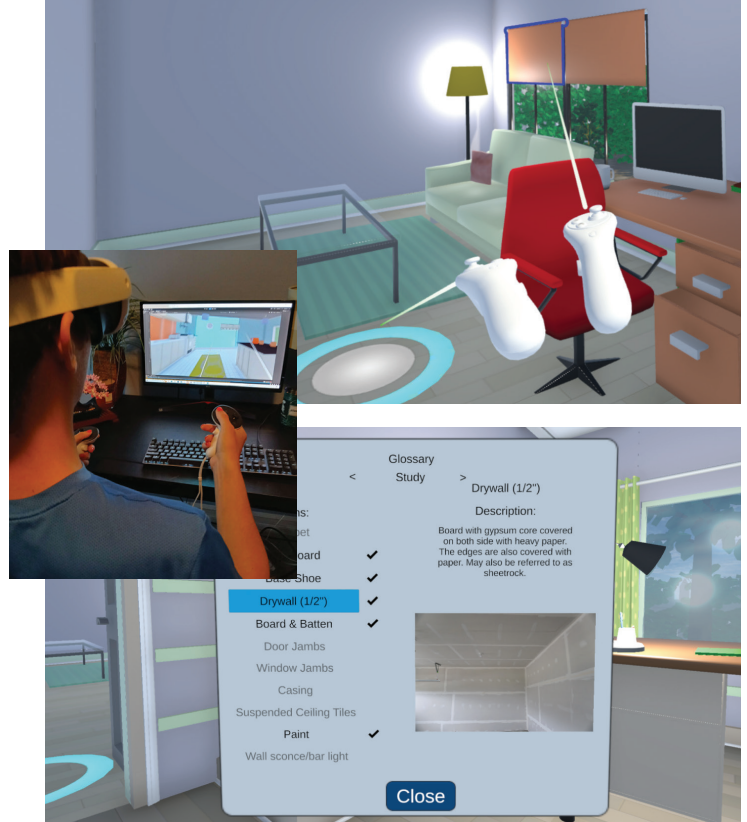
Auto-Owners Insurance
From the Ground Up VR

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

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

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

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

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

Michigan State University
Team Members (left to right)

Owen Cochell
Ann Arbor, Michigan

Alex Hawkins
Shelby Township, Michigan

Elijah Medina
Lansing, Michigan

Emma Lamb
St. Clair, Michigan

Connor Blackmer
DeWitt, Michigan

Alan Feng
South Lyon, Michigan

Auto-Owners
Project Sponsors

Tony Dean
Lansing, Michigan

Ross Hacker
Lansing, Michigan

Scott Lake
Lansing, Michigan

Kolien Owens
Lansing, Michigan

Chad Peterman
Lansing, Michigan

Brad Schafer
Lansing, Michigan

DaCia Thompkins
Lansing, Michigan

Andrew Wegener
Lansing, Michigan

Julie Wilkinson
Lansing, Michigan

DRIVEN-4
DRIVEN-4 Connect Application

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

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

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

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

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

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

The DRIVEN-4 Connect Application is powered by the Flask framework. Data is hosted in a MySQL database and accessed via SQLAlchemy. The analysis is conducted using Python scripts.
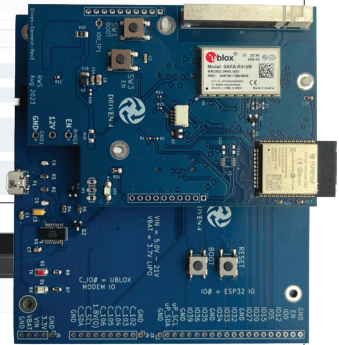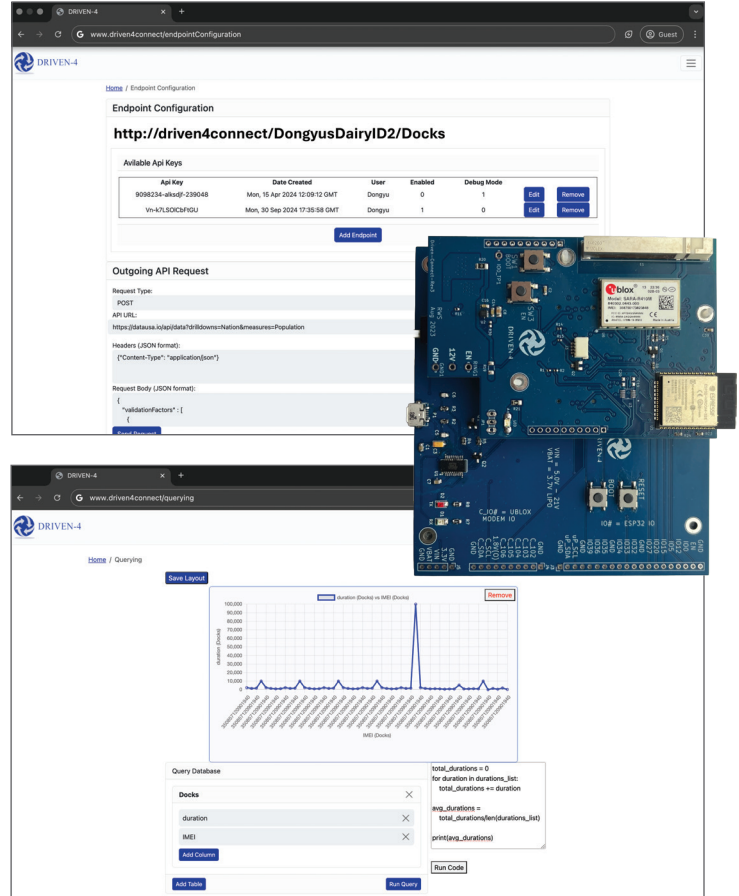
Michigan State University
Team Members (left to right)

Siddarth Satish
Glen Allen, Virginia

Quin Strausbaugh
Defiance, Ohio

Aiden Foley
Grandville, Michigan

Tess Murphy
New Boston, Michigan

A.J. Brummel
Grand Haven, Michigan

Mufeez Mulbagal
Riyadh, Central, Saudi Arabia

DRIVEN-4
Project Sponsors

Fred Bellio
Saint Joseph, Michigan

Ryan Slaugh
Saint Joseph, Michigan

Carl Wendtland
Saint Joseph, Michigan

General Motors
Recycling Identification System

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

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

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

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

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

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

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

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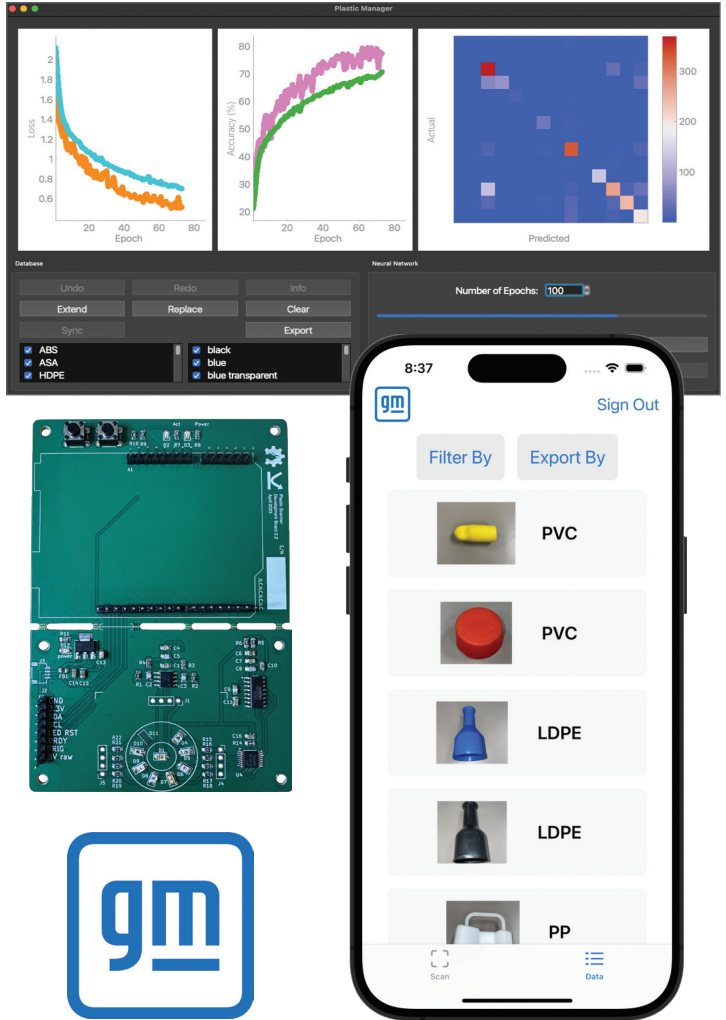
Michigan State University
Team Members (left to right)

Jerry Hoskins
Lake Orion, Michigan

Safiya Fareed
Brownstown, Michigan

Pedro De Oliveira Mitkiewicz
Belo Horizonte, Minas Gerais, Brazil

Matt Miller
West Bloomfield, Michigan

Andres Tamayo
Grand Rapids, Michigan

Keerthi Ramesh
Bangalore, Karnataka, India

GM RIS
Project Sponsors

James Currie
Detroit, Michigan

Patrick Doyle
Detroit, Michigan

Jeffrey Seibert
Detroit, Michigan

Peter Wyatt
Detroit, Michigan

General Motors
## Remote Wildlife Habitat Monitoring System

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

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

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

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

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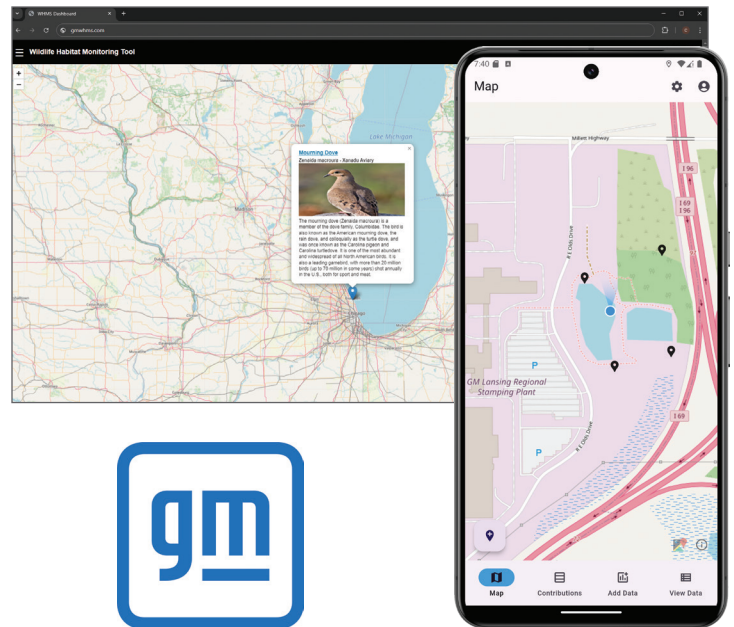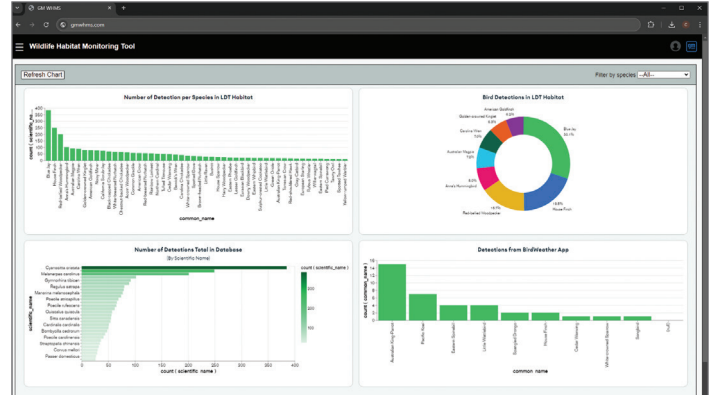
Michigan State University
Team Members (left to right)

Jacob Walsh
Grand Rapids, Michigan

Sanjay Bhuvaneswaran
Rochester Hills, Michigan

Chase Halligan
Clarkston, Michigan

Anna Clark
Grandville, Michigan

Jude Cox
Battle Creek, Michigan

Kevin Zhang
Farmington Hills, Michigan

GM WHMS
Project Sponsors

Patrick Doyle
Detroit, Michigan

Jeffrey Seibert
Detroit, Michigan

Steve Tomaszewski
Detroit, Michigan

HAP
Healthcare Payer Price Transparency

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

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

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

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

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

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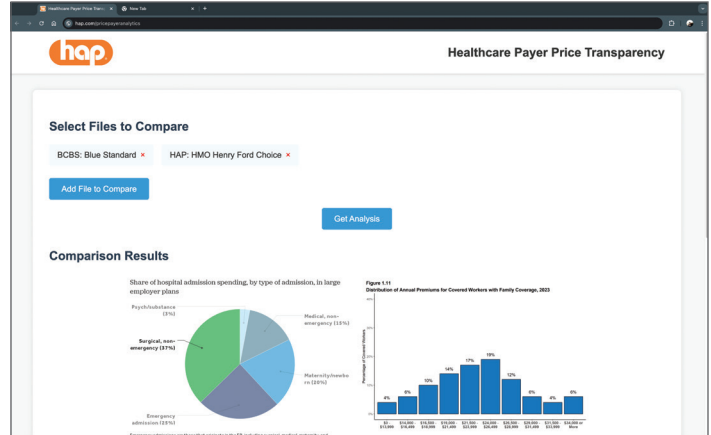
Michigan State University
Team Members (left to right)

Alvin Hoang
Holland, Michigan

Joshua Thomas
Novi, Michigan

Manan Vyas
Gandhidham, Gujarat, India

Sai Upparapalle
Novi, Michigan

Drew Hamilton
Holt, Michigan

Mansour Alblooshi
Al Ain, Abu Dhabi, United Arab Emirates

HAP
Project Sponsors

Angela Endres
Detroit, Michigan

Steve Neubecker
Detroit, Michigan

Henry Ford Innovations
Modernizing Robotic Surgery Education

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

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

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

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

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

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

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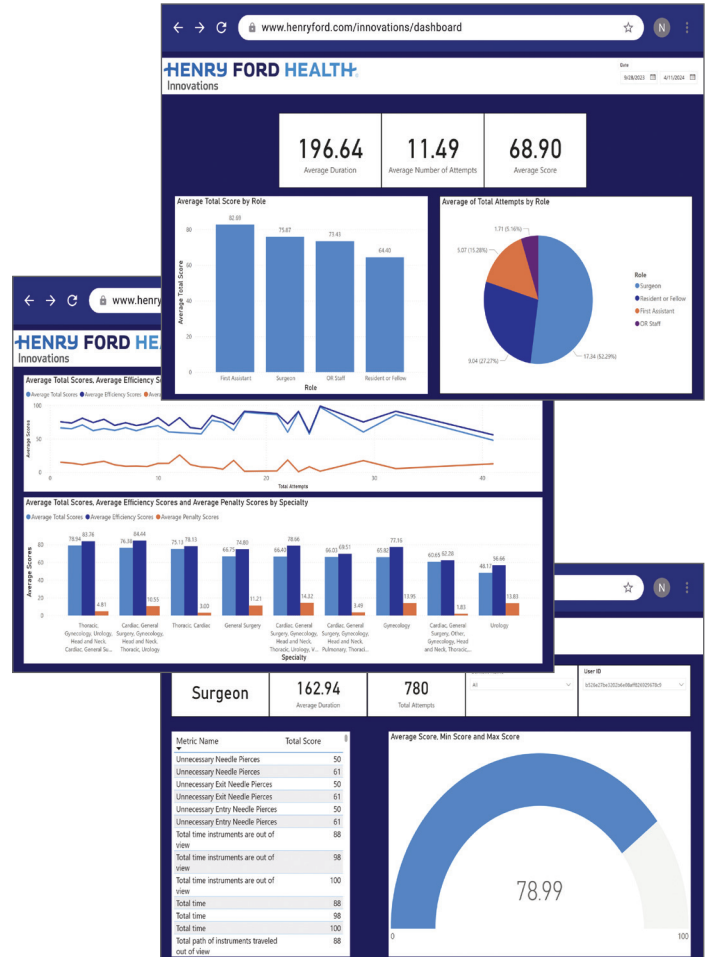
HENRY FORD HEALTH
Innovations

Michigan State University
Team Members (left to right)

Joseph Eisho
Hazel Park, Michigan

Olivia Jordahl
Midland, Michigan

Sid Pawa
Novi, Michigan

Lilly Yanke
Novi, Michigan

Jacob Guty
Macomb Township, Michigan

Shaili Annadurai
Troy, Michigan

Henry Ford Innovations RSE
Project Sponsors

Surya Nalamati
Detroit, Michigan

Vikas Relan
Detroit, Michigan

Alexander Reynolds
Detroit, Michigan

Henry Ford Innovations
MSU-HFH Research Synergy Vanguard Portal (RSVP)

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

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

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

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

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

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

Our portal is built using a ReactJS front end for a dynamic user interface and a Flask back end for application logic. We utilize Bidirectional Encoder Representations from Transformers (BERT) for natural language processing to enhance search capabilities, and Elasticsearch for efficient search performance.

