



MICHIGAN STATE UNIVERSITY *Spring 2018*  
**Design Day**  
COLLEGE OF ENGINEERING



MICHIGAN STATE  
UNIVERSITY

 **TechSmith**<sup>®</sup>  
Executive Partner Sponsor



TechSmith Corporation was founded in 1987 in the heart of mid-Michigan. As a technology company headquartered just one mile from MSU, we feel a special sense of pride and excitement about the Design Day event. We are continually amazed by the passion, creativity, and ambition of MSU's engineering students. One day, these talented students will impact the lives of the local, national and global communities. Some already are.

Evidence of the importance of science, technology, engineering and mathematics is all around us. This technical knowledge is required in the next generation of engineering graduates, but the creativity to connect this knowledge to real world problems is equally important – as is having the perseverance and communication skills to take action. We love that Design Day touches on all the components critical for success.

We are pleased to say that this year marks our 11th year as Design Day and capstone program sponsors. TechSmithies are passionate about solving problems with technical innovation, which makes this partnership a natural fit.

TechSmith extends our gratitude to the many other corporate sponsors and, of course, to the MSU academic team. Thank you for everything you do to recognize the importance of STEM education, and to prepare our youth for the future.

Congratulations to all of the participants of Design Day! We hope you enjoy the event. This is the time for all of us to marvel at the impact engineering has on our lives and well-being, to appreciate the talent in the coming generation, and to thank everyone who has helped to make Design Day a success each and every year.

Sincerely,

A handwritten signature in white ink that reads "Wendy Hamilton".

Wendy Hamilton  
CEO, TechSmith Corporation



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# Mark Your Calendars!! It's time to save the date for Fall 2018 Design Day!

**Join us December 7, 2018  
for another energetic  
celebration showcasing  
talented engineering  
students**

Check our website often for  
updates during the semester:  
<http://designday.msu.edu/>

**GO GREEN!!**



# Welcome from the Dean



## **As Dean of the College of Engineering, on behalf of the entire faculty, I welcome you to Design Day!**

We wish you an enjoyable event as you experience our students and their amazing talents through presentations, competitions, demonstrations and posters.

We are pleased to acknowledge TechSmith as our Design Day Executive Partner Sponsor and the MSU Foundation as our Design Day Directing Partner Sponsor. Our Design Day Supporting Partner Sponsors include Amazon, Auto-Owners, Blackstone, Bosch, Dow, Ford, MSU Federal Credit Union and SpartanNash. We thank all of our sponsors for their generosity and their ongoing commitment to Design Day.

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

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

Another exciting part of Design Day is the Dart Foundation Day of Engineering Innovation and Creativity, which involves some 160 high school students. On Design Day, these future engineers explore design principles with hands-on projects requiring the application of their creativity and ingenuity.

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

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

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

A handwritten signature in black ink, appearing to read "Leo Kempel", with a long, sweeping flourish extending to the right.

**Dr. Leo Kempel**

Dean of the College of Engineering  
Professor of Electrical and Computer Engineering  
Michigan State University

# Events Schedule Friday, April 27, 2018

EVENTS	7 a.m.	8 a.m.	9 a.m.	10 a.m.	11 a.m.	Noon	1 p.m.
Audio Enthusiasts and Engineers		2nd Floor Rm 2228 8:00 a.m. – Noon					
Engineering Students Organizations		1st Floor West Wing Lobby 8:00 a.m. – Noon					
ECE 101 Demonstrations			2nd Floor 2300 Hallway 9:00 a.m. – Noon				
EGR 100 Demonstrations			2nd Floor 2300 Hallway 9:00 a.m.-11:30 a.m.				
ME 371 Demonstrations			1st Floor Rooms 1225, 1230 & 1234 8:30 a.m.-Noon				
ME 412 Competition		1st Floor Rooms 1252 8:00 a.m.-11:30 a.m.					
ME 471 Competition		1st Floor Room 1240 8:00 a.m. - 11:40 a.m.					
ME 478 Competition			2nd Floor Room 2320 9:00 a.m.-11:00 a.m				
ME 497/MKT 420 Demonstrations				1st Floor Dow Wing 9:30 a.m.-10:30 a.m.			

CAPSTONE COURSES							
All Capstone Posters for most projects, including BE485/487 and ChE 434		1st Floor 1200/1300 Hallway 8:00 a.m. - Noon for most. BE on 2nd Floor 2200 Hallway; ChE on 2nd Floor 2400 Hallway					
AESC 410/SCM 472 Project Presentations		1st Floor Rooms 1255, 1257 & 1260 Anthony Hall: 8:00 a.m. – 11:00 a.m.					
CE 495 Project Presentations		1st & 3rd Floors – Rooms 1538, 3105, 3400 & 3540, 8:00 a.m. - Noon					
CSE 498 Project Presentations		3rd Floor, Room 3405 7:30 a.m. - 12:18 p.m.					
ECE 480 Project Presentations		2nd Floor Rooms 2205 and 2250 8:30 a.m.-11:50 a.m.					
ME 481 Project Presentations		1st Floor Rooms 1202, 1220 & 1300 7:30 a.m. - Noon					
MSE 466 Project Presentations		1st Floor Room 1145 8:30 a.m. – 11:50 a.m.					

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



### Social Media Links:

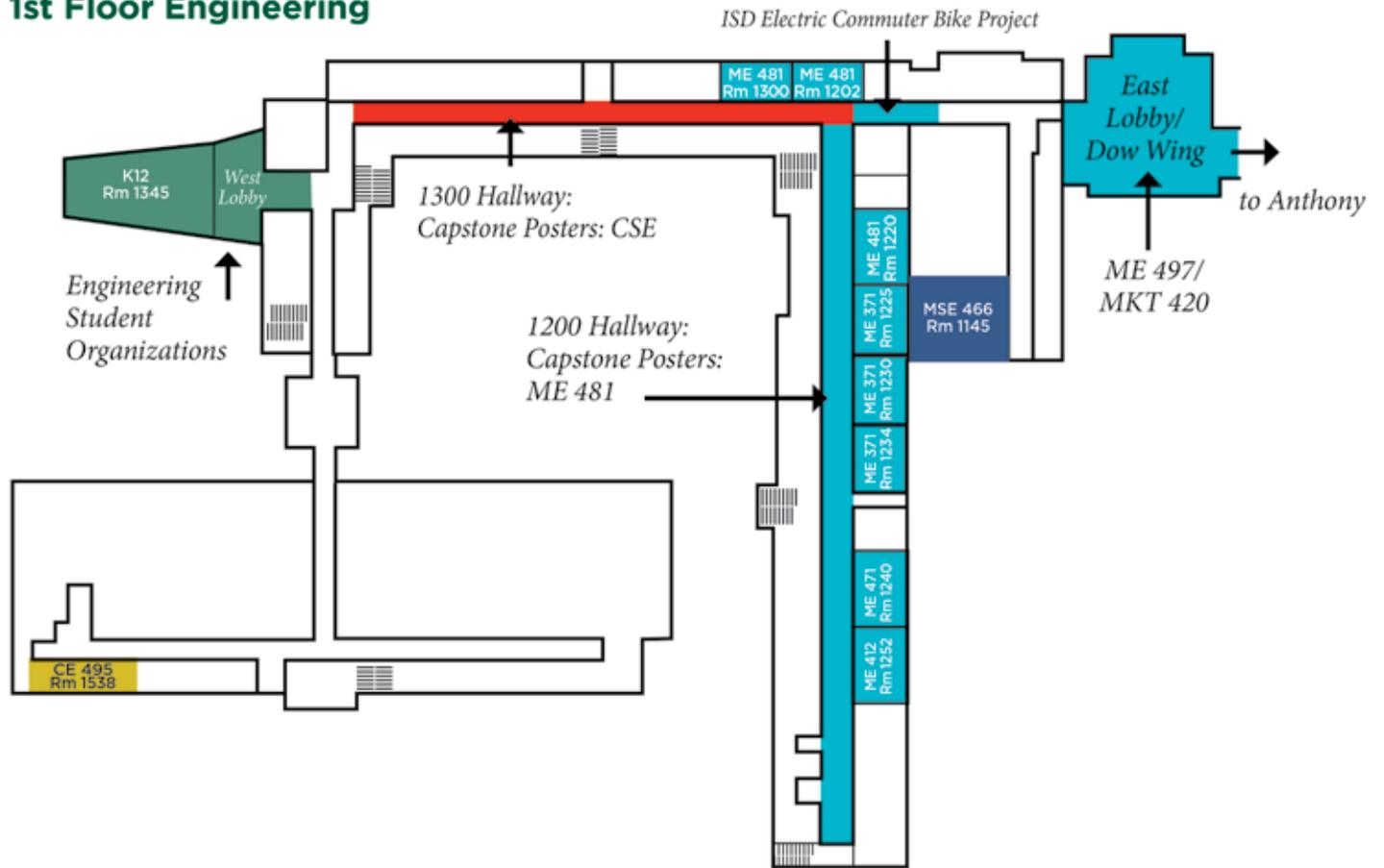
"Like" the College: <https://www.facebook.com/SpartanEngineering> "Follow" the College: [https://twitter.com/msu\\_egr\\_news](https://twitter.com/msu_egr_news)

### To stay up to date w/Careers in Engineering:

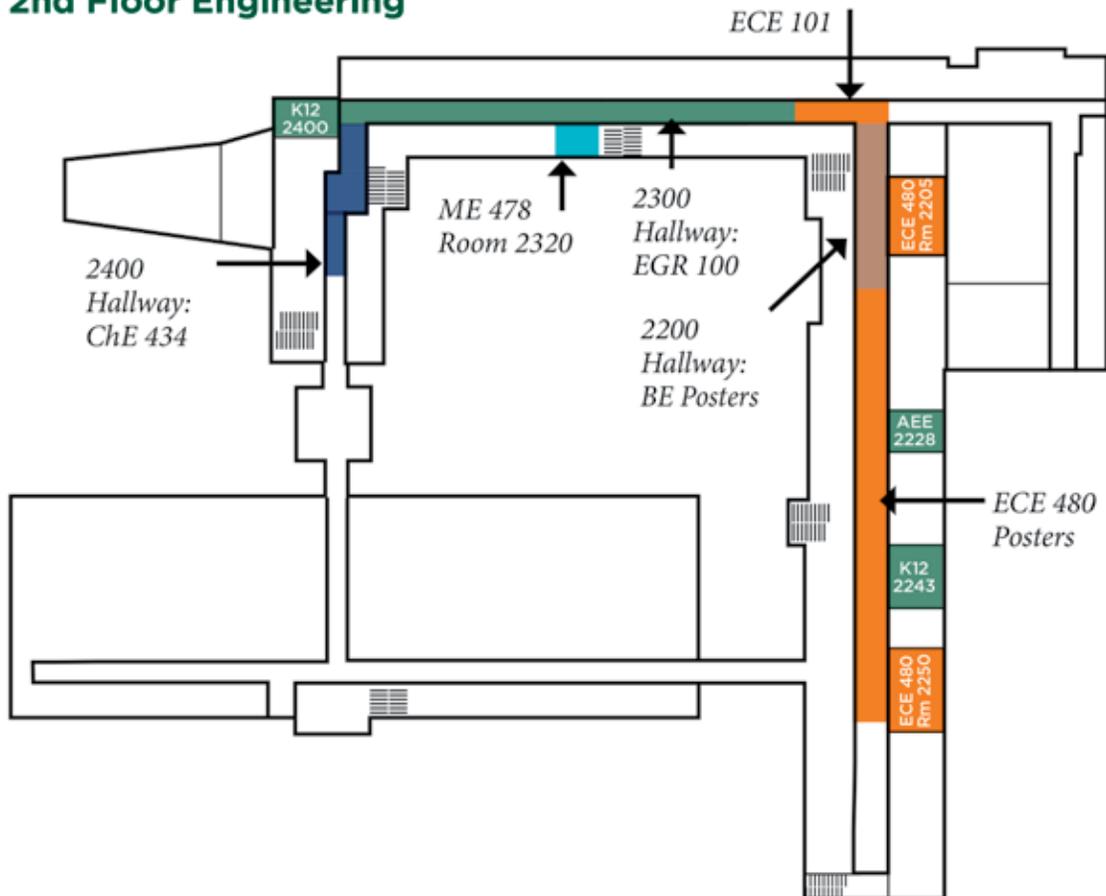
"Like" Us <http://www.facebook.com/pages/The-Center-for-Spartan-Engineering/226159694117936>

"Follow" Us: <https://twitter.com/msuengineer>

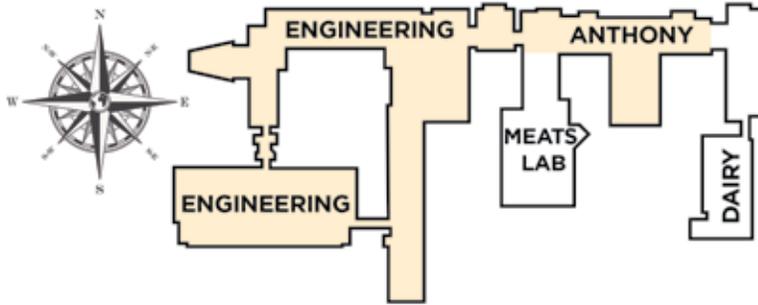
## 1st Floor Engineering



## 2nd Floor Engineering

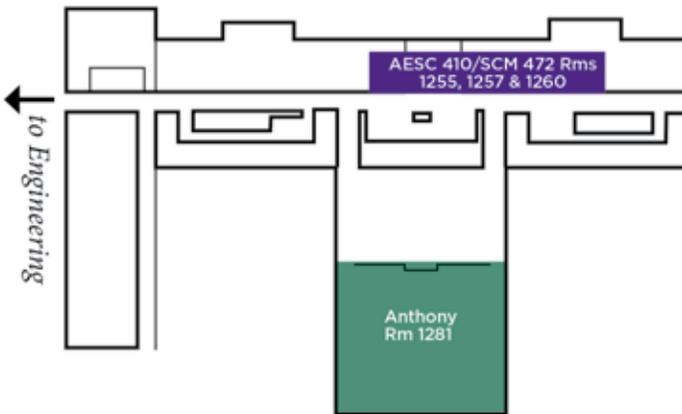


## Overview



# Design Day Floor Plans of the MSU Engineering Building

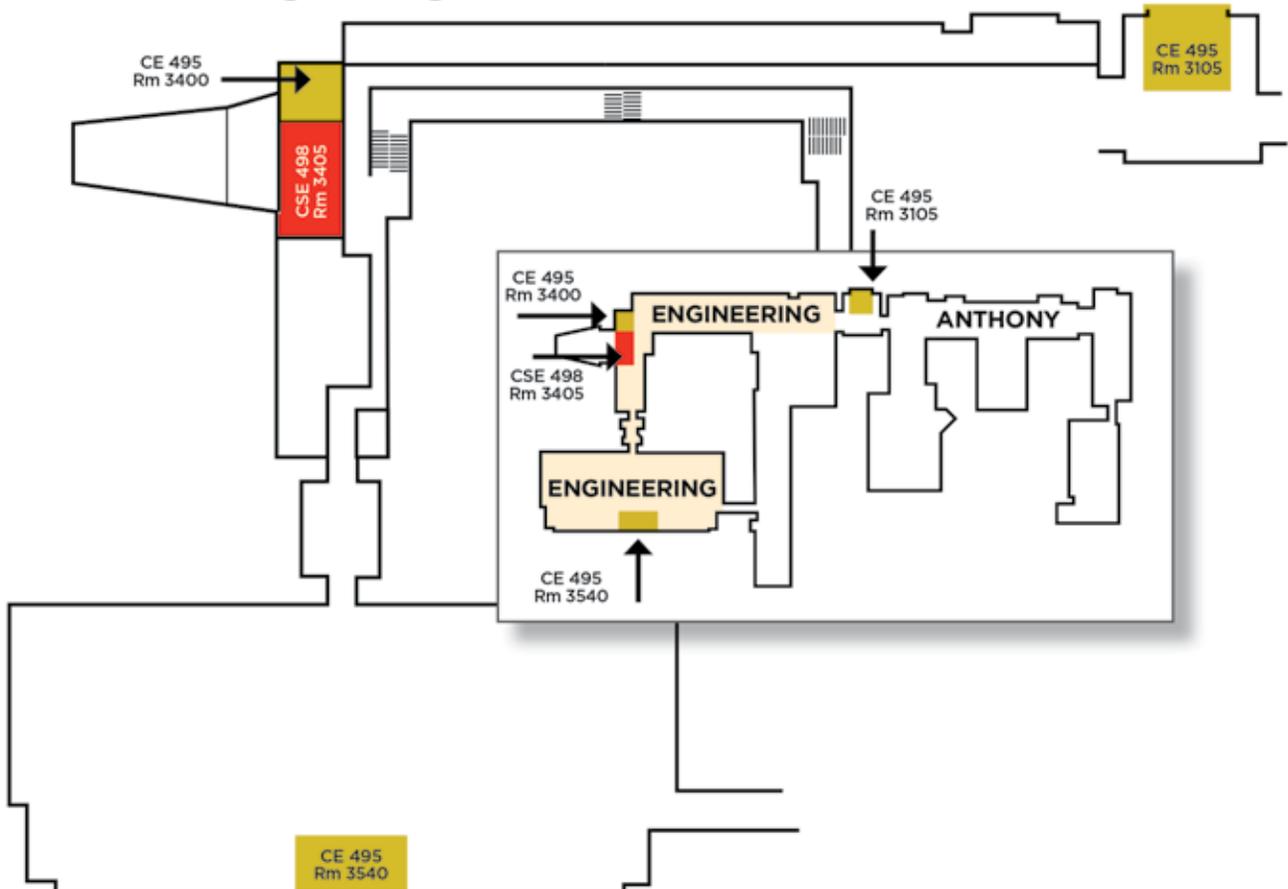
## 1st Floor Anthony



### Color Legend:

<span style="color: purple;">■</span> AES / SCM	<span style="color: red;">■</span> CSE
<span style="color: brown;">■</span> BAE	<span style="color: orange;">■</span> ECE
<span style="color: yellow;">■</span> CEE	<span style="color: cyan;">■</span> ME
<span style="color: blue;">■</span> ChE & MSE	<span style="color: green;">■</span> Joint/ Other

## 3rd Floor Engineering





## Software made in Michigan

Founded in 1987, TechSmith pioneered the revolutionary idea of capturing screen content for better communication. Today, TechSmith is the world's #1 source for visual communication software with our flagship products Snagit and Camtasia.

We are constantly innovating our offerings, as well as developing exciting new cloud-based visual communication tools. We do all of this in a creative, team oriented environment.

We aim to hire the brightest minds and nurture them with challenging projects, the freedom to be creative, and opportunities to grow across TechSmith.

Learn more about our open positions at [www.techsmith.com/careers](http://www.techsmith.com/careers)

# Dart Day of Innovation and Creativity *for 9th-12th Grade Students*



## **Our Future Lies in Some Very Precious Hands...**

At the Dart Foundation, we are committed to developing scientifically literate students in Michigan. We're proud to sponsor the MSU College of Engineering Design Day for pre-collegiate students.

Funded by the Dart Foundation



MICHIGAN STATE UNIVERSITY | College of Engineering

# High School Innovation and Creativity Day

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

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

The following schools will be participating in this Spring’s Design Day events: Battle Creek Area Math and Science Center, Detroit Edison Public School Academy, East Lansing High School, Innovation Central, Jenison International Academy.



	Room 1345 Engineering Building Check in for all schools	K’NEX Bridge Team Build Room 2243	VEX Robotics Room 2400	1st & 2nd Floor Voting/project viewing	Trebuchet Launch Competition Room 1345
<b>8:00–8:15</b>	Check in for all schools				
<b>8:15–8:30</b>	Welcome & voting procedures				
<b>8:40–9:30</b>		Detroit Edison Public School Academy	East Lansing High School	Innovation Central/ Jenison Int. Academy	Battle Creek Area Math and Science Center
<b>9:35–10:20</b>		East Lansing High School	Innovation Central/ Jenison Int. Academy	Battle Creek Area Math and Science Center	Detroit Edison Public School Academy
<b>10:25–11:10</b>		Innovation Central/ Jenison Int. Academy	Battle Creek Area Math and Science Center	Detroit Edison Public School Academy	East Lansing High School
<b>11:15–12:00</b>		Battle Creek Area Math and Science Center	Detroit Edison Public School Academy	East Lansing High School	Innovation Central/ Jenison Int. Academy
<b>12:15–12:30</b>	Awards Ceremony, 1345 Engineering Building, lunch immediately after (EVERYONE)				

## VEX ROBOTICS

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



## INTERDISCIPLINARY ENGINEERING BUILD

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

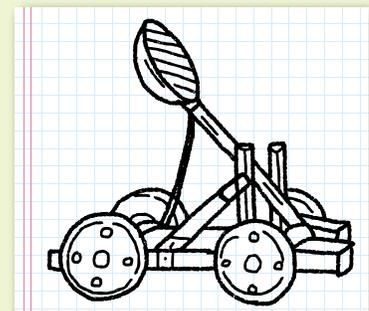


During the build portion of this session you and your team will be given the design constraints for the structure. Utilizing the information learned at the start of the session and the limited materials provided, your team will need to design and then construct a model to be tested. Your finished structure will be placed on one of our test beds for

evaluation. With the help of MSU Engineering students, the results will be collected by a sonic ranging sensor. These data points will be interpreted by the computer program and your team will be evaluated on percent deflection of your support. Throughout this session you will need to listen, learn and utilize your team to be successful. Good Luck.

## TREBUCHET LAUNCH COMPETITION

The trebuchet activity at Design Day provides students with an opportunity to manipulate some of the parameters associated with launching a small projectile at a specific target. Using basic conservation of mechanical energy concepts from physics, student groups load a small, pre-made trebuchet with potential energy and release the device, transforming the stored energy into kinetic energy to throw the projectile. Students have control over the length of the throwing cord, the placement of the counterweights, and the pivot point on the throwing arm. The event is scored based on proximity to the target point.



## MEMBERS OF THE ORGANIZING COMMITTEE SPRING 2018



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



**Dean Buggia**  
Instructor and  
Technology  
Teacher, Okemos  
High School



**Rigoberto Burgueno**  
Civil Engineering  
Faculty



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



**Rachel Esch**  
K-12 Outreach  
Secretary



**John Plough**  
AP Physics Teacher  
East Lansing  
High School



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

# K12 Awards Fall 2017



## EGR 100 Design Project: (Tie)

Two EGR 100 teams tied for the EGR 100 Design Project Award



## EGR 100 Design Project: (Tie)

Lego: The winning EGR 100 team was taught by Prof. Jenahvive Morgan



## ME 371 Best Project Award:

Prof. Michael Lavagnino's winning ME 371 team was selected by visiting high school students



## ECE 480 Design Award

The ECE 480 team, led by Profs. John Albrecht and Lalita Udpa, won the Kids' Choice Award with their "Autonomous Robot Navigation"



## VEX Robotics Programming and Race

Mr. Bob Watson once again taught VEX Robotics. The winning team is from Jackson High School



## Bridge Building and Deflection Testing

Women in Engineering, with a winning Bridge Build, was instructed by Mr. Dean Buggia



## Trebuchet Design and Competition

The trebuchet toss was designed and taught by Mr. John Plough, East Lansing High School AP Physics teacher. The winning group is from the Kalamazoo Area Math and Science Center



## EGR 100 Introduction to Engineering Design

**Dr. Jenahvive Morgan**  
Academic Teaching Specialist

### Course Project

EGR 100, Introduction to Engineering Design, is a college-level course required of all incoming first-year engineering students. It is an integral part of the CoRe (Cornerstone and Residential) Experience. The course introduces students to the engineering profession and the engineering design process through team-based, interdisciplinary design projects and assignments. There are 655 students enrolled in EGR 100 this semester.

For the final course project, the student teams selected from six project types: (i) Solar Car Competition, (ii) Cell Phone App Inventor, (iii) Advanced Robotics, (iv) 3D Printing, (v) Water Quality, and (vi) CoRe industry-sponsored projects. CoRe industry-sponsored projects involved collaborations with ArcelorMittal on an annealing furnace gas sampling system, Aptiv on autonomous vehicle sensing design, and Tenneco on the design of a heat pipe. Teams from each of the project types will display their prototypes at Design Day along with posters detailing their design concepts. Pre-college students will recognize the most outstanding projects with awards.

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

### Fall 2017 EGR 100 Project Poster Award Winners:



l-r: Tim Hinds, Dean Kempel, Antonino Destasi, Brian Daugherty, Nathan Buchweitz, Jenahvive Morgan



l-r: Tim Hinds, Dean Kempel, Colin Duyck, Matt Davis, Jenahvive Morgan



**BOSCH**  
Invented for life







# Opportunities for students and new graduates

At Amazon, our evolution has been driven by the spirit of innovation that is part of our DNA. As a new college graduate or intern, you can have multiple opportunities to innovate and solve real-world, complex technical and business problems as you join us on our journey.

We strive to hire the brightest minds from the best universities globally, and have various career opportunities available for undergraduates and advanced degree students with diverse academic backgrounds.

The work environment here is fast-paced and continually evolving, and every Amazonian is passionate about ownership and delivering results for the company. If you want to work in an environment that will challenge you to relentlessly improve the Amazon experience for our customers, where each day is different from the next, and your learning never truly ends, take a look at Amazon's many university and graduate opportunities.



[www.amazon.jobs](http://www.amazon.jobs)

# Applied Engineering Sciences

## Capstone Project Sponsors

American Axle & Manufacturing, Inc.  
Detroit, Michigan



Hess Corporation  
Houston, Texas



ArcelorMittal  
East Chicago, Indiana



Ingersoll Rand  
Davidson, North Carolina



Asahi Kasei Plastics North America  
Fowlerville, Michigan



Intel  
Chandler, Arizona



BASF  
Wyandotte, Michigan



Johnson Controls  
Milwaukee, Wisconsin



Bosch  
West Memphis, Arkansas



MSU Infrastructure & Planning Facilities  
East Lansing, Michigan



General Motors  
Warren, Michigan



MSU Office of Sustainability  
East Lansing, Michigan



Grant Thornton  
Chicago, Illinois



Roberts Sinto  
Grand Ledge, Michigan



# Applied Engineering Sciences



**Dr. Laura J. Genik**  
**Director**  
**Applied Engineering**  
**Sciences**



**Dr. Srinivas (Sri) Talluri**  
**Professor of Operations**  
**and Supply Chain Management**  
**The Eli Broad Graduate**  
**School of Management**

## Graduate TAs, Supply Chain Management, The Eli Broad Graduate School of Management



**Ana Cecilia**  
**Sarabia**  
**Flores**  
**MBA (2018)**



**Mohamed**  
**Hrezi**  
**MBA (2018)**



**Abhinav**  
**Iyer**  
**MBA (2019)**



**Chris**  
**Winter**  
**MBA (2019)**

Time	Sponsor	Project Title
<b>PRESENTATION SCHEDULE ANTHONY HALL I255</b>		
8:00 a.m.	MSU IPF	Business Case for Campus-wide Temperature Control Guidelines
8:25 a.m.	MSU Sustainability	EV Charging Stations
8:50 a.m.	MSU Sustainability	Innovation for Efficiency – Library Lighting System
9:15 a.m.	MSU IPF/JCI	Analysis of Current Operation of the Regional Chilled Water Plant
9:35 a.m Break		
9:50 a.m.	Bosch	Reducing Order Cycle Time
10:15 a.m.	Roberts Sinto	Mapping Internal Processes
<b>PRESENTATION SCHEDULE ANTHONY HALL I257</b>		
8:00 a.m.	Ingersoll Rand	Supply Chain Optimization
8:25 a.m.	Ingersoll Rand	Retail-Distribution Market Network Optimization
8:50 a.m.	Ingersoll Rand	E-procurement
9:15 a.m.	Hess	Strategic Category Development
9:35 a.m Break		
9:50 a.m.	Intel	Inventory Management Strategy for xPV Testers
10:15 a.m.	Grant Thornton	Historical Merger and Acquisitions Deal Analysis Study
<b>PRESENTATION SCHEDULE ANTHONY HALL I260</b>		
8:00 a.m.	BASF	Market Research for High Insulation Material
8:25 a.m.	ArcelorMittal	“Beached” Iron Decision-Making Model
8:50 a.m.	Asahi Kasei	Warehouse Expansion Project
9:15 a.m.	American Axle	Transportation Initiative
9:35 a.m Break		
9:50 a.m.	GM	Spring Hill Plant: Logistic Total Cost Dashboard
10:15 a.m.	GM	Silao Plant: Total Enterprise Cost/Ship Frequency Dashboard
10:40 a.m.	GM	Fairfax Plant: Total Enterprise Cost/Ship Frequency Dashboard

## AESC 410 Senior Capstone Project Course

The culmination of coursework in engineering and business, the Capstone course for Applied Engineering Sciences focuses on a semester-long project from a sponsor (industry or non-profit), typically at the confluence of modern business operations and engineering or technical issues. The course is interdisciplinary with Supply Chain Management.

# MSU Infrastructure Planning and Facilities Business Case for Campus-wide Temperature Control Guidelines

**M**ichigan State University's Infrastructure Planning and Facilities (IPF) department is tasked with the enormous project of maintaining the heating, ventilation, and air conditioning (HVAC) systems campus-wide consisting of over 550 buildings. The control technology currently utilized ranges across several decades from entirely manual to entirely automated.

Our team was brought in to develop a business case for a campus-wide temperature control guideline. This guideline includes multiple approaches acknowledging the fact that IPF utilizes a variety of technologies, including direct digital control (DDC). Big data analysis techniques were used to pinpoint weak systems and prioritize the order in which they should be updated. Additionally, a statistic-based marketing scheme was developed to encourage behavioral shifts towards sustainability. This project will serve as the foundation for a campus-wide cultural and behavioral shift towards increased HVAC efficiency and sustainability.

Our team targeted buildings with the most potential to save energy and created a business case/best practices guideline to help move campus towards sustainability regarding room temperatures. To reach this, a 3-faceted approach was developed.

First is the DDC building protocol development, which includes the utilization of current and historical data. This determined the efficiency difference between DDC and non-DDC buildings, the savings from a DDC system, and conveyed possible savings in relatable terms.

The second approach was the non-DDC building protocol for optimal comfort and efficiency, as well as a compliance determination system. The focus was to engage and inspire non-DDC building occupants to follow the guideline.

Lastly, a DDC conversion priority guideline was created. This was a data driven guideline for converting non-DDC buildings to DDC buildings. Metrics to determine this are theoretical energy savings, reduction in comfort complaints, and the cost of DDC installation.



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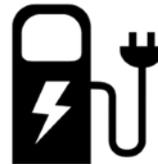
# MSU Sustainability

## EV Charging Stations

Sustainability has always been a major priority of Michigan State University (MSU), both internally with their own operations, as well as externally to the faculty/staff, students and other visitors to the campus. Now the university is taking things one step further to promote environmental responsibility through the installation of several new EV (Electric Vehicle) and Plug-In Hybrid charging stations.

The university currently has a number of charging stations in various spots around campus. But, MSU's Infrastructure Planning and Facilities (IPF) team does not believe those existing stations are sufficient to keep up with current or future demand for EV/Plug-In Hybrid charging. This project will, however, be a very costly addition to the campus and should not be done without a proper feasibility analysis. In order to gain further understanding about current and future demand, MSU IPF has collaborated with our team.

The goal of our team is to perform market research on the demand for these charging stations and derive a recommendation for how many new charging stations should be installed as well as where to install them. They should be located in places where it is both convenient for users to access as well as be compatible with the current infrastructure of campus, specifically in terms of electrical power draw capability and potential remote monitoring capabilities. This recommendation will also be dependent on projections of expected use of EV/Plug-In Hybrid vehicles among drivers at MSU.



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# MSU Sustainability Innovation for Efficiency – Library Lighting System

The current Michigan State University library was constructed in 1955 and is a dynamic and evolving facility for many types of study, learning, networking, and collective application of academic outcomes. The library also houses and manages vast amounts of data in both print and digital form.

As technology advances so does the use of library space. Presently, the facility is moving from housing numerous traditional books stacked on shelves to a digital library. This has opened a lot of space for new uses by the campus community.

These changes have resulted in an inefficient and inflexible lighting system. Our team analyzed the current state of the lighting system and developed a proposal for an updated system. The proposal includes a three-part plan for updating the library lighting.

Part one of the updated lighting proposal utilizes current infrastructure through the use of new technology, creatively improving the lighting system. This includes the utilization of light motion sensors in strategic areas, daylight harvesting where possible, ensuring proper lighting levels, and other energy saving strategies.

Part two focuses on updating the first floor of the east wing. This involves a full renovation of the current lighting system as well as the implementation of energy efficient lighting fixtures. This new lighting system will be more energy and cost efficient and be designed to be adaptable to future uses of the space as well as compatible with IOT technology.

Part three will adapt the process our team developed in updating the first floor of the east wing to the rest of the library. This process will provide a step-by-step map for future lighting renovations in other parts of the library lighting system.



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# MSU IPF/Johnson Controls

## Analysis of Current Operation of the Regional Chilled Water Plant

Michigan State University's Infrastructure Planning and Facilities (IPF) is working with our team and Johnson Controls Inc. (JCI) to improve their Regional Chilled Water Plant on MSU's campus. The Regional Chilled Water Plant (RCWP) provides cool air to almost 20 buildings around MSU's campus. The plant has ten chillers that vary in age and usage. Within the next two years, two of the chillers are going to be replaced due to exceeding a 30-year life span. The objective of this project is to find the most efficient way to remove and replace these chillers, while taking into consideration the long-term effects of the replacement.

Our team will be using the Johnson Controls Planning Tool to test different options for the new chillers in the plant. The JCI Planning Tool is a simulation software system that allows companies, such as IPF, to see an overhead view of their current plant layout and test its yearly efficiencies and usage, as well as test new options. When a new change is made to the digital plant layout, future efficiencies and usage are predicted. The purpose of using the Planning Tool is to compare current efficiencies to new predictions, and determine which changes should be made for a given facility. Johnson Controls provides an Optimization Tool that monitors and controls the new plant changes once the Planning Tool simulation has been run and approved. The Optimization Tool will not be used in this project but will be a possible resource for IPF in the future.

For this project, there is no budget or limit to creativity. Our team has the opportunity to think outside the box and implement an effective change. A new idea for these chillers could benefit Michigan State University for decades to come and change the way MSU uses their resources.



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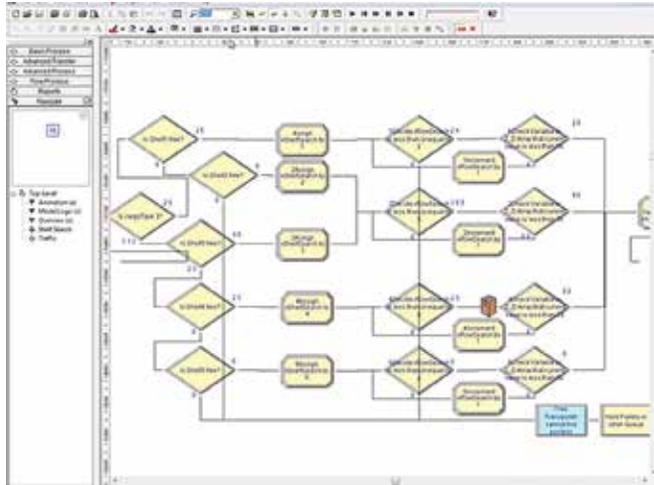
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# Bosch

## Reducing Order Cycle Time

**B**osch is an engineering and electronics company headquartered in Germany. Bosch supplies a multitude of parts, ranging from brakes to power tools, that are shipped to different companies in numerous industries. Our group was tasked with finding the inefficiencies in Bosch's processes that would lead to the solution of reducing order cycle time from three days to two days. Our team was focused on one of Bosch's tool distribution centers located in West Memphis, Arkansas. Reducing Bosch's order cycle time would increase profitability and decrease lead time for customers. The approach our team took to accomplish this goal was the creation of a simulation in Arena. This simulation successfully captured the flow of different packages throughout the distribution center.

Our team designed this simulation to include the pick-to-pack procedure of Bosch's tool shipping process. Our team was searching for any flaw in the current system that was slowing the process throughput time. Using the simulation, our team looked for different bottlenecks, inefficiencies, or inactive systems. Once the problems were identified, discussions were held to review the different opportunities for Bosch to assist with its main goal of reducing order cycle time and the best means of implementing these improvements.



