MICHIGAN STATE UNIVERSITY

URBAN SCIENCE

Executive Partner Sponsor

WELCOME TO THE 25TH ANNIVERSARY OF DESIGN DAY

From all of us at Urban Science and the College of Engineering at Michigan State University, welcome to the 25th Anniversary of Design Day!

Urban Science is honored to be a sponsor of this great program for seven years and counting. We are continually impressed by the talents of the participating students – several who we have proudly welcomed as Urban Scientists. This day showcases some of the brightest thinking, a result of many hours of hard work, collaboration and innovation by the students.

The spirit of Design Day is what Urban Science is all about. Our mission is to create a world in which innovation is powered by science and inspired by the entrepreneurial spirit to invent a better future. Every day, we use data and science to create solutions and opportunities to solve our clients' business challenges around the globe. MSU's engineering students embody the same passion for science and engineering that we do. They already stand out as emerging leaders and will undoubtedly help shape the future of design and engineering, of our communities and beyond.

Congratulations to the students and all those involved that helped make this year's Design Day another wonderful success.

Elizabeth Klee

Elizabeth Klee
Urban Science Chief Information Officer

URBAN SCIENCE

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Mark Your Calendars!! It's time to save the date for Fall 2019 Design Day!

Join us Friday, December 6, 2019 for another energetic celebration showcasing talented engineering students

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

Welcome from the Dean

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

This year we celebrate 25 years of Design Day. The first Design Day featured 12 Mechanical Engineering Capstone teams.

Since then, Design Day has grown into the premier undergraduate academic event of the semester, featuring over 100 capstone teams and 600 seniors from all 10 of the College's academic programs.

Check out the Design Day milestones highlighted on a timeline on pages 8 and 9 of this booklet.

We are pleased to acknowledge Urban Science as our Design Day Executive Partner Sponsor and Amazon as our Design Day Directing Partner Sponsor. Our Design Day Supporting Partner Sponsors include Blackstone, Bosch, Ford, MSUFCU, Technology Services, and TechSmith. We thank all of our sponsors for their generosity and their ongoing commitment to Design Day.

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

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

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

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

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

Dr. Leo Kempel

Dean of the College of Engineering

Professor of Electrical and Computer Engineering

Michigan State University

Events Schedule Friday, April 26, 2019

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 412 Competition		1st Floor Rooms 1252 8:00 a.m.-11:45 a.m.					
ME 470 Competition		1st Floor Room 1345 8:00 a.m. - Noon					
ME 478 Competition		2nd Floor Room 2320 10:00 a.m.- Noon		2nd Floor Room 2320 10:00 a.m.- Noon			
ME 497/MKT 420 Demonstrations			1st Floor 1200 Hallway 9:00 a.m.-11:30 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 and ECE on 2nd Floor 2200 Hallway ChE on 2nd Floor 2400 Hallway					
AESC 410/SCM 472 Project Presentations		1st Floor Rooms 1225, 1230 & 1234 7:30 a.m. – Noon					
CE 495 Project Presentations		1st & 3rd Floors – Rooms 1538, 3400 & 3540 8:00 a.m. - Noon					
CSE 498 Project Presentations		3rd Floor, Room 3405 7:15 a.m. - Noon					
ECE 480 Project Presentations			2nd Floor Rooms 2243 and 2245 8:30 a.m.-11:50 a.m.				
ME 481 Project Presentations	1st Floor Rooms 1202, 1220 & 1300 7:00 a.m. - Noon						
MSE 466 Project Presentations			1st Floor Room 1145 8:30 a.m. – Noon				

LUNCH AND AWARDS							
Middle School Opening			1st Floor Anthony Hall, Room 1279 8:00 a.m. - 8:30 a.m.				
Middle 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:

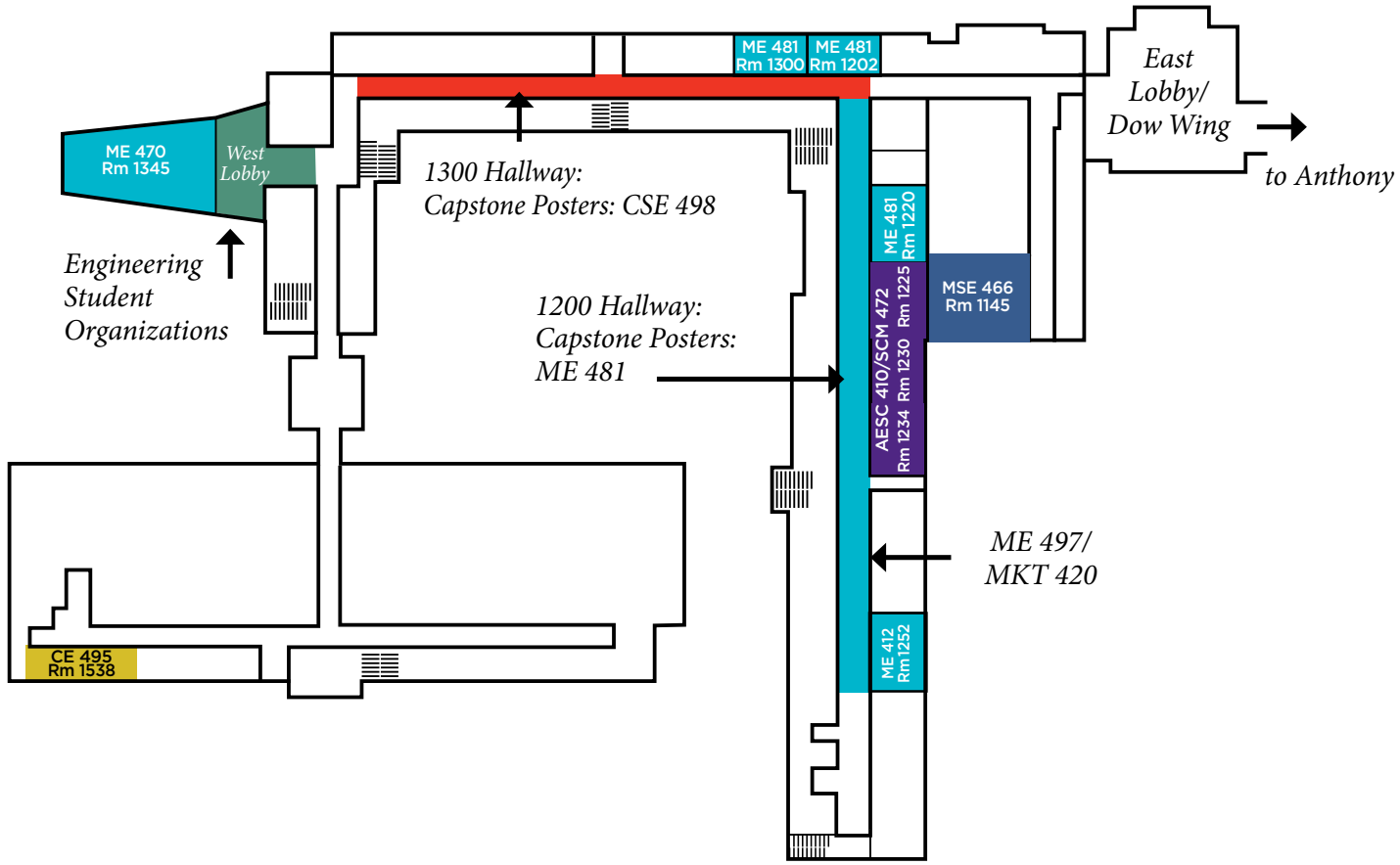
"Like" the College: https://www.facebook.com/SpartanEngineering "Follow" the College: https://twitter.com/msu_egr_news

To stay up to date w/Careers in Engineering:

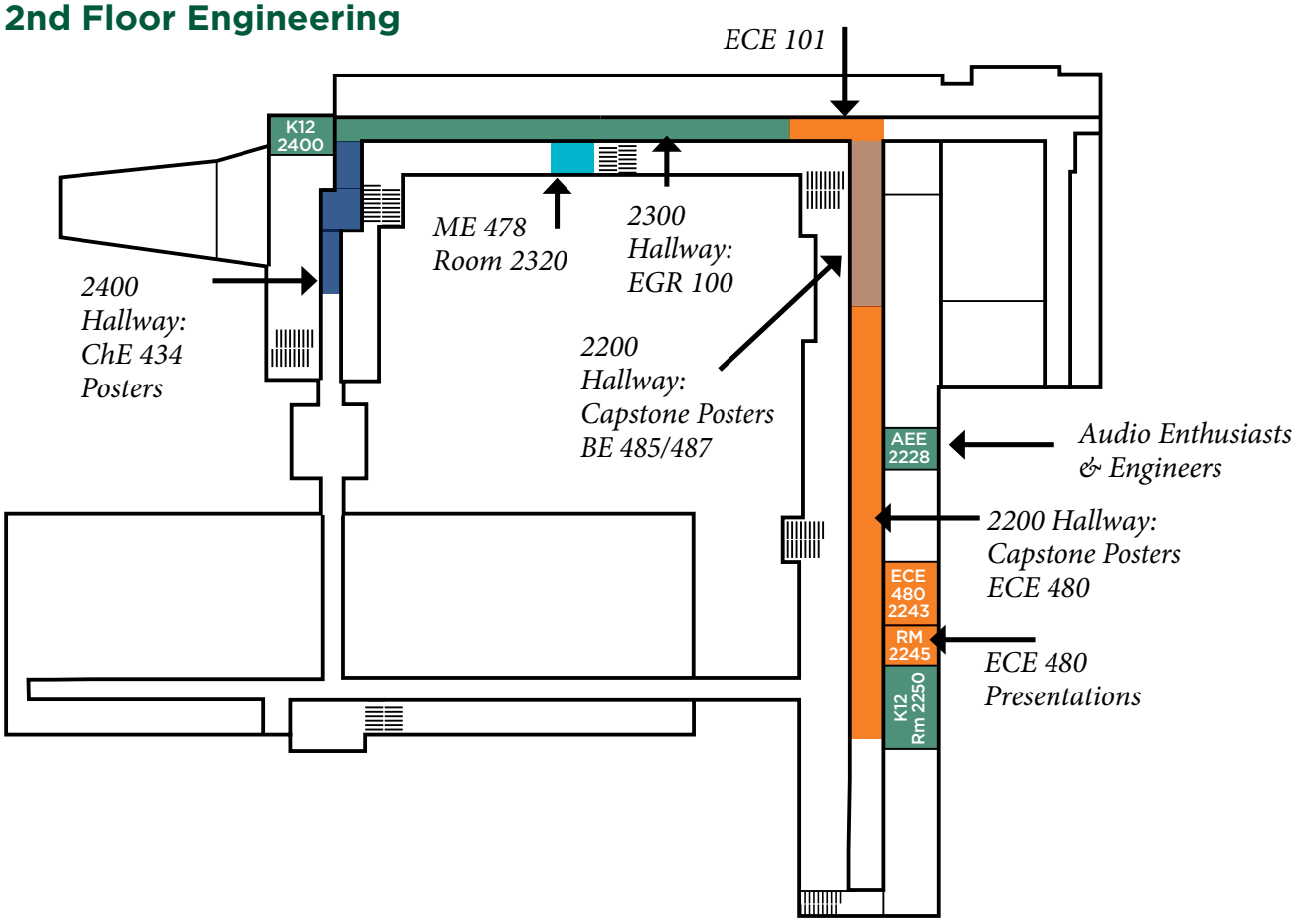
"Like" Us http://www.facebook.com/pages/The-Center-for-Spartan-Engineering/226159694117936

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

1st Floor Engineering

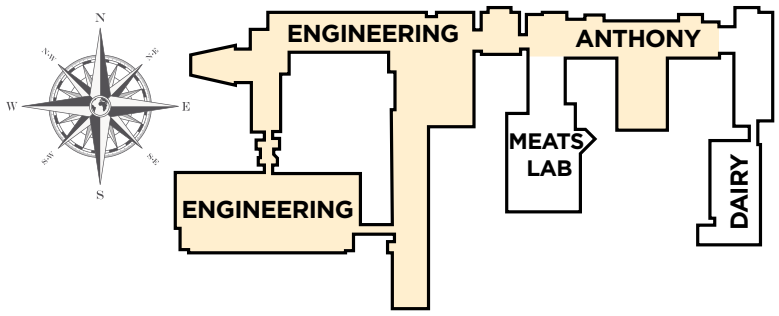


2nd Floor Engineering

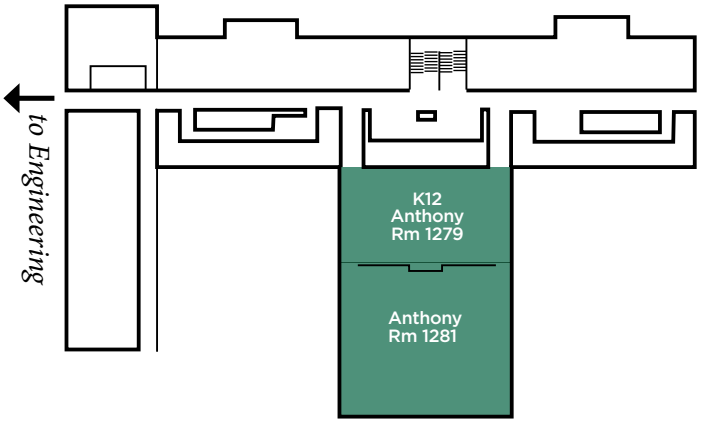


Design Day Floor Plans of the MSU Engineering Building

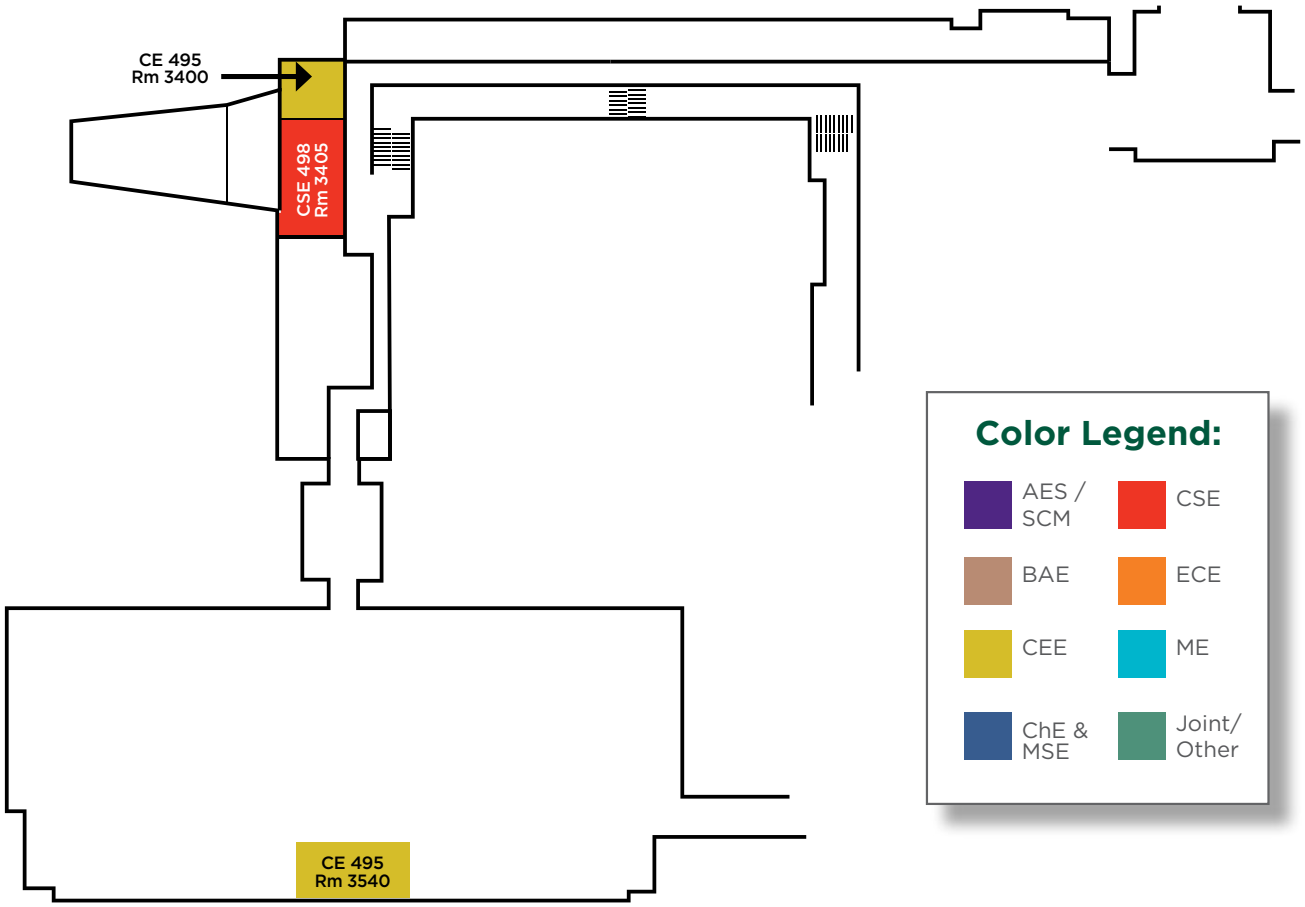
Overview



1st Floor Anthony



3rd Floor Engineering



Color Legend:

- AES / SCM
- CSE
- BAE
- ECE
- CEE
- ME
- ChE & MSE
- Joint/ Other

SOME MILESTONES DURING 25 YEARS OF

DESIGN DAY

1994
First "Design Day" is held in the Communications Arts Building; 12 Mechanical Engineering teams present their "Environmentally Friendly Designs;" ME Design II teams present their projects; awards are given

1996
Design Day moves to the MSU Union

1998
First humanitarian project – Zack's Bike – is presented

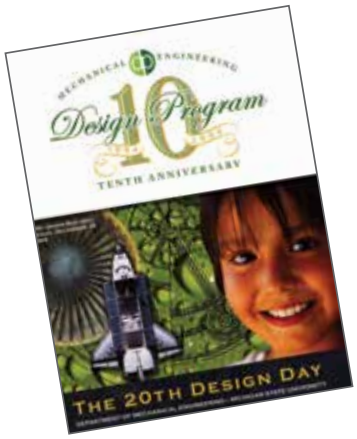
2002
Chemical Engineering teams display posters; two Materials Science teams present projects

1994-1998 | **1999-2003** | **2004-2008**

1995
Design Day is held in Brody Hall; 20 Mechanical Engineering teams are supported by 5 corporate sponsors

1997
K-12 students are invited to attend

2004
10th Anniversary of Design Day is celebrated

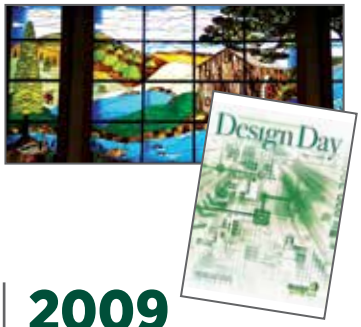


2005
Dart Foundation begins sponsoring K-12 activities

1997
Most current capstone students are born in this year

1999
Google celebrates its first birthday!

from 1994-2019



aes Applied Engineering Sciences

2006
Electrical & Computer Engineering joins; name is changed to College of Engineering Design Day

2009
Biosystems & Agricultural Engineering joins Design Day with poster presentations; Auto-Owners Insurance becomes the first Executive Partner Sponsor

2010
With the addition of Applied Engineering Sciences, all academic programs in the College now participate in Design Day

2014
Design Day celebrates its 20th year; its 5th with all academic programs participating

2018/19
Design Day celebrates its 25th anniversary!

2009-2013 | **2014-2019**

2007
Computer Science & Engineering joins Design Day with 6 teams

2008
Engineering 100 and Civil Engineering begin participating

2013
Design Day outgrows the MSU Union and moves to the Engineering Building

2007
Apple introduces the iPhone to the world

2010
The world's tallest building opens in Dubai at 2716 ft

Middle School Innovation & Creativity Day

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

During this time college students will have a chance to interact with "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 and groups will be participating in this Spring's Design Day events: Brighton Middle School, Perry Middle School, Plainwell Middle School and Women In Engineering.

	1279 Anthony Hall: Auditorium	K'NEX Bridge Team Build Room 2250	VEX Robotics Room 2400	1st & 2nd Floor Voting/project viewing	Trebuchet Launch Competition: Room 1279 Anthony Hall
8:00–8:15	Check in for all schools				
8:15–8:30	Welcome & voting procedures - Drew Kim, Assistant to Dean, and Luis Donado, Assistant Director				
8:40–9:30		Brighton Middle School	Perry Middle School	Plainwell Middle School	Women in Engineering
9:35–10:20		Perry Middle School	Plainwell Middle School	Women in Engineering	Brighton Middle School
10:25-11:10		Plainwell Middle School	Women in Engineering	Brighton Middle School	Perry Middle School
11:15-12:00		Women in Engineering	Brighton Middle School	Perry Middle School	Plainwell Middle School
12:15–12:30	Awards Ceremony (Everyone) 1345 Engineering Building, lunch at Brody immediately after the awards ceremony				

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

MEMBERS OF THE ORGANIZING COMMITTEE SPRING 2019

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

Dean Buggia
Instructor and
Technology Teacher,
Okemos High School

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

Rachel Esch
K-12 Outreach
Secretary

Danielle Farness
K-12 Outreach
Secretary

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

VEX ROBOTICS

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

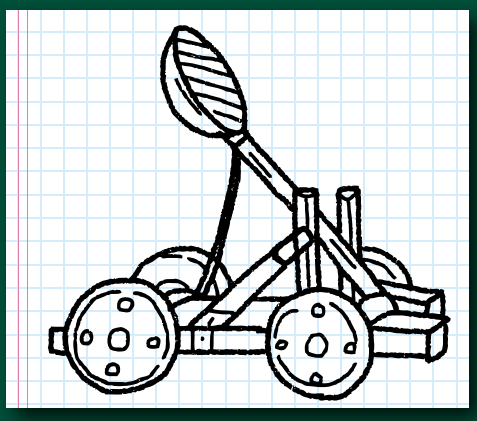
INTERDISCIPLINARY ENGINEERING BUILD

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

During the build portion of this session you and your team will be given the design constraints for the structure. Utilizing the information learned at the start of the session and the limited materials provided, your team will need to design and then construct a model to be tested. Your finished structure will be placed on one of our test beds for evaluation. With the help of MSU Engineering students, the results will be collected by a sonic ranging sensor. These data points will be interpreted by the computer program and your team will be evaluated on percent deflection of your support. Throughout this session you will need to listen, learn and utilize your team to be successful. Good Luck.

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.



High School Innovation and Creativity Day

K12 Awards Fall 2018

Dean Kempel with a group of Brighton High School Bridge Building competition winners, Erik Toulol, Courtney Smith, Thomas Rye, Jacob Terlecki along with BHS Engineering teacher, Matt Jourden. The course was taught by Dean Buggia, Okemos HS Engineering and Technology teacher.

Dr. Morgan taught EGR 100, Solar Car Competition. The winning group was Grant Cook, Zack Fiess, Michael Monticciolo, and Cooper Strebeck with Dean Kempel and Tim Hinds, the director of CoRe program.

Winning ECE 480 group members, Amanda Anguiano, Edward Chan, Brandon Roek, Jacob Stanowski, and Robert Long with Dean Kempel and Dr. John Albrecht.

Mr. Robert Watson, MSU K-12 Outreach Office Robotics Coordinator, and the winners of the VEX Robotics Competition: Casi, Ivonne, and Elsie with Dean Kempel, teachers Mr. Mike Larson and Elisabeth Giem from Innovation Central High School in Grand Rapids.

Tim Hinds, director of the CoRe program, Dean Kempel with EGR 100 faculty, Dr. Morgan and the winning team titled, "3-D Printing," Francisco Camposiannacone, Mingzhe Huang, Ryan Koschay, and Nicholas Scamardizalala.

K-12 Design Day school/organization teachers/lead with Dean Kempel; Teresa VanderSloot-WIE; Elisabeth Giem-Innovation Central High School; Karen Payson-Battle Creek Area Math and Science Center; and Matt Jourden-Brighton High School. Thank you for your efforts!

Admitted WIE student group won the Trebuchet Design and Toss competition for FS18. The winners are Allison Mattson and Leah Barczynski, with Teresa VanderSloot, Director of WIE Recruitment and K-12, Geralynn Phelps, Assistant Director of WIE Recruitment and K-12, Dean Kempel. Connor Boss and Sanders, Mechanical Engineering Ph.D. candidates served as instructors.

EGR 100 Introduction to Engineering Design

Dr. Jenahvive Morgan
Course Instructor

Course Project

EGR 100, Introduction to Engineering Design, is a college-level course required of all incoming first-year engineering students. It is an integral part of the CoRe (Cornerstone and Residential) Experience. The course introduces students to the engineering profession and the engineering design process through team-based, interdisciplinary design projects and assignments. There are 689 students enrolled in EGR 100 this semester.

For the final course project, the student teams selected from seven project types: (i) Solar Car Competition, (ii) Cell Phone App Inventor, (iii) Design of a Heat Exchanger, (iv) 3D Printing, (v) Arduino Programming, (vi) Costa Rica Design of an Eco-Lodge, and (vii) CoRe Industry-Sponsored Projects. CoRe Industry-Sponsored Projects involved collaborations with Aptiv on electrical distribution system design optimization and ArcelorMittal on optimal basic oxygen furnace steelmaking scrap mix design. 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 2018 EGR 100 Project Poster Award Winners:

l-r: Jenahvive Morgan, Cooper Strebeck, Grant Cook, Zack Friess, Michael Monticciolo, Dean Kempel, Tim Hinds

l-r: Jenahvive Morgan, Francisco Camposiannacone, Ryan Koschay, Dean Kempel, Tim Hinds

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Applied Engineering Sciences

Capstone Course Sponsors

We thank the following sponsors for their generous support of the Applied Engineering Sciences senior capstone course. We gratefully acknowledge the Supply Chain Council for their project support.

American Axle & Manufacturing, Inc.

ArcelorMittal

Asahi Kasei Plastics North America

BorgWarner

BP

Creative Foam

Ellison Brewery

Ford

Gerdau

Ingersoll Rand

John Deere

MagPlasma

MSU Infrastructure Planning & Facilities

Michigan State University

MSU School of Planning, Design and Construction

NASA/ASU

Bosch Rexroth

Roberts Sinto

Snackwerks

ZF Friedrichshafen AG

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

Liliya Kalyenich
MBA (2020)

Ryan Meadows
MBA (2019)

Elliot Lourie
MBA (2020)

Chris Winter
MBA (2019)

Abhinav Iyer
MBA (2019)

Presentation Schedule – Engineering Building, Room 1225

Time	Team Sponsor	Project Title
7:30 a.m.	ZF	Competitive Advantage in a Commodity
7:55 a.m.	ZF	Dynamic Bill of Material for Forecasting
8:20 a.m.	ZF	Supply Chain Optimization through Advanced Analytics
8:45 a.m.	ZF	Steel Raw Material Specification Consolidation
9:10 a.m.	AAM	Verifying Cost Analysis of Tariffs
Break		
9:45 a.m.	ArcelorMittal	Safe, Sustainable Steel
10:10 a.m.	MSU Transportation Services	Driving Campus Forward!
10:35 a.m.	Ford	Simplifying the FMVSS Self-Certification Process
11:00 a.m.	Ford	Total Road Load Horsepower Database Management
11:25 a.m.	Creative Foam	Laser Metrology Scanning Equipment Utilization

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.

ZF Friedrichshafen AG
Competitive Advantage in a Commodity

ZF Friedrichshafen (ZF Group) was founded in 1915 in Friedrichshafen, Germany, which is still the company's headquarters. ZF is a worldwide automotive manufacturing company present in 40 countries with a global workforce of over 146,000 employees. They are a global automotive leader in driveline, chassis, and safety technology. Their presence can be seen in both original equipment manufacturing and aftermarket automotive products.

Currently, there is concern within ZF purchasing about the relationships with some of their suppliers of a specific commodity. ZF is highly dependent on these suppliers because the commodity is difficult to source and manufacture. This dependency enables suppliers to increase prices annually and ZF does not have insight into the cost drivers behind the increases. The increases are highly profitable for the suppliers and are driven by manufacturing expertise and ownership of proprietary information about the commodity.

Despite facing annual price increases, it is difficult for ZF to resource to new suppliers because the commodity requires high testing costs and involves long lead times to validate new qualified suppliers. For these reasons, ZF's goal for our project is to develop strategic and sustainable partnerships that will help ZF reduce their dependence on suppliers, provide more insight into the manufacturing process, and increase their competitiveness in the automotive market.

Our team will perform an analysis of ZF's portfolio of parts that contains the commodity and determine which part family to focus on based on which provides the greatest potential for cost-savings. Once the part family has been selected, a third party will also be selected as a candidate with which ZF can partner. Due to the shelf life of the commodity and other logistical obstacles, the region in which the third party operates will also be a key factor in the selection process.

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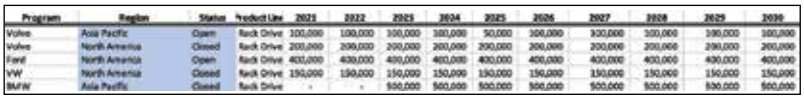
ZF Friedrichshafen AG
Dynamic Bill of Material for Forecasting

ZF Group, headquartered in Friedrichshafen, Germany, is a global manufacturer in the automotive industry, specializing in driveline and chassis technology. Achieving nearly $48 billion in sales in 2017, and with approximately 230 production facilities in 40 countries, ZF has established itself as one of the largest suppliers in the world. For many reasons, forecasting and supply planning are central to ensure growth and financial success.

Receiving bids from multiple OEMs worldwide each year, it becomes a challenge to organize them and predict how many parts will need to be manufactured. ZF asked our team to create a dynamic forecasting system with user inputs for both customer programs and bill of materials costs for over 300 components.

Our team, composed of Supply Chain Management and Applied Engineering Sciences students, created a framework within Microsoft Excel to quickly and accurately compute the future volumes and cost of OEM bids based on the user inputs. Keeping in mind that bids may close and need to be reflected easily within the framework, an "open" or "closed" feature for bids was implemented. A primary focus for the team was to keep the framework user-friendly in order to ensure a smooth handoff to ZF and ensure its success into the future.

Part Description	Index #	Volvo	Ford	VW	BMW	Total
Bellow Seal O-Ring (2 Per)	1	2		2	2	6
Bellows (2 Per)	2	2		2	2	6
Large Clamp (2 Per)	3	2	2	2	2	8
Small Clamp (Seal Clip) (2 Per)	4	2	2	2	2	8
Nut (IBJ/OBJ) (2 Per)	5	2	2	2	2	8
Plug (Power Connector)	6	3	1	2		6
Plug (Can Connector)	7	3	1		1	5
Bar Code Label	8			1		1
AvSeal - BD only / Firewall Seal	9		1	1	1	3
Travel Restrictor	10	1		1	1	3
Vent Pill	11	1	1	1		3



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ZF Friedrichshafen AG: Supply Chain Optimization through Advanced Analytics

ZF Friedrichshafen AG, also known as ZF Group, is a worldwide vehicle manufacturing company headquartered in Germany. As a system provider, it provides solutions for future mobility. The ZF Group in North America sector is responsible for axle drives, front and rear systems, automatic passenger car transmissions and active and passive safety systems.

For this project, ZF Group is concerned with cost-saving throughout its transportation network. The goal of our team is to identify cost-saving solutions for the trucks that are being under-utilized. From this, we will create a catalog of tools that will allow consumers, stakeholders, and plant workers to analyze the current transportation network and quickly identify potential opportunities for cost savings, resource allocation, or network optimization.

Our team utilized Tableau in creating an efficient method to analyze the transportation network and display all analyzed data in the dashboard. The primary tool created is a supplier radius map, which was incorporated into the dashboard. This map will help find cost-saving solutions to transport trucks that are not being utilized at full capacity. By selecting a specific supplier, stakeholders will be able to capitalize the usage of their trucks based on load capacity and routes taken. Results will display all other suppliers in a specific distance with weekly volumes and frequencies. The reduction in trucks delivering to the same location without full loads or near their weight capacity will result in large cost savings for ZF Group. Through identifying these inefficiencies, the data and its solutions will be presented in a visual, easy-to-read manner for all stakeholders and consumers of the dashboard.

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ZF Friedrichshafen AG
Steel Raw Material Specification Consolidation

ZF Friedrichshafen AG, is a German-headquartered company with over 200 locations and 146,000 workers in 40 different countries. Founded in 1915, ZF is a global leader in driveline, chassis and safety technology.

Our team has been tasked with finding opportunities to consolidate different steel grades used globally by the company. The complexity and variety of steel raw material requirements used by ZF Friedrichshafen has led to this need for consolidation. After the company's acquisition of TRW, requirements have become even more extensive and excessive. The main task is to analyze sets of data to determine where steel grades overlap in a variety of metrics and where opportunities for consolidation of supply exist. These consolidation efforts must not compromise the quality of the output; this will be ensured through collaboration with the engineering team at ZF.

The key metrics for quality and safety include stress capability, gauge tolerance, width tolerance and flexibility of steel. Once analysis is done and the team is prepared to suggest future consolidation possibilities, engineers will review potential changes to approve safety and quality, ensuring a consolidation decision is feasible. Further data analysis using different features in Excel will provide determinations of volume and areas for potential changes. Successful consolidation efforts will be necessary and will allow the company to order less grades in larger quantities to take advantage of economies of scale. Even though our team is unlikely to be a part of the realization of this project, we have created a pathway for the sponsor to continue with our work. Upon successful completion of this project, the results will hopefully show savings, both monetary and timing, in the form of cost reductions and simplification in purchasing.

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American Axle and Manufacturing Verifying Cost
Analysis of Tariffs

American Axle and Manufacturing is a global Tier-1 manufacturer of automobile driveline and drivetrain components and systems. Headquartered in Detroit, AAM has over 25,000 associates operating at more than 90 facilities in 17 countries around the world.

Our team was asked to help AAM realize tariff savings in their global imports to their plant in Three Rivers, Michigan, by creating a variance reporting tool to show what they are paying to import parts, as well as a "should cost" to help them determine where and how they can save.

Data from the Three Rivers plant's Plan for Every Part (PFEP) was used to create a Microsoft Excel spreadsheet. The PFEP contains the tariff number for each part and the corresponding duty rate. The duty rate is determined by the numerous and ever-changing Free Trade Agreements that the United States government forms with other nations.

The deliverable requested from American Axle and Manufacturing was an autonomous dashboard to replace their manual review processes to determine the lowest duties possible to pay for their imported parts. AAM requested that the dashboard be created with Microsoft Excel for smoother implementation.

Our team also automated a time-consuming process for American Axle's Supply Chain employees, freeing up time for them to do other value-added work for the company.

Our team, comprised of Applied Engineering Sciences and Supply Chain Management students, learned how trade agreements affect global businesses as well as received valuable experience working with a prominent automotive supplier.

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ArcelorMittal
Safe, Sustainable Steel

ArcelorMittal is the largest steel manufacturer in the world today, capable of producing 114 million tonnes of crude steel per year. During the production of this steel, harmful emissions are released into the atmosphere. As the world continues to move in a greener direction, ArcelorMittal has become more and more conscious of their carbon footprint and are exploring possibilities of how to reduce it.

ArcelorMittal's goal is to be the world's safest steel and mining company. Committed to the promise of 'transforming tomorrow,' values of sustainability, quality, and leadership guide their mission for the future. Transforming tomorrow is about understanding where society is today and how to have the biggest contribution in the years to come. This strategy is shaped and established by having a competitive edge in industry, but more so by taking society's expectations of a more circular low carbon economy.

Modern carbon capturing technologies have become more prevalent, providing ArcelorMittal more options to be able to reduce their carbon emissions. ArcelorMittal has been working with another company, LanzaTech. LanzaTech produces a microbe which feeds on carbon monoxide and carbon dioxide molecules in carbon emissions. This creates a liquid byproduct which can then be turned into ethanol fuel or plastics. Our team has conducted research on the inputs and outputs of steel production to understand exactly how their raw materials are being used and what is contained in steel-making process emissions. To help ArcelorMittal move in a more sustainable direction, a spreadsheet analysis tool was created. It can be used to decide whether implementation of LanzaTech's technology is feasible on all scales. Through this analysis and feasibility study, the team hopes to give ArcelorMittal a more sustainable and environmentally friendly future with the ultimate goal of a completely circular emission process.

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MSU Transportation Services
Driving Campus Forward!