HENRY FORD HEALTH
Innovations
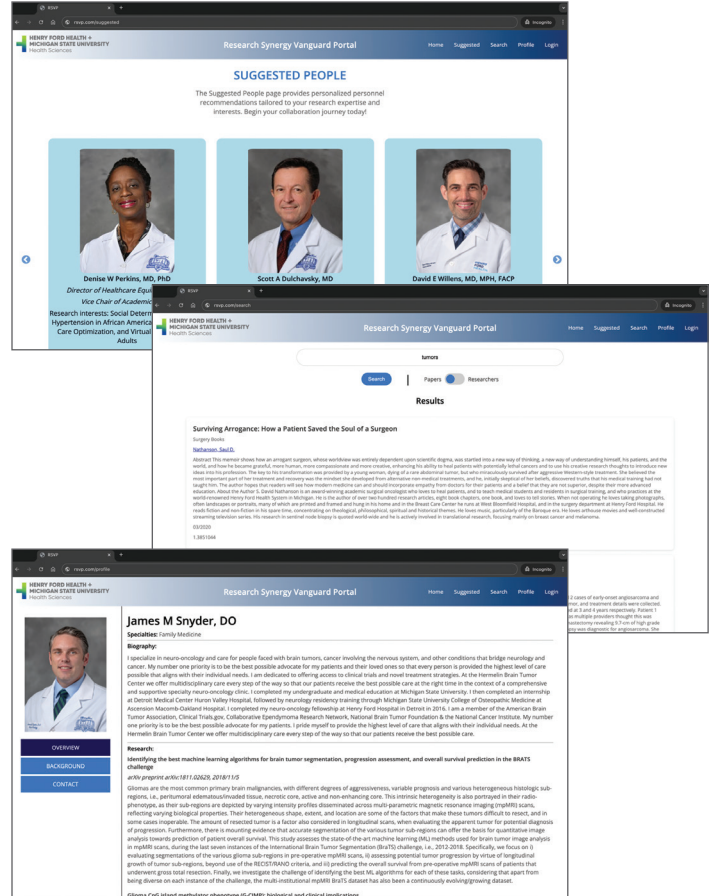
Michigan State University
Team Members (left to right)

Mannan Dhillon
Canton, Michigan

Michael Faucher
Chesterfield, Michigan

Aarham Khan
Dhaka, Dhaka, Bangladesh

Harshita Rathod
Jackson, Michigan

Pranav Shukla
Rochester Hills, Michigan

Tom Brown
Aurora, Illinois

Henry Ford Innovations RSVP
Project Sponsors

Scott Dulchavsky
Detroit, Michigan

Madison Myers
Detroit, Michigan

Vikas Relan
Detroit, Michigan

Alexander Reynolds
Detroit, Michigan

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

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

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

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

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

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

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

Our system is fully dockerized and hosted on GCP powered by Kubernetes. On the back end, data is pulled from Big Query database and processed through a Python Flask server. This is displayed on the front end via a ReactJS web interface.
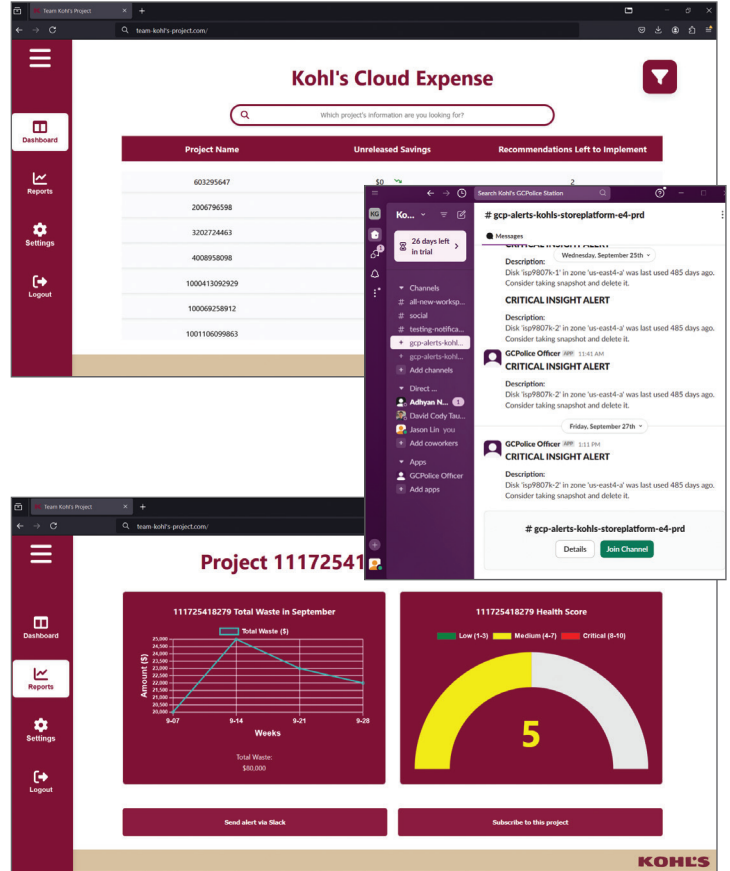
Michigan State University
Team Members (left to right)

Jason Lin
Harrison Township, Michigan

David Lingan
Orland Park, Illinois

Aiden Dixon
Rochester, Michigan

Meredith Heberling
Rochester, Michigan

Adhyan Negi
New Delhi, Delhi, India

Samay Achar
Troy, Michigan

Kohl's
Project Sponsors

Thad Craft
Menomonee Falls, Wisconsin

James Hendley
Menomonee Falls, Wisconsin

Will White
Menomonee Falls, Wisconsin

Launch by NTT DATA
Spatial IoT Control using Apple Vision Pro

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

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

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

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

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

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

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

Launch
by NTT DATA

Michigan State University
Team Members (left to right)

Noah Wolff
Grand Rapids, Michigan

James Ashworth
Novi, Michigan

Jacob Hakala
Kalamazoo, Michigan

Sanaye Lewis
Kennesaw, Georgia

Nathan Motzny
Troy, Michigan

Ethan Egger
Williamston, Michigan

Launch
Project Sponsors

Scott Campagna
Troy, Michigan

Jeff Meador
Troy, Michigan

Magna
Offline-Ready Mobile App for Delivery Optimization

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

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

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

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

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

The front end is implemented in Flutter separately for both mobile and web applications. The back end encompasses route computation using NextBillion.ai and Node.js. Moreover, remote and local data storage is synchronized between both platforms using MongoDB.
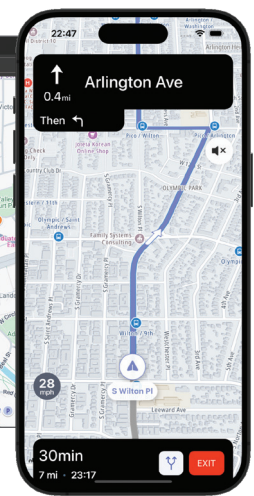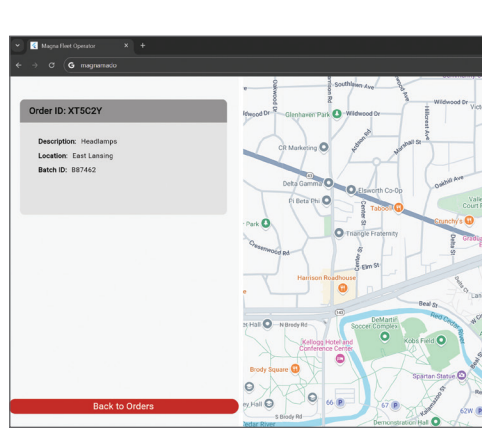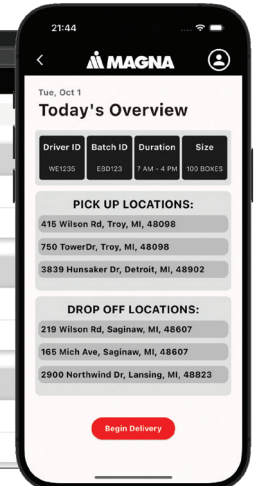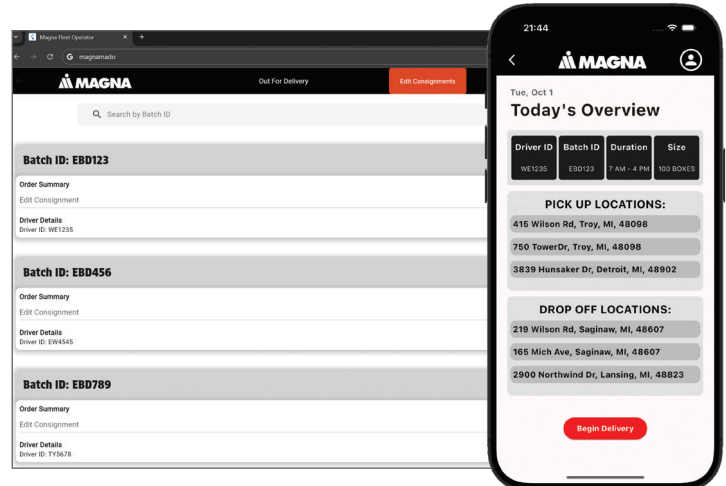
Michigan State University
Team Members (left to right)

Adam Farkas
Northville, Michigan

Muhammad Shaikh
Karachi, Sindh, Pakistan

Shrey Kohli
Dehradun, Uttrakhand, India

Mia Granata
Chicago, Illinois

Chetan Chigurupati
Hyderabad, Telangana, India

Shane Patrarungrong
St. Joseph, Michigan

Magna MADO
Project Sponsors

Esha Gavali
Troy, Michigan

Jim Quesenberry
Troy, Michigan

Raidu Rayasam
Troy, Michigan

Sundar Selvaraj
Troy, Michigan

Princi Sharma
Troy, Michigan

Magna
Test-Driven Development for Embedded Software

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

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

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

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

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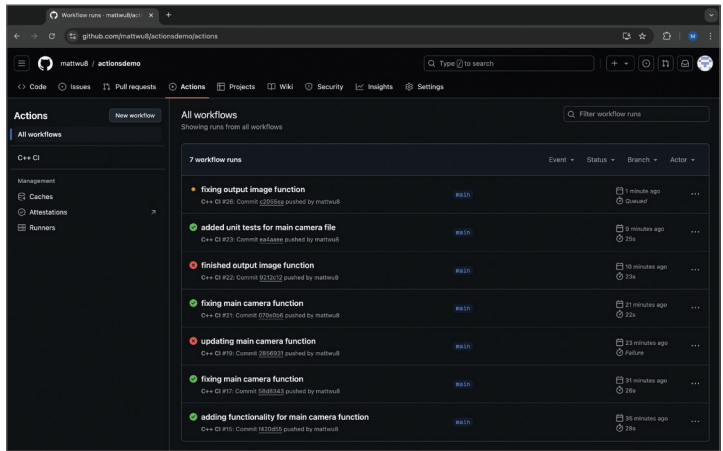
Users are also able to analyze the percentage of the code tested to ensure that the platform has full coverage of the code base.

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

Michigan State University
Team Members (left to right)

Matthew Wu
Rochester Hills, Michigan

Camilo Carmona
Guilford, Connecticut

David Mikola
South Lyon, Michigan

Eliezer Amponsah
Livonia, Michigan

Duong Nguyen
Hanoi, Vietnam

Radhe Patel
Grandville, Michigan

Magna TDD4ES
Project Sponsors

Nikhil Parlapalli
Troy, Michigan

Jim Quesenberry
Troy, Michigan

Magna
Visualizing Neural Network Gradients

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

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

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

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

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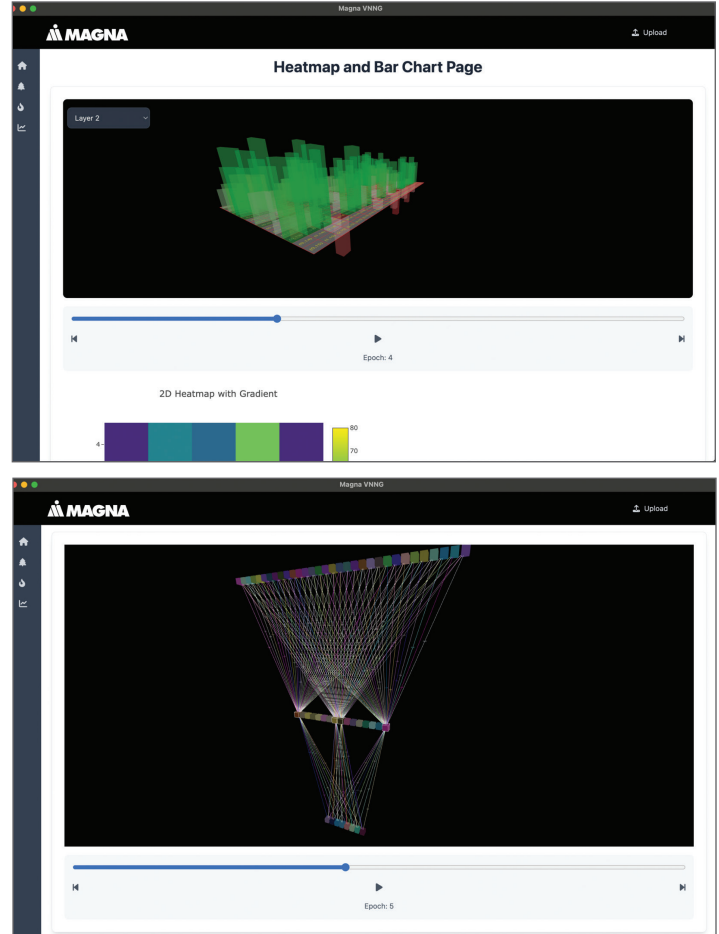
Michigan State University
Team Members (left to right)

Devin Dematto
Hastings, Michigan

Arhan Mulay
Santa Clara, California

Don Truong
Ho Chi Minh, Vietnam

Sarah Regan
McLean, Virginia

An Le
Hanoi, Vietnam

Alex Stornant
Birmingham, Michigan

Magna VNNG
Project Sponsors

Jim Quesenberry
Troy, Michigan

Rajeev Verma
Troy, Michigan

Magna
## World Feature Generation for ADAS Simulation

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

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

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

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

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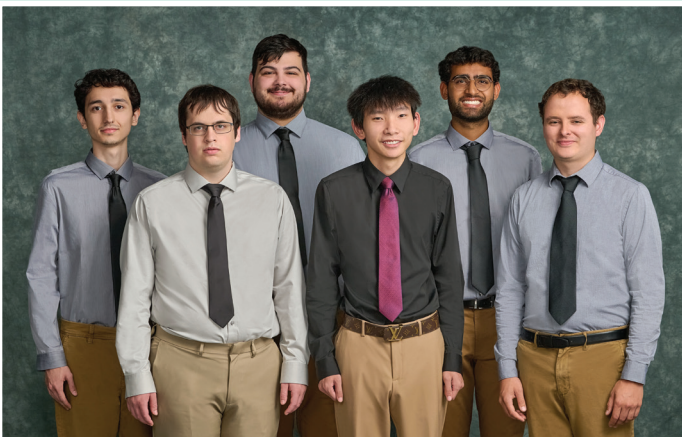
Michigan State University
Team Members (left to right)

Ethan Gomez
Macomb, Michigan

Walker McDonald
Ponce Inlet, Florida

Gabe Militello
Commerce Township, Michigan

Yi Wu
Wayne, Pennsylvania

Rohit Chavan
Okemos, Michigan

Jake Brown
Farmington Hills, Michigan

Magna WFG4ADAS
Project Sponsors

Banu Büyüker
St.Valentin, Austria

Jim Quesenberry
Troy, Michigan

Daniel Schleicher
St.Valentin, Austria

Meijer
Increasing Awareness of Meijer-Branded Products

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

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

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

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

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

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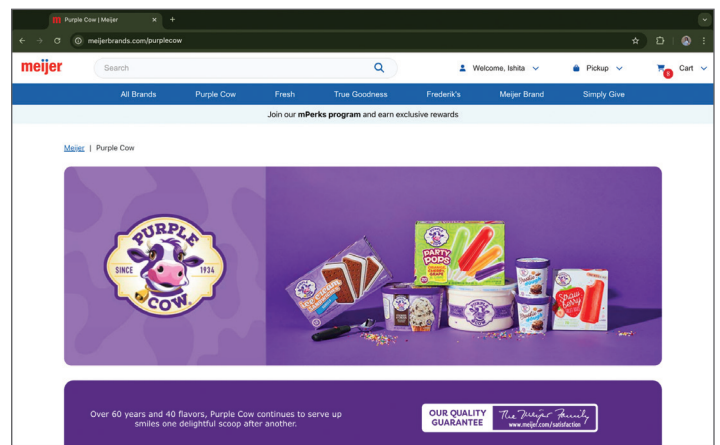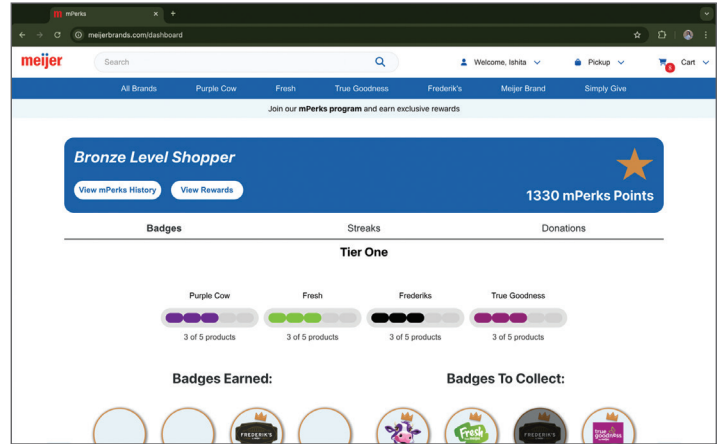
Michigan State University
Team Members (left to right)

Viraj Shah
Troy, Michigan

Robby Dewar
Royal Oak, Michigan

Mackenzi Steinmetz
St. Clair Shores, Michigan

Ishi Saripalle
Novi, Michigan

Sonia Thalatoti
Vijayawada, Andhra Pradesh, India

Meijer
Project Sponsors

Ariel Firon
Grand Rapids, Michigan

Phil Kane
Grand Rapids, Michigan

Terry Ledbetter
Grand Rapids, Michigan

John Morrison
Grand Rapids, Michigan

Michigan State University
Robotic Job Coaching

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

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

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

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

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

Michigan State University
Team Members (left to right)