**BOSCH**



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# Roberts Sinto Corporation

## Mapping Internal Processes

**R**oberts Sinto Corporation (RSC) is the US branch of Sintokogio, Ltd, headquartered in Japan. RSC builds a variety of machines ranging from automation equipment used in large assembly plants to molding machines, mold handling systems and blast equipment used in the foundry industry. All of their systems have constantly moving machine parts, whether they're being transferred into a welding robot or connected to the other side of the car. Roberts Sinto is responsible for ensuring all parts fit accordingly.

The main goal of this project is to map the purchasing process at Roberts Sinto Corporation in Grand Ledge, Michigan. Process mapping will help the company discover any opportunities for improvement in their current process and create a future state process map of the purchasing process. The process maps will use swim lines to visually distinguish jobs that share responsibilities with purchasing and display different sub-processes that are directly or indirectly involved.

Surveys will be conducted with the shop floor managers to assess the improvements that need to be made in the purchasing department. Our team will ask questions that assess what needs to be changed to make this process more efficient. Process mapping and data from RedMap will be able to shorten cycle times on products for the buyers at Roberts Sinto Corporation. Roberts Sinto can also use process maps to reduce costs throughout their inventory, labor hours, and waste elimination through surveys and review of the warehouse shop floor.

The future state process map will display a more efficient method of the current purchasing process. Our team will create a more efficient map that displays the processes with the improvements that our team has made by working with the Roberts Sinto purchasing department and other departments related to purchasing. Areas of improvement will be documented and used in creating this future state process map.



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# Ingersoll Rand

## Supply Chain Optimization

This project, sponsored by Ingersoll Rand, is concerned with supply optimization. This is accomplished through the use of a milk-run model to consolidate shipments. Specifically, our team focused on inbound supplier routes for an Ingersoll Rand manufacturing plant located in Lynn Haven, FL. The milk-run route was determined through an analysis of the suppliers for the Lynn Haven plant and the corresponding volumes in each region. Further research was done to find a path that targeted multiple suppliers while also optimizing the overall supply chain for the milk-run region. Ingersoll Rand enlisted our team to develop a model and the supporting documentation for a fully developed milk-run that increased efficiency, reduced inbound freight and inventory costs, and upheld Ingersoll Rand's commitment to being environmentally conscious through the reduction of carbon emissions. Ingersoll Rand requested a process that consolidated multiple separate supplier routes into a more efficient route that is not only consistent with the Lean Strategy Ingersoll Rand has in place but also reduces the quantity of empty trucks and Less Than Truckload deliveries to the manufacturing plant.

The process that was created is intended to be implemented immediately by Ingersoll Rand at the Lynn Haven Plant as a pilot program. Then, if the milk-run process model is a success, it will be applied across all locations and divisions of Ingersoll Rand and their suppliers. This will exponentially save costs given the many milk-run opportunities available, reducing freight, inventory, and carbon emissions with each new implementation.



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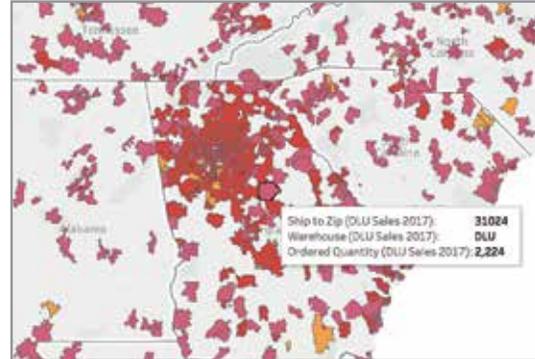
# Ingersoll Rand

## Retail-Distribution Market Network Optimization

Ingersoll Rand is a business-to-business company that manufactures and sells various products across four different product lines. Currently, their product lines include industrial tools, club cars, heating, and cooling. In addition, they also provide transportation refrigeration. Products are sold in over 100 countries through distributors and sales branches. The objective of this project is to optimize Ingersoll Rand’s Heating Ventilation and Cooling (HVAC) delivery network in the Atlanta, Georgia area.

Our team will be analyzing order shipments from three Ingersoll Rand warehouses and 6 parts stores to the final customer. Currently, there is overlap in service coverage resulting in multiple warehouses serving the same area. The overlap in service coverage creates an opportunity for reduction in operational and logistics costs through network optimization while maintaining unsurpassed delivery to customers.

There are four milestones to be completed throughout the project. The first milestone consists of identifying current and new services for shipping. For the second milestone, heat maps will be created to compare the relationship of current warehouse sites and sales. This will show the gaps and overlap areas that need to be worked on or consolidated. For the third milestone, our team will create optimized network models in which warehouses and parts stores do not overlap in services. In milestone four, all of the prospective models will be reviewed and compared to the current services. As of now, the project will focus on the Atlanta, Georgia area but, in the long run, our team hopes to establish a standard process for footprint optimization initiatives to implement across the United States.



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# Ingersoll Rand

## E-procurement

**F**ounded in 1905, Ingersoll Rand is a global manufacturing company headquartered in Ireland. It enhances operational efficiency, saves energy, and improves productivity through innovative equipment, products, and services. In collaboration with Rochelle Savel, Christian Solorzano, and Erin Nuccitelli, Our team will work to evaluate and help to implement the E-procurement process.

E-procurement is the business of purchasing supplies, work, and services through the internet. Ingersoll Rand has identified an opportunity to improve the procurement process through a third-party company called Coupa, a cloud-based software that works to make the purchasing process more efficient. Through the implementation of E-procurement and Coupa, Ingersoll Rand hopes to identify opportunities to improve the cycle time and total savings of indirect procurement.

Our team is assisting Ingersoll Rand in their effort to enhance the current E-procurement Catalog within the indirect-spend category. The project objective is to identify indirect-spend items to catalog based on market research and company data. In addition, our team will determine which items are sourceable or non-sourceable, identify whether current catalogued items are goods or services, and document which indirect commodities to catalog. Our team hopes to evaluate the change in cycle time to procure indirect items and evaluate the total cost savings related with E-procurement.



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# Hess Corporation

## Strategic Category Development

**H**ess Corporation is a leading global independent energy company engaged in the exploration and production of crude oil and natural gas. Founded in 1933 by Leon Hess, the company is currently headquartered in Houston, TX with operations around the globe. Hess has two industry leading positions in the U.S. in Bakken, North Dakota and Utica, Ohio.

Last year Hess Corporation had 4 rigs that drilled 80 wells in Bakken. This year, Hess has 115 planned wells. This increase in business has caused an increase for services provided to the drilling rigs. As the drilling rigs are running they produce solid waste from the well they are drilling. This waste is removed from the site and disposed of by contractors in accordance with EPA regulations.

To accommodate the increase, vendors in Bakken received a request for proposal. The request for proposal includes questions for the vendor to answer and pricing booklets, among other things. When the request for proposal is returned, four different criteria are used to score the vendors that choose to respond to the request for proposal: safety, quality, delivery, and cost.

Hess operates using lean techniques that they have adapted to the oil and gas industry. They are committed to sustainable business practices and social practices within the community. They are seeking a vendor that can operate in the same way and scale with Hess in Bakken.



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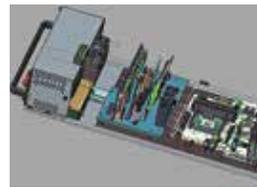
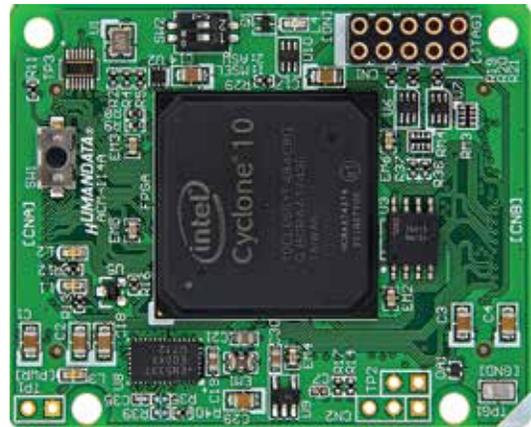
# Intel

## Inventory Management Strategy for xPV Testers

Intel is a supplier of processors for computer system manufacturers and other IT products. Intel's business is expanding at this point and has been having issues with inventory management. This project focuses solely on one of its product testers, known as xPV, and on their manufacturing facility located in Malaysia. The xPV testers are a highly customized chip tester made according to both chip design and customer requirements. Due to its characteristics, which include uniqueness, unpredictable demand, long lead-time, sensitive components, and minimum quantity orders, Intel's current inventory strategy is not equipped to handle the high variability in demand. The xPV testers are a high part count, high mix and low volume product, which ultimately results in a high level of excess inventory.

Overall, there are two main opportunities. First, our team has proposed a new inventory management strategy for the xPV testers. Although the xPV inventory strategy is very broad, it focuses heavily on the commonly faced problems that occur when managing xPV inventory. Next, our team has performed internal data analysis to reduce the level of excess inventory. Intel uses an SAP system, and it requested various internal data reports, including the bill of materials, customer purchase orders, point-of-sale transactions, and the shelf life of xPV testers.

Our team is focused on creating guidelines of how much excess inventory to keep in-house and find an effective inventory management strategy for the unique xPV tester product. Ultimately, by utilizing the internal data analysis, it is hoped that our team can help reduce xPV inventory by 50% as well as create a more time efficient decision-making and purchasing process.



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# Grant Thornton

## Historical M&A Deal Analysis Study

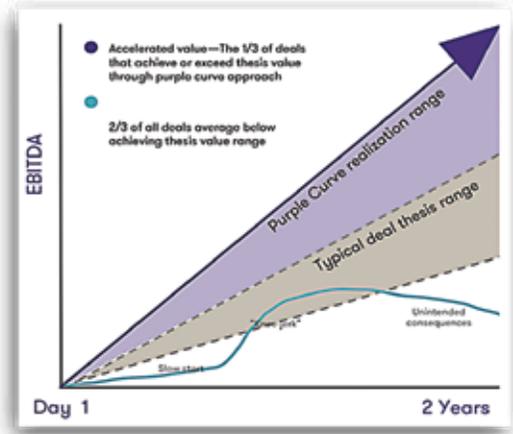
Established in 1924 and headquartered in Chicago, IL, Grant Thornton has evolved into one of the world's leading organizations of independent audit, tax and advisory firms. With revenues in excess of \$16 billion and 59 operating offices, Grant Thornton is on a mission to help clients achieve their business and personal goals.

Grant Thornton deals largely with mergers and acquisitions, creating value across the M&A life cycle using their unique process that follows the Purple Curve. With this approach, GT avoids the pitfalls that many M&A deals face, while maximizing sustainable deal value.

It is essential to understand original deal drivers, or rather the compelling reasons why a company decided to make a deal, and what the results were, in order to understand any value gaps. After identifying value gaps, it is important to understand the root cause of them. Because each deal is different, numerous reasons arise.

All data analyzed comes from surveys completed by previous GT M&A clients. Using Excel and Tableau, our team analyzed how well deals within the last 5 years performed against Grant Thornton's Purple Curve, in regards to both value realized and timing of value realization. Our team confirmed that the surveys typically did not reach the intended respondent (C-Suite or one level below), leading to less accurate and less descriptive results, and that the majority of value 'missed' or 'lost' was in areas relating to IT systems and culture integration.

The findings, compiled into a valuable White Sheet document, will help private equity, middle market, and Fortune 500 companies to better understand the common sources of value, timing of realization, and deal risk so they can better position their organizations to create more value in their own deals.



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# BASF

## Market Research for High Insulation Material

Our team worked with BASF to analyze two new high-performance insulation materials (HPIM): Slentex® and Slentite®. Within BASF, the HPIM market belongs to the multi-billion-dollar Performance Materials business function, which in 2016 accumulated €6.888 billion in sales. The ultimate goal is to add to this bottom line by researching a variety of applications and markets for the two insulation materials that BASF has yet to enter.

Slentex® and Slentite® are both high-performance insulation materials that provide inimitable performance compared to the rest of the market. They provide significantly greater insulation, while using less material. Both products are aerogels, which are Nano porous solids in which gas has replaced the liquid component in traditional gel. Their differentiating features, however, provide a variety of unique applications for each product.

The first step towards identifying new applications and new markets for Slentex® and Slentite® was to establish a basic understanding of the HPIM market, after which our team developed a methodology for evaluating future applications. This methodology involved evaluating market size, market growth, weight of environmentally friendly pressures, and the degree to which Slentex® and Slentite® could provide a sustainable competitive advantage. In this way, BASF will be able to use this decision-making process to evaluate future uses of these two materials.

After developing a list of applications and markets for Slentex® and Slentite®, our team conducted additional research, including cold calling potential clients and meeting with current key account managers at BASF to further determine the market appeal of the future applications.

Through this process, several different markets and applications were identified and recommended to BASF as future business ventures to pursue.



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# ArcelorMittal

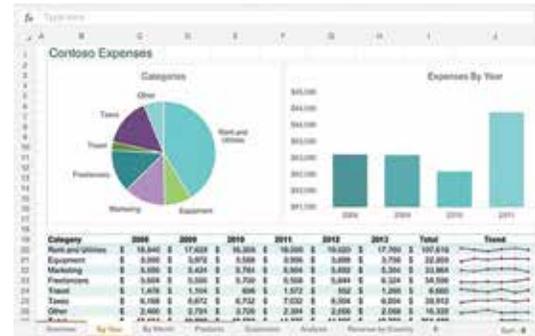
## “Beached” Iron Decision- Making Model

**A**rcelorMittal is the world’s leading steel and mining company producing approximately 133 million tons of crude steel annually. ArcelorMittal was ranked as 123 in the 2017 Fortune Global 500, a ranking of the world’s biggest corporations. With 199,000 employees across 60 countries, ArcelorMittal is leading the way in the steel business.

The first major process in creating steel is the creation of molten iron from various raw materials including scrap, iron ore and oxygen; this molten iron is later refined into steel. Since ArcelorMittal’s iron creation is a continuous process, there are instances when the amount of molten iron produced is too much for the steelmaking process to handle. The plant must “beach” some of the molten iron, by pouring it slowly over a bed of slag, in order to save it for future uses. The company may break it up and reuse it later in the steelmaking process or sell it to an outside company.

For this project our team has designed a model that operates on a monthly basis to determine the most cost-effective strategy for the plant’s excess beached iron. The model considers the different conditions for each month and determines the best decision based on various factors including the amount of scrap inventory on hand, the market price of beached iron, and transportation costs.

This model will have a major impact on ArcelorMittal by generating revenue from the sale of beached iron or reducing the costs of purchasing raw materials, depending upon monthly conditions. The project will also open up acres of storage space in their facilities currently being occupied by unassigned beached iron. Lastly, the project will save the company valuable time by giving them an immediate answer to a monthly decision.



**Michigan State University**  
*Team Members*

(back row left to right)  
**Josh Chartier**  
Chester Springs, Pennsylvania

**Samuel Morris**  
Dammariscotta, Maine

**Joe White**  
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**Patrick Kuiper**  
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**Saisha Johnson**  
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**Colin White**  
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**Shayna Evans**  
Detroit, Michigan

**ArcelorMittal**  
*Project Sponsors*

**William Sammon**  
East Chicago, Indiana

**Doug White**  
East Chicago, Indiana

*Teaching Assistant*

**Chris Winter**

# Asahi Kasei Plastics Warehouse Expansion Project

Located in Fowlerville, Michigan, Asahi Kasei Plastics North America (APNA) currently faces a dilemma one could only hope for: their innovative plastics are proving to be in high demand. APNA is becoming increasingly aware that their current facility lacks the capacity for storing their high demand of finished goods. Lately, APNA has been housing finished products in third-party warehouses as the plastic resins await their end destination.

To keep up with demand, which is forecasted to increase, APNA has concluded that expansion is necessary to output future volumes and to maintain a competitive supply chain advantage. Their goal is to expand for future production, offset third party storage costs by adding additional warehouse space, and to do this all within a 5-year period.

The challenge presented to our team of is full of logistical conflicts. Material flow and productivity must be maintained to prove financially beneficial. The site to be built upon is landlocked in virtually all directions. Westward expansion involves moving extensive masses of machinery, resulting in large takedown costs paired with an unknown length of downtime. The logical response to add additional space towards the east is met with residential properties. The north is locked in by a heavily utilized railyard, while the southern portion is hindered by the presence of Interstate 96.

By analyzing capacity requirements, our team is set to deliver a warehouse expansion plan within budget, material flow, and facility location limitations. Tasked with providing a unique solution to an international supplier with local Michigan roots, our team is developing a space that all members involved will find both aesthetically and fiscally rewarding.



## Michigan State University

*Team Members* (left to right)

**Aaron Dunn**  
Okemos, Michigan

**Arian Jaber**  
Okemos, Michigan

**Harrison Duong**  
Grand Rapids, Michigan

**Ian Burgler**  
Grand Rapids, Michigan

**Rachel O'Neill**  
Plymouth, Michigan

**Erich Grohs**  
Royal Oak, Michigan

**Jake Seitz**  
Rochester, Michigan

## Asahi Kasei

*Project Sponsors*

**Sean Catt**  
Okemos, Michigan

**Aaron Zabik**  
Columbus, Michigan

*Teaching Assistant*

**Ana Sarabia Flores**

# American Axle & Manufacturing, Inc.

## Transportation Initiative

American Axle & Manufacturing is a global Tier-1 manufacturer of automobile driveline and drivetrain components and systems. Headquartered in Detroit, MI, AAM has over 25,000 associates operating at more than 90 facilities in 17 countries around the world, including France, The UK, Germany, India, and Japan. To support AAM's customers on a global and regional platform, their focus is mainly drawn towards quality, operational excellence and technology leadership.

AAM currently uses a third-party logistics provider to transport their products. The goal of this project is to determine whether a leased transportation fleet would provide cost savings when compared to their current transportation network.

As a starting point, the project will only encompass dedicated lanes within Michigan. The project will have two deliverables, with the first being a cost analysis report related to leasing a fleet of trucks. The report will have detailed information pertaining to what kind of trucks will make up the fleet, as well as additional information regarding the operating costs of a leased fleet of trucks. The second major deliverable will be a map of the dedicated lanes servicing Michigan. These maps will show where improvements can be made within the lanes.

In order to successfully determine the feasibility of this project, both deliverables will be heavily considered in the final report. After creating a map of dedicated lanes with the best efficiency and considering costs of transportation and travel, AAM will be able to successfully determine the best logistical option.



### Michigan State University Team Members

(back row left to right)  
**Jackson Rapaich**  
Foster City, California

**Austin Murray**  
Hoffman Estates, Illinois

**Andrew Lunder**  
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**Eurick Crayton**  
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(front row left to right)  
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**Joe Szczupakiewicz**  
Muskegon, Wisconsin

**Mitchell Sokolsky**  
Vernon Hills, Illinois

**Daniel Johnson**  
Sanford, Michigan

### American Axle Project Sponsor

**Raymond Hatfield**  
Detroit, Michigan

### Teaching Assistant

**Chris Winter**

# General Motors – Spring Hill Plant

## Logistic Total Cost Dashboard

**G**eneral Motors Company (GM) is a long time automotive manufacturing leader. The corporation started over 100 years ago and in 2016 sold over 10 million vehicles globally. Headquartered in Detroit, Michigan, GM has more than 400 facilities worldwide and has millions of parts shipped to its assembly plants.

General Motors operates a vehicle assembly plant in Spring Hill, TN where parts from multiple suppliers are delivered. These parts employ various modes of transportation to reach the plant. General Motors currently uses spreadsheets to monitor thousands of these shipments. At its volume, General Motors needs an interactive visual model to determine the most cost-efficient mode of transportation for the deliveries, and the effects of selecting each mode to aid in its decision-making of the overall logistics strategy.

This project provides General Motors with a visual representation of these costs to assist its logistics operations at the Spring Hill Plant. In order to solve the problem, our team used R, DAX, Python, and relational databases to integrate software and create an interactive dashboard that provides in-depth analysis of elements that are used to compute the Total Enterprise Cost (TEC).

The dashboard helps the user review and visualize the financial trade-offs of TEC across different functional areas such as logistics, handling, and manufacturing. It will aid GM's Global Logistics team in understanding the trade-offs when selecting modes of transportation to ship both frequent and infrequent items to its Spring Hill plant in Tennessee.



### Michigan State University

#### Team Members

(back row left to right)  
**Malik Hall**  
Ypsilanti, Michigan

**Samuel Cawood**  
East Lansing, Michigan

**Alex Knop**  
Commerce Twp, Michigan

**Wesley Ma**  
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(front row left to right)  
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Dominican Republic

**Michael Kemper**  
Beverly Hills, Michigan

**Natalie Hepburn**  
St. Joseph, Michigan

**Mackenzie Vespa**  
Harrison Twp, Michigan

### General Motors

#### Project Sponsor

**Andrea Budzynski**  
Warren, Michigan

#### Teaching Assistant

**Abhinav Iyer**

# General Motors – Silao Plant

## Total Enterprise Cost/Ship Frequency Dashboard

Our team was tasked with a project to lower the total enterprise cost for the General Motors Silao truck plant. When looking at total enterprise cost, multiple factors are included. This includes costs for transportation, holding, logistics, carrying, container, and numerous other costs. When working to lower the total enterprise cost, our team had to consider all these factors, but more importantly, we had to look at the various modes of transportation. All parts that arrive at the Silao truck plant come from suppliers in various locations. All of these parts can be transported via four ways: less than truckload (LTL), truckload (TL), intermodal (ITL), and milk-runs (MR). Choosing what mode to utilize is a timely and inconsistent process for General Motors.

Our team worked to create a tool that can evaluate all these options and create an output of the right form of transportation that General Motors should use at that point in time. This tool is a dashboard that is created via object-oriented programming. The dashboard will save General Motors employees a significant amount of time in their day-to-day operations. Before, GM employees had to look at multiple data sources and manually input different alternatives to find the best solution. After this tool was created, all the alternative options could be automatically evaluated via the program that our team created. This led to significant employee time savings, less room for error, and a consistent method that will not vary based on human error, leading to overall cost savings for the Silao truck plant's transportation mode decision.



### Michigan State University

*Team Members* (left to right)

**Hew Hamilton**  
Clarkston, Michigan

**Jake Herwaldt**  
Grand Rapids, Michigan

**Conor Estabrook**  
Bay City, Michigan

**Jayson Armbruster**  
Redford, Michigan

**Yujie (Chris) Zhang**  
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**Collin Thompson**  
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**Steven Schaller**  
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**Weilin Du**  
China

**General Motors**  
*Project Sponsor*

**Andrea Budzynski**  
Warren, Michigan

*Teaching Assistant*

**Abhinav Iyer**

# General Motors – Fairfax Plant

## Total Enterprise Cost/Ship Frequency Dashboard

General Motors is one of the world's foremost designers and manufacturers of cars and trucks sold in more than 125 countries. In order to deliver parts on time with cost in mind, General Motors must factor in many decision-making variables to obtain an optimal cost. GM operates a large, complex network to deliver parts to vehicle assembly, propulsion, and stamping plants across North America. One of the primary drivers of cost within this logistics network is the ship frequency between the supplier and assembly plant.

The global logistics department for General Motors had tasked our team with creating a Total Enterprise Cost/Ship Frequency Dashboard for its Fairfax plant. Using Microsoft BI, our team created this practical tool that can be used by members of the logistics department to evaluate different options for shipping network design. The user will be able to compare the cost incurred from different modes of shipping (Truck Load, Milk-Run, Intermodal, and Cross-docking) on different ship frequencies (once a week vs every other day, etc.). For example, if the members of the global logistics department wanted to determine if multiple two-supplier milk-runs are cheaper than dedicating a truckload to each supplier on a lower frequency, the dashboard would evaluate that information and help the user make an accurate and informed decision. The costs that the dashboard will evaluate will be fuel costs, container costs, floor space cost to the plant, and ordering cost if the reorder point were to change. This dashboard will not only reduce costs by allowing the user to optimize network design, but it will save time by generating all the calculations automatically.



### Michigan State University

*Team Members* (left to right)

**Matt May**  
Philadelphia, Pennsylvania

**Alec Levine**  
Franklin, Michigan

**Matt Miller**  
Miles, Michigan

**Josh Murray**  
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**Brian L'Heureux**  
Keystone, Colorado

**Nicholas Kilpatrick**  
Lansing, Michigan

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Farmington Hills, Michigan

**General Motors**  
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**Andrea Budzynski**  
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**Abhinav Iyer**

# AESC Awards 2017

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Dr. Philip L. Fioravante is the longstanding sponsor of the Applied Engineering Sciences Capstone Awards for Most Sustainable and Most Impactful projects. Dr. Fioravante is an alumnus (BS '84) of our program, winner of the 2004 AES Distinguished Alumni Award, winner of the 2013 College of Engineering Claud R. Erickson Distinguished Alumni Award and former Chair of the College of Engineering Alumni Board. Design Day award winners are selected based on both final written project reports and on oral presentations at Design Day. We thank Dr. Fioravante for his generous and continuing support of the AES Design Day awards.

## **The 2017 Most Impactful Award:**

Team Ranir LLC “Continuous Improvement/Lean Manufacturing Project for a Toothbrush Packaging Line”

Left to right: Joseph Haack, Beatriz Ibarra, Phuoc Ngo, Khai Van, Sean O'Malley, Matthew Lucero, Armando Quiroga



## **The 2017 Most Sustainable Award:**

Team Ingersoll Rand: Trane  
“Transportation Mode Optimization”

Left to right: Carl McConkle, Jen Maisner, Chris Talaga, Justice Schihl, Jordan Hughes, Shawnee Joyce, Austin Gross



# AESC Awards 2017



As punter for Michigan State University's football team, Mike Sadler was well known

for giving his team a competitive edge by flipping the field with perfect punts that pinned the opponents back near their own end zone.

In addition to being well known as an outstanding punter, Mike was also well known for being an outstanding scholar, exemplifying what it means to be a true student-athlete.

Mike was the first football player in Spartan history to earn Academic

All-America honors four times. He was a two-time first-team Academic All-American, a National Football Foundation Scholar-Athlete, and a William V. Campbell trophy finalist.

Mike completed an undergraduate degree in Applied Engineering Sciences in just three years and then went on to earn a master's degree in Public Policy. After graduating from MSU in 2015, he was excited to begin Stanford Law School.

The Mike Sadler Competitive Edge Award is presented annually to the Applied Engineering Sciences capstone team that strives to achieve the highest possible outcome in order to attain the next level of success. The winning project

is considered to have "flipped the field" with an innovative and creative solution that results in a competitive edge that not only solves the problem but distances itself from the competition.

*"I am very proud to call myself an Applied Engineering Sciences alumnus. The program has fostered within me maturity, discipline, leadership, and a worldly sense of systems thinking."*

- Mike Sadler



## 2017 Mike Sadler Competitive Edge Award:

Team Johnson Controls/MSU IPF "Design of a Decentralized, Decarbonized District Energy Strategy"

Left to right: Junyu Liu, Chang Joon Kim, Jasmine Lim, Edward Okuniewski, Rachel Gasparovich, Derek Stockman, Hanish Mehta, Daniel Feenstra

Presented by Mark Dantonio and Karen Sadler

Advised by Laura Genik, Director of Applied Engineering Sciences



**Dr. Dana Kirk, PE**  
Asst. Professor of  
Biosystems &  
Agricultural Engineering



**Dr. Luke Reese**  
Assoc. Professor of  
Biosystems & Agricultural  
Engineering

## About the Program

Graduates of the MSU Biosystems Engineering (BE) Undergraduate Program are expected to succeed in diverse careers where they integrate and apply principles of engineering and biology to a wide variety of globally important problems. MSU Biosystems Engineering graduates are expected to attain that success by:

- identifying and solving problems at the interface of biology and engineering, using modern engineering techniques and the systems approach;
- analyzing, designing, and controlling components, systems, and processes that involve critical biological components; and
- demonstrating vision, adaptability, creativity, a practical mindset, effective communication skills for technical and non-technical audiences, the ability to work in diverse, cross-disciplinary teams, and a commitment to sustainability, continuing professional growth, and ethical conduct.

## BE 485 / BE 487 Courses

Biosystems Engineering student teams, enrolled in the two-semester biosystems design capstone experience, BE 485/487, develop, evaluate, and select design alternatives in order to solve real-world problems. Projects are diverse, but each reflects systems thinking by integrating interconnected issues affecting the problem, including critical biological constraints. The engineering design process is documented in a detailed technical report. Teams present project designs to engineering faculty and a review panel of professional engineers for evaluation. Each BE 485/487 capstone design team prepares and presents a design solution in report, poster and oral formats to industry, faculty, peers and the public that:

- Requires engineering design
- Combines biology and engineering
- Solves a real problem
- Uses a holistic approach
- Interprets data
- Evaluates economic feasibility

## 2017/18 Projects

### Oven Optimization

Team Name – Tony’s Kronies  
Sponsor – Kellogg (project under NDA agreement)  
Faculty Advisor – Dr. Chris Saffron



In facilities that utilize ovens, the ability to maintain a consistent production environment is difficult due to seasonal atmospheric fluctuations. Our task was to define the relationship between environmental conditions and finished food quality based on direct gas-fired (DGF) oven profile fluctuations and to develop a control plan for adjusting oven operation based on atmosphere changes in a facility.



(L to R) Monika Michalik, Andrew Kovach, Eduardo Maya-Luevano & Matthew Paxhia

### **Nutritional Analysis Sample Preparation Optimization**

Team Name – The Process Professionals  
Sponsor – Covance (project under NDA agreement)  
Faculty Advisors – Dr. Ilce Medina Meza & Dr. Dan Guyer



The Process Professionals developed standardized sample homogenization protocols and corresponding process maps for a wide variety of food products. The goal of these recommendations was to increase sample throughput and reduce sample rework.



(L to R) Nate Garpel, Paige Leppanen, Serenity Skillman & Emma Heckelsmiller

### **Milk Plant Data Management Implementation**

Team Name – Milkin' It  
Sponsor – Meijer (project under NDA agreement)  
Faculty Advisor – Dr. Yan (Susie) Liu & Dr. Kirk Dolan

Team Milkin' It worked with the recently acquired Meijer Purple Cow production facility. The facility, located in Holland, MI, produces a range of milk products for all Meijer stores. The focus of the project includes the conversion of all data collection processes to digital recording methods as well as the analysis of production and quality data to identify areas of opportunity and implement quality management practices.



(L to R) Brock Roelofs, Eric Lausch, Ryan Scott & Melissa Schneider

### **Oven Operation Analysis and Optimization**

Team Name – L'Oven It  
Sponsor – Bimbo Bakeries, USA (project under NDA agreement)  
Faculty Advisor – Dr. Sanghyup Jeong



Team "L'Oven It" worked with Bimbo Bakeries, USA, located in Beaverton, Oregon – a major producer of premium breads, buns and specialty rolls in the Pacific Northwest. From March to September, Bimbo Bakeries-Beaverton doubles their bun production output to match increased product demand. The oven Bimbo Bakeries-Beaverton currently uses to produce these buns does not deliver optimal baking performance due to the oven age, design, and outdated standard maintenance and operating procedures. To help Bimbo Bakeries-Beaverton, our team developed a set of standard procedures for both preventative and corrective maintenance practices. Our team also created silicone bun models to act as mock product while profiling the oven's internal temperature eliminating product loss relating to this procedure.



(L to R) Anthony Tomaski, Aleks Popovic, Morgan Harris & Eric Klein

### **Poultry Sheet Meat Processing Equipment Line Optimization**

Team Name – Spiral  
Sponsor – JBT FoodTech (project under NDA agreement)  
Faculty Advisor – Dr. Brad Marks, PE



Sheet meat processing is a specific poultry product application, for a frozen, ready-to-eat product. Sheet meat processing involves several equipment systems that result in product yield loss at each step, allowing for opportunities throughout the process to increase the overall product yield. Our team designed an optimal sheet meat processing line using existing equipment from JBT FoodTech that will maximize the total yield of poultry and result in economic gain.



(L to R) Steve Hogan, Meaghan Rea, Nicole Rigdon & Jordan Sica

### Manufacturing Plant Energy Audit and Optimization

Team Name – Energy Pharmsers  
Sponsor – Perrigo (project under NDA agreement)  
Faculty Advisor – Mr. Aluel Go & Dr. Truman Surbrook



Perrigo Holland wants to contribute to the corporate goal of reducing energy consumption by 15% by the year 2020. The Energy Pharmsers performed an energy audit to evaluate the facility’s energy profile and recommended energy conservation measures that will offset the impact of the new addition on overall energy consumption.



(L to R) Nick Servadio, Emily Willis, Kara Dean & Alexandra Whitman

### Red Swamp Crayfish Control in Michigan

Team Name – Crayfish Will  
Sponsor – MDNR  
Faculty Advisor – Dr. Wei Liao, PE



Red Swamp Crayfish, *Procambarus clarkii*, are an invasive species in Michigan, and the Michigan Department of Natural Resources (MDNR) has found invasive *P. clarkii* in ponds and lakes of southern Michigan. The crayfish are a cause of concern for the environment and are a threat to the surrounding infrastructure due to their burrowing methods. Our team was tasked to design and implement a technically and economically feasible solution to control the invasive species, Red Swamp Crayfish, from a retention pond in Novi, MI, to prevent further environmental and economic degradation.



(L to R) Alexis Kontorousis, Xin Tang, Bolun Li & Elizabeth Ausmus

### Phosphorus Removal from Wastewater

Team Name – Team OO  
Sponsor – MDOT  
Faculty Advisor – Dr. Steve Safferman, PE



Michigan Department of Transportation (MDOT) expects the Michigan Department of Environmental Quality (MDEQ) to implement future surface wastewater discharge limits on phosphorus at the Dewitt Rest Area 831. Team OO designed and optimized two system options to reduce phosphorus to satisfy the anticipated limit: a subsurface mound and the electrochemical Waterloo Biofilter. The subsurface mound design focuses on removing the surface discharge component, while the electrochemical precipitation coagulates phosphorus for later filtration.



(L to R) Emily Banach, Anna Nelson, Jessica Carleton & Joshua Shah

### Germination Chamber Design and Optimization

Team Name – Stem Meets STEM  
Sponsor – MSU Student Organic Farm  
Faculty Advisor – Dr. Ajit Srivastava, PE



Stem Meets STEM designed and optimized a low-tech, automated germination chamber to minimize labor requirements. A germination chamber facilitates the efficient germination of seedlings for transplant production, allowing staff to have more uniform and consistent seedlings available for planting year-round.



(L to R) William Vanmaele, Courtney Vanderhoof, Linda Lay, Caitlin Knedgen & Alex Darrow

# Industry Advisory Board & Project Evaluators

The purpose of the Industry Advisory Board is to facilitate the exchange of ideas between Board members, faculty, and students of the BE program. Its function is to improve continuously the BE program quality by keeping it current and relevant to industry needs. Regular and adjunct board members also serve as external project evaluators.

## Board

Mr. Kevin Blue - Meijer  
Ms. Holly Bowers - Consumers Energy  
Ms. Lisa Buchholz - Dow AgroSciences  
Mr. Matthew (Matt) Burt - AbbVie  
Ms. Shelley Crawford - Kellogg  
Ms. Michelle F. Crook, PE - MDNR  
Ms. Cassandra Edwards - Bimbo Bakeries  
Mr. Gene Ford - Nestlé Nutrition  
Mr. Jeremy Hoeh, PE - MDEQ  
Mr. Eric Iversen, PE - LSG Engineers and Surveyors  
Ms. Ashley Julien, PE - MDARD  
Mr. Andrew Knowles - JBT FoodTech  
Mr. Kevin Kowalk, PE - EA Engineering, Science, and Technology (MI) PLC  
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Mr. Mitch Miller - General Mills-Yoplait  
Mr. Eric Van Middendorp, MSE - Spectrum Health Innovations, LLC  
Mr. Chad Volkmann - Covance Laboratories, Inc.

Mr. Kirk Walter - Perrigo  
Mr. Richard Woodford, PE - USDA-NRCS  
Mr. Rob Yoder - BDI, Inc.