MSU Transportation Services drives campus forward–literally. They operate a charter bus service, and they lease vehicles of all kinds to campus departments and colleges to get any job done, while making sure the vehicles are always in optimal condition, with a repair and a fueling station on campus.

Transportation Services has been looking to increase sustainability efforts for several years. They have traditionally done this by purchasing vehicles that still can accomplish whatever job is necessary while being as fuel efficient as possible. They are now looking to continue their sustainability efforts by reducing their fleet size, via a ride-sharing program.

Our team has provided recommendations through a feasibility analysis with extensive data analytics. This analysis shows the path forward to both reduce the internal long-term leases and recoup lost costs through a new delivery method. We gauged the feasibility of using a ride-sharing service, or a shareable vehicle service. Our solution includes an analysis of optimal geographical placement of shareable vehicles. Optimal placement is defined as ensuring highest mobility between departments such that the vehicle is utilized to its full potential. In addition, our recommendations include a cursory analysis of potential labor costs incurred by operating a shared ride service.

With the emissions data from MSU Transportation Services, we were able to propose a plan that will eliminate the highest emission vehicles from the long-term lease program and add the most efficient ones to the new delivery method.

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Ford Motor Company
Simplifying the FMVSS Self-Certification Process

Ford is currently one of the top leaders in the automotive industry. Ranked #2 in the United States and #5 globally, its success has continued to flourish since its establishment in 1903.

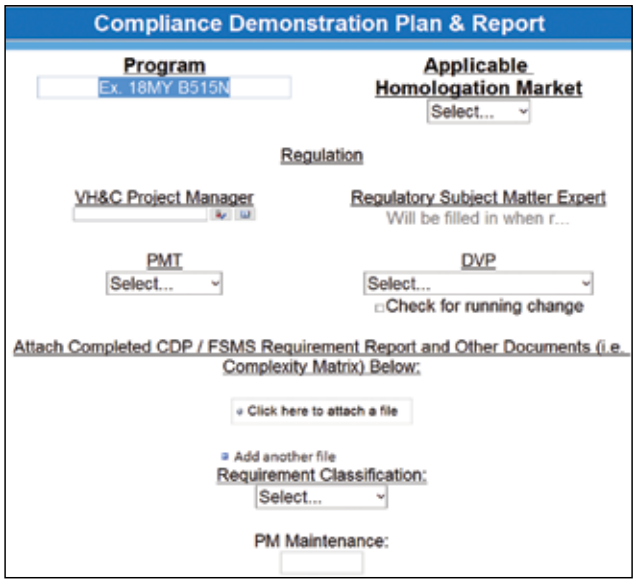
Our team has been tasked with working alongside Ford, specifically with its Vehicle Homologation & Compliance section, to create a linear self-certification process system.

In 2018, Ford manufactured over 2.5 million vehicles. Each vehicle has to go through the Federal Motor Vehicle Safety Standards, also known as the FMVSS. This process is to ensure that vehicles are safe to be put on the roads and meet all the safety standards requirements, which are signed-off by engineers and Subject Matter Experts (SMEs).

The objective of our team is to assist Ford with a vehicle's end-to-end FMVSS process. Our plan is to create a more linear process between Ford's current programs, InfoPath and Excel, that will reduce the time taken to access and collect files from different engineers and SMEs. We will also focus on removing any of the redundancies Ford has within its current process.

The process will provide an engineering "sign-off" function, a regulated specific proforma and checklist, an auto-generated status report, and an individualized task list for the Vehicle Homologation & Compliance section of Ford. We will also provide a dashboard for Ford's data, which the company uses to present in its weekly meetings, using Tableau for a cleaner and well-formatted layout.

With the knowledge that InfoPath is being phased out by Microsoft in 2026, our team hopes that the improved process will help the company carry out the FMVSS self-certification process with ease as a short-term plan.



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Ford Motor Company: Total Road Load Horsepower (TRLHP) Database Management

Since the 1990 amendments to the Clean Air Act of 1963, the automotive industry has prioritized the increasing stringent requirements of its automobiles' emissions. Failure to comply with these federal regulations could not only cost the offending company millions in recalls, but also result in hefty fines.

Our project will help Ford Motor Company streamline the effectiveness of pulling reports from its database to support calculations regarding regulation laws that require the fuel economy data of each vehicle. We will be looking at the Total Roadload Horsepower (TRLHP) Database. Working with data provided in Microsoft Excel, our team is delivering process documents and a tool to be integrated into the database by the Global Program Management team to improve data management.

Ford's current procedure to complete this process takes over an hour per coastdown test, involves redundant and manual data input within Excel, and entails the potential for numerous human errors. This inefficient, costly method is something the Ford team has been seeking to change. There is an opportunity for significant time-saving and risk reduction by automating the data flow and removing the human error and redundancy from the process. The introduction of an automated tool that can coexist with the current process documents and applications without drastically redefining the workflow of the affected stakeholders would be an ideal solution for the Global Program Management team. This tool will collect the necessary data from several other Ford-supplied documents.

The tool will be handed over to the Ford Motor Company upon completion. Our team will not be implementing the tool into the database nor doing any calculations within the documents. Mock data has been utilized in the tool as a representation of the actual coastdown data observed on the test track.

Veh Tag	VIN	PV/VP	MY	Program	Model	Model 2	Drive Config	Engine (L)	Trans	Trans Type	Tire Size	HF35 (T=1, F=-1	AWD (T=1, F=-1
123A456		PV	2018	789	Superfly		4x2	1.0L	AT	Auto	Tire USA	-1	-1

Input Vehicle Tag -->	123A456	
Input Vehicle Description (MY, ModelCode, Build level, Engine, etc.) -->	18MY Superfly 1.0L Auto 16" Tires	
Tire	Driven Axle/Total weight ratio	ETW (lbs)
Chart	0.6	3375.0
Veh DRIVEN AXLE tire	0.6	3375.0
Veh NON-DRIVEN AXLE tire	0.6	3375.0
Driven Axle Parasitic Losses (A1)	System	Trans
Chart	FWD	Auto
Veh test 1	FWD	Auto
Veh test 2	FWD	Auto
(copy test 1 if test 2 was not run)		
Non-Driven Axle Parasitic Losses (D)	System	Trans
Chart	FWD	Auto
Veh test 1	FWD	Auto
Veh test 2	FWD	Auto
(copy test 1 if test 2 was not run)		

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Creative Foam Corporation
Laser Metrology Scanning Equipment Utilization

Creative Foam is an engineering company that specializes in die-cut, formed foams and composites.

Our team worked to utilize CreaFoam 3D laser metrology scanning equipment optimally to the current business needs for innovation and development. The first and most important phase of this project is to assess the software currently used by Creative Foam and decide whether this is optimal for the CreaFoam 3D scanning equipment. To accomplish this, the team will study the particulars of the tool to determine whether the software will work well with the tool. If not, we will search for software that works better or propose a potential upgrade to the current software.

The second goal is to prepare a video and/or document with pictures that would help train employees on using the scanner.

The final goal is to use the scanner to improve a given design of a piece that Creative Foam creates and then compare the scan to a given prototype drawing in CAD.

Reaching these three goals will enable Creative Foam to have a better and more efficient way of using the CreaFoam 3D scanning equipment in future projects. If time permits, the team will determine the most efficient way of scanning materials and find the optimal scanning area that minimizes errors when scanning materials. The team will also assess changes that would need to be made for the scan to fit well with a given prototype drawing in CAD.

CREATIVE FOAM CORPORATION

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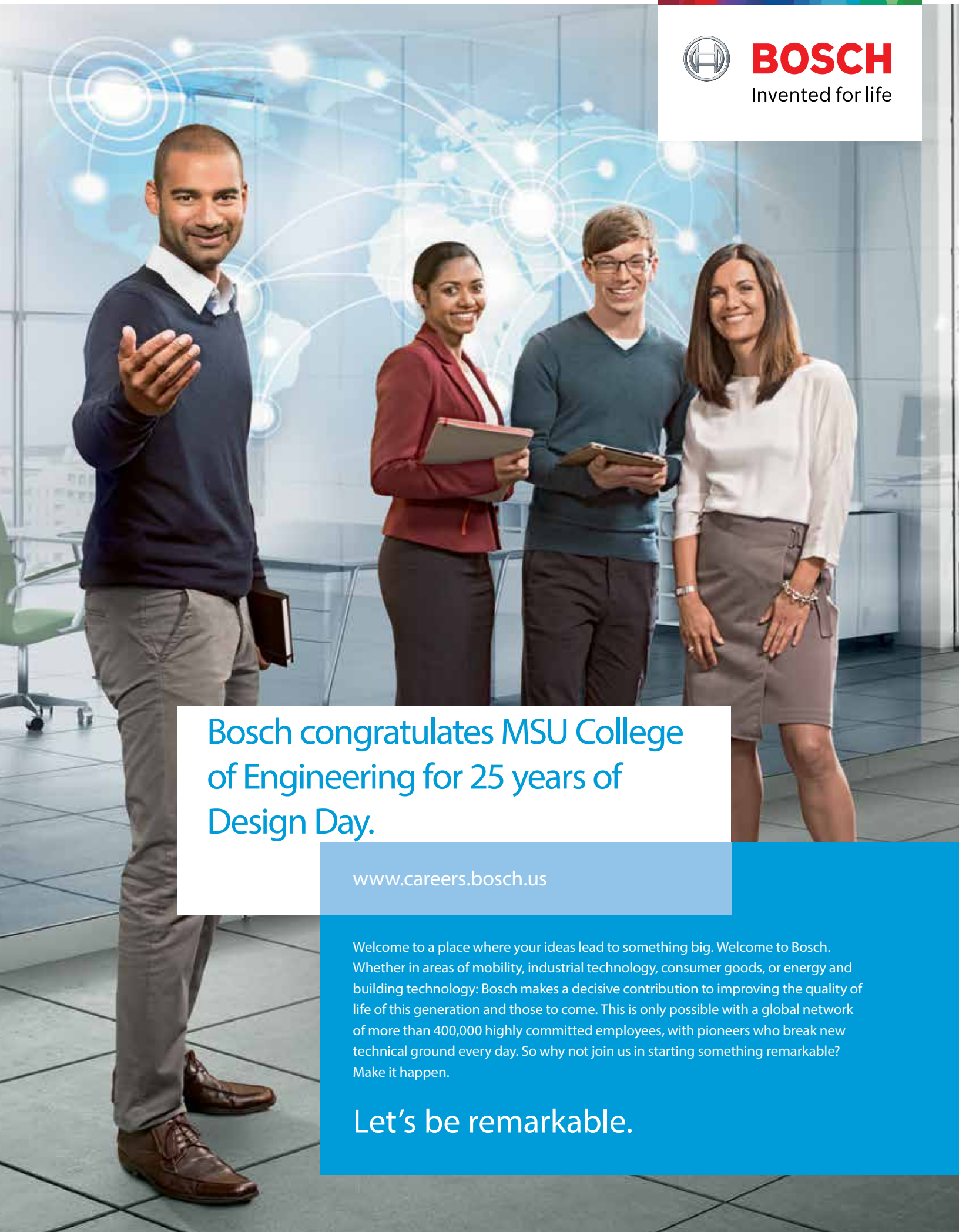

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Bosch congratulates MSU College of Engineering for 25 years of Design Day.

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Professor of Operations and Supply Chain Management
The Eli Broad Graduate School of Management

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Presentation Schedule – Engineering Building, Room 1230

Time	Team Sponsor	Project Title
7:30 a.m.	Snackwerks	Automation of Commercial Bakery
7:55 a.m.	Roberts Sinto	Barcode Integration for Inventory Visibility
8:20 a.m.	MSU MTRAC	Kent County Economic Sensitivity Study
8:45 a.m.	BP	Labor Rate Harmonization
9:10 a.m.	BP	Analyzing Incentivization in Construction Contracts
Break		
9:45 a.m.	Bosch	Implementation of Production Dashboard
10:10 a.m.	Gerdau	Long Lead Time Product Optimization
10:35 a.m.	Ingersoll Rand	Predict Regional Peak Seasons with Online Weather Forecast Data
11:00 a.m.	Ingersoll Rand	Design of a New Plant Layout
11:25 a.m.	MagPlasma	Plasma Activated BioChar Prototype

AESC Engineering Program

Since its inception, the Applied Engineering Sciences program has been successful in attracting students with diverse interests and varied backgrounds. Employers have especially responded positively to the graduates who bring a unique blend of courses and experiences to the workplace. These students have been heavily recruited by a wide range of organizations with starting salaries commensurate to those of other engineering programs.

SnackWerks of Michigan
Automation of Commercial Bakery

Snackwerks of Michigan is located in Battle Creek, Michigan and produces shelf-stable bakery food products and ingredients for branded food companies. Snackwerks' current operations include contract manufacturing of customer-branded cookies, granola/clusters, snack bites and nutrition bars.

Snackwerks is interested in spot automating within their production cycles, allowing for a smoother and safer working environment. For example, trays of product to be placed in batch ovens are typically hand-loaded and unloaded. Snackwerks currently uses the same production space and ovens for all of their baked products, which means using this space for the spot automation will improve efficiency for many of the products they make.

Implementation of automation systems, such as robots, will help Snackwerks to reduce costs, improve production rate, improve consistency and reduce worker fatigue by replacing manual labor in repetitive operations with mechanical systems. This will further allow Snackwerks to redeploy labor to more rewarding, less monotonous activities in the manufacturing environment.

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Roberts Sinto Corporation
Barcode Integration for Inventory Visibility

Roberts Sinto Corporation is a North American group of companies that focuses on providing cost-effective, technologically advanced solutions to a variety of industries. These industries include foundry, sand, bulk material handling, surface treatment and automotive markets. Roberts Sinto specializes in turnkey solutions and machinery for all industrial needs.

Currently, Roberts Sinto uses manual entry for their MRP system, which is inefficient and time-consuming. This manual entry process also makes it more difficult to track inventory as it moves through the warehouse. Conducting cycle counts and looking up locations of parts would be streamlined by implementing a barcode system such as 2D barcode, linear barcode, or Radio Frequency Identification.

The first step is learning how the Roberts Sinto warehouse operates. This leads to the creation of new work instructions for the workers as well as a process flowchart to outline the entire process from receiving an item to the time it ships out. Having a precise instructional document outlining what a worker should be doing along with a flowchart means the workers will always be on the right task.

Following the new task lists, the time studies help to reveal areas where improvements could be made with a barcode system. The barcode system allows for an easy scanning process to update the computer software with the inventory location within the warehousing process. This creates more traceability and eliminates the need to manually type it all into the computer.

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MSU MTRAC
Kent County Economic Sensitivity Study

For this project the team will be performing an economic sensitivity analysis of the process of turning plastic waste into fuel. The fuel will be created from plastic waste and the final product is a pelletized fuel substance. This process can produce two types of fuels: 1) untreated fiber-plastic pellets, and 2) thermally treated dechlorefied fiber-plastic pellets (torrefied). This process will be broken down into three main aspects of the waste-to-fuel process which the team will be analyzing.

First, the team will be analyzing the source from which the plastic waste and fiber will be obtained. For this project the team will be specifically looking at landfills and recycling centers within a radius surrounding Kent County.

Next, the team will be identifying potential users of the fuel. The team will be focusing on medium sized power plants, cement factories, farms, and any other small to medium sized operations that require a source of fuel to burn for energy. As a result, transportation costs will then be estimated for the distance from Kent County Sustainability as well as other locations.

Last, with this information, analysis will be performed on the financial feasibility of building a waste-to-pellet fuel plant in the Kent County Sustainable Business Park in comparison to other locations. In doing so, the team will be finding the cost of the entire process of creating pelletized fuel from plastic waste and fiber including, but not limited to, the material, transportation and processing costs involved. The cost of the torrefacted and non-torrefacted processes will then be compared to that of other fuel processes, such as coal and gas. The final proposal will be handed over to Kent County Sustainability Group for their use.

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BP
Labor Rate Harmonization

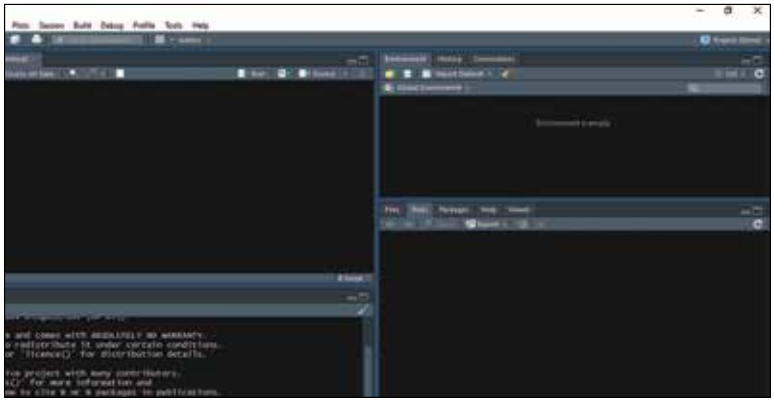
BP is a British oil and gas company based in London, England. It is a vertically integrated organization that deals directly with all operations regarding oil and gas, including hydrocarbon exploration, production, and distribution.

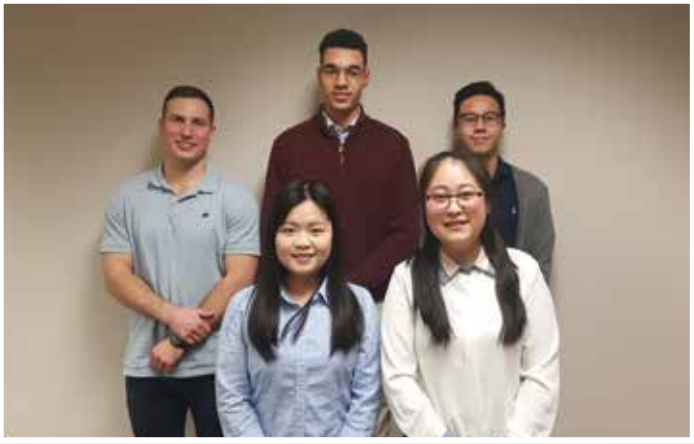
With operations in 70 countries and roughly 74,000 employees, BP ranks amongst the top ten of Fortune 500 companies in the world. Inefficiencies within the supply chains of the oil and gas industry can no longer be masked by strong oil prices, as they were in the past. An efficient supply chain is crucial in the modern business field.

Over half of the hours worked by BP are performed by contractors. This tool was developed to simplify and standardize labor rates of contractors relating to maintenance within the Upstream sector of the Gulf of Mexico region.

This tool takes the internal labor data provided by BP and compares it to the most up-to-date industry average wages for each job category. Using regression analysis methods, it extrapolates a simplified rate structure for each specific subcategory of labor. This will allow BP to have a standardized and transparent view of their rates, thus reducing costs related to contracting and hiring, as well as simplifying the labor sourcing process.

The implementation of this tool will greatly reduce the time required to analyze and select contracting options for maintenance labor by minimizing the complexity of the process. This time reduction combined with a lower assigned labor rate due to the standardization of the tool, will result in a monetary savings for BP.





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BP
Analyzing Incentivization in Construction Contracts

BP is known around the world as an industry leader in the oil and gas industry. In order to gain and maintain their standing in the industry, the development of infrastructure that processes and transforms the materials our world runs on is imperative. In turn, a significant arm of BP's global operations lies in the construction industry.

BP invests significant financial resources towards construction projects around the world on a yearly basis. In order to get the most return value on each of these projects, it is in their best interest to determine the effects of the incentives they use in the contracts they award to their suppliers. Different aspects of the projects they undertake can be affected by the different incentives used in the contracts. The incentives used can have an effect on how well the supplier does in delivering what is outlined in the contract.

As a result, one of the project's main goals is to develop a tool or methodology that will help BP determine the effectiveness of incentivization on future construction projects. This is done using a weighted analysis of different factors that go into the contracts themselves in coordination with multiple regression analysis. These factors include completion time, management, and cost. The developed framework will take into account supplier-risk analysis to help determine the best route forward regarding individual construction projects.

Major themes driving the project include data analysis, supplier risk analysis, and analytical framework methodologies. Data analysis is limited to historical industry data, specific to the oil and construction industries.

In turn, this tool will be utilized in the selection of suppliers for construction contracts around the world and help predict the effectiveness of incentivization in the awarding of contracts. The tool is developed in Excel and incorporates multiple regression analysis and includes aspects of the Analytical Hierarchy Process.

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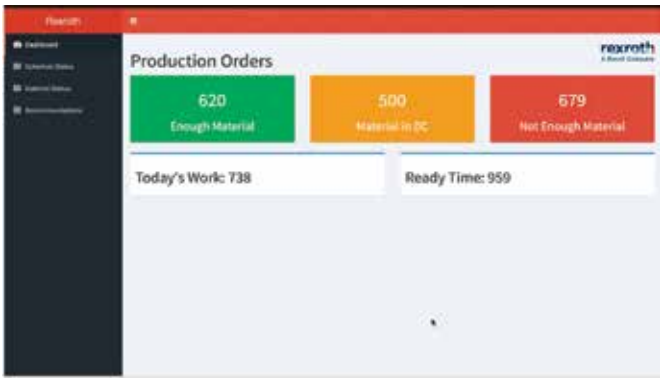
Bosch Rexroth
Implementation of Production Dashboard

Founded more than 200 years ago, Bosch Rexroth has been one of the leading specialists in the field of drive and control technologies, employing over 33,100 people worldwide and reaching approximately $6.25 billion in sales yearly. With Bosch Rexroth's passion for becoming an Industry 4.0 leader, Rexroth has tasked our team with devising a production dashboard to create material visibility for the Industrial Controls Multi-Product line. For the purpose of this project, we focused on one of Rexroth's Industrial Hydraulics production plants located in Bethlehem, Pennsylvania.

Our team designed a production dashboard that streamlines production orders and their status by providing a convenient and efficient way to analyze, summarize, and display data from the production orders and material inventory at a single glance. This includes various visual representations of the data that provide insight into inefficiencies within the production line. The overall goal of the dashboard is to eliminate production deviations due to lack of material visibility.

The dashboard provides high-level metrics so that the user can determine the status of production for any given day. It can also assist the planners and pickers in visualizing the status of materials on-hand and materials still needed for production orders. An embedded algorithm is incorporated that recommends the best sequence of production based on material needs, date, and priority. This provides clarity so that the user can make better production decisions, ultimately increasing work efficiency.

The dashboard is delivered in the form of a web-based application utilizing Shiny, RStudio, and Python, that includes a homepage and three pages with the following content: Schedule Status, Material Status and Recommendations. The final automated solution is designed in such a way that additional features can be built in later.



rexroth
A Bosch Company

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Gerdau
Long Lead-Time Product Optimization

Gerdau is a leading company in the production of long steel in the Americas. With an installed capacity of 26 million metric tons of steel annually, Gerdau is among the major worldwide suppliers of special long steel for the automotive industry but also controls a large share of the Gun Barrel Specialty Steel market. Although gun barrel only accounts for approximately 1% of total shipments annually, due to its high visibility and Gerdau's unique casting process, it currently serves as an untapped market for potential profit.

In any special bar steel market with significant demand, there are a multitude of constraints that can impact delivery performance. The main objective of this project was to find the location of those constraints and bottlenecks in gun barrel production. In order to complete this objective, three deliverables were agreed upon between our team and the company: a process map, a production scorecard, and a monitoring dashboard.

A swim lane diagram was used to map the process flow for the highest volume products. A scorecard was designed in Microsoft Excel to track the production progress and create a relative comparison between the current On-Time In Full (OTIF) percentage and the goal OTIF percentage. Tableau was used to create a dashboard in order to monitor delivery metrics for specific customers and time ranges. The ARENA Simulation tool was also utilized as it allowed our team to take the process map and run trial simulations in order to showcase where potential bottlenecks could be occurring. The data were restricted to solely focus on pre-recorded data from the melt shop to testing and the top 30% of volume. Cost analysis, products other than gun barrel, and the causes of delay were out of the scope of the project.

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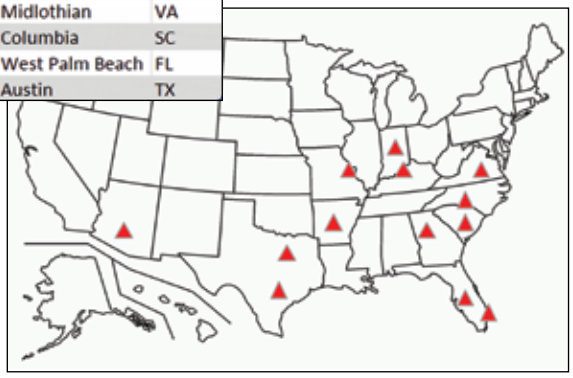
Ingersoll Rand: Predict Regional Peak Seasons With Online Weather Forecast Data

Ingersoll Rand is a global industrial manufacturing company founded in 1905. Its Global Headquarters is located in Dublin, Ireland. The company is built on its Irish-American roots, and contains several divisions including: Club Car, Ingersoll Rand (Industrial Equipment), ThermoKing, and Trane.

Our team was tasked to support Trane HVAC product lines by effectively predicting the start and end of peak seasons for 5 product families in 13 regions around the United States. This will minimize service drops, by gaining customer appreciation and increased sales around the US. The project focuses on the top selling, and high velocity items of air handlers, coils, furnaces, package units, and splits.

Using previous years' sales data from each region, it was determined there was a correlation between sales and temperature. By relating the increase in temperature to the increase in sales for the given units, the region's peak season lies within it. It is commonly known when it is hot outside, people are likely to turn on their A/C units. This is when customers may realize their units are not functioning properly, resulting in a high influx of sales. If the peak season can be predicted prior to when this occurs, planners will then be able to ensure that enough inventory is shipped to the Dealer Sellers Offices (DSOs) to minimize loss of sales.

DSO Region	City	State
ARIZONA	Phoenix	AZ
DALLAS	Dallas	TX
GEORGIA	Duluth	GA
HEARTLAND	St. Louis	MO
KY - TENN	Louisville	KY
MID-SOUTH	Little Rock	AR
MIDWEST	Indianapolis	IN
NORTH CAROLINA	Charlotte	NC
NORTH FLORIDA	Lakeland	FL
RICHMOND	Midlothian	VA
SOUTH CAROLINA	Columbia	SC
SOUTH FLORIDA	West Palm Beach	FL
SOUTH TEXAS	Austin	TX



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Ingersoll Rand
Design of a New Plant Layout

Ingersoll Rand is a worldwide industrial manufacturing company that produces a wide variety of products. Their plant in Madison Heights, Michigan manufactures jib cranes and Zimmerman rails.

Our team was tasked to support the Zimmerman Rails manufacturing plant. The goals of the project are to reduce the time it takes to manufacture each beam from start to finish by better utilizing floor space in the plant, enhance safety protocols to mitigate accidents, create a process workflow and organize incoming and outgoing inventory.

The raw materials for Zimmerman rails and jib cranes are steel and aluminum beams ranging from 14 to 30 feet in length. The steel beams are imported from India and the aluminum beams are ordered domestically. The international orders have long lead times of about three months and, because of this, the shipments are very large. The shipments generally contain enough inventory for about six months of orders. Due to the length and weight of the beams, unorganized storage space, and an imbalance of worker responsibility, the manufacturing and receiving processes are not at optimal efficiency.

A new plant layout will also be implemented to ensure efficient storage of the beams. Overall, the workflow process will be enhanced, allowing Ingersoll Rand to produce their product more efficiently.

Ingersoll Rand
Inspiring Progress™

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MagPlasma
Plasma Activated BioChar Prototype

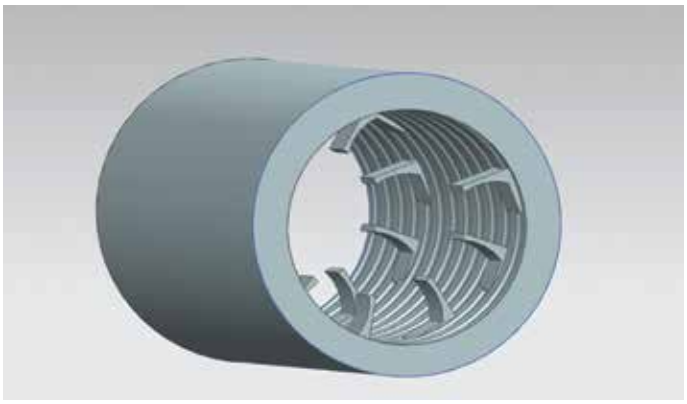
MagPlasma was started in order to apply the latest advances in technology to commercial markets.

Our team was tasked with the improvement and design of a biochar filter component to be used for water treatment. Once the biochar is created, it is treated with plasma to make the surface of the biochar more porous. Activation also increases the surface area of the biochar, allowing for water to flow through the material in order to be treated. Additionally, the porousness of the activated biochar allows for the filtration of extremely small substances that otherwise could not be filtered using traditional methods.

The advantage of activated biochar is that it can reduce the energy needed for the water desalination process. The biochar can be activated in minutes by continuously running the material through the plasma. In order to do this, a rotating filter is used.

The filter component is a hollow cylinder threaded along the inside. The threads are outfitted with L-shaped extrusions spiraling throughout. The extrusions scoop biochar and drop it through the plasma as the cylinder rotates. The material is moved through the entire cylinder in under 10 minutes using a motor that rotates the apparatus. By threading the inside and staggering the extrusions, biochar can move from one end to the other through the rotation alone. The component will be made of a stainless steel or aluminum.

The moving system will allow larger amounts of biochar to be activated without stop. The part is simple enough that it can be scaled up easily, making larger industrial applications feasible in the future.



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technology services group

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Presentation Schedule – Engineering Building, Room 1234

Time	Team Sponsor	Project Title
7:30 a.m.	MSU IPF	Improvement of Recycling Processes
7:55 a.m.	MSU IPF	IPF Fleet Optimization
8:20 a.m.	MSU BCM	Market Study for Lumber Salvaging Device
8:45 a.m.	John Deere	Achieving Excellence Program
9:10 a.m.	John Deere	Tillage Bundling Optimization
Break		
9:45 a.m.	NASA/ASU	NASA Psyche Mission: Send Your Name to Psyche
10:10 a.m.	Asahi Kasei Plastics	Predictive Modeling of Cashflow
10:35 a.m.	Ellison Brewery	Sustainable and Efficient Brewery
11:00 a.m.	BorgWarner	Variable Cam Timing Green Machining

Applied Engineering Sciences Awards

Applied Engineering Sciences Design Program presents three awards on Design Day. The Most Impactful Award is given to the team whose project will potentially have the most immediate impact on their sponsor. The team whose project will produce the most sustainable results for their sponsor receives The Most Sustainable Award. Finally, The Mike Sadler Competitive Edge Award is given to the 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.

MSU IPF: Materials & Logistics Department
Improvement of Recycling Processes

The Materials & Logistics Department within Michigan State University's Infrastructure & Planning Facilities is responsible for procuring, stocking, and delivering tools, materials, and equipment for direct support of Maintenance Services. They are continually working to improve their sustainability efforts throughout campus and at their facility.

This project is focused on evaluating the different recycling processes that are currently in place throughout the department. The team is responsible for identifying potential issues in the cardboard, aerosol can, propane tank, battery, mixed paper and plastic recycling processes. Our team researched sustainable ways of reducing waste and improving the flow of materials throughout the department. Suggestions for improvements and identification of potential issues on the several different recycling processes are given to Michigan State's IPF management. This will increase the amount of materials recycled from the facility and help improve their sustainability efforts based on the results obtained from this project.

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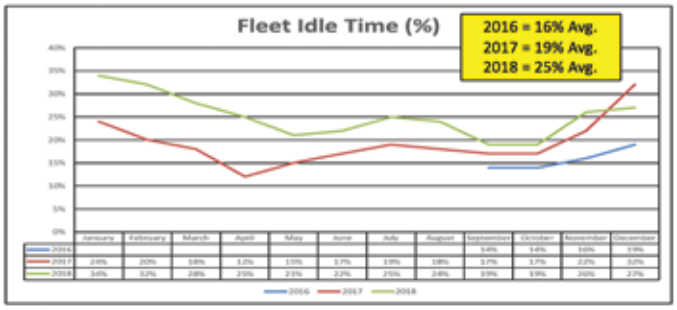
MSU IPF: Materials & Logistics Department
IPF Fleet Optimization

Michigan State Infrastructure Planning and Facilities (IPF) plans, builds and maintains the physical environment for the university. This includes managing over 179 vehicles used by 19 trades such as HVAC, plumbing, and electrical that maintain MSU's facilities. Due to the growth of the university and technological advancement, there has been an increased demand for IPF vehicles and requests for additional vehicles to be added to the fleet. However, IPF's utilization data does not support the additional purchases, and over the last three years IPF's fleet efficiency has decreased as a result of the challenging environment.

The goal of the project is to improve IPF's fleet efficiency, reducing carbon footprint and minimizing costs. In order to do so, the team analyzed fleet data metrics such as idle time, utilization rate, geofencing, fuel economy, and carbon emissions. Using these metrics along with interviews conducted with department supervisors to conceptualize the data, each department was ranked anonymously and given corresponding efficiency scores. Our team used the optimization technique of data envelopment analysis to generate efficiency scores based on 12-month historical data.

Leveraging this data, IPF was provided a report summarizing the current state of fleet operations, highlighting potential areas for improvement, and providing recommendations corresponding to each metric analyzed. The report includes statistical and social analysis, standard operating procedures, and tools to assist IPF in reaching sustainability goals.



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MSU Business Construction Management
Market Study for Lumber Salvaging Device

Michigan is home to approximately 225,000 abandoned homes and thousands of abandoned commercial buildings. Within these buildings, there are approximately 903,784,000 board feet of salvageable lumber. Nationally, there are 5.43 million abandoned homes. In the US, there are over 23 billion board feet of salvageable lumber, which is equivalent to over 32 million trees. Often, the cost to prepare and reuse salvageable lumber is greater than its market value. This leads to approximately 14.5 million tons of wood going into landfills each year, which is more than the amount of timber harvested from national forests each year. With rising dumping fees, deforestation and pressure for future sustainability, this is a major opportunity to reduce landfill waste.

Our team is seeking to develop a time- and cost-efficient solution to salvaging lumber during deconstruction by creating a device that could expedite the process. The project focuses on creating a robust market study for the economic viability of such a device. The goal of the project is to form a market study that identifies improvement opportunities within the process of reclaiming wood in order to gain a deep understanding of the market potential and what features the proposed device should be able to accomplish. A key objective in this process includes researching alternative non-destructive processes for reclaiming wood. Another objective is to investigate current and future economic, legal and political variables such as the cost of cutting down virgin lumber, landfill price fluctuations, and trade tariffs. Upon completion of these objectives, the team will be able to delineate where and when this device will be most effective.

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John Deere
Achieving Excellence Program

John Deere is a Fortune 500 company that manufactures agricultural, construction, and forestry machinery, as well as other products. With such a vast range of products, John Deere relies heavily on their suppliers' performance. To ensure the necessary parts for each product are on time and at the right quality, John Deere utilizes their supplier performance program known as Achieving Excellence (AE). AE has been in place for over 20 years and has been a critical tool for building strong supplier relationships. This program allows John Deere to work with their suppliers to improve their performance in key categories such as delivery and quality. This project focuses on the delivery component of AE, which has the greatest opportunity for improvement.

Our team performed an assessment of the current John Deere AE program. Working with the AE team, we focused on measuring performance of suppliers through the delivery segment of the AE program. Our team analyzed past data and produced a proposal to accurately rank suppliers based on specific chosen metrics. These metrics were modeled through a point rating system. The proposal allows suppliers to strive for continuous improvement which will enable John Deere to work with the best suppliers available.

For the first deliverable we utilized software, such as Microsoft Excel and R, to perform analysis of the data. For this project, our team focused on John Deere's global suppliers that supply the direct materials for all product lines. Using software, we built a quartile system for the delivery parts per million of these suppliers. Delivery is historically a subjective ranking system, so using more data can make this process objective. This will give suppliers more feedback to see how they compare to their peers. This deliverable will be presented in Tableau.

The second deliverable was a stretch goal that includes doing an impact assessment for deliveries by these same domestic suppliers. Our team looked at deliveries by these suppliers and assessed how an early or late delivery affects the manufacturing line and ultimately the final product.

John Deere relies heavily on strong relationships with the best suppliers in the industry. Upon completion, our goal is to help improve the already successful AE program and create better feedback between John Deere and its suppliers.