Kyle Roleson
Hamburg Township, Michigan

Ekene Umobi
Abuja, FCT, Nigeria

Adam Cohen
Chesterfield, Missouri

Olivia Pal
Kharagpur, West Bengal, India

Stavro Polis
Sterling Heights, Michigan

Kaiwen Jiang
Kunming, Yunnan, China

Michigan State University CSE
Project Sponsors

Ashrut Aryal
East Lansing, Michigan

Hung Jen Kuo
East Lansing, Michigan

Ranjan Mukherjee
East Lansing, Michigan

Charles Owen
East Lansing, Michigan

MSU Federal Credit Union
Branch Pickup Lockers

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

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

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

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

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

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

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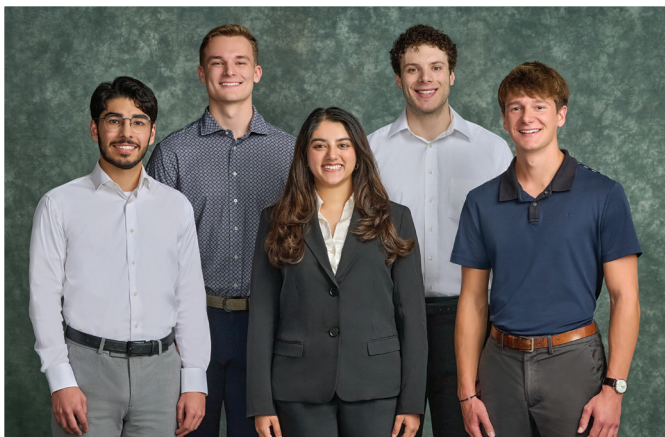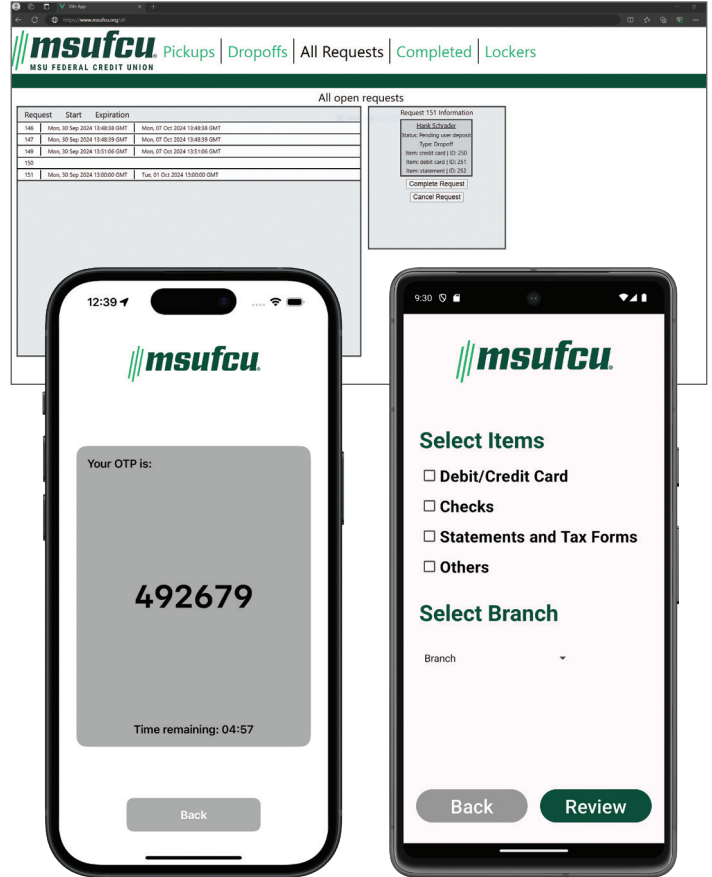
Michigan State University
Team Members (left to right)

Abdulla Alblooshi
Al Ain, Abu Dhabi,
United Arab Emirates

Lucas Fankhauser
Toledo, Ohio

Rida Mahmood
Jubail, Eastern Province,
Saudi Arabia

Will Morant
Grand Rapids, Michigan

David Kuehn
West Chicago, Illinois

MSUFCU
Project Sponsors

April Clobes
East Lansing, Michigan

Filip Danielewicz
East Lansing, Michigan

May Isrow
East Lansing, Michigan

Ben Maxim
East Lansing, Michigan

Meredith Nicholoff
East Lansing, Michigan

Roosevelt Innovations
Intelligent Benefits Parser and Knowledge Assistant

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

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

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

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

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

Our system's front end is built using the Angular framework. The back end utilizes FastAPI. All data for our application is stored on MongoDB Atlas. The knowledge assistant runs on the OpenAI API.
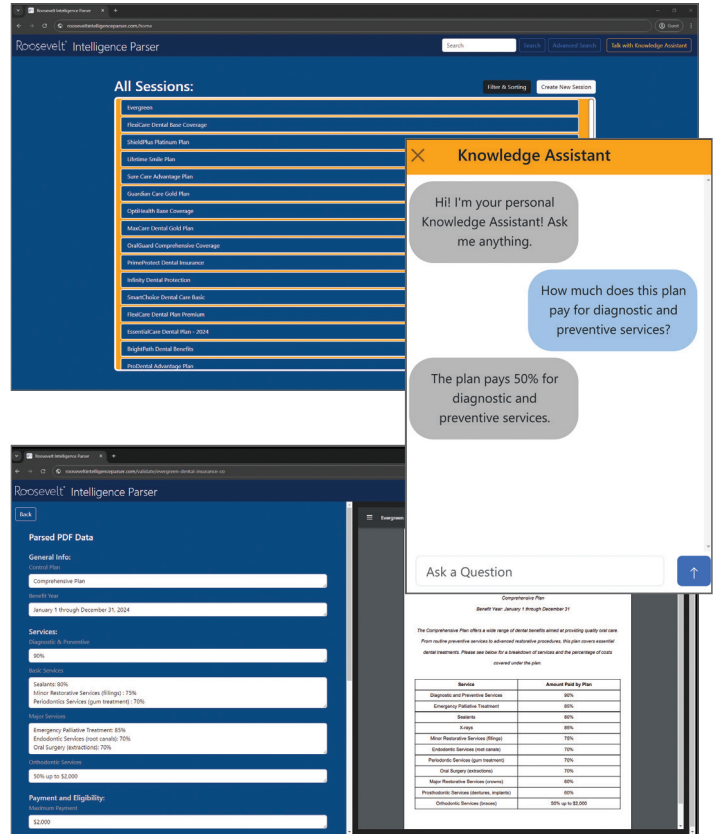
Michigan State University
Team Members (left to right)

Brenden Cwiek
White Lake, Michigan

Jada Clark
Marquette, Michigan

Kyle Raeside
Clinton Township, Michigan

Riley Cook
Beverly Hills, Michigan

Austin Sawicki
Howell, Michigan

Maanasi Ganapathy
Dallas, Texas

Roosevelt Innovations Knowledge Science
Project Sponsors

Mukundan Agaram
Okemos, Michigan

Jacob Ernst
Okemos, Michigan

Daniel Magaway
Okemos, Michigan

RPM
# Automated VIN Integration for RPM Logistics

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

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

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

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

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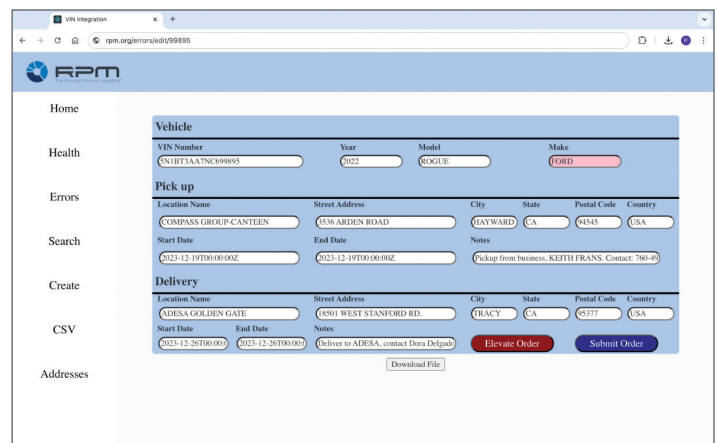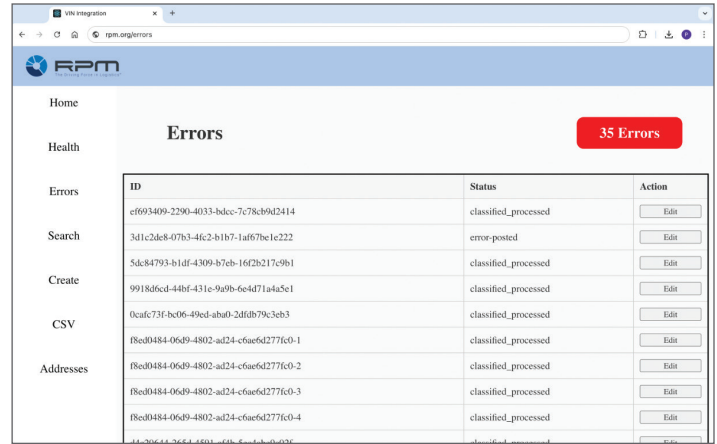
Michigan State University
Team Members (left to right)

Connor Sheridan
Macomb, Michigan

Ajay Suresh
Troy, Michigan

Brandon Linville
Whitmore Lake, Michigan

Palmer McGuire
Lake Orion, Michigan

Thomas Huynh
Grand Rapids, Michigan

RPM
Project Sponsors

Rick Grubb
Royal Oak, Michigan

Synica Melton
Royal Oak, Michigan

Andy Thielking
Royal Oak, Michigan

Stryker
Surgical OR Instruments and Needle Tracking

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

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

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

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

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

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

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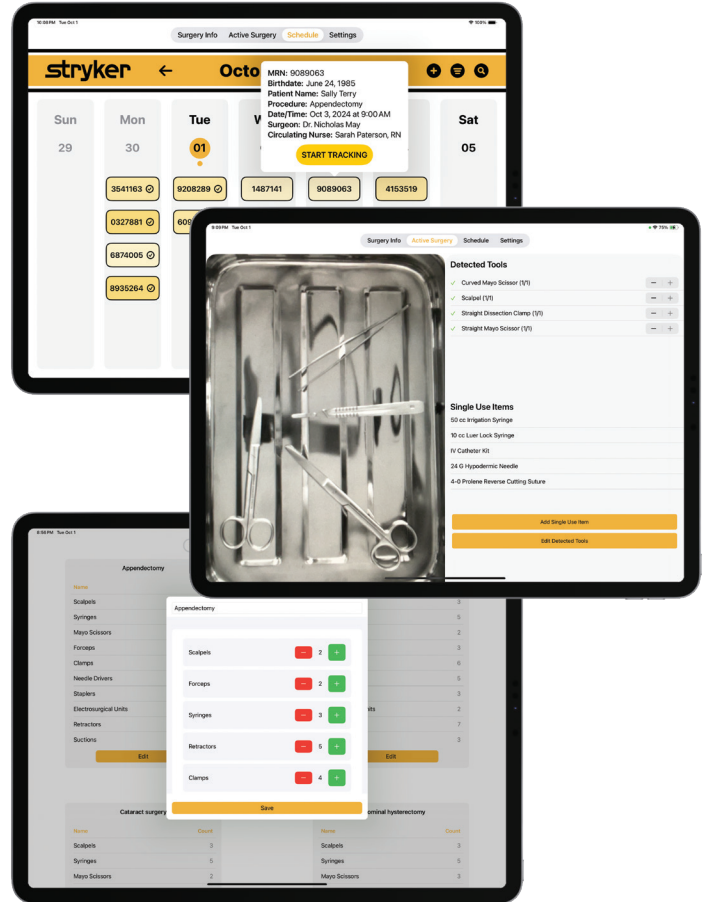
stryker

Michigan State University
Team Members (left to right)

Ryan Filipiak
Dexter, Michigan

Duong Tran
Hanoi, Vietnam

Joshua Mae
Rochester Hills, Michigan

Ashley Siegmund
Midland, Michigan

Declan Bahen
Canton, Michigan

Aditya Chaudhari
Aurangabad, Maharashtra, India

Stryker IST
Project Sponsors

Martin Griffin
Portage, Michigan

Patrick Lafleche
Portage, Michigan

Ross Nave
Portage, Michigan

Slaven Sutalo
Portage, Michigan

TechSmith
Video Insight and Knowledge Interface (VIKI)

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

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

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

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

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

The front end of VIKI is built using ReactJS while our back end is built with FastAPI. Our web application is hosted using Microsoft Azure. VIKI uses OpenAI and Hugging Face models, and Azure AI Video Indexer to provide feedback.
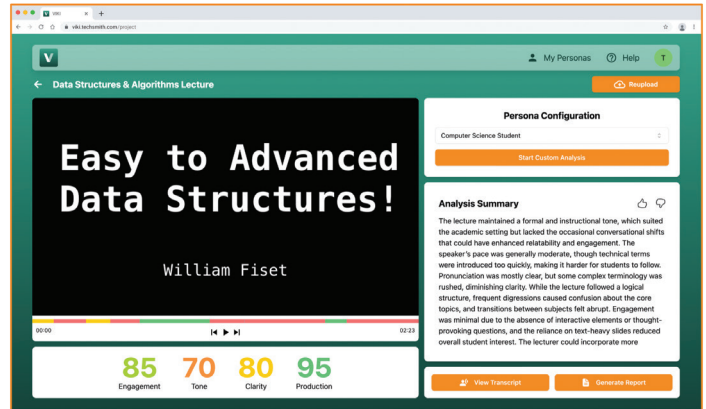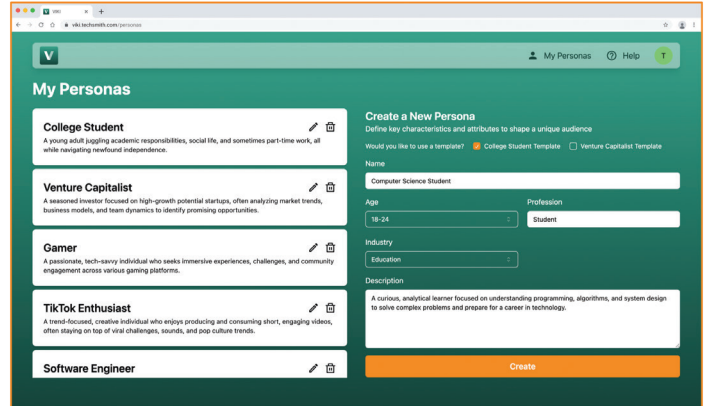
Michigan State University
Team Members (left to right)

Samuel Blashill
Park Ridge, Illinois

Brandon Hwang
Seoul, South Korea

Andrew Strominger
Highland, Michigan

Sania Sinha
Kolkata, West Bengal, India

Tyler McDonald
Rochester Hills, Michigan

Prajeeth Naliganti
Okemos, Michigan

TechSmith
Project Sponsors

Dorie Blaisdell
East Lansing, Michigan

Wendy Hamilton
East Lansing, Michigan

Derek Hammond
East Lansing, Michigan

Tony Lambert
East Lansing, Michigan

Michael Malinak
East Lansing, Michigan

Scott Schmerer
East Lansing, Michigan

Craig Smith
East Lansing, Michigan

Xochitl Weiss
East Lansing, Michigan

Union Pacific
## Virtual Reality Inspection Training

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

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

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

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

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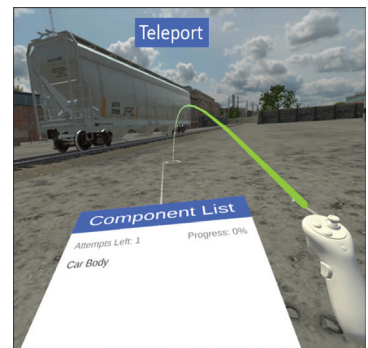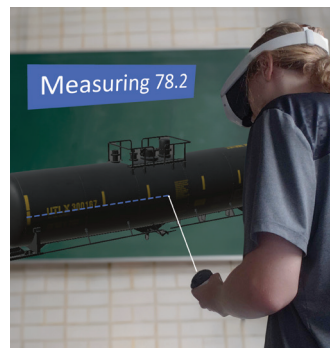
Michigan State University
Team Members (left to right)

Nicolas Georgescu
Grand Rapids, Michigan

Tyler Ziegenfelder
Orchard Lake, Michigan

Luc Walz
Grosse Pointe, Michigan

Sasha Tarasova
Lansing, Michigan

Sean Burch
Tampa, Florida

Mohammad Zaman
Warren, Michigan

Union Pacific
Project Sponsors

Jeff Girbach
Milford, Michigan

Adam Halley
Omaha, Nebraska

Hunter Oestmann
Johnson, Nebraska

Brian Partlow
Omaha, Nebraska

Prasanna Rajendran
Omaha, Nebraska

Daniel Riedel
Lincoln, Nebraska

Urban Science
Predicting Automotive Sales Using Generative AI

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

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

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

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

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

Our web application is built using React and Tailwind for the front end, MySQL for data storage, and C# and .NET framework for the back end. The software utilizes Azure cloud services for hosting.
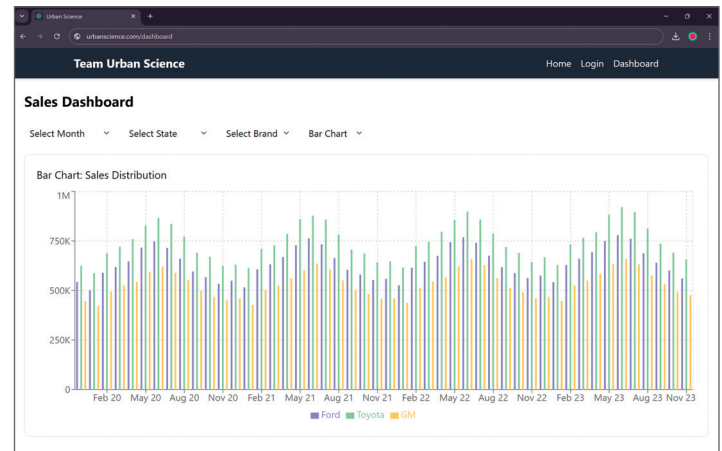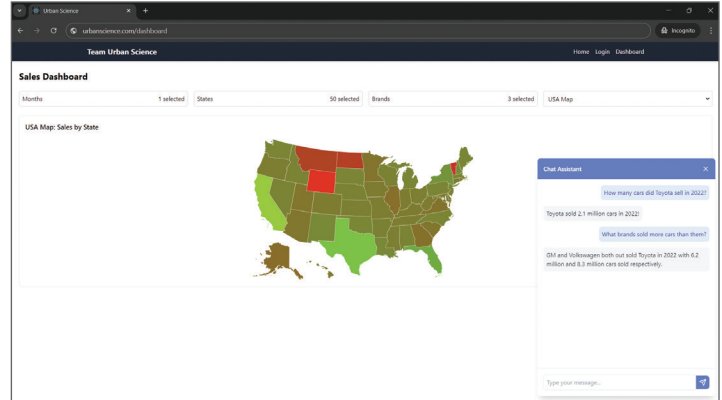
Michigan State University
Team Members (left to right)