## Project Evaluators

Mr. Dylan Comer - JBT FoodTech  
Mr. Dave Cotton - MDEQ  
Ms. Laura Doud, PE - MDARD  
Ms. Denae Friedheim - MSU Student Organic Farm  
Mr. Eric Gordon - Covance Laboratories Inc.  
Ms. Adrian Harrell - Kellogg  
Mr. John Heiser - Perrigo  
Mr. Seth Herbst - MDNR  
Mr. Louis Nelson - Kellogg  
Dr. Brian Roth - MSU Department of Fisheries & Wildlife  
Ms. Brittany Tomlin - Kellogg  
Mr. Steve Urda - MDOT  
Mr. Jim Vinoski - Meijer



BE Showcase Public Presentations - April 26, 2018



BAE 2016-17 Industry Advisory Board

**If you are interested in sponsoring a BE 485/487 capstone project for the 2018–19 Senior Design teams, please contact Dr. Dana Kirk at [kirkdana@msu.edu](mailto:kirkdana@msu.edu) or Dr. Luke Reese at [reesel@msu.edu](mailto:reesel@msu.edu).**

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[spartannash.com](http://spartannash.com)



# The Capstone Projects

**Faculty Advisors:**

**Professors Chatti, Haider, Haq, Hashsham, Ingle and Li**



Chatti



Haider



Haq



Hashsham



Ingle



Li

**Presentation Schedule – Room 3540**

Time	Team	Room
8:00 a.m.	Team 10 – First Class Engineering	Third Floor Room 3540 EB
9:20 a.m.	Team 9 – Red Cedar Consulting	Third Floor Room 3540 EB
10:40 a.m.	Team 8 – Miller & Associates	Third Floor Room 3540 EB

**Presentation Schedule – Room 3400**

Time	Team	Room
8:00 a.m.	Team 7 – Andrews and Associates	Third Floor Room 3400 EB
9:20 a.m.	Team 6 – TLE Solutions	Third Floor Room 3400 EB
10:40 a.m.	Team 5 – Impact Consulting Engineering	Third Floor Room 3400 EB

**Presentation Schedule – Room 1538**

Time	Team	Room
9:20 a.m.	Team 4 – E7 Engineering & Consulting	First Floor Room 1538 EB
10:40 a.m.	Team 3 – OCCAM Engineering Solutions	First Floor Room 1538 EB

**Presentation Schedule – Room 3105**

Time	Team	Room
9:20 a.m.	Team 2 – BAMZACO Consulting	Third Floor Room 3105
10:40 a.m.	Team 1 – Civil Engineering Services	Third Floor Room 3105

## CE 495 Senior Design in Civil & Environmental Engineering

Undergraduates in civil and environmental engineering must take CE 495. This capstone course prepares students for the workplace by providing an experience with the following challenges:

- A project with multiple issues that must be resolved using civil and environmental engineering knowledge;
- Formulation of conceptual solutions and resolution of conflicting design elements;
- Development of plans that comply with regulations and provide a basis for cost estimates;
- Balancing individual responsibility and group participation in a team based effort;
- Preparation of written reports and oral presentations.

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

# CE 495 SENIOR DESIGN IN CIVIL & ENVIRONMENTAL ENGINEERING

## Michigan State University Wilson Road Extension

Michigan State University has proposed a new entrance/exit on the east side of campus. The Wilson Road extension will connect the existing Wilson Road to Hagadorn Road. Figure 1 depicts the planned routing as designed by the student teams. This project was identified in the 2020 Vision (campus master plan). In addition to reconfiguring and reconstructing Wilson Road, Fee Road, and Parking Lots 30 and 32, this project will install a new traffic signal at the intersection of Conrad Road and Shaw Lane and the intersection of Wilson Road at Hagadorn Road. The university has proposed a water tower to replace the function of the water reservoir on campus at a location in the southwest of the site. The water tower must be connected to a proposed water treatment plant located immediately south of the railroad tracks. In addition, Conrad Hall is proposed to be expanded or replaced to function as a residential hall. The building expansion is expected vertically covering the existing footprint of the current building.

The preliminary engineering design must identify infrastructure improvements necessary to procure this project for construction. Elements of the design require the services of an engineer for transportation, pavements, geotechnical, structures, hydrology, environmental, and project management. This project is to be developed for construction starting spring of 2018. The project shall be opened to traffic by October 2018. The project will improve the water distribution in the region. It will improve vehicular, pedestrian, and bicycle safety.

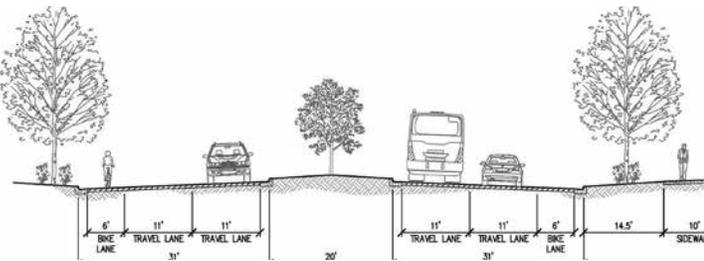


Fig. 1: Wilson Road Cross Section

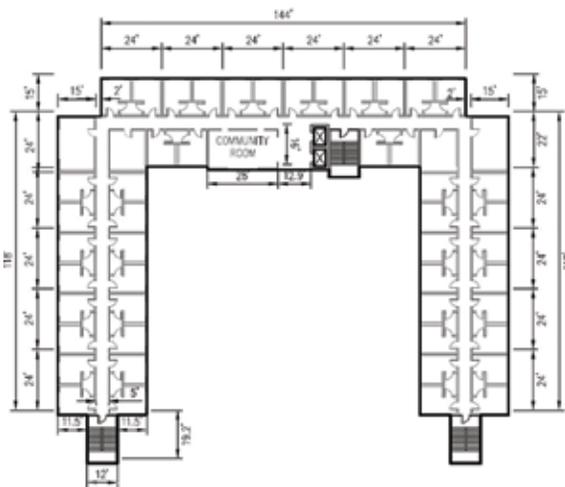
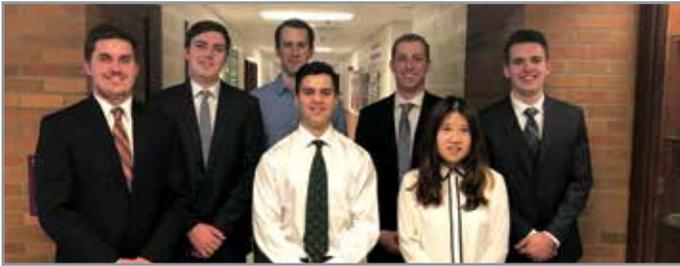


Fig. 2: Conrad Hall



Fig. 3: Site Map



**Team 1: Civil Engineering Services**

**Left to Right:** Robert Zablock (PM), Alan Panley (S), Eric Matynowski (E), Joe Defrenza (P), Matthew Knetchel-Bernath (G), Ling Yang (H), Garrett Olson (T)



**Team 2: BAMZACO Consulting**

**Left to Right:** Chris Harrington (G), Marina Ostaszewski (H), Zach Maskin (P), Anneka Hart (PM), Amir Mafarjeh (T), Bryanna DeLeon (S), Michael Keenan (E)



**Team 3: OCCAM Engineering Solutions**

**Left to Right:** Feifan Yu (P), Nan Gao (E), Millicent Mlauzi (H), Nick Beyers (P), Danielle Janks (PM), James Temple (G), Cole Christy (S), Andy Stocki (T)



**Team 4: E7 Engineering & Consulting**

**Left to Right:** Phillip Wandyez (T), Shyly Katibai (E), Jacob Phifer (G), Brandon Walters (P), Evan Patton (S), Daniel Hurley (H), Colleen Bianco (PM)



**Team 5: Impact Consulting Engineering**

**Left to Right:** Dylan Schuberg (H), Aditya Pokale (E), Abdulkarem Alhuthail (G), Carly Nylander (PM), Junxi Huang (T), Yafeng Jiang (P), Georgiy Kariagin (S)



**Team 6: TLE Solutions**

**Left to Right:** Jacob VanZalen (T), Kelsea Pohl (PM), Jake Mayich (P), Travis Asher (E), Jackson Zuhl (G), Kari Beckley (H), Nicholas Aukerman (S)



**Team 7: Andrews and Associates**

**Left to Right:** Nick Desimpreare (H), Lucas Manhice (E), Jordan Doddie (T), Lauren Woods (S), Rodolfo Espinelcabrera (G), Han Wang (P), Nick Andrews (PM)



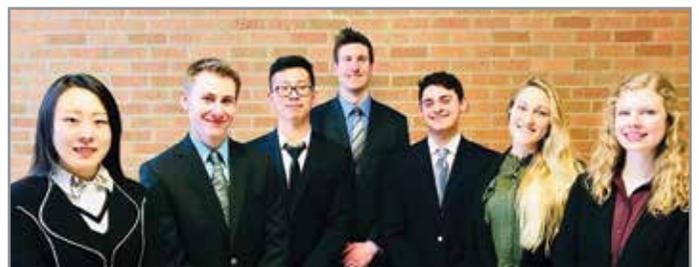
**Team 8: Miller & Associates**

**Left to Right:** Kira Fillar (H), Matt Beatty (G), Alissa Yanochko (E), Jimmy Milligan (S), Elaina Medvedik (P), JT Covington (T), Stan Miller (PM)



**Team 9: Red Cedar Consulting**

**Left to Right:** Jorind Bardhollari (G), Dan Smith (PM), Pei Xu (E), Mike Weiss (S), Anthony Carrier (H), Dan Bomzer (T), Mitch Chaput (P)



**Team 10: First Class Engineering**

**Left to Right:** Siqi Xue (H), Lukas Gallup (T), Xun He (S), Jacob Wysocki (P), Joseph Michael (G), Kelsey Goss (PM), Allison Lukens (E)

# CE 495 SENIOR DESIGN IN CIVIL & ENVIRONMENTAL ENGINEERING

---

## PROFESSIONAL SEMINAR SPEAKERS

**Michele Buckler, P.E.**  
Detroit Diesel

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

**Andy Harris, P.E.**  
OHM Advisors

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

**Greg Losch, P.E.**  
Michigan Department of  
Transportation

**Ryan Musch, P.E.**  
Fishbeck, Thompson, Carr  
& Huber

**Leanne Panduren, P.E.**  
Rowe Professional Services

**Robert Rayl, P.E.**  
RS Engineering LLC

**Charles Rolfe, P.E.**  
OHM Advisors

**Talal Salem**  
Michigan State University

**Scott Stowitts, P.E.**  
Barton Mallow

**Leah Tapp, P.E.**  
HNTB

**Roy D. Townsend, P.E.**  
Washtenaw County Road  
Commission

**Mark VanPortfleet, P.E.**  
Michigan Department of  
Transportation

---

## PROFESSIONAL EVALUATORS

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

**Sam Baushke**  
Barr Engineering Co.

**Erik Carlson**  
Michigan Department of  
Transportation

**Rick Chelotti**  
Bergmann Associates

**Dan Christian**  
Tetra Tech MPS

**Matt Chumbley**  
WPS

**Brian Davies**  
Hubbell, Roth & Clark

**Tyler Dawson**  
NTH Consultants

**Brad Ewart**  
Soil & Materials Engineers

**Nathan Fettes**  
Michigan Department of  
Transportation

**Matt Hill**  
WPS

**Cindy Irving**  
Lansing Board of Water & Light

**Megan Jacobs**  
Soil & Materials Engineers

**Kevin Jones**  
RS Engineering, LLC

**Matt Junak**  
HNTB

**Peter Margules**  
NTH Consultants

**Beverly McCready**  
US Army Corps of Engineers

**George McKenzie**  
Consumers Energy

**Mario Quagliata**  
Bergmann Associates

**Lauren Roller**  
HED Development

**Emily Schlanderer**  
Fishbeck, Thompson,  
Carr & Huber

**Todd Sneathen**  
Hubbell, Roth & Clark

**Michael Thelen**  
Consumers Energy

**Anthony Thomas**  
Soil & Materials Engineers

**Geneva Vanlerberg**  
Lansing Board of Water  
& Light

**Phil Vogelsang**  
AECOM

**Jeremy Wahlstrom**  
Soil & Materials Engineers

**Jon Ward**  
Rowe Professional Services

**Emily Warners**  
Consumers Energy

# Design Day Awards Fall 2017

## Rolla C. Carpenter Senior Design Award

*The Rolla C. Carpenter Senior Design Award (\$700 and plaques) is presented to the best team as judged by the faculty and a panel of practicing engineers.*

Rolla C. Carpenter, Renaissance Engineer, was a graduate of The State Agricultural College in 1873 with a Bachelor of Science degree. After earning a Master of Science Civil Engineering, he was appointed professor of the Department of Mathematics and Civil Engineering at the State Agricultural College, which would later become MSU. He designed bridges, built ice houses, taught students French, astronomy, mathematics, mechanical drawing, hydrostatics, hydraulics, survey, and civil engineering. He prepared the design and working drawings for the Farm Lane Bridge, laid a water supply pipe to Williams and Wells Halls, and designed a pile driver for a dam built across the Red Cedar River. He later designed several buildings on campus, including the Mechanical Building, which was constructed in 1885. Throughout all of his work on campus, he involved students throughout the analysis, design and construction, forming what was essentially the first senior capstone design class.



*The faculty and students of the Department of Civil and Environmental Engineering gratefully acknowledge the generous contributions from Fishbeck, Thompson, Carr & Huber, Inc. (FTC&H) and Barr Engineering Co.*

## Rolla C. Carpenter Senior Design Award Winners, Fall 2017

Team 5: Pelfrey Pathway Consultants

Left to Right: Logan Bowling, Michael Gold, Mary Leverentz, George Anganis, Stryder Crosswhite, Evan Pelfrey

Presented by Nancy Carpenter and Anthony Ingle



## ChE Process Design and Optimization



**Dr. Mark Worden**  
Class Instructor and Professor  
of Chemical Engineering and  
Biomedical Engineering



**Apoorva Kulkarni**  
Graduate Student &  
Teaching Assistant of  
Chemical Engineering

## Course Description

Chemical Engineering's capstone design sequence includes Process Design and Optimization I and II (CHE 433 and 434, respectively). In these courses, students integrate content from earlier courses for complex, open-ended design assignments. As students progress through ChE 433, their assignments require increasingly more effort, initiative, knowledge and individual responsibility. The capstone design experience culminates in CHE 434, when students spend a month designing a commercial-scale chemical plant and use economic analyses to optimize the plant's profitability.

For about 50 successive years, CHE 434 students have spent 30 days working intensively on the annual American Institute of Chemical Engineering (AIChE) Student Design Competition Context problem. The Chemical Engineering and Materials Science Department uses these industry-based problems to enhance chemical engineering students' capstone design experience for three reasons: 1) they provide real-world, open-ended design experiences typical of those students are likely to face after graduation; 2) they

require self-directed active learning, including project-specific research to obtain information needed to solve the problem; and 3) they serve as a national benchmark for MSU chemical engineering students to demonstrate excellence in their professional skills.

Each year, eight posters are presented on Design Day describing CHE 434 student solutions to the AIChE Student Design Competition problem (four individual solutions and four two-person team solutions). In addition, in June, MSU's four best solutions (two teams and two individuals) are submitted for judging as part of the national AIChE competition. Since 1968, MSU has had the best record of any school nationally for awards in this national contest.

(<https://www.chems.msu.edu/academics/undergraduate/aiche>).



### National Award from 2017 AIChE Design Competition

In 2017, MSU chemical engineering student Eric Monville (shown to the left) received an Honorable Mention Award (third place nationally) for his solution to the design problem entitled, "Manufacturing Facility for Nylon 6-6." (<https://www.aiche.org/community/awards/student-design-competition-individual>).

# AIChE<sup>®</sup>

# Manufacturing Facility for Dimethyl Ether

In 2018, the AIChE Student Design Competition problem was to design a safe and sustainable chemical process to produce dimethyl ether (DME). DME is used as a chemical feedstock and also shows promise as an alternative transportation fuel. Because DME can be produced from natural organic wastes, it could reduce the transportation industry's carbon footprint. The US market for DME is expected to grow about 12% per year to \$7.5 billion by 2022, motivating expansion of DME-production capacity.

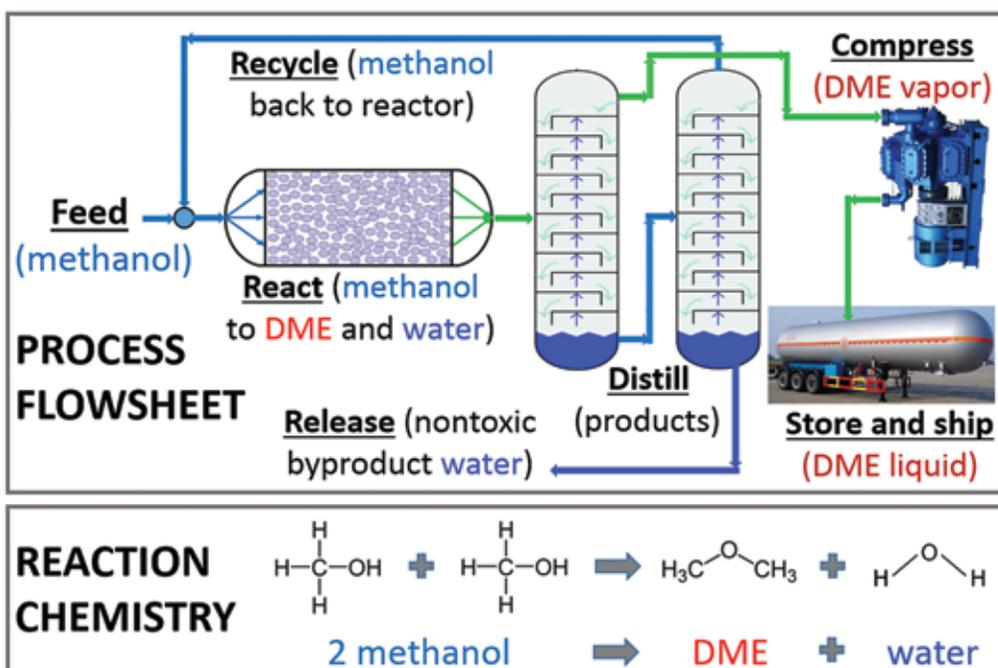
This capstone design project required students to integrate a broad range of chemical engineering skills as they developed a process flowsheet; designed and costed the process equipment; incorporated strategies for heat and mass integration; conformed to environmental, health, and safety guidelines; developed mathematical models of major equipment; integrated multiple equipment models into a plant-wide process simulation using Aspen software; and then combined economic analysis with

Aspen simulations to determine optimal plant operating conditions that maximized the plant's profitability.

In solving this open-ended design problem, students were encouraged to incorporate creative design innovations while adhering to imposed constraints (e.g., safety guidelines and environmental regulations). All design specifications had to be justified. As in most real-world design projects, students were not given all the necessary information, so they had to do literature research, make (and verify) assumptions, and apply engineering heuristics (i.e., rules of thumb) to complete the design.

The example process flowsheet below shows how multiple unit operations (a chemical reactor, two distillation columns, and a compression system) could be integrated to convert methanol into DME and water, increase product yield using a recycle loop, purify DME and byproduct water streams via distillation, and compress DME vapor into a liquid DME product suitable as a diesel fuel replacement.

## Process Flowsheet and Reaction Chemistry



## Individual-Solution Poster Presenters



James Wortman



Maria Allen



Stacie Schroll



Ben Stephens

## Team-Solution Poster Presenters



Jeevan Boparai and Andrew Koziel



Elizabeth Sutara and Matthew Bjork



Devinda Wijewardena and Alice Kilvington



Dan Gillespie and Rachel Martin



## The Capstone Projects

**Dr. Martin Crimp**  
Professor of Chemical Engineering and Materials Science

# Course Description

MSE466 is a senior level course for Materials Science & Engineering majors, providing students with a team-based capstone design experience. A major aspect of this course is to have students apply their course-learned background knowledge and skills in materials science and other disciplines to real-life design problems. A failure analysis investigation (FAI) fits this context. Failures are a major motivating factor for promoting more innovative designs or design changes. A failure analysis investigation provides a unique platform to design and to solve real-world engineering problems via systematic engineering approaches. By focusing on a specific design failure, the student teams learn how to confront an open-ended problem that requires them to develop a strategic design plan and to execute the methodology for assessing how and why the failure occurred. The analysis is conducted using established investigative procedures and constraints for conducting failure analysis investigation. This semester, there are eight teams working on eight real engineering failures.

### Presentation Schedule – First Floor Room 1145

Time	Team	Project
8:30 a.m.	Shifty Shafts	Failure Analysis of a Subaru Impreza Front Axle Shaft
8:55 a.m.	Make Hips Grate Again	QUICKSET Acetabular Grater Head Failure Analysis
9:20 a.m.	Missing Connections	Briggs & Stratton Connecting Rod Failure
9:45 a.m.	Press “I” for Spanish	Foldable Attic Ladder Hinge Fracture Analysis
10:10 a.m.	One Cylinder Wonders	An Analysis of Chrome Plating Failure in a 3cc Nitromethane Engine Cylinder Bore
10:35 a.m.	This is No Yoke	Front Drive Axle Input Yoke Failure Analysis
11:00 a.m.	The Kobalt Calamity	Torque Wrench Failure Analysis
11:25 a.m.	The Bat Street BoyZ	Cracked DeMarini Bat

# MSE 466 Fracture and Failure Analysis

*Successfully completed team projects culminate in a comprehensive written final report and a strategic redesign plan to improve the design and mitigate future failures. For Design Day the teams present their findings in twenty-five-minute presentations. For 2018, the eight teams are conducting the following failure analysis investigations:*



(left to right) Kacper Biernacki, Ana Tajuelo and Tyler Johnson

**Team Name:** Shifty Shafts

**Project Name:** Failure Analysis of a Subaru Impreza Front Axle Shaft

**Time:** 8:30 a.m.

One sunny day the owner of a beautiful Subaru Impreza was driving, when suddenly his car became unmaneuverable. Upon further inspection it was discovered that, through some unknown mechanism, the front axle shaft failed. With no known previous issues with the vehicle, the cause of failure was unknown. Metallographic and fractological analysis will be performed to determine the microstructure of our sample and the most probable fracture origin/modes of propagation. Our analysis will use a combination of non destructive testing, like X-Ray spectroscopy, and destructive testing, like tensile and hardness tests, to discover the most likely cause(s) of failure.



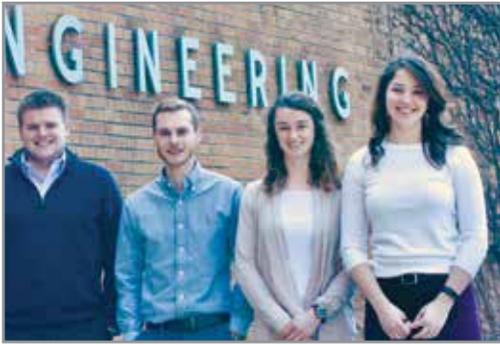
(left to right): Lexi Rogien, Nick Dionise and Joshua Caudill

**Team Name:** Make Hips Grate Again

**Project Name:** QUICKSET Acetabular Grater Head Failure Analysis

**Time:** 8:55 a.m.

Team “Make Hips Grate Again” is tasked with the failure analysis of a QUICKSET acetabular grater head that was manufactured by Depuy Synthes Joint Reconstruction. This device is used in hip reconstruction surgeries to hollow out the bone to prepare it for the placement of the prosthetic hip joint. The failure occurred during this reaming process. Upon initial investigation, it seems that the failure had occurred along the weld line resulting in a complete separation between the two individual components that make up the grater head. Failures such as this could easily result in injury to a patient or in surgical delay and therefore merit investigation. It seems that non-conformance during the fusion weld process resulted in inferior mechanical integrity, which caused the premature failure of the device.



(left to right): Doug Simpson, Luke Russell, Mckinley Brewer and Megan Wheelock

**Team Name: Missing Connections**  
**Project Name: Briggs & Stratton Connecting Rod Failure**

**Time: 9:20 a.m.**

A Briggs & Stratton connecting rod, from MSU's Baja car engine, was selected for study after failure occurred during testing. The failure of the connecting rod occurred during testing the vehicle for a race under normal operating conditions for rod and engine. The exact chemistry of the part was still unknown. Through use, the connecting rod experienced stresses, creep and fatigue within the piston. However, under normal conditions and use these stresses should not have caused failure. The failure was studied microscopically to find anomalies. With non-destructive and destructive tests, the team will work to discover the cause of failure. The team will also design preventative measures to ensure failure of this connecting rod will not occur again.

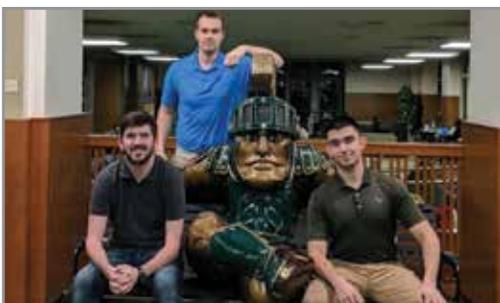


(Left to Right) Claudia Vazquez Sanz, Michael Bordas and Hector Giner

**Team Name: Press "1" For Spanish**  
**Project Name: Foldable Attic Ladder Hinge Fracture Analysis**

**Time: 9:45 a.m.**

A Werner Co. foldable attic ladder failed catastrophically on a cold December day. The zinc-aluminum hinges, located between the second and third rungs, fractured entirely causing the bottom most portion of the ladder to collapse. Failure resulted from the step of the consumer with a load under the specified maximum. A stress analysis using the approximate loading was modeled to determine how the fracture developed and proceeded. Composition of the zinc alloy hinges was identified with chemical analysis. Fracture surfaces were photo-documented and examined with SEM. The team used the data collected from these methods and mechanical testing to determine the cause of this fracture.

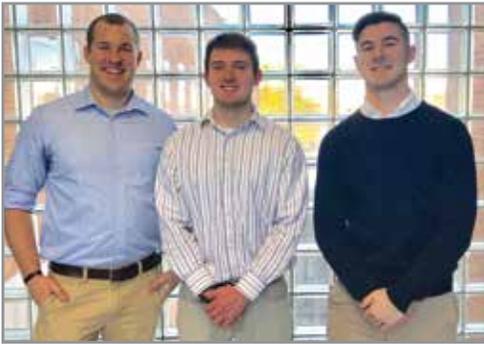


(Left to Right) Charles Filipiak, Nicholas Ostrander and Gill Levental

**Team Name: One Cylinder Wonders**  
**Project Name: An Analysis of Chrome Plating Failure in a 3cc Nitromethane Engine Cylinder Bore**

**Time: 10:10 a.m.**

Aluminum-block internal combustion engines of all types use a hard liner within their cylinders to provide a wear surface for the pistons that reciprocate within them. A radio-controlled car's nitromethane engine is no exception. This project concerned one such nitromethane engine, which lost part of the chromium liner of its single cylinder during the initial stages of its breaking-in period. This, in turn, caused a compression failure that disabled the engine. Mindful of the implications for potential failures in larger, more important engines, the One Cylinder Wonders created and executed a detailed test program to ascertain the reasons for the coating failure, as well as ways in which the failure may be avoided in future engines.

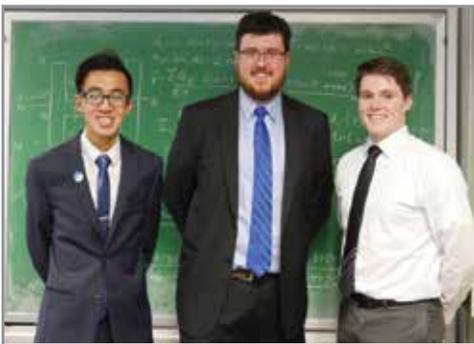


(left to right) Grant Kunzi, Joshua Young and Daniel Crosby

**Team Name: This Is No Yoke**  
**Project Name: Front Drive Axle Input Yoke Failure Analysis**

**Time: 10:35 a.m.**

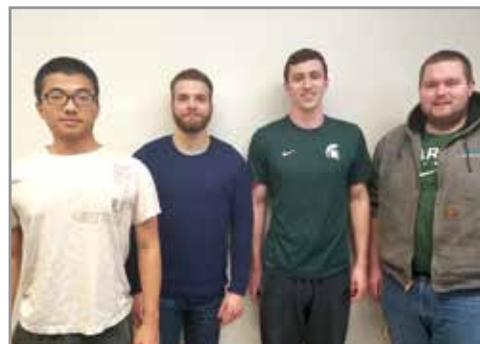
Our team was assigned the task of determining the failure mode of a front drive axle input yoke. This yoke's sole purpose is to connect the driveline to the front axle and is located in a semi-truck that became stuck in a gravel pit in Jackson, Michigan. As the truck was spinning its tires to get out of the gravel pit, the yoke fractured. In order to determine the cause of failure, the team separated the fracture surfaces of the part and performed numerous tests. These tests included finite element analysis, chemical analysis, microhardness testing, microstructural analysis, and fractography.



(left to right) Steven Liu, Daniel Mckenna and Bryce Ewing

**Team Name: The Kobalt Calamity**  
**Project Name: Torque Wrench Failure Analysis**  
**Time: 11:00 a.m.**

While performing regular maintenance on his car, Bryce Ewing broke his Kobalt™ torque wrench. Does Bryce possess superhuman strength? Probably not. We attempted to identify all the possible reasons this tool failed using the resources available to us at Michigan State University. The failed component, known as the anvil, was the focus of our failure analysis investigation. Electron microscopy, hardness testing, and other destructive and non-destructive failure analysis methods determined the cause of the failure and aided us in recommending a preventative solution.



(left to right) Tianyu Wang, Pablo Minué, Nicholas Leshok and Brock Wowianko

**Team Name: The Bat Street BoyZ**  
**Project Name: Cracked DeMarini Bat**  
**Time: 11:25 a.m.**

A high-end DeMarini baseball bat cracked while being used under unknown conditions and was retrieved from a second-hand sporting goods store in Novi, Michigan. The substantial crack caused the bat to be unusable, taking away all the value, which in turn imposed significant financial harm to the owner. Utilizing various materials testing techniques, such as tensile testing, metallography and stereo microscopy, the group used their experience and resources provided by the college to determine why the bat cracked. The results of the testing, determination of root cause, and suggested corrective measures of the failure will be presented to ensure that this type of failure will not happen again.

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# Computer Science and Engineering

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Okemos, Michigan



Detroit, Michigan



Chicago, Illinois



## The Capstone Projects

**Dr. Wayne Dyksen**  
Professor of Computer Science and Engineering



**Jonny Dowdall**



**James Mariani**

Teaching Assistants

### Presentation Schedule – Engineering Building, Room 3405

Time	Team	Project
7:30 a.m.	Accenture	AMAP: Automated Malware Analysis Platform
7:42 a.m.	Amazon	AMPED: Amazon Marketplace Podcast Earnings Detection
7:54 a.m.	Aptiv	CMS: Cybersecurity Management System
8:06 a.m.	Auto-Owners	IMAGINE: IMAGE INtake Experience
8:18 a.m.	Dow	Virtual Reality Simulation for Railcar Loading
8:30 a.m.	DRIVEN-4	2020 Business in a Box
8:42 a.m.	GM	Plato: DevBot for Microsoft Teams
8:54 a.m.	Herman Miller	Adjust: Augmented Reality Chair Adjustment
9:06 a.m.	Meijer	Thrifty: Personal Shopping Assistant
9:18 a.m.	Michigan State University	Pulse: Classroom Engagement System
9:30 a.m.	Mozilla	Dark Theme Darkening
9:42 a.m.	MSUFCU	Digital Assistant and Personal Financial Coach
9:54 a.m.	Phoenix Group	Customer Service System with Chatbot
10:06 a.m.	Proofpoint	Next Generation Malware Analysis Platform
10:18 a.m.	Quicken Loans	Fundamenta: Trust in New Home Construction
10:30 a.m.	Rook	Endpoint Data Monitoring and Analysis Agent
10:42 a.m.	SpartanNash	Volunteer Tracking System
10:54 a.m.	Spectrum Health	Spectrum Health Go
11:06 a.m.	Symantec	Detecting Security Threats from User Authentications
11:18 a.m.	TechSmith	Snagit and Camtasia Output Extensibility
11:30 a.m.	Union Pacific	“Alexa, what’s my work schedule look like?”
11:42 a.m.	Urban Science	Mobile Maestro
11:54 a.m.	USAA	LIMElight: Life Insurance Made Easy
12:06 p.m.	Yello	IVAT: Interview Video Analysis Tool

## CSE 498 Collaborative Design

CSE498, Collaborative Design, provides the educational capstone for all students majoring in computer science. Teams of students build software systems for corporate clients.

During the capstone experience, students

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

Our clients are local, regional, and national including Accenture, Amazon, Aptiv, Auto-Owners Insurance, Boeing, Chrysler, Dow, Ford, GE, General Motors, Google, Herman Miller, Meijer, Michigan State University, Microsoft, Mozilla, MSU Federal Credit Union, the Phoenix Group, Proofpoint, Quicken Loans, Rook Security, SpartanNash, Spectrum Health, Symantec, TechSmith, Union Pacific, Urban Science, USAA, Whirlpool and Yello.

# Accenture

## AMAP: Automated Malware Analysis Platform

Accenture is a professional services company that solves their clients' problems by providing services in strategy, consulting, digital, technology and operations. Accenture's iDefense provides timely, relevant and actionable cyber threat intelligence to the largest organizations in the world.

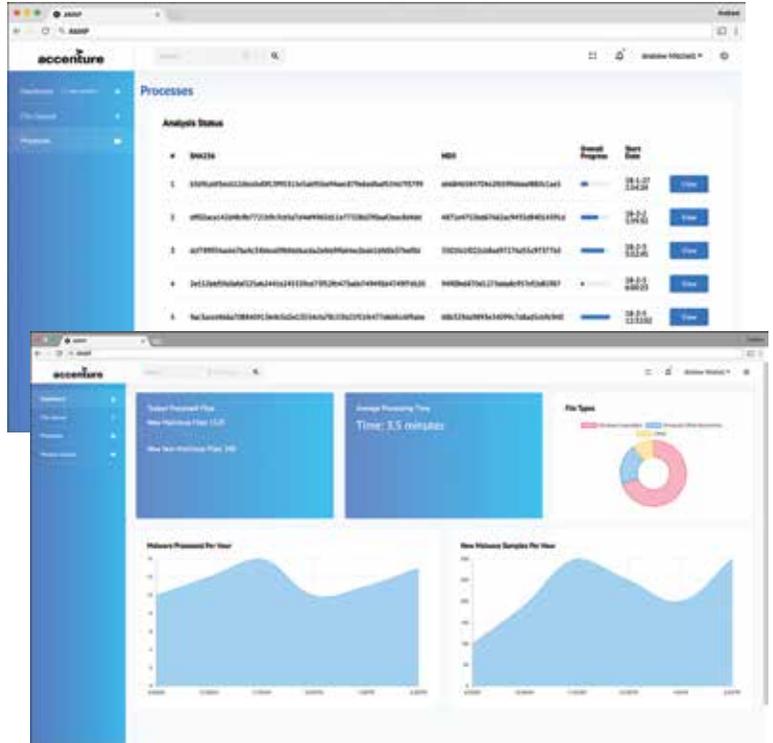
Malware is software that is intended to damage or disable computers. Accenture iDefense maintains a large database with more than 260 million samples of malware. Before being added to this database, each new malware sample must be analyzed to determine what it does and how it works.

iDefense uses various software modules to analyze malware. However, the number of malware samples is growing so fast that it cannot be processed manually.

Our Automated Malware Analysis Platform (AMAP) is a web app that combines iDefense's various malware analysis modules to process malware automatically at the speed and scale required.

For each batch of malware, users choose which iDefense malware analysis modules to apply. Our dashboard displays the status of malware currently being processed and the status of the overall system. Malware is also processed automatically by our system when users are not actively using it.

Our Automated Malware Analysis Platform runs as a web-based application with a backend written in Python. The underlying database holding malware samples and analysis output is mongoDB.



### Michigan State University

Team Members (left to right)

**Griffin Metevia**  
Midland, Michigan

**Sam Kling**  
Muskegon, Michigan

**Julian Ellis**  
Troy, Michigan

**Andrew Mitchell**  
Rochester, Michigan

**Teng Xu**  
Hefei, Anhui, China

### Accenture

Project Sponsors

**Lisa Calley**  
Chicago, Illinois

**Josh Ray**  
Washington, D.C.

**Kevin Richards**  
Chicago, Illinois

**Alireza Salimi**  
Washington, D.C.

**Brian Urbanski**  
Chicago, Illinois

# Amazon

## AMPED: Amazon Marketplace Podcast Earnings Detection

Amazon is an e-commerce and cloud computing company based in Seattle. Accounting for 1 in 3 online shopping transactions in North America, Amazon is the world's largest online retailer.