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John Deere
Tillage Bundling Optimization

John Deere is an American corporation that has made an impact on revolutionizing agriculture with its technology in farming equipment. One of the main product lines within its agriculture division is tillage machinery. Tillage is the preparation of soil by digging, stirring, and overturning, with an aim to ready the soil for the growth of crops.

Although John Deere is a giant within the agricultural world, there is always competition from rival products. Both John Deere and their competitors send pieces of their products to a dealership. The dealership is then responsible for finishing the assembly of both John Deere's and the competitor's products at the same location.

Final assembly of John Deere tillage equipment is a top inconvenience for dealerships with John Deere products. Dealerships have stated that the total assembly time for tillage equipment is much higher than the projected time provided by the factories and the competitors' average assembly time. When the final assembly takes longer than expected, several issues and risks may occur. A few of these risks include the dealers' profit margin may decrease, dealer resources may be in conflict, and customer delivery dates may be missed.

John Deere asked our team to analyze the current processes and create a solution that streamlines the assembly process. The solution included optimizing the pre-delivery instructions as well as improving the bundling of materials. In addition, we provided a value stream map to John Deere that focused on the cost of bundling. Lastly, they led a leadership workshop that illustrated the benefits of switching from the current process to the proposed solution. Overall, the potential benefits of the proposed solutions are reducing waste, cost, and most importantly, strengthening relationships with their dealerships.

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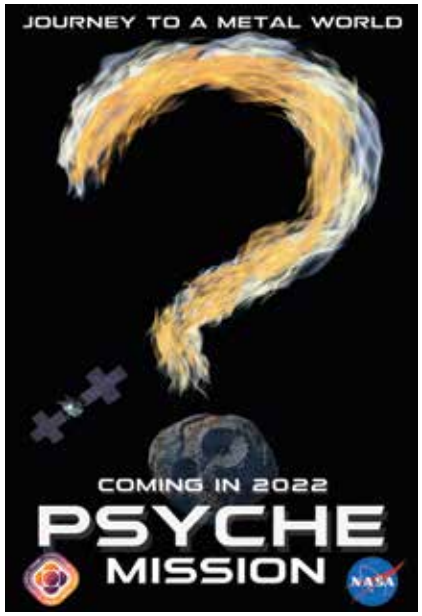
NASA/Arizona State University
NASA Psyche Mission: Send Your Name to Psyche

NASA is launching a global campaign called "Send Your Name to Psyche" to engage the public in their mission to explore an all-metal asteroid called Psyche. NASA, in partnership with Arizona State University (ASU), aims to excite the public throughout the Psyche mission timeline, while ensuring that all mission phases are carried out successfully. The "Send Your Name to Psyche" campaign is important for the mission as a means involving the public. The campaign allows the public to register their name for implementation onto a microchip being sent with the spacecraft. Hence, the campaign is titled "Send Your Name." There are numerous capstone teams from different universities involved in a project of this size and scope, which makes our team's final product part of a larger whole.

Our team has focused on developing a tangible, modeled concept of the frontend user experience for the campaign website, from the point of user name submission to the point of mission completion. We have administered surveys to collect data on preferences regarding website design and security options from the general public. Data collected has been analyzed using statistical tools and presented to the team's sponsor as consideration for further campaign development. The final deliverable is a recommended outline of the user interface based on the quantitative data collected. In conjunction with the outline, our team is providing a high-level guide that will address potential threats and technical issues that could arise on the backend of the website. With our recommendations, NASA and ASU, along with other capstone projects, can continue to advance and finalize the phases of the "Send Your Name to Psyche" campaign.



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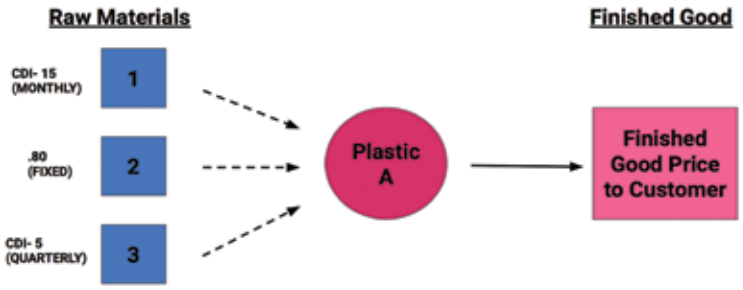
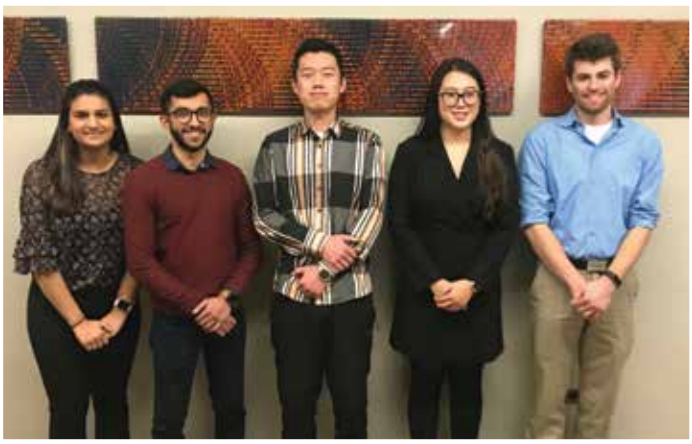
Asahi Kasei Plastics North America
Predictive Modeling of Cashflow

Asahi Kasei Plastics North America, headquartered in Fowlerville, Michigan, is a chemical company that manufactures plastic compounds. It produces plastic for customers in a variety of industries including, but not limited to, automotive, electrical, and housing. In manufacturing plastic, there are various raw materials that go into each type of plastic. Many of these raw materials are in markets that are constantly changing and can be very unpredictable. Operating in these fluctuating markets makes it difficult to predict future net income. Asahi Kasei is working to create a predictive model to anticipate its cashflow impact based on these changing feedstock markets. Because Asahi has contracts with its raw material suppliers and customers based on market indices, being able to understand how these indices have been changing will help anticipate what will happen in the months to come. Not having this visibility can impact the company's ability to hit cash targets and, in turn, reduce shareholder value.

Asahi Kasei Plastics desires to have a model in place that will visually show the impact of these changing markets on its cost of goods sold, gross profit, and net income. Building such a model requires a deep dive into Asahi's raw material and finished material purchase agreements. Being able to see the changing market indices from the past month, quarter, year, etc. will help strategically plan contract negotiations and determine what factors might be causing these upward or downward trends in the market and Asahi's net income.



AsahiKASEI
ASAHI KASEI PLASTICS NORTH AMERICA



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Ellison Brewery + Spirits
Sustainable and Efficient Brewery

Ellison Brewery + Spirits is a microbrewery based in East Lansing, Michigan. Sustainability and efficiency are two target areas for improvement at Ellison. The recycling and reuse of spent grain present an opportunity for such value addition. Spent grain is a type of waste resulting from the beer brewing process after all the desired flavor and ingredients have been harvested from fresh grain. Two opportunities that arise from reusing spent grain lie in converting spent grain into a material similar to recycled cardboard and the creation of 100% edible feed for livestock.

The first option entails milling and pressing the spent grain into a usable cardboard-type material in the form of plates, multi-pack cases and even straws. This would not only be sustainable by recycling the leftover waste after the brewing process, but it would also provide tangible objects that Ellison could potentially use in their day-to-day operations. With the help of the School of Packaging at MSU, our team will be able to utilize lab space and equipment to perform trials and create cardboard out of the spent grain on a small scale.

Another option for Ellison to reuse the spent grain is turning it into an edible product for livestock. The treatment of spent grain would turn it into readily available feed which presents an opportunity to generate revenue by selling the repurposed waste. The treated spent grain could not only be used for livestock, but it could also be used for making bread, dog treats and more.

The main goal of our team is to provide a complete solution that Ellison Brewery + Spirits would be able to implement into their daily operations.

Ellison
BREWERY + SPIRITS
EAST LANSING, MI

Michigan State University
Team Members (left to right)

Kyle Valden
Milford, Michigan

Lizzie Finazzo
Grosse Ile, Michigan

Alex Wrighton
Lake Orion, Michigan

Noah Lindlbauer
Canton, Michigan

Ellison Brewery
Project Sponsor

Aaron Hanson
Howell, Michigan

Teaching Assistant

Lilya Kalyenich

BorgWarner
Variable Cam Timing Green Machining

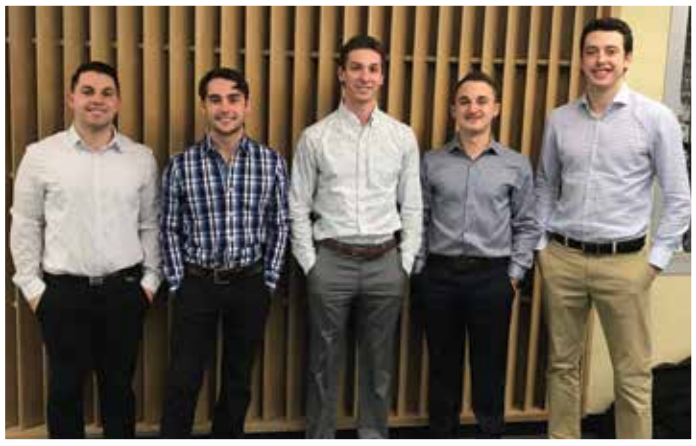
BorgWarner Inc. is a global leader in clean and efficient technology solutions for combustion, hybrid, and electric vehicles.

Our team was tasked with analyzing the current processes employed in the production of BorgWarner's powder metal rotors used in their variable cam timing applications. Our focus was to develop a plan to improve the processes used by reducing cost and cycle time through the implementation of green machining.

Green machining is an alternative method of manufacturing powder metal. It involves post-machining the powder metal component while it is in the 'green state.' Machining parts prior to sintering can greatly extend tool life, which can have great cost benefits as well as reduce cycle time.

BorgWarner provided our team with all of the necessary technical information to complete this project. We were provided with rotors, rotor blanks, 'green state blanks,' CAD models, engineering prints, and a cost model. Along with the technical tools to complete the project, we maintained a constant open line of communication with some field experts internally in BorgWarner.

Using the resources available, we were to develop a plan through research, analysis, and innovation. The plan would detail specific actions that would improve BorgWarner's current rotor manufacturing method. These suggested activities were executed with the overall goal in mind, which was to find a low-cost approach to machining that improves market competitiveness and helps expand BorgWarner's global supply footprint.



Michigan State University
Team Members (left to right)

Tony Zanatian
Buffalo, New York

Matt Burns
Grosse Pointe Shores, Michigan

Austin May
Walled Lake, Michigan

Kyle Young
St. Clair Shores, Michigan

Joe McConachie
Troy, Michigan

BorgWarner
Project Sponsors

Shank Kolhatkar
Ithaca, New York

Chris Mickiewicz
Troy, Michigan

Jay Stearns
Ithaca, New York

Teaching Assistant

Abhinav Iyer

AESC Awards 2018

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 AESC 2018 Most Impactful Award:

Team Ingersoll Rand
"Retail-Distribution Market Network Optimization"

Left to right: Chris Rinaldi, Sweet Hou, Maureen Conway, LaToya Smith, Walt Thomas, Milena Montalbano, Austin Latack, Drew Antonelli. Presented by AESC Director Laura Genik

The AESC 2018 Most Sustainable Award:

Team ArcelorMittal
" 'Beached' Iron Decision-Making Model"

Left to right: Josh Chartier, Michael Hamilton, Saisha Johnson, Samuel Morris, Shayna Evans, Patrick Kuiper, Colin White, Joe White. Presented by Holly Aikens, President of AESC Alumni Board

AESC Awards 2018

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.

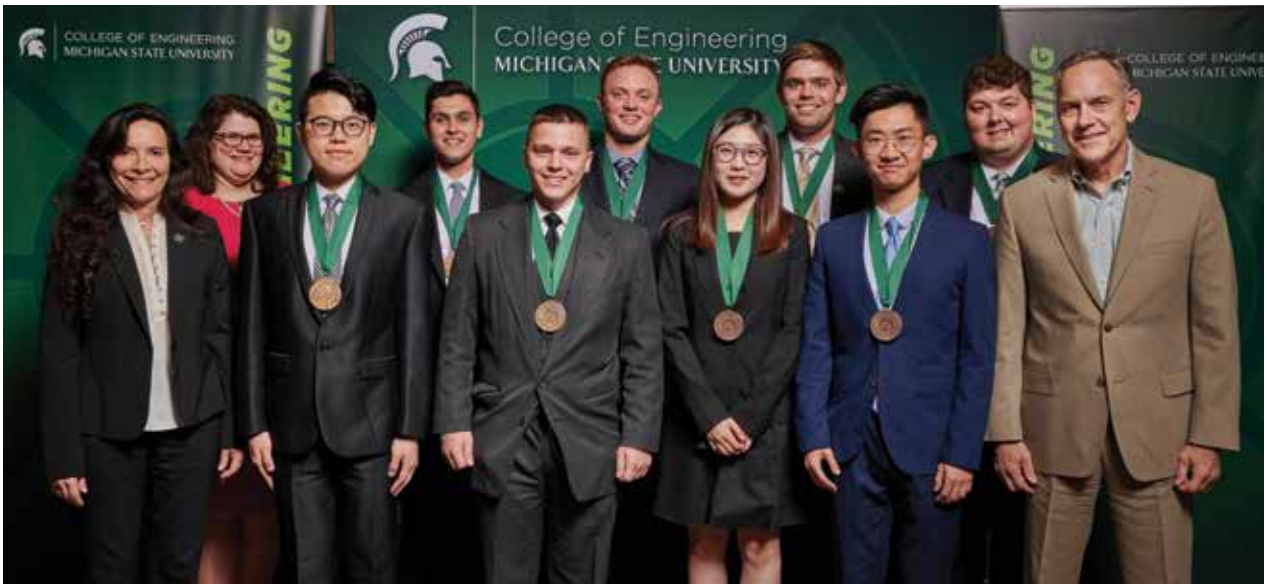
Mike was the first football player in Spartan history to earn Academic All-America honors four times. He was a two-time first-team Academic All-American, a National Football Foundation Scholar-Athlete, and a William V. Campbell trophy finalist.

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 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 worldy sense of systems thinking."

- Mike Sadler



AESC 2018 Mike Sadler Competitive Edge Award:

Team MSU Sustainability "Innovation for Efficiency – Library Lighting System"

Left to right: Hao Chen, Charlie Morgan, Paul Rankin, Tim Els, Detong Che, Patrick Donovan, Zixuan (Eddie) Zhang, Joe Backlas

Presented by Karen Sadler, Mark Dantonio, and AESC Director Laura Genik

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

2018/19 Projects

Improving Potato Storage Ventilation with a Computational Fluid Dynamics Model

Team Name – Super Modelers
Sponsor – Techmark, Inc
Faculty Advisor – Dr. Wei Liao, PE

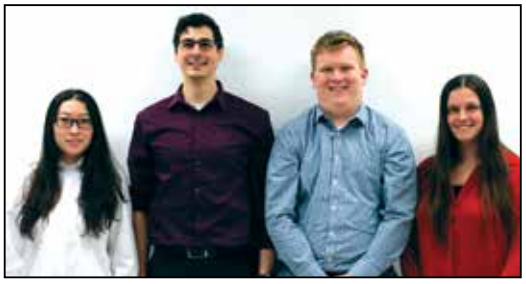
Super Modelers developed a computational fluid dynamics (CFD) model to study airflow characteristics in Techmark's Riverdale potato storage facility. This model was used to identify the cause of non-uniform aeration to the facility's potato pile, and recommend improvements to the air distribution systems. Uniform airflow to the potatoes is critical to ensure optimal temperature and humidity during storage. Upon completion of this project, Techmark will have an airflow model they can apply to future storage facility design work, and design recommendations supported by the model.

(L to R) Samuel Effa, Christopher Robbe, Jacob Duckworth & Jessica Schultz

Red Swamp Crayfish Control Plan Using Acoustic Stimuli

Team Name – Invasive Crustacean Eradication
Sponsor – Michigan Department of Natural Resources
Faculty Advisor – Dr. Wei Liao, PE

An infestation of Red Swamp Crayfish (*Procambarus clarkii*) was reported in 2015 in southeast Michigan. The invasive species has since spread. Invasive Crustacean Eradication was tasked to find an engineering solution to contribute to the MDNR's population control plan. Auditory stimuli were found to influence crayfish motility through experimental trials. Pure tones, white noise, and pink noise were tested to determine the most effective stimuli. A trap was retrofitted to utilize a sound system resulting in increased trapping rates.



(L to R) Xiaojing Ma, Douglas Clements, Henry Frost & Megan Beaver

Manufacturing Chiller Operation Optimization

Team Name – Energy Efficienados
Sponsor – Perrigo (project under NDA agreement)
Faculty Advisors – Mr. Aluel Go and Dr. Truman Surbrook

The Energy Efficienados partnered with Perrigo's Plant 4, a pharmaceutical manufacturing facility in Allegan, Michigan. The team was tasked with developing a chiller staging scheme in hopes of reducing the plant's energy consumption and environmental footprint in conjunction with the corporate goal of reducing greenhouse gas emissions, water and energy usage by 15% in 2020. The team utilized a variety of tools such as MatLab and Excel to develop the chiller staging scheme. The staging scheme takes advantage of higher chiller efficiency at partial load as compared with full load and ensures chillers are operated in a manner that leads to reliability and a long life.

(L to R) Matthew Schweiss, Brittany Esser, Karoline Russek & Seung Lee

Brown Kernel Rot Treatment System for Post-harvest Chestnuts

Team Name – The Rot Roasters
Sponsor – Chestnut Growers, Inc.
Faculty Advisor – Dr. Dan Guyer

In the chestnut industry, emerging pathogens that cause nut rot are becoming a problem. The Rot Roasters designed a continuous-flow heat treatment system to reduce the incidence of one specific pathogen, *Gnomoniopsis Castaneae*, which causes brown kernel rot. The team performed an experimental study to validate the treatment efficacy and designed a 5,000 lb/hr throughput hot water blanching system. This system will reduce the growth of rot during cold storage, maintaining the quality of Chestnut Growers, Inc.'s fresh chestnut product.

(L to R) Matt Kay, Brigit Culkeen, Brandon Dulaney & Rebecca Jones

Trommel Cleaning System Enhancement

Team Name – Trommel Cleaners
Sponsor – Grobbel's
Faculty Advisor – Dr. Susie Liu

Clean processing equipment is critical in the food industry to ensure a safe, quality product to the consumer. Large industrial sized trommels are essential for corned beef production; however, they are labor-intensive to clean. To reduce cost and improve ergonomics, it is essential that Grobbel's cleaning process is fast, efficient, and effective. Trommel Cleaners was tasked with enhancing the trommel cleaning system to reduce the resources required for cleaning. With the team's design, yearly operating costs for trommel cleaning are reduced by over 30%.

(L to R) Chris Rybinski, Kyle Forbush, Kennedy Coxon & Jack Blackhurst

Sediment Management to Support Boat Traffic

Team Name – The Canal Pals
Sponsor – Grand Pointe Homeowner's Association
Faculty Advisor – Dr. Ehsan Ghane

The Grand Pointe Subdivision in Dimondale, Michigan consists of 87 homes, surrounding 5 man-made canals. Sediment build-up in the canals has restricted access of large boats to the Grand River through the canal entrances. The Canal Pals were tasked with finding a long-term solution for reducing the rate of sediment accumulation in the canals. The team designed a sediment trap as a local solution and recommended agricultural Best Management Practices as upstream solutions to reduce sediment load depositing in the canals.

(L to R) Sarah Skinner, Lindsey Defrain, Elizabeth Walls & Tyler Lahusky

Sandwich Cookie Process Line Design Improvement

Team Name – Ernie's Engineers
Sponsor – Kellogg (project under NDA agreement)
Faculty Advisors – Dr. Ilce Medina Meza & Dr. Kirk Dolan

Kellogg's production of sandwich-style cookies and crackers is the cause of significant downtime and lost product resulting in economic loss. Ernie's Engineers examined the process line to determine the areas of highest product loss. The design improvement recommendations, based on this data collection, will enhance the system with upgraded technology while maintaining production rates and complying with food safety regulations.

(L to R) Craig Campbell, Nicole Urrea, Linnea Riddell & Katie Church

Adsorption Media Contact System for Michigan Winery Wastewater Treatment

Team Name – Partners in Wine
Sponsor – Michigan Craft Beverage Council
Faculty Advisor – Dr. Steve Safferman, PE

Michigan winery wastewater has high concentrations of ammonia and soluble phosphorus. Treatment of this wastewater prior to discharge is required to meet state regulations defined under Rule 22, Groundwater Quality. Traditional treatment approaches for winery wastewater are often land intensive. Partners in Wine designed additions and modifications to a gravel vertical flow contactor to achieve regulatory treatment levels of ammonia and soluble phosphorus in winery wastewater for facilities producing between 5,000 and 25,000 cases per year. The final design was a compact constructed wetland system that reduces land required for treatment by 80% when compared to common land application methods.

(L to R) Thiramet Sotthiyapai, Jessica Hauda, Katelyn Skornia & Corrine Zeeff

Master Plan for Red Cedar Weir Removal

Team Name – Get Out Of Weir
Sponsor – GEI Consultants
Faculty Advisor – Dr. Steve Safferman, PE

MSU is interested in preparing a master plan for the restoration of the Red Cedar River. As part of the preparation, "Get Out Of Weir" developed a plan for the weir located south of the Administration Building. The recommended design improves the environmental quality and diversity of the river, decreases the chances of flooding, protects threatened species, and opens the river for recreational enjoyment. The final design replaces the weir with rock arch rapids. The report includes a feasibility study, a HEC-RAS hydrologic model, cost analysis, permits required, and potential funding sources.

(L to R) Cody Howard, Brittany Macintyre, Sam Rolling & Matt Champion

Peer Verification Process for Livestock Anaerobic Digester Carbon Offsets

Team Name – Peer Energy
Sponsor – Duke University Carbon Offsets Initiative
Faculty Advisor – Dr. Dana Kirk, PE

Carbon offsets are an important part of carbon neutrality. Duke University's goal to be carbon neutral by 2024 requires a diverse portfolio of verified carbon offsets. Anaerobic digestion of manure generates carbon offsets; however, these cannot be used in carbon accounting unless verified by an unbiased third party at a significant cost. Peer verification is an affordable alternative allowing students from partnering universities to calculate and verify carbon offsets, adhering to the requirements created by the Duke University Carbon Offsets Initiative. Peer Energy created a data collection tool with user guide materials that was piloted with a full 2-year verification of the Loyd Ray Farm.

(L to R) Amanda Godar, Maria Barrios Arosemena & Julia Guzy (Not pictured Nina Dermody)

Assay Development for Evaluation of On-farm Probiotic Application

Team Name – Probiotic Pros
Sponsor – Dr. Larry Walker
Faculty Advisors – Dr. Darrell Donahue, PE & Dr. Timothy Harrigan

Probiotic Pros has developed an assay to quantify viable *Bacillus subtilis* in agricultural soils after probiotic application. Quantification is necessary for farmers to observe the presence of *B. subtilis* pre- or post- application and after extreme weather events. First, a screening for *B. subtilis* DNA using a colorimetric gold nanoparticle assay was performed. Then, *B. subtilis* was quantified using viability PCR (vPCR), which involved the removal of non-viable DNA from the sample before quantitative PCR is performed. The team designed a kit with guidelines and materials for farmers to sample their soil for the assay.

(L to R) Alex Hernandez, Jill Check, Tess Cannon & Jenna Baughman

Student Organic Farm Hoophouse Winter Internal Cover Design

Team Name – Cold Hardy Greens
Sponsor – Student Organic Farm
Faculty Advisor – Dr. Ajit Srivastava, PE

To extend the Michigan growing season into the winter months, MSU's Student Organic Farm uses an internal cover system within their hoophouses to create a favorable microclimate for winter production. An internal cover maintains a temperature buffer against radiative heat loss. Cold Hardy Greens designed a more efficient internal cover system reducing labor, heat loss and extending equipment life. The design's updated extension and retraction system improved worker ergonomics.

(L to R) Carly Drobny, Jamison Midgley, David Chickering & Kody Carpenter

Antibiogram-Biosensor Design to Rapidly Detect Antibiotic Resistant Bacteria

Team Name – Peru Crew
Sponsors – Dr. Alex Castañeda Sabogal & Dr. Ruben Kenny Briceno
Faculty Advisor – Dr. Evangelyn Alocilja

Carbapenem resistant Enterobacteriaceae (CRE) are an emerging threat to patients in healthcare settings. Currently, physicians in Peru do not have an efficient method to test if bacteria strains isolated from patients in their hospitals are antibiotic resistant, so they potentially overprescribe multiple antibiotics while awaiting test results. This can lead to progression of infection, proliferation of antibiotic resistant bacteria, and expensive treatments for low-income patients. Peru Crew developed a low-cost biosensor to rapidly detect antibiotic resistance in *K. pneumoniae*, a type of CRE often isolated from patients in the clients' hospitals.

(L to R) Carly Gomez, Nathan Dickinson, Jeanelle Grosvenor & Cayla Harrison

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

Ms. Holly Bowers - Consumers Energy
Ms. Lisa Buchholz - Corteva Agriscience
Mr. Matthew (Matt) Burtt - AbbVie
Ms. Shelley Crawford - Kellogg
Ms. Michelle F. Crook, PE - MDNR
Ms. Laura Doud, PE - MDARD
Mr. Cassaundra Edwards - Tillamonk
Mr. Gene Ford - Nestlé Nutrition
Mr. Jeremy Hoeh, PE - MEGLE
Mr. Eric Iversen, PE - LSG Engineers and Surveyors
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 - PPD Laboratories Inc.
Mr. Kirk Walter - Perrigo
Mr. Richard Woodford, PE - USDA-NRCS
Mr. Rob Yoder - BDI, Inc.

Board (Ex-officio)

Dr. Larry Walker, PhD, Cornell Emeritus Faculty
Mr. Michael Wozniak, PE, MDARD

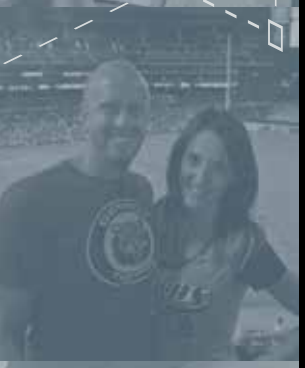
Project Evaluators

Mr. Matthew Bailey - IPF Campus Services
Mr. Carlos Becho - Kellogg
Mr. Roger Blackwell - Chestnut Growers, Inc.
Dr. Ruben Kenny Briceno - Hospital de Alta Complejidad Virgen de la Puerta, Trujillo, Peru
Ms. Karel Bush - Michigan Craft Beverage Council
Dr. Brad Day, PhD - Department of Plant, Soil and Microbial Sciences
Mr. Scott Dierks, PE - GEI Consultants, Inc.
Mr. Todd Forbush - Techmark, Inc.
Ms. Sarah Geurkink - MSU Student Organic Farm
Mr. Brandon Guthrie - Kellogg
Ms. Kate Heflick - MSU Student Organic Farm
Dr. Seth Herbst, PhD - MDNR
Ms. Sharon Hiller - Grand Pointe Homeowner's Association
Mr. Norm Lenhart - Perrigo
Ms. Celee Marchek - Grand Pointe Homeowner's Association
Ms. Amber Mostiller - Grobbel's
Dr. Alex Castañeda Sabogal - Hospital Victor Lazarte Echegaray, Trujillo, Peru
Mr. Greg White - Grand Pointe Homeowner's Association
Mr. Nate Wood - Perrigo

BE Showcase Public Presentations - April 25, 2019

BAE 2017_18 Industry Advisory Board

If you are interested in sponsoring a BE 485/487 capstone project for the 2019_20 Senior Design teams, please contact Dr. Dana Kirk at kirkdana@msu.edu or Dr. Luke Reese at reesel@msu.edu.



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The Capstone Projects

Mr. Anthony Ingle
Teaching Specialist

Faculty Advisors: Professors Chatti, Hashsham, Lajnef and Li


Chatti


Hashsham


Lajnef


Li

Presentation Schedule – Room 1538

Time	Team	Room
8:00 a.m.	Team 1 – Beaumont Engineering	First Floor Room 1538 EB
9:20 a.m.	Team 2 – Seven Engineering Consultants	First Floor Room 1538 EB
10:40 a.m.	Team 3 – G.S. LAND Associates	First Floor Room 1538 EB

Presentation Schedule – Room 3400

Time	Team	Room
8:00 a.m.	Team 7 – Big Dog Consulting, Inc.	Third Floor Room 3400 EB
9:20 a.m.	Team 8 – Sparta Engineering	Third Floor Room 3400 EB
10:40 a.m.	Team 9 – S&E Inc.	Third Floor Room 3400 EB

Presentation Schedule – Room 3540

Time	Team	Room
8:00 a.m.	Team 4 – Red Cedar Consulting	Third Floor Room 3540 EB
9:20 a.m.	Team 5 – GreenWay Engineering	Third Floor Room 3540 EB
10:40 a.m.	Team 6 – NexGen Engineering	Third Floor Room 3540 EB

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

McLaren Greater Lansing New $450 million Health Care Campus

McLaren Greater Lansing will consolidate operations at its two south Lansing facilities into one new $450 million hospital on what was once farmland near Michigan State University. The new health care campus will be developed on land acquired from the MSU Foundation in the foundation's University Corporate Research Park between Collins Road and US-127 south of Forest Road. Work on the project will begin in spring of 2019 and should be completed by 2021. This new hospital represents an expanding partnership between Michigan State University and McLaren Health Care for the advancement of research and education in human health.

The new facility will have 240 beds, a cancer center and an ambulatory care center. The building will be nine stories tall and have 18 operating rooms. Nine student-lead teams have proposed preliminary design solutions for this highly complex project site. Their design covers aspects of the structural framing and foundations of the main hospital building, traffic impact and site circulation including driveways and parking lots, storm water collection and conveyance systems, and the treatment of environmentally regulated waste products from the hospital. This project provides an excellent opportunity for students to see the context of their design in real circumstances.

Fig. 1: Conceptual Site Plan

Fig. 2: Architectural rendering looking west (courtesy of McLaren Health Systems)

Team 1: Beaumont Engineering

Left to Right: Michael Grazioli (H), Matthew Thompson (G), Perpetual Koech (S), Logan Devereaux (T), Sydney Waynic (E), Luke Dionise (P), Anna Kayser (PM), Bob Urban (E)

Team 2: Seven Engineering Consultants

Left to Right: Dan Kim (P), Mitch Egan (T), Sean Powell (H), Matthew Marx (G), Yash Roy (PM), Chaoyi Shi (E), Ibrahim Alinaizi (S)

Team 3: G.S. LAND Associates

Top (l-r): Garet Rice (P), Liam Dwyer (H), Michael Ridley (G), Neil Guest (E) **Bottom (l-r):** Abrar Aldhamen (S), Alexandra Fischer (PM), Sydney Garner (T), Daniel Hong (E)

Team 4: Red Cedar Consulting

Top (l-r): John DeLang (G), Chris Miller (S), Ali Alahbabi (T), Brandon Walker (P) **Bottom (l-r):** Chuck Whetstone (E), Rachel Zywiczynski (PM), Sydney Salit (H), Chaoliang Zhang (E)

TEAM 5: GreenWay Engineering

Top (l-r): Ian Lindsay (T), Evan Flashner (H), Jake JaBaay (P) **Middle (l-r):** Alina Viehweber (PM), Clark VandenBossche (S) Nura Aden (E) **Bottom (l-r)**: Nico Saco (G), Nate Coffin (E)

Team 6: NexGen Engineering

Left to Right: Amber Mote (E), Iesha Bush (E), Jack Fox (P), Renae Sagorski (S), Joe Farrington (S), Lydea Noye (H), Garrett Shafer (T), Carly Cohen (PM)

Team 7: Big Dog Consulting, Inc.

Left to Right: Cameron Alvado (G), Thomas Horak (H), Cade Gunther (PM), Madeline Hanford (E), David Upton (T), Michelle Babst (S), Weidi Sun (E), Quinn Foster (P)

Team 8: Sparta Engineering

Left to Right: Mario Meo (PM), Brendan Wrobel (H), Majedah Alruwaily (P), Kyle Smith (G), Hannah Sislow (E), Steven Meister (T), Matthew Walz (E), Chan Park (S)

Team 9: S&E Inc.

Left to Right: Josh Eisenman (E), Erin Emmanuel (T), Danielle Garlington (P), Megan Duda (H), Vincenzo Vultaggio (PM), Ben Silvi (E), Kody Yee (S), Joel Arseneault

Key to primary roles and responsibilities of each team member:

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

CE 495 SENIOR DESIGN IN CIVIL & ENVIRONMENTAL ENGINEERING

PROFESSIONAL SEMINAR SPEAKERS

Michele Buckler, P.E.
Detroit Diesel

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

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

Greg Losch, P.E.
Michigan Dept. of Transportation

Leanne Panduren, P.E.
Rowe Professional Services

Robert Rayl, P.E.
RS Engineering LLC

Charles Rolfe, P.E.
OHM Advisors

Scott Stowitts, P.E.
Barton Mallow

Leah Tapp, P.E.
HNTB

Dan Thome, P.E.
Nicholson

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

Brad Wieferich, P.E.
Michigan Dept. 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.

Juan Alcantar
Michigan Dept. of Transportation

Leigh Burgess
RS Engineering

Erik Carlson
Michigan Dept. of Transportation

Rick Chelotti
Bergmann Associates

Dan Christian
Terra Tech MPS

Jim Corsiglia
HED Development

Brian Davies
Hubbell, Roth & Clark

Tyler Dawson
NTH Consultants

Mike Ellis
Barr Engineering Co.

Matt Hill
WPS

Matt Junak
HNTB

Al Kaltenthaler
C2AE

Michael Labadie
Rowe Professional Services

Mario Quagliata
Bergmann Associates

Emily Schlanderer
Fishbeck, Thompson, Carr & Huber

Michael Thelen
Consumers Energy

Anthony Thomas
Soil & Materials Engineers

Phil Vogelsang
AECOM

Thomas Wolff
Michigan State University

Design Day Awards Fall 2018

Rolla C. Carpenter Senior Design Award

The Rolla C. Carpenter Senior Design Award ($900 and medals) 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.

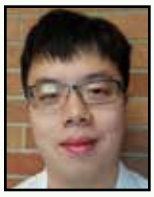
Rolla C. Carpenter Senior Design Award Winners, Fall 2018

Team 4: Exponential Engineering

Left to right: Anastasia Matta, Bradford Shelle, Diego Acevedoquintanilla, Stephen Subu, Anyssa Schember, Nick Borkowski

ChE Process Design and Optimization

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



Ziwei Wang
Graduate Student & Teaching Assistant of Chemical Engineering

Course Description

Chemical Engineering's capstone design sequence includes Process Design and Optimization I and II (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 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 that 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. MSU's four best solutions (two teams and two individuals) are then submitted for judging as part of AIChE's national Student Design 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 Awards in 2018 Design Competition

In 2018, MSU students won two of the three national awards in the Individual Solution category of AIChE's Student Design Competition. Evan Draplin won Second Place, and James Wortman won Third Place for their designs of a manufacturing facility for dimethyl ether, a chemical feedstock that shows promise as an alternative fuel. In addition to this national award, James Wortman also received an MSU Board of Trustees' Award for having the highest scholastic average (4.0 GPA) upon graduation.

https://www.aiche.org/community/awards/student-design-competition-individual).