Quang Nguyen
Hanoi, Vietnam

Sam Wycoff
Clarkston, Michigan

Zeeshan Naeem
Sterling Heights, Michigan

Max Tetlow
Plymouth, Michigan

Aidan Gollan
Traverse City, Michigan

Trinity Johnson
Detroit, Michigan

Urban Science
Project Sponsors

Pratap Chennamoulu
Detroit, Michigan

Pierre Gilbert
Detroit, Michigan

Majd Nashwati
Detroit, Michigan

Vectra AI
AI Cyberattack Early Warning System

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

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

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

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

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

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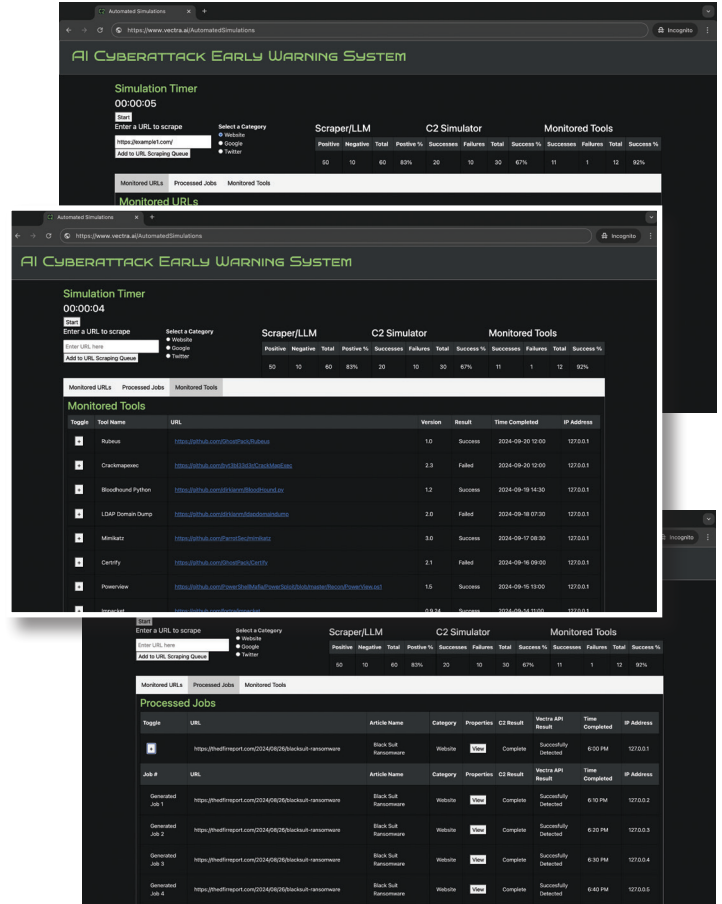
Michigan State University
Team Members (left to right)

Ajay Kumar
Farmington Hills, Michigan

Aleksa Popovic
Belgrade, New Belgrade, Serbia

Alex Fortsch
Rochester, New York

Morghane McAnelly
Rochester Hills, Michigan

Graham Holley
Kalamazoo, Michigan

Jacob Sock
Detroit, Michigan

Vectra AI
Project Sponsors

Campbell Robertson
Traverse City, Michigan

Brad Woodberg
Plymouth, Michigan

Volkswagen Group of America
Safe Journey AI

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

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

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

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

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

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

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

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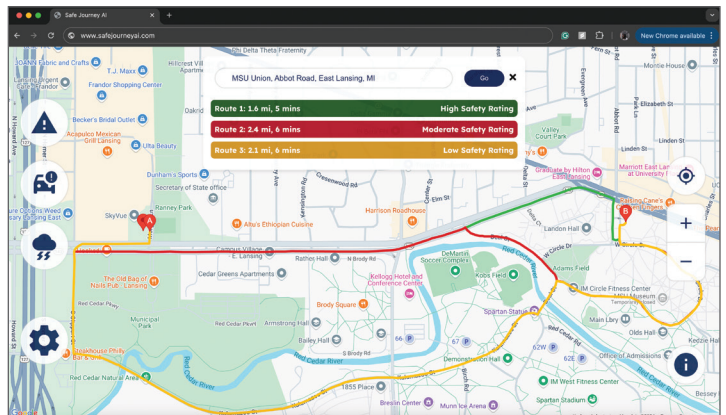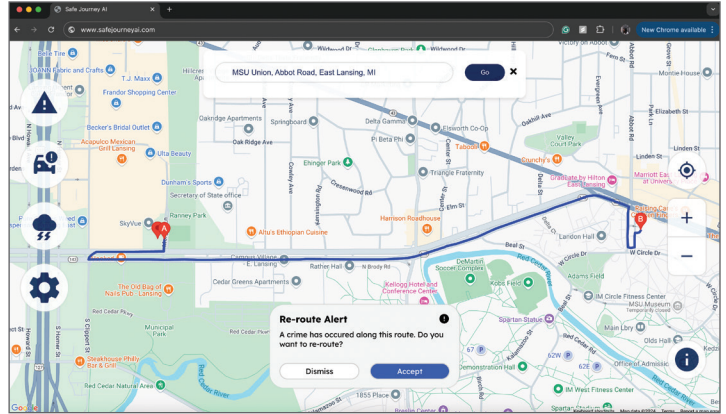
Michigan State University
Team Members (left to right)

Sudhanv Komanduri
Okemos, Michigan

Navya Singh
Dubai, United Arab Emirates

Ricardo Quinonez
San Salvador, El Salvador

Shashank Jayaram
Troy, Michigan

Pranav Premchand
Sterling Heights, Michigan

Maui Baba
Royal Oak, Michigan

Volkswagen
Project Sponsors

Igor Efremov
Auburn Hills, Michigan

Hassan Elnajjar
Auburn Hills, Michigan

Frank Weith
Auburn Hills, Michigan

Whirlpool Corporation
Cooking GPS

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

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

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

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

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

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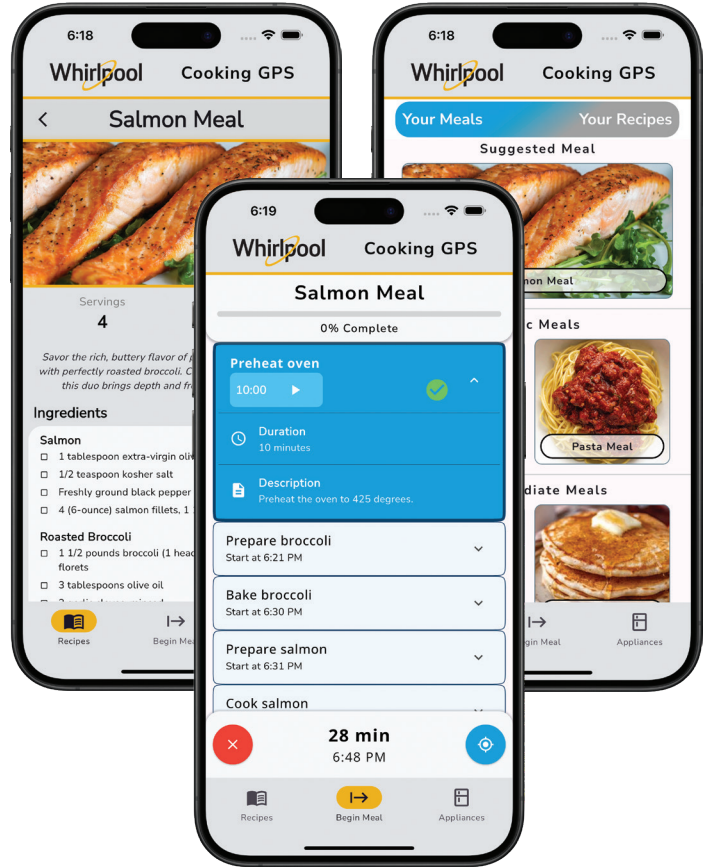
Michigan State University
Team Members (left to right)

Conner Smith
Troy, Ohio

Ruitao Liu
Jinhua, Zhejiang, China

Bruce Smith
Clawson, Michigan

Audrey Parsons
Wixom, Michigan

Chris Swiecicki
Grand Rapids, Michigan

Connor Wurtz
Kalamazoo, Michigan

Whirlpool
Project Sponsors

Alessandro Gigante
Cassinetta, Italy

Elizabeth (Liz) Kacpura
Benton Harbor, Michigan

Jackie Li
Benton Harbor, Michigan

Estefany Chavez Ruiz
Benton Harbor, Michigan

WK Kellogg Co
## Cereal Industry Analysis Tool Using Generative AI

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

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

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

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

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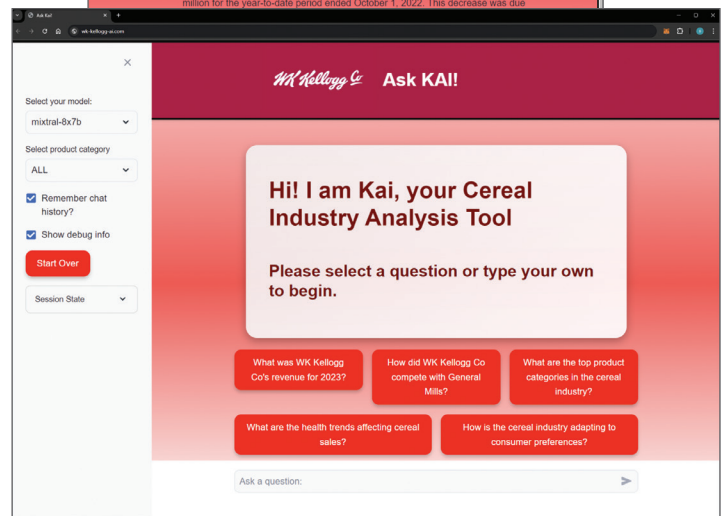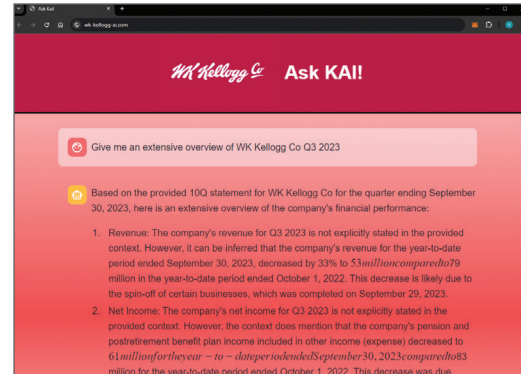
Michigan State University
Team Members (left to right)

Anand Pinnamaneni
Ann Arbor, Michigan

Daniel Flanagan
Huntington Woods, Michigan

Shubh Sharma
Kolkata, West Bengal, India

Roshni Kaur
Lansing, Michigan

Suryansh Singh
Mumbai, Maharashtra, India

Samin Matin
Dhaka, Dhaka, Bangladesh

WK Kellogg Co
Project Sponsors

Federico Conde
Battle Creek, Michigan

Gerry Finck
Battle Creek, Michigan

Bill Rex
Battle Creek, Michigan

Aaron Smith
Battle Creek, Michigan

Jay Swiatek
Battle Creek, Michigan

James Wright
Battle Creek, Michigan

Design Day

At the end of each semester, the College of Engineering sponsors Design Day, at which student teams from across the College showcase their Capstone projects throughout the Engineering Building.

Computer science capstone teams demonstrate the software projects that they have designed, developed and delivered for their corporate client. Teams compete for four awards, which are conferred by a panel of corporate judges.

As the Executive Director of Design Day, Professor Dyksen gives the opening remarks at the College of Engineering Design Day Awards Ceremony.

Brad Shaffer and Ross Hacker present the Design Day Auto-Owners Exhibition Award to Team Union Pacific.

THANKS TO AUTO-OWNERS INSURANCE

We thank Auto-Owners Insurance, a Fortune 500 company headquartered in Lansing, Michigan, for their continued support of Michigan State University and the Capstone Experience, including the printing of The Capstone Experience booklet.

Check out the Capstone Experience web site at www.capstone.cse.msu.edu. For more information about the capstone experience or becoming a capstone project sponsor, contact Dr. Wayne Dyksen by email (dyksen@msu.edu) or by phone (517-353-5573).

Project Sponsors Spring 2025

ally
Detroit, Michigan

amazon
Detroit, Michigan & Seattle, Washington

Anthropocene Institute
Palo Alto, California

Auto-Owners INSURANCE
Lansing, Michigan

Corewell Health™
Grand Rapids, Michigan

DELTA DENTAL®
Okemos, Michigan

gm
Detroit, Michigan

hap
Detroit, Michigan

HENRY FORD HEALTH
Innovations
Detroit, Michigan

Launch by NTT DATA
Troy, Michigan

MAGNA
Troy, Michigan & Aurora, Ontario, Canada

McKESSON
Irving, Texas

meijer
Grand Rapids, Michigan

MICHIGAN STATE UNIVERSITY Founded 1855
East Lansing, Michigan

msufcu
East Lansing, Michigan

NETJETS®
Columbus, Ohio

RPM
Royal Oak, Michigan

stryker
Kalamazoo, Michigan

TechSmith®
East Lansing, Michigan

UNION PACIFIC
BUILDING AMERICA®
Louisville, Colorado & Omaha, Nebraska

URBAN SCIENCE
Detroit, Michigan

UWM®
UNITED WHOLESALE MORTGAGE
Pontiac, Michigan

VW
Auburn Hills, Michigan

Whirlpool
Benton Harbor, Michigan

WK Kellogg Co
Battle Creek, Michigan

Ally Financial
AI System Testing Framework

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

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

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

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

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

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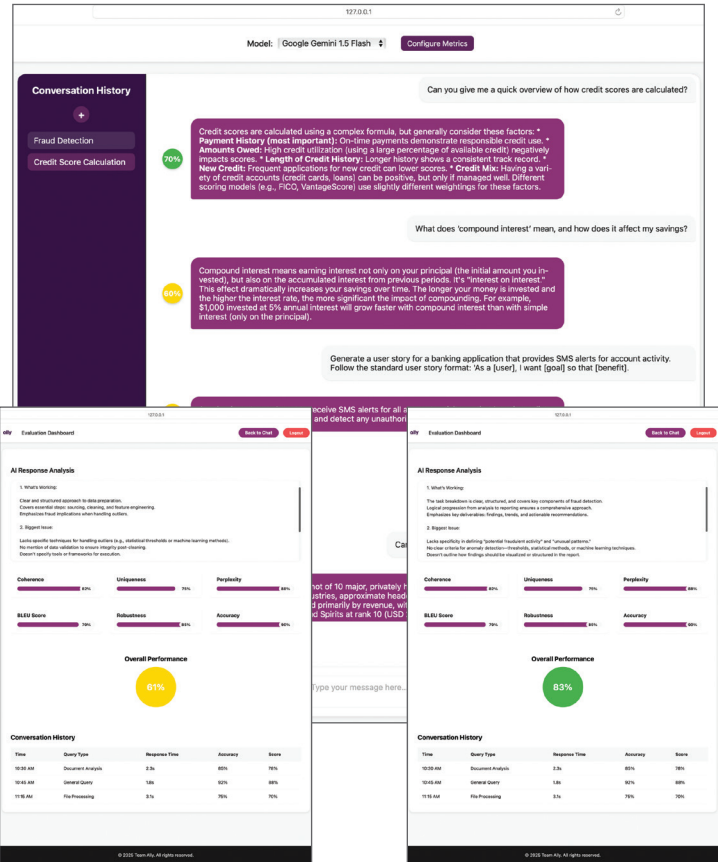
Michigan State University
Team Members (left to right)

Vu Ho
Hanoi, Vietnam

Andrew Dagher
Livonia, Michigan

Gabe Moraru
Grand Rapids, Michigan

Michael Plante
Ada, Michigan

Ethan Gomez
Macomb, Michigan

Amit Wagh
Novi, Michigan

Ally
Project Sponsors

Jesue Jackson
Charlotte, North Carolina

Divyesh Jambusaria
Charlotte, North Carolina

Dan Lemont
Detroit, Michigan

Jesse Podell
New York, New York

John Stoutenger
Charlotte, North Carolina

Theresa Weaver
Detroit, Michigan

Amazon
Semantic Search for Code and Architecture Assets

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

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

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

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

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

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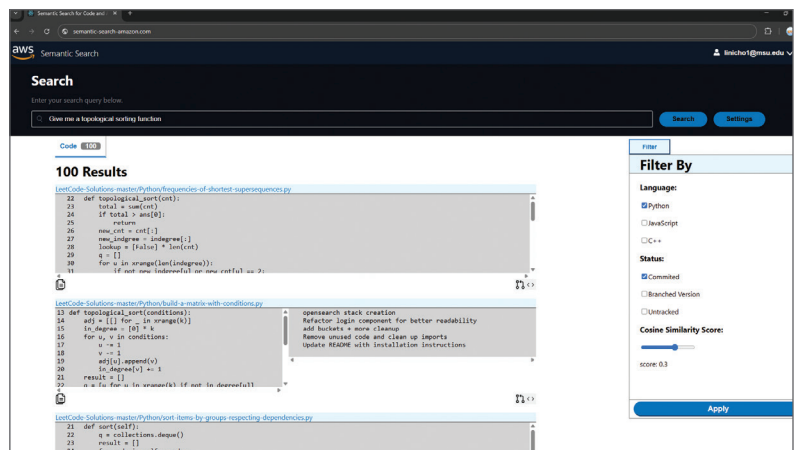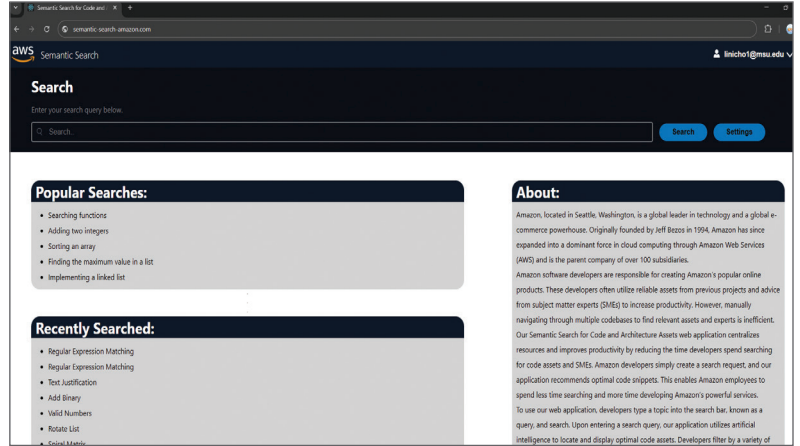
Michigan State University
Team Members (left to right)