In the third quarter of 2017, Nielsen reported that 40% of Americans listened to a podcast. Despite having a large audience, podcast producers have few opportunities to profit from their work.

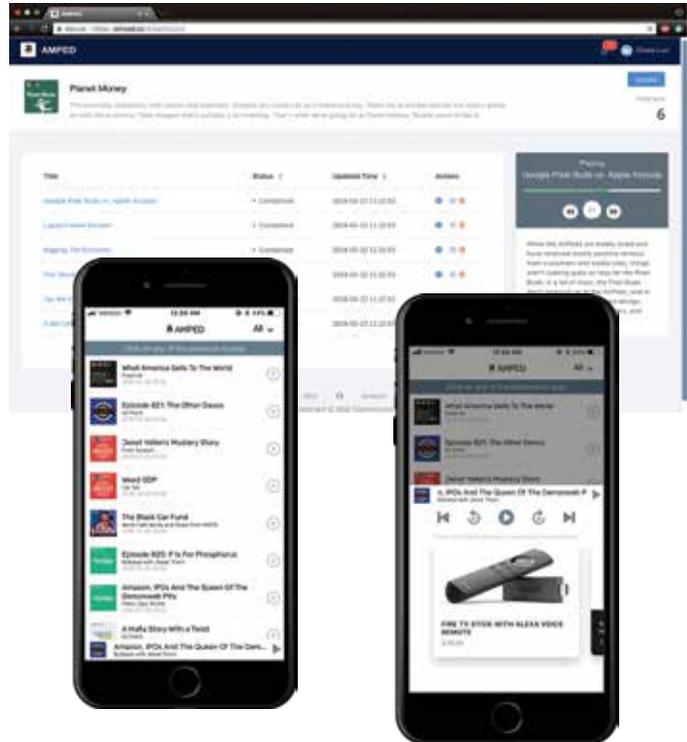
Our Amazon Marketplace Podcast Earnings Detection system (AMPED) provides podcast producers an additional source of revenue by finding products related to their content. The results are displayed on a dashboard for producers with an audio player integrated with the items.

For example, if a podcast producer is doing a tech review on the latest MacBook Pro, AMPED searches the Amazon marketplace for the latest MacBook Pro, and provides an image and link for the listener to buy it.

AMPED finds relevant products by first transcribing the podcast's audio content to text. Next AMPED comprehends the meaning of the text. Finally, AMPED searches the Amazon marketplace for the most relevant products.

Products appear in the bottom of the app as the podcaster mentions them. Listeners can choose to purchase the products in Amazon's app or website by clicking on the picture of the product.

AMPED is built with Python and is hosted on AWS Lambda serverless architecture. AMPED uses Amazon Transcribe for speech to text, Amazon Comprehend for natural language processing, and Product Advertising API to find products.



**Michigan State University**  
*Team Members* (left to right)

**Zach Whitener**  
Fenton, Michigan

**Hansheng Zhao**  
Hanzhong, Shaanxi, China

**Dillon Stock**  
Northville, Michigan

**Cam Korzecke**  
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**Chess Luo**  
Yueyang, Hunan, China

**Amazon**  
*Project Sponsors*

**Tim Downs**  
Detroit, Michigan

**Peter Faricy**  
Seattle, Washington

**Garret Gaw**  
Detroit, Michigan

**Mike Linington**  
Detroit, Michigan

# Aptiv

## CMS: Cybersecurity Management System

With over 147,000 employees in 45 countries around the world, Aptiv is a global technology company focused on creating the next generation of active safety, autonomous vehicles and smart cities.

Technology-focused mobility solutions introduce an increased need for implementing and testing product cybersecurity standards to ensure that Aptiv's products are not susceptible to malicious attacks.

Aptiv's cybersecurity lab conducts cybersecurity consulting and testing on every new product during the entire development process. The team works closely with product engineers to ensure the company's products are up to the latest security standards and impenetrable from outside attacks.

Our Cybersecurity Management System (CMS) is a web app that automates the entire product cybersecurity process. This five-tiered process includes threat analysis, mitigation remediation, vulnerability assessment, penetration testing and incident response.

Maintaining all cybersecurity-related information for Aptiv products, our CMS includes database trackers to visualize important trends and analyze data for threats, vulnerabilities, risks, incidents and mitigations.

CMS provides the source of communication between product and cybersecurity engineers who utilize our app's request system and task management service to increase productivity and streamline Aptiv's entire cybersecurity process.

Our Cybersecurity Management System is an ASP.NET app written in CSS and HTML. Our backend database is implemented with MS SQL.



### Michigan State University

*Team Members* (left to right)

**Dillon Brown**  
Webberville, Michigan

**Clayton Peters**  
Oxford, Michigan

**Ashtaan Rapanos**  
Midland, Michigan

**Winton Qian**  
Ningbo, Zhejiang, China

**Wei Jiang**  
Dongyang, Zhejiang, China

### Aptiv

*Project Sponsors*

**Dave Connett**  
Fenton, Michigan

**Chris Lupini**  
Kokomo, Indiana

**Chris Lussenhop**  
Troy, Michigan

**Justin Montalbano**  
Fenton, Michigan

# Auto-Owners Insurance

## IMAGINE: IMAGE INTake Experience

**A**uto-Owners Insurance is a Fortune 500 company represented by over 4,900 associates nationwide. Founded in 1916, Auto-Owners Insurance provides its claims service to 2.7 million policyholders.

In order to appraise risks, Auto-Owners underwriters must evaluate physical environments such as homes or businesses with as much information as possible.

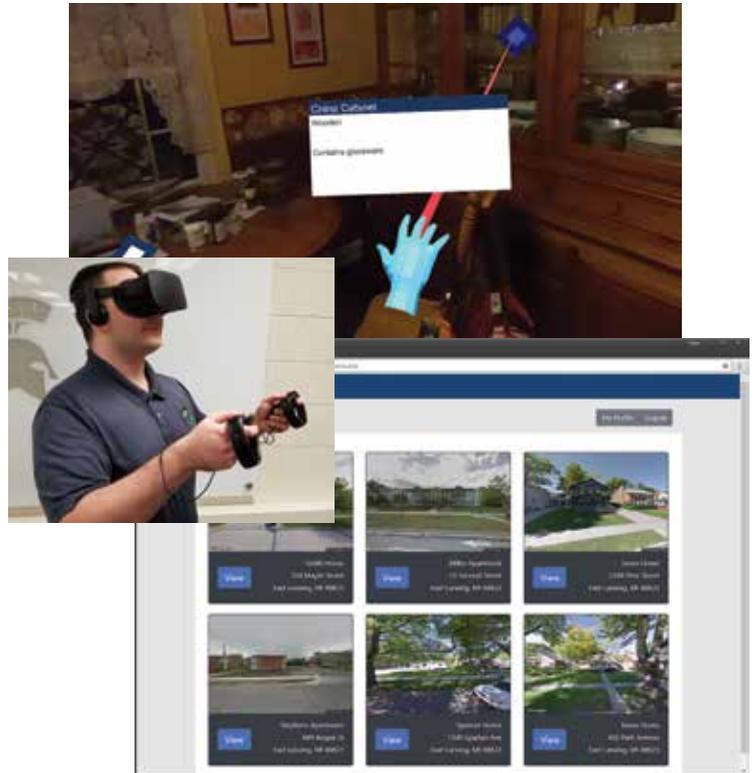
Our IMAGE INTake Experience system (IMAGINE) automates part of this process by identifying objects of interest in images taken of an environment and enabling Auto-Owners associates to recreate a physical environment at any time in virtual reality (VR).

Auto-Owners associates upload 360-degree images taken by a spherical camera to our web app, which analyzes the images to detect relevant objects such as a door or a piece of furniture. Associates can then display and edit information about the environments in those images.

Associates can create and edit names, descriptions and comments about environments and the objects in them. They can also download inventories of detected objects in various formats.

Our companion VR app creates a virtual version of the physical environment, which is viewed using an Oculus Rift headset. Associates use Oculus Touch controllers to select objects and to view and edit environment information such as item descriptions or comments.

IMAGINE is written in PHP and JavaScript and runs on all modern web browsers. Our virtual reality application is developed in Unity for the Oculus Rift platform and runs on Windows computers. Our object detection suite is written in Python using TensorFlow.



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# The Dow Chemical Company

## Virtual Reality Simulation for Railcar Loading

With over 100 years of success and industry-leading innovation, Dow is a global leader in specialty chemicals, advanced materials and plastics. Along with Dow's ongoing innovation and success is a commitment to its employees' safety and wellbeing.

Dow manufactures hazardous chemicals that require care and knowledge when handling and transporting. Training new employees is dangerous because a mistake could have serious health implications if employees are exposed to these chemicals.

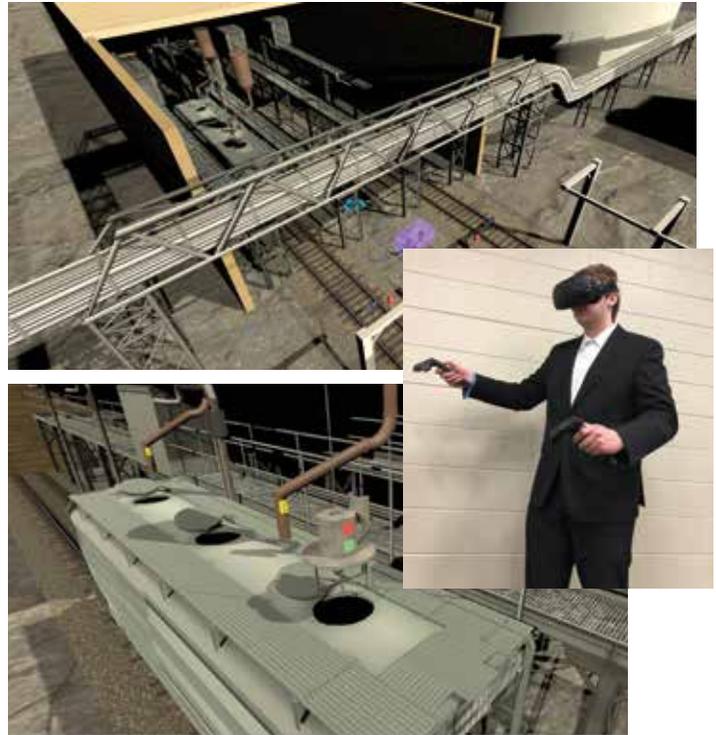
Our Virtual Reality Simulation for Railcar Loading eliminates this danger by training employees safely in a virtual environment. Our simulator trains employees in the proper way to load a railcar in a virtual railcar facility.

Dow employees wear an HTC Vive Headset and use two controllers to simulate a real working environment. Trainees are taught the steps needed to load a railcar properly and what to do when a spill occurs.

Our training simulator has two difficulty levels, non-certified and certified. The non-certified level gives a trainee hints to teach them the proper procedure. In the certified level, a trainee receives no aid, so they need to know what to do. Our simulator also includes scenarios where a spill occurs, so trainees can learn the proper way to clean a spill.

To help the employees learn, our training simulator gives the employees a score when they complete a session along with feedback on how to improve.

Our Virtual Reality Simulation for Railcar Loading uses Unity Game engine and is played on a Windows computer with the HTC Vive hardware.



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# DRIVEN-4

## 2020 Business in a Box

**D**RIVEN-4 is focused on driving competitive advantage for their customers by providing strategies, insights and proven implementations of integrated process and technology to deliver products and services to market.

Our 2020 Business in a Box system shows how a connected product platform can bridge the gap between product design and consumer use.

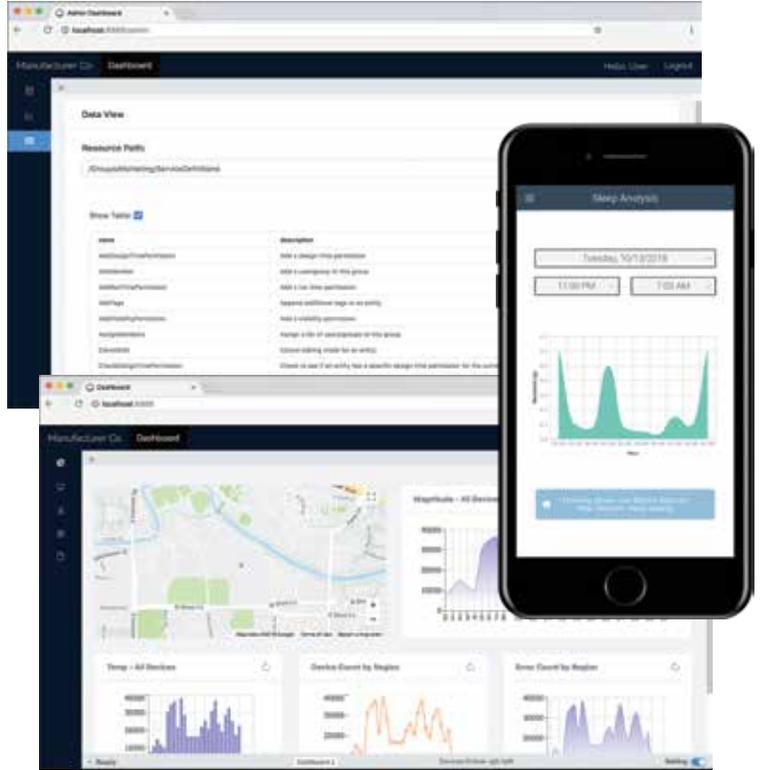
Our system comprises both manufacturer and consumer platforms to provide the insight needed to improve product design and consumer relationships while at the same time providing consumers with an enhanced experience for improving their daily lives.

Our web-based manufacturer portal provides for domain-specific configuration to create a dashboard for users in various job roles to visualize data and perform actions specific to their fulfillment of business and consumer needs. The built-in device simulator allows manufacturers to digitally simulate connected products before they are produced.

Our showcase of the platform demonstrates its use through the eyes of a mattress manufacturer and its consumers. When placed in the mattress, our connected device uses accelerometer and temperature sensors to transmit sleep cycle information to the platform.

The end-consumer experiences the platform through a mobile app that provides sleep analysis, suggestions to improve sleep quality and augmented reality visualizations for servicing their device.

Our web portal is written in CSS, HTML and ReactJS. Our device simulator is written in Java. Our mobile app is built in React Native for Apple iOS devices.



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# General Motors

## Plato: DevBot for Microsoft Teams

Founded in 1908, General Motors designs and manufactures a wide variety of vehicles that meet the needs and expectations of drivers around the globe.

GM's continued success requires its software developers to integrate an expanding number of software applications into their workflow. To do so, they use several unique applications to design, develop, test, and maintain software. Having to frequently maneuver between these applications hinders the development process.

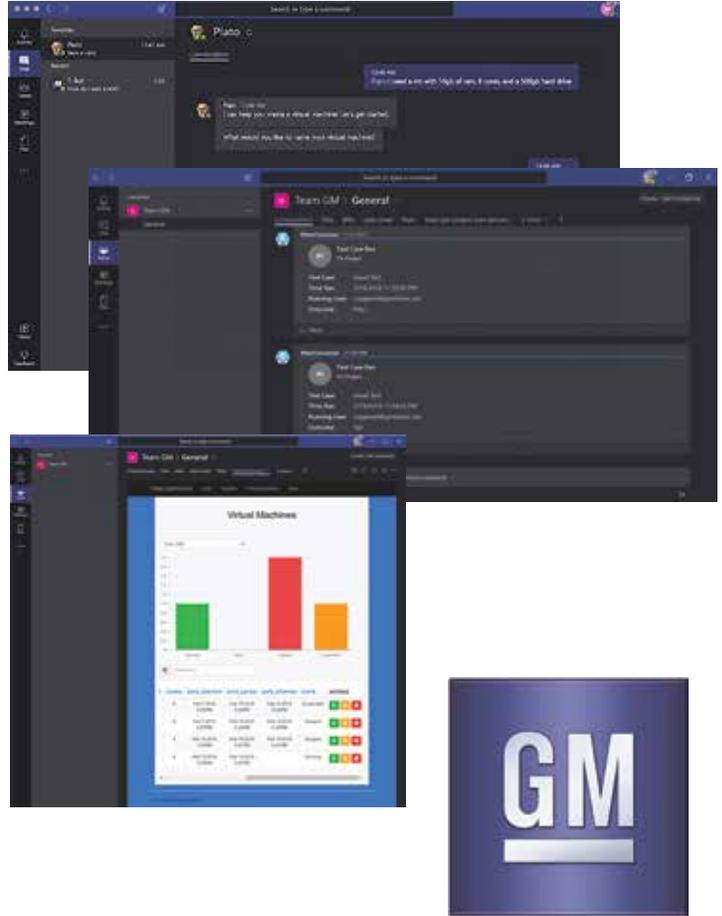
To enable collaboration and teamwork, GM developers use Microsoft Teams, a chat-based workspace. Developers are members of a channel, which is specific to their team where they can chat, manage files, and access external applications.

Our DevBot for Microsoft Teams system (Plato) extends the functionality of Microsoft Teams through the creation of three separate but cohesive applications.

Our first Plato app is an artificially intelligent chatbot that enables team members to create and manage virtual machines and test cases. A graphical web dashboard embedded into Microsoft Teams in the form of a tab is our second extension. Our third app is a Microsoft Teams connector that enables the team to configure regular notifications about the system's activity.

GM developers using our apps have full control over their resources and can monitor resource allocation, run tests and update the status of virtual machines all within a familiar Microsoft Teams environment.

Our Plato system is designed with the Microsoft Bot Framework, Microsoft LUIS, C# with .NET, AngularJS, HTML and CSS, and is deployed into Microsoft Teams.



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# Herman Miller

## Adjust: Augmented Reality Chair Adjustment

Headquartered in Zeeland, Michigan, Herman Miller is one of the world's largest producers of high-end office furnishings. The company's ergonomic office chairs are used in modern workspaces around the globe.

Every Herman Miller chair is highly configurable to match the unique needs of each user, ensuring proper ergonomic support in any office setting.

Adjust is our augmented reality (AR) chair adjustment app for owners of Herman Miller chairs.

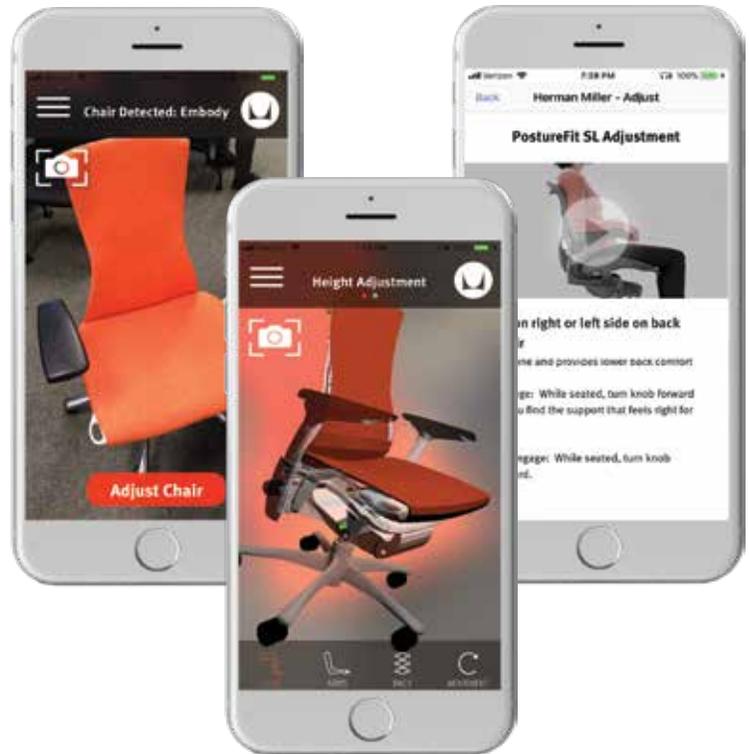
Adjust automatically identifies the model of a chair using an iPhone's camera along with computer vision and machine learning.

Once the chair model is known, Adjust displays an interactive 3D model and guides the user through an ergonomic adjustment session by highlighting the relevant chair parts.

Tapping on any highlighted part presents an instructional video and additional adjustment tips. For returning users, the application menu features a gallery option, which enables users to interact with a variety of Herman Miller chairs.

Our Adjust app reduces the need for in-person training sessions, allows for day-two training and eliminates the need for paper reference texts. Chair owners can locate any adjustment instantly using our built-in search functionality.

Adjust is a native iOS app written in Swift. Object recognition is performed using Microsoft Custom Vision and CoreML. Interactive 3D chairs are rendered using Apple's SceneKit.



**HermanMiller**



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# Meijer

## Thrifty: Personal Shopping Assistant

Meijer is a large supercenter chain located in the Midwest. With 237 supercenters in six states, Meijer is one of the largest retailers and private companies in the nation.

From shopping carts to self-checkouts, Meijer always leads on the frontline of innovation to ensure Meijer guest satisfaction.

Our Personal Shopping Assistant app (Thrifty) continues that tradition by enabling a guest to ask Thrifty anything they would ask an in-store Meijer team member. In addition, a guest can navigate through coupons and check competitor pricing.

Meijer guests interact with Thrifty using either text or voice. If Thrifty isn't sure what they mean, it responds with a list of possibilities from which a guest can select.

After an item is selected, Thrifty tells a guest where it's located in the store, how much it costs, and if there are any coupons available from Meijer's rewards program, mPerks. Guests can clip all coupons to their mPerks account and display a single barcode at checkout to apply all of their savings.

Thrifty also informs guests of item prices at competitors like Target or Walmart.

If an item is missing from the shelf, Thrifty notifies a Meijer team member to check for more.

Thrifty is built using the Microsoft Bot Framework and is hosted on Microsoft Azure cloud services. It uses Microsoft LUIS for natural language processing and supports both Apple iOS and Google Android devices.



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# Michigan State University

## Pulse: Classroom Engagement System

Michigan State University (MSU) is the nation's pioneer land-grant university and is a world-renowned research university, with top-tier academic and service-learning programs.

Our Classroom Engagement System (Pulse) provides a simple and convenient interface that enables extended engagement between course instructors and students. Pulse is designed around attendance, communication and analytics.

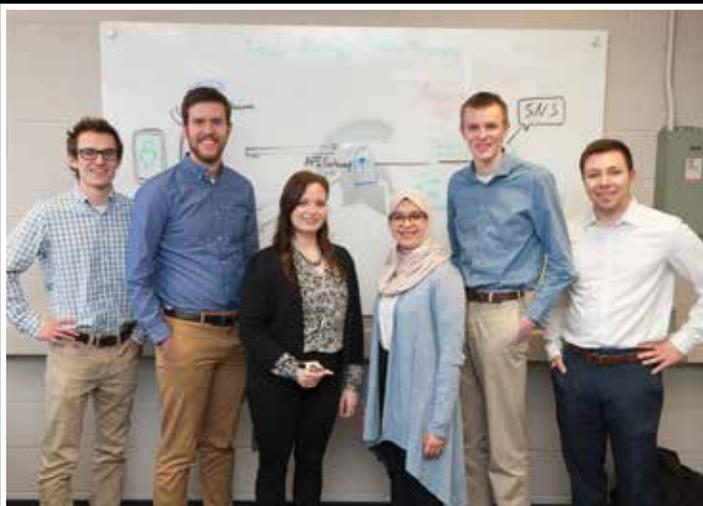
Attendance is made easy. Students simply respond to a notification that is sent to their mobile device as they enter a classroom. The student is then transported into the app to access the class material.

Pulse allows students and instructors to access multiple classroom resources on a compact and intuitive platform. Pulse offers a class overview page with course information, as well as a class forum where students and instructors can hold discussions.

Pulse's quizzes replace paper quizzes, thereby saving paper and time. The quizzes can be taken during class or at any time. Progress bars and timers are available to enhance the user experience.

Analytics are collected and displayed by our instructor-side web app for evaluation in real-time. Based on student responses to questions, instructors can vary the content in their lectures.

Our Pulse mobile apps are native apps for Apple iOS and Google Android developed with Swift and Kotlin, respectively. Our web apps are created with Vue.js. The backend interface consists of several platforms from Amazon Web Services.



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# Mozilla Corporation

## Dark Theme Darkening

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

Mozilla's most popular open-source project is Firefox, the second most used web browser globally. Its most recent release, Quantum, includes new styles, features and ways for users to customize the appearance of the browser.

Users are reluctant to switch internet browsers once the browser has been personalized to their liking. Previously, themes only had the ability to alter the appearance of the default toolbars and tabs.

Our Dark Theme Darkening increases the customizability of Quantum to include menus, popups, settings pages, loading indicators, sidebars, icons and added theme transitions. Additionally, Google Chrome themes can now be imported directly into Firefox.

The default Dark Theme is updated to reflect the new additions. Extending theme support in the browser gives theme developers more power to express their creativity, and gives users more surface area on which to enjoy themes.

In the screenshots to the right, one can see the current un-themed sidebar and settings page in the background, while the foreground shows the same content themed.

Our Dark Theme Darkening is implemented using CSS and JavaScript, and impacts hundreds of millions of users.



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# MSU Federal Credit Union

## Digital Assistant and Personal Financial Coach

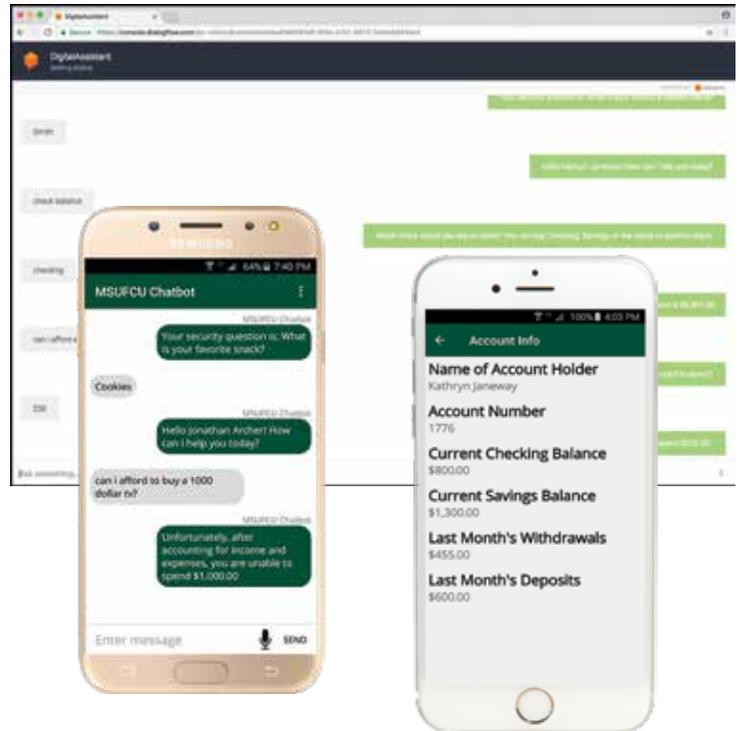
Founded in 1937, Michigan State University Federal Credit Union (MSUFCU) is the largest university-based financial credit union in the world. With over 246,000 members around the globe, customer service is a high priority for MSUFCU.

Our Digital Assistant and Personal Financial Coach expands the capabilities of MSUFCU's existing apps for Apple and Android devices. In addition, it offers services through a web app, an Amazon Alexa app, Facebook Messenger and iMessage.

Using a chatbot interface, MSUFCU members can get answers to questions to everything from "What's my account balance?" to "Can I afford to buy a laptop?" Our bot also offers financial planning services. If a member cannot afford a laptop, for example, our Digital Assistant and Personal Financial Coach will suggest a plan for a member on how to save for one.

For MSUFCU members who prefer a hands-free approach to banking, our Alexa skill can respond to the same voice commands as the chatbot interface. Our Apple and Android apps, as well as Facebook Messenger and iMessage, all accept the same voice commands.

Our Digital Assistant and Personal Financial Coach Apple iOS app is written in Swift, and the Google Android app in Java. Our Alexa skill is written in JavaScript. The natural language processing is handled using DialogFlow. All six of the available apps contact a SQLite database hosted on a server.



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# The Phoenix Group Customer Service System with Chatbot

The Phoenix Group (TPG), an Ingram Micro company, is one of the largest distributors of credit card terminals. They offer customers a vast selection of devices from all major manufacturers and take pride in having outstanding customer service.

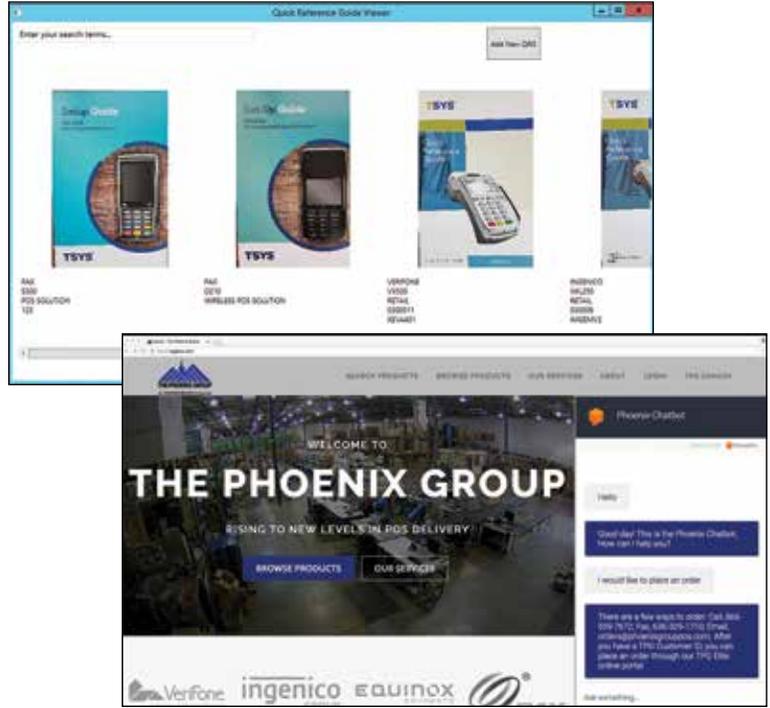
Customer service associates at TPG frequently reference paper device manuals to provide customers with helpful information. With hundreds of manuals to reference, TPG associates need a better way to manage and access them.

Our Customer Service System enables TPG to convert paper manuals to a digital format using optical character recognition (OCR) technology. An associate easily adds new manuals into the system by uploading images of its pages. Once added to our system, a specific manual can be found quickly by searching for it and viewed conveniently as an eBook.

Our Customer Service System enables TPG's customer service associates to maintain their outstanding responsiveness despite a growing lineup of carried devices.

Additionally, our Customer Service Chatbot provides an informative resource for customers visiting TPG's website. Customers can converse with the chatbot to ask about TPG and the devices it offers.

Our Customer Service System is a Windows WPF application written in C# that communicates with our custom remote server where the digital manuals are stored. Our Customer Service Chatbot is implemented using Google Dialogflow and is written in AngularJS.



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# Proofpoint Next Generation Malware Analysis Platform

Proofpoint is a leading next generation cybersecurity firm that provides comprehensive cloud-based security solutions to protect organizations from advanced threats and attacks that target email, mobile apps and social media.

Every day Proofpoint blocks threats in more than 600 million emails, 7 million mobile apps and hundreds of thousands of social media accounts. This volume of threats makes it increasingly more difficult to rely solely on human analysis.

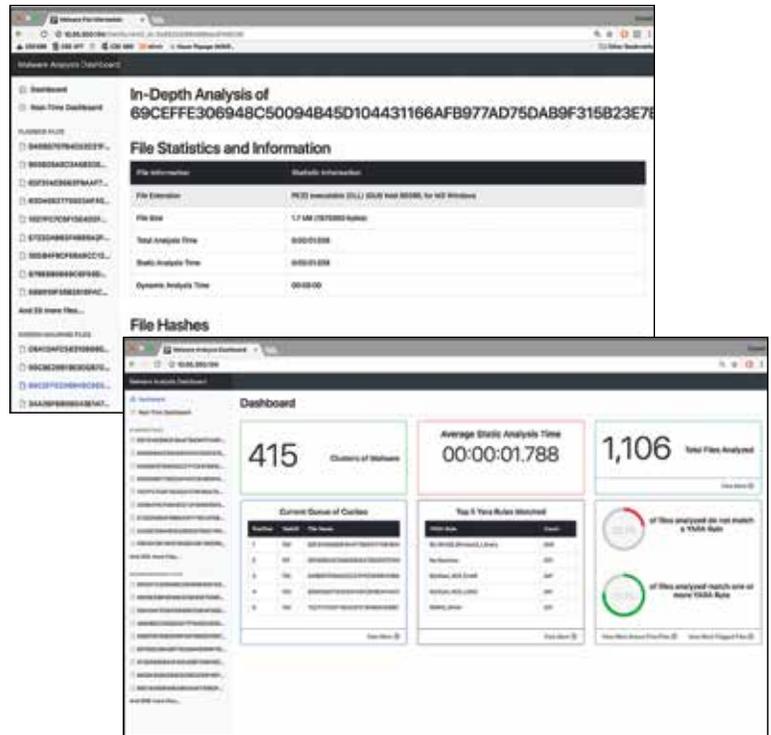
Our Next Generation Malware Analysis Platform provides a comprehensive tool for analyzing malware samples automatically and quickly.

Our system first analyzes malware using a basic set of tools. Depending on the results of this initial analysis, our system determines whether or not more in-depth analysis should be done.

Malware is classified and identified using something called a signature. Our system clusters malware based on similarity, thereby enabling Proofpoint analysts to generate signatures more efficiently.

Analysts use our dashboard to visualize the results of malware analysis. Additionally, they can view malware of interest and apply filters.

Our Next Generation Malware Analysis Platform uses Bootstrap. A RESTful API based on NodeJS communicates with the MongoDB Database. Cuckoo, YARA, ClamAV and Suricata are utilized for the malware analysis tools. All of our tools run on virtual machines handled by an ESXi Hypervisor.



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# Quicken Loans

## Fundamenta: Trust in New Home Construction

Quicken Loans is the largest online mortgage lender in the US, and is the nation's largest FHA lender and premier Veteran Affairs lender.

New home construction is a complex process involving many parties including the home buyer, the builder, subcontractors and inspectors. Dependencies among the steps in the building workflow can cause bottlenecks. Lack of communication can further delay the process.

Our Trust in New Home Construction web app (Fundamenta) facilitates the home building process. Fundamenta is a platform for organization and collaboration among parties involved in a build.

Fundamenta displays a construction workflow comprised of tasks for all parties. It visualizes the workflow with progress bars that show who completes tasks and when, along with all construction deliverables.

In addition, Fundamenta provides a conversation page, which enables messaging between parties.

Blockchain technology manages the workflow, opening new tasks for completion when contingent steps are finished, and stores all data pertaining to a home build.

Our Fundamenta app keeps all parties informed on the current state of a home build, thereby bringing transparency to the entire process.

Fundamenta is written in C# with React and the .NET framework. Hyperledger Fabric blockchain is used with the Composer framework. The database is implemented using Microsoft SQL Server.



**Quicken Loans**  
Engineered to Amaze



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# Rook Security

## Endpoint Data Monitoring and Analysis Agent

Rook Security, based out of Indianapolis, Indiana, is a leader in the managed detection and response service, providing IT security solutions to clients around the world.