AIChE®

Manufacturing Facility for a Monoclonal Antibody

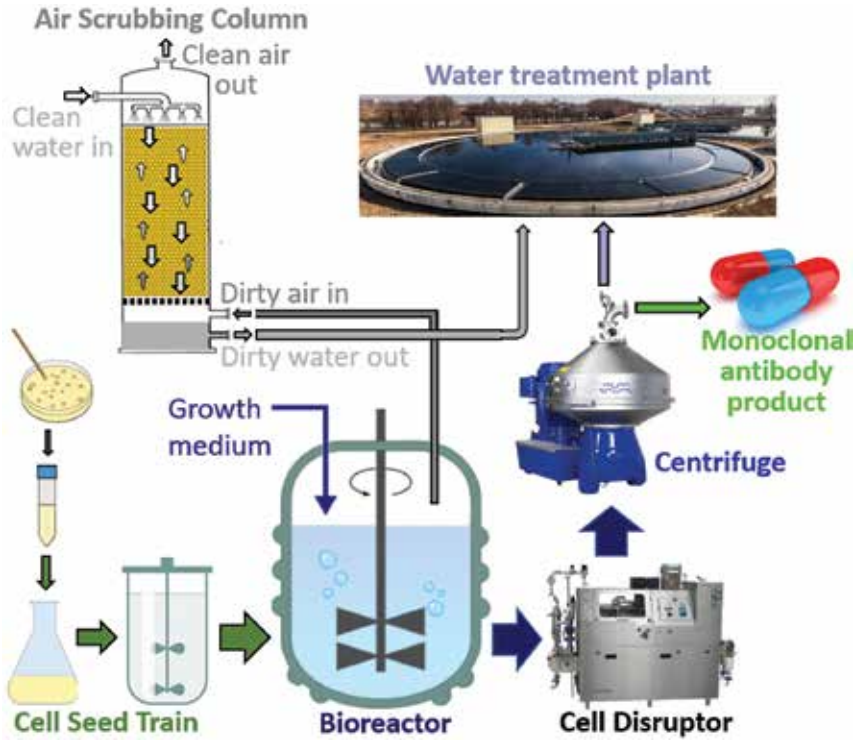
In 2019, the AIChE Student Design Competition problem was to design a biopharmaceutical plant to manufacture recombinant proteins used in a drug to treat advanced macular degeneration (AMD). The proteins are to be produced in Escherichia coli fermentations as intracellular "inclusion bodies"—protein aggregates about half a micron in size. After the fermentation, the E. coli cells are to be ruptured, and the inclusion bodies art to be recovered by centrifugation. Finally, the inclusion bodies are to be transported to another facility, where they will be dissolved, and the protein components will be self-assembled into a monoclonal antibody that is biosimilar to the AMD drug Ranibizumab (trade name Lucentis). This antibody inhibits angiogenesis in the retina and thereby prevents the excessive blood-vessel growth that damages retinal function in AMD patients.

A simplified process flowsheet to produce the inclusion bodies is shown below. A seed train will be used to grow enough recombinant E. coli cell culture to inoculate the 6,000 L fermentor (about 5% by volume). To achieve a high final cell density and intracellular inclusion-body concentration, additional liquid growth medium is added, and air is sparged into the bioreactor. After the fermentation, the cells are mechanically ruptured to release the inclusion bodies, which are then recovered using a centrifuge and shipped. To protect the environment, an air-scrubbing column is used to remove H2S gas produced by the cells, and a wastewater-treatment process is used to remove cell debris and other contaminants.

AIChE Design Competition problems like this one require students to integrate a broad range of chemical engineering skills as they develop a process flowsheet; design and estimate costs of process equipment; incorporate strategies for heat and mass integration; follow environmental, health, and safety guidelines; develop mathematical models describing equipment performance; use process-simulation software (e.g., ASPEN) to predict the effect of key independent variables on overall plant performance, and then integrate economic models (e.g., discounted cash flow rate of return) with ASPEN simulations to analyze and optimize plant profitability.

AIChE problems provide only a modest amount of details, requiring students to apply strategies typical of real-world designs: conduct project-specific research, use experience-based engineering heuristics (i.e., rules of thumb), make reasonable engineering assumptions, and assess accuracy of the designs.

Process Flowsheet for Antibody Production



Individual-Solution Poster Presenters

Joseph Gazall

Nicholas Heilman

James Johnston

Mason Sitar

Max Sunter

Devin Vogel

Team-Solution Poster Presenters

Nicole Dobrzelewski and Lauren Vance

Bethany Kaczanowski and Jonathon Brock

The Capstone Projects

Dr. Martin Crimp
Professor of Chemical Engineering and Materials Science

Course Description

MSE 466 is a senior level course for Materials Science & Engineering majors, which provides 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 problems. A failure analysis investigation (FAI) fits this context. Failures are a major motivating factor for promoting more innovative designs or design changes. The MSE 466 failure analysis investigation framework provides a unique platform for designing investigations and solving real-world engineering problems via systematic engineering approaches. By focusing on specific design failures, the student teams learn how to confront open-ended problems that require them to develop strategic investigation design plans and to execute the methodology for assessing how and why the failures occurred. The analyses are conducted using established failure analysis investigative procedures and constraints. This semester there are seven teams working on seven real engineering failures.

Presentation Schedule – First Floor Room 1145

Time	Team	Project
8:30 a.m.	Get A Grip!	Failure Analysis of an INSTRON Tensile Testing Machine Jaw Face
9:00 a.m.	A Bad Hinge Date	Failure Analysis of Blum Cabinet Hinge
9:30 a.m.	The Three Screw-ges	Polymer Extrusion Screw Failure
10:00 a.m.	Boom Vang Pow	Seldén Rodkicker Rigid Vang Failure Analysis
10:30 a.m.	F.C.A.P.	PINNACLE® Acetabular Hip System Impactor Failure
11:00 a.m.	Hard Hitters	Framing Hammer Failure Analysis
11:30 a.m.	Fellowship of the Pin	Analysis of a Differential Cross Pin

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 half-hour presentations. For 2019, the seven teams are conducting the following failure analysis investigations:

(left to right): Keegan Lawler, Jacob Shereda, Sierra Scott

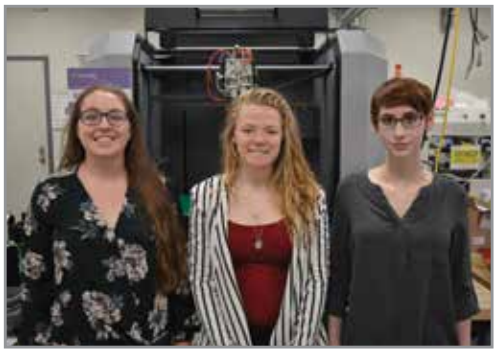
Time: 8:30 a.m. | Team Name: Get A Grip!
Project Name: Failure Analysis of INSTRON Tensile Testing Machine Jaw Face

Machines have been helping us understand material analysis for hundreds of years, one of the simplest being a tensile testing machine. This apparatus can apply massive loads to any material, causing it to fail in a way that can then be characterized by engineers. When machines are not used correctly, however, things begin to go wrong. The material failure studied in this project was a jaw face from a tensile testing machine whose top surface broke off in the middle of what should have been a standard tensile test. Through a series of analysis steps, including microscopy (both stereo and SEM), chemical analysis, FEM, and physical characterization, the cause of failure was determined.

(left to right): Gonzalo Venegas, Alec Arabia, Lindsay Fricano

Time: 9:00 a.m. | Team Name: A Bad Hinge Date
Project Name: Failure Analysis of Blum Cabinet Hinge

In the battle of hinge vs. cabinet doors, cabinet doors hold the winning record in the Arabia household. Over the years, several Blum hinges of various models broke under seemingly normal use conditions. A cause of failure was determined through careful examination and imaging of the fracture surfaces via stereomicroscopy and scanning electron microscopy (SEM) in combination with other non-destructive and destructive testing methods. Chemical composition and mechanical properties of the failed hinges were compared to undamaged exemplars to determine processing variability. Exemplars were also examined with similar microscopy techniques to determine their material suitability in this specific hinge application.



(left to right): Rachael Zarger, Carli Shaloksy, Risa Hocking

Time: 9:30 a.m. | Team Name: The Three Screw-ges
Project Name: Polymer Extrusion Screw Failure

While attempting to extrude polycarbonate filament, the extrusion screw fractured catastrophically in the metering region. Notably, this piece of equipment was still under warranty. The manufacturing company labeled it as part of a "bad batch," but the root cause was not determined. The failure surface was visually inspected and documented. Additionally, the screw sent as the warranty replacement was also inspected and documented as an exemplar to evaluate potential differences. Several microstructural cross-sections were obtained along the length of the screw and examined for anomalies. Along with other non-destructive and destructive testing, the team worked to determine the root cause of failure.

(left to right): Alfred Farleigh V, Austin Crimmins, Alexander Bonn, Anne Jondle

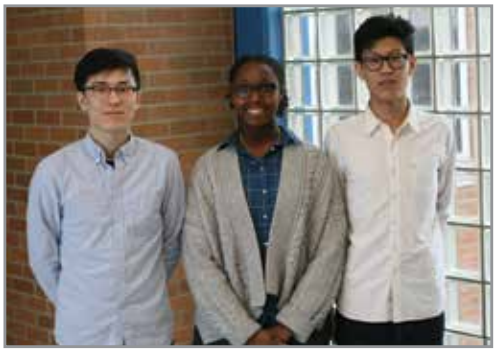
Time: 10:00 a.m. | Team Name: Boom Vang Pow
Project Name: Seldén Rodkicker Rigid Vang Failure Analysis

A Seldén Rodkicker Rigid Vang end fitting of a sailboat was analyzed after it failed due to a sudden and strong gust of wind while out on Lake Erie. The purpose of the device is to aid in sail handling when reefing, as well as to keep the boom from dropping into the cockpit. The failure of the device resulted in the sailboat being unable to sail. The fracture occurred at the end of the part where the vang is attached to the boom by a stainless-steel pin. The exact force exerted on the vang was approximated using historical data of the wind gusts from that day and the surface area of the sail. Destructive testing like chemical composition analysis and non-destructive testing like Scanning Electron Microscopy were used to determine the type and cause of fracture.

(left to right): Greg Knight, Annabeth Yang, Josh Patrick

Time: 10:30 a.m. | Team Name: F.C.A.P.
Project Name: PINNACLE® Acetabular Hip System Impactor Failure

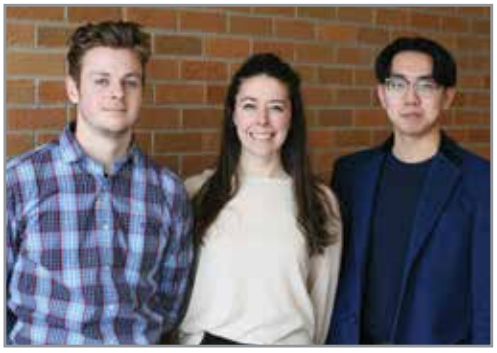
The PINNACLE® Acetabular Hip System Impactor Assembly from DePuy Synthes has been developed in collaboration with an experienced design team of surgeons. This device, in use, provides a surgeon with general guidance when implanting the PINNACLE® Acetabular Hip System. Three PINNACLE® Straight Impactor Assemblies were obtained, all of which failed in the same manner: the cup impactor end cap broke away from the handle during implantation of the acetabular shell (replacement for the hip). The surgeon was striking the cap with a mallet while performing seating of the shell as it broke. Immediately after failure, both pieces of the device were retrieved, and a replacement impactor of the same type was subsequently installed to complete the surgery. Upon initial investigation of the fracture surfaces, the exact cause of failure was unclear. Further investigation of the fracture surface, assembly design, and manufacturing (through imaging, mechanical testing and analysis, chemical analysis, and microscopy) aided in the determination of what was responsible for the failure.



(left to right): Wenhao Zhou, Requal Harris, Bingchen Wang

Time: 11:00 a.m. | Team Name: The Hard Hitters
Project Name: Framing Hammer Failure Analysis

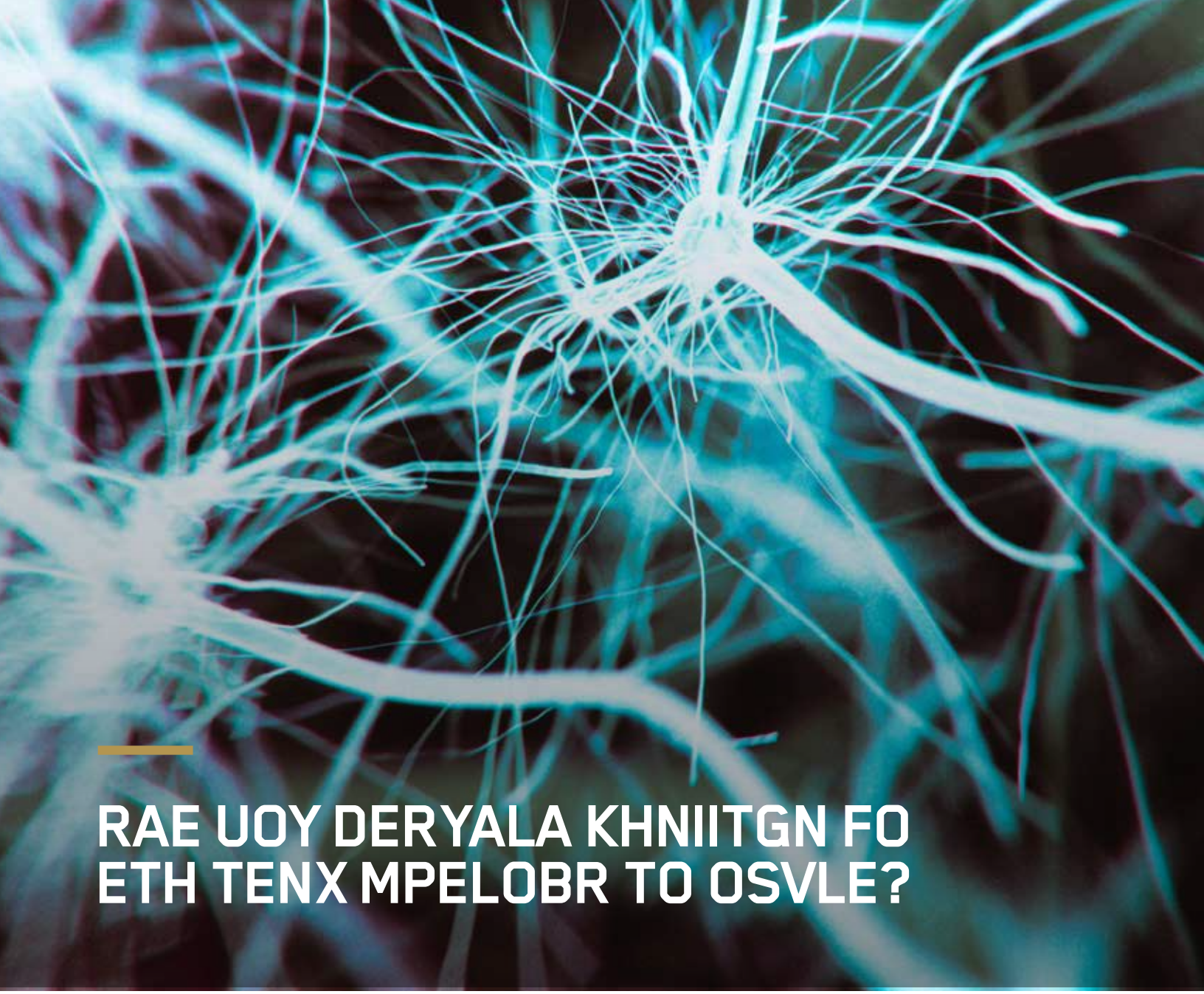
A claw of a 32-oz heavy-duty claw hammer broke apart on January 14, 2019 while it was being used by a worker from the Christman Construction Company in an on-campus construction site. On this thoroughly rusted hammer, its claw tip and the hammerhead were severely worn. However, there were no traces of brand and product information to be found on this rusty surface. The exact chemistry was unknown, but it would be determined in the following EDS test. Fractographic imaging will help to determine the direction of fracture propagation. Nondestructive test methods like SEM and X-ray spectroscopy along with destructive tests such as hardness tests and fracture toughness will be used to determine possible loading during fracture and the ultimate likely cause of fracture.



(left to right): Nolan Murphy, Kiera Kimninau, Ziyan Liu

Time: 11:30 a.m. | Team Name: Fellowship of the Pin
Project Name: Analysis of a Differential Cross Pin

An American Axle and Manufacturing Differential Cross Pin was selected for fracture analysis after the pin, which is nickel plated and made of SAE 4320 steel, fractured during routine differential fatigue testing. It is hypothesized that the part experienced bending and shear stresses from improper gear interaction during fatigue testing. The failure surface was examined via optical microscopy and scanning electron microscopy. Through destructive and non-destructive testing, the sample's integrity will be investigated to identify the failure cause and initiation site.



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If you can decode the above headline, then you think like an Urban Scientist.
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Chicago, Illinois

Auburn Hills, Michigan

The Capstone Projects

Dr. Wayne Dyksen
Professor of Computer Science and Engineering

Ryan Johnson

James Mariani

TEACHING ASSISTANTS

Presentation Schedule – Engineering Building, Room 3405

Time	Team	Project Title
7:15 a.m.	Amazon	Browser Sharing for Customer Support
7:26 a.m.	Aptiv	Analysis of Autonomous Vehicle Testing Video
7:37 a.m.	Auto-Owners	Secretary of State (SoS) Software Robot
7:48 a.m.	Consumers Energy	New Customer Service Channel
7:59 a.m.	Dow	AR Model Management Platform
8:10 a.m.	DRIVEN-4	Product Development Portfolio and Planning
8:21 a.m.	Evolutio	AppDynamics Platform Configuration Tool
8:32 a.m.	Ford	Greenfield Labs SHARED Locker System
8:43 a.m.	Google	Kubernetes Cluster Inspection Tool
8:54 a.m.	Herman Miller	Office Navigation Using Augmented Reality
9:05 a.m.	Humana	Technology Peripheral Inventory Predictor
9:16 a.m.	Meijer	aislePerks: Location-Based Personalized Shopping
9:27 a.m.	Michigan State University HPCC	Simplifying High Performance Computing
9:38 a.m.	Michigan State University ITS	Group Project Organization and Scheduling
9:49 a.m.	Mozilla	Optimizing Firefox Localization
10:00 a.m.	MSUFCU	AutoBudget Chatbot
10:11 a.m.	Principal	Integrated Analyst Ratings and Notes
10:22 a.m.	Proofpoint	Defeating Malware Payload Obfuscation
10:33 a.m.	Spectrum Health	Patient Training Tool
10:44 a.m.	Surge Solutions	xOS: Visualization of Automated Underwriting
10:55 a.m.	Technology Services Group	Multi-Video Case Management
11:06 a.m.	TechSmith	Internal Telemetry for TechSmith Products
11:17 a.m.	Union Pacific	Railroad Arcade
11:28 a.m.	United Airlines	Training Scheduling and Optimization System
11:39 a.m.	Urban Science	Dealer4U
11:50 a.m.	Volkswagen	Cognitive Enterprise Software Robots

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, and
- consider issues of professionalism and ethics.

Our clients are local, regional, and national including Accenture, Amazon, Aptiv, Auto-Owners Insurance, Fiat Chrysler, Consumers Energy, Dow, DRIVEN-4, Evolutio, Ford, General Motors, Google, Herman Miller, Humana, Meijer, Michigan State University, Microsoft, Mozilla, MSU Federal Credit Union, Principal Financial Group, Proofpoint, Quicken Loans, Spectrum Health, Surge Solutions, Technology Services Group, TechSmith, Union Pacific, United Airlines, Urban Science, and Volkswagen.

Amazon

Browser Sharing for Customer Support

Originally founded as an online bookstore, Amazon is now a leader in e-commerce and cloud computing, accounting for one in three online shopping transactions in North America.

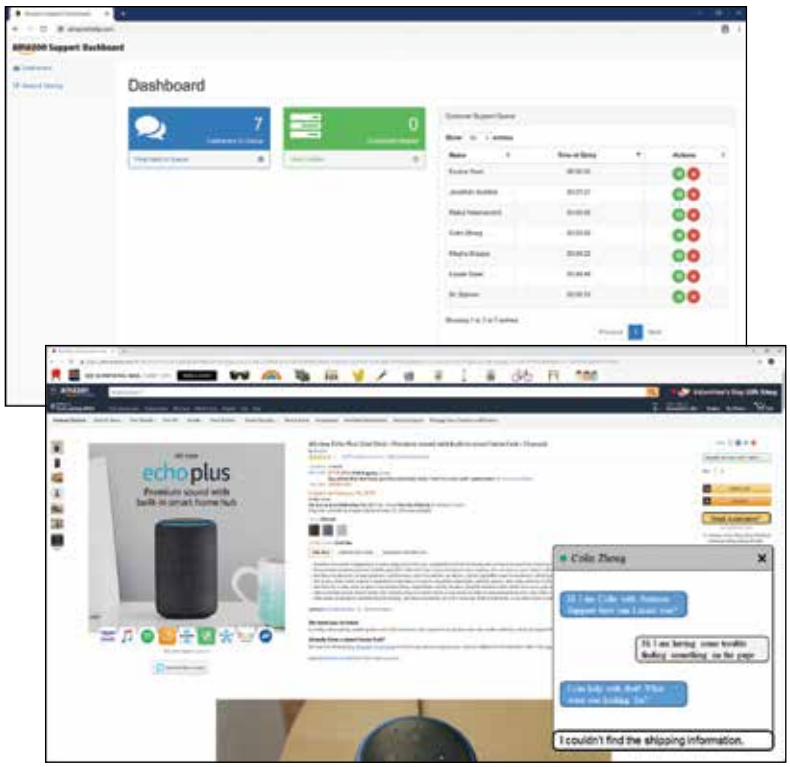
When an Amazon customer needs help with a product, support staff must be ready immediately to ask him or her for more information in order to diagnose the problem, working hard to further avoid frustrating the customer.

Customer support organizations need better ways to understand the problems their customers are facing in order to help them more efficiently. Browser sharing, or co-browsing, provides support representatives with a visual way to guide customers to a quick and painless resolution.

With our Browser Sharing for Customer Support, the click of a button allows customers to share their browsers with Amazon representatives. The representative can offer quick and efficient assistance without having access to the customer's screen or computer. In most cases the customer gets immediate assistance, without any time-consuming installation needed.

Because the Amazon representative cannot view any other content on the customer's desktop, this is much safer than traditional remote control solutions.

Our browser sharing tool is written in JavaScript and hosted on Amazon Web Services (AWS) EC2 servers. It uses the W3C DOM API to capture the DOM events. The REST API is hosted on AWS and saves interactions in an AWS RDS Database for auditing purposes.



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Aptiv
Analysis of Autonomous Vehicle Testing Video

Headquartered in Dublin, Ireland, and with more than 147,000 employees in 45 countries, Aptiv is a global technology company focused on helping create the next generation of active safety, autonomous vehicles, and smart cities.

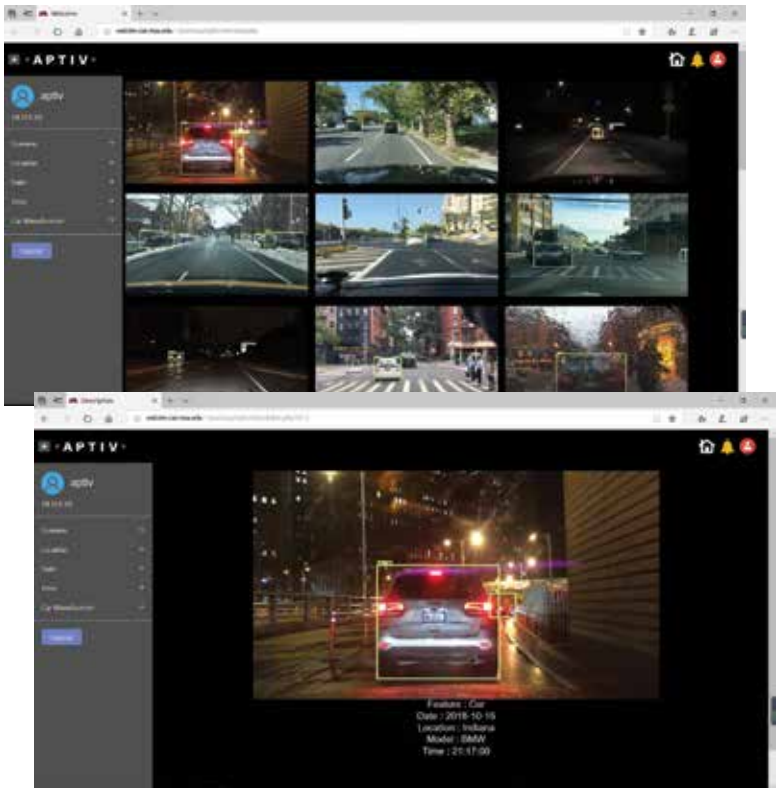
With the ultimate goal of improving the safety of autonomous vehicles, Aptiv has a video database that presents a wide range of driving scenarios that a vehicle may encounter, including traffic signs, traffic lights, other vehicles, and pedestrians, all of which help to ensure vehicular safety for their customers.

Heightened highway and road safety concerns have introduced the need to expand the range of scenarios identified in their driving data.

Our Analysis of Autonomous Vehicle Testing Video model identifies and places boxes around salient features including overpasses, bridges, tunnels and tollbooths, and stores the labeled images in a database. The web app is connected to the database and visualizes entries from it. In order to navigate the web application, Aptiv users must first create an account and log in.

Our Analysis of Autonomous Vehicle Testing Video web app allows vehicle testing engineers access to enhanced driving scenarios that increase the safety of autonomous vehicles being manufactured by Aptiv and minimize loss of life and damage to property caused during vehicular crashes.

Our model is written in Python. Our web application is written using HTML, CSS, PHP, JavaScript and Bootstrap. The backend database is implemented with MySQL.



APTIV

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Auto-Owners Insurance
Secretary of State (SoS) Software Robot

Founded in 1916, Auto-Owners Insurance is a Fortune 500 company that provides auto, home, life and commercial insurance to more than four million policyholders.

One of its products is workers' compensation insurance. Agents fill out applications for this insurance and submit them to be reviewed by an underwriter at Auto-Owners.

Frequently, the business name is entered differently than what the Secretary of State has on file. This can be caused by a slight variation in the business name or simply by a typo. Finding the official business name is time-consuming and not a productive use of an Auto-Owners associate's valuable time.

Our Secretary of State (SoS) Software Robot automates this process, using what's called robotic process automation, or RPA. With the click of a button, the software robot, or softbot, assumes the role of the insurance underwriter, searching first for the correct Secretary of State website, then searching for the proper name of the business.

Agents enter applications into the form provided on the website. Once submitted, underwriters can access applications for review from the web portal. After running the softbot, underwriters utilize the softbot's results to finish the application review process and approve the application. To monitor how well the softbot is performing, there is a reporting dashboard that allows managers to view statistics and metrics captured during processing.

Our website is implemented in PHP and hosted on a CentOS Linux server. The community edition of UiPath was used to create our software robot.

Auto-Owners INSURANCE
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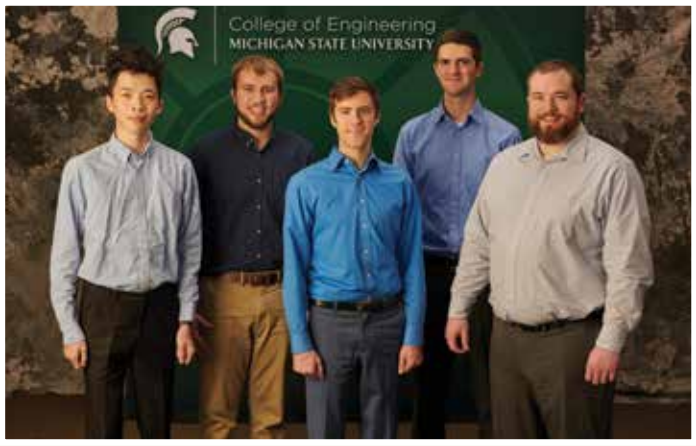

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Consumers Energy
New Customer Service Channel

Founded in 1886, Jackson, Michigan-based Consumers Energy provides natural gas and electricity to nearly 6.7 million residents using a large power-generating system portfolio.

At some point, nearly everyone has had to contact a company using its customer service telephone line. Navigating through a confusing automated system and call tree or waiting in long phone queues can be a troubling process that sometimes results in a negative perception of the company.

Our New Customer Service Channel web application improves this experience for Consumers Energy customers by offering an option that allows them to utilize self-service methods to handle inquiries and save valuable time.

When customers first call into the Consumers customer service line, they are given the option of receiving a text message containing a link to the web application. This process handles their inquiry much faster than if they had waited to speak to a representative.

If customers choose to load the web application, they can view the account and balance, set up payment options, pay bills, or create payment arrangements on their own with a simple and user-friendly layout.

Customers are automatically placed in a priority queue in case they elect to speak with a representative.

Our New Customer Service Channel uses the Angular framework for frontend development, consisting of HTML5, CSS3, JavaScript, Typescript, Node.js, and Bootstrap. The backend utilizes ASP.Net, Entity Framework, and C#, while the Twilio API maintains call functionality.

Consumers Energy
Count on Us®

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The Dow Chemical Company
AR Model Management Platform

With more than 100 years of success and industry-leading innovation, Michigan-based Dow is a global leader in specialty chemicals, advanced materials and plastics. From bottles to boxes, Dow provides a world-class portfolio of advanced, sustainable and leading-edge products.

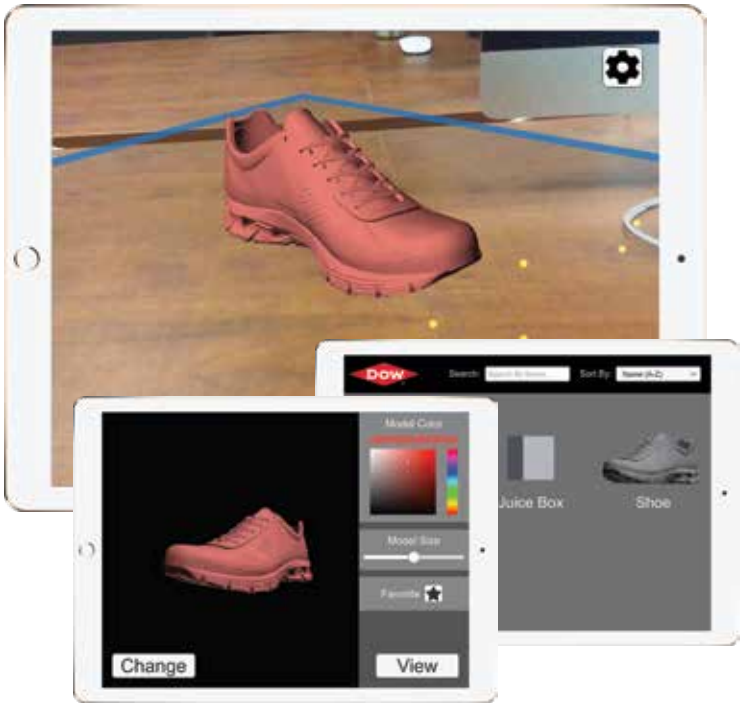
In addition to face-to-face interactions with their customers, Dow sales professionals also visit dozens of trade shows and other events, showcasing their products using augmented reality (AR) via the representative's mobile phone. The problem the representatives often run into is this: when a new product is to be showcased, either a new application must be created or an old one manually updated before it can be shared with a potential customer.

Our AR Model Management Platform eliminates the need for separate applications. This iOS and Android mobile application functions company-wide. AR models update automatically. Any employee with permission can view, color, scale and download models.

Utilizing a mobile device's camera and screen, sales professionals exhibit product models as if they exist in the space around them. The user places the product on any surface, displaying real-world scale and structure to a potential customer. In addition, tapping the model highlights features and displays additional information.

Administrators add models to a central storage location and give model viewing capabilities to sales professionals.

Our platform is built with the Unity game engine, ARKit and ARCore. The models are saved on a SharePoint site, and access is handled through Azure Active Directory.



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DRIVEN-4
Product Development Portfolio and Planning

Based in Michigan, DRIVEN-4 offers its customers a competitive edge by providing them with innovative strategies, insights and proven implementations of integrated process and technology.

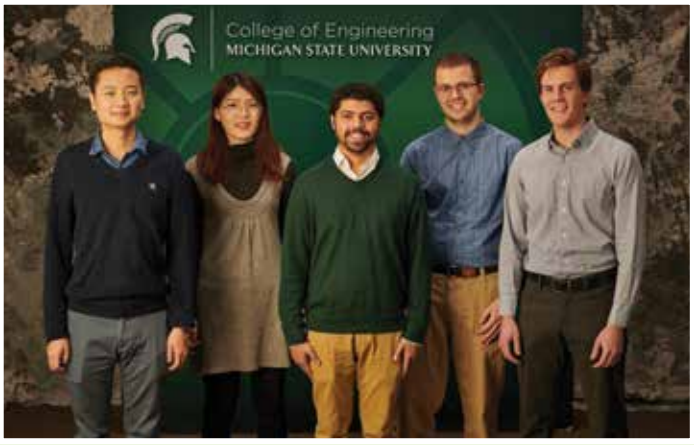
Original equipment manufacturers, or OEMs, are companies whose goods are used as components in the products of another company. In order to be competitive, OEMs must have plans in place that guide them to the most profitable results. These plans include budget information and hiring needs, as well as the storage of information that may be useful for future projects.

Our Product Development Portfolio and Planning software gives project managers the ability to forecast and track execution of annual product development budgets.

In addition, it provides them with the ability to insert the data required to build multiple forecasts and then generate graphs with just a click of a button. This enables them to visualize plans and choose the best possible one to build the product. It also gives them the ability to track the execution of an ongoing development and compare it with the forecast to ensure timely delivery of the product.

Our mobile app allows project managers to view updates or changes made to the project by other managers. It also allows employees to log the hours they have spent working on different projects throughout the week.

Our web app frontend uses Angular and the backend uses PTC ThingWorx, a platform to create business logic. Our mobile app is written in Xamarin and is available on both Android and iOS devices.



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Evolutio
AppDynamics Platform Configuration Tool

Evolutio is a group of technology professionals convinced that business problems have significantly simpler solutions than the market is led to believe. Living and breathing big data, one tool they use to help meet their customers' goals is Cisco's AppDynamics platform, designed to learn application behavior as well as visualize critical health and performance data.

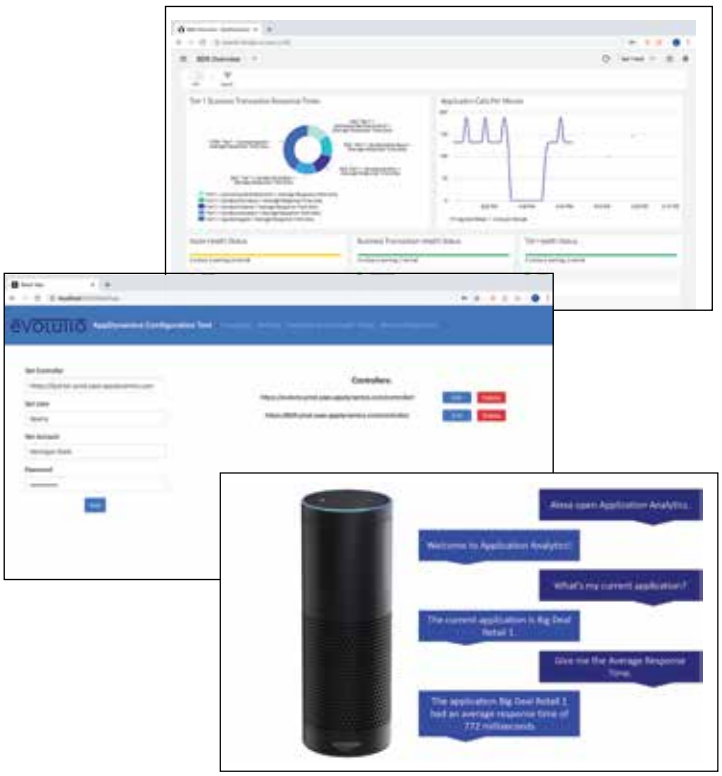
Dashboards are one of the best ways AppDynamics makes the data visible and understandable to the user. For example, it can let the company know if the site is getting too much traffic and unless more servers are put into use the site could slow considerably or even crash.

A company's applications are crucial to attracting new customers or retaining existing ones. AppDynamics reminds them how their complex apps directly affect their businesses.

Our AppDynamics Platform Configuration Tool is utilized by Evolutio to deploy efficiently dynamic template dashboards that allow for quick and easy exportation across applications. It significantly reduces the amount of work required to create custom dashboards by using specially created templates and a simple-to-use interface assisting in dashboard deployment.

There also is an Amazon Alexa feature that interfaces with AppDynamics. Customers simply use their favorite Alexa device to ask questions about the performance of and health information for a given application that AppDynamics is monitoring and receive easy-to-understand results.

Our AppDynamics Platform Configuration Tool is written in JavaScript and communicates via a Java RESTful API. The Alexa skill is run via an AWS Lambda function.



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Ford Motor Company
Greenfield Labs SHARED Locker System

Ford Motor Company is a multinational automotive manufacturer based in Dearborn, Michigan, employing 202,000 employees and producing a total of 6.6 million vehicles in 2017.