Nicholas Li
Troy, Michigan

Zayd Abualfellat
Grand Blanc, Michigan

Jerry Chen
Lincolnshire, Illinois

Atharva Kirkole
Pune, Maharashtra, India

Sampan Chaudhuri
Canton, Michigan

Amazon
Project Sponsors

Steven Carpenter
Detroit, Michigan

Garret Gaw
Detroit, Michigan

Cole Riggle
Detroit, Michigan

Anthropocene Institute
Balancing the Power Grid with Nuclear Power

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

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

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

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

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

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

The front end of our web application is in HTML, CSS, and JavaScript. The back end is implemented with Python Flask and is connected to a MySQL database.
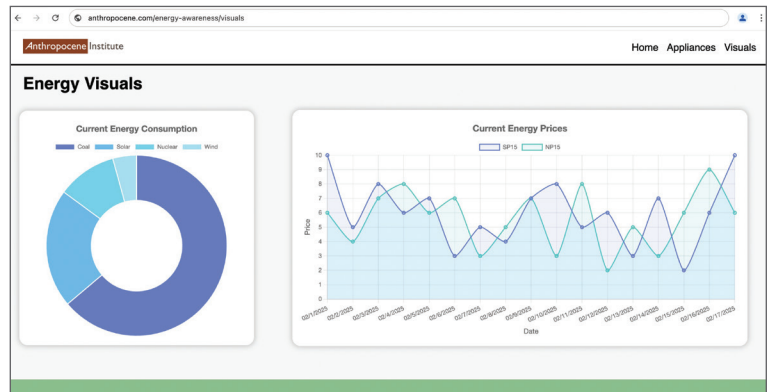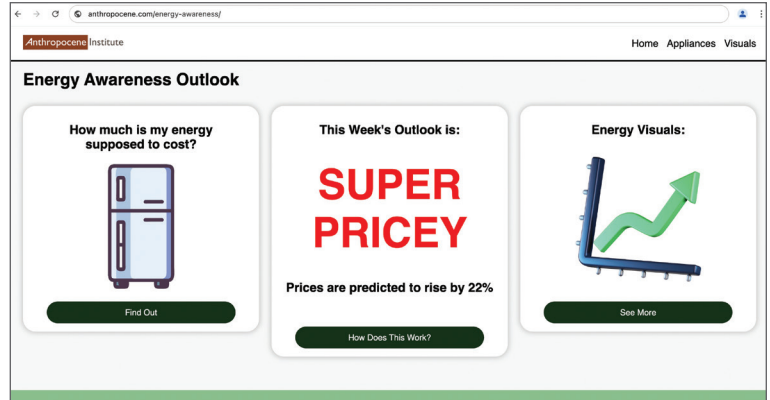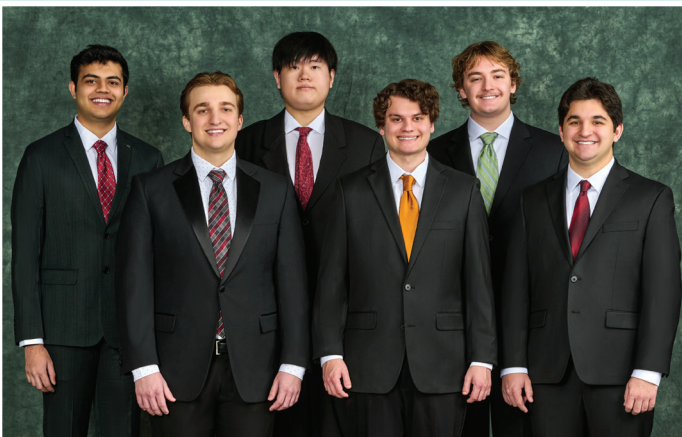
Michigan State University
Team Members (left to right)

Aarav Desai
Mumbai, Maharashtra, India

Austin Blackwell
DeWitt, Michigan

Xinyu Tian
Qingdao, Shandong, China

Jaden Shah
Farmington Hills, Michigan

Hayden Cheney
Mason, Michigan

Owen Lenkiewicz
Grand Rapids, Michigan

Anthropocene Institute
Project Sponsors

Melinda Alankar
Denver, Colorado

Frank Ling
Tokyo, Japan

Guido Núñez-Mujica
San Francisco, California

Carl Page
Palo Alto, California

Jesús Alejandro Pineda
Bogotá, Colombia

Auto-Owners Insurance
Next Step Insight

Auto-Owners Insurance is a Fortune 500 company headquartered in Lansing, Michigan. Auto-Owners is represented by 48,000 licensed insurance agents in 26 states and provides insurance to nearly 6 million policyholders.

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

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

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

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

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

The front end of our application is built with HTML, CSS and TypeScript, while the back end is implemented with Spring Boot 3. The data for our application is stored in a Microsoft SQL database.
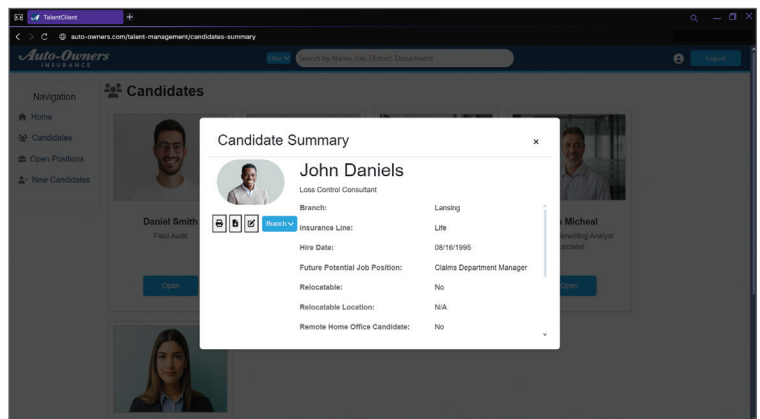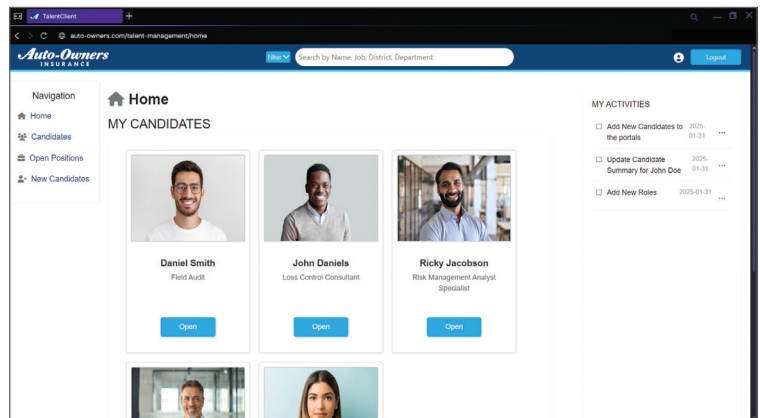
Michigan State University
Team Members (left to right)

Jacquelyn Nehra
Saint Clair Shores, Michigan

Alek Russa
Jenison, Michigan

Briana Hill
Southfield, Michigan

Jason Janz
Beecher, Illinois

Bhaaniu Jain
Farmington Hills, Michigan

Auto-Owners
Project Sponsors

Tony Dean
Lansing, Michigan

Ross Hacker
Lansing, Michigan

Brad Schafer
Lansing, Michigan

Julie Wilkinson
Lansing, Michigan

Corewell Health
AI for Med Students Learning About Basket Management

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

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

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

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

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

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

Corewell Health™

Michigan State University
Team Members (left to right)

Pradyumna Karyamapudi
Holland, Michigan

Shaheer Khan
West Bloomfield, Michigan

Isaac Zelenak
Chesterfield, Michigan

Daphne Martin
Huntsville, Alabama

Julian Akkashian
Birmingham, Michigan

Christopher Nguyen
Macomb, Michigan

Corewell Health
Project Sponsors

Paige Heckel
Grand Rapids, Michigan

Harland Holman
Grand Rapids, Michigan

Brian McAllister
Grand Rapids, Michigan

Nathan Ostlund
Grand Rapids, Michigan

Candace Smith-King
Grand Rapids, Michigan

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

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

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

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

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

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

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

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

The front end of our web application is built with Angular. Three.js is used to display 3D models and Bootstrap provides formatting for the front end. Java Quarkus is used for connecting Angular to the PostgreSQL back end.
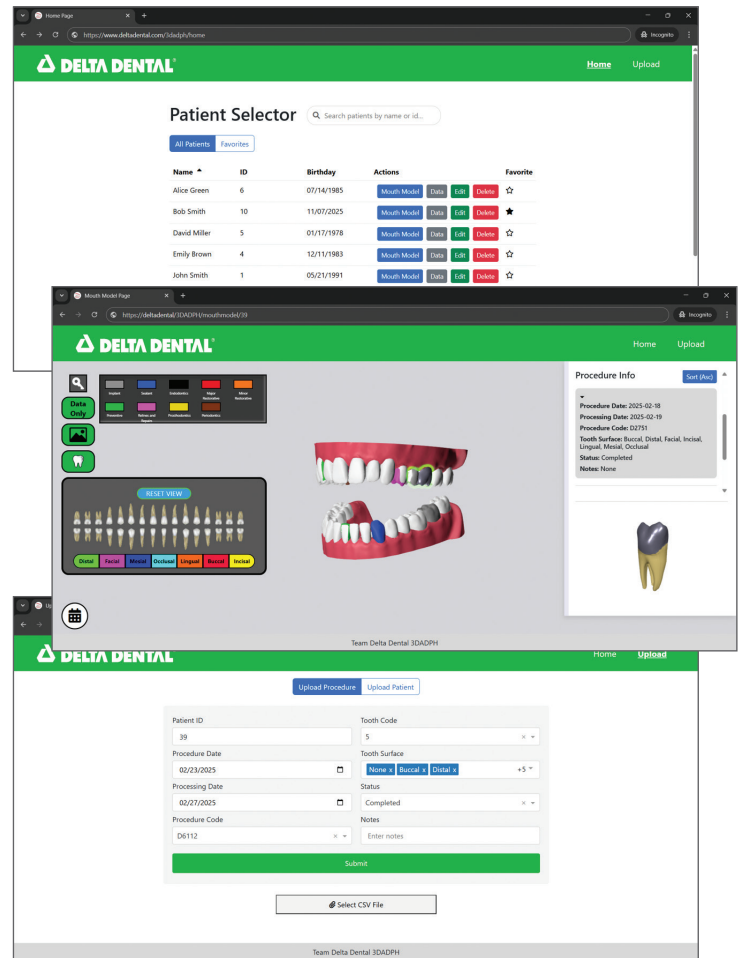
Michigan State University
Team Members (left to right)

Ben Crimmins
Beverly Hills, Michigan

Lance Stemple
Midland, Michigan

Jacob Robson
New Lenox, Illinois

Sanju Kona
Saint Joseph, Michigan

Jasen Van Acker
Rochester Hills, Michigan

Thomas Toaz
Ionia, Michigan

Delta Dental 3DADPH
Project Sponsors

Mukundan Agaram
Okemos, Michigan

Michael Chen
Okemos, Michigan

Jacob Ernst
Okemos, Michigan

Toby Hall
Okemos, Michigan

Daniel Magaway
Okemos, Michigan

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

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

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

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

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

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

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

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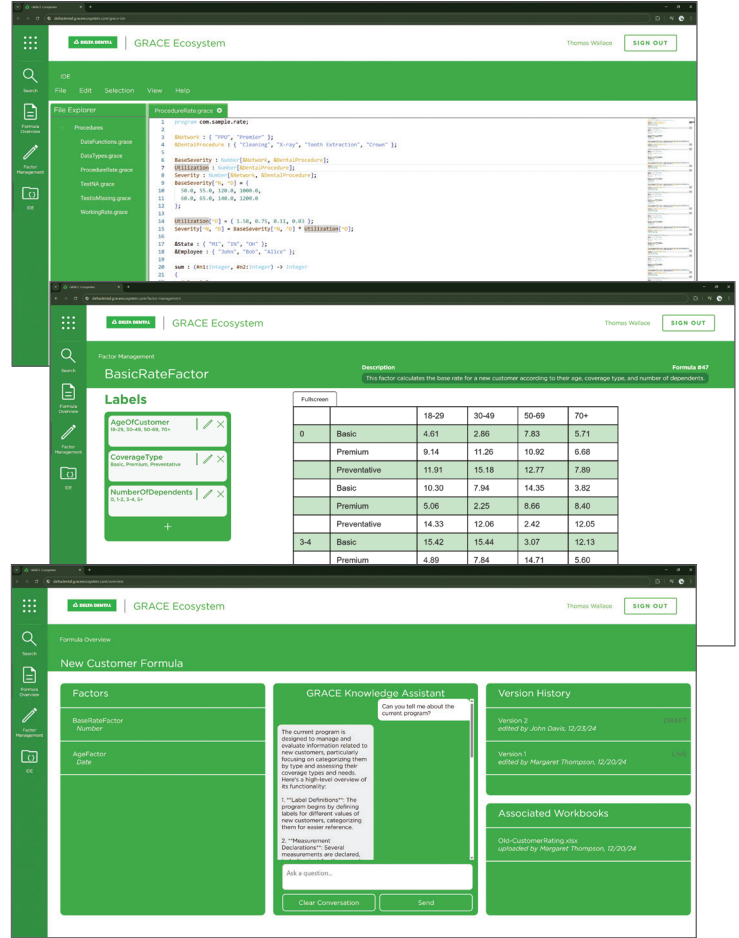
Michigan State University
Team Members (left to right)

Henry Greer
Grosse Pointe Park, Michigan

David Wells
Harrison Township, Michigan

Mitchell Ballinger
Iron River, Michigan

Jude Hansen
Aurora, Illinois

Antonio Capozzoli
Northville, Michigan

Joseph Hughes
Gibraltar, Michigan

Delta Dental dSLATE
Project Sponsors

Mukundan Agaram
Okemos, Michigan

Jacob Ernst
Okemos, Michigan

Toby Hall
Okemos, Michigan

Chang Liu
Okemos, Michigan

Daniel Magaway
Okemos, Michigan

General Motors
Global Waste Management System

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

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

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

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

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

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

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

The front end of the Global Waste Management is built using React while the back end utilizes Flask, Python libraries, and MySQL.
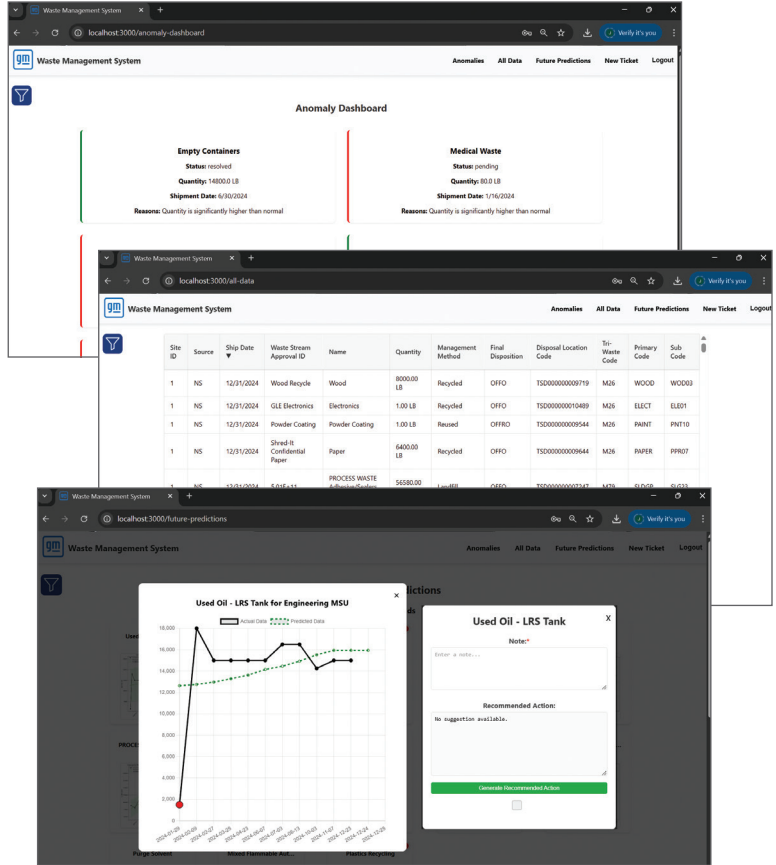
Michigan State University
Team Members (left to right)