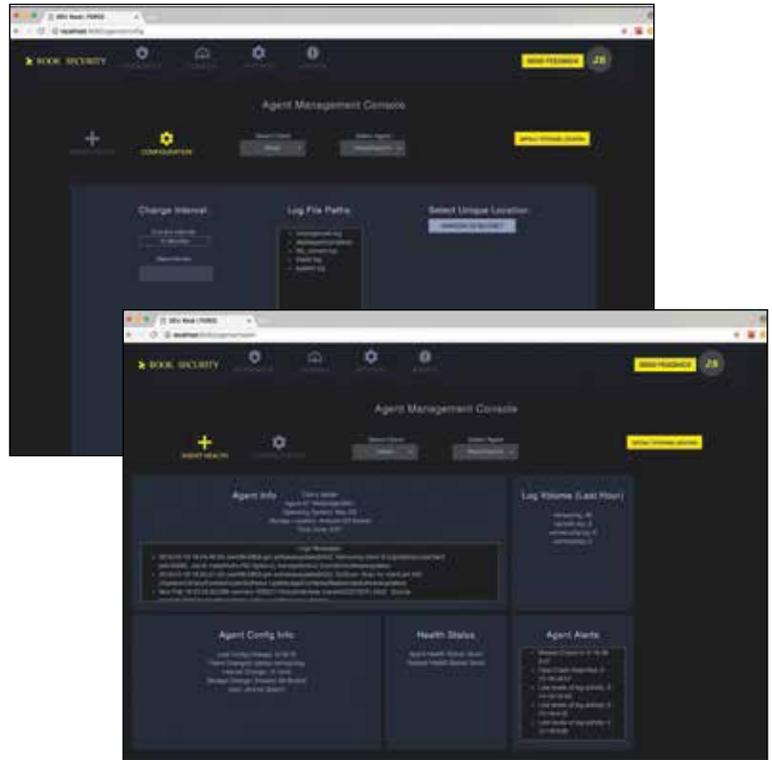
Rook's Force Platform protects their clients from malicious attacks by analyzing log data about client devices and appliances such as critical application servers. This log data is collected by Rook's software agents running remotely on client host computers.

Rook's diverse client base is growing quickly. In order to keep up with this growth, Rook's log data agents must support various operating systems, and be easy to install and configure on client computers.

Our Endpoint Data Monitoring and Analysis Agent sends the digital defenders at Rook their clients' system and application logs from client machines running Microsoft Windows, Apple MacOS or Linux operating systems. This enables client computers to continue working seamlessly and securely with our agent running in the background.

In addition to the agent, an extension of the Force Platform enables Rook analysts to deploy and configure agents as well as view agent health metrics. The ability of our agent to be managed remotely by Force Platform administrators ensures that any infringing anomalies are acted upon quickly.

Our Endpoint Data Monitoring and Analysis Agent system is written in Go for Windows, Mac, and Linux. The logs are stored using Amazon Simple Storage Service (S3). Our extension of the Force Platform is written in Python using the Django web framework. The front end utilizes ReactJS and Redux.



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# SpartanNash Volunteer Tracking System

SpartanNash is a wholesale grocery distributor, supplying more than 2,100 independent grocery retail locations throughout the US, as well as a grocery retailer with more than 140 corporate supermarkets in 47 states.

Known as the local grocery store, SpartanNash values its close relationship with the local community. As part of their commitment to these local communities, SpartanNash sets yearly goals of volunteer hours for their associates.

Our Volunteer Tracking System provides a new automated way for SpartanNash to keep track of associates' volunteer hours, replacing the previous manual "paper and pencil" system.

Our cross-platform app provides a simple and intuitive user experience. SpartanNash volunteers keep track of volunteer hours easily by using our web app. Social media integration and gamification increases overall participation.

When a SpartanNash associate logs into our app, the leaderboard is displayed showing their progress towards reaching their individual goal along with overall company progress. Associates can compare their progress with others.

SpartanNash supervisors manage the system using our companion administrative web portal.

Our Volunteer Tracking System is developed using React Native. Our administrative web portal is written with PHP and HTML. All of the data is stored in a MySQL database with OAuth2 security measures.



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# Spectrum Health

## Spectrum Health Go

Spectrum Health is a not-for-profit health system based in Grand Rapids, Michigan that provides high quality healthcare at over 140 sites in West Michigan, including 12 hospitals, 8 urgent care centers and 43 laboratories.

Patients, visitors and volunteers often have trouble navigating the large Spectrum Health facilities. Our Spectrum Health Go mobile app helps these patrons find their destinations with ease.

Our Spectrum Health Go app employs the user's smartphone camera and waypoints set up throughout the facility. These waypoints are posters that include the Spectrum Health Go icon, a QR code and the name of the waypoint.

After launching the app, a user chooses from a list of destinations and scans the nearest waypoint. Spectrum Health Go then displays an arrow that points to the next waypoint on their route along with a textual description of the directions. As the user turns, the arrow remains pointed towards the next waypoint.

Administrative assistants at Spectrum Health use our companion web app to view data about the routes, alter routes, and add or remove waypoints to improve navigation.

Our Spectrum Health Go mobile app supports both Apple iOS and Google Android devices and is written in Swift and Java, respectively. Our web app is written in C# and HTML. Data is stored using Microsoft SQL Server.



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# Symantec

## Detecting Security Threats from User Authentications

Symantec is a global leader in providing security and information management solutions. Their customers range from consumers and small businesses to large global organizations.

Symantec's flagship authentication solutions include Symantec VIP, a multifactor authentication solution that enables businesses to secure access to networks and applications without affecting productivity.

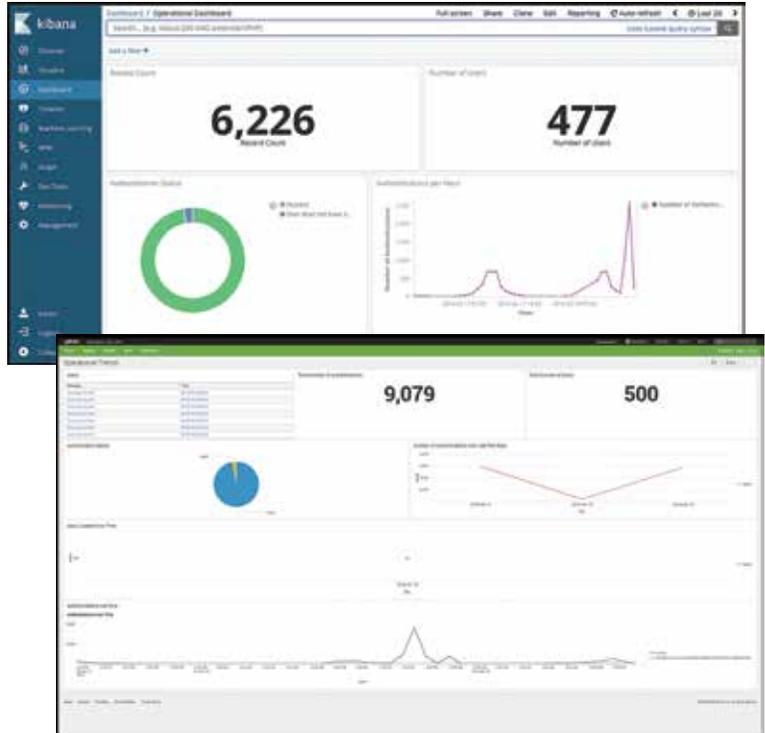
Our system detects security threats by analyzing user authentication patterns and visualizing the results using Splunk and Elasticsearch, Logstash and Kibana (ELK).

Our custom Splunk and ELK apps enable VIP customers to view and analyze various operational and security trends in near real time. Both apps ingest and visualize VIP authentication log data pulled from Symantec servers using their VIP Reference Client.

A VIP customer initially configures their Splunk or ELK apps with their VIP account certificate. The apps open directly to pre-built dashboards, which show operational data and security trends. Users can add custom charts and panels to their dashboard.

While our dashboards do help to visualize data trends and behavior, security analysts may not always be viewing the dashboards. To prevent an analyst from missing an important security event, both the Splunk and ELK apps alert analysts via alternate methods when threats are detected.

Our Splunk app is written using the Splunk Enterprise software and dashboards are created with Splunk Processing language. Our ELK app runs on an Amazon Machine Image hosted on Amazon Web Services.



### Michigan State University

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# TechSmith

## Snagit and Camtasia Output Extensibility

TechSmith engineers engaging products which help people share ideas and information around the globe. With a focus on visual content, TechSmith software provides users with intuitive communication solutions.

TechSmith's flagship products, Snagit and Camtasia, create image and video files for sharing with others. The TechSmith Extensibility Framework (TEF) provides support for the creation of specialized output plugins, which enable users to output their media directly to another product or service.

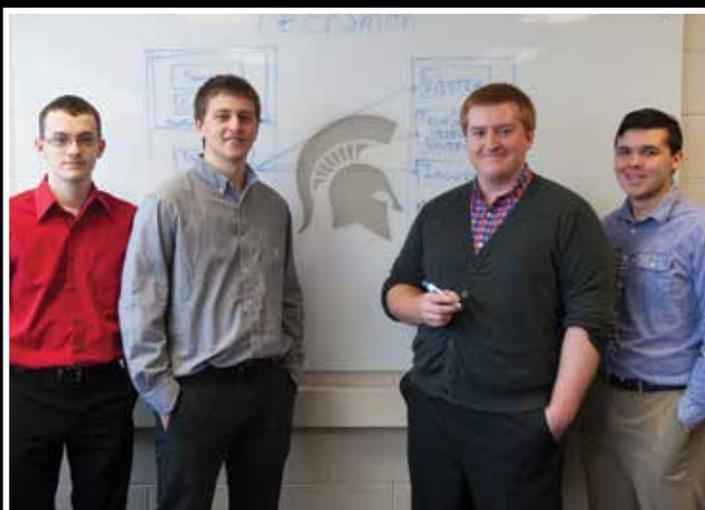
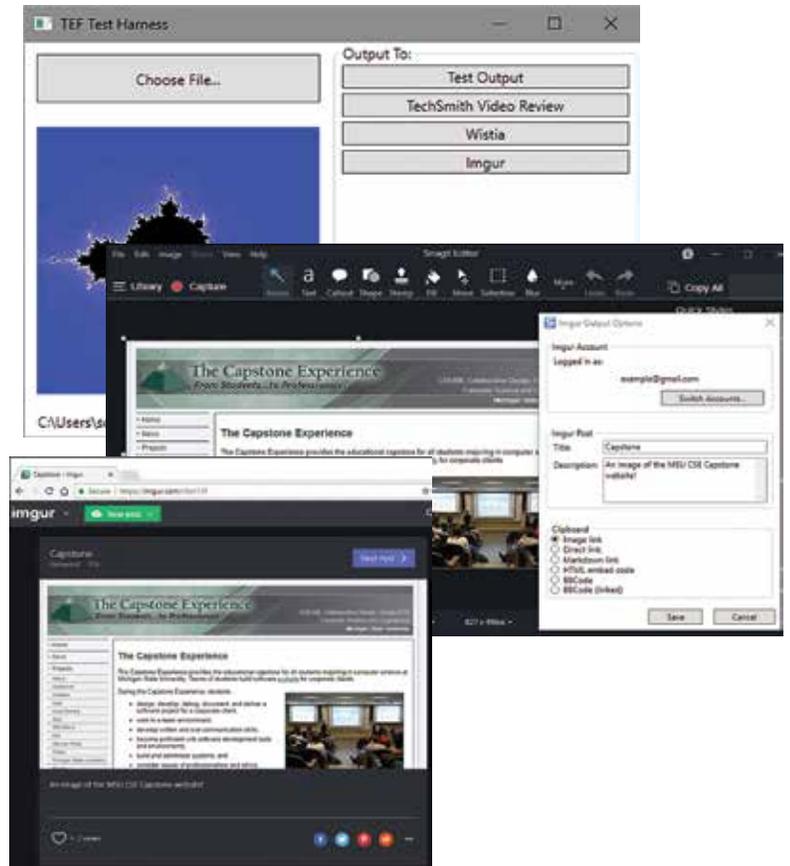
Imgur is a popular website for hosting images. TechSmith Video Review is a TechSmith service where users can have others review their videos. Wistia is a popular video hosting site used by businesses.

Our Snagit and Camtasia Output Extensibility suite of TEF outputs features three new options. These enable users to send their media directly from Snagit or Camtasia to Imgur, TechSmith Video Review and Wistia.

Users can specify several options specialized to these destinations, such as a review-by date for TechSmith Video Review.

Supplementing the addition of our plugins, our test harness is used to aid in output development and demonstration. The harness, much like Snagit and Camtasia, can dynamically load any TEF output plugin. Consequently, it serves as a tool for developers to help create any future outputs.

Our outputs are written in C# using abstraction provided by TEF. The user interface design for both the outputs and harness utilizes C# and XAML under WPF.



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**Paul Stanos**  
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# Union Pacific

## “Alexa, what’s my work schedule look like?”

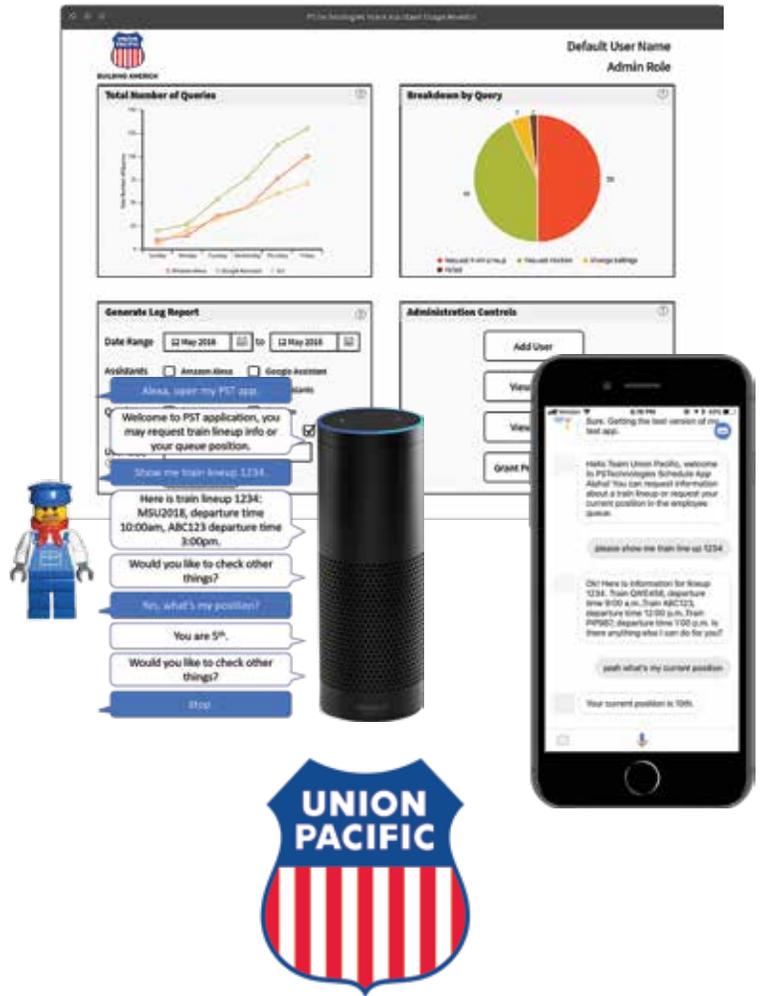
Union Pacific is a leading transportation company headquartered in Omaha, Nebraska. Union Pacific has over 8,500 locomotives running on 32,100 miles of track across 23 states with almost 43,000 employees.

Union Pacific currently provides access to scheduling information for trainmen, yardmen and enginemen (TY&E) employees by phone or web app. Employees are on call 24/7 and are assigned trains to work on through a revolving list of employees. Train schedules are frequently updated, so employees must always stay up to date.

Our custom Google Assistant and Amazon Alexa voice assistants provide Union Pacific TY&E employees hands-free access to their place in the list as well as up-to-date train schedules that they can listen to individually or in groups. Voice assistants provide a fast and flexible solution to access essential scheduling information.

Our system also keeps a detailed log of every employee interaction with the assistants. These logs are viewable through our companion web app that enables managers to monitor the application’s usage statistics and to filter the logs to see individual assistant or user statistics.

Alexa uses the Amazon Developer Console and Google Assistant uses DialogFlow to map dialogs. Each voice assistant sends HTTPS requests to a NodeJS web URL, which calls a Java web service that accesses a MySQL database and returns a response. Our web app is implemented with HTML5, CSS and JavaScript.



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# Urban Science Mobile Maestro

Urban Science is a consulting firm that helps clients identify and improve market share, sales and profitability, and customer loyalty. They work closely with their sister company, Talem Technologies, to build medical devices that empower disabled people.

Talem Technologies has an exoskeleton arm, the X-Ar, that enables wheelchair bound people with Duchenne muscular dystrophy to regain control of their arms and experience a much larger range of motion.

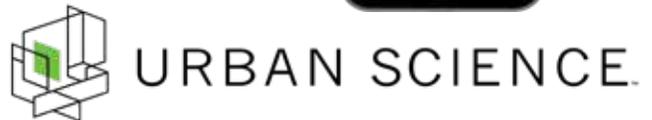
The X-Ar is purely mechanical and must be calibrated to a stable angle of incline, which is adjusted using a push button key fob. Unfortunately, using this key fob presents a significant challenge for some users.

Our Mobile Maestro app enables users to control their X-Ar from their mobile devices, which are often mounted on their wheelchairs. Using touch button or voice controls, users can adjust the mount, lock and unlock the joints, enable auto leveling and voice controls, and put the app into standby mode.

Mobile Maestro also adjusts the incline calibration automatically when the user changes inclines and it provides user profiles to allow quick settings changes.

Our app supports both Apple iOS and Google Android devices. It is fully integrated with Siri and Google Assistant, allowing the user to access all touch button controls through them at any time. Furthermore, the user can add new voice commands to trigger any of the available actions.

Our Mobile Maestro app is written using Ionic for cross platform development and MySQL for data storage. The mobile devices communicate with the X-Ar using Bluetooth Low Energy.



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### Andrea Michaud

Detroit, Michigan

### Majd Nashwati

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### Michael Nelson

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### Nikolas Steel

Detroit, Michigan

# USAA

## LIMElight: Life Insurance Made Easy

USAA is a Fortune 500 company based in San Antonio, Texas. USAA provides a range of competitive financial products and services to the military community and their families.

Life insurance is one of USAA's primary services. Applying for life insurance can be a time-consuming and tedious process for customers.

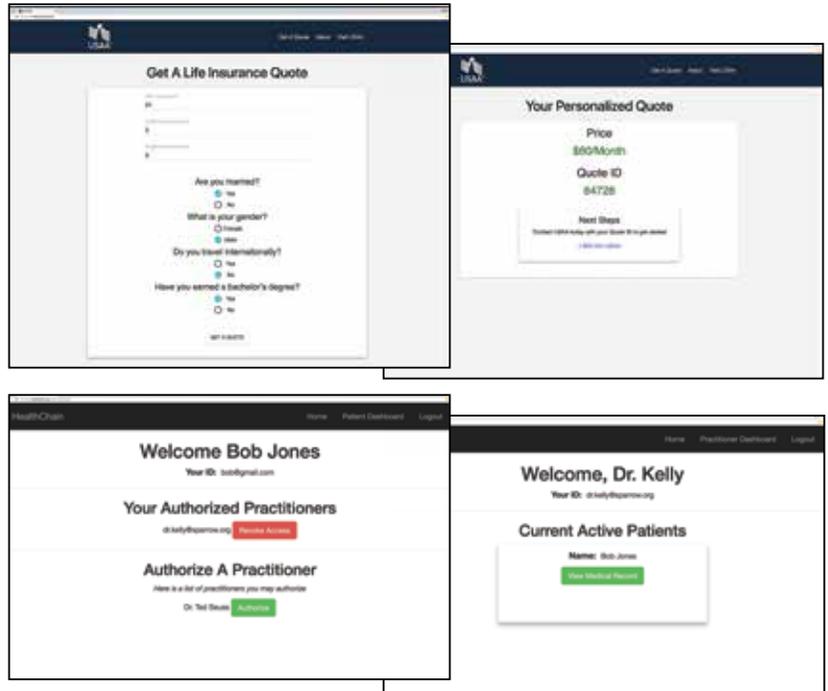
Our Life Insurance Made Easy app (LIMElight) delivers personalized quotes quickly and easily, thereby expediting the underwriting process and converting more life insurance applicants to enrolled USAA members. LIMElight accomplishes this by using machine learning and blockchain technology.

Applicants use a mobile-friendly web app to answer a few questions about their demographic and lifestyle. Our machine learning model then assesses the risk class of the applicant and quickly generates a personalized life insurance quote.

LIMElight also enables USAA and medical providers to exchange applicant medical records via blockchain technology.

Due to the nature of blockchain, information stored on the blockchain is secure, immutable and easily accessible by authorized parties. As a result, USAA underwriters have quicker access to the medical records that are critical in the life insurance underwriting process.

Our LIMElight quote generation web app is built utilizing React with a Python machine learning component. Our medical record interface uses Angular with a Hyperledger blockchain solution.



### Michigan State University

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# Yello

## IVAT: Interview Video Analysis Tool

**Y**ello is a Chicago-based company that provides software for talent acquisition. Their products help recruitment teams hire the right talent at the right time.

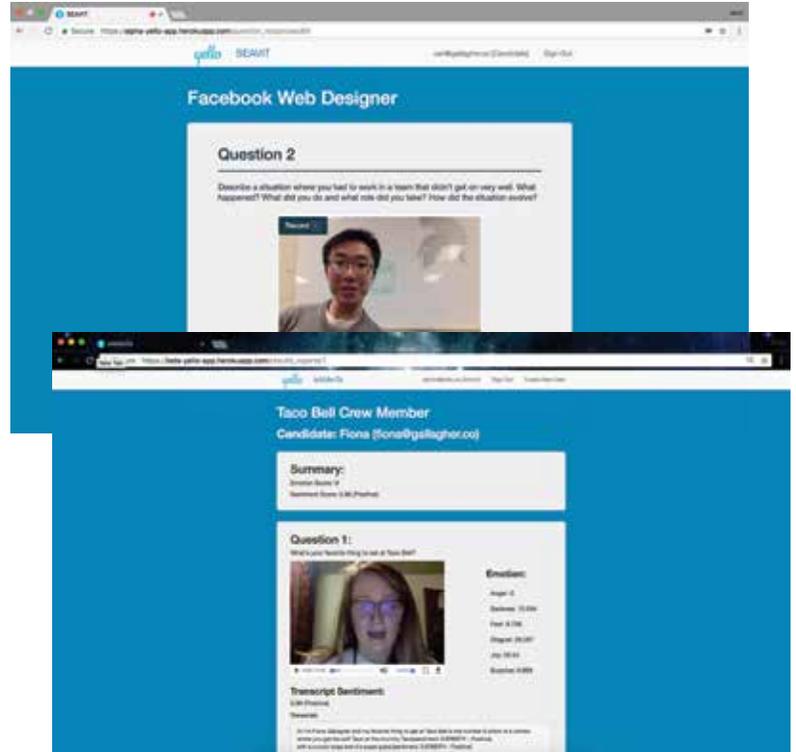
When evaluating job applicants, recruitment teams often have conflicting assessments due to differing opinions of applicants. This is challenging for recruiters when selecting candidates with conflicting reviews.

Automated emotion and sentiment analysis provides unbiased assessments to help evaluate candidates. Our Interview Video Analysis Tool (IVAT) automatically evaluates a candidate's sentiment (speech attitude) and emotion (facial expressions) in a video interview.

IVAT allows recruitment teams to set up video interview questions, schedule live interviews, and invite candidates to an interview. A candidate can pre-record video responses to interview questions or participate in a live interview.

A candidate's speech is processed and evaluated in terms of the sentiment of their words being negative, positive or neutral. Likewise, a candidate's facial expressions are analyzed and summarized across a set of emotions such as angry, sad or joyful.

IVAT is built with Ruby on Rails. The video interviews are streamed and archived using TokBox's OpenTok API. Sentiment analysis is done with Microsoft's Video Indexer and Emotion analysis uses Kairos Human Analytics API. Videos are stored on Microsoft's Azure cloud storage.



### Michigan State University

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**Quan Zhou**  
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**Mitch Joa**  
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**Keith Marter**  
Chicago, Illinois

**Jason Weingarten**  
Chicago, Illinois

# Design Day Awards

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

## Auto-Owners Insurance Exposition Award

**Auto-Owners**  
INSURANCE

LIFE • HOME • CAR • BUSINESS

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

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

Team Amazon

Faia: Fashion Artificial Intelligence Assistant



David He, Dominic Zottolo, Zizhen Wang, Danielle Schugars, Nikhil Ramu  
Presented by Ross Hacker and Scott Lake

## MSU Federal Credit Union Praxis Award

**MICHIGAN STATE UNIVERSITY**  
FEDERAL CREDIT UNION  
*Building Dreams Together*

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

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

Team Yello

Automatic Resume Verification



Brandon Burt, Ryan Nagy, Giorgio Maroki, Nathaniel Hagan, Wan Kim  
Presented by April Clobes

## Design Day Judges

Jason Allen  
Yello

Bob Dyksen  
The Phoenix Group

Jason Joseph  
Spectrum Health

Fareed Mohammed  
Dow Chemical Company

Anthony Bettencourt  
Imperva

E.J. Dyksen  
Michigan State University

Fred Killeen  
General Motors

Marty Strickler  
Rose Packing Company

April Clobes  
MSU Federal Credit Union

Rich Enbody  
Michigan State University

Elizabeth Klee  
Urban Science

Karen Wrobel  
Fiat Chrysler

Ashlee DeLine  
Humana

Mat Gangwer  
Rook Security

Terry Ledbetter  
Meijer

Matt Dupuis  
TechSmith

Adam Haas  
Ford Motor Company

Rob McCurdy  
Michigan State University

## TechSmith Screencast Award



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

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

Team Union Pacific  
RailBuilder: The Great Race to Promontory



Declan McClintock, Jacob Young, Zachary Brenz, Kyle Bush, Trever Daniels  
Presented by Matt DuPuis

## Urban Science Sigma Award



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

The capstone team that delivers the best overall capstone experience is recognized with the Urban Science Sigma Award, which is sponsored by Urban Science of Detroit, Michigan.

Team Michigan State University  
SEA: Spartan Experience App



Nayana Kodur, Patrick Pale, Roy Perryman, Ryan Johnson, Scott Swarthout  
Presented by Elizabeth Klee





## MSU Federal Credit Union is a proud supporter of the 2018 MSU College of Engineering Design Day!

It's our mission at **MSUFCU** to help you achieve your financial goals. We serve MSU students, staff, and faculty by offering low cost loans and higher rate savings.

Join today and learn great tips from our Financial 4.0 team. Gain access to budgeting tools financial calculators, blogs, contests, and more through the Financial 4.0 app!

Visit us online at [msufcu.org/financial40](http://msufcu.org/financial40) or download the Financial 4.0 app.

### BRANCH LOCATIONS:

- East Lansing** 3777 West Road  
4825 E. Mt. Hope Road  
523 E. Grand River Avenue  
MSU Union, 49 Abbot Road  
Room 108
- Lansing** 104 S. Washington Square  
200 E. Jolly Road  
653 Migaldi Lane  
Sparrow Professional Building  
Suite 300
- Haslett** 16861 Marsh Road
- Okemos** 1775 Central Park Drive  
2300 Jolly Road
- Mason** 1133 S. Cedar Street
- Charlotte** 180 High Street
- Auburn Hills** 3265 Five Points Drive
- Rochester** 102 Oakland Center
- Clarkston** 8055 Ortonville Road
- Ortonville** 4 South Street
- Grand Rapids** 86 Monroe Center Street NW



[www.msufcu.org](http://www.msufcu.org)  
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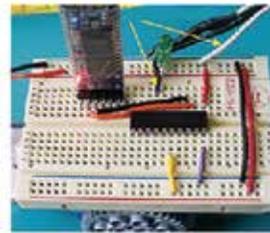
## ECE 101 Introduction to Electrical and Computer Engineering

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

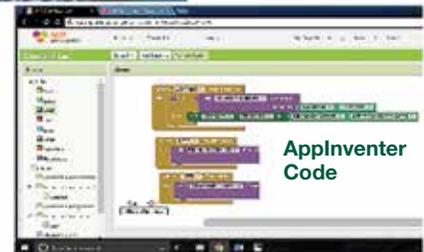
### PROBLEM STATEMENT

ECE 101 is an elective course introducing freshman students to Electrical and Computer Engineering through a series of unique/innovative hands-on flipped laboratory experiments linked to Smartphone and new research/teaching approaches. The experiments include (a) Brainwaves Using Mindwave Mobile and Smartphone, (b) MATLAB Mobile, (c) App Inventor, (d) Smart Bracelets for Health Monitoring, (e) Smartphone Digital Microscope, (f) Smartphone Controlled LED/Motor Using Bluetooth Module, and (g) Microcontroller Programming Using a Smartphone-based IDE (Integrated Development Environment).

Microcontroller, Bluetooth



Smartphone



AppInventor Code

**Student Assistant: Dillon Carrington**

Team Members	Project Title
<b>Team #1</b> Marshall Mapes, Vincent Marinas, Joe Schmidt	<b>Video Board App Using Smartphone</b>
<b>Team #2</b> Davis Brown Devon Corbett Mary Grosman	<b>Self-loading Crossbow App Using Smartphone</b>
<b>Team #3</b> Jamie Lock Nathan Nicevski	<b>LED Blink Morse Code App Using Smartphone</b>
<b>Team #4</b> Shatha Alabbad Kyle Downey Jonathan Lang Artan Tagani	<b>Remote Control Boat App Using Smartphone</b>
<b>Team #5</b> Bailey Bakerson Vasaf Soofi Alex Vanhorn	<b>Blink LEDs Using Smartphone App</b>
<b>Team #6</b> Nada Alqaderi Mitchell Dumoulin Anwar Mohammad	<b>Game App Using Smartphone</b>
<b>Team #7</b> Hamza Alhadai Gary Cai Gaoyi Hu Christian Thompson	<b>Remote Control Car Using Smartphone</b>
<b>Team #8</b> William Balfour Shahriar Hossain Brian Rush	<b>Data Base App Using Smartphone</b>

## The Capstone Projects



**Dr. John Albrecht**  
Associate Professor of  
Electrical and Computer  
Engineering



**Dr. Lalita Udpa**  
Professor of  
Electrical and Computer  
Engineering

### Presentation Schedule – Rooms 2205 and 2250 Engineering Building, Second Floor

Room 2205	Team Sponsor	Project Title
8:30 a.m.	FRIB	Low-level RF Controller
8:55 a.m.	MSU ECE Department	Millimeter Wave Robotic-arm Measuring System
9:20 a.m.	OIH/MSU RCPD	Hospital Power Monitoring System
9:45 a.m.	MSU RCPD	Lee Cleaveland’s Prosthetic Bionic Arm
10:10 a.m.	Fraunhofer	Fixture for Diamond Coating
10:35 a.m.	MSU Solar Racing Team	Solar Array Maximum Power Point Tracker
11:00 a.m.	Aptiv	Tire Pressure Monitoring System

Room 2250	Team Sponsor	Project Title
8:30 a.m.	CANVAS/AutoDrive	Lane Following and Obstacle Avoidance
8:55 a.m.	CANVAS/AutoDrive	Autonomous Vehicle Safety & Integrity Monitor
9:20 a.m.	Tenneco	Road Condition Reporting System
9:45 a.m.	MSU ECE Department	Pet Accident Detection
10:10 a.m.	MSU CSANN Lab	Portable Deep Neural Networks for Image Classification
10:35 a.m.	The James Dyson Foundation	Compact Multi-Sensor System
11:00 a.m.	Union Pacific	Ultrasonic Rail Testing
11:25 a.m.	MSU ECE Department	Voice Fitbit

## ECE 480 Senior Design

ECE 480 is required of all electrical engineering or computer engineering majors at MSU. It prepares students for the workplace, or for graduate school, including:

- Putting into practice the technical skills learned in the classroom, on industrially sponsored team projects, under faculty guidance, doing open-ended design, giving them experience in teamwork, project management, product life cycle management, intellectual property, accommodation issues and entrepreneurship;
- Polishing their communication skills – individual and team – on proposals, reports, résumés, evaluations, posters, web pages, and oral presentations; and
- Requiring each student to complete four individual hardware/software laboratory assignments.

Team sponsors are local and national, including Aptiv, CANVAS, CSANN Lab, The James Dyson Foundation, ECE Department, Fraunhofer, FRIB, MSU College of Engineering, Orphans International Helpline, Resource Center for Persons with Disabilities, Union Pacific, and Tenneco. Thank you to each of these team sponsors.

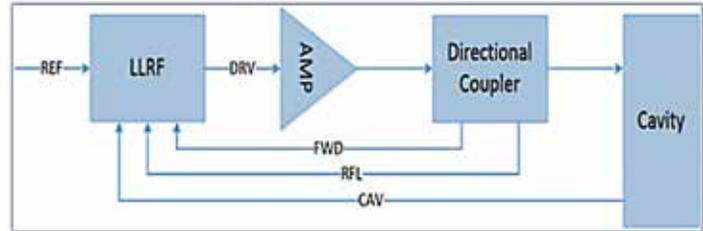
# FRIB

## Low-level RF Controller

The Facility for Rare Isotope Beams (FRIB) is a new linear accelerator being funded by the U.S. Department of Energy, Office of Science and operated by Michigan State University. Once the FRIB is completed, it will enable scientists across the nation to make discoveries about the properties of rare isotopes, nuclear astrophysics, fundamental interactions, and applications for society, including medicine, homeland security, and industry.

The FRIB is sponsoring our project to design and test a controller for a 644 MHz superconducting resonant cavity. The new controller needs to be designed and tested to deal with the 644 MHz frequency, as the old controllers do not have enough analog input bandwidth. The FRIB is supplying some of the latest technology in analog and digital converters as well as a programmable microcontroller for the project.

Our goal is to design an analog signal chain to direct sample the signal from the new 644 MHz cavity for further processing using the best off-the-shelf components available. A phase locked loop will compare the cavity's exact resonant frequency to the synchronization signal. Our project will utilize evaluation boards and a coaxial resonant structure to simulate how the cavity will respond at the FRIB.



### Michigan State University

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**Neel Patel**  
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**Brendon Johns**  
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### FRIB

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**Peter Ostroumov**  
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### Project Facilitator

**Dr. Prem Chahal**

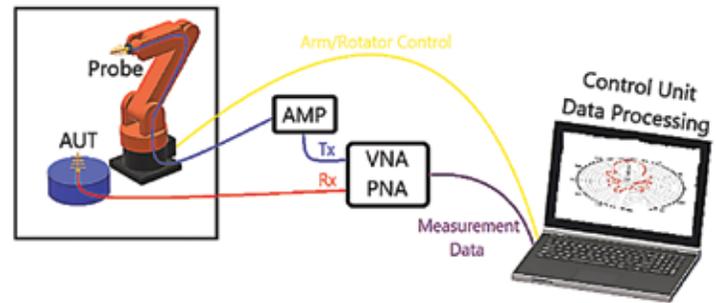
# MSU Electrical and Computer Engineering Department Millimeter Wave Robotic-arm Measuring System

Millimeter-wave frequencies are becoming more and more essential for various wireless communications and sensing applications. High-speed small cells, millimeter-wave imaging and automotive radars are some examples. Therefore, characterization of antennas is becoming a very important task.

Our team has been tasked to design a robotic arm measurement system that will be able to determine the characteristics of millimeter wave antennas.

The robotic arm mechanism will be programmed to rotate the probe antenna by specified angle increments for the desired measurement. The probe antenna will go around the antenna under test (AUT) to gather S-parameter data. A network analyzer will be used to supply a millimeter wave signal between the antennas and collect the necessary S-parameter data to determine antenna characteristics. The collected data will be sent to a laptop which will process the data and output radiation pattern images and polar plots detailing characteristics of the AUT.

A user interface will be created to allow users to determine what type of plot they wish to have produced from the data and angle increment for level of resolution.



**MICHIGAN STATE**  
UNIVERSITY



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**MSU Electrical and  
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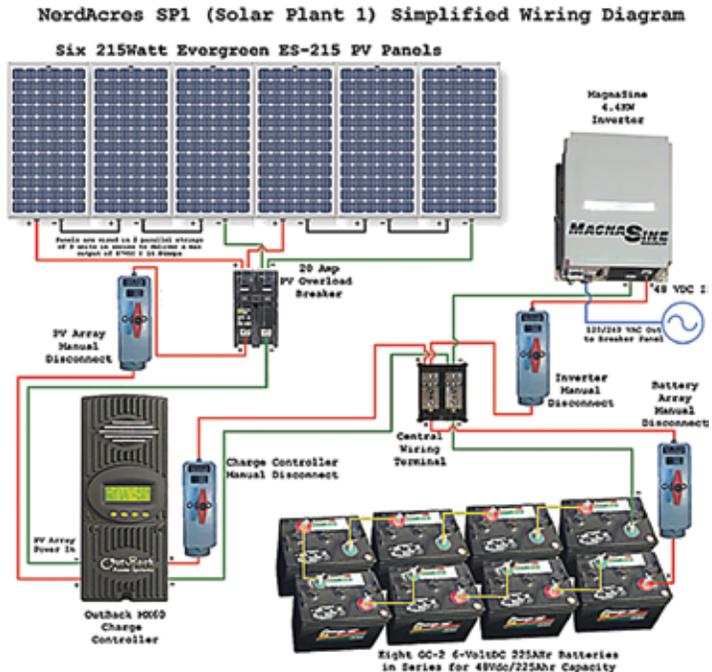
**Project Facilitator**

**Dr. Jeffrey Nanzer**

# Orphans International Helpline (OIH)/MSU RCPD Hospital Power Monitoring System

The OIH hospital in Haiti is located in Bombardopolis, 242 kilometers from the capital, Port-au-Prince. The country still has not fully recovered from the devastating earthquake that happened in 2010. Along with earthquakes, the country experiences frequent hurricanes, making living conditions even more difficult. With these conditions, the need for local clinics is critical for the survival of the community. With lack of power infrastructure and inaccessible cities with few power sources, creating these clinics poses a challenge. In light of these hardships however, Haiti contains an abundance of wind and solar energy that they can use as their main sources of power to keep certain facilities running.