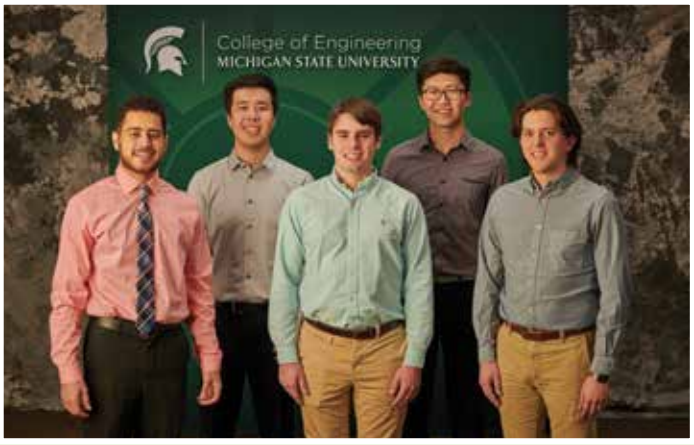
Ford's Greenfield Labs in Palo Alto, California is made up of a cross-functional team of researchers who often acquire cutting edge hardware. Upon completion of each research project, these devices often find their way to the back of a drawer or a storage rack within the lab.

Our "SHARED" system, or Shared High-value Asset Reallocation Enablement Device Locker System, showcases these devices in such a way to encourage more efficient use. Unlike most lockers, which hide objects stored within, our system enables the process of walk-up, checkout, and basic tracking of the assets inside.

When an employee checks out or in an item, it is done using our cross-platform app that requires authentication and unlocks the locker. Locker reservations save the requested item at a specific date and time that is set by the user. Administrators keep track of devices, as well as monitor what devices are used.

There are three colors of LED lights that indicate the current status of a locker. Green is for available, yellow is for reserved, and red is for unavailable.

Our system utilizes a Raspberry Pi device to control a cluster of lockers. The corresponding software is written with React and React Native to support web, Android, and iOS platforms. The status of all lockers is displayed within the applications as well as within the physical locker itself.



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Google
Kubernetes Cluster Inspection Tool

Google's mission is to organize the world's information and make it universally accessible and useful.

To this end, Google provides Kubernetes, which is open-source software that enables a customer's cloud application to scale based on current usage and other factors.

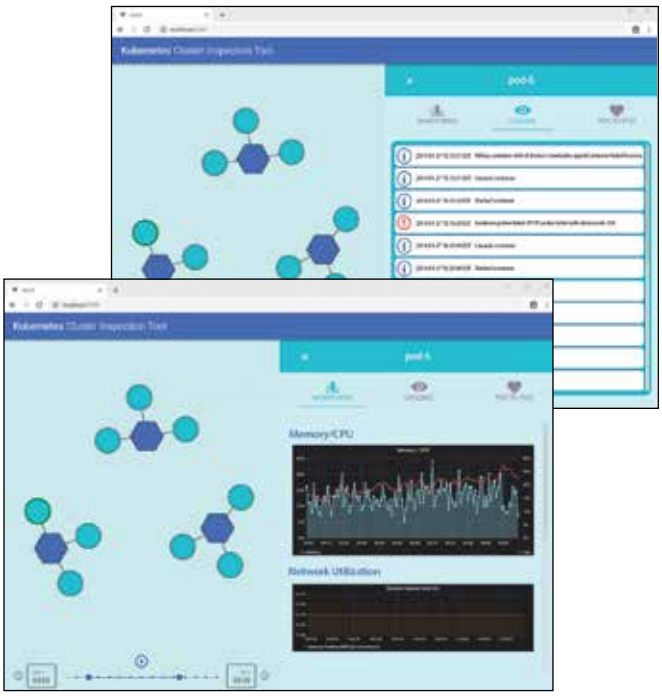
For example, if a website is experiencing a high volume of traffic that slows the application, Kubernetes increases the number of servers needed to keep the application healthy.

The information to assess the health of a Kubernetes cluster is in many different places. As a result, diagnosing problems is time-consuming and becomes more difficult as the cluster increases in size.

Our Kubernetes Cluster Inspection Tool organizes cluster information, making it available in a single web app. Our tool lowers the barrier to entry for new users, improves the functional experience for existing users, and allows users to spend less time diagnosing problems.

Users are presented with a visual overview of the cluster and click-on components to gather more information. When a component is clicked, a window appears with a list of data stored in logs, as well as a variety of metrics displayed on a series of graphs. Additionally, network communications between cluster components are shown in one view.

Our Kubernetes Cluster Inspection Tool utilizes the Stackdriver Monitoring and Logging APIs and the Kubernetes API to obtain data. The backend is built in Go, and the frontend uses Vue.js and D3.js.



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Herman Miller
Office Navigation Using Augmented Reality

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

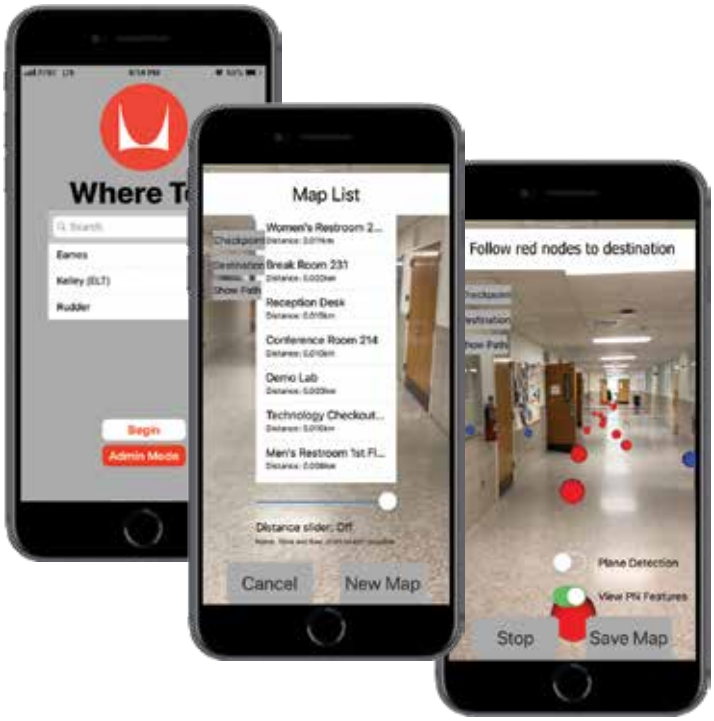
When moving to a new location, workers can easily get lost trying to find their office, the breakroom or even the bathroom. Finding their way can also be challenging for visitors, including potential customers.

Our Office Navigation Using Augmented Reality app is an indoor AR navigation tool for clients and employees of Herman Miller.

Our app provides turn-by-turn instructions on how to maneuver through an unfamiliar building. It allows a building administrator to set up the environment by locating multiple destinations, as well as identifying the routes throughout the building. After selecting a destination, directional spheres, as shown on the right, will be displayed on the screen. Users then follow the spheres to lead them to their destination.

Our app uses computer vision via Apple's ARKit and machine learning to detect features and landmarks within an enclosed space. It uses AR to display turn-by-turn instructions. It also has the potential to be useful in a variety of other settings, including hospitals, shopping malls and parking structures.

Our Office Navigation Using Augmented Reality app is built using ARKit, Placenote, AWS Cognito, AWS SageMaker and Pods. They work together to create a coherent user experience.



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Humana
Technology Peripheral Inventory Predictor

Humana is a Fortune 100 health insurance company that provides products and services to more than 13 million U.S. customers. Humana seeks to empower its members, urging them to live healthy, active and rewarding lives.

Providing as many as 40,000 employees with the technology they need to more efficiently do their jobs presents a significant challenge for the company. Its goal for 2019 is to increase the accessibility of computer peripherals and to improve the process of procuring those items.

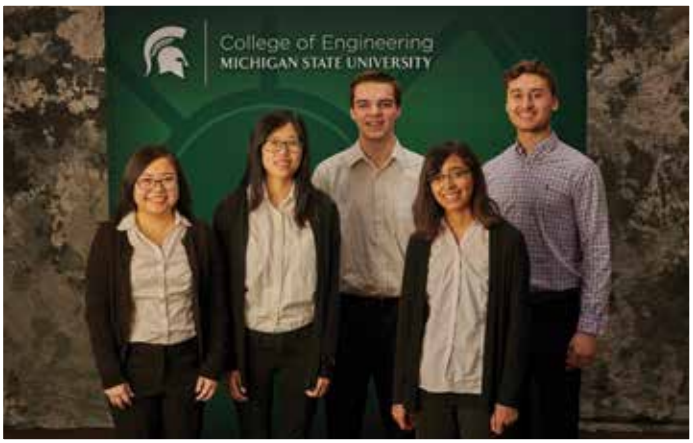
To this end, Humana uses our web app, Technology Peripheral Inventory Predictor, to predict the future demand of various peripherals based on past purchase history. With these tools, purchasers make well-informed decisions about which items are needed the most. Peripherals include any computer-related products, from keyboards to mice to external hard drives.

Our app closely monitors new purchases and then indicates how these purchases differ from past trends. This allows users to see how demand shifts over time. Users also can observe the purchase history by itself in order to make judgments based on both data and their own experiences. In this way, the application does not supersede the user, but instead enables him or her to make better decisions more quickly.

Additionally, users input large quantities of data all at once by uploading a .csv file. This way, new sources of data are incorporated into the system quickly and efficiently.

Django is used to host the backend of the web application. The data is stored using PostgreSQL.

Humana



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Meijer
aislePerks: Location-Based Personalized Shopping

Meijer is a supercenter chain with roots firmly planted in Michigan. With 242 stores in six states, Grand Rapids-based Meijer is one of the biggest retailers in the nation.

Meijer is at the forefront of innovation with the early adoption of products such as shopping carts, automated checkout conveyor belts, and the mPerks digital-coupon program. mPerks enhances shoppers' experiences by helping them earn discounts without the hassle of paper coupons.

Our Location-Based Personalized Shopping system, or aislePerks, improves the mPerks experience by notifying customers of deals and specials that may interest them while they are shopping. Customers who have the mPerks app on their mobile device have the option to download aislePerks.

When customers enter the store, they can open the app to see any relevant deals or specials. As they walk through the store, deals are recommended based on their previous purchases and where they spend the most time in the store. Deals are selected by customers and saved to their "Saved Deals" page where they can view their deal history.

Our system includes a companion dashboard website that Meijer employees utilize to view aislePerks usage data. This data includes statistics about top-selling products, the number of customers using it, and its effectiveness.

aislePerks utilizes APIs of Mist wireless networks to determine a customer's exact location within a store. aislePerks is written in Java for Google Android devices and Swift for Apple iOS devices. Our backend system is hosted on Microsoft Azure. Our companion administrative dashboard is written in AngularJS.

meijer®

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Michigan State University HPCC
Simplifying High Performance Computing

The MSU High Performance Computing Center (HPCC) provides large-scale computing resources for university researchers as well as industry leaders trying to solve complex problems.

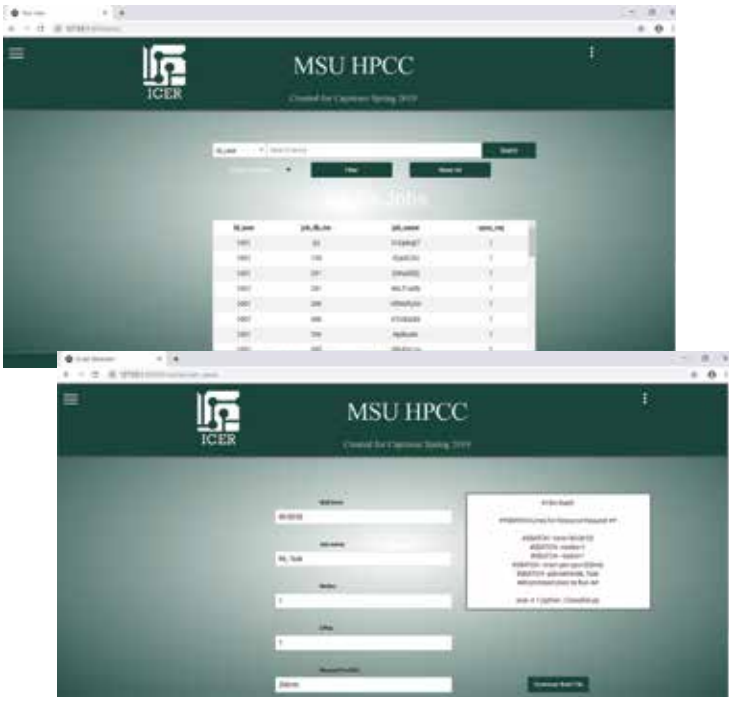
The HPCC is a cluster computer, which means many computers are brought together to form a single computer system. A cluster can do much more work than a single computer, which is why it is a great resource for research.

Using the HPCC can be challenging for people without a technical background. Users don't have a simple webpage on which to do their work and often must learn to write code for menial tasks.

To make high performance computing more accessible, our Simplifying High Performance Computing application creates a simple user interface for researchers to do their work. Users view helpful statistics and information about their work. Head researchers also view information on the work their employees are doing.

Computer code for certain tasks is automatically generated for users, which frees scientists to focus on the research that's important to them. It also has the potential to provide a "sandbox" environment not connected with the HPCC cluster, which allows researchers to test and evaluate their work.

Our Simplifying High Performance Computing app makes high-performance computing more accessible and abstract technical details more understandable. Our web app is built using Python, JavaScript, HTML, SQL Databases and SLURM.



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Michigan State University ITS
Group Project Organization and Scheduling

Michigan State University is a public research institution founded in 1855. The goal of its Information Technology Services unit is to deliver and maintain effective technology resources for students, faculty and staff.

All students frequently take part in group projects. This is frustrating because finding the best way to communicate, setting up meeting times, and managing resources used for the project is very difficult.

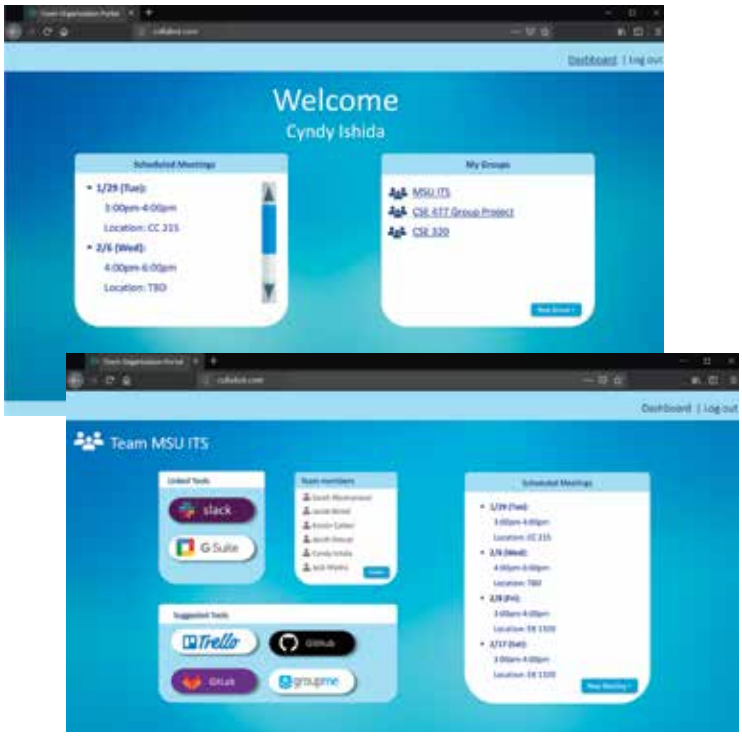
Our Group Project Organization and Scheduling app reduces the stress of these tasks in a quick and simple way by allowing a user to create a group, easily add members, and connect with any services they find useful for their project.

The user simply clicks to create the group, invitations are sent out, and the tools selected are automatically configured. A team portal is revealed, displaying scheduled meetings, linked tools, and suggested tools the group may find useful.

The main feature of our app is the ability to schedule meetings based on a user's linked calendar, whether it is Google Calendar or Outlook Calendar.

The scheduling algorithm finds available times from the individual calendars and proposes times which work for all or most members. After approval by a group member, the new meeting time is added to a list of scheduled meetings.

Our web app is built with the Serverless Framework and calls to Amazon API Gateway endpoints to invoke AWS Lambda functions written in Python. Our user interface is constructed with Vue.js and Bootstrap, served from a public Amazon S3 Bucket.



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Mozilla Corporation
Optimizing Firefox Localization

Mozilla's mission is to ensure the Internet is a global public resource, open and accessible to all. Mozilla is most well-known for its browser Firefox, their main effort in making this vision a reality.

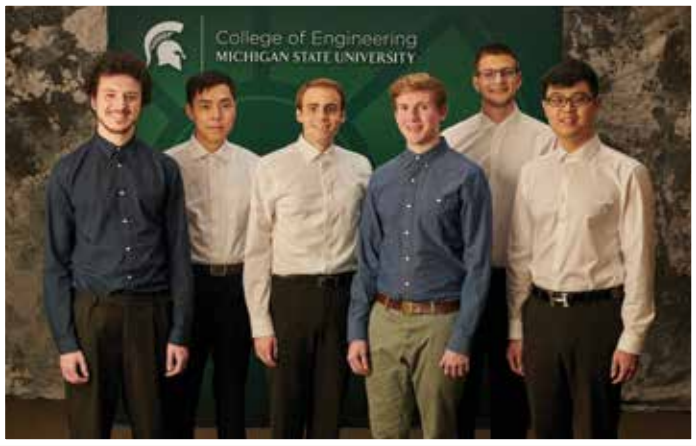
Firefox, with its more than 250 million active users, is available in 98 languages. However, only 40 percent of those users consider English their primary language. Previously, in order to change Firefox to a new language, users were required to select the new language and restart the browser.

To make changing languages easier, Mozilla created Fluent, a new technology that allows the Firefox interface to have more natural sounding and culturally appropriate translations. This type of translation is called localization.

Our Optimizing Firefox Localization tools enable Firefox developers to work more efficiently, spending less time catching small mistakes and more time integrating Fluent.

Our tools use a cutting-edge technology called WebAssembly, which is a new computing language designed specifically for modern web browsers like Firefox. WebAssembly speeds up the time to load Firefox in different languages. Translation to a new language is made with a simple setting change in the browser.

Optimization of the localization system is achieved by the integration of a Rust implemented parser through the use of WebAssembly, a version of JavaScript that achieves near native performance. These two factors decrease the time it takes to switch Firefox to a new language by one to two orders of magnitude.



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MSU Federal Credit Union
AutoBudget Chatbot

Since 1937, Michigan State University Federal Credit Union (MSUFCU) has offered financial services to members of the MSU and Oakland University communities. MSUFCU is the largest university-based credit union in the world, with nearly 900 employees and more than 265,000 members.

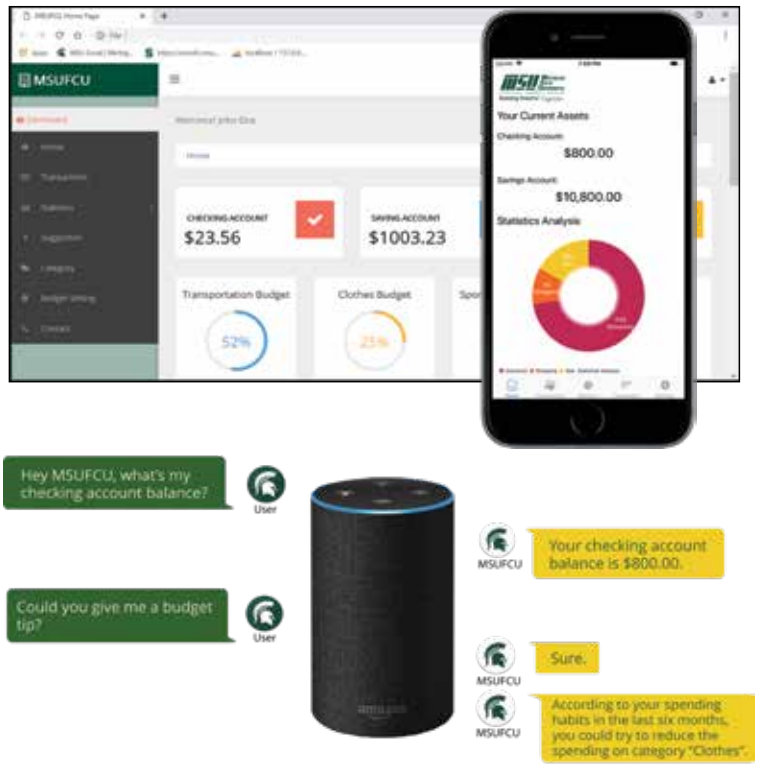
With the evolution of financial tools comes a need for a tailored, more personalized user experience. MSUFCU currently offers robust home banking and mobile apps for members to connect with their accounts, check their balances, transfer funds, move money, and more.

However, these apps have not provided a personalized budgeting solution to assist members with their financial planning needs. MSUFCU has enhanced its services with our AutoBudget Chatbot, a voice-enabled tool that helps members get their financial worlds in order.

Our AutoBudget Chatbot provides members with a suggested budget based on their income and spending patterns. The chatbot also allows members to categorize their transactions and provides a graphical overview of the member's transactional trends. Members can set spending goals for any number of categories while the app helps them stay on track.

Our AutoBudget Chatbot is available on Alexa and Google Home devices, all web browsers, and mobile devices running iOS or Android.

The iOS app is built using Swift, the Android app is built with Java, and the website is primarily HTML, CSS and PHP. All applications call an API running Node.js.



MICHIGAN STATE UNIVERSITY FEDERAL CREDIT UNION
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Principal Financial Group
Integrated Analyst Ratings and Notes

The Principal Financial Group is an investment management and insurance company, with offices located in 19 countries. It welcomed 2019 with $626.8 billion in assets under management.

A major key to the company's success is the investment information generated by its financial analysts. Analysts generate reports on investment opportunities, thus ensuring that Principal is managing its assets in the most effective way possible.

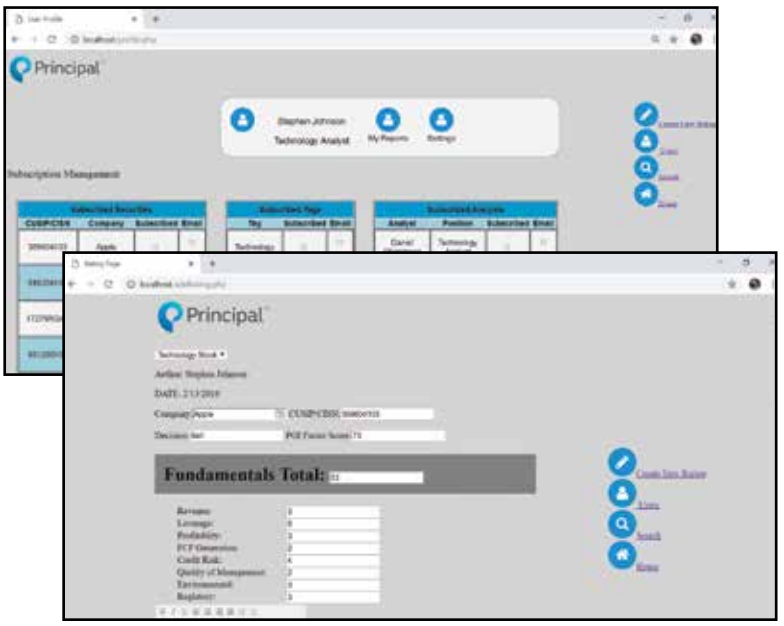
Our Integrated Analyst Ratings and Notes system is a web app that aggregates Principal's divergent reporting systems into a single, comprehensive tool.

This allows analysts to more easily search through company and investment ratings and update the ratings if necessary. Analysts find they spend less time filling out forms and more time making data-driven decisions. The improved report viewing interface provides a central location for all report analyses, while also maintaining historical ratings.

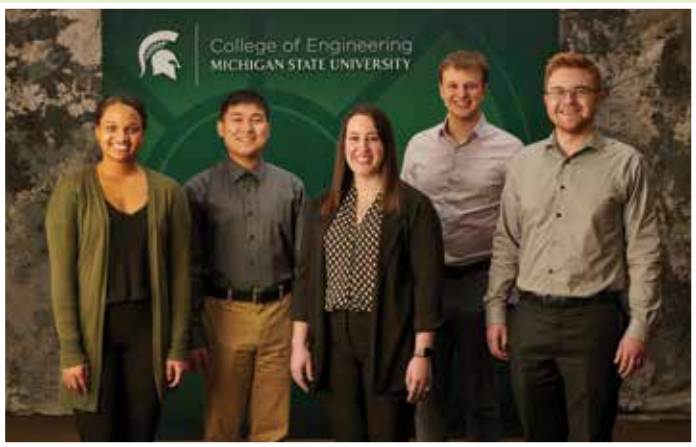
Our app also improves collaboration between analysts, making access to imperative data widely available. Ratings and notes are easily accessible through the notification, feed and search functions.

In addition, analysts have the option to subscribe to investment portfolios, securities, user-generated tags or other Principal analysts to receive up-to-date information regarding the most vital investments.

Our app is built using PHP, Python, CSS, JavaScript and HTML, and is supported by a PostgreSQL database backend.



Principal



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Proofpoint
Defeating Malware Payload Obfuscation

Proofpoint is a leading cybersecurity firm which provides comprehensive, cloud-based security that protects organizations from malware threats.

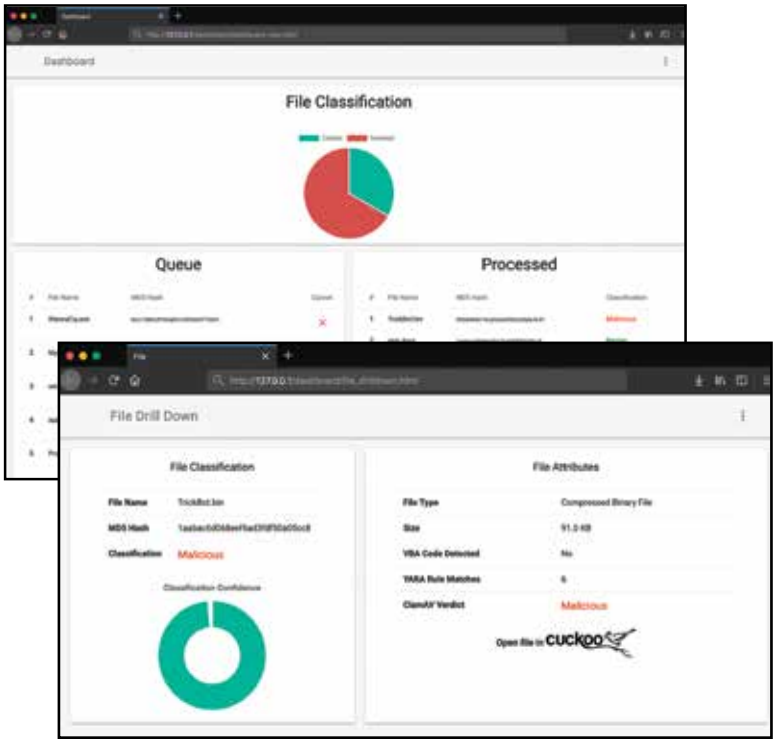
Every day, Proofpoint stops billions of attacks on email, mobile apps and social media accounts. This massive volume of attacks requires an efficient method for detecting malware.

Our Defeating Malware Payload Obfuscation platform provides a faster and more efficient way to determine whether incoming files are benign or malicious. Our system utilizes a machine learning approach to detect and neutralize malware payloads.

Among other things, our platform detects so-called obfuscated malware, in which an attacker hides malware in a seemingly innocent document, such as a photo. Such a diagnostic process can be difficult and expensive. By handling different file types separately, our machine learning algorithm quickly and accurately classifies a wide range of malware files.

Our platform includes a companion web dashboard that displays basic system information, including a system health information page, and pages that examine details of the classification of an individual file and allow the user to submit files manually to be analyzed.

Our backend platform uses a Python controller to extract metadata from different file types and feeds that information into our machine learning algorithm running Keras, Tensorflow and scikit-learn to make a classification. Our web dashboard uses Flask for the backend, and Bootstrap, HTML and JavaScript for the frontend.



proofpoint™

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Spectrum Health
Patient Training Tool

Spectrum Health is a not-for-profit health care provider based in Grand Rapids, Michigan, consisting of 12 hospitals and over 140 service sites throughout the state.

Among its offerings are urgent care and ER services, MedNow, for virtual doctor appointments, and eVisit, an online questionnaire in which a health care provider provides a diagnosis and treatment plan.

Many patients are not aware of these services and will instead head directly to the emergency room. These visits are usually unnecessary, can be overly expensive for both patient and provider, and could lead to longer wait times for all.

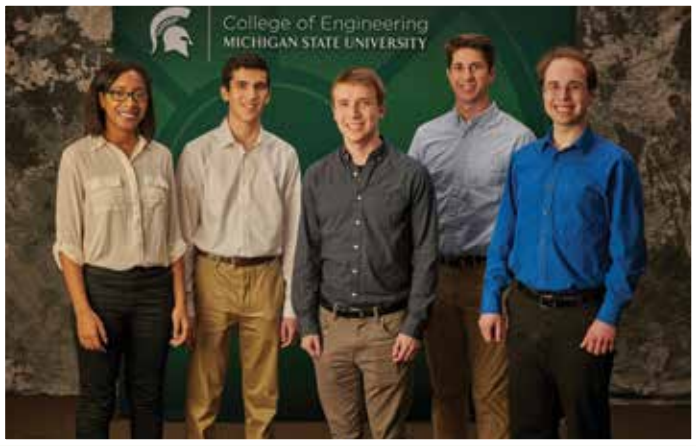
To combat this, our Patient Training Tool is a chatbot app that recommends the appropriate Spectrum service based on the symptoms the patient is experiencing.

After a patient speaks to the Google Home device, describing their symptoms, our Patient Training Tool searches through a database and identifies the condition that best matches those symptoms. It relays the matching condition to the patient in easy-to-understand terms and recommends the appropriate service.

The recommended service for a condition may change based on patient choices. Once recommended a service, the patient accepts or rejects the recommendation, informing the Google Home device of the service that will be utilized. If an alternative service is repeatedly chosen for a condition, the Patient Training Tool changes its recommendation to match for all future users.

Our Patient Training Tool, compatible with both Google Home and Amazon Alexa, is written in JavaScript using the Node.js framework to query an Azure SQL database. Dialogflow is utilized for natural language processing.

SPECTRUM HEALTH



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Surge Solutions
xOS: Visualization of Automated Underwriting

Surge Solutions is a Michigan-based technology company whose goal is to provide custom software solutions for its clients. It utilizes cloud technology to create quick and creative results.

In the financial world, moneylending is challenging and complex. Lenders want their investments to be risk-free; borrowers want to make the right decisions. Efficiency, accuracy and speed are attained with the automation of the underwriting process.

To assist its clients in the lending industry, Surge is utilizing our xOS: Visualization of Automated Underwriting applications. Our product consists of two user-friendly web apps designed to streamline the underwriting of loan products, product recommendation and risk analysis.

Clients provide their financial information to the product-recommendation app, which searches for all products that match their needs. The best-fitting product is suggested, together with similar alternative products, with the ultimate goal of providing clients with the best loan option that meets their needs.

Loan officers also use our risk analysis app to visualize the change in risk and net benefit to the company as a result of changing loan guidelines. With the use of a tree structure, parameters are easily and quickly visualized and altered.

Our xOS: Visualization of Automated Underwriting application frontends are built using React and D3 in JavaScript. Our backend is accessed via a REST API and is hosted on Amazon Web Services.

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Technology Services Group
Multi-Video Case Management

Founded in 1996 in Chicago, Technology Services Group (TSG) focuses on helping companies manage their data and business processes. Today, TSG has many clients across a wide range of industries and is a leading provider of content management solutions.

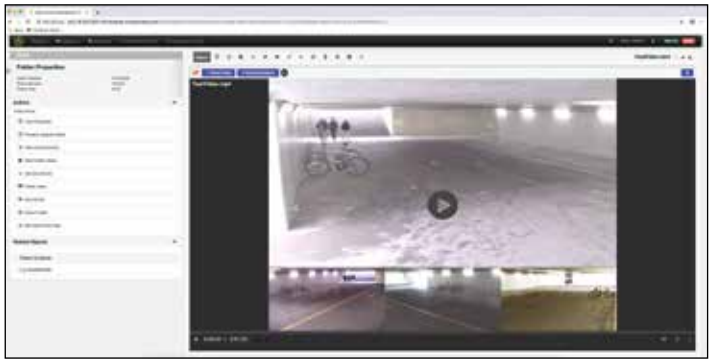
Clients of TSG include insurance companies, whose claims agents must quickly deal with incidents that often contain large amounts of security video footage. These incidents can include anything from the theft of a bicycle to a multi-vehicle accident. Claims agents can spend large amounts of time searching for important pieces of security videos in order to sum up an incident.

Our Multi-Video Case Management tool helps clients more efficiently deal with cases containing multiple videos.

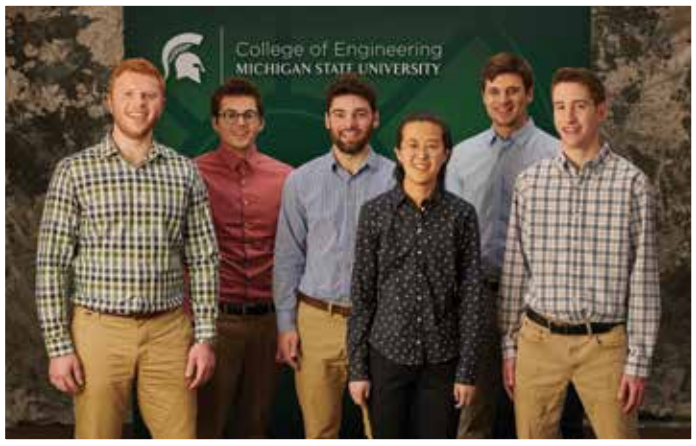
Our tool includes a feature known as Add Videos, which allows for the quick searching of security videos by prompting users for a location, time and date of an incident. It then retrieves security video files that match the criteria and displays each on an interactive map. Videos can be selected and added into the case folder by the user.

Multiple videos are then merged together into a single view, showing all angles of the incident using the Merge Videos feature. The merged video shows the most relevant video, based on annotations assigned by the user.

The Add Videos action is built with OpenContent Web Services (OC) and the Google Maps API provides the interactive map. The Merge Videos action is built with OC and uses FFmpeg as the video manipulation tool. The backend for both consists of DynamoDB, S3 and Solr.



technology services group



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TechSmith
Internal Telemetry for TechSmith Products

To help its customers communicate more effectively, TechSmith assists in the creation of images and videos. Its flagship products, Snagit and Camtasia, are used by more than 30 million customers.

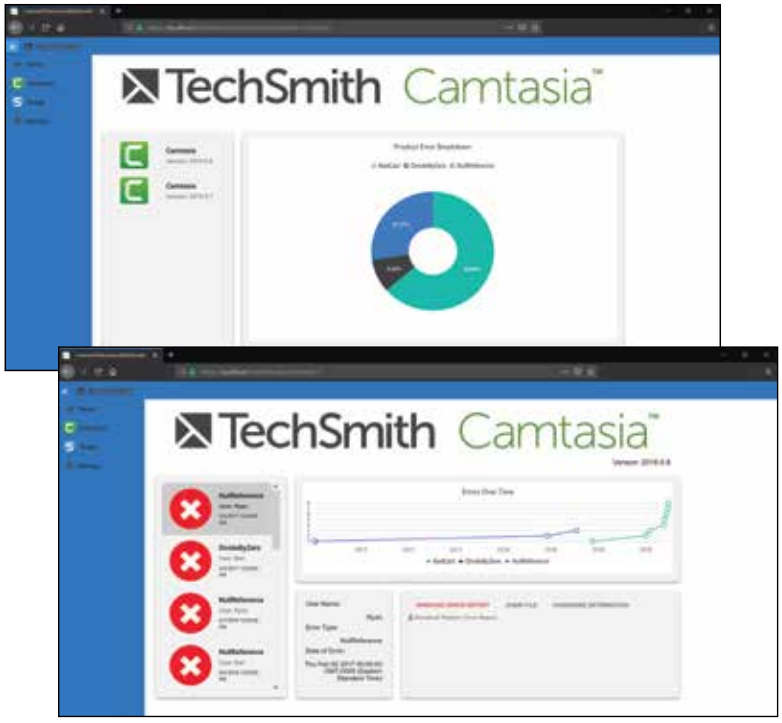
While TechSmith prides itself on providing a superior product to its customers, like all companies, problems sometimes arise.