Hassan Maklai
Dubai, Dubai, UAE

Manh Tran
Hanoi, Hanoi, Vietnam

Ben Blanchard
Grand Rapids, Michigan

Joseph Khalaf
Troy, Michigan

Nathan Shammami
Walled Lake, Michigan

GM
Project Sponsors

Michael Cherry
Warren, Michigan

James Currie
Warren, Michigan

Patrick Doyle
Warren, Michigan

Laura Evans
Warren, Michigan

Jeffrey Seibert
Warren, Michigan

Peter Wyatt
Warren, Michigan

HAP
# Customer Intent Engine and Training Tool

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

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

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

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

Our front-end software is developed using HTML, CSS, and JavaScript, while the back end is implemented using Python Flask with PostgreSQL as the database. The software leverages Python for data analysis and generates interactive dashboards using the Python Dash library. The chatbot is trained and implemented using the Hugging Face library in Python.
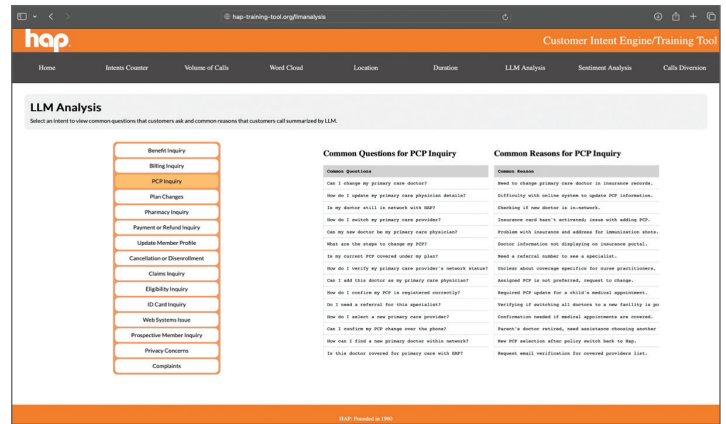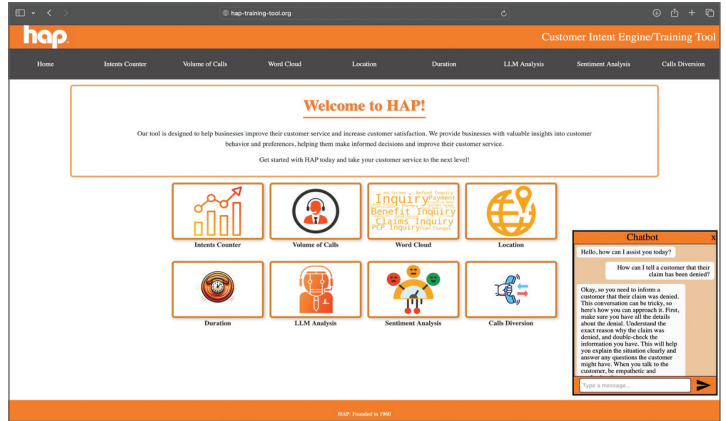
Michigan State University
Team Members (left to right)

Saarthak Sharma
Sterling Heights, Michigan

Praneetha Ankisettipalli
Troy, Michigan

Averey Davis
Whitmore Lake, Michigan

Abdulrahman Alanazi
Tabuk, Tabuk, Saudi Arabia

Bao Hoang
Hanoi, Hanoi, Vietnam

Karoline Yashin
Plymouth, Michigan

HAP
Project Sponsors

Angela Endres
Detroit, Michigan

Rachel Mclean
Detroit, Michigan

Vinoth Mohan
Detroit, Michigan

Steve Neubecker
Detroit, Michigan

Henry Ford Innovations
Electronic Laboratory User's Guide (eLUG)

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

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

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

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

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

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

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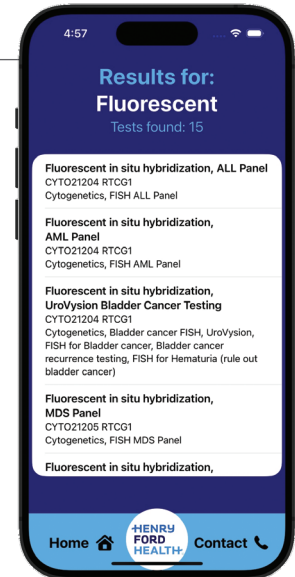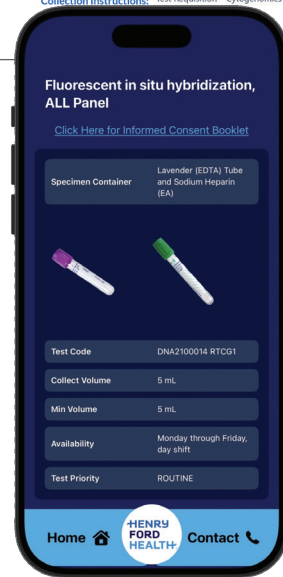
HENRY FORD HEALTH
Innovations

Michigan State University
Team Members (left to right)

Shreyas Sankar
Troy, Michigan

Shreya Rudagi
Troy, Michigan

Trevor Jacobs
Rockford, Michigan

Deenie Vichitpap
Troy, Michigan

Abhi Rao
Troy, Michigan

Anushka Basani
Novi, Michigan

Henry Ford Innovations eLUG
Project Sponsors

James Adams
Detroit, Michigan

Adam Baldwin
Detroit, Michigan

Bryce Crumrine
Detroit, Michigan

Vikas Relan
Detroit, Michigan

Henry Ford Innovations
Modernizing Robotic Surgery Education 2.0

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

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

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

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

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

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

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

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

Our web-application uses Flask, PyTorch, Docker, JavaScript, Dash, HTML, and CSS to provide a seamless experience. We use Swift to extend the application to iOS platforms.
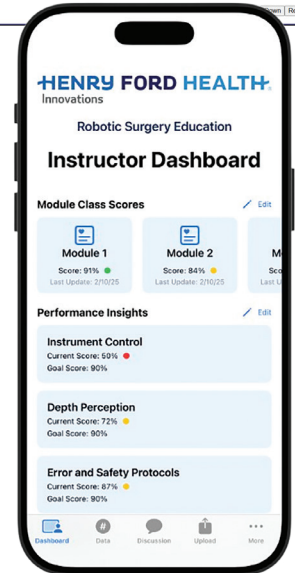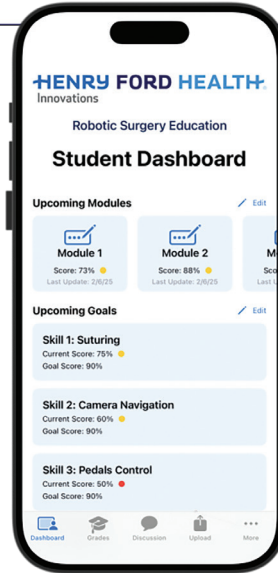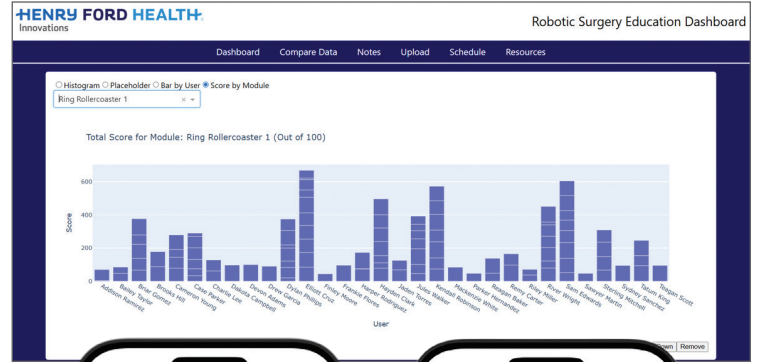
Michigan State University
Team Members (left to right)

Caden Fisher
Grand Rapids, Michigan

Bryan Tran
Southfield, Michigan

Hayden Hiller
Grand Blanc, Michigan

Neha Kumar
Canton, Michigan

Dylan Troyer
Northville, Michigan

Miranda Gabbara
Washington, Michigan

Henry Ford Innovations RSE
Project Sponsors

James Adams
Detroit, Michigan

Surya Nalamati
Detroit, Michigan

Vikas Relan
Detroit, Michigan

Henry Ford Innovations
MSU-HFH Research Synergy Vanguard Portal (RSVP) 2.0

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

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

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

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

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

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

HENRY FORD HEALTH
Innovations
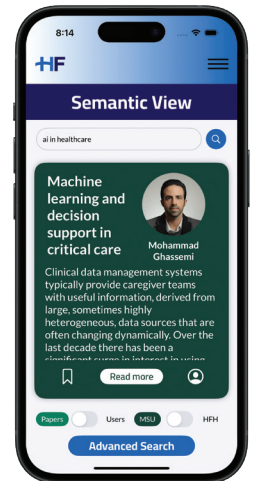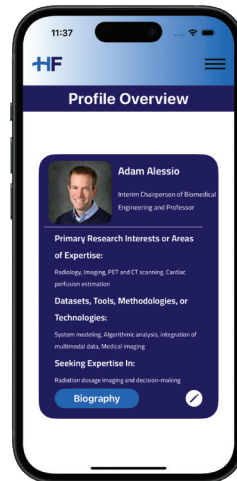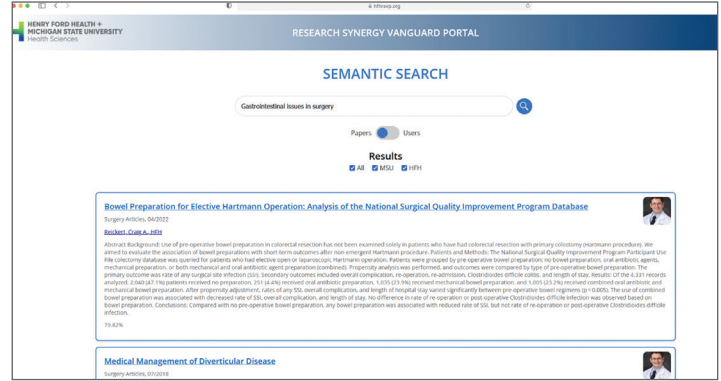
Michigan State University
Team Members (left to right)

Aaron Breese
Ann Arbor, Michigan

Felipe Marques Allevato
Rio de Janeiro, Rio de Janeiro, Brazil

Owen Nyenhuis
Holland, Michigan

Spandana Kodali
Novi, Michigan

Andriy Tryshnivskyy
Warren, Michigan

Nika Ghasemi Barmi
Tehran, Tehran, Iran

Henry Ford Innovations RSVP
Project Sponsors

James Adams
Detroit, Michigan

Scott Dulchavsky
Detroit, Michigan

John Furcean
East Lansing, Michigan

Vikas Relan
Detroit, Michigan

David Willens
Detroit, Michigan

Launch by NTT DATA
Everyday Agent

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

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

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

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

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

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

Michigan State University
Team Members (left to right)

Anthony Oo
Novi, Michigan

Palina Skakun
Mogilev, Belarus

Gregory Lis
Lexington, Michigan

Swabhan Katkoori
Okemos, Michigan

Will Bray-Cotton
Troy, Michigan

Deirdre Eusebi
Bloomfield Hills, Michigan

Launch
Project Sponsors

Scott Campagna
Troy, Michigan

Anna Kowalak
Troy, Michigan

Jeff Meador
Troy, Michigan

Magna
Manufacturing Tracking System

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

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

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

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

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

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

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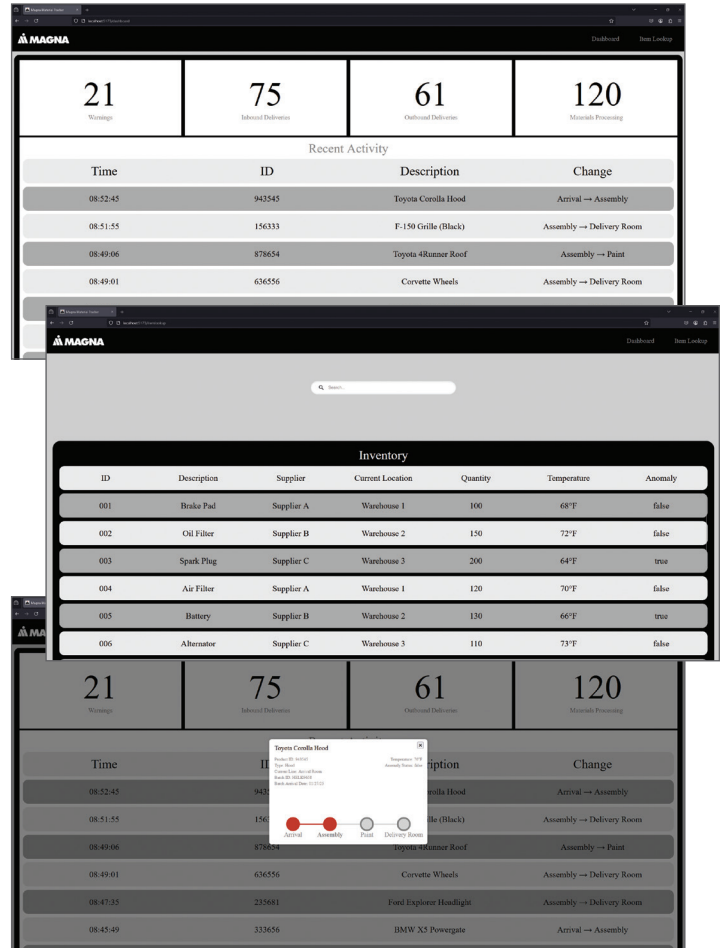
Michigan State University
Team Members (left to right)

Kaustubh Siriki
Troy, Michigan

Charlie Cicchella
Bloomfield Hills, Michigan

Eli Gudeman
Grayslake, Illinois

Dung Nguyen
Warren, Michigan

Tim Bodholt
Las Vegas, Nevada

Allen Shi
Rochester, Michigan

Magna
Project Sponsors

Jim Quesenberry
Troy, Michigan

Raidu Rayasam
Boston, Massachusetts

Chantal Ruggaber
Troy, Michigan

Sundar Selvaraj
Boston, Massachusetts

McKesson
Vulnerability Scan and Detect

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

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

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

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

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

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

Michigan State University
Team Members (left to right)

Nicholas Felarca
Shelby Township, Michigan

Demetrius Wilson
West Bloomfield, Michigan

Brady Johnson
Rockford, Michigan

Ananya Chittineni
Vijayawada, Andhra Pradesh, India

John Bannon
Northville, Michigan

Chris Nguyen
Madison Heights, Michigan

McKesson
Project Sponsors

Kosti Cami
Irving, Texas

Antony Mathew
Detroit, Michigan

Spencer Searle
Detroit, Michigan

Meijer
Online Customer Experience with Meijer Branded Products

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

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

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

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

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

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

The front end of this application uses ReactJS. The back end is implemented in C# with .NET, and the platform is hosted on Microsoft Azure. Microsoft SQL Server handles all data storage. The mobile app is written in Swift and SwiftUI.
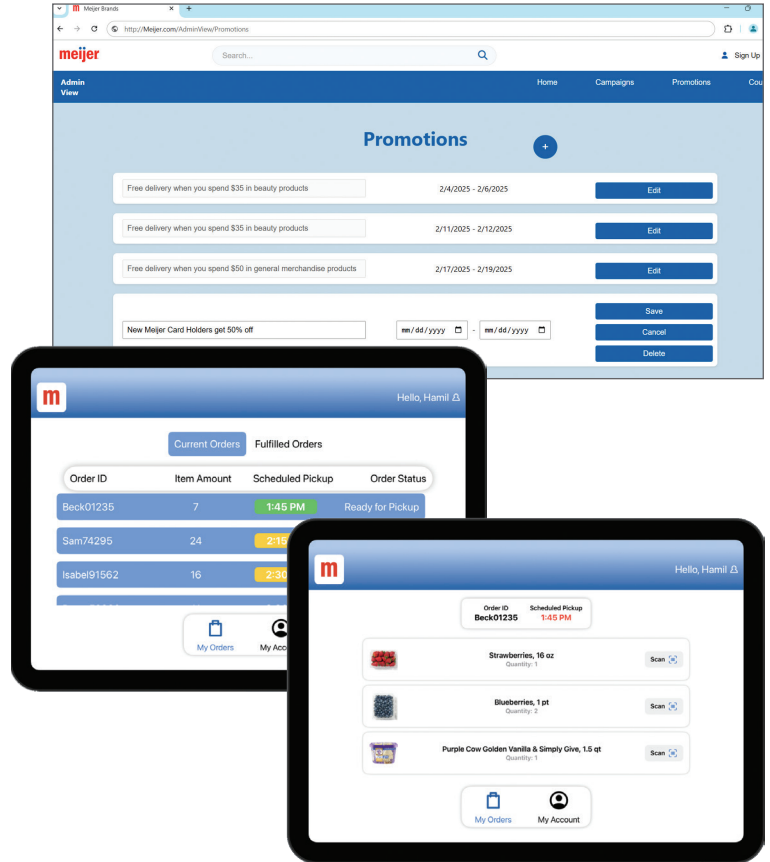
Michigan State University
Team Members (left to right)