Our task involves designing a power monitoring system for the OIH hospital in Haiti, which will be used by the hospital to monitor incoming power sources: solar panels, wind generators, batteries, engine generators, and room power availability. Along with the power monitoring system, we are researching what input power sources will be most practical for powering the hospital. These will include specific types of solar and wind power, and how these sources will be integrated into the hospital.



MICHIGAN STATE UNIVERSITY

Resource Center for  
**Persons with Disabilities**



## Michigan State University Team Members (left to right)

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## Orphans International Helpline / MSU Resource Center for Persons with Disabilities Project Sponsor

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## Project Facilitator

**Dr. Nelson Sepulveda**

# MSU Resource Center for Persons with Disabilities Lee Cleaveland's Prosthetic Bionic Arm

The Resource Center for Persons with Disabilities (RCPD) is dedicated to assisting and encouraging full participation of students who have disabilities. They thrive on the idea that disabilities do not hinder one from achieving goals and dreams, rather they mandate a greater level of creativity, commitment and a repertoire of compensatory techniques. Lee Cleaveland is an acting student at MSU, registered with the RCPD, and is missing his left arm from the elbow down. His hobbies include playing the guitar and playing sports. Although Lee has mastered life with this disability, he wishes to have a prosthetic arm not only to move better but to help with his daily activities.

Our team has been asked to work with Lee and his team to design and build the electronic control interface that will operate a motor in a 3-D printed hand to actuate grip. The team will use EMG sensors that will read the neural signals sent to the muscles in the arm, and translate these signals into hand motions on a 3-D printed prosthetic. Steve Blosser, a technology specialist at MSU's RCPD, is concurrently working with Carlot Dorve, a Haitian MSU graduate who lost his arm in Haiti due to poor medical care. Current prosthetics can cost more than rural families make in one decade. Blosser would also like to use our design to provide low-cost prosthetics to people in developing countries. He believes that an inexpensive option will enable thousands of individuals with disabilities in Haiti.



MICHIGAN STATE UNIVERSITY | Resource Center for Persons with Disabilities



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Grand Rapids, Michigan

**Kyle Cendrowski**  
Macomb, Michigan

**Kenedi Price**  
Detroit, Michigan

**Jack Christie**  
Holland, Michigan

**Kyle Gray**  
Farmington Hills, Michigan

## MSU Resource Center for Persons with Disabilities

*Project Sponsor*

**Stephen Blosser**  
East Lansing, Michigan

## Project Facilitator

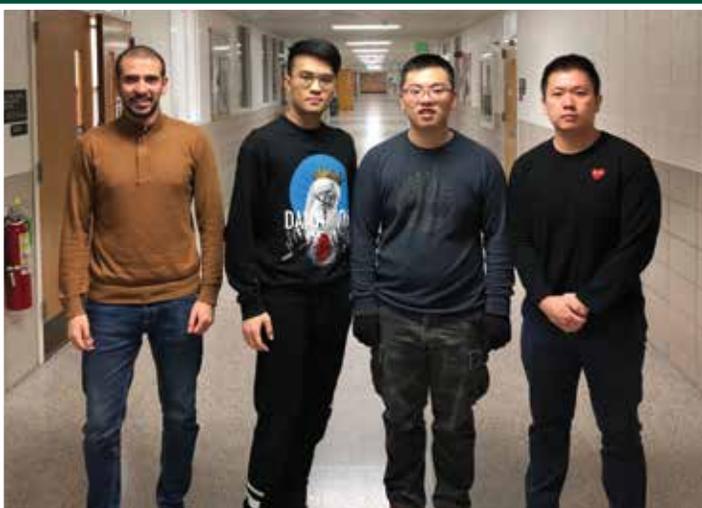
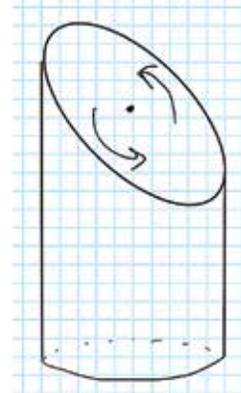
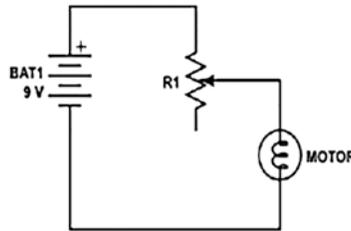
**Dr. Robert McGough**

# Fraunhofer Rotating/Vibrating Reactor Fixture for Diamond Coating

The Fraunhofer Institute is Europe's largest applied research organization performing projects of direct utility to private and public enterprise and of a wide benefit to society.

Diamond has several advantageous properties as a semiconductor material. Applications span across many different fields from biomedical and environmental sensors to electronic and mechanical devices. Always at the forefront of cutting-edge diamond research, the MSU-Fraunhofer Center for Coatings and Diamond Technologies would like to expand upon the current diamond fabrication capabilities by incorporating a new, novel coating fixture. With the current diamond fabrication capabilities at Fraunhofer, substrates are limited to planar geometries such as silicon wafers and metal plates.

Our team is tasked to design and manufacture a rotating fixture for the diamond coating process. This coating fixture should allow coating of powder and other non-planar substrate shapes.



## Michigan State University

*Team Members* (left to right)

**Ibrahim Abudulrahman Sairafi**  
Madina, Saudi Arabia

**Jiahui Lu**  
Dongguan, Guangdong, China

**Yuankun Hong**  
Shanghai China

**Honggang Zhuang**  
Quanzhou, Fujian, China

## Fraunhofer

*Project Sponsors*

**Michael Becker**  
East Lansing, Michigan

**Cory Rusinek**  
East Lansing, Michigan

## Project Facilitator

**Dr. Dean Aslam**

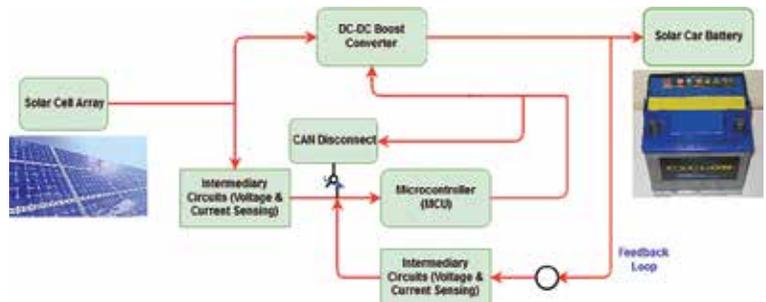
# MSU Solar Racing Team

## Solar Array Maximum Power Point Tracker

The MSU Solar Car Racing Team is a primarily undergraduate group that completely designs and builds all aspects of a solar car. To put their design to the test, the team participates in two competitions throughout the summer: the American Solar Challenge, a week-long 2,000-mile journey across seven states, and the Formula Sun Grand Prix, a three-day “Last Car Standing” style race.

The sole source of propulsion for a solar car comes from the electrical power generated from a photovoltaic cell array, so charging the car battery efficiently is critical. The goal of this project is to design a maximum power point tracker (MPPT) to efficiently charge the car battery from the solar array. The MPPT should boost the lower, variable voltage of the solar array to supply the 130V car battery and obtain the maximum power output of the solar array in any conditions. The maximum power output of the solar array varies with the external illumination and temperature.

The maximum power point tracker will be realized through a DC-DC boost converter and a microcontroller. The microcontroller will locate and obtain the maximum power point of the solar array through the “Perturb and Observe” algorithm implemented in software. This algorithm will continuously alter the duty cycle of the DC-DC boost converter, observe the impact on the solar array output power, and determine how the duty cycle should be altered in the next iteration until the maximum power point is reached. The duty cycle adjustment will be implemented through pulse width modulation from the microcontroller to MOSFET switch of the boost converter. This system will be mounted on the solar car, ensuring operation at temperatures of 110 °F and speeds of 60 mph.



**MICHIGAN STATE**



**SOLAR RACING TEAM**



**Michigan State University**  
*Team Members*

**Sean Murray**  
Livonia, Michigan

**Jack Whinham**  
Rochester Hills, Michigan

**Alan Alen**  
Astana, Kazakhstan

**Corey Beyer**  
Holland, Michigan

**Gurveer Deol**  
Northville, Michigan

**Chris Hawkey**  
Lansing, Michigan

**MSU Solar Racing Team**  
*Project Sponsor*

**Gregory Stark**  
East Lansing, Michigan

**Project Facilitator**

**Dr. Joydeep Mitra**

# Aptiv Tire Pressure Monitoring System

Aptiv is a global technology company headquartered in Gillingham, England. Using industry-leading software capabilities, Aptiv is ushering in the next generation of active safety, autonomous vehicles, smart cities, and connectivity solutions.

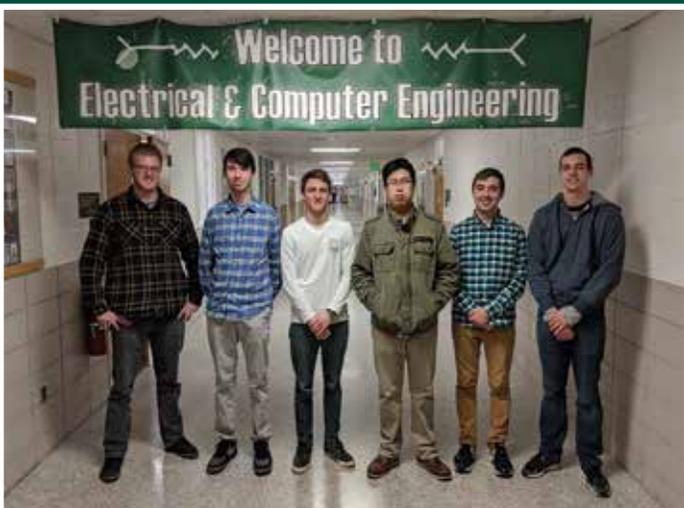
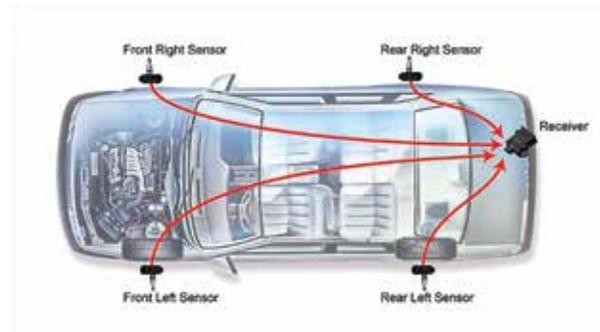
Aptiv's goal is to transform mobility to a portfolio of safe, green and connected solutions. As a part of accomplishing this, Aptiv set its sights on implementing the Tire Pressure Monitoring System using Bluetooth Low Energy.

Bluetooth 5.0 offers many advantages over its predecessor, with an update to Bluetooth Low Energy (BLE). BLE allows for low power consumption, a higher data rate, and longer range.

Monitoring tire pressure is key to ensuring the longevity of the tire, along with an efficient fuel economy and also plays a vital role in passenger safety. A tire with 15% under the ideal pressure lasts ½ year less than an ideal tire. At 20% under ideal pressure, fuel consumption rate increases by 4%. Finally, at 30% under ideal pressure, the tire wear rate increases by 50%.

The system level breakdown of our project is comprised of a tire pressure sensor installed on a tire communicating with a transmitter microcontroller. This microcontroller will receive the pressure data from the sensor and, using Bluetooth 5.0, will send this data to a receiver microcontroller. Finally, the receiver microcontroller will run analysis on the pressure data and transmit it through a physical connection to be displayed on a monitor.

	BLUETOOTH 4.2	BLUETOOTH 5.0
<b>SPEED</b>	1 mbps	2 mbps
<b>RANGE</b>	MAX: 50m INDOORS: 10m	MAX: 200m INDOORS: 40m
<b>DATA</b>	31 bytes capacity	255 bytes capacity
<b>POWER</b>	High energy	Low energy
<b>INTERFERENCE</b>	Standard	Reduced



## Michigan State University

*Team Members* (left to right)

**Benjamin Roytburd**  
West Bloomfield, Michigan

**John Slavin**  
Riverview, Michigan

**Mark Leja**  
Northville, Michigan

**Raymond Huang**  
Ann Arbor, Michigan

**Thomas Szilard**  
Rochester Hills, Michigan

**Tom Humphrey**  
Lansing, Michigan

## Aptiv

*Project Sponsors*

**Sunil Javali**  
Kokomo, Indiana

**Linh Pham**  
Kokomo, Indiana

## Project Facilitator

**Dr. Fathi Salem**

# CANVAS/AutoDrive Challenge

## Lane Following and Obstacle Avoidance

The Autodrive Challenge is a collegiate student design competition with a focus on designing and building autonomous vehicles. The competition is sponsored by General Motors, SAE International, and many other companies involved in the autonomous vehicle industry. The competition has a three-year duration, during which student design teams from eight different universities are tasked with equipping a Chevy Bolt with the necessary technology to achieve the status of a level four autonomous vehicle.

The team has been challenged with building autonomous systems to find and maintain vehicle position within lane lines on a roadway, as well as detecting and avoiding obstacles that might be in the vehicle's path. This project's focus is to develop the software required to accurately detect lane lines in the environment of a vehicle, prevent the vehicle from colliding with any obstacles, and enable passing maneuvers whenever possible.

To meet the functional requirements of our project, the vehicle will have multiple distinct subsystems including perception, sensor fusion, motion planning, motion control, and vehicle interfacing.



**Michigan State University**  
AutoDrive Challenge Team



### Michigan State University Team Members (left to right)

**Boyuan Sun**  
Beijing, China

**DJ Seeds**  
Lake Orion, Michigan

**Ryan Ashbaugh**  
Byron Center, Michigan

**Kyle Lammers**  
Grand Rapids, Michigan

**Manoj Agarwal**  
Gujarat, India

### CANVAS / AutoDrive Project Sponsor

**Daniel Morris**  
East Lansing, Michigan

### Project Facilitator

**Dr. Vaibhav Srivastava**

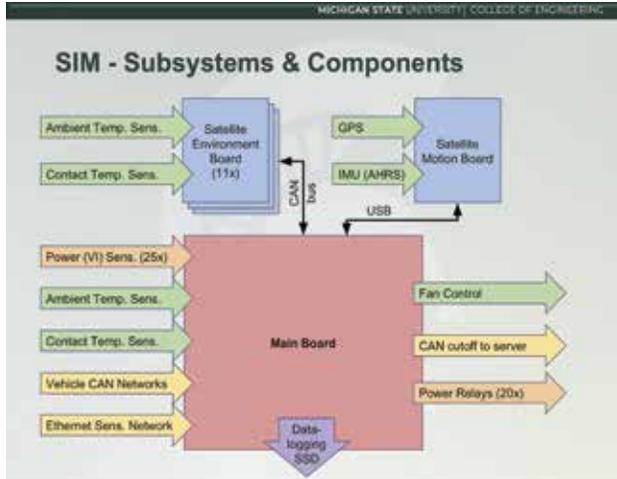
# CANVAS/AutoDrive Challenge

## Autonomous Vehicle Safety & Integrity Monitor (SIM)

An independent hardware system to monitor the safety and integrity of signals and systems on the vehicle is proposed. Our team will design this Safety and Integrity Monitor (SIM) system to sense and react to vehicle performance and system performance.

The vehicle performance will be monitored through an Inertial Measurement Unit (IMU) and will communicate driving quality to the main driving computer. If necessary, the SIM will disconnect the driving computer from the CAN bus, effectively disabling autonomous operation. The physical health of sensors will be monitored through voltage and current draw, while their operational health will be monitored by analyzing the data returned.

Additionally, ambient and contact temperatures will be monitored and controlled by a network of fans around the vehicle, evacuating hot air from the vehicle through vents if necessary. Finally, this device will function as a “Black Box,” data-logging all recordable metrics for later use in optimization or failure analysis.



**Michigan State University**  
*Team Members* (left to right)

**Steven Yik**  
Grand Rapids, Michigan

**Jason Merlo**  
Rochester, Michigan

**Anton Schlegel**  
Vaduz, Liechtenstein

**CANVAS / AutoDrive**  
*Project Sponsor*

**Daniel Morris**  
East Lansing, Michigan

**Project Facilitator**

**Dr. Vaibhav Srivastava**

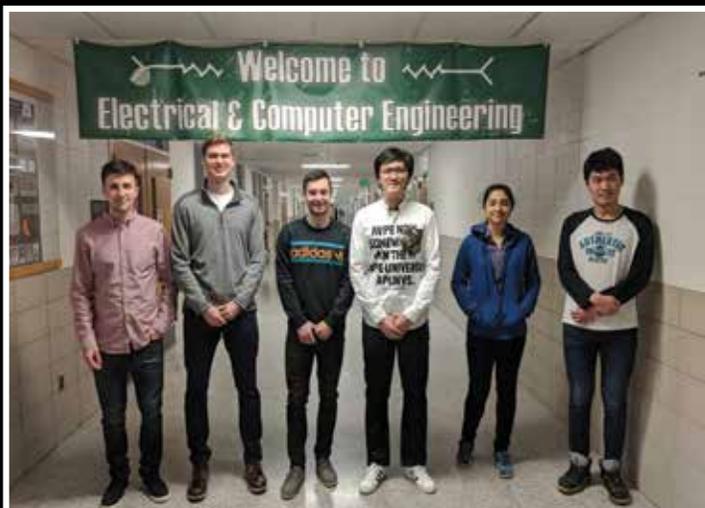
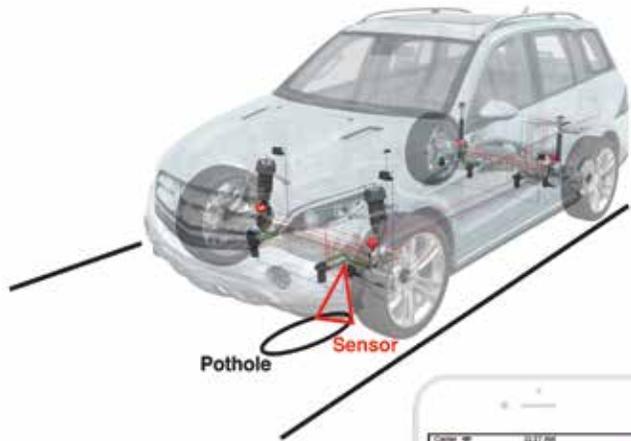
# Tenneco

## Road Condition Reporting System

Tenneco is a worldwide manufacturer of automotive components that include aftermarket ride control and emission products for vehicles. As vehicles become more automated, the ride control and predictive nature of their decision-making will also become automated by taking advantage of various detection and vision systems. These systems will enable Tenneco to have more data for controlling the ride performance of vehicles, and included in this data will be road condition information.

The Road Condition Reporting System will gather and record road condition information through the use of a mobile application. The designed system will function as a maps application which can give directions and create markers for an end user while driving through the integration of Google Maps using the Google Maps API. The system will record both user input and sensor data to record the locations of potholes and poor road conditions in a SQL Database and automatically report potholes to the MDOT Pothole Reporting website.

The System will increase the safety of drivers by allowing them to see where potholes are relative to their vehicles and allowing for an automated system to report potholes. The more frequent and detailed reporting of potholes to the state of Michigan will allow roads to be fixed at a faster rate, and place less stress on the ride performance of vehicles.



### Michigan State University

*Team Members* (left to right)

**Sean Zanyk McLean**  
Midland, Michigan

**Kevin Scott**  
Midland, Michigan

**Ryan Yergin**  
Novi, Michigan

**Weili Xu**  
Shenzhen, China

**Dena Mujtaba**  
Okemos, Michigan

**Qiuyang Yue**  
Xinxiang, Henan, China

### Tenneco

*Project Sponsor*

**Bradley Fingland**  
Lake Forest, Illinois

### Project Facilitator

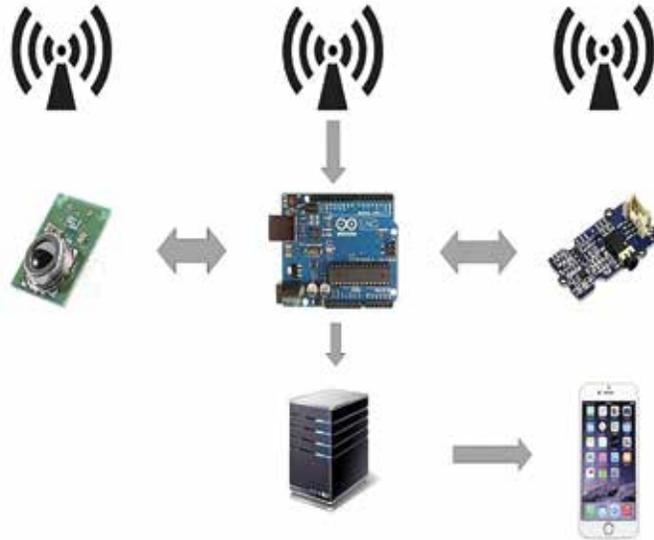
**Dr. Tongtong Li**

# MSU Electrical and Computer Engineering Department

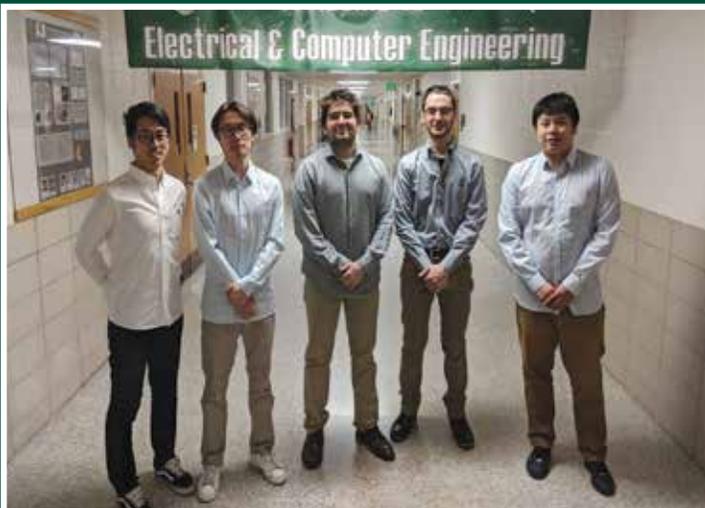
## Pet Accident Detection

Our design team was tasked with prototyping a new product in the market of robotic pets and robotic pet care. We will be conducting research on different market sectors to find a device that is in an underutilized area or to design a new product that is not currently available on the market.

The robotic pet market is already full of many different products, and our team decided to focus on a device for cleaning up after a pet. We are working on designing a system to detect if an animal accidentally relieves itself inside the home and send a notification of which room it is in. Eventually, this system would be used to alert a more advanced cleaning robot to go to that room and take care of the mess without the owner needing to do anything.



**MICHIGAN STATE**  
UNIVERSITY



**Michigan State University**  
*Team Members* (left to right)

**Yuyang Ji**  
Suzhou, China

**Guohao Sun**  
Nanjing China

**Mirza Hadzialijagic**  
Novi, Michigan

**Mario Pipitone**  
Utica, Michigan

**Kan Cheng**  
Shanghai, China

**MSU Electrical and Computer Engineering Department**  
*Project Sponsors*

**John Albrecht**  
East Lansing, Michigan

**Lalita Udpa**  
East Lansing, Michigan

**Project Facilitator**

**Dr. Virginia Ayres**

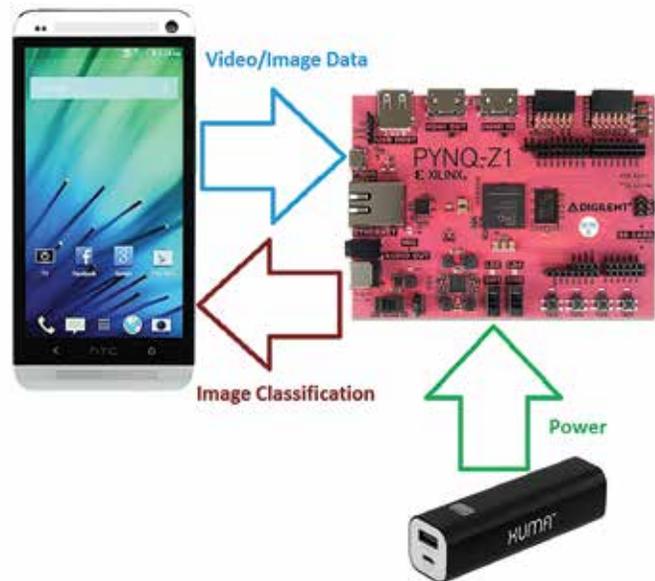
# MSU CSANN Lab

## Portable Deep Neural Networks for Image Classification

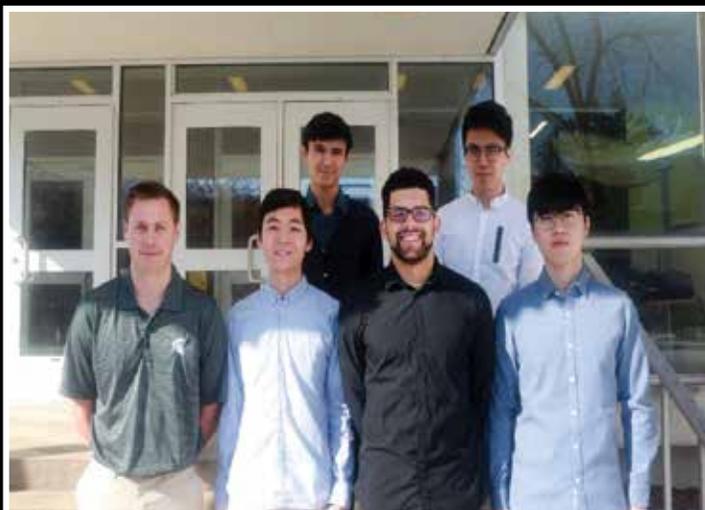
The Circuits, Systems and Artificial Neural Networks Laboratory (CSANN) is a research group at MSU that specializes in artificial neural network algorithms. These neural networks are systems patterned after the neurons found in a human brain and have demonstrated appealing capabilities in image recognition and classification.

With the increased integration of technology on smartphones, most smartphone owners have access to the sensors needed in order to produce valid input for classifying neural networks. Giving the owner a way to interact with these networks using their phone would grant the owner the ability to receive instant processing information from the sensor data they can access.

Our team will be creating a prototype based on the idea of a portable deep neural network. The prototype will allow a smartphone user to capture an image on their phone, run the image through a classification network, and have the result of the classification displayed on the phone screen. The network will be loaded onto a portable, embedded device that will be powered by an external battery and plug into the phone.



**MICHIGAN STATE**  
UNIVERSITY



**Michigan State University**  
*Team Members* (left to right)

**Travis Leffel**  
Crystal Lake, Illinois

**Alan Chen**  
Kalamazoo, Michigan

**Dinmukhammed Aimurzayev**  
Almaty, Kazakhstan

**Edward Vasquez**  
Brooklyn, New York

**Bingquan Gu**  
Yancheng, Jiangsu, China

**Xiao Chang**  
Jinan, Shandong, China

**Michigan State University**  
**CSANN Lab**  
*Project Sponsor*

**Fathi Salem**  
East Lansing, Michigan

**Project Facilitator**

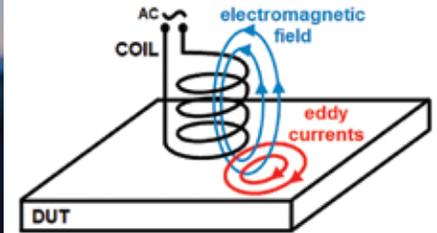
**Dr. John Deller**

# The James Dyson Foundation Compact Multi-Sensor System

All manufactured products need to be tested to ensure that the material integrity is upheld. In many cases, cracks or defects in a material are not visible to the human eye. As of today, the devices and techniques used to detect cracks in structures are expensive and not easily portable.

The James Dyson Foundation is seeking to develop a small inexpensive portable system to detect cracks/defects in structures that can be displayed on an iOS app. Allowing ease of testing on manufactured surfaces will help prevent premature failures and improve the overall safety of the product. The application that our team is focusing on is an aluminum airplane wing.

A handheld wireless device comprising a differential coil array will be designed to use eddy currents to measure changes in impedance as it moves across the surface of a structure. The analog information collected from the coil array will be converted to digital by the AD5933, an impedance converter, within the handheld device. The AD5933 will perform a discrete Fourier transform which will return the magnitude of the impedance and relative phase at each frequency point. The AD5933 device will then send the digital format data to a Raspberry Pi 3+ which is connected to a Bluetooth module. The data will be sent to the iOS app, where it will be analyzed to display the coil impedances in a simple text format, and a heat graph to show concentrations of changes in detected impedance.



# THE JAMES DYSON FOUNDATION



### Michigan State University Team Members (left to right)

**Marcus Collins**  
Canton, Michigan

**Westin Lane**  
Brooklyn, Michigan

**Garrett Parks**  
Davidson, Michigan

**Shubo Chen**  
Chaozhou, Guangdong, China

**Jiyan Shi**  
Shanghai, China

### The James Dyson Foundation Project Sponsor

**Satish Udpa**  
East Lansing, Michigan

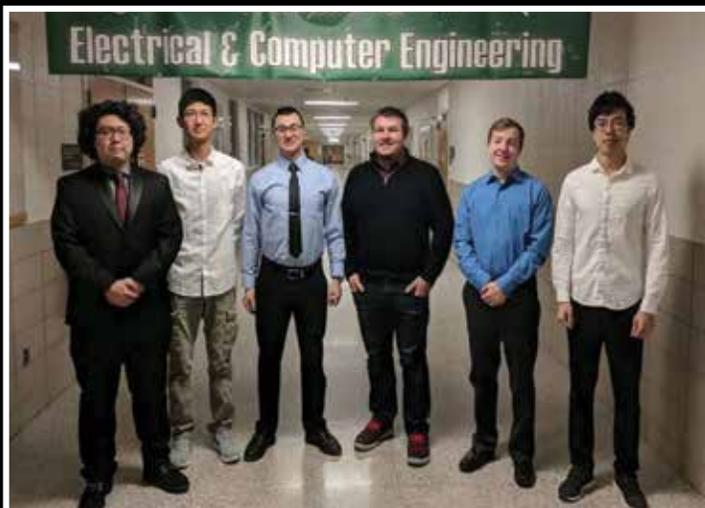
### Project Facilitator Dr. John Deller

# Union Pacific Ultrasonic Rail Testing

Union Pacific is one of America's leading transportation companies and operates a 32,100-mile network of railroads in North America. The railroads cover two-thirds of the western United States and cross through 23 different states.

Stress in rails occurs when the rail is either at a temperature hotter or colder than its neutral temperature, defined as the temperature when the rail is neither in tension nor compression, giving stress-free conditions. The neutral temperature is important to know because if the rails are not installed correctly, it can lead to derailments.

The project objective is to investigate whether ultrasonic technology can be utilized to determine the stress and temperature of the rail. Since the density of rail varies with temperature, speed of sound through the rail will also change. Our project will use the data from an ultrasonic device to calculate speed of sound, then compare current speed with the speed in neutral temperature to determine whether the rail is in tension or compression.



## Michigan State University Team Members (left to right)

**Zhengze Liu**  
Beijing, China

**Shihao Meng**  
Shijiazhuang, Hebei, China

**Jordie Liao**  
Ann Arbor, Michigan

**Kellen Collison**  
Westland, Michigan

**Corey Wysozan**  
Muskegon, Michigan

**Shu Liu**  
Ningbo, Zhejiang, China

## Union Pacific Project Sponsor

**Eric Gehringer**  
Omaha, Nebraska

## Project Facilitator

**Dr. Sunil Kishore Chakrapani**

# MSU Electrical and Computer Engineering Department Voice Fitbit

Michigan State University's Electrical and Computer Engineering Department has requested the development of a new type of wearable technology that will track the daily vocal health of a user.

Wearable technology has been around since the 1980s, when Casio started to mass produce calculator watches. Today, wearable technology has become part of everyday life. From smart watches, such as the Apple Watch, to Samsung's Virtual Reality Headsets, many devices, such as a fitbit, provide data related to the physical health of the user.

Our Wearable device, the "Voice Fitbit," will provide data regarding the vocal health of the user. Vocal health data can also be used to interpret the emotion of the user, such as angry or happy, and whether they are ill. In order to appropriately demonstrate useful functionality in this device, a lightweight and compact board with the necessary processing and audio recording peripherals will be researched in the hardware design.



MICHIGAN STATE  
UNIVERSITY



**Michigan State University**  
*Team Members* (left to right)

**Brent Cavner**  
Cedar Springs, Michigan

**Austin Winarski**  
Shelby Twp, Michigan

**Wanxuan Chen**  
Nanning, Guangxi, China

**Ibnul Khan**  
Canton, Michigan

**Ruikai Chen**  
Hangzhou, Zhejiang, China

**MSU Electrical and  
Computer Engineering  
Department**  
*Project Sponsor*

**Mi Zhang**  
East Lansing, Michigan

**Project Facilitator**

**Dr. Ramakrishna Mukkamala**

# Design Day Awards Fall 2017

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## Electrical & Computer Engineering Winners, Fall 2017

Prizes are awarded each semester to the most outstanding teams in the Electrical and Computer Engineering Senior Capstone Design Course, as judged by a panel of engineers from industry. A team with members from both ECE and another engineering major (mechanical engineering, for example) is also eligible, if the team's project is administered through ECE 480.

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### First Place: Team Union Pacific “Regenerative Railcar Braking”

Left to Right:  
Zach Bates, Zach Shannon, Josh Clouse, James Staley, Lucas Wolfe



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### Second Place: Team Fraunhofer “SpartanStat: A Portable Potentiostat for the Detection of Heavy Metals”

Left to Right:  
Nathan Bagnall, Justin Opperman, Brandon Gevaert, Haitai Ng, Yuzhou Wu,  
Xingchen Xiao



---

### Third Place: MSU Electrical and Computer Engineering Department “Handheld Device to Detect Cracks in Aircraft”

Left to Right:  
Nicholas Gajar, Ryan Sajkowski, Peter Jones, Ryan Brozovich, John Bono



**ME 371  
Mechanical  
Design I**



**Dr. Michael Lavagnino**  
Academic Specialist  
Department of  
Mechanical Engineering

**Thrills for Pre-collegiates: Mechanisms that Fascinate, Captivate, Stimulate and Entice**

Teams of students were required to design and manufacture mechanisms that would thrill an audience of pre-collegiate students. The constraints imposed upon this assignment were that each mechanism must incorporate at least one linkage, one gear set and one cam-follower combination. Each team manufactured or utilized 3D printing to create the majority of their components. These engineering marvels will be demonstrated and displayed with a complementary poster explaining the subtleties of each mechanism. The winner, chosen by the visiting students, will be awarded certificates, medals, and have their names added to the Kids' Choice Award plaque.