For example, when an app crashes, customers can submit a report so that TechSmith can investigate. Often these reports don't provide the best or enough information.

Our Internal Telemetry for TechSmith Products collects crash reports from multiple sources, gathering as much relevant information as possible. It then sends the combined crash report to a database, where an automatic notification is sent to the assigned TechSmith development team.

The tech team can then use an internal web portal to access the detailed crash report and associated information from each active product, together with access to a direct download of the report file. This, in turn, makes the diagnostic and repair process more streamlined, more efficient, and more to the customer's satisfaction, as well as resulting in long-range improvements to a product.

Our Internal Telemetry for TechSmith Products is written in C#/C++ and incorporated into Snagit and Camtasia as a dll file. The web portal uses ASP.NET Core and is hosted on Microsoft Azure. The crash report data is stored in an SQL database in Azure. Two prototype applications, modeled after Snagit and Camtasia, are used to demonstrate the working Internal Telemetry.



TechSmith®

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Union Pacific
Railroad Arcade

Union Pacific was founded in 1862. Today it is a leading transportation company, employing 43,000 people, utilizing more than 8,600 locomotives that run on 32,100 miles of track through 23 states.

Union Pacific uses interactive training simulations to help its employees learn how to properly operate its machinery, something known as gamification. Unfortunately, when a new training module is created, each component must be redeveloped, a slow, time-consuming process.

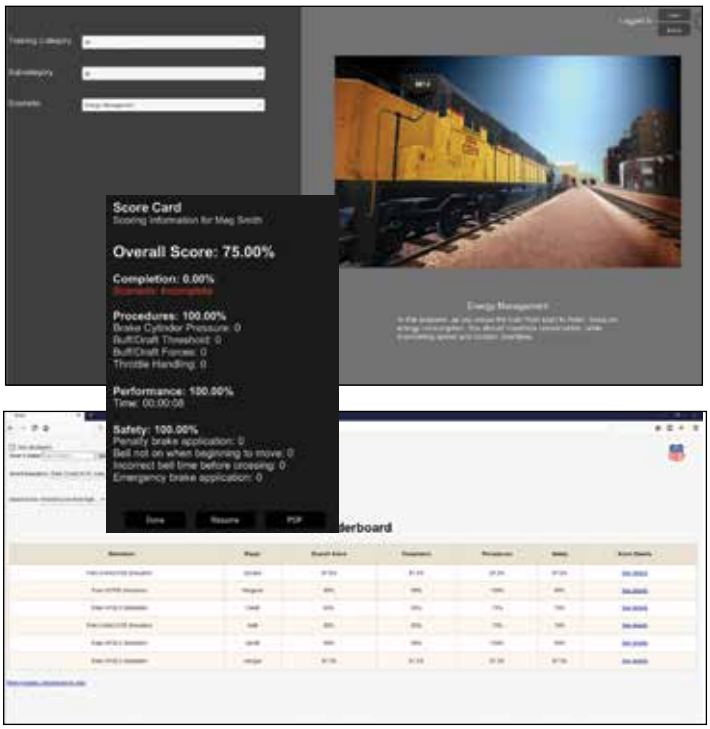
Our Railroad Arcade provides a framework for building training simulation systems. Our framework includes a variety of reusable components such as a main menu, a scoring system and a leaderboard.

Our Railroad Arcade significantly reduces the amount of time needed to develop a training simulation, as well as increases accessibility for a future one. It also allows simulations to be stored in a single location.

We provide both web and Windows applications so that simulations run in both environments. Developers configure our components to fit their needs.

Our framework, with its reusable components, enables Union Pacific developers to create new training simulations without having to reinvent the proverbial wheel. As examples to developers, our system includes three sample games.

The reusable components and sample games in Railroad Arcade are written using C# in Unity. The website is implemented with TypeScript and CSS based on Angular.



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United Airlines
Training Scheduling and Optimization System

United Airlines is a major United States airline, operating 4,600 flights a day out of more than 350 airports.

Having properly trained personnel to maintain its fleet of aircraft is vital to the successful operation of each flight.

In order to maintain a staff of trained personnel, United's Technical Operations division has 60 instructors that deliver some 700 courses to more than 7,000 employees a year.

Our Training Scheduling and Optimization System provides a web app and a mobile app that enable United's schedulers to schedule, instructors to teach, and students to take courses around the country.

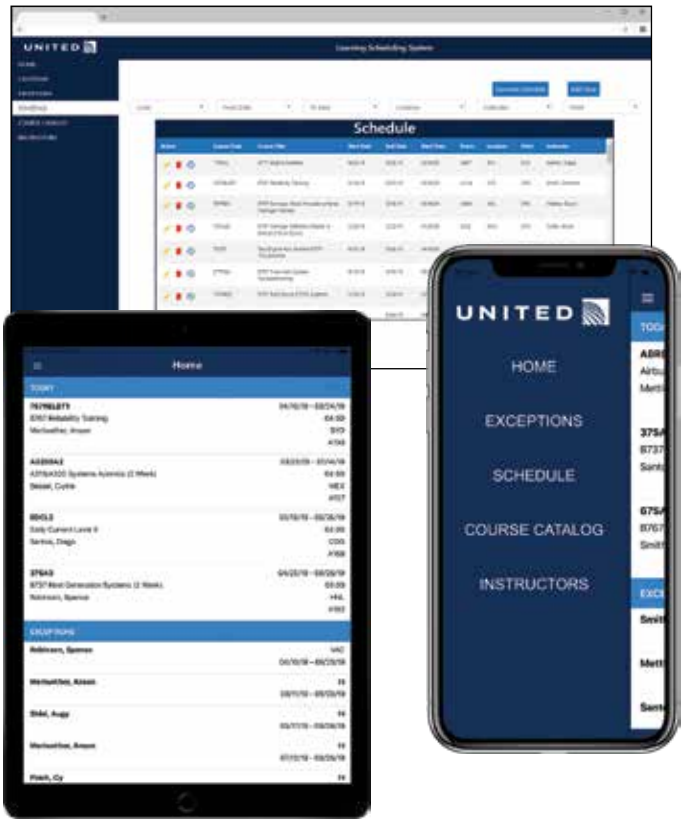
When the scheduler wants to schedule a course, the system automatically displays the available locations and instructors that can be assigned to that course. It allows instructors to track attendance of their classes and generate a completion roster at the conclusion of the course.

Our system includes a schedule optimization system. Using a given set of classes and a timeframe, the optimizer recommends an optimal schedule. This reduces the amount of time it takes for the scheduler to plan courses.

Instructors also can request time off through the system and supervisors have the ability to approve or deny these requests, as well as track their instructors' time.

All of the functionality of our system is available using either our web app or our Apple iOS app with the exception of scheduling, which is exclusive to the web app.

Our Training Scheduling and Optimization System web app is built with ASP.NET Core, Angular 7 and a Microsoft SQL Server database. The Apple iOS app is written in Swift.



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Urban Science
Dealer4U

Urban Science is a Detroit-based company that uses scientific approaches to help solve the problems of modern business. Urban Science provides data-driven solutions to the retail, health and automotive industries.

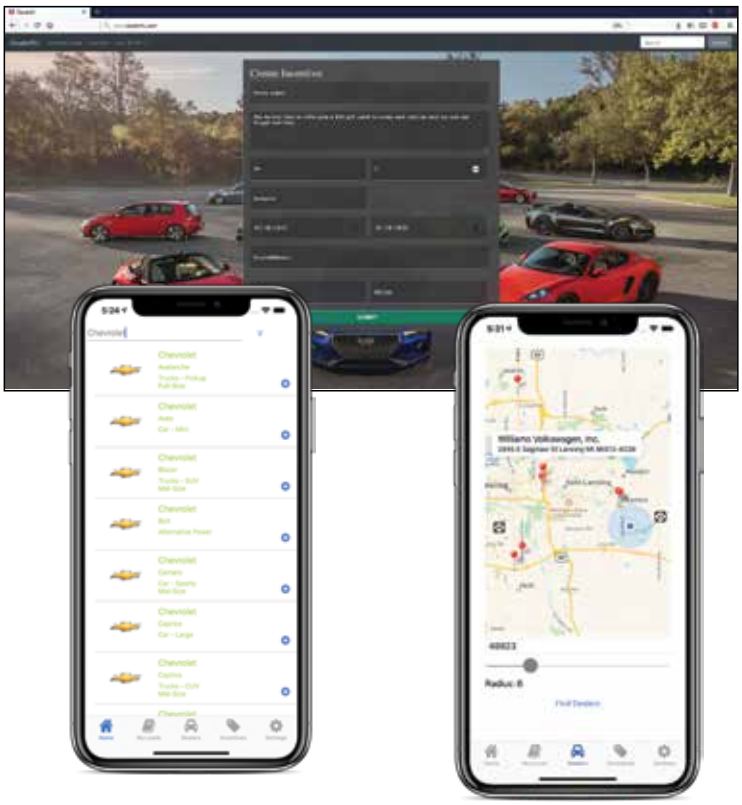
In the world of car buying and selling, customers can identify what a certain dealership has to offer, but dealers cannot readily identify their customers' interests. This puts a burden on the customers and may overwhelm those who are more inexperienced, thereby decreasing the chances of a successful purchase.

Our Dealer4U system is an innovative method of connecting customers with car dealers. Using a mobile app, customers search through inventories of local car dealers, selecting brands and models that interest them. Once completed, it also allows potential buyers to view offers and incentives from dealers on cars that match their selections.

For the car dealer, our app enables them to see leads from customers in their area and create car-buying incentives based on those leads. Once a customer specifies their interests, dealers view them and create incentives designed to lure the customer into the showroom for a test drive and, hopefully, a successful sale.

Dealer4U simplifies and improves the experience of buying and selling cars for all involved.

Our Dealer4U system is accessible by customers through Android and iOS mobile apps, and by dealers through a web app. The mobile apps are written with Xamarin, and the web app is written with Angular. The backend uses ASP.NET Core, and the data is stored on a MongoDB database.



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Volkswagen Group of America
Cognitive Enterprise Software Robots

Volkswagen Group of America is the North American operation headquarters and subsidiary of the Volkswagen Group, which is comprised of 16 brands producing a variety of cars, motorcycles and commercial vehicles.

Volkswagen uses sophisticated robotic automation in direct manufacturing processes. By contrast, the indirect and administrative processes are yet to be automated on a large scale. With a workforce of over 600,000 employees, roughly 400,000 workers spend much of their day executing repetitive tasks.

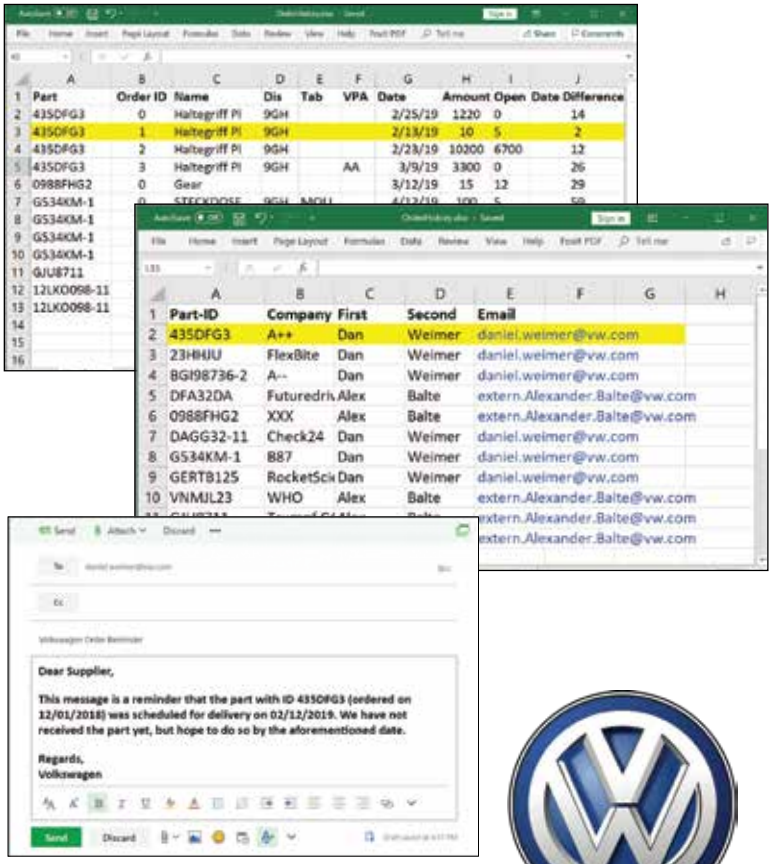
Our Cognitive Enterprise Software Robots, referred to as softbots, take over manual work a human is performing on a computer and act as an intelligent co-worker.

For example, a Volkswagen Logistics Specialist spends several hours a day contacting suppliers to ensure all deliveries arrive on time. An employee must continuously look up shipments in a spreadsheet and compare the expected delivery date with the current date.

If the expected delivery date is five days or less away, the employee must send a reminder email to the supplier that the shipment has not arrived yet.

Using a technique called deep learning, our softbots learn a business process and execute it on the human's behalf. The employee is now able to focus on more complex tasks.

Our softbots use a recurrent neural network to predict future clicks in a clickstream. Utilizing natural language processing, the softbots read emails and then perform the appropriate actions.



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Design Day Awards

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

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 Volkswagen
VW Car-Net Demo App

Zebin Liang, Kira Chan, Emily Brent, Cyprian Blunt, Tim Guertin
Presented by Ross Hacker

MSU Federal Credit Union Praxis Award

MSU 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 Proofpoint
Improved Detonation of Evasive Malware

Ian Murray, Ryan Gallant, Jack Mansueti, Sean Joseph, Tae Park
Presented by Ben Maxim

Design Day Judges

Bob Dyksen
Evolutio

Elizabeth Klee
Urban Science

David Norris
TechSmith

Frank Weith
Volkswagen

E.J. Dyksen
Michigan State University

Terry Ledbetter
Meijer

Matt Olmsted
Dow Chemical

Laura Williams
Herman Miller

Rich Enbody
Michigan State University

John Marx
Amazon

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Spectrum Health

Dave Giordano
Technology Services Group

Ben Maxim
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Laura Vetter
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Adam Haas
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Rob McCurdy
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Justin Walker
Surge Solutions

TechSmith Screencast Award

TechSmith®

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

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

Team Auto-Owners
Jeffrey: Virtual Insurance Claim Advisor

Alex Klingel, Nabiha Biviji, Michael Dickmann, Connor Stabnick
Presented by David Norris

Urban Science Sigma Award

URBAN SCIENCE

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 Herman Miller
FIBRE: Fabric Identification Based Recommendation Engine

Joe Smith, Ted Stacy, Ritwik Biswas, Josh Bhattarai, David Xuan
Presented by Elizabeth Klee and Bill Bye

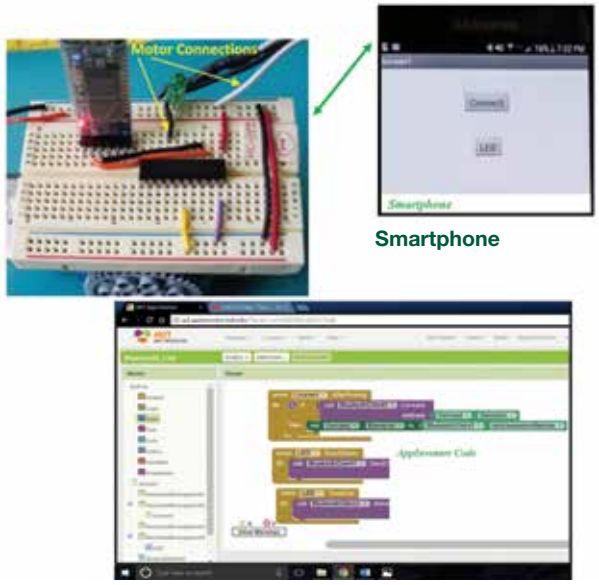
Introduction to Electrical and Computer Engineering

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

Graduate Student Assistant: Yan Gong

Team Members	Project Title
Team #1: Reed Corrin Joe Fantin Lucas Raines	Bluetooth Controlled Car
Team #2: Sophia Cibulka Kathy Gu Ndeye Gueye	Microcontroller Program with Android Device
Team #3: Justin Kuligowski Kartik Soni	Raspberry Pi – Retro Pi
Team #4: David Cisneros Julian Harris Carlisle Jenkins	Map Light Game
Team #5: Kent Bazman Dan Beaudrie Yen-Ling Huang Joey Tyner	Smartphone Controlled House Door Locking Mechanism
Team #6: Anna Citko Mike Kilmurray Hunter Long	Dynamic Password Generation System
Team #7: Seth Ansel Rohit Cheemalamarri Holly Demers Samuel Oladeru	Bluetooth Controlled Vehicle

The Capstone Projects

Dr. John Albrecht
Associate Professor of Electrical and Computer Engineering

Dr. Mi Zhang
Assistant Professor of Electrical and Computer Engineering

Faculty Advisors: Aviyente, Deng, Hogan, Morris, Tan, Wang


Aviyente


Deng


Hogan


Morris


Tan


Wang

Presentation Schedule – Room 2243 Engineering Building, Second Floor

Time	Team Sponsor	Project Title
8:30 a.m.	Aptiv	Advanced Analytics & Visualization on Time Series User Experience Data for Infotainment Services
8:55 a.m.	MSU Bikes/RCPD	Intelligent Defense System: Hazard Detection & Collision Avoidance
9:20 a.m.	MSU RCPD	Jungle Power Pod: A Photovoltaic Battery-Powered System for Common Portable Electronic Devices
9:45 a.m.	Michigan State University	Robotic Crop Weeder
10:10 a.m.	MSU Rocketry Club	Rocket Elevation Control
10:35 a.m.	MSU College of Engineering	Voice Fitbit
11:00 a.m.	NDE Lab	Wireless Sensor Network for Water Quality Monitoring

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:

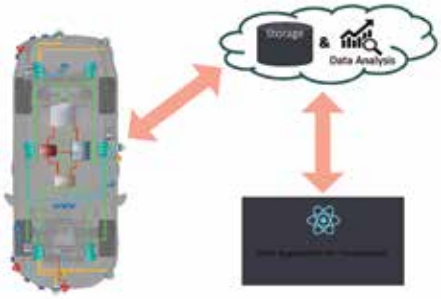
- Putting into practice the technical skills learned in the classroom, on industrially sponsored team projects, under faculty guidance, doing open-ended design, giving them experience in teamwork, project management, product life cycle management, intellectual property, accommodation issues and entrepreneurship;
- 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.

Aptiv: Advanced Analytics and Visualization on Time Series User Experience Data for Infotainment Services

Aptiv is a Global Technology company headquartered in Dublin, Ireland. It employs over 6,400 engineers and scientists across 45 countries working in four major technical centers, as well as ten manufacturing sites and customer support centers. It has revenue exceeding $3.5 billion.

Analyzing infotainment data can be inconvenient because data must be collected from a port in each vehicle, which is a time-consuming process. Recent developments have made it more efficient for the vehicle to send data to a database using the cloud.

Our team was tasked with creating a database, a REST API, and a web platform. The goal is to have a working web application that analyzes and visualizes infotainment system data.



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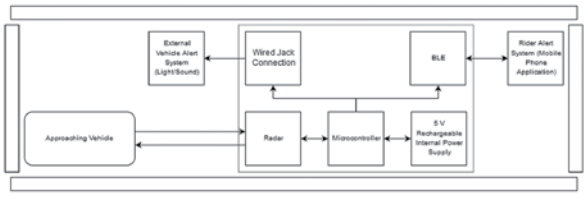
Selin Aviyente

MSU Bikes Service Center/RCPD: Intelligent Defense System: Hazard Detection and Collision Avoidance

Throughout the world, cycling and walking are some of the most common methods of transportation today. In 2013 in the United States, 4,735 pedestrians were killed in traffic accidents and people with disabilities suffered a higher chance of injury. Again, in the US, in 2015, there were 818 fatalities and 45,000 injuries involving cyclists and automotive vehicles. The goal of the HDCAS is to reduce the number of cyclist and pedestrian injuries and fatalities using a radar-based detection system. We seek to provide an affordable, effective, and durable solution to enable bicyclists and pedestrians to improve their awareness of hazards and to reduce the risk of collisions.

Our team was tasked with designing a system that detects hazards, such as vehicles, approaching from behind. Continuing the success of last semester's team, we worked on a system which is comprised of a radar sensor and microcontroller with a Bluetooth Low Energy (BLE) interface to a phone application to alert the user of incoming hazards. The oncoming vehicle will be alerted through a series of lights and sound connected via a jack from the main sensor and controller.



RCPD
Maximizing Ability & Opportunity

BIKES

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MSU Resource Center for Persons with Disabilities

Jungle Power Pod: A Photovoltaic Battery-Powered System for Common Portable Electronic Devices

An estimated 16% of the world's population has little or no access to electricity. The majority of this population resides in developing nations. Solar power systems have become increasingly popular in recent years due to the growing demand for reliable energy. However, the present method for utilizing solar power in off-grid applications has high initial cost, limited energy storage, and lacks robust electrical and mechanical designs.

Our team is tasked to design, develop, and test a low-cost, photovoltaic battery-powered charging system for small electronic devices for use in hospital rooms at the Bombardopolis Health Center, Haiti and the surrounding households.

The wall mountable, portable and compact design solution includes common USB, coaxial, and cigarette charging ports. The design will be easily mass producible which can provide scalable business opportunity for individuals in low income third world settings. It is comprised of a microcontroller-based monitoring and warning system to display energy consumption, warn the user when units consumed fall below a predetermined value, and automatically shut down the system at the critical consumption limit. The user interface will be accessible to visually and hearing impaired persons. Through this proposed design, users will get an affordable power system capable of charging multiple devices.

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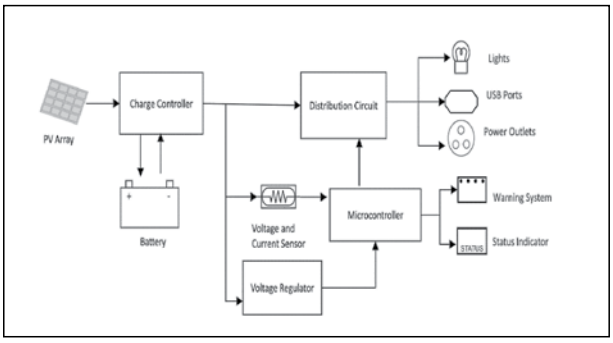

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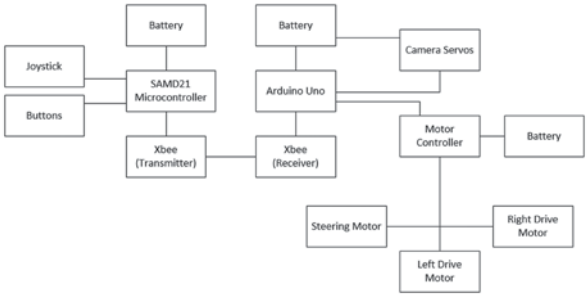
Michigan State University
Robotic Crop Weeder

Weeding is a time-consuming and labor-intensive task for farmers. An autonomous weeding machine is proposed to help alleviate this.

A prior Electrical Engineering capstone team installed a camera, built a manually powered cart, and implemented a robotic arm to uproot weeds.

Our team is continuing that work by enabling the cart to move, steer and be wirelessly controlled using a joystick. The cart must have a battery life of 30 minutes or greater, have a top speed of at least three mph and be able to be wirelessly controlled from 50 feet away.



MICHIGAN STATE UNIVERSITY

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Marcel Meijer
Commerce, Michigan

Michigan State University
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Vaibhav Srivastava
East Lansing, Michigan

Project Facilitator

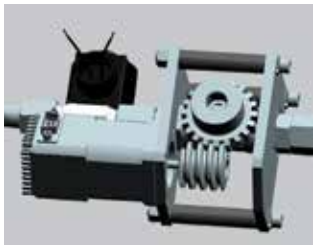
Xiaobo Tan

MSU Rocketry Club
Rocket Elevation Control

MSU Rocketry Club is building a student researched and designed hybrid-fuel motor to compete in the 2019 Spaceport America Cup. The object of the competition is to launch a rocket carrying a 10-pound payload to an altitude of 10,000 feet. The team with the highest accuracy wins.

The rocket motor has a combustion chamber and an oxidizer tank. The SA cup rules require our team to remotely fill the oxidizer tank, disconnect the fuel hose, and drain the oxidizer tank. We will also need to achieve maximum precision of the rocket's altitude. For this, it is desirable to have a controlled cutoff of the oxidizer flow into the combustion chamber. This will extinguish combustion, halting thrust and resulting in the slowing of the rocket as it approaches apogee.

Our team must design and build a mechanism for remotely filling, disconnecting, and draining the oxidizer tank from an external port. To control rocket elevation, a flight computer must continually read measurements on altitude, tilt, acceleration, and atmospheric pressure, and use this data to derive a trajectory curve given its current state. If the maximum of the curve is near 10,000 feet, it will close the valve to halt thrust. We must be able to wirelessly control these processes at a distance of up to two miles.



MSU ROCKETRY

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MSU Rocketry Club
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Project Facilitator

Tim Hogan

MSU College of Engineering Intelligent Sensing & Mobile Systems Group: Voice Fitbit

Wearable fitness trackers, such as Fitbit, are devices capable of monitoring the physical activity of the individual wearing it. Most of them are worn as a watch. These devices can monitor activity parameters such as heart rate, quality of sleep, steps taken, etc. These measurements can provide a good overview of the physical health of the individual wearing the device, and can notify the user of any abnormal or unhealthy patterns.

Our team was tasked to create a device that can detect human voice and then determine if the person speaking into the device is the one that is pre-programed into the device. The device will continuously run during the day to detect the user. The prototype will use machine learning algorithms and spectrogram analysis to detect the human voice. This device will be wearable for day-to-day use.

voice fitib

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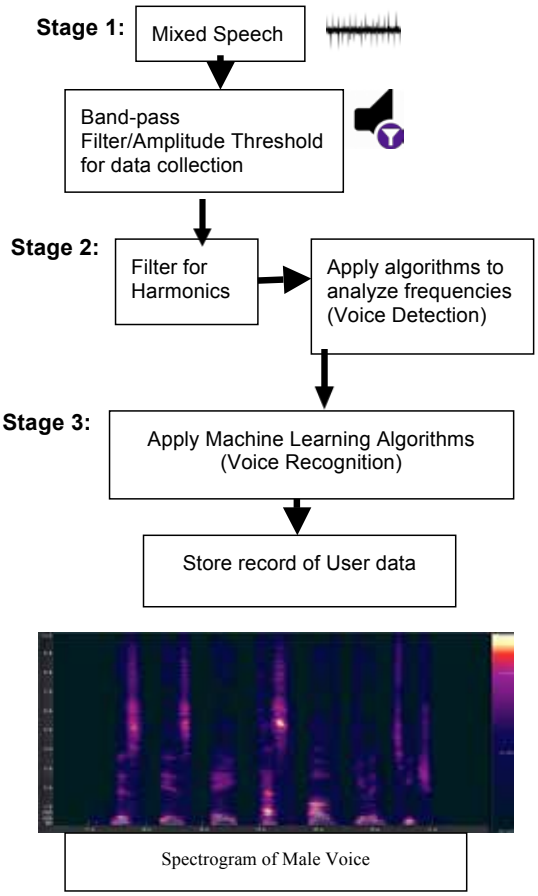

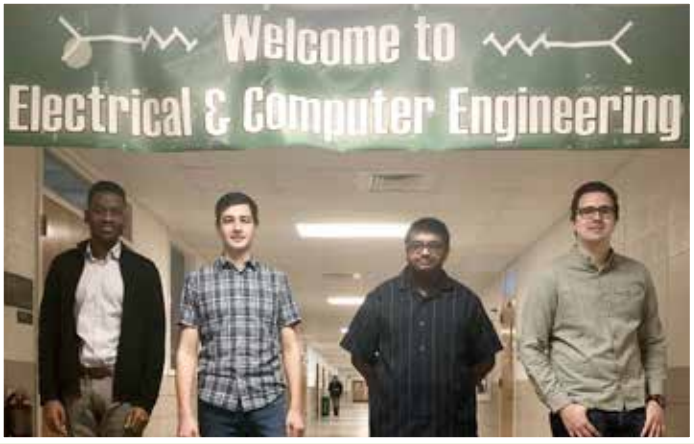

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MSU College of Engineering Intelligent Sensing & Mobile Systems Group
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Project Facilitator

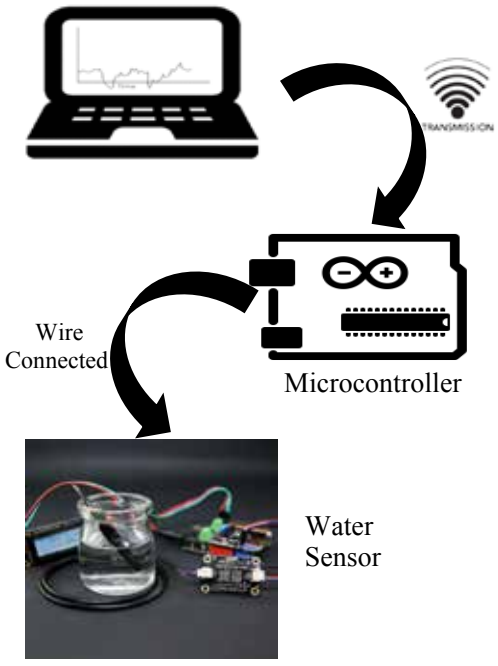
Mi Zhang

MSU Nondestructive Evaluation Lab: Wireless Sensor Network for Water Quality Monitoring

Wireless sensor network (WSN) refers to a group of spatially dispersed and dedicated sensors for monitoring and recording the physical conditions of the environment and organizing the collected data at a central location.

In recent years, more and more people have been affected by water pollution. The traditional method of measuring water quality is using the portable analysis devices which need to be operated manually. However, these types of devices are unable to perform real-time monitoring and the collected data is difficult to transfer to other devices. Those limits make it inconvenient to measure the water quality accurately and efficiently.

Our team is working on developing a wireless sensor network which can monitor the real-time water quality. This device should be able to receive data from other sensors and display the water quality collected from different locations in real time. The sensors are connected to one Arduino board, and signals are transmitted to PC through Wi-Fi. A program will be designed to control the data collection and signal transmission. Then software will be created to display and analyze the data. In addition, it will report an enormous variation in water quality.



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Yiming Deng

The Capstone Projects

Dr. John Albrecht
Associate Professor of Electrical and Computer Engineering

Dr. Mi Zhang
Assistant Professor of Electrical and Computer Engineering

Faculty Advisors: Aslam, Baryshev, Mahapatra, McGough, Rothwell, Salem


Aslam


Baryshev


Mahapatra


McGough


Rothwell


Salem

Presentation Schedule – Room 2245 Engineering Building, Second Floor

Time	Team Sponsor	Project Title
8:30 a.m.	Michigan State University	Autonomous Snowblower
8:55 a.m.	MSU CSANN Lab	Deep Neural Networks for Navigation Rovers for Sound/Image/Video Classification
9:20 a.m.	Fraunhofer	Measurement of Diamond Substrate Top Surface Shape
10:10 a.m.	NASA/ASU (joint with ME 481)	Neutral Flux Detector Probe
10:35 a.m.	Niowave	Energy Stability for High-Power Superconducting Electron Accelerators
11:00 a.m.	Fraunhofer	Sound Emission Measurement – Diamond Polishing
11:25 a.m.	MSU College of Engineering	Design of a Dynamometer for Electric Bicycle Testing

ECE 480 Senior Design

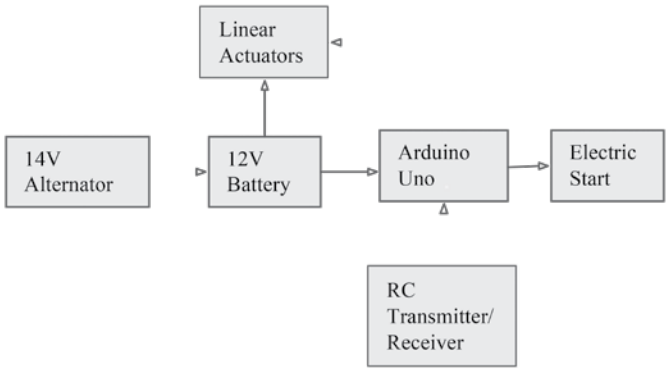
We gratefully acknowledge the support of this semester's project sponsors: Aptiv, Arizona State University, CSANN Lab, Fraunhofer, MSU Bikes Service Center, MSU College of Engineering, MSU Recycling, MSU Resource Center for Persons with Disabilities, MSU Rocketry Club, NASA, NDE Lab, and Niowave. Thank you to each of these team sponsors.

The ECE project facilitators who supervised ECE 480 teams this semester are: Dean Aslam, Selin Aviyente, Sergey Baryshev, Yiming Deng, Tim Hogan, Nihar Mahapatra, Robert McGough, Daniel Morris, Edward Rothwell, Fathi Salem, Xiaobo Tan and Bingsen Wang.

Michigan State University
Autonomous Snowblower

Clearing snow from residential sidewalks and driveways can be hazardous and create potential safety and health risks, such as heart attacks, for homeowners.

To help alleviate this, our team worked to develop an aftermarket "kit," which modifies an existing snowblower to make it autonomous, or controllable via tablet. We plan to add functionality to start and stop the engine, control the auger and chute, and initiate and halt forward motion. We will power this with a 12V battery that is recharged by a 14V alternator connected to the gas engine, and control it with a Radio Control system attached to an Arduino. Our project will have implications for future autonomous snowblowers.



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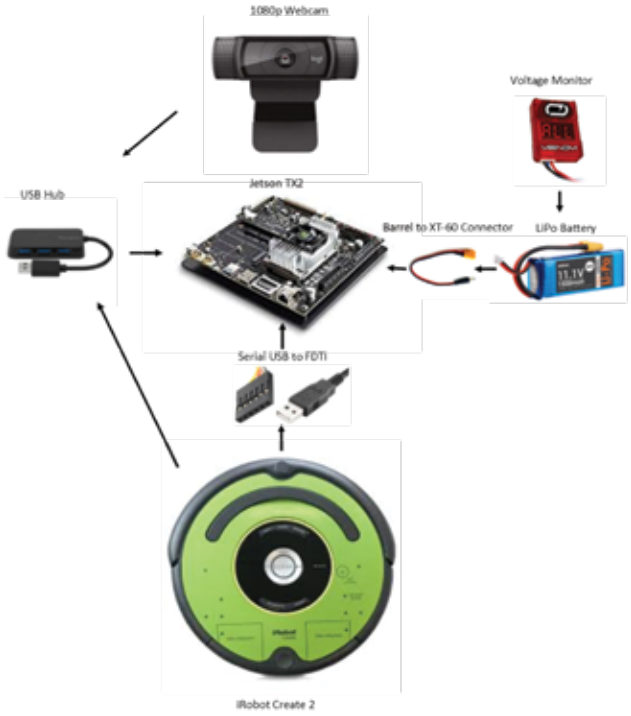
Dean Aslam

MSU CSANN Lab: Deep Neural Networks for Navigation Rovers for Sound/Image/Video Classification

Advancements to deep neural networks and dedicated processing resources such as the NVIDIA Jetson TX2 GPU have greatly expanded the potential applications in real time image/video recognition, identification, tagging, navigation etc.

Our team was tasked with exploring a potential application of deep neural networks while being evaluated on real-time classification accuracy, execution speed, and power consumption expense. The goal of this project is to provide movement capability for the NVIDIA Jetson TX2 development board, so image/video recognition can be performed on the go. This allows our team to complete the two main objectives of following a person and scanning a room to find a specified object.

Our solution involves using the iRobot Create 2 and Robot Operating System (ROS) to provide movement capability based on sensor feedback. Meanwhile the NVIDIA Jetson TX2 will handle the processing for real time image/video recognition.