Hamil Viray
Okemos, Michigan

Christopher Kocher
Norwalk, Ohio

Jordan Jones
Memphis, Tennessee

Alex Beck
Oakland Township, Michigan

Aidan Baird
Kalamazoo, Michigan

Meijer
Project Sponsors

Ariel Firon
Grand Rapids, Michigan

Phil Kane
Grand Rapids, Michigan

Terry Ledbetter
Grand Rapids, Michigan

John Morrison
Grand Rapids, Michigan

Michigan State University
Robotic Job Coaching 2.0

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

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

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

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

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

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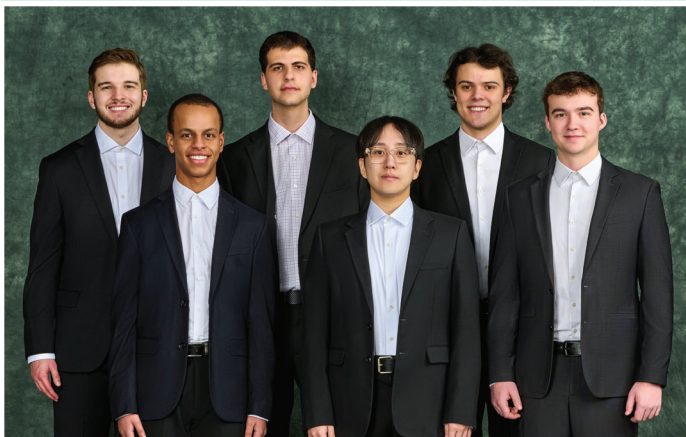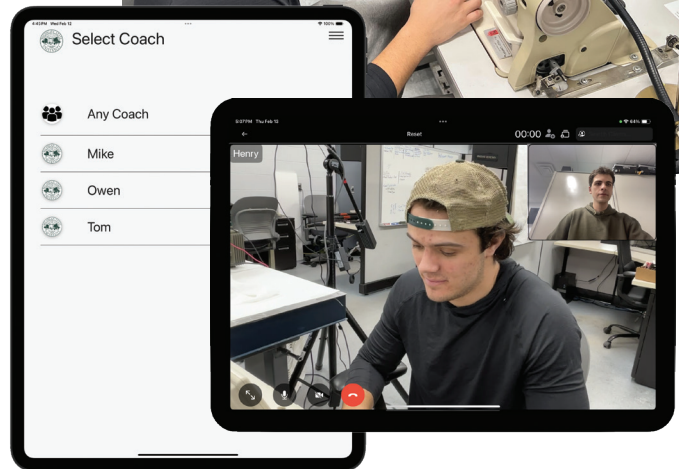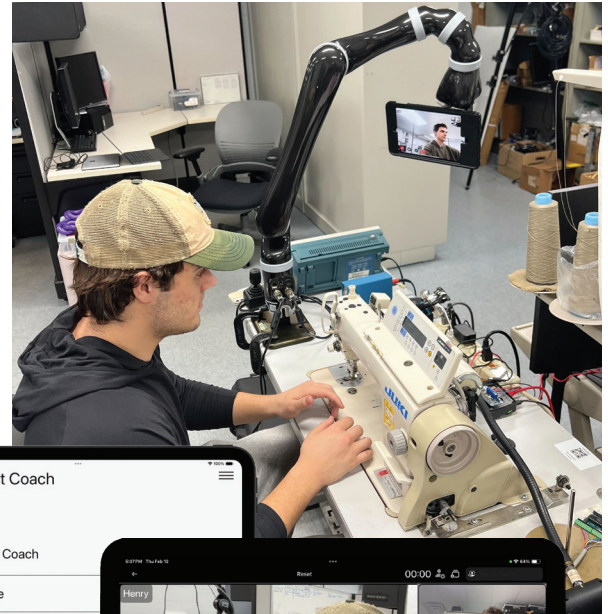
Michigan State University
Team Members (left to right)

John Nowinski
Blacksburg, Virginia

Gera Berhanu
Seattle, Washington

Nicolas Clark
Livonia, Michigan

Hail Lim
Seoul, Seoul, South Korea

Sean Finkel
Northbrook, Illinois

Cole Lanzinger
Toledo, Ohio

Michigan State University CSE RJC
Project Sponsors

Hung Jen Kuo
East Lansing, Michigan

Ranjan Mukherjee
East Lansing, Michigan

Charles Owen
East Lansing, Michigan

Michigan State University
Test Platforms for Self-Driving Race Cars

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

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

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

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

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

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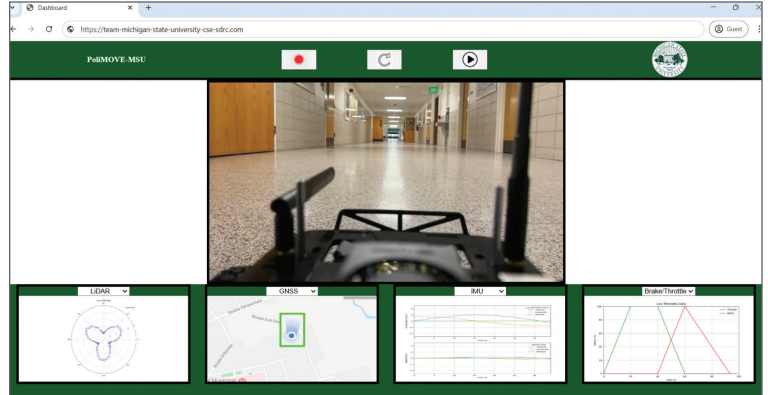
Michigan State University
Team Members (left to right)

Toby Wright
Ann Arbor, Michigan

Andrew Nguyen
Sterling Heights, Michigan

Jacob Youngerman
Holland, Michigan

Ricardo Flores
Holland, Michigan

Vu Phi
Hanoi, Hanoi, Vietnam

Yuxuan Li
Beijing, Beijing, China

Michigan State University CSE SDRC
Project Sponsors

Pragyan Dahal
East Lansing, Michigan

Josh Siegel
East Lansing, Michigan

Michigan State University
Crowd-Sourcing Intuitions of Vowel Classifications

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

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

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

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

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

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

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

The front end is built with React.js and structured with HTML, CSS and JavaScript to handle various data. The back end is powered by Flask which handles API requests and communication with the database.
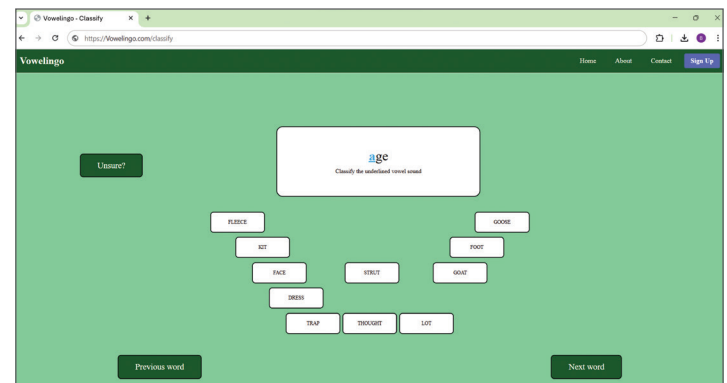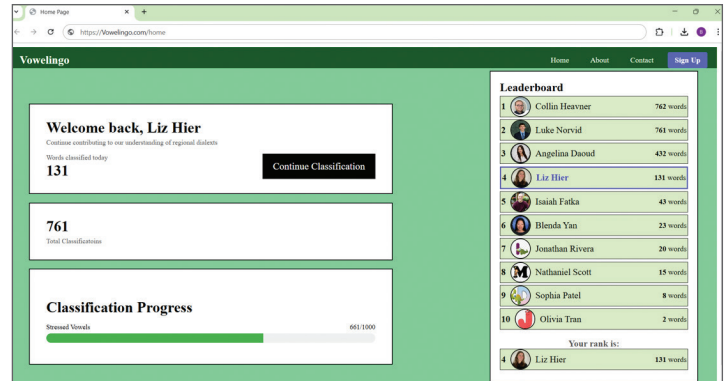
Michigan State University
Team Members (left to right)

Luke Norvid
Glen Ellyn, Illinois

Blenda Yan
Rochester Hills, Michigan

Collin Heavner
Dorr, Michigan

Angelina Daoud
Macomb, Michigan

Isaiah Fatka
Wixom, Michigan

Elizabeth Hier
Plymouth, Michigan

Michigan State University Linguistics
Project Sponsors

Monica Nesbitt
Bloomington, Indiana

Betsy Sneller
East Lansing, Michigan

Joey Stanley
Provo, Utah

MSU Federal Credit Union
Logged-In Branch Experience

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

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

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

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

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

Our Logged-In Branch Experience utilizes a front end built with HTML, CSS, and JavaScript with a Python back end. Information is stored and updated using a MySQL database.
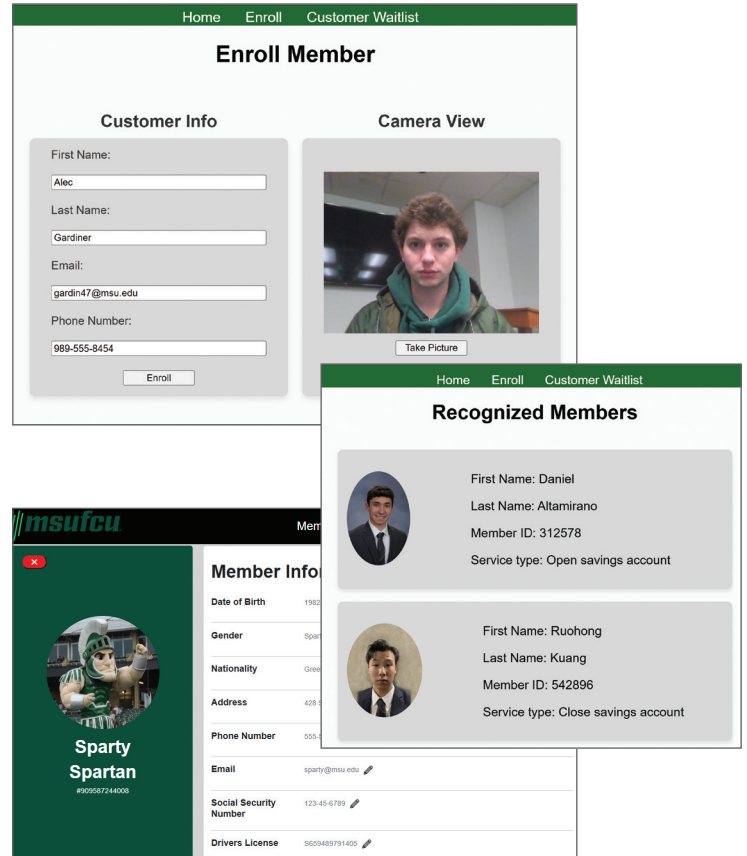
Michigan State University
Team Members (left to right)

Alec Gardiner
Grayling, Michigan

Spencer Russell
Livonia, Michigan

Ryan Fitzgerald
Oakland Township, Michigan

Reyna McConville
El Dorado Hills, California

Ruohong Kuang
Hengyang, Hunan, China

Daniel Altamirano
St. Louis, Missouri

MSUFCU
Project Sponsors

Alex de Almeida
East Lansing, Michigan

April Clobes
East Lansing, Michigan

Filip Danielewicz
East Lansing, Michigan

May Isrow
East Lansing, Michigan

Ben Maxim
East Lansing, Michigan

Meredith Nicholoff
East Lansing, Michigan

NetJets
Airport Capacity and Ground Space Management

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

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

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

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

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

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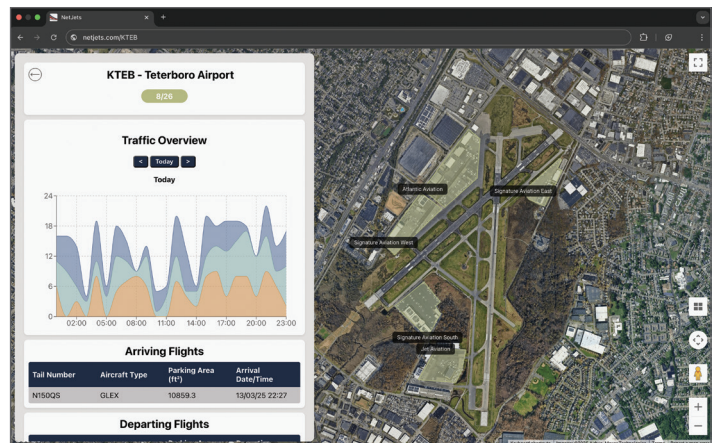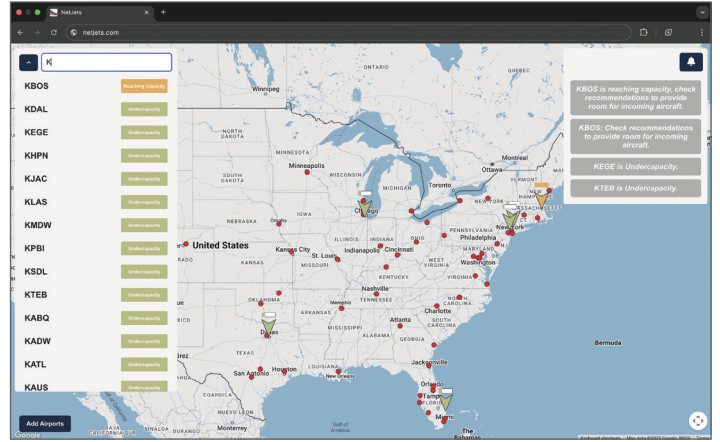
NETJETS®

Michigan State University
Team Members (left to right)

Ryan MacDonald
DeWitt, Michigan

Kendall Korcek
Dexter, Michigan

Jay Scott
Warren, Michigan

Emily Telgenhoff
Midland, Michigan

Ben Grycza
Clarkston, Michigan

Ryann Seymour
Grand Rapids, Michigan

NetJets
Project Sponsors

Amadou Anne
Columbus, Ohio

Eric McCarty
Columbus, Ohio

Morgan Schall
Columbus, Ohio

Kyle Sims
Columbus, Ohio

RPM
# Automated Damage Logging for Truck Drivers

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

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

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

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

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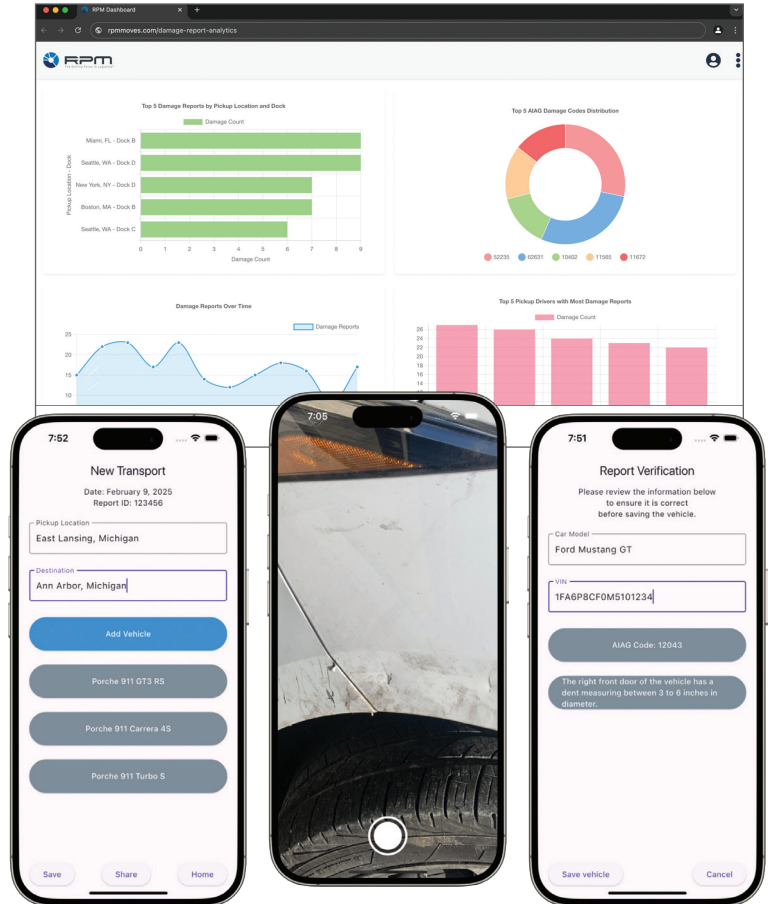
Michigan State University
Team Members (left to right)

Alfredo Sanchez Perez
Caracas, Miranda, Venezuela

Dheeraj Thota
Vijayawada, Andhra Pradesh, India

Gavin Bourdon
Livonia, Michigan

Flower Akaliza
Nairobi, Nairobi County, Kenya

Hayden Rance
Troy, Michigan

Troy Williams
Detroit, Michigan

RPM
Project Sponsors

Rick Grubb
Birmingham, Michigan

Synica Melton
Birmingham, Michigan

Stryker
Surgical Needle Tracking

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

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

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

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

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

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

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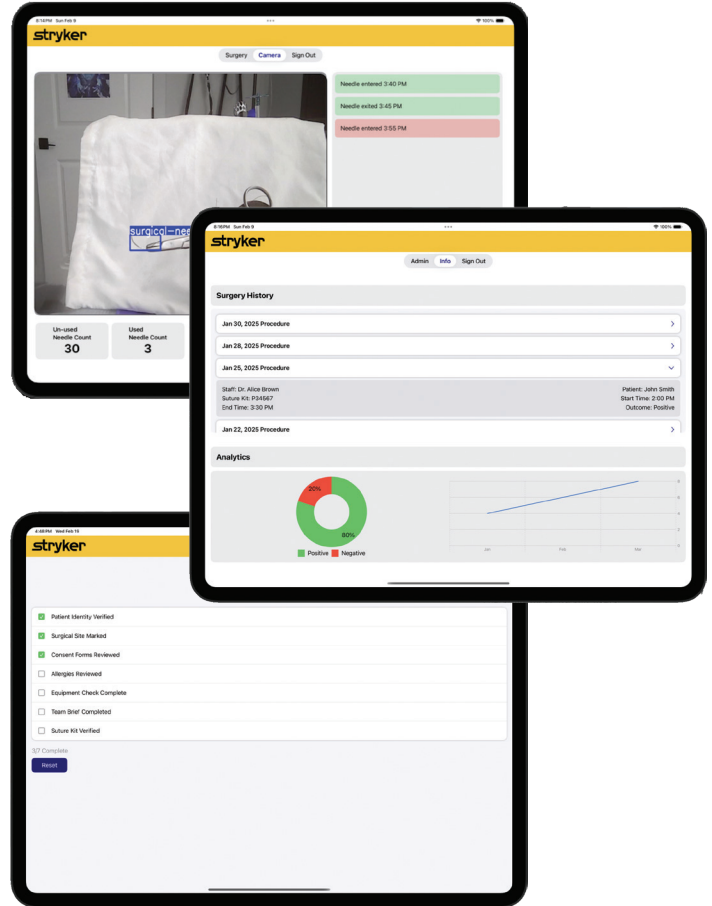
stryker

Michigan State University
Team Members (left to right)