**Teams and members: Section 1**

**Team 1**

Mimi Asante  
Alexis Gheorghiu  
Ginnie Olszewski  
Jake Prusakiewicz

**Team 2**

Andy Albright  
Jack Brinkley  
Sarah Plant  
Philip Wandor

**Team 3**

Ryan O'Quinn  
Kai Selwa  
Nic Wiggins

**Team 4**

Mark Macharia  
Bradley Moore  
Josephine Muscato  
Taylor Stensen  
Brian Valentine

**Team 5**

Mason McDiarmid  
Jonathan Theoret  
Lars Thornton  
Connor Walters

**Team 6**

Will Barrett  
Frank Biondo  
Mitch Cline  
Justin Piccolo

**Team 7**

Nick Kerby  
Vincent Richard  
Connor Zehr

**Team 8**

Ryan Boufford  
Nick Gerich  
Andrew Lamkin  
Matthew Urdea

**Team 9**

Drew Barnett  
Brooks Reno  
Frank Spica  
Sarah Wegert

**Team 10**

David Marshall  
Brandon Okray  
Kyle Oliynyk  
Eric Stauffer

**Team 11**

Trevor Byers  
Joe Gusumano  
Ryan Qamar  
Griffen Rourke

**Team 12**

Brooks Beattie  
Jordan Hermiz  
Eddie Kelly  
Nick Van Oost

**Team 13**

Shariq Ameer  
Mark Leiman  
Aashish Nagpal  
Robert Wei

**Team 14**

Alec Adgate  
Colton Fairbanks  
Hyang Kim

**Team 15**

Jacob Bloom  
Thomas Burke  
Kurtis Potier  
Spencer Rinke

**Team 16**

Ahmed Alblooshi  
Mohammed Alneyadi  
William Ham  
Xiaohang Wei

**Teams and members: Section 2**

**Team 1**

Benjamin Anklin  
Trevor Chamberlain  
Candace Latnie  
Zachary Wagner

**Team 2**

Thomas Cook  
Alex Napolitan  
Lucas Serraiocco  
Ross Wolniakowski

**Team 3**

Sam Case  
Analeeza Dubay  
John Kalil  
Andrew Kistler  
Julia Waelchi

**Team 4**

Sarah Daugherty  
Katie Filipovic  
Alexandra Konopka  
Mackenzie Meyers

**Team 5**

Brendan Mclean  
Kent Peterson  
Joe Russell  
Steven Smith

**Team 6**

James Ellison  
Victoria Farrell  
Brianna Forsthoefel  
Ross Zalewski

**Team 7**

Huan Liu  
Yangzhe Liu  
Kaidi Ma  
Leiqi Pan  
Zhenyu Wang

**Team 8**

Albert Asta  
Olivia Hargrave-Thomas  
Bella Henry  
Alex Jennings

**Team 9**

Jamal Ardister  
Nick Thiel  
Jay Wideman

**Team 10**

Brad Chapman  
Craig DeClerck  
Jessica Derkacz  
Zach Flowers

**Team 11**

Andrew Aziz  
Zac Brei  
Hana Irvine  
Thomas Lindsey

**Team 12**

David Bang  
Derek Edwards  
Chase Lamere  
Sangseung Jay Lee  
Joseph McKinney

**Team 13**

Matt Forsyth  
Mark Gjeloshaj  
Matt Pusheck  
James Schradle

**Team 14**

Rishi Gupta  
Josue Natarenmoran  
Austen Shiau  
Nick Tottis

**Team 15**

Lauren Lage  
Mitchell Morin  
Garrett Weidig

**Team 16**

Andrew Adkins  
Brad Fischer  
Nathaniel Lewis



**ME 412**  
**Heat Transfer Laboratory**

**Dr. Yuping Wang**  
**Academic Specialist**

## Enhancing Heat Transfer with Heat Pipes

Heat pipes are passive heat transfer devices with no moving parts and no external power supply. They can create a high conductivity heat transfer path from a heat source to a heat sink with minimal temperature gradients, through two-phase operation (evaporation/condensation) of a working fluid. Heat pipes are very reliable and effective components in thermal designs, and hence can be found in a wide variety of thermal systems from electronics cooling to aerospace applications. In this project each team will design, model, build, and test a heat pipe to operate at low pressure. The design objective is to effectively remove heat from a liter of boiling water. An additional objective is to understand the thermal-fluid principles of heat pipes through modeling, simulating and/or reviewing existing experimental and computational works. For testing, each team will have 15 minutes to set up, demonstrate, and disassemble their pipe. Cooling is provided by ambient air. A vacuum pump will be available to lower the pressure inside the heat pipe. Each team will also prepare a power-point slideshow or video clip for the audience to explain their design decisions, analysis and operation of their heat pipe.

### Competition Schedule

Time	Station	Team members
8:00	A	Phillip Erickson, Shane Neal, Evan Paupert, Adam Ziembra
	B	Andrew Baran, Grant Gooch, Daniel Middleton, James Moran
8:15	A	Farhan Ahmed, Adri Johari, Nathan O'sullivan, Yuexing Sun, Jianan Yao
	B	Jake Blankemeier, Aaron Gordon, Meredith Jonik, Jean Klochko-Bull
8:30	A	Nathanael Ginnodo, Lance Haner, Vince Rende, Zachary Sadler, Reed Williams
	B	Brian Doyle, Hunter Jenuwine, Evan Lile, Spencer Schang
8:45	A	Sawyer Dmoch, Aaron Feinauer, Nicholas Flannery, Kayla Starr
	B	Anthony Ethridge, Genevieve Kobrossi, Jonathan Ristola, Courtney Zimmer
9:00	A	Chris Brenton, Robert Chaney, Drew Daily, Nick Delang, Spencer Thompson
	B	Lexi Baylis, Jack Kuerbitz, Ryan Loveland, Brandi Mazzella
9:15	A	Payton Bauman, Shuang Liu, Maria Magidsohn, Jacob Richter, Aryka Thomson
	B	Morgan Burr, Emily Duddles, Lauren Green, Jack Michalski
9:30	A	Curtis Carne, Colton Knopf, Tracey Nguyen, Michael Walicki
	B	Abdullah Boshgeia, Samantha Brown, Danny McCarty, Justin Ngo
9:45	A	Tristan Eggenberger, Quanjing Li, Anna Robinson, Yanze Wang
	B	Yibin Cheng, Andy Dong, Kanshu Mori, Li Ren, Chengming Zhang
10:00	A	Thomas Baldwin, Kole Brunsman, Austin Miller, Justin Slagter
	B	Will Hartnagel, Owen Middleton, Miranda Whah, Jacob Wilson
10:15	A	Morgan Ergen, Jackson Garber, Brandon Miller, Kathryn Stimetz
	B	Andres Garcia, Najah Mubashira, Robbert Schmit, John Schumaker
10:30	A	Shwan Al-Howrami, Jacob Bullard, Matthew Cassiday, James Garrett, Spencer Miller
	B	Ian Albert, Ben Dunklee, Charlie Guidarini, Jason Sammut
10:45	A	David Cohle, Grant Gibson, Duy Nguyen, Mauricio Ponsmartinez
	B	Patrick Miyamoto, Kevin Payne, Nick Santi, Chun-Kit Yung
11:00	A	Nathan Hadobas, Ryan Kruzel, Robert Pizzimenti, Joel Todd
	B	Prakash Agrawal, Kyle Bauer, Chase Quencer, Becky Reneker
11:15	A	Zhan Liu, Tyler Smith, Jonathan West, Henry Wikol
	B	Lindsay Hoard, Nathan Mclean, Maria Osinski, Kelly Patterson

## ME 471 Mechanical Design II



**Dr. Alejandro Diaz**  
Professor of Mechanical  
Engineering

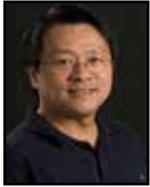


**Dr. Al Loos**  
Professor of Mechanical  
Engineering

### Machine Fastener Sorter

A common problem in machine shops is the accumulation of fasteners -screws, nuts, washers- of various sizes, unsorted. The goal in this project is to design a general-purpose, mechanical-only sorter than will separate fasteners of different types, sorting them into separate containers. Mechanical action is to be provided only by a single hand-cranking mechanism, the only source of energy in the sorter. The design will be tested using a given volume of material that includes screws, nuts and washers. This mix must be sorted into three separate containers, each holding the same type of fastener. Randomly, the mix may also include a small number of odd pieces that should be sorted into a fourth container. Performance will be measured by the volume of material sorted accurately during a short trial.

Time	Team	Station	Team members
8:00	1	A	Ryan Britain, Andrew Capaldi, Lauren Chance, Alayna Farrell, Brandon Praet
	1	B	Steven Atkin, Ben Beckas, Eli Broemer, Madison Duncan, Michael Houser, Tyler Piotrowski
8:20	2	A	Nick Delang, Megan Ebejer, Taylor Fuhrman, Nathan Hadobas, David Mackens
	2	B	Ally Austin, Amanda Boone, Morgan Ergen, Jennifer Ju, Jennifer Kozlowski, Brant Toback
8:40	3	A	Qianhui Dong, Tal Hanani, Ivan Iovtchev, Yanze Wang, Joey Xie
	3	B	Sydney Clark, Val Gueorguiev, Suhas Kodali, Allison Nielsen, Jordan Thayer, Gary Zakarian
9:00	4	A	Andrew Baran, Eric Gierc, Kevin Schuett, Diamant Topllari, Levi Zimmerman
	4	B	Mitch Agrwal, Brian Doyle, Jill Hubbard, Rachael Jannette, Erin Maroney, Spencer Schang
9:20	5	A	Ethan Jacobs, Jonah Kowalczyk, Sarah Lohman, Anna Robinson, Brock Walquist
	5	B	Zachary Brokaw, Nathan Mclean, Lucas Notarantonio, Reed Potter, Drew Roth, Zac Zettle
9:40	6	A	Jillian Chandler, Luke Crompton, Oscar Scheier, Sivajyothi Vemulapalli, Aaron Winter
	6	B	Connor Campbell, Zachary Cook, Emily Duddles, Ben Dunklee, Matt Sarver, Marc Veihl
10:00	7	A	Tony Anason, Morgan Burr, Tecumseh Hakenjos, Jason Koberstein, Antonio Ulisse
	7	B	Xueran Gao, Andrew Lee, Marcus Li, Michael Logan, Katie Miller, Gabriel Sarnacki
10:20	8	A	Ryan Ahee, Dallas Creech, Samantha Jones-Jackson, Patrick Kelly, Joey Ritter
	8	B	Yin Chenxi, Jun Jiang, Zhan Liu, Josh Miller, Hansheng Zhang, Yi Zhou
10:40	9	A	Dean Kuharevicz, Najah Mubashira, Elizabeth Pollack, Andrew Webb, Simone Young
	9	B	Branden Goebel, CJ Johnson, Patrick Miyamoto, Tianlun Shi, Xiaoke Wang
11:00	10	A	Drew Dunker, Lauren Green, Marc Lowenfeld, Nicole Stanley, Ruiwei Sui
	10	B	Shane Brady, Vincent Rogers, Anindow Saha, Jared Steen, Zach Wurtz
11:20	11	A	David Cohle, Alexander Johnson, Mackenzie Martin, Kevin Payne, Michael Zielinsky
	11	A	Samuel Mcalvey, Michael Mccauley, Ethan Vassallo, Bryan Warholak, Matthew Weber



## ME 478 Product Development

**Dr. Patrick Kwon**  
Professor of Mechanical Engineering

### 3D Printing Machine

The objective is to design, produce and demonstrate a 'simplified version' of a 'metallic' 3D printing machine whose requirements are: 1) the minimum build envelope must be 10cm x 10cm with the height up to 10cm, 2) the powder must be deposited in a layer-by-layer fashion with the maximum thickness of each layer of 1mm, and 3) the electric motors must be controlled by MyRio, which will be provided.

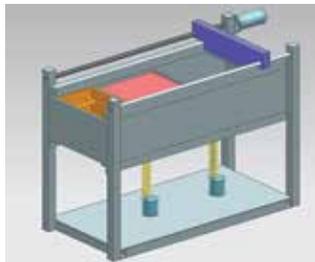
Starting from an individual project and progressing into a team project, each team must produce the machine through a series of design and manufacturing tasks. Each student needs to contribute individually as well as collaboratively to accomplish a series of tasks. CAD/CAM packages, CNC machining, rapid prototyping, testing, etc., will be used to produce the machine. Finally, selected teams will demonstrate their machines on Design Day.

### Teams and Members

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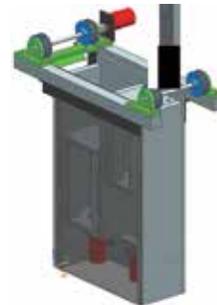
#### Do Not Be A Beach:

Majed Almughair  
Michael Bertrand  
Grant Kunzi  
Kayla Starr  
Siva Vemulapalli  
Zac Zettle



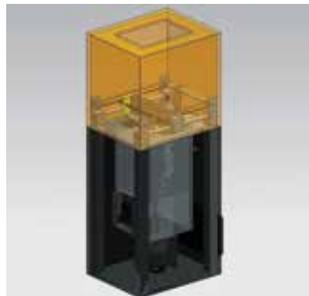
#### Sand Castle:

Michael Bordas  
Jason Kim  
Ian Lindsley  
Danny McCarty  
Patrick Miyamoto  
Mirza Saifulbahri



#### Sandy Cheeks:

Shane Brady  
Duy Nguyen  
Chase Quencer  
Heather Raymor  
Justin Slagter  
Matthew Weber



#### Six Guys Two Beds:

Andrew Biggie  
Jake Blankemeier  
Mohammed Bomoza  
Robert Cortese  
Ethan Jacobs  
Do-Hyung Kim



#### Team Sandlot:

Zach Bowling  
Steven Liu  
Elizabeth Pollack  
Joey Ritter  
Matt Sarver  
Tyler Smith





**ME 497**  
**Biomechanical Design**  
**Dr. Tamara Reid Bush**  
**Associate Professor of**  
**Mechanical Engineering**



**MKT 420**  
**New Product Development**  
**Dr. Hang Nguyen**  
**Assistant Professor of Marketing**  
**Business College**

## Biomechanical Design and New Product Development

The Biomechanical Design and New-Product Development course (ME 497/MKT 420) provides students with a unique opportunity to develop and market a real, new product that incorporates biomechanical function. Students work in inter-disciplinary teams of engineers and marketers and experience the entire process of new product development from need identification, concept generation and testing, to product development, design analysis and launch. This course further strengthens students' knowledge and real-world exposure by working with Spartan Innovations. This year General Motors sponsored an in-class competition providing awards to the top three product ideas, and the National Science Foundation (NSF) provided funds for prototyping.



Team members	Team Slogan
Nick Bonaccini, Xingyu Cai, Val Gueorguiev, Ivan Igotchev, Cory Wilson	<b>Grab-'n'-Go:</b> An assistive device that empowers adults suffering from loss of muscle strength to regain an active life with the ability to effectively grab, hold and operate common household items.
Abdul Alqami, Amanda Anderson, Jacob Fiebke, Branden Goebel, Gonzalo Pugnaire	<b>Disburdening Drawer:</b> This device assists seniors in accessing and utilizing a lower level drawer by propelling it upwards to the level of a higher drawer so that it may be reached without bending over.
Jeffrey Couger, Carly Dugan, Holly Iglewski, Kory Iott, Becky Reneker	<b>Twist Assist:</b> A portable device designed for turning doorknobs for individuals with poor wrist function due to varying conditions such as those with arm casts or wrist arthritis.
Katie Frayer, Sarah Mulkey, Abbie Reimel, Amy Sutton	<b>The Uplift:</b> A personalized, portable transfer device.
Connor Campbell, Jack Michalski, Brady Nicholson, DeAndre Strongtoins, Marc Veihl	<b>Spring Knee-XT:</b> A wearable, low-cost rehabilitation device designed for reparative knee surgery recipients to regain functional strength in the quadriceps through spring-resisted extension of the knee with adjustable range of motion limitation.
James Garrett, Michael McCauley, Maria Osinski, Nick Santi, Alexandra Wallin	<b>Safe-T-Stair:</b> An attachable stair rail device intended to assist elderly people with walking up- and downstairs while preventing falling.
Chris Brenton, Brian Pieciak, Gabriel Sarnacki, Brittany Shaheen, Michael Walicki	<b>The Seed Squeeze:</b> This device is targeted toward developing countries. It uses compression to extract oil from seeds and creates more opportunity for laborers to market their seed oil.
Majed Almughair, Michael Bertrand, Shane Brady, Ben Halstead, Leland Pavlinac	<b>Life Lift:</b> An assisted dolly lifter for everyday use by anyone who has difficulty lifting or lowering heavy objects.
Edward Clark, Ilse Granados-Lerma, Lauren Green, Brandi Mazzella, Evan Paupert	<b>Pull-up Pal:</b> A collapsible full-body fitness solution that is meant for those who are looking to improve their strength training at an affordable price in the comfort of their home.
Malik Hall, Wesley Ma, David McCriston, Elizabeth Pollack, Justin Suh	<b>The Launch Pad:</b> An at-home foot strengthening and ankle rehabilitation device, perfect for recovering athletes and those suffering from plantar fasciitis.
Madison Duncan, Matthew Fernandez, Jack Leckner, Nathan Mclean, Steve Moon, Miranda Whah	<b>The Soothing Seat:</b> This device is a comforting constraining chair that simulates rocking motions back and forth for the purpose of calming children/students with Autism Spectrum Disorder (ASD).
Stephen Christy, Emily Duddles, Tristan Eggenberger, Genevieve Kobrossi, Matt Rimanelli	<b>rEVOLVE:</b> The rEVOLVE is a newly designed manual wheelchair that gives users and caretakers the ability to easily raise and lower the height of the chair, providing 360° of swivel motion and enabling easier transfers and increased range of motion.
Mohammed Bomoza, Hyeungsuk Kim, Josh Miller, Travis Revard	<b>Quick Step:</b> An assistive walker for children that is lightweight and easily foldable for travel and storage.
Daniel Burchart, Madison Case, Sarah Daugherty, Grant Newton, Taylor Stensen	<b>Sky Chair:</b> An addition to a wheelchair that carries a piece of luggage and easily rotates for the user to access.

# The Capstone Projects



**Dr. William Resh**  
Professor of  
Mechanical Engineering

**Faculty Advisors: Seungik Baek, Giles Brereton, Tamara Reid Bush, Alejandro Diaz, Abraham Engeda, Norbert Mueller, Ranjan Mukherjee, Ahmed Naguib, Elisa Toulson**



Baek



Brereton



Bush



Diaz



Engeda



Mueller



Mukherjee



Naguib



Toulson

## Presentation Schedule – Engineering Building, Room 1202

Time	Team Sponsor	Project Title
7:30 a.m.	NSCL	Development of Neutron Detector Frames
8:00 a.m.	Consumers Energy	Natural Gas Compressor Turbocharger Study
8:30 a.m.	DENSO	Procedure for Ignition Energy Measurements
9:00 a.m.	DENSO	Design of a High Energy Ignition System
9:30 a.m.	The James Dyson Foundation	Hand Cycle Propulsion Adapter Production Prototype
10:00 a.m.	The James Dyson Foundation	Hand Cycle Propulsion Adapter - Reverse Gear
10:30 a.m.	Ingersoll Rand - Trane	Shipping Split Protection
11:00 a.m.	Ingersoll Rand - Trane	Shipping Support Redesign
11:30 a.m.	Ingersoll Rand - Trane	VFD Stand Cost Reduction

# ME 481 Mechanical Engineering Design Projects

ME 481 is a required course for mechanical engineering majors at MSU. The course provides students with a team-based capstone design experience in which they:

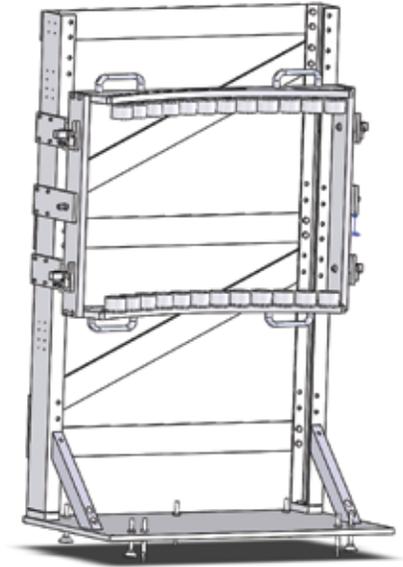
- use the technical expertise, communication skills, and teaming methodologies they have learned throughout their mechanical engineering curriculum, together with their creativity, to solve real world problems,
- collaborate with practicing engineers to address problems sponsored by industry,
- develop new products or redesign existing products to reduce costs or enhance reliability and functionality,
- interact with large, medium, and small companies in the automotive, defense, aerospace, consumer products, and agricultural industries, and with US government agencies.

*We gratefully acknowledge the support of this semester's project sponsors: ArcelorMittal, BorgWarner Morse Systems, Bosch, Consumers Energy, DENSO North America Foundation, Detroit Bikes, Dynamotive IP LLC, EPA, Ford Motor Company, Hanson Logistics, Heartwood School/Ingham ISD, Hitachi Automotive Systems Americas Inc., Ingersoll Rand - Trane, The James Dyson Foundation/MSU Adaptive Sports and Recreation Club, MSU Department of Entomology, National Superconducting Cyclotron Laboratory, Pratt & Miller Engineering, Ranir, Roberts Sinto Corporation, and Stryker.*

# National Superconducting Cyclotron Laboratory Development of Neutron Detector Frames

The National Superconducting Cyclotron Laboratory (NSCL) is one of the leading nuclear research facilities in the world. It is located on the campus of Michigan State University. The mission of the NSCL is to allow researchers from around the world to come and conduct nuclear physics experiments with beams of rare, unstable isotopes. These experiments run for roughly a week and can be expensive. This makes the design of experimental equipment important, so that experiments can be run efficiently. The Mechanical Design Department works closely with the research groups in order to develop innovative solutions for the equipment. The Mechanical Design Department produces a full set of engineering drawings and specifications that will allow for future fabrication of the equipment.

Our team worked in collaboration with the NSCL Mechanical Design Team to create detector frames for neutron detectors. Two frames were developed. One frame was based on an existing design; but instead of it being mounted next to a reaction target from where neutrons are emitted, it was placed above the reaction target in such a way that the flight path of the neutrons emitted from the target to the neutron detectors is 1 m. The second frame was designed to hold new and larger neutron detector bars than are presently available at NSCL. This frame is positioned at a distance of 3 m from the reaction target. The detector frames were designed in CAD software and documented for future fabrication. The project resulted in the development of new detector frames that will be used in experiments tentatively scheduled for Fall 2018.



## Michigan State University

### Team Members (left to right)

**Justin Slagter**  
Grand Rapids, Michigan

**Ryan Loveland**  
Rochester, Michigan

**Andrew Palucki**  
Park Ridge, Illinois

**Peter Chew**  
Northville, Michigan

**Vincent Pahl**  
Chicago, Illinois

## National Superconducting Cyclotron Laboratory

### Project Sponsors

**Don Lawton**  
East Lansing, Michigan

**Craig Snow**  
East Lansing, Michigan

### ME Faculty Advisor

**Dr. Ahmed Naguib**

# Consumers Energy Natural Gas Compressor Turbocharger Study

Consumers Energy is one of the largest electricity and natural gas providers in the United States. In Michigan alone, Consumers Energy supplies natural gas to more than 6 million residents. Due to the lower demand for energy in the summer, Consumers Energy uses compressor stations to place natural gas into underground storage fields. The gas is then extracted during the winter to allow for prices to be cheaper for customers.

Consumers Energy tasked our team to analyze the performance and efficiency of the turbochargers used in the compressor station. One of two seemingly identical turbochargers located at the Overisel Compressor Station was working less efficiently than the other. Our team's goal was to assess why the turbocharger was running less efficiently and create a 'Troubleshooting Guide' to assist with any future efficiency issues.



## Michigan State University

*Team Members* (left to right)

**Miranda Whah**  
Chesterton, Indiana

**Jacob Wilson**  
Lansing, Michigan

**Maria Magidsohn**  
Clarkston, Michigan

**Brian Peciak**  
Troy, Michigan

**Payton Bauman**  
Clarkston, Michigan

## Consumers Energy

*Project Sponsors*

**Pierce Dehring**  
Jackson, Michigan

**Jessica VanDussen**  
Hamilton, Michigan

*ME Faculty Advisor*

**Dr. Abraham Engeda**

# DENSO North America Foundation Procedure for Ignition Energy Measurements

**D**ENSO North America Foundation is a corporate foundation, funded by the DENSO Corporation, dedicated to helping students advance their education in engineering and technology. Through the DENSO NA Foundation, Michigan State University was awarded a grant to further students' education in internal combustion engines.

One of the greatest obstacles in internal combustion engines is how to maximize efficiency and performance while minimizing harmful emissions. The automotive ignition system is not only a major component to engine efficiency, performance, and emissions; it also contributes to an engine's robustness and long-term operation. Ignition, in modern spark ignition (gasoline engines) is initiated between the electrodes of a sparkplug and a charged flow (air-fuel mixture), delivered through an intake system at a velocity dependent on intake throttle position and engine rpm.

Our team was tasked with designing an experimental procedure whereby the average gas flow rate in the intake duct to an ignition chamber can be related to the gas velocity between the sparkplug electrodes in that chamber. The ignition energy required for ignition was then measured experimentally as a function of the prescribed intake-duct gas velocity, from which the gas velocity between the electrodes was inferred.



# DENSO



## Michigan State University Team Members (left to right)

**Jiaji Zhang**  
East Lansing, Michigan

**Grant Gibson**  
Rochester Hills, Michigan

**Reison Gjolaj**  
Hartland, Michigan

**Henry Wikol**  
Beverly Hills, Michigan

**Michael Walicki**  
Hartland, Michigan

**Matthew Cassiday**  
Oakland, Michigan

## DENSO North America Foundation

**Project Sponsor**

**Giles Brereton**  
East Lansing, Michigan

**ME Faculty Advisor**

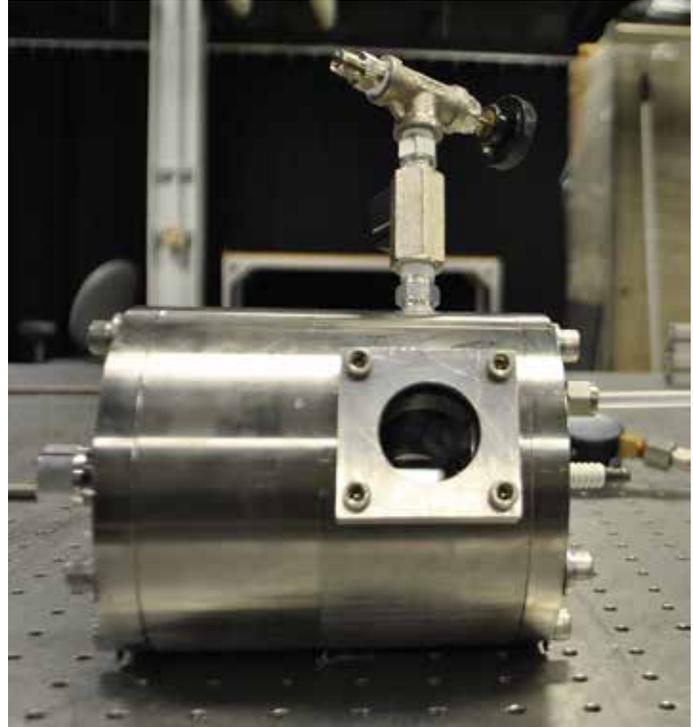
**Dr. Giles Brereton**

# DENSO North America Foundation

## Design of a High Energy Ignition System

The DENSO North America Foundation, headquartered in Southfield, Michigan, has awarded more than \$1 million in grants to colleges and universities across North America in the past two years. DENSO is committed to advancing the education of students in engineering, technology, and related fields. The DENSO Foundation looks to advance students and communities by developing a knowledgeable and experienced workforce. Dr. Elisa Toulson and Dr. Giles Brereton have been awarded funding by the foundation to develop a major design project for undergraduate seniors to improve their training for the automotive industry. Specifically, the ignition system is a component that affects the efficiency, pollution, and overall performance of the vehicle.

Due to the key role of the ignition energy in combustion, the Michigan State Team was asked to design, build, and test a high-energy ignition system, which was incorporated into an ignition test chamber and bench. The system needed to be externally adjustable and provide at least 50% more ignition than the baseline system. The sparkplug and the coils were changed to achieve the desired energy. Once the high-energy system was created, the combustion chamber was tested under a variety of conditions to demonstrate how pressure, temperature, and the state of the surrounding gas affects the performance of the system.



# DENSO



### Michigan State University Team Members (left to right)

**Alex Clark**  
Grand Rapids, Michigan

**Jean Klochko Bull**  
Orchard Lake, Michigan

**Meredith Jonik**  
Farmington, Michigan

**Madison, Case**  
Grand Haven, Michigan

**Tyler Smith**  
Westphalia, Michigan

### DENSO North America Foundation Project Sponsor

**Elisa Toulson**  
East Lansing, Michigan

### ME Faculty Advisor

**Dr. Elisa Toulson**

# The James Dyson Foundation Hand Cycle Propulsion Adapter Production Prototype

The MSU Adaptive Sports & Recreation Club is a Registered Student Organization at Michigan State University. This club was started in 2014 in order to create a physically and socially accessible space where Athletes with Physical Disabilities, Able-Bodied Volunteers and Academic Project Personnel can come together to use sports as a method of eradicating inaccurate societal stereotypes and invalid self-perceptions about disabilities. Within this club, the range of motion for each athlete varies from person to person based on their individual disabilities. Due to this, various versions of specialized Adaptive Sports Equipment are used by the members of this club. The difficulty with this equipment is that it is designed with elite level wheelchair athletes in mind, leaving the majority of people with physical disabilities with minimal choices. This makes understanding these difficulties crucial when designing Adaptive Sports Equipment.

Our team has been asked to design a Hand Cycle Propulsion Adaptor Prototype that will resolve any basic function and durability difficulties identified by users in the MSU Adaptive Sports & Recreation Club. Four main areas of focus for the design were considered: propulsion method, turning, discomfort, and safety. A successful design and prototype will allow more athletes with varying disabilities to partake in club activities with more ease of operation. Our team worked collaboratively with The James Dyson Foundation.



# THE JAMES DYSON FOUNDATION



## Michigan State University

*Team Members* (left to right)

**Adam Ziemba**  
Livonia, Michigan

**Jonathan Ristola**  
Livonia, Michigan

**Spencer Miller**  
Clarkston, Michigan

**Andrew Biggie**  
St. Johnsbury, Vermont

**Aaron Feinauer**  
Freeland, Michigan

## The James Dyson

**Foundation**

*Project Sponsor*

**Chia-Wei Wang**  
Ann Arbor, Michigan

*ME Faculty Advisor*

**Dr. Seungik Baek**

# The James Dyson Foundation Hand Cycle Propulsion Adapter – Reverse Gear

As a Registered Student Organization at Michigan State University, the MSU Adaptive Sports Club provides opportunities to athletes with a variety of physical disabilities. This organization integrates able-bodied volunteers and athletes with physical disabilities using sports to eliminate stereotypes, improve self-confidence, and increase physical health. To accomplish this, the Club provides a diverse portfolio of adaptive sports equipment. In a previous semester, a team of Spartan engineers engineered and manufactured a Rowing Hand Cycle to accommodate specific needs of club members. This 1st Generation Rowing Hand Cycle allowed users with upper and lower body limitations to increase their physical activity in a safe, enjoyable fashion. The MSU Adaptive Sports Club reached out to our team to implement improvements to the current design to promote user independence and functionality.

Our team was primarily tasked with redesigning the propulsion system used to power the Rowing Hand Cycle, giving the user reverse capability while maintaining a similar frame design and input rowing motion. A chain, gear, and sprocket system were implemented to enable forward and reverse operation, allowing users to maneuver around obstacles more efficiently and independently. The 2nd Generation Rowing Hand Cycle design was optimized for safety, functionality, and durability, and has been tested and approved by members of the MSU Adaptive Sports Club for outdoor use. The addition of this adaptive sports device to the club's resources accommodates a more broad range of users and promotes greater participation.



# THE JAMES DYSON FOUNDATION



## Michigan State University

*Team Members* (left to right)

**Evan Lile**  
Midland, Michigan

**Reed Williams**  
Shelby Twp, Michigan

**Brandi Mazzella**  
Warren, Michigan

**Evan Paupert**  
Dryden, Michigan

**Matthew Lawrence**  
Pinckney, Michigan

## The James Dyson Foundation

*Project Sponsors*

**Celia Cunningham**  
Ann Arbor, Michigan

**Stephanie Ribet**  
Ann Arbor, Michigan

**Mike Smiley**  
Ann Arbor, Michigan

**Chia-Wei Wang**  
Ann Arbor, Michigan

## MSU Adaptive Sports & Recreation Club

*Project Sponsors*

**Stephen Blosser**  
East Lansing, Michigan

**Piotr Pasik**  
East Lansing, Michigan

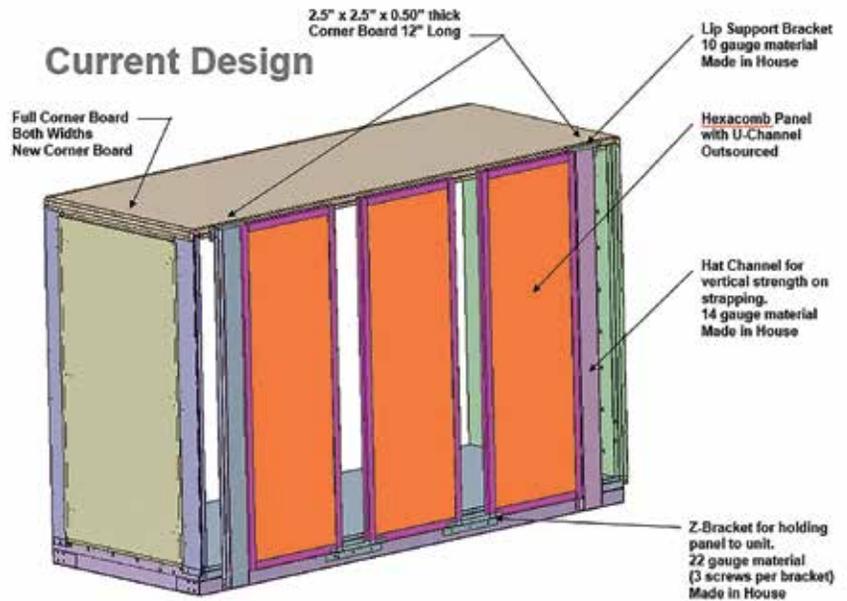
*ME Faculty Advisor*

**Dr. Tamara Reid Bush**

# Ingersoll Rand - Trane Shipping Split Protection

Ingersoll Rand is an Irish industrial manufacturing company founded in Dublin, Ireland, and has its US operations headquartered in Davidson, North Carolina. The company's products include tools, material handling, air solutions, utility vehicles, and air conditioning systems.

Trane, a subsidiary of Ingersoll Rand, is a manufacturer of HVAC systems. Trane frequently uses shipping split units to transport many of its products, making it easy to divide or "split" large shipments into units that are then later assembled at the customer's site. The unit suffers from several problems, and a better solution that offered protection to the shipping split needed to be designed. It was necessary to redesign the covering of the airflow opening and structure so they could withstand strapping on CSAA Indoor Unit 17 through 35 (no deformation) that works in conjunction with stretch wrap to seal the unit and prevent rain and debris from entering the unit.



## Michigan State University Team Members (left to right)

**Mirza Saifulbahri**  
Terengganu, Malaysia

**Leo Calaj**  
Southfield, Michigan

**Yuexing Sun**  
Chengdu, Sichuan, China

**Courtney Zimmer**  
Grand Rapids, Michigan

**Adri Johari**  
Ipoh, Perak, Malaysia

## Ingersoll Rand - Trane Project Sponsor

**Scott Wyant**  
Lexington, Kentucky

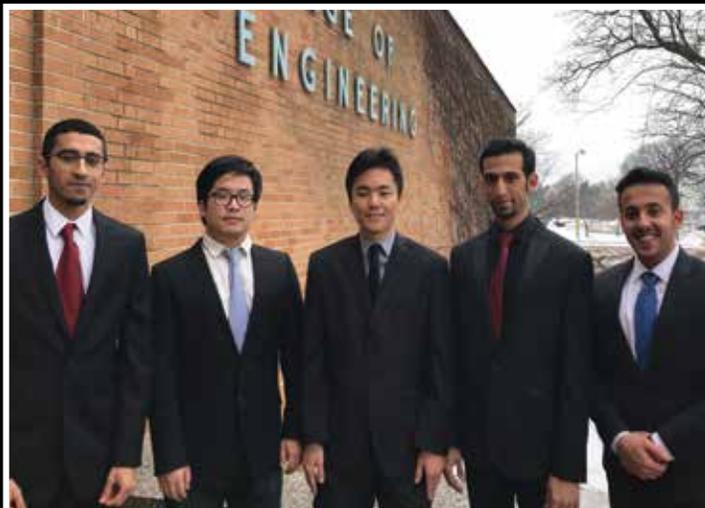
**ME Faculty Advisor**

**Dr. Norbert Mueller**

# Ingersoll Rand - Trane Shipping Support Redesign

Ingersoll Rand, founded in 1905, is a diversified industrial manufacturer that specializes in enhancing the quality and comfort of air in homes and buildings. At Trane, one of its subsidiaries, air conditioning systems with high energy efficiency are manufactured and shipped to commercial and residential markets. These systems are costly and need protection during shipping and after installment. The company designs and builds air handler units to support the different parts of these air conditioning systems during transit and to connect them in the field. These units use stiffeners to support the structure from stacking and wind forces along with vibration caused by shaking during shipping. These stiffeners are costly and hard to handle on tall units.