College of Engineering
MICHIGAN STATE UNIVERSITY

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MSU CSANN Lab
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Project Facilitator

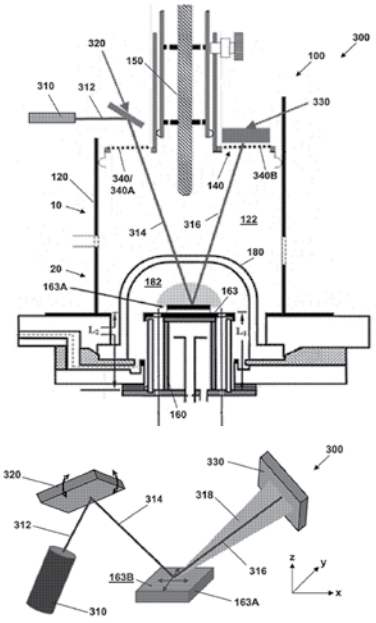
Fathi Salem

Fraunhofer
Measurement of Diamond Substrate Top Surface Shape

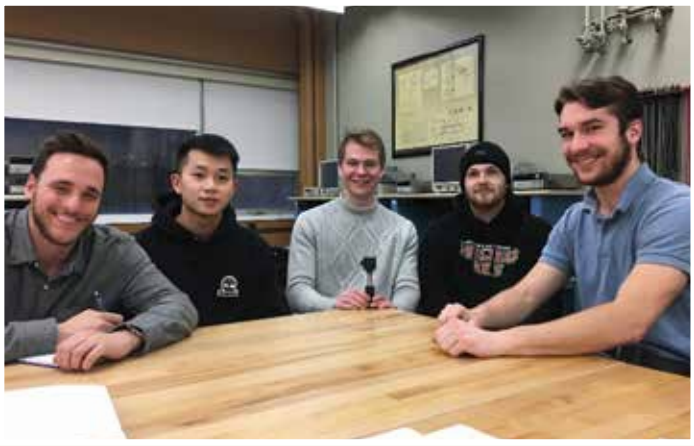
Synthetic diamonds are desirable for applications in circuits due to their extremely high conductivity. The Fraunhofer CCD at MSU studies and improves upon creation processes for synthetic diamonds.

The process for growing diamonds involves depositing carbon atoms on an existing diamond called a substrate. Due to the random nature of the carbon atoms, it is possible that the atoms will not come to rest on the substrate in a crystalline form and a flaw will be created. This greatly decreases the value and utility of a diamond. These defects can be removed from the diamond if caught early enough. In order to detect the defects in sufficient time, there would need to be a method of observing the progress of the diamond as it is growing.

The proposed system to be used to observe the surface of the diamond is a laser to be reflected off of the surface of the growing diamond onto a detector which will measure the intensity of the laser. A constant intensity is a sign that the diamond is growing evenly without any problems. A decreasing intensity is a sign of roughness or other defects forming on the surface of the diamond due to their interference with the laser's reflection.



Fraunhofer USA



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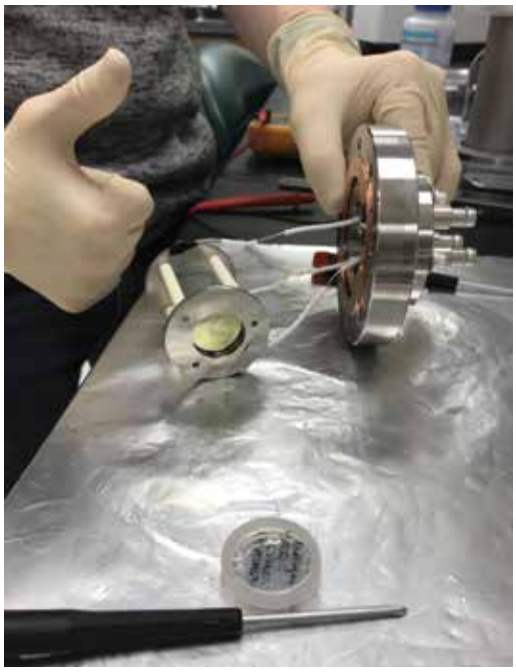
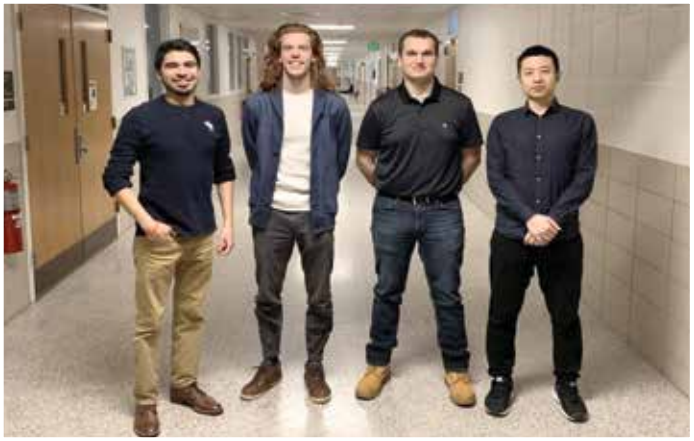
NASA/Arizona State University
Neutral Flux Detector Probe

Psyche is the name of a metal-rich asteroid orbiting the sun between Mars and Jupiter. The NASA Psyche Mission is planned to launch in 2022 and arrive at the asteroid in 2026. The objective of the mission is to view a previously unexplored object and look for building blocks of a terrestrial planet.

The Neutral Flux Detector Project, which will be used to help with the Psyche Mission, is sponsored through NASA in collaboration with Arizona State University (ASU). The project objective for this semester is to continue the work performed by the MSU capstone students in the Fall semester, and it is a joint project with an MSU Mechanical Engineering capstone team.

The focus for this semester is to design, prototype, and calibrate the probe. The probe must be able to maneuver and measure the flux of neutrals inside NASA's vacuum test facility. The probe will be utilized to assist the engineers at NASA and ASU in obtaining the true efficiency of the spacecraft's thrusters while being tested. It is essential to know the thrusters' true efficiency for accurate calculations of events and mission longevity. Psyche will be equipped with a set of Hall Effect Thrusters (HETs) in order to reach the asteroid. Since the journey is so far, the spacecraft will need a long-lasting energy supply, thus Psyche will utilize this type of solar-electric low thrust propulsion.





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Zhen Liu
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NASA/Arizona State University
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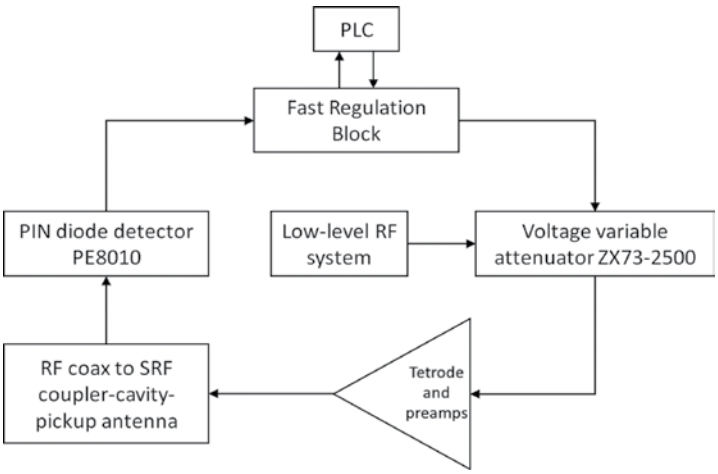
Sergey Baryshev

Niowave: Energy Stability for High-Power Superconducting Electron Accelerators

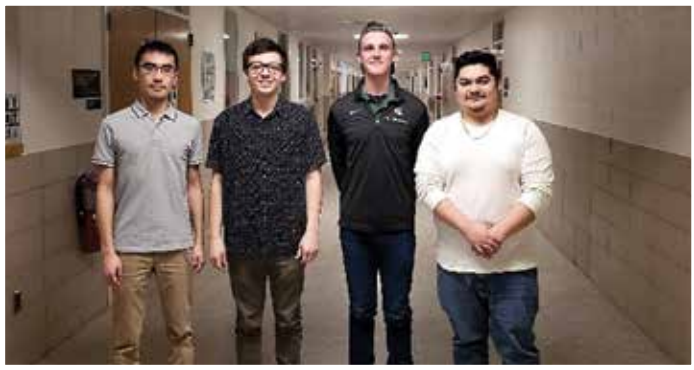
Niowave, Inc. in Lansing, Michigan is a spin-off from Michigan State University dedicated to the production of medical radioisotopes, which include molybdenum-99, using high-power superconducting electron accelerators.

The behavior of an electron beam in an accelerator depends on its energy. Instabilities in the energy of the electron beam make the accelerator difficult to operate. Some of these fluctuations result in positive feedback – where loss of beam current results in a rise in electric field strength inside the cavity, which then causes further beam loss.

Our team's objective is to design a controller that is fast enough to maintain stability in the energy of the electron beam. The controller will communicate to the voltage variable attenuator (VVA) that will throttle the power to handle the disturbances. The controller will be able to communicate to the operator via a programmable logic controller, which will allow for manual operation.



NIOWAVE
Accelerating Your Particles



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Niowave
Project Sponsor

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Edward Rothwell

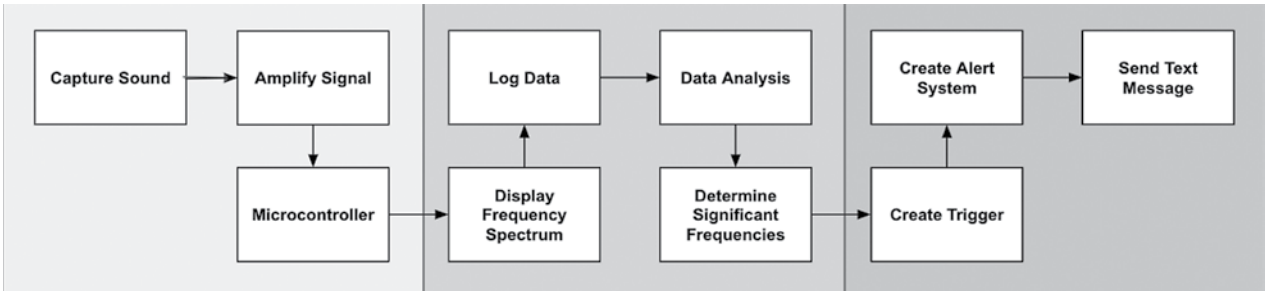
Fraunhofer
Sound Emission Measurement – Diamond Polishing

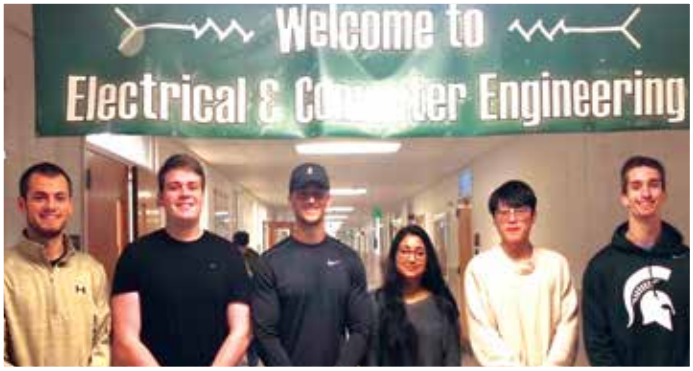
Michigan State University and the Fraunhofer Center have worked together to synthetically produce diamonds for use in electronics and advanced applications development.

In order to more effectively polish these diamond substrates and remove small imperfections in the diamond surface, our team was tasked with creating a device that will be able to detect the quality of the diamond polishing occurring and notify the operator when optimal polishing levels are not sustained.

We must also determine the ranges of quality polishing and how to detect them utilizing a frequency spectrum.

Fraunhofer USA





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Sean Christie
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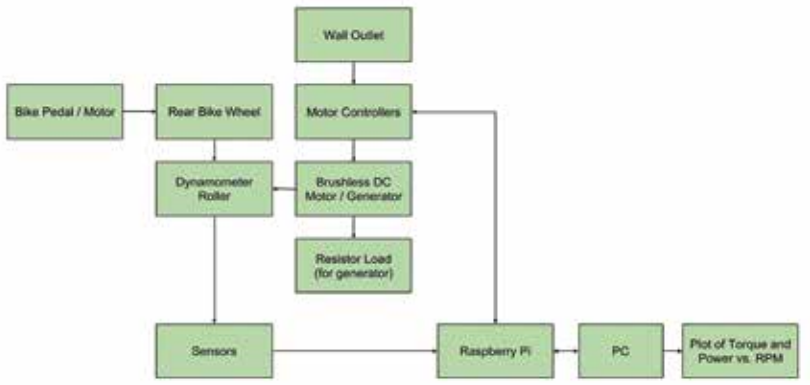
Robert McGough

Michigan State University
Design of a Dynamometer for Electric Bicycle Testing

The fundamental challenge with hybrid vehicles is determining how much power to obtain from available sources to produce an efficient output while considering the dynamic environment. An electric bicycle represents this form of hybrid vehicle, where the sources of power are both electrical and mechanical. The electrical source being the motor and the pedals of the bike being the mechanical source. Environments experienced by the bicycle include uphill, downhill, and flat inclines. Therefore, the range of loads and speeds that the electric bicycle undergoes varies depending on the environment being considered. This proposal presents a constrained testing configuration using a dynamometer to investigate control and sensing strategies for the bicycle and motor controls, allowing the sources of power to interact smoothly over the full range of operating conditions. Along with the proposed configuration, detailed justifications and analysis are provided for all selected parts.



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William Resh
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Project Facilitator

William Resh

Design Day Awards Fall 2018

Electrical & Computer Engineering Winners, Fall 2018

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.

First Place:
Team CANVAS SOAR – AutoDrive Challenge: "Ride Quality Monitor"

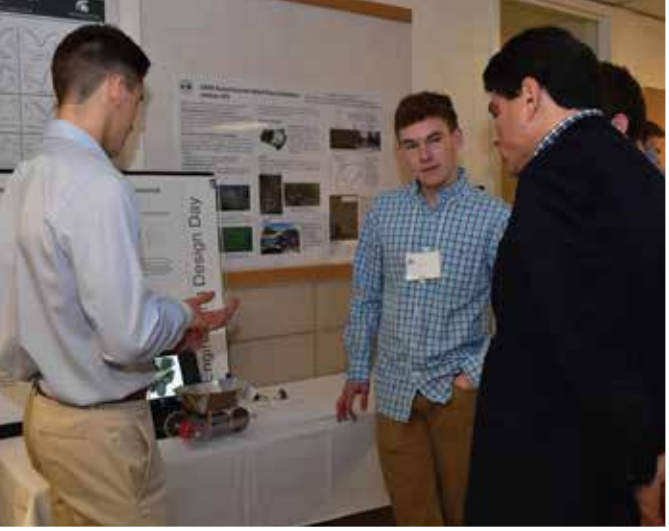
Left to right: Brandon Roek, Jacob Stanowski, Amanda Anguiano, Robert Longo, Edward Chan

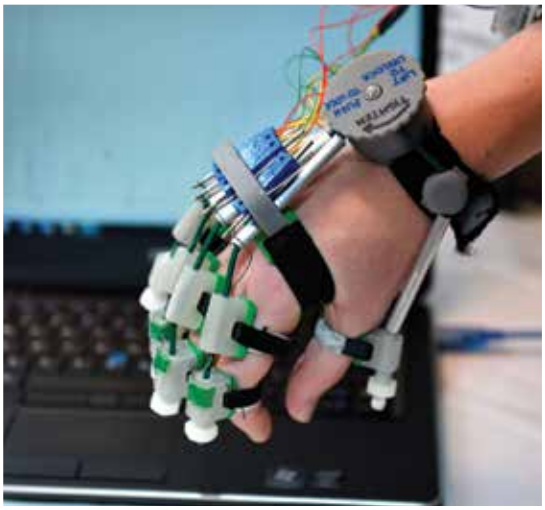
Second Place:
Team Aptiv: "Advanced Study of Antenna Coverage for Implementing Next Gen V2X Technology in Commercial Vehicles"

Left to right: Udit Puri, Mitchell Ensz, Shashank Karthikeyan, Chet Smith
Presented by Sunil Javali of Aptiv

Third Place:
Team MSU Bikes Service Center/RCPD "Bicycle Collision and Blind-spot Detector"

Left to right: Randi Dortch, Dan Kach, Felix Chiang, Sean Mulcahy, James Meadows



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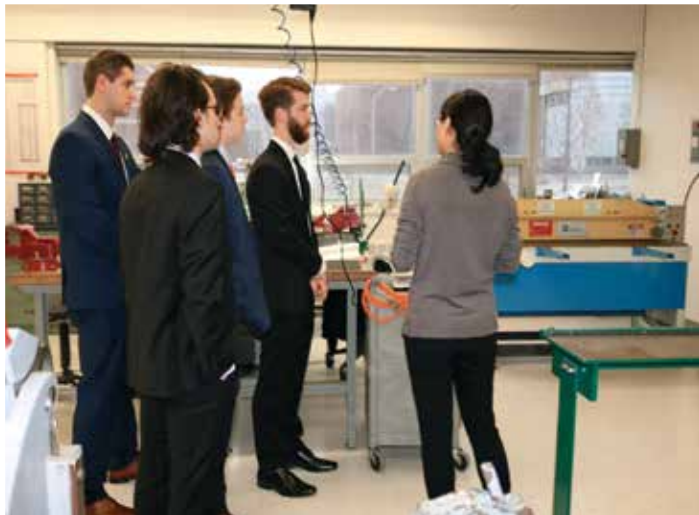
WILL.



ME 412 Heat Transfer Laboratory

Yuping Wang
Academic Specialist
Department of Mechanical Engineering

Heat Recovery Study – Hot-Air Water Boiler/Heater

Usable energy can be found and captured from the exhaust gas of engines or other industrial processes. Various heat recovery units are designed to recover the exhaust waste heat and use it to generate steam or heat water, hence improving the overall system efficiency. In this project, students are expected to understand the heat recovery process through two parts of work. For the major part, each team will design, analyze, build, and test a water heating device with hot air as the heat source. Hot air supplied through a heat gun, simulating the hot exhaust gas, is to heat or vaporize a given amount of water. The objective of the design is to maximize the thermal energy delivered to the water, while cost and weight are also considered as factors in evaluation. For the second part, each team will choose an exhaust heat recovery unit, or a specific type of water heater/boiler of their interest, conduct a review of its design, performance, and thermal analysis as well. Each team will have 15 minutes to set up, demonstrate/test, and disconnect their device. Cold water supply, small water pump, and temperature measurements are available. Each team will also prepare a PowerPoint slideshow or video clip to explain the design decisions, fabrication, and thermal analysis of their heating device.

Competition Schedule

Time	Station	Team members
8:00 .	A	Rosalie Deliz, Andrew Lee, Sarah Plant, Matthew Urdea
	B	David Bang, Brad Fischer, Michael Perrin, Oscar Scheier
8:15	A	Mimi Asante, Lauren Chance, Michael Mccauley, Frank Spica
	B	Jillian Chandler, Alexis Gheorghiu, Alex Napolitan, Allison Nielsen
8:30	A	Jamal Ardister, Niklas Boisten, Carly Dugan, Kai Selwa
	B	Connor Campbell, Andrew Kistler, Scott Michael, Marc Veihl
8:45	A	Ally Austin, Mark Gjeloshaj, Candace Latnie, Erin Maroney, Sean Powers
	B	Jenna Beauregard, Kaidi Ma, Owen Parmeter, Ethan Vassallo, Zak Woods
9:00	A	Mark Leiman, David Odonnell, Connor Walters, Nic Wiggins
	B	Katie Filipovic, Jonah Kowalczyk, Tyler Piotrowski, Brooks Reno
9:15	A	Rachael Jannette, Dean Kuharevicz, Ana Otero, Ross Wolniakowski
	B	Haoran Chen, Peiran Jiang, Brendan Mclean, Stephen Sutherland
9:30	A	Stephen Branch, Simon Liu, Jules Waelchli, Bryan Warholak
	B	Xingyu Cai, Sarah Daugherty, Sophia Miller, Michael Powers
9:45	A	Joe Gusumano, Megan Luzenski, Brandon Praet, Nick Tottis, Zach Wurtz
	B	Alec Adgate, Maria Martinpereira, Ryan Qamar, Zhenyu Wang
10:00	A	Drew Barnett, Huan Liu, Matt Pusheck, Hansheng Zhang
	B	Colton Fairbanks, Mason Mcdiarmid, Brandon Okray, Jay Wideman
10:15	A	Zach Flowers, Jason Koberstein, Derek Roggenbuck, Philip Wandor
	B	Benjamin Anklin, Tal Hanani, Hana Irvine, Sarah Wegert
10:30	A	Jake Prusakiewicz, Joey Ritter, Brock Walquist, Ross Zalewski
	B	Will Barrett, Yangzhe Liu, Joseph Mckinney, Jordan Thayer
10:45	A	Jacob Bloom, Kyle Klocko, Justin Piccolo, Lars Thornton, Austin Zeitler
	B	Timur Aminov, Analeeza Dubay, Eric Gierc, Leiqi Pan
11:00	A	Ryan Bohr, Jack Brinkley, Marc Lowenfeld, Aashish Nagpal
	B	Trevor Chamberlain, Craig Declerck, Alex Jennings, Jordan Sosnoski
11:15	A	Zachary Brokaw, Alexandra Konopka, Samuel Melrose, Lucas Notarantonio, Gary Zakarian
	B	Branden Goebel, Thomas Lindsey, Jeff Masten-Davies, Trevor Zak
11:30	A	Ryan Boufford, James Ellison, Josue Natarenmoran, Jared Steen
	B	Mark Macharia, Samuel Mcalvey, Bradley Moore, Demetria Webster

8:00 a.m. - Noon Engineering Building, Room 1345 | First Floor

ME 470 Mechanical Design & Manufacturing II

Michael Lavagnino
Academic Specialist
Department of
Mechanical Engineering

Pick and Place Race

The goal in this project is to design a machine that can pick up and place a variety of sports balls (basketballs, table tennis balls, etc.) from atop a tube stand to a collection area of their device in a rapid and accurate manner. 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. Performance will be measured by the speed in which each device can collect a ball and safely store it without the ball touching the ground.

Time	Team	Station	Team members
8:00	1	A	Allison Bell, Brian Fedewa, Levi Graves, Erin Mettler
	1	B	Ali Abedi, Joe Brenton, Sam Rinke
8:20	2	A	Hadi Alnaji, Haoran Chen, Peiran Jiang, Stephen Sutherland
	2	B	Zach Daniels, Brendan Frenczli, Diego Prakash, Ryan Simon
8:40	3	A	Jacob Broman, Muhammad Kamarudzaman, Warren Purvin, Tomo Saito
	3	B	Reed Hylka, Simon Liu, Ana Otero, Demetria Webster
9:00	4	A	Matthew Belknap, Mike Johnson, Blake Swift, Trevor Zak
	4	B	Demarcus Gregory, Zach Kraut, Danny McGrail, Morrice Morris
9:20	5	A	Leah Brickner, Trevor Dame, Ryan Heinze, Elizabeth Schester
	5	B	Nick Borellis, Nathan Engler, Brett Roginski, Dong Yang
9:40	6	A	August Butzke, Patch Floyd, Dillon McClintock, Molly McClorey
	6	B	Ali Alhajji, Torre Crown, Zach Hoffman, Jordan Odehnal
10:00	7	A	Faris Alghool, Caleb Kartha Bortles, Ben Merrill, Josh Meyer, Chad Winner
	7	B	Laura Hohnstadt, Emily Money, Jacob Sickelsteel
10:20	8	A	Chelsey Jenkins, Sophia Miller, Nick Stein, Conner Stevenson
	8	B	Carson Eby, Anthony Lafata, Michael Mazza
10:40	9	A	Zach Borgerson, Michael Powers, Tommy Tsuchiya, Che-Kuan Yu
	9	B	Timur Aminov, Maria Martin, Chase Wilterdink, Yifan Zou
11:00	10	A	Fanghan Lu, John Miller, Wayne Wang, Chizun Zou
	11	B	Alex Matkowski, Danielle Rosebrook, Heidi Theisen, Yongyi Yang
11:20			Semi-Final Competition
11:40			Final Competition

ME 478
Product Development

Haseung Chung
Assistant Professor of Mechanical Engineering

3D Printing Machine

The objective is to develop an automated mixing and depositing system of an olive oil-sand mixture that can be adopted by a 3D printing machine based on a resin-powder (metal, ceramic) mixture.

The requirements of the system are: 1) the system should be capable of combining and homogeneously mixing a solution of 1:4 weight ratio of olive oil and sand (i.e., 5 grams of oil and 20 grams of sand, and 2) the olive oil mixed with sand should be deposited on a 10 x 10 cm platform in a weight controlled manner.

Presumably, the system might consist of: 1) a material supplying module, which is capable of adding sand and oil into the mixer with a specific weight ratio (this is very similar to what the binder jet 3D printer does), 2) a mixing module to blend the oil and sand together until the solution is homogeneous, and 3) a deposition module to deposit a certain amount of the mixed solution (10 grams) onto a platform.

Evaluation criteria: 1) the homogeneity of the solution will be inspected visually, and 2) the quality of the deposit will be based on the weight of each deposit.

If necessary, the electric motors will 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. The following teams will demonstrate their machines on Design Day. The details of the designed machines will be presented prior to Design Day.

Teams and Members

GROUP 1:

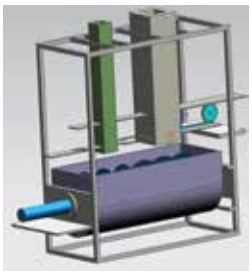
Mitch Cline
Rishi Gupta
Hana Irvine
Jonah Kowalczyk
Lucas Notarantonio

GROUP 2:

Derek Edwards
Peiran Jiang
Nate Lewis
Jordan Sosnoski

GROUP 3:

Brad Fischer
Andrew Lee
Marc Lowenfeld
Ryan Qamar
Zachary Wagner

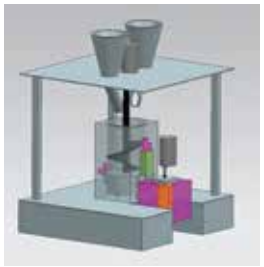


GROUP 4:

Andrew Aziz
Levi Graves
Samuel Mcalvey
David Mccriston
Sebastian Mendez

GROUP 5:

Zach Daniels
Jennifer Kozlowski
Samuel Melrose
Jonathan Theoret
Chenxi Yin



9:00 a.m. - 11:30 a.m. Engineering Building, 1200 Hallway | First Floor

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
01	Madrid Ellis, Brianna Forsthoefel, Natalie Landis, Madeline Oesch, Nick Van Oost	**Restrictive Rehab:** This device is designed to be an at-home rehabilitation tool for stroke patients or others with arm or shoulder injuries.
02	Trevor Joy, Alex Kroski, Scott Michael, Tyler Piotrowski, Alex Stangeland	**The Iron-Ade:** This device is designed to hold and distribute the weight of a dumbbell past the hand and wrist onto the forearm of individuals with wrist and/or grip ailments.
03	William Hahn, Evan Hardy, Krishna Midathada, Sam Uecker, Zach Wagner	**Flex:** This device is designed to be a portable hip abduction/adduction machine for people that want an easy way to work out at home or on-the-go.
04	Christian Buse, Melissa Karas, Kelsey Lilley, Simon Liu, Brock Walquist	**Ez Reach:** This device enables wheelchair users to store and access their belongings by positioning their bags within reach.
05	Tanner Austin, Rachael Jannette, LeeAnn Lugo, Megan Luzenski, Ryan Simon	**Easy Trunk:** This device is designed for those with back problems or limited upper body strength to aid in raising and lowering heavy objects from the trunk of a car.
06	Jacob Bloom, Lauren Kubiske, Sam Schowalter, John Vetter, Austin Zeitler	**Simplicitee:** This device is designed for golfers with back and/or knee pain to place a golf ball and tee into the ground simultaneously without bending down.
07	Andrew Albright, Troy Albrecht, Isabella Henry, Alex Jennings, Ian Walczak	**The Crank N' Paint:** This device is designed to help painters reduce their chances of injury, including Carpel Tunnel Syndrome or rotator cuff injury, as well as to increase painting efficiency.
08	Paul Holmes, Mackenzie Meyers, Sophia Miller, Benj Shapiro, Michael Truong	**Slide 'N Hide:** This device is designed to enable caregivers to efficiently help patients out of a wheelchair without removing the footrests.
09	Stephen Branch, Brianna Dingman, David Donigan, Chad Winner	**Cargo Carrier:** This device is designed to allow easy transport of cargo from the back of a short truck or SUV into a home or building while being able to climb up to two stairs.
10	Mohammed Alneyadi, Miles Hoy, Trystan Melynk, Connor Nelson	**Rise Assistive Cane:** This device is a cane designed for multifunctional use. The main function of the cane is to help the elderly stand up.
11	Cat Armstrong, Tal Hanani, Jared Rogers, Billy Shisler, Benjamin Washington	**REFLEX:** This ankle brace/rehabilitation device provides assistance in plantarflexion (toe point) and resistance in dorsiflexion (flexed foot) to those with chronic conditions, such as osteoporosis, spasticity and rheumatoid arthritis, as well as those with acute injuries, such as fractures and sprains.
12	Devan deJong, Karl Havens, Malik Jackson, Conor Van Dusen, Kyle Woods	**Atlas:** This product is designed to provide ergonomic arm support to workers frequently engaged in tasks requiring precise hand movements over long periods of time such as surgeons.
13	Ryan Boufford, Kara Cochran, Brent Diamond, Rachel Gothro, Cameros Ploss	**The Rubbish Remover:** This device will assist users with lifting a full trash bag out of the trash can without getting stuck.
14	Anthony Hourani, Nick Kerby, Luke Menne, Claire Trygstad, Connor Xehr	**Bench Buddy:** This device is designed to transform from a bench to a chair to assist in the overall showering experience. It is designed for the elderly and physically disabled.
15	Katie Filipovic, Josh Kasper, Dylan Lott, Aspen Pyle, Frank Spica	**Vulcan:** This device is designed to enable people who have back problems, limited strength, or people with limited mobility to reach objects in the back of a truck without having to climb into it.
16	Mesha Farahani, Demarcus Gregory, Morrice Morris II, Anthony Sugiharto	**MediRoll:** This device is designed to provide access to portable, affordable, and effective friction massage at home for muscle relaxation used to treat IT band syndrome patients and physically active people who experience exercise-associated muscle cramps.

The Capstone Projects

Dr. William Resh
Professor of Mechanical Engineering

Faculty Advisors: Baek, Brereton, Feeny, Kwon, Mueller, Recktenwald, Xiao


Baek


Brereton


Feeny


Kwon


Mueller


Recktenwald


Xiao

Presentation Schedule – Engineering Building, Room 1202

Time	Team Sponsor	Project Title
7:00 a.m.	MSU Solar Racing Team	Feasibility of a Titanium Solar Car Chassis
7:30 a.m.	MSU Adaptive Sports & Recreation Club	Hand-Cycle Propulsion Adapter
8:00 a.m.	ArcelorMittal	Steel Coil Stretch Wrap Machine
8:30 a.m.	Ingersoll Rand – Trane	Indoor CSAA Unit Shipping Protection
9:00 a.m.	Swagelok	Custom Solutions Fixture Design
9:30 a.m.	USS Battleship New Jersey	Modeling Steering & Propulsion Systems
10:00 a.m.	MSU Department of Mechanical Engineering	Device to Prep Exams for Electronic Scanning
10:30 a.m.	Michigan AgrAbility	Folding Tractor Step Overlay
11:00 a.m.	McLaren Greater Lansing	Rehabilitation Services Leg Press
11:30 a.m.	MSU MTRAC	Mechanized Plug Injection System

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:

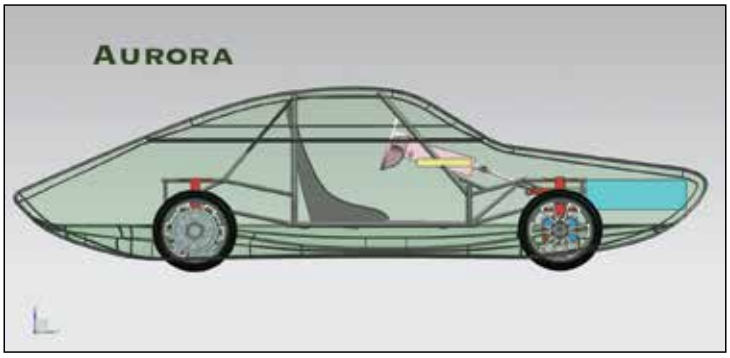
- Use the technical expertise, communication skills, and teaming methodologies they have learned throughout their mechanical engineering curriculum, together with their creativity, to solve real world problems,
- Collaborate with practicing engineers to address problems sponsored by industry,
- Develop 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, EPA, Fiat Chrysler Automobiles, Gerdau Special Steel North America, Heartwood School/Ingham ISD, Hitachi Automotive Systems Americas Inc., Ingersoll Rand - Trane, McLaren Greater Lansing, Michigan AgrAbility, MSU Adaptive Sports and Recreation Club, MSU Baja Racing Team, MSU Department of Mechanical Engineering, MSU Department of Theatre, MSU Entomology, MSU MTRAC, MSU Recycling Center, MSU Solar Racing Team, NASA/Arizona State University, National Superconducting Cyclotron Laboratory, Salt Yoga, Swagelok, TERPHANE, USS Battleship New Jersey, and Whirlpool Corporation .

MSU Solar Racing Team
Feasibility of a Titanium Solar Car Chassis

The Michigan State University Solar Racing team is a student-led organization that designs and builds full-sized solar electric vehicles. Beginning in fall of 2017, the team started designing a two-person solar car to compete in the cruiser class of the 2020 American Solar Challenge. Currently, the design phase is finished and the construction of the car is almost complete. The current car, Aurora, is designed with a steel tube chassis that adheres to the regulations and specifications of the American Solar Challenge.

Our team was asked to conduct a feasibility analysis of producing a titanium chassis for a solar vehicle. To achieve this goal, the current steel tube chassis was considered as a benchmark for analyzing the benefits of titanium. We have created an extensive 3-dimensional model of a new titanium chassis that fits into the body of the Aurora. A cost analysis and a finite element analysis were conducted for the newly designed chassis. A manufacturing plan was created so this chassis could potentially be implemented into Aurora's body. All regulations from the American Solar Challenge were considered and designed for this new chassis. The success of this study will provide insight for the benefits and drawbacks of incorporating titanium rather than steel into a car chassis.



MSU SOLAR RACING TEAM

Michigan State University
Team Members (left to right)

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Alex Konopka
Macomb, Michigan

Jamal Ardister
Lansing, Michigan

Lauren Chance
Okemos, Michigan

Lucas Notarantonio
Royal Oak, Michigan

MSU Solar Racing Team
Project Sponsor

Lauren Chance
East Lansing, Michigan

ME Faculty Advisor

Brian Feeny

MSU Adaptive Sports & Recreation Club
Hand-Cycle Propulsion Adapter

The MSU Adaptive Sports and Recreation Club is a registered student organization that serves as a free program open to athletes with physical disabilities, able-bodied volunteers, and residents of the greater East Lansing community. The club strives to promote the physical health, social behavior, and psychological wellness of its members. This is achieved by providing recreational activity opportunities to individuals with physical disabilities by ensuring a wide variety of quality wheelchair and adaptive sport equipment and facilities.

Our team was asked to design a hand-cycle propulsion adapter that enables the rider to have increased control over speed and direction. The intended users of the propulsion adapter are those with limited use of lower limbs, as well as asymmetry between their dominant and non-dominant sides. The design needs to accommodate limited strength and range of motion. In order to do this, the propulsion and steering need to be two separate functions that are easily accessible and limit discomfort to the users. These two functions must also be interchangeable depending on which arm the rider prefers to use. It is important that this product provide a level of security and safety, which in addition to functionality, is the reason many members feel the product is unusable.

Michigan State University
Adaptive Sports & Recreation Club
Est. 2014

Michigan State University
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Ally Austin
Ann Arbor, Michigan

Katie Frayer
DeWitt, Michigan

Branton Toback
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Candace Latnie
Columbus, Ohio

MSU Adaptive Sports & Recreation Club
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East Lansing, Michigan

Piotr Pasik
East Lansing, Michigan

ME Faculty Advisor

Brian Feeny

ArcelorMittal
Steel Coil Stretch Wrap Machine

ArcelorMittal is a steel and mining company that is one of the top suppliers of steel products for major markets such as construction, appliances, automotive, and packaging. With its nearly 200,000 employees across 60 countries, ArcelorMittal produces 113 million tons of crude steel per year. They are the largest producer of steel in North and South America and one of the largest producers of iron ore in the world. ArcelorMittal's headquarters is located in Luxembourg, and they operate six steelmaking plants located within the Midwest United States.