Eric Redmon
Muskegon, Michigan

Brendan Niles-Bautista
Tecumseh, Michigan

Tyler Mirabitur
Hartland, Michigan

Ricky Huang
Taichung, Taiwan, ROC

Joseph Renas
Livonia, Michigan

Eli Asmar
Birmingham, Michigan

Stryker IST
Project Sponsors

Martin Griffin
Portage, Michigan

Patrick Lafleche
Portage, Michigan

Ross Nave
Portage, Michigan

Slaven Sutalo
Portage, Michigan

TechSmith
Watcher of Attuned Video Experiences (WAVE)

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

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

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

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

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

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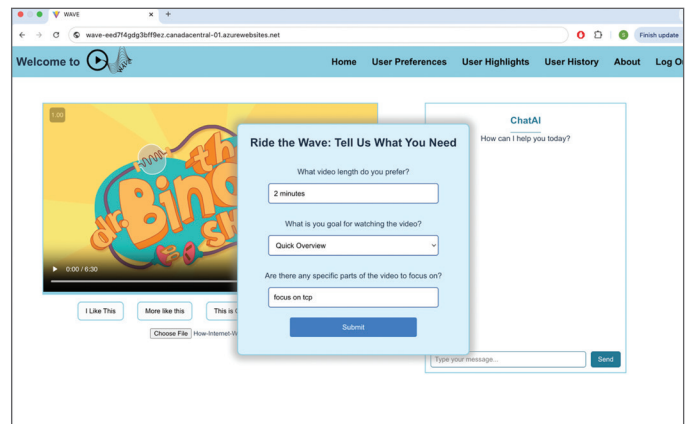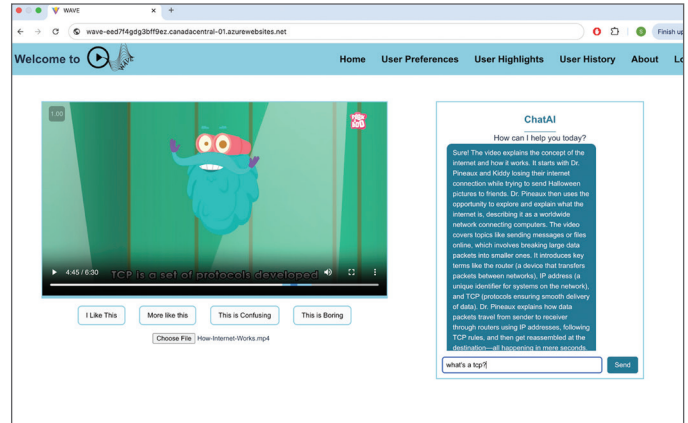
Michigan State University
Team Members (left to right)

Josh Costantino
Dearborn, Michigan

Phoebe Mensah
Tema, Greater Accra Region, Ghana

Marcus Cohen
Ann Arbor, Michigan

Shane Jose
Livonia, Michigan

Noor Muhammad
Chesterfield, Michigan

Meenakshi Menon
Troy, Michigan

TechSmith
Project Sponsors

Dorie Blaisdell
East Lansing, Michigan

Wendy Hamilton
East Lansing, Michigan

Derek Hammond
East Lansing, Michigan

Tony Lambert
East Lansing, Michigan

Michael Malinak
East Lansing, Michigan

Daewoo Maurya
East Lansing, Michigan

Scott Schmerer
East Lansing, Michigan

Craig Smith
East Lansing, Michigan

Union Pacific
Training Simulator Using GPS-Indexed Video

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

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

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

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

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

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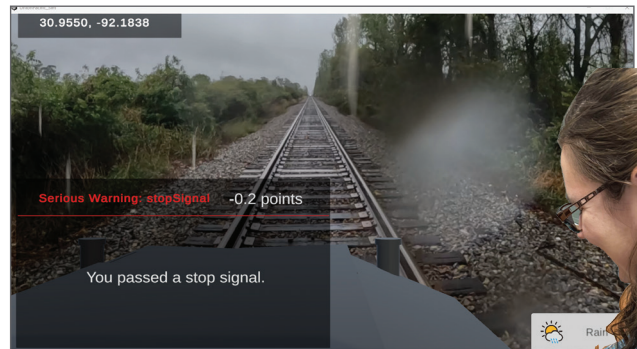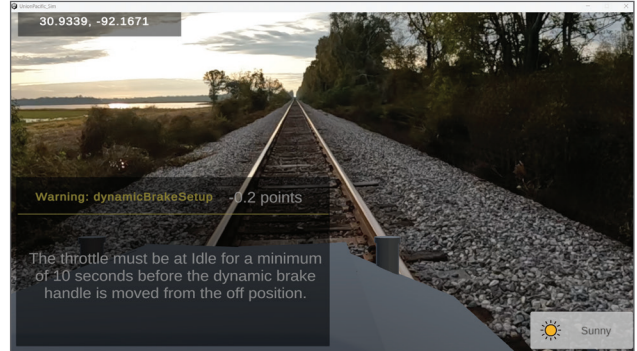
Michigan State University
Team Members (left to right)

Tre Benson
Grosse Pointe Park, Michigan

Nico Roberts
Pinckney, Michigan

Ravi Gangaiahanadoddi Kumar
Bangalore, Karnataka, India

Abigail Werden
Adrian, Michigan

Mohamed Ahmed
Canton, Michigan

Melinda Fadool
White Lake, Michigan

Union Pacific
Project Sponsors

Jeff Girbach
Milford, Michigan

Adam Halley
Omaha, Nebraska

Prasanna Rajendran
Omaha, Nebraska

Urban Science
Automotive Service Advisor AI Assistant

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

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

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

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

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

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

Our application is built with C# featuring a .NET MAUI front end and a .NET Core web API back end. Azure AI Services, along with Synthesia, are used to generate personalized media.
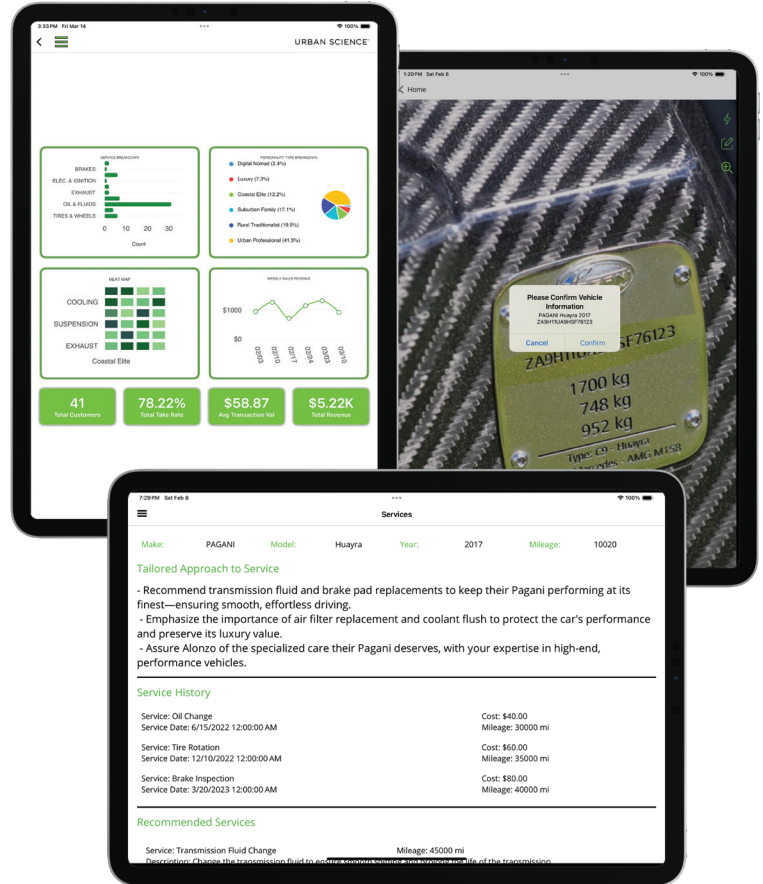
Michigan State University
Team Members (left to right)

Travis Wright
Lansing, Michigan

Owen Miller
Livonia, Michigan

John Harris
Ann Arbor, Michigan

Omar Osman
Lansing, Michigan

Josh VanBynen
Pinckney, Michigan

Srujan Patil
Novi, Michigan

Urban Science
Project Sponsors

Pratap Chennamoulu
Detroit, Michigan

Pierre Gilbert
Long Beach, California

Julian Gombos
Detroit, Michigan

Majd Nashwati
Detroit, Michigan

UWM
Centralized Comment History Microservice

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

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

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

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

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

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

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

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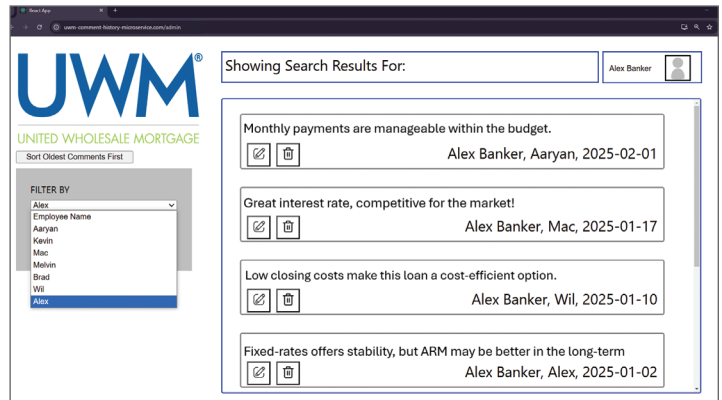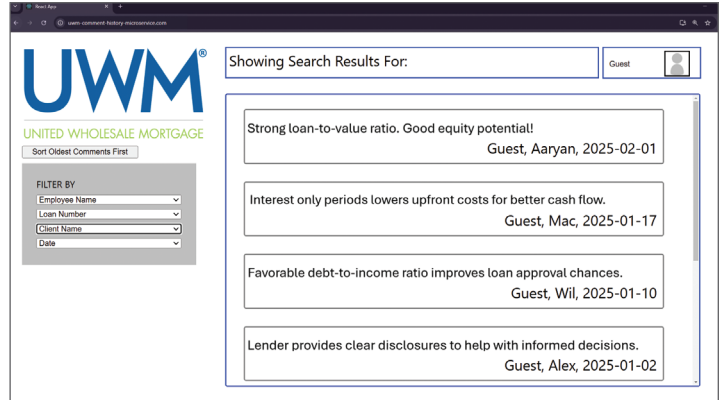
Michigan State University
Team Members (left to right)

Aaryan Walia
Canton, Michigan

Mac Dailey
Grosse Ile, Michigan

William Arnold
Shanghai, Puxi, China

Melvin Thomas
Farmington Hills, Michigan

Brad Deaner
Memphis, Michigan

Alex Banker
Fairfax, Virginia

UWM
Project Sponsors

Jillian Mantua
Pontiac, Michigan

Andrew Pirkola
Pontiac, Michigan

Jenni Sproul
Pontiac, Michigan

Volkswagen Group of America
Safe Journey AI 2.0

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

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

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

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

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

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

Michigan State University
Team Members (left to right)

Ethan Rush
South Lyon, Michigan

Seth Neubauer
Ann Arbor, Michigan

CJ Nwogu
Sterling Heights, Michigan

Emberlynn Zhao
Novi, Michigan

Aashish Harishchandre
Portage, Michigan

Grant Bossio
Beverly Hills, Michigan

Volkswagen
Project Sponsors

Shelly Desmet
Auburn Hills, Michigan

Igor Efremov
Auburn Hills, Michigan

Hassan Elnajjar
Auburn Hills, Michigan

Frank Weith
Auburn Hills, Michigan

Whirlpool Corporation
AI-Powered Precision Cooking with TasteLogic

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

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

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

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

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

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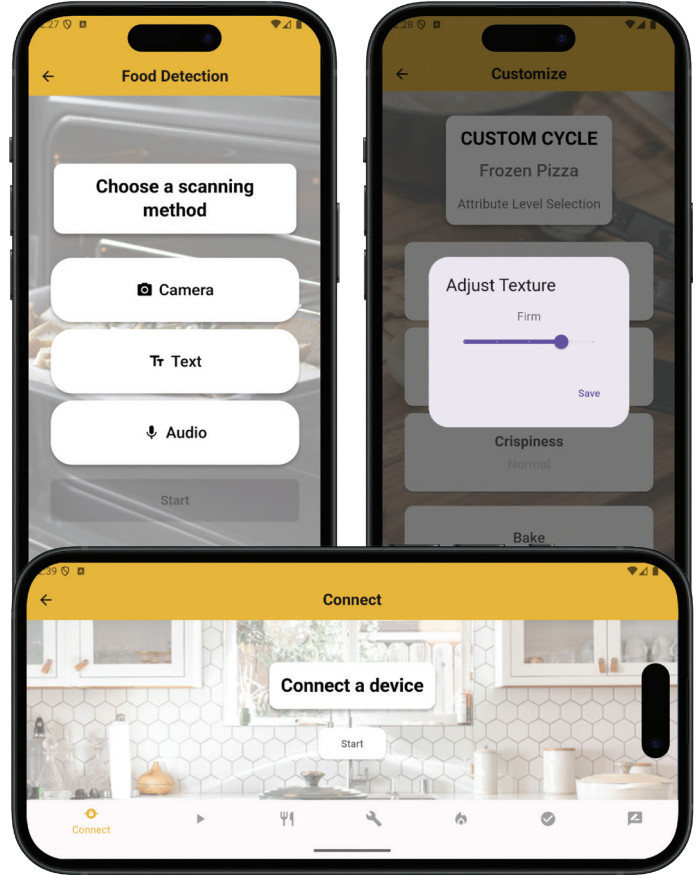
Michigan State University
Team Members (left to right)

David Wasilewski
Grand Rapids, Michigan

Lauren Funk
Troy, Michigan

Darayus Daboo
Ann Arbor, Michigan

Pavel Shevchenko
Okemos, Michigan

Aaron Ngo
East Lansing, Michigan

Frank Puglise
Romeo, Michigan

Whirlpool
Project Sponsors

Esther Faronbi
Benton Harbor, Michigan

Elizabeth (Liz) Kacpura
Benton Harbor, Michigan

Jackie Li
Benton Harbor, Michigan

WK Kellogg Co
Intelligent Ticketing and Release Management

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

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

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

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

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

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

Our system uses Amazon Web Services to improve the sustainability of the technology footprint at WK Kellogg Co. Our web application is built using React and Tailwind for the front end and Node.js for the back end.
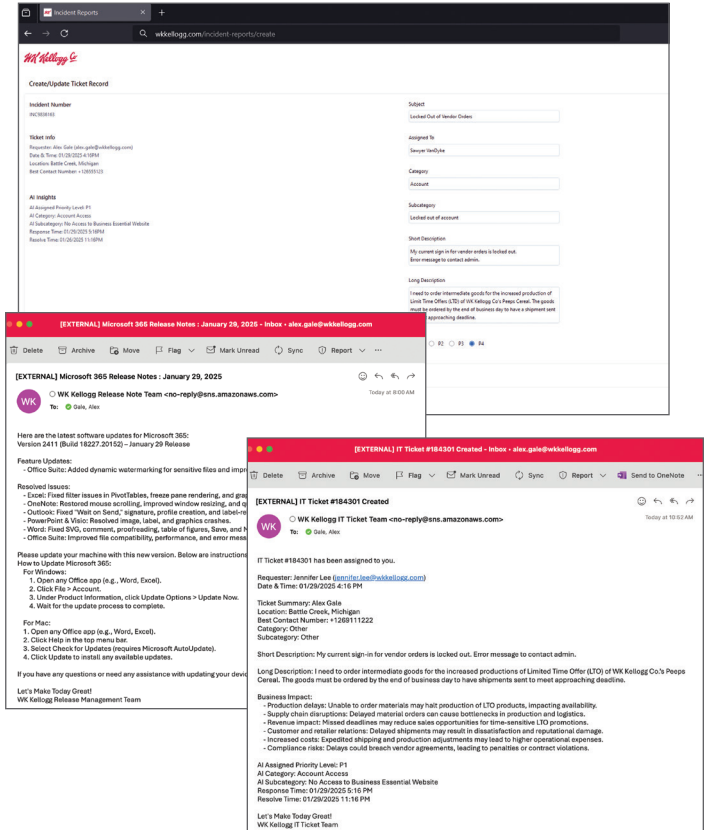
Michigan State University
Team Members (left to right)

Alex Gale
Naperville, Illinois

Shuja Husain
Nagpur, Michigan

Sawyer Vandyke
Wyoming, Michigan

Jennifer Lee
Troy, Michigan

Gavin Heiner
Plymouth, Michigan

Ryan Lind
Woodhaven, Michigan

WK Kellogg Co
Project Sponsors

Shwet Bhasin
Battle Creek, Michigan

Federico Conde
Battle Creek, Michigan

Alex Jantz
Grand Rapids, Michigan

Brian Krygsman
Grand Rapids, Michigan

Naveen Paul
Battle Creek, Michigan

Bill Rex
Battle Creek, Michigan

Aaron Smith
Battle Creek, Michigan

Ganesan Vasudevan
Battle Creek, Michigan

Adolfo Vazquez
Battle Creek, Michigan

Design Day Award Winners

Fall 2024

Auto-Owners Exposition Award
Team Vectra AI

MSU Federal Credit Union Praxis Award
Team Launch

TechSmith Screencast Award
Team Kohl's

Urban Science Sigma Award
Team Meijer

Spring 2025

Auto-Owners Exposition Award
Team Union Pacific

MSU Federal Credit Union Praxis Award
Team RPM

TechSmith Screencast Award
Team McKesson

Amazon Sigma Award
Team NetJets

Auto-Owners is a proud sponsor of the
Department of Computer Science and Engineering

Capstone Experience

Ranked in the Fortune 500
every year since **2002**

90% of our associates say
their work atmosphere is great

Our IT division has **750+**
associates in **45+** departments

We employ over **480**
Spartans companywide

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

simple human sense. | *Auto-Owners*
INSURANCE

MICHIGAN STATE
U N I V E R S I T Y