The commercial branch of Trane was interested in reducing the cost of the stiffener by remodeling the product design to have a new profile part while implementing different manufacturing methods. Our team focused on analyzing the stiffness and buckling characteristics of current and new shipping unit designs by simulating the response of the units under loads using finite element analysis. Alternative solutions were studied to develop the most appropriate design that fulfills the company's requirements of strength and durability manufactured at the lowest cost possible.



## Michigan State University

*Team Members* (left to right)

**Abdullah Bo Shgeia**  
Al-Ahsaa, Saudi Arabia

**Qilin Zhu**  
Guiyang, China

**Kanshu Mori**  
Wixom, Michigan

**Mojtaba Almiskeen**  
Saihat, Saudi Arabia

**Mohammed Bomoza**  
Al-Ahsaa, Saudi Arabia

## Ingersoll Rand - Trane

*Project Sponsor*

**James Little**  
Lexington, Kentucky

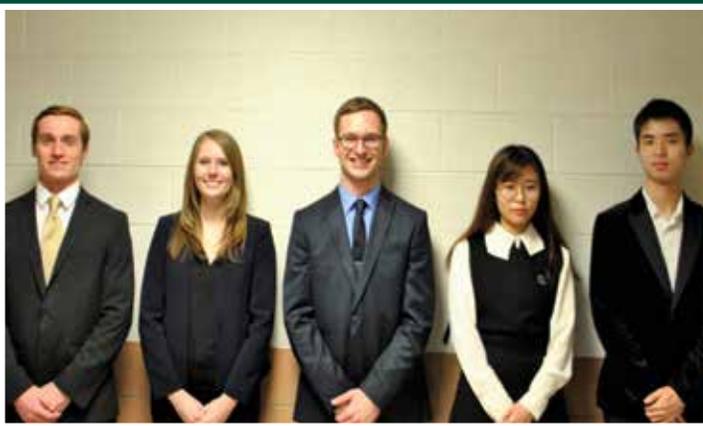
*ME Faculty Advisor*

**Dr. Alejandro Diaz**

# Ingersoll Rand - Trane VFD Stand Cost Reduction

Trane, a subsidiary of Ingersoll Rand, is a leader in air conditioning systems. Accompanying many of these systems is a Variable Frequency Device. These Variable Frequency Devices are mounted over a fan system through the use of a pedestal. Currently, the pedestal being used is oversized and purchased completely fabricated. This outsourced part costs the company over \$20,000 annually.

Our team was asked to create a new design for the pedestal that could be made at the Lexington, Kentucky plant. The new pedestal was designed to be smaller than the currently oversized pedestal. It was also designed to have no welded joints and be made with cost-effective materials. Finally, the product aimed to be roughly 25% of the price of the current pedestal when considering materials and labor.



## Michigan State University Team Members (left to right)

**Jacob Richter**  
Belleville, Michigan

**Tess Reed**  
Northville, Michigan

**Daniel Burchart**  
South Lyon, Michigan

**Shuang Liu**  
Shanxi, China

**Quanjin Li**  
Sichuan, China

## Ingersoll Rand - Trane Project Sponsor

**Elizabeth Denny**  
Lexington, Kentucky

## ME Faculty Advisor

**Dr. Ranjan Mukherjee**



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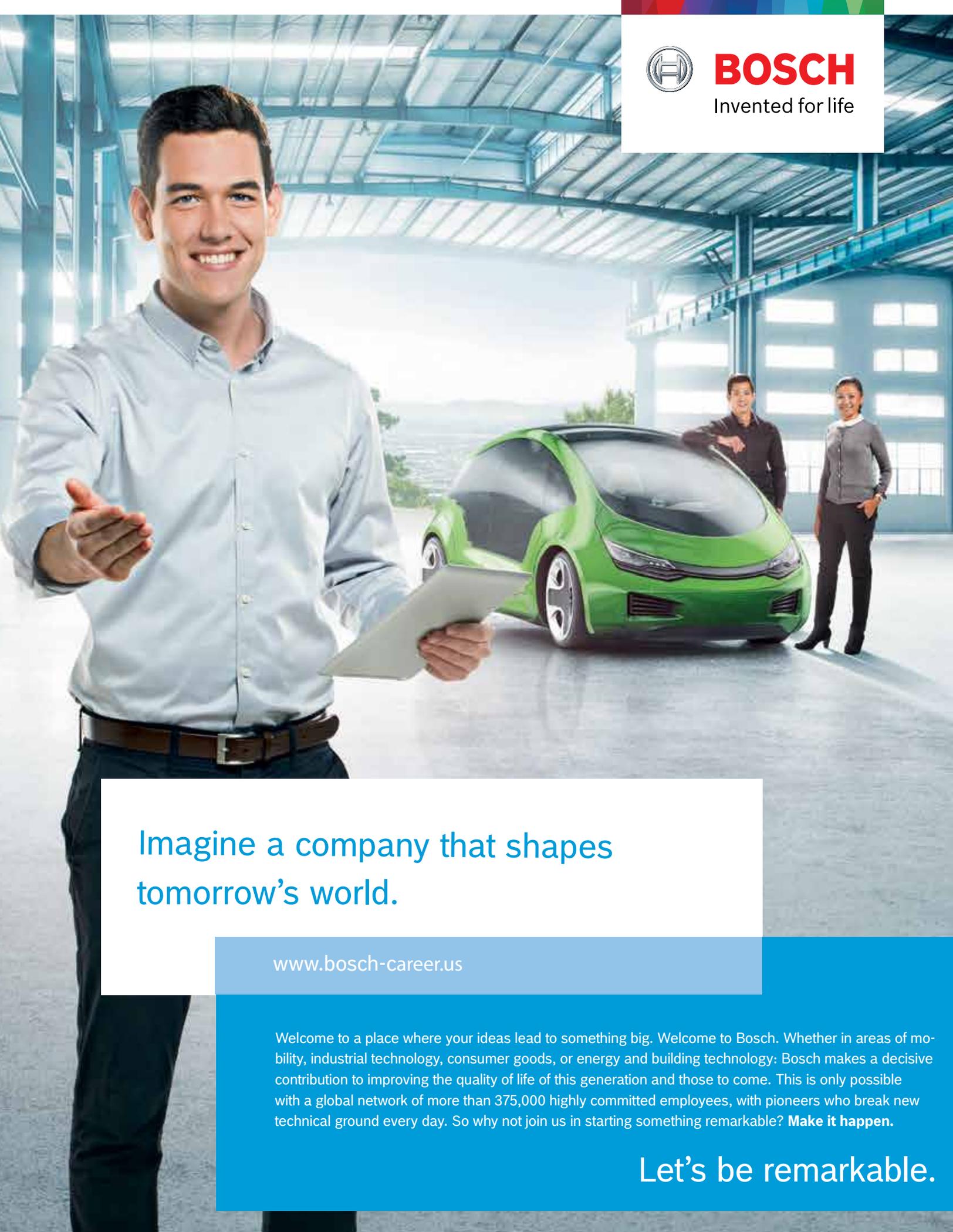
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# The Capstone Projects



**Dr. William Resh**  
**Professor of**  
**Mechanical Engineering**

**Faculty Advisors: Seungik Baek, Andre Benard, Brian Feeny, Al Loos, Indrek Wichman, Guoming Zhu**



Baek



Benard



Feeny



Loos



Wichman



Zhu

## Presentation Schedule – Engineering Building, Room 1220

Time	Team Sponsor	Project Title
8:00 a.m.	EPA	HVAC Monitoring and Display System
8:30 a.m.	Detroit Bikes	Bike Spoke Tension Meter Calibration Stand
9:00 a.m.	Hanson Logistics	Prevention of Damaged and Dumped Pallets in Freezer Environments
9:30 a.m.	Dynamotive	Self-Powered Water Circulator
10:00 a.m.	Stryker	Stretcher Ride Characterization & Improvement Methods
10:30 a.m.	ArcelorMittal	Rotating Mount for Vision Sensor
11:00 a.m.	Bosch	Fixture for Turbo Disassembly
11:30 a.m.	BorgWarner	Electrically-Assisted Engine Oil Pump

# Mechanical Engineering Design Program

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

*The ME faculty who supervised ME 481 design teams this semester are: Seungik Baek, Andre Benard, Giles Brereton, Tammy Reid Bush, Gary Cloud, Alejandro Diaz, Abraham Engeda, Brian Feeny, Al Loos, Norbert Mueller, Ranjan Mukherjee, Ahmed Naguib, Thomas Pence, Elisa Toulson, Yuping Wang, Indrek Wichman, Neil Wright, Xinran Xiao and Guoming Zhu.*

# U.S. Environmental Protection Agency HVAC Monitoring and Display System

The mission of the U.S. Environmental Protection Agency (EPA) is to protect human health and the environment. The EPA has numerous labs that are used to set national standards. The National Vehicle and Fuel Emissions Laboratory (NVFEL) located in Ann Arbor, Michigan, is used to conduct research and complete testing on motor vehicles, heavy-duty engines, and nonroad engines. The NVFEL uses the testing to set standards for air pollutants from vehicles and confirm that all vehicles comply with these standards. The NVFEL develops new technologies to reduce vehicle and engine emissions and increase fuel efficiency.

Our team was asked to provide a data acquisition system to monitor a device to display the particulate matter (PM) Clean Room Heating Ventilation and Air Conditioning (HVAC) system environment on an ongoing basis. The first aspect of the project was to analyze and model the HVAC system already in place. The second aspect of the project was to collect and display data on the HVAC system. The data collected at the input and output of the HVAC system include temperature, relative humidity, and airflow. To collect the data, data sensors were connected to a digital processor and the data were then exported for display.



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**Dr. Andre Benard**

# Detroit Bikes

## Bike Spoke Tension Meter Calibration Stand

**D**etroit Bikes, located in the heart of Detroit, Michigan, is an industry frontrunner for US manufactured upscale commuter bicycles. Capable of producing up to 150 bikes per day in their 50,000-square-foot factory, its mission is to make the bike owning experience as fun and enjoyable as possible for customers throughout the lifecycle of their purchase. This is done by producing bikes that are made to last. Durable bikes start from the ground up, specifically, the wheels. Each wheel is composed of many load bearing spokes, each of which is adjusted to the correct tension, allowing the wheel to spin true. If the spokes are tensioned unevenly, the wheels will wobble, resulting in a less than satisfactory ride.

Our team has designed and fabricated a bike spoke tension meter calibration stand, which will be used on the production floor at Detroit Bikes. A bicycle spoke is loaded into the calibration stand and tensioned under a specific load that is shown on a digital scale. The operator then uses their handheld tension meter on the spoke and gets a specific load readout. This calibration stand allows the operator to ensure that the spoke tension meter is calibrated correctly and to determine when it needs to be adjusted. With this newly implemented process, Detroit Bikes is able to continue building bikes made to last with added precision.



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**James Garrett**  
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### Detroit Bikes

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# Hanson Logistics

## Prevention of Damaged and Dumped Pallets in Freezer Environments

Hanson Logistics specializes in the transportation and storage of refrigerated or frozen goods. Day to day business for Hanson Logistics requires continuous use of fork trucks. These trucks are constantly unloading, storing, and unloading pallets as required by its customers. With this comes the unavoidable issue of occasionally dropping or damaging pallets. This issue costs the company hundreds of thousands of dollars annually. The solution to this problem is difficult due to the large number of variables involved, for example the height of the pallet, the operators' experience, the location of the pallet, and several other factors that can all be correlated with pallet damages. As a result, the solution to the issue must take multiple forms as well. That is why our team developed a two-pronged solution. The first is the implementation of a camera system that would be mounted between the forks and have a display in the cab of the fork truck. The goal of this is to aid the forklift operator and decrease the number of damaged pallets that result from operator error. The second is implementing better data acquisition and analysis techniques for Hanson Logistics to use going forward. There is a similar goal for this component, mainly in that it would allow Hanson Logistics to easily analyze what the primary sources of damages are. It also provides the ability for them to address issues as they continue to arise, thus providing a key component in a sustainable system.



Example monitor display of forklift camera. Image Source: LIFTek Corporation



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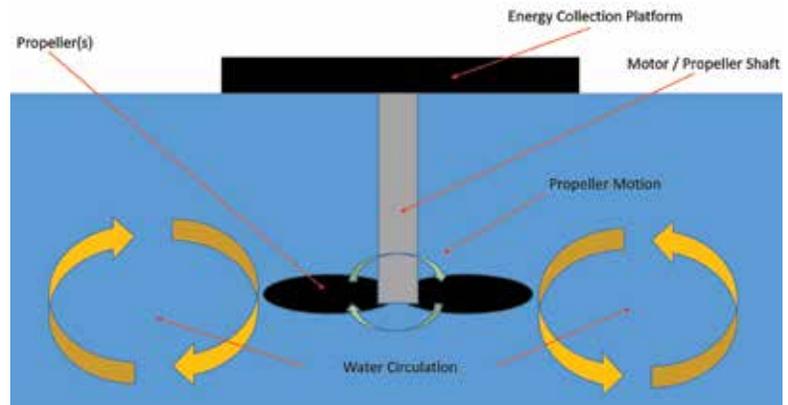
# Dynamotive IP, LLC

## Self-Powered Water Circulator

There are many recreational issues associated with still bodies of water and the natural decomposition processes they foster. As organic debris collects at the bottom of a body of water such as a lake, it is then broken down by anaerobic bacteria that produces hydrogen sulfide. This chemical can be harmful and often leads to the reduction of surrounding wildlife and plant-life, as well as being an aromatic displeasure to society.

In order to reduce the amount of hydrogen sulfide present in the water, it is necessary to circulate water from the bottom of the lake to the surface. Circulation exposes more water to the atmosphere, which allows the hydrogen sulfide to be able to be rejected and oxygen to be absorbed. Introduction of fresh oxygenated water to the bottom of these lakes then allows aerobic bacteria to break down organic matter. This improves the recreational value of the lake by decreasing levels of muck on the bottom and creating a more favorable environment for fish.

This project focused on effectively clearing this waste buildup for a small lake. A self-powered water circulator can achieve what traditional devices fail to do by providing an inexpensive mobile platform that can circulate water wherever needed. The self-powered water circulator utilizes photovoltaic panels to generate power to drive a propeller, which induces water circulation within a given area.



# DYNAMOTIVE IP, LLC



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# Stryker

## Stretcher Ride Characterization and Improvement Methods

Ride quality throughout the hospital while being transported on stretchers is crucial to patient safety and comfort. Currently, small interruptions in incline, surface, and traction disrupt the ride quality for the patient. These disturbances propagate throughout the device due to its rigid structure. To further understand these conditions that are felt during hospital transport, our team conducted ride quality testing. Accelerometers were attached to different areas of a stretcher and data were collected over various terrain (flooring transitions, tiling, etc.). The measured accelerations caused by the prescribed conditions were then correlated with subjective observations and comfort felt by a team member lying on the stretcher.

With a better understanding of ride quality, the team then designed different attachments to minimize the propagated shock throughout the stretcher. Multiple areas on the stretcher were identified as possible locations to modify. With the new prototypes in place, further ride quality testing was conducted to determine which one minimized vibrations the most, and data were compared to the initial ride quality of the stretcher. Our team submitted the attachment prototype with the best vibration damping properties to Stryker for further cycle, durability, and impact testing.



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### Michigan State University

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*ME Faculty Advisor*

**Dr. Seungik Baek**

# ArcelorMittal

## Rotating Mount for Vision Sensor

ArcelorMittal is a world leader in steel mining and manufacturing. The facility in Burns Harbor, Indiana, produces rolls of steel for a variety of consumers. In one of the final stages of the steel production process, the unrolled steel passes through vats of hydrochloric acid to cleanse the steel of surface impurities. This process requires that the steel continues to move to avoid being destroyed by the acid. Because of the need for continuous flow, the individual coils must be welded together at the beginning of the line and separated at the end of the line, so there must be accumulation at each end. A large accumulation pit at the end of the line allows the steel flow to increase or decrease to facilitate the welding and cutting while maintaining constant speed through the acid.

Our team was tasked with designing a rotating sensor mount that will position a vision sensor over the center of the accumulation pit to monitor the amount of steel in it. The team will develop CAD models and perform Finite Element Analysis on several proposed designs that can be used by ArcelorMittal to improve the efficiency of its manufacturing process. The design must be durable, easy to repair, and must be able to move out of the way of the pit for maintenance.



ArcelorMittal



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# Bosch

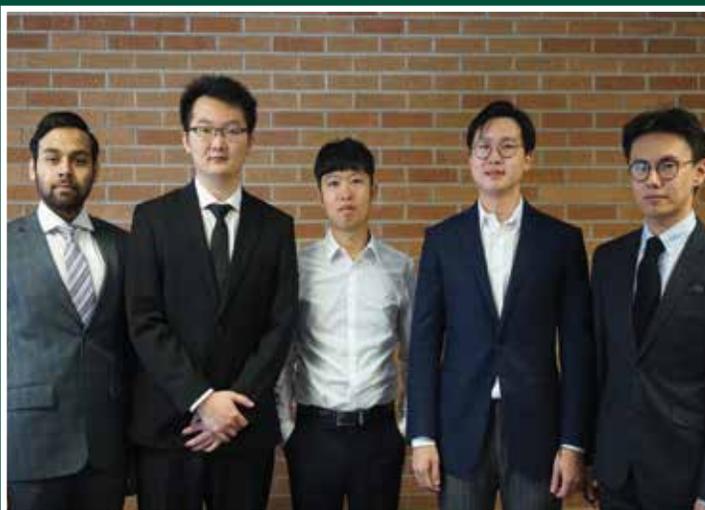
## Fixture for Turbo Disassembly

**B**osch, a global manufacturer of exhaust gas turbochargers, is also a well-established partner of the automotive industry. Right now Bosch is producing exhaust turbochargers for passenger cars, light commercial vehicles, and off-highway applications. Due to the larger amount of orders placed by different buyers, the North American branch of Bosch often receives parts of its products that need some level of disassembly and inspection. Currently, all the returned parts are shipped to Germany or Austria for teardowns and inspections; it could be more efficient if the North American branch were able to inspect these parts itself, even on a more basic level.

Our team focused on designing, building, and testing a disassembly fixture that could quickly, easily, and safely disassemble a key component of a turbocharger, which is often one of the most difficult parts to remove. Since the design of the turbochargers varies due to different applications, the fixture has to accommodate these turbos that range in different interface size and angles. Considering the different turn-in conditions, this fixture should also be able to overcome a substantial amount of force when disassembling the turbo because of the rusted or tightly sealed parts, which requires the fixture to be robust enough to hold the turbo in place and not break under load. The success of this project should have a significant impact on the process of turbocharger inspection.



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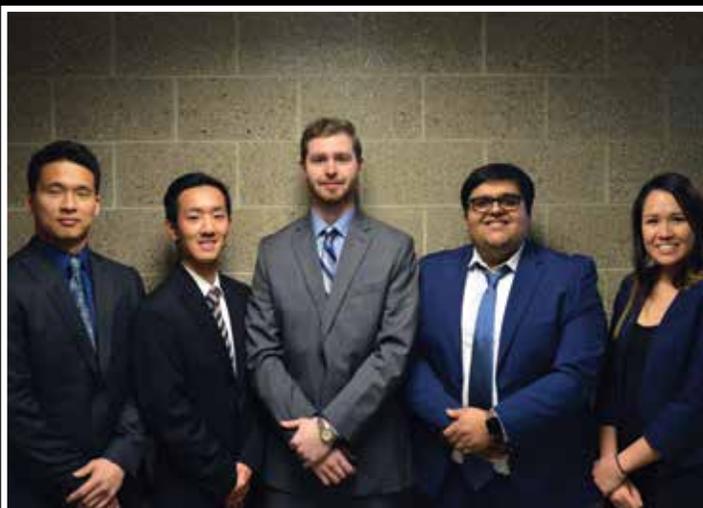
# BorgWarner Morse Systems

## Electrically-Assisted Engine Oil Pump

**B**orgWarner Inc. is a global leader in clean and efficient technology solutions for combustion, hybrid, and electric vehicles. The company's engine timing systems, valve timing through cam phasing, and power transmission solutions provide its global customers innovative solutions that increase efficiency and performance.

The Electrically-Assisted Engine Oil Pump, or EAEOP, is a solution aimed at improving engine starting emissions and NVH. This device can increase the functionality of existing Morse Systems products, such as the hydraulic cam phaser, by providing oil pressure when the engine is turned off. This is accomplished by using an electrified oil pump to unlock a phaser allowing cam timing changes during engine cranking.

Our team was tasked with analyzing and testing an electrical pump to operate the lock pin on a hydraulic cam phaser. A mobile test bench was fabricated to show that the system parameters were met. Additionally, conceptual designs and methods for implementing the electrical pump into the engine system were developed.



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# The Capstone Projects



**Dr. William Resh**  
Professor of  
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**Faculty Advisors: Gary Cloud, Thomas Pence, Yuping Wang, Neil Wright, Xinran Xiao,**



Cloud



Pence



Wang



Wright



Xiao

## Presentation Schedule – Room 1300

Time	Team Sponsor	Project Title
8:00 a.m.	Pratt & Miller	Formula SAE Active Four-Wheel Steering
8:30 a.m.	MSU Department of Entomology	Self-Purging Manifold for SSCDS
9:00 a.m.	Ford	Interior Vehicle Air Quality Measurement System
9:30 a.m.	Ranir	Semi-Automated Dental Floss Assembly
10:00 a.m.	Roberts Sinto	Accumulation Conveyor Off-Center Tooling
10:30 a.m.	Heartwood School, Ingham ISD	Adjustable Workstand
11:00 a.m.	Heartwood School, Ingham ISD	Personal Lift System (PLS)
11:30 a.m.	Hitachi	PCB Thermal Vias - FEA Investigation

# Mechanical Engineering Design Program Awards

The Mechanical Engineering Design Program makes three project awards on Design Day. The most significant award is the Thomas Alva Edison Design Award—a medal—given to each member of the ME 481 Capstone design team that produces the most outstanding technical design project. This award considers the team’s performance over the duration of the project, their presentations, the project solution, and prototype quality.

A second ME 481 Capstone award is given to the team that gives the best technical project presentation. The importance of communication of scientific and engineering ideas cannot be understated, and it is for this reason that we make the ME 481 Project Presentation Award. Award winners typically will have built an impressive prototype which forms the basis for a very clear and effective presentation of the project background and its solution, often incorporating live or video demonstrations of its functionality.

The ME Design Program also presents the Leonardo da Vinci Machine Design Award to the winners of its ME 471 Machine Design competition. The specific design problem and criteria for this competition change from semester to semester.

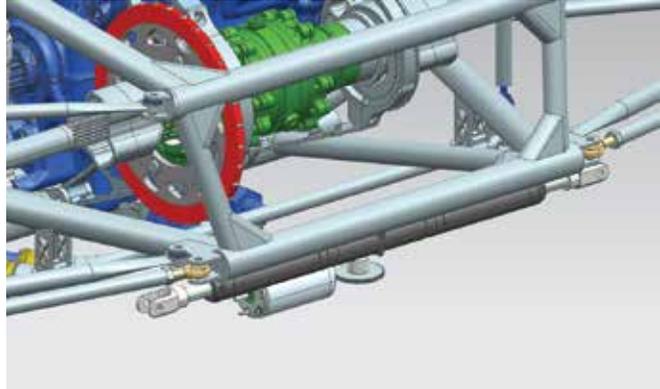
# Pratt & Miller Engineering

## Formula SAE Active Four-Wheel Steering

Formula SAE is the largest collegiate design series in the world, offering teams the opportunity to design, build, and race a one-of-a-kind open-wheel racecar. Over 500 teams compete in 12 sanctioned events spread across five continents. The student-developed cars are evolving rapidly, becoming lighter, faster, and more advanced in every aspect. To remain in the top tier, The Michigan State Formula SAE Racing Team must continue to come up with innovative designs that improve the performance of the vehicle.

The project goal was to design a rear-wheel steering and control system that will aid maneuverability, decrease lap times, and ultimately improve the Michigan State Formula Racing Team's competition rank. Four-wheel steering (4WS) is used in a variety of road cars, but a lightweight system had yet to be developed for the FSAE platform. The final hardware consisted of a DC motor coupled to a high reduction, self-locking worm gear driving a pinion and steering rack. All are paired together with sensors and a controller to create a bespoke system.

Technical support was provided by Pratt & Miller Engineering. PME is a product development company that, through innovation and technology, solves its customers' most technically complex challenges in the motorsports, defense, and mobility markets. PME specializes in low rate production and early-stage product development by providing R&D, prototype, manufacturing, and development services.



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**Dr. Gary Cloud**

# MSU Department of Entomology

## Self-Purging Manifold for SSCDS

Historically, apple trees have been trained to have large, spherical canopies. However, only the first few feet of the canopy, where sunlight penetrates, produce the majority of the fruit. So over the past few decades there has been a transition from apple trees with large, spherical canopies to much smaller trees with narrow canopies, increasing the yield of crop per acre. With this change, there is a need to change the way orchardists apply pesticides. The Michigan State Entomology Department has been working with local orchards, the Clarksville Research Center, and engineers to move from air blast application systems to solid set canopy delivery systems (SSCDS). The current air blast system application involves significant loss of expensive pesticide to the surrounding environment due to airflow drift. SSCDS makes a direct control volume application to decrease that amount of pesticide loss and drift to the surrounding environment.

Our team developed a manifold to allow the release of pesticide in a controlled, equally distributed manner. It also allows the system to be filled with low-pressure pesticide, then discharged with a higher pressure air. To ensure the longevity of the product, it allows drainage to eliminate residue buildup. This design is low-cost and robust for mass manufacturing and large application across orchards with little to no maintenance required.



Department of Entomology  
MICHIGAN STATE UNIVERSITY



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# Ford Motor Company

## Interior Vehicle Air Quality Measurement System

Ford Motor Company, headquartered in Dearborn, Michigan, is one of the largest automobile makers in the world. Ford is constantly trying to improve customer satisfaction and, in doing so, some geographically specific problems arise from time to time. One of these problems involves the new-car smell in Asian countries – China and Japan specifically. In a study of vehicles in China, about 17% of the industry's vehicles received complaints regarding the smell of the interior of the vehicle. This is theorized to be due to an enzyme variation that a portion of the Asian community has where acetaldehyde, a byproduct of alcohol, is metabolized more slowly by the body and causes flush or nausea. Acetaldehyde and other chemicals are also present in the new-car smell and are believed to be the reasons some people within the Asian community do not like this smell.

Our team was asked to create a device that will help Ford sample the new-car smell in order to determine what concentration of new-car smell is tolerable for various populations. The device uses butanol and acetone to calibrate. After calibration, it dilutes the interior air of a vehicle and gently blows a sample of this air so that a subject can smell the sample and then be able to answer questions about it. This device must be compatible with Ford's custom Data Acquisition System and must also ensure that the sample provided to the subject is not influenced by sampling artifacts.



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# Ranir

## Semi-Automated Dental Floss Assembly

Ranir, headquartered in Grand Rapids, MI, is a global leader in the manufacturing of store brand consumer oral care products. Ranir's products can be found at major retailers in over 40 countries and cover a range of dental products from power and manual toothbrushes to teeth whiteners and dental floss. In the manufacturing processing involving dental floss containers, there is a need to eliminate losses. These losses come from the excessive length of the dental floss spools, otherwise known as bobbins, during the winding and assembly process. The current winding operation drops four bobbins at a time into a large tote, creating lots of scrap material, and is inconsistent for the next step in the assembly process. This inefficient design is costly and further complicates the assembly process for Ranir.

Our team was tasked with designing a semi-automated assembly solution for dental floss containers. This project was the second step in a three-part process Ranir is undergoing with the end goal of fully automating their dental floss packaging process. This project focused on taking control of the bobbin during the winding process, modifying the cutting operation, and reducing scrap from unraveled bobbins while increasing manual assembly rates by 15-20%.



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# Roberts Sinto Corporation

## Accumulation Conveyor Off-Center Tooling

Roberts Sinto Corporation (RSC) designs and manufactures conveyor systems for automotive assembly plants. These conveyors transfer large body panels from one point to another. RSC designs the conveyor system, and the customer is responsible for acquiring the tooling specific to the part they are moving. As a customer's projects change, they often change the tooling without RSC review or approval, and the center of gravity of the tooling is sometimes neglected and parts often hang off-center. When redesigned tooling is out of spec, the conveyor systems exhibit undesired vibration, which can increase wear on the mechanical components of the conveyor and therefore decrease the life of the conveyor.

Roberts Sinto Corporation is interested in a design that will prevent vibration from occurring and increase the life of conveyor systems with offset tooling. Our team worked to develop a simple, cost-effective solution that can be installed in all customer plants with as little downtime as possible, while also being rugged enough to withstand the normal use of the conveyor. The team demonstrated a prototype to allow for further testing and improvement before the design is offered to all RSC customers.



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# Heartwood School, Ingham ISD

## Adjustable Workstand

**H**earthwood School provides educational services to students with physical and cognitive disabilities and autism. The school gives its students a safe, educational environment and culture where all will achieve their greatest potential. Students at Heartwood School range in age from 3 to 26 and come from all 12 districts in Ingham County. The school's focus is to further develop its students as community and family members by participating in prevocational and life-skill activities. To do so, Heartwood School utilizes the MOVE Curriculum, which is a research-based program shown to improve functional mobility skills with a goal that students can better direct their own lives. Transitioning students, ages 16 to 26, who attend Heartwood have goals of participating in meaningful paid work and volunteer opportunities. However, accessing and manipulating supplies can be a barrier to the students' opportunity to participate in these activities.

Our task from Heartwood School was to design an adjustable workstand to assist in the development of students' vocational skills. The adjustable stand allows students to participate in a variety of purposeful job tasks with greater independence and allows students to access materials from a wheelchair, walker, or gait trainer. The stand is adjustable in height, tilt, and rotation and can be modified for certain tasks such as paper shredding, laminating, and sorting objects. The number one priority when designing the stand was safety because the device would be near students with uncontrolled motor movements.



**Ingham Intermediate School District**  
A Regional Educational Service Agency



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**Heartwood School**  
*Project Sponsor*

**Melissa Walraven**  
Mason, Michigan

**ME Faculty Advisor**

**Dr. Yuping Wang**

# Heartwood School, Ingham ISD Personal Lift System (PLS)

Heartwood School is a facility in the Ingham County Intermediate School District that serves children ages 3 – 26 with moderate and severe cognitive impairments, severe multiple impairments, and autism spectrum disorders. Heartwood School places an important emphasis on its specialized curriculum incorporating the MOVE Program, CORE Vocabulary, reading, mathematics, social studies, daily living, and social skills. These activities are structured to be hands-on and highly interactive in order to actively engage the students as much as possible.

The design project received from Heartwood was a redesign of a PLS created in the Fall of 2014. The previous project experienced catastrophic material failure when it was put into use. The previous PLS failed when a critical weld snapped. This caused safety to be a number one priority in the new design. The new PLS is a reliable, durable, safe, and mobile system that satisfies various roles. The PLS is used to vertically lift heavier students aged 16 – 26, support them at a 24-inch height, and transport them into alternate support units. Due to the severe physical impairments of the students, this device needed to be capable of lifting students off the floor with no assistance, as well as being as safe and sturdy for long-term use at the school.



**Ingham Intermediate  
School District**  
*A Regional Educational Service Agency*



## Michigan State University Team Members (left to right)

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Brighton, Michigan

**Austin Miller**  
Macomb, Michigan

**Jack Kuerbitz**  
Lebanon, Connecticut

**John Schumaker**  
Canton, Michigan

**Sawyer Dmoch**  
Walled Lake, Michigan

## Heartwood School Project Sponsor

**Joanne Janicki**  
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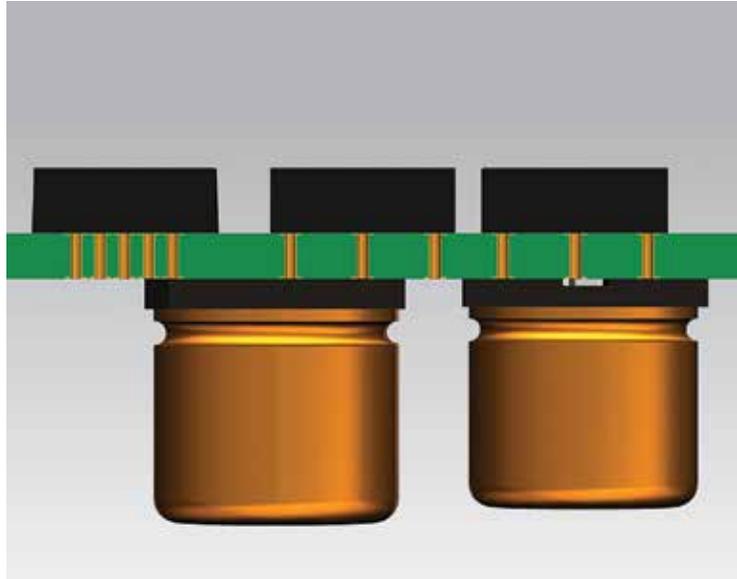
**Dr. Neil Wright**

# Hitachi Automotive Systems Americas, Inc.

## PCB Thermal Vias - FEA Investigation

Hitachi Automotive Systems wishes to speed the Finite Element Analysis (FEA) of the thermal performance of its automotive electronic controllers. A challenge that Hitachi has encountered is the computational demand required for developing an appropriate mesh for accurate heat transfer analysis of the cooling of a processing chip through vias to the opposite surface of the Printed Circuit Board (PCB). However, the large quantity of relatively small thermal vias increases the simulation time and meshing difficulty. Therefore, the company desires an equivalent structure that can simulate thermal results with less calculation time and better FEA correlation accuracy.

Our team has designed and developed a new structure that could replace the original shape of thermal vias with the same amount of heat transferred. The outcome should help reduce the simulation time and improve FEA correlation accuracy for the vias.



**HITACHI**  
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Hitachi Automotive Systems



**Michigan State University**  
*Team Members* (left to right)

**Duy Nguyen**  
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**Hitachi Automotive Systems Americas, Inc.**  
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**Dr. Neil Wright**

# Design Day Awards

## ME 481 Thomas Alva Edison Undergraduate Design Award



Left to right: Jeri Ann Sutter, Alexander Athens, Manea Yousuf Alhammadi, Jason Moll, Paul Ferraiuolo, Marissa Meaney

The Edison Undergraduate Design Award is given to the ME 481 Design Team that is judged to have produced the best technical design project.

Last semester's winner was Team DENSO for the project "Pressure Chamber to Measure Ignition Energy." Team members were Manea Yousuf Alhammadi, Alexander Athens, Paul Ferraiuolo, Marissa Meaney, Jason Moll and Jeri Ann Sutter.

**ME 481 Project Presentation Award:**

The ME 481 Project Presentation Award for the best presentation of a design project was awarded to Team Packsize for “Design of a Muck Bucket Dolly.” Last semester’s winners were Anxhelo Lalaj, Kevin McCarty, Mitchell Pollee, Michael Rasmussen, Amad Wahib and Matthew Walz.



Left to right: Kevin McCarty, Mitchell Pollee, Amad Wahib, Anxhelo Lalaj, Matthew Walz, Michael Rasmussen

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**ME 471 Machine Design Award:  
The Leonardo da Vinci Award**

The Leonardo da Vinci Award was presented to the team with the best machine design. The winning team was Yibin Cheng, Grant Gooch, Brandi Mazella, Li Ren and Henry Wikol.



Left to right: Yibin Cheng, Brandi Mazella, Henry Wikol, Li Ren, Grant Gooch





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