Our team has designed a standalone process line for the wrapping of multiple steel coils for a shipping warehouse at the Burns Harbor, Indiana facility. The design includes a stretch wrap machine and a conveyor system that replaces the need for operators to manually wrap the steel coils. In doing so, the new system decreases the ergonomic issues related to manually wrapping the coils, as well as reducing the number of operators needed in the warehouse per shift. The system works alongside the overhead crane in the warehouse to prepare the coils before they are shipped to customers.

ArcelorMittal

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Sarah Daugherty
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Grand Ledge, Michigan

Jake Bloom
Romeo, Michigan

ArcelorMittal
Project Sponsor

Lauren Hart
Burns Harbor, Indiana

ME Faculty Advisor

Giles Brereton

Ingersoll Rand - Trane
Indoor CSAA Unit Shipping Protection

Ingersoll Rand provides products, services, and solutions to improve the quality and comfort of air in homes and buildings across the globe, as well as to transport and protect food and perishables. An important aspect of transporting such valuable equipment is protection from rain, debris, and other factors that come from moving individual CSAA indoor units to homes and businesses. Because CSAA indoor units are shipped on open flatbed trucks, are not painted, are often shipped with openings and open ends, and shipped with various control and electrical boxes mounted to the outside of the units, shipping protection covers are used to protect the units before they are sealed and secured for transportation. The current design involves integrating hexacomb panels with house-made support brackets and corner boards to create a protected environment for each unit to be safely transported without being damaged or compromised.

Our team's project was to model, build, and test a revised design based on the existing shipping panels used to protect air handling units during transport. The panels will be used in conjunction with plastic wrapping to keep wind, rain, and debris from damaging the air handlers. This design will also be able to be scaled accordingly to fit other sizes of CSAA indoor units. The goal of the new design is to reduce weight and decrease costs while retaining the durability and weatherproofing protection of the previous iteration. The new prototype was tested in real shipments between various Kentucky plants to ensure a successful solution. With the new design, Ingersoll Rand will be able to reduce costs while maintaining their confidence in the shipping containers to protect the valuable cargo.

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Sebastian Mendez
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Ingersoll Rand - Trane
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Davidson, North Carolina

ME Faculty Advisor

Giles Brereton

Swagelok
Custom Solutions Fixture Design

Swagelok, headquartered in Solon, Ohio, is a global fluid system component supplier that offers a variety of fluid transport and sealing components as well as custom assemblies for its customers. Known for producing a variety of fluid and gas transport products, Swagelok additionally offers metal tubing for custom fluid system assemblies. In order to uphold their values of quality, customer focus, and continuous improvement, Swagelok is interested in optimizing their current tube handling processes. Their current methods of cutting and deburring tubing, while feasible, can be improved to increase Swagelok's productivity.

Our team focused on the improvement of Swagelok's processes for measuring, cutting, moving, and deburring metal tubing. The current cutting process involves inefficient handling and creates burrs which must be removed by hand. The designed solution for Swagelok must provide a loading station nearby for cutting and deburring the tube. It must also provide a method to measure the stainless-steel tubing with increased precision. The inefficient process of deburring by hand must be replaced with a safe, easy-to-use, mechanized, and ergonomic device that will increase the speed of the deburring process. Furthermore, the deburring device must align with the cutting process to streamline the product flow. With the implementation of these components in their cutting and deburring processes, there will be an increase in efficiency and productivity while also providing both physical and environmental improvements at Swagelok.

Swagelok®

Swagelok Michigan | Toledo

Michigan State University
Team Members (left to right)

Jessica Derkacz
Macomb, Michigan

Mason McDiarmid
Clawson, Michigan

Anthony Connors (Sponsor)

Christopher Kiesling (Sponsor)

Samuel Mcalvey
Lansing, Michigan

Michael McCauley
Novi, Michigan

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Spring Lake, Michigan

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Farmington Hills, Michigan

Aaron Sexton
Farmington Hills, Michigan

ME Faculty Advisor

Norbert Mueller

USS Battleship New Jersey
Modeling Steering & Propulsion Systems

The USS New Jersey is an Iowa-class battleship in the United States Navy that was commissioned 4 different times between 1943 and 1991. The New Jersey was among the last battleships ordered for service by the United States government. The USS New Jersey participated in World War II, the Korean War, the Vietnam War, and the Lebanese Civil War and is the most decorated Battleship in the U.S. Navy. In 1991, the USS New Jersey was decommissioned for the final time and became a museum ship in Camden, New Jersey. The USS New Jersey still serves as a museum ship to this day, with the goal of restoring, preserving, exhibiting, and interpreting the history of the ship to visitors.

Our team was tasked with demonstrating the ship's propulsion and steering system to museum guests. The Battleship New Jersey Museum is currently in the process of opening up the boiler and engine rooms for tours and would like to display the massive size and power of the propellers and steering system to guests. Our team developed a virtual reality representation of the underwater exterior of the USS New Jersey. This VR tour allows museum guests to see the enormous size of the propulsion and steering system in a manner that is not possible though physical models. This project greatly enhances the visitor experience at the museum, providing guests of all ages with an exciting view of the underwater area of the ship.

Michigan State University
Team Members (left to right)

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Wixom, Michigan

Matthew Urdea
Novi, Michigan

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USS Battleship New Jersey
Project Sponsor

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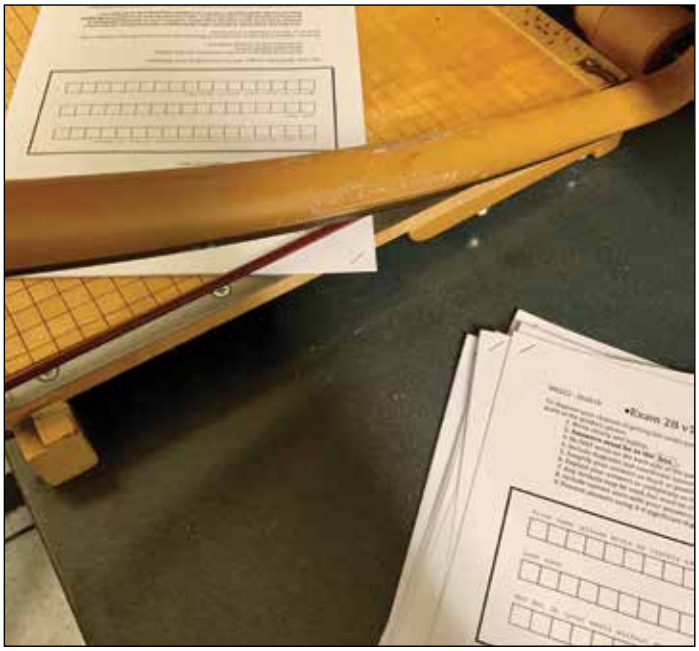
ME Faculty Advisor

Norbert Mueller

MSU Department of Mechanical Engineering
Device to Prep Exams for Electronic Scanning

Michigan State University is a public research university located in East Lansing, Michigan. There are over 5,000 students enrolled in the College of Engineering, most of whom will be taking examinations each semester. One specific area needing improvement is the device currently used to prepare exams to be scanned. In attempts to incorporate technology into the classroom, exams are scanned and sent directly to students. Before scanning the exams, the staples must be removed. The current protocol is to remove the staples from the exams by using a paper cutter to slice off the corners containing the staples. The paper cutter used is capable of only slicing about 10 sheets of paper at a time. Also, the blade is exposed, which makes this a tedious, potentially dangerous, and time-consuming process.

Our team designed and manufactured multiple devices to remove the staples, to improve upon the current method. These devices will be used by different departments within the College of Engineering. The focus was to design devices that are relatively safe, efficient, and easy to operate. The devices must also be durable enough to withstand ~10,000 exams per semester. With the new devices, teaching assistants and professors can reallocate the time spent removing staples to grading and returning the exams more quickly.



Department of Mechanical Engineering
MICHIGAN STATE UNIVERSITY

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MSU Department of Mechanical Engineering
Project Sponsor

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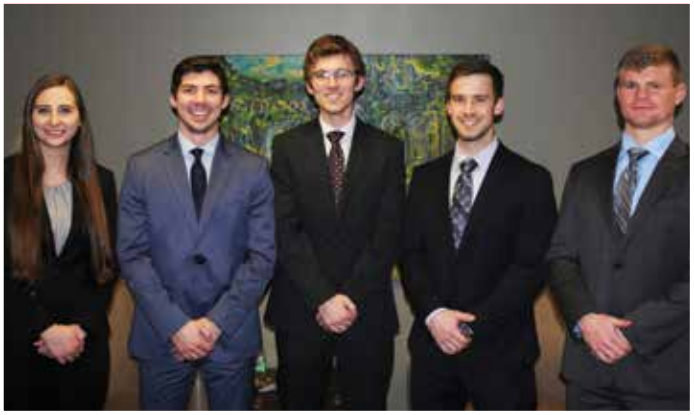
ME Faculty Advisor

Geoffrey Recktenwald

Michigan AgrAbility
Folding Tractor Step Overlay

AgrAbility was established at both the national and regional level by the 1990 Farm Bill to assist agricultural workers who are in need of services and networking. Every division of AgrAbility is partnered with both a land grant university and a nonprofit organization. The goal is to supply aid to those who are disabled. These disabilities include spinal cord injuries, amputations, hearing impairments, and arthritis. The 2012 Census of Agriculture estimates that over 1,900 farm workers per year in Michigan are in need of AgrAbility's services. Through the services that are provided to rural communities across the nation, living conditions are improved and independence is returned to those farm workers.

Our team has created an attachable extension step that aids a local farmer struggling with severe arthritis. This extension step reduces strain on the farmer's knees, while providing easier access to the tractor on a daily basis. During operation, the tractor step is stowed in a position that interferes neither with the ground nor with its surroundings. This position also allows operators that do not require assistance to use the steps normally. The newly developed design will improve the local farmer's ability to perform daily tasks and prolong his work life.



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Michigan AgrAbility
Project Sponsor

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ME Faculty Advisor

Xinran Xiao

McLaren Greater Lansing
Rehabilitation Services Leg Press

McLaren Health Care, headquartered in Grand Blanc, Michigan, is a diverse health care network dedicated to quality and evidence-based patient care. The McLaren system includes 14 hospitals, ambulatory surgery centers, imaging centers, and a primary and specialty care physician network. McLaren's Greater Lansing rehabilitation and therapy services is a sector focused on treating both the most complex and most common conditions relating to illness and injury. Restoring function to patients who have had surgery, suffered an injury, have chronic pain or are in various forms of recovery are all goals of McLaren's physical rehabilitation and therapy services. McLaren's approach to treatment involves many aspects, but strengthening is often a focus for many of their patients. For lower body strengthening, the leg press currently used by McLaren maxes out on using 30% of a person's body weight for resistance. Once a patient has progressed past that point, the next option is to use full body weight.

Our team has created two possible designs for a brand new Leg Press, both of which are able to bridge the gap between the 30-100% body weight range. The designs constructed focus heavily on keeping the user's body stationary, thereby easing the process of getting in and out of the device. Delivering McLaren multiple designs allows it to choose the option best suited for its needs. The success of this project will improve the quality of care as well as helping McLaren become more of a presence in sports medicine rehabilitation.

McLaren
GREATER LANSING

Michigan State University
Team Members (left to right)

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McLaren Greater Lansing
Project Sponsor

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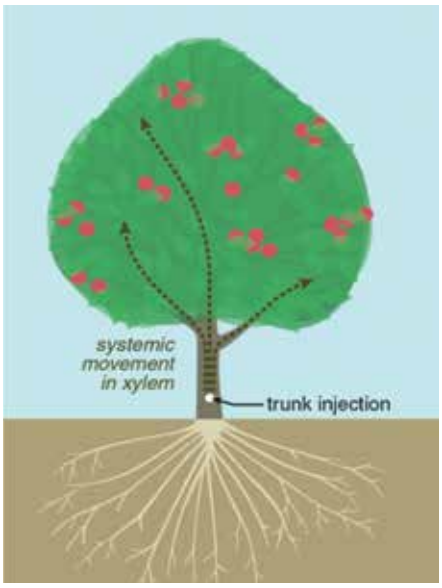
Seungik Baek

MSU MTRAC
Mechanized Plug Injection System

Trunk injection is an alternative technology for delivering pesticides into fruit trees. Trunk injection eliminates spray drift which results in unintentional coverage, reduces worker exposure, protects natural enemies, and limits the product needed to protect the crop. This technology involves drilling a hole into the tree and injecting a liquid pesticide directly into the xylem. However, this process takes too long to be economically viable for tree fruit and tree nut production. The current trunk injection method that MSU MTRAC created is a solid composite plug and mechanized injector prototype that engages trees singularly, which takes about two minutes per tree. The task is to modify the mechanized injector to function as a tractor-mounted PTO hydraulic unit for high speed orchard use.

One way to combat this limitation and improve efficiency is to design a "magazine" that can hold multiple pods in order to decrease the loading time, and overall injection time. The most efficient method is a mechanical injection system that attaches to a tractor and uses mechanical force to inject the pods, while having a rotating drum magazine for the pods that are controlled by a motor. This decreases loading time as well as having a relatively light injection system that is easily maneuvered between trees. To reduce the time required for each tree, instead of using a single injector, using multiple injectors will be explored in the initial design. This will reduce injection time and could help counteract the force of injection.



MICHIGAN STATE
UNIVERSITY

Michigan State University
Team Members (left to right)

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Dr. John Wise
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MSU MTRAC
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ME Faculty Advisor

Patrick Kwon


INFORMATION
Design Day
VISIT THE 2ND FLOOR
Design Day
ENGINEERING


MICHIGAN STATE
UNIVERSITY


PRATT&MILLER
81

The Capstone Projects

Dr. William Resh
Professor of Mechanical Engineering

Faculty Advisors: Baek, Diaz, Jaberi, Mukherjee, Naguib, Pence, Yeom, Yuan


Baek

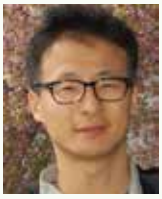

Diaz


Jaberi


Mukherjee


Naguib


Pence


Yeom


Yuan

Presentation Schedule – Engineering Building, Room 1220

Time	Team Sponsor	Project Title
7:30 a.m.	MSU Department of Theatre	Theatre Deck Winch
8:00 a.m.	Fiat Chrysler Automobiles	Seat Bracket
8:30 a.m.	Fiat Chrysler Automobiles	Automated Goniometer
9:00 a.m.	National Superconducting Cyclotron Laboratory	LaBr Detector, Half Ball NERO, DSSD Detector
9:30 a.m.	Environmental Protection Agency	PHEV Smart Charger
10:00 a.m.	Heartwood School/Ingham ISD	Therapeutic Mechanical Pony Enhancements
10:10 a.m	NASA/Arizona State University Note: This Presentation takes place in Room 2245	Neutral Flux Probe Traversing Mechanism (Joint Project with ECE 480)
10:30 a.m.	Heartwood School/Ingham ISD	Single Motion Stamp Press
11:00 a.m.	MSU Baja Racing Team	Custom Brake Calipers & Validation
11:30 a.m.	MSU Entomology	Quick Connection System for Solid Set Canopy Delivery System

ME 481 Mechanical Engineering Design Projects

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.

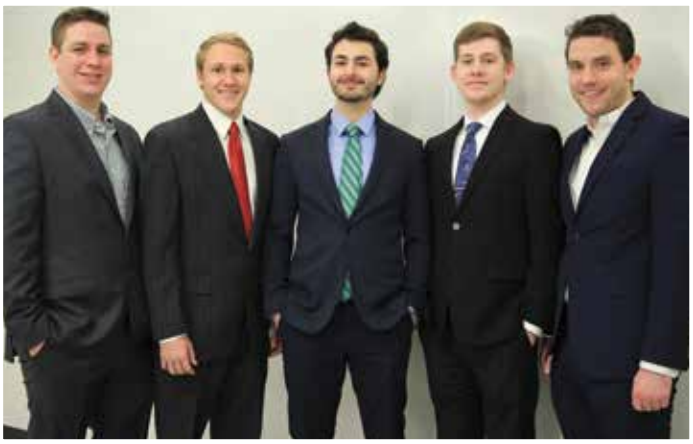
ME faculty who supervised ME 481 design teams this semester are: Seungik Baek, Andre Benard, Giles Brereton, Alejandro Diaz, Abraham Engeda, Brian Feeny, Farhad Jaberi, Patrick Kwon, Peter Lillehoj, Norbert Mueller, Ranjan Mukherjee, Ahmed Naguib, Thomas Pence, Geoffrey Recktenwald, Daniel Segalman, Indrek Wichman, Neil Wright, Sharon Xiao, Junghoon Yeom, Junlin Yuan, and Guoming Zhu.

MSU Department of Theatre
Theatre Deck Winch

The MSU Theatre Department hosts play productions held at the Wharton Center and is responsible for not only the cast and crew but also the creation of set pieces. These set pieces can weigh up to 3,000 pounds. During a production, these set pieces can be moved either manually or by a deck winch. A deck winch eliminates the need for manual labor and automates the set moving process. Deck winches are widely used throughout the theatre industry. The MSU Theatre Department currently has a deck winch, however it is heavy, cumbersome and horizontal, making it difficult to transport.

The MSU team focused on designing a system that is easier to transport without disassembly. To do this, the team used lighter materials for the frame and designed the winch to operate with a vertical design, as most modern designs are. With a lightweight frame and vertical standing, the winch system can be easily loaded and transported via dolly. Besides the lightweight and vertical design, the winch meets a number of parameters. The winch can pull set pieces at a pace of three feet per second and has a maximum pulling force of 2,500 pounds. To ensure rigidity of the frame, the frame parts are welded together and the system is anchored to the floor via lag bolts.

DEPARTMENT OF THEATRE
www.theatre.msu.edu



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MSU Department of Theatre
Project Sponsor

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East Lansing, Michigan

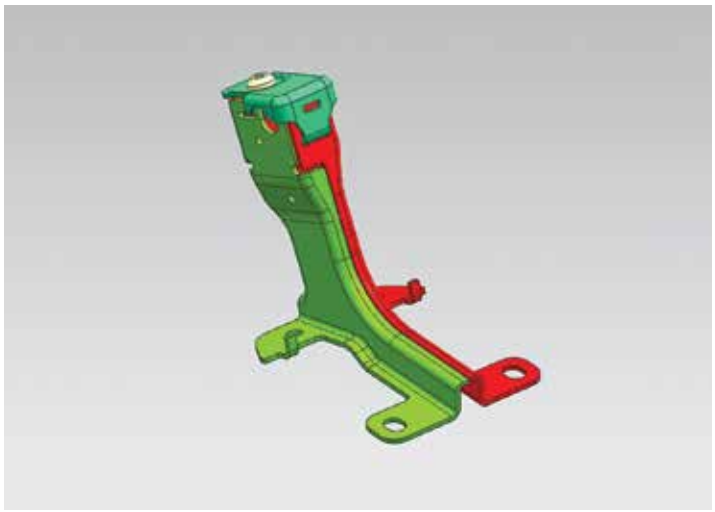
ME Faculty Advisor

Alejandro Diaz

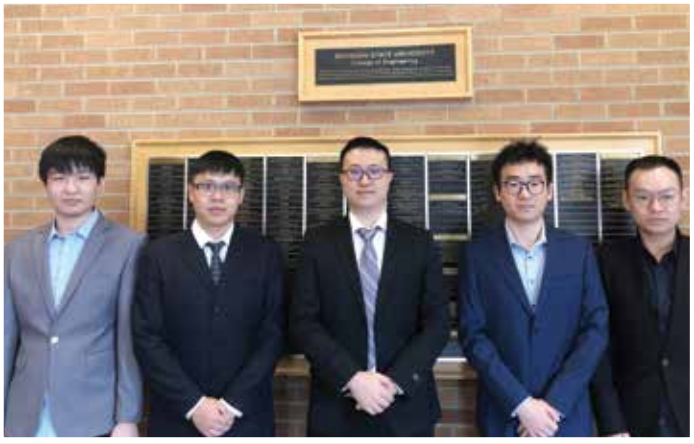
Fiat Chrysler Automobiles
Seat Bracket

Fiat Chrysler Automobiles, an Italian and American multinational corporation, is one of the largest automakers in the world, with headquarters located in London. Fiat Chrysler Automobiles operations include design, engineering, manufacturing, distribution and sales of automobiles and light commercial vehicles, engines, transmission systems, automotive-related components, metallurgical products, and production systems.

Our team focused on investigating the use of additive manufacturing techniques for car seat brackets to replace the traditional method of manufacturing for a low-volume production. Additive manufacturing includes technologies such as sheet lamination, and directed energy deposition. At the same time, the seat bracket structure is regulated by the global regulatory requirements such as FMVSS, CMVSS, and ECE R17. After considering the cost of each of the additive manufacturing technologies, global regulatory requirements, loadings and material properties, we decided to seek an optimized result that includes the specific low-volume manufacturing method, material, structure optimization and the overall cost that will result in the highest performance and lowest cost and complexity.



FCA
FIAT CHRYSLER AUTOMOBILES



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Project Sponsor

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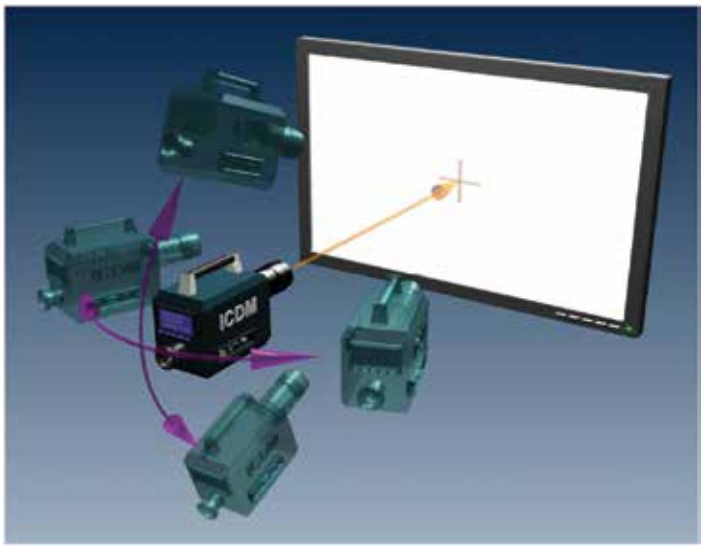
Alejandro Diaz

Fiat Chrysler Automobiles
Automated Goniometer

Fiat Chrysler Automobiles is a global supplier of OEM automotive components. FCA's System and Components EE Lab is tasked with validating the performance of next generation automotive displays. To ensure displays perform at a level that will meet rising customer expectations, extensive testing is done. In direct sunlight many electronic displays will exhibit problems with reflection; thus, it is important to be able to measure reflection accurately.

This project focuses on developing a Goniometer for display and lens material reflection measurement. The goniometer allows the user the ability to position light sources and measurement sensors relative to a DUT (device under test), such as an electronic display or lens. The device allows for rapid and accurate measurements of display and lens reflection at any angle relevant to the position of a display in a vehicle environment. The device is accurate to one degree of arc, allowing repeatable test setup and consistent measurements. The success of this project could have an impact on the quantity and quality of reflection testing at FCA as well as vehicle display end-user satisfaction.



FCA
FIAT CHRYSLER AUTOMOBILES

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Fiat Chrysler Automobiles
Project Sponsor

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Ranjan Mukherjee

National Superconducting Cyclotron Laboratory
LaBr Detector, Half Ball NERO, DSSD Detector

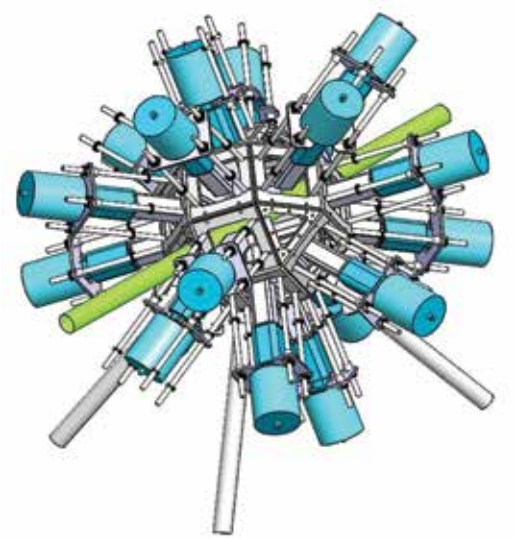
The National Superconducting Cyclotron Laboratory (NSCL) is a national user facility with the mission to allow scientists to make scientific discoveries about the inner workings of atoms and their role in the universe.

The designed decay station, shown on the right, needs to accommodate multiple detector arrays in a flexible and modular system with the ability to measure all possible nuclear decay paths of rare isotopes produced at NSCL. The project design and development of variations to the support frame are to be used in nuclear physics experiments at NSCL. Our project was further divided into three sub-projects.

Project one was the Lanthanum Bromide detector mounting where a mounting system was designed to support LaBr detectors and complete various tasks.

Project two was to create a mounting system, which was designed to suspend the DSSD detector and target mount.

The final project was the half-ball with NERO detector. This allowed access to the inner components of other detectors surrounding the LaBr detectors.



NSCL

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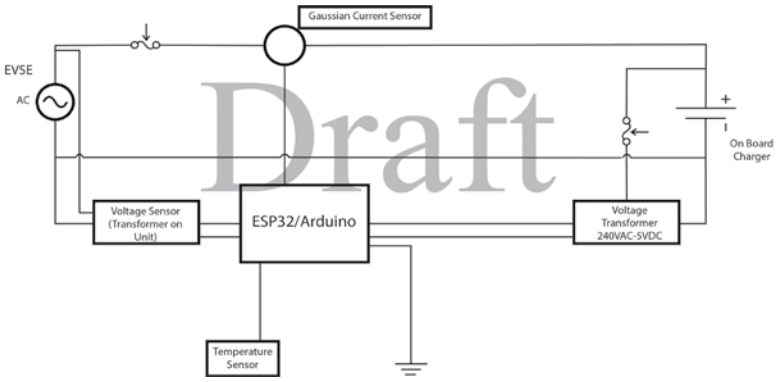
US Environmental Protection Agency
PHEV Smart Charger

The United States Environmental Protection Agency is responsible for setting emission standards for the entire transportation industry. Currently, the EPA is researching ways of documenting and reducing the carbon footprint of electric vehicles. With the facilities currently available, they can accurately track the power draw that EV chargers demand from the power grid. However, in addition, the EPA would also like to test the impact of temperature on power consumption during charging.

Our team was tasked with creating and developing a "smart adaptor" attachment for Level 2 AC high-voltage (HV) charging stations used both indoors and out in the field. The purpose of the device is to record charging data, including voltage and current drawn. It also includes a temperature sensor that measures the outdoor conditions while plugged into the vehicle. The device stores the data on an SD card to be post-processed after the charging is complete. The design of the dongle is low profile, interfaces with all plug-in hybrid vehicles, and supports the weight of the charger while plugged in. It also adheres to the design standards set by SAE document J1772, which outlines the overall function, interface conditions between car and charger, and necessary insulation required for all HV charging equipment. As designed, the charger attachment should allow the EPA to accurately record, log, and compare charging power statistics and weather data during charging.



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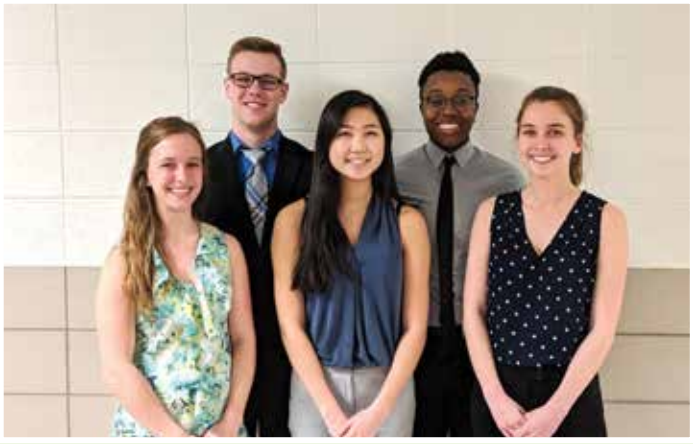
Heartwood School/Ingham ISD
Therapeutic Mechanical Pony Enhancements

Heartwood School is a center-based school serving students throughout Ingham County. The school assists students ages 3-26 with cognitive and physical impairments and autism spectrum disorders. Heartwood School places an emphasis on its specialized curriculum by incorporating the MOVE program in order to improve the quality of life of affected individuals by allowing them to become more independent through innovative techniques and exercises. One of these is therapeutic horseback riding, which was previously developed by a Mechanical Engineering capstone team in Spring 2017. Therapeutic horseback riding allows the students to develop core and lower back strength, which are crucial for stability and motor control. Having an aesthetically pleasing design allows the students to express their imagination, making it feel less like a routine exercise and more like a horseback ride.

Our team was asked to improve the previous design with structural, storage, and visual upgrades. To improve the structure, the support system was made more rigid, allowing for greater loads. For improving storage, a modular design was implemented, together with improvements for transportability. For visual improvement, the horse was made more realistic with cosmetic upgrades and sound effects. These upgrades allow for a long-lasting design capable of withstanding wear and tear, allowing the students a more realistic and enjoyable therapeutic horseback riding session.

Ingham Intermediate School District
A Regional Educational Service Agency



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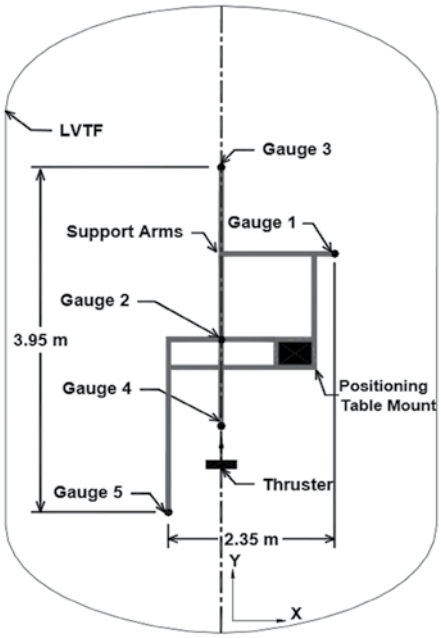
NASA/Arizona State University
Neutral Flux Probe Traversing Mechanism

Psyche is the name of a metal-rich asteroid orbiting the sun between Mars and Jupiter. It is also the name of the NASA mission, led by Arizona State University to visit this asteroid. The spacecraft will launch in 2022 and will utilize solar-electric Hall Effect Thrusters (HETs) in order to reach the asteroid in 2026. A HET is a type of ion thruster that accelerates propellant with electrons in an electric field, then neutralizes these ions as they exit the thruster.

Our team worked in collaboration with an Electrical Engineering capstone team to design and create a neutral flux probe capable of moving throughout the HET test chamber. The ECE group was responsible for creating the neutral flux probe, while our team designed a traversing mechanism that would move the probe around the test chamber. The design of the traversing mechanism had numerous challenges that were overcome throughout the design process. Some of the design constraints are as follows: the weight and dimensions of the neutral flux probe, the dimensions of the test chamber, and the time needed to obtain an accurate test sample. We were able to overcome all of the challenges and constraints and design a traversing mechanism capable of moving the ECE group's neutral flux probe throughout the test chamber.



Walker, Mitchell. "Effects of Facility Backpressure on the Performance and Plume of a Hall Thruster" University of Michigan. 2015

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NASA/Arizona State University
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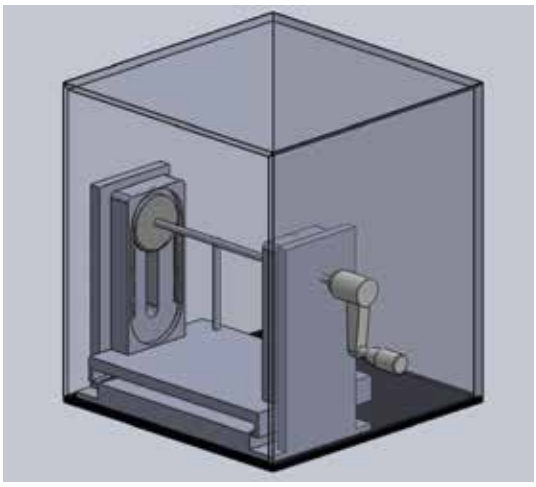
Heartwood School/Ingham ISD
Single Motion Stamp Press

Heartwood School is a local school that services students with moderate to severe cognitive impairments, severe multiple impairments, and autism spectrum disorders. The students attending Heartwood School, from ages 16 through 26, learn skills that center around transitioning to life after school, including cooking, cleaning, money management, and self-determination. One activity that has become popular and has helped with this goal is the process of making and selling cards using rubber stamps. This can be difficult for some students depending on their particular impairment.

Our team was asked to make this process easier and simpler for all students by using a single motion method that incorporates a hand crank similar to a hand-pedal bike. The objectives were met by creating a simple process, including an adjustable crank for students with differing physical impairments, allowing easy portability that doesn't compromise mobility while in use, and above all ensures the safety of the students at all times.



Ingham Intermediate School District
A Regional Educational Service Agency

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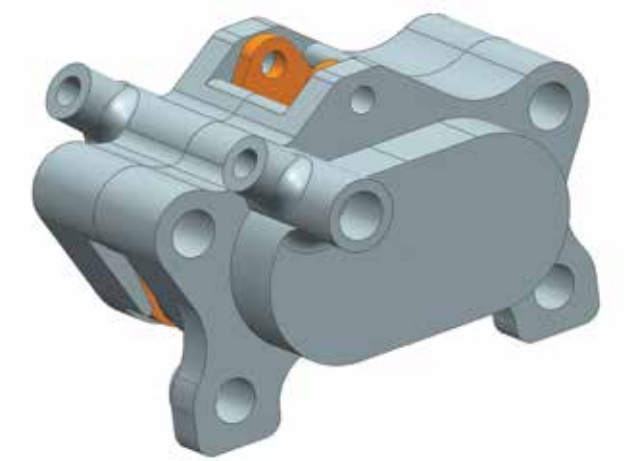
Farhad Jaberi

MSU Baja Racing Team
Custom Brake Calipers & Validation

The MSU Baja Racing Team is an official SAE Collegiate Design Team that designs, builds, and races an off-road vehicle each academic year. The team is student-led and provides an opportunity for engineers to develop hands-on experience in design and manufacturing. The team travels around the country each year to participate in three official Baja SAE competitions where the cars compete in dynamic events and a four-hour endurance race. The cars are also judged on the design, cost, and a sales pitch. To improve overall placement, more custom parts are optimized and validated to bring a better car to competition every year.

Our team focused on the design and implementation of custom brake calipers for the 2019 Baja car. The calipers were designed to provide better braking than the Wilwood PS1 calipers that the team has employed for the past ten years. The calipers were designed to provide enough braking force and prevent any brake fluid leaks that could lead to a loss in pressure. They were manufactured on a Haas CNC using 7075 aluminum to provide a light and strong product. One set of brake calipers was manufactured and assembled on the car. The MSU Baja Team's engine dynamometer was modified, and an additional caliper was added to perform a full brake study. Data were collected on brake fade along with brake pad and rotor wear. The new calipers and validation will help the team pass brake check and earn it design points at the competitions this year.



MICHIGAN STATE BAJA

Michigan State University
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Highland, Michigan

Alayna Farrell
Dewitt, Michigan

Matthew Pusheck
Waterford, Michigan

Brandon Praet
Sterling Heights, Michigan

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Bloomfield, Michigan

MSU Baja Racing Team
Project Sponsor

Jacob Khodl
Lansing, Michigan

ME Faculty Advisor

Junlin Yuan

MSU Entomology: Quick Connection System for Solid Set Canopy Delivery System

The solid set canopy delivery system (SSCDS) is a distributed network of micro-sprayers in fruit crop canopies that are fed by a pumping system that is located outside of orchards. This system has been created to help farmers across the world reduce drift and waste, limit exposure to the chemicals, and reduce labor. Unlike the conventional tractor-based system, this system helps create a safer working environment and protect surrounding crops and environments.

To improve the current SSCDS, our team was asked to develop an integrated quick connect system. This connector will make it easier for the pumping system to be attached to the sprayers and will be capable of withstanding the application and environmental conditions which are present in an orchard.

The connector will have a male part that will always be attached to the pump's tubing and a female part attached to the tubing out in the field. This connector will need to be a slip coupling that is both water and airtight. The connector also needs to be able to dry lock. These three requirements are the most important in designing the coupling because together they provide the safest connector for the user and the environment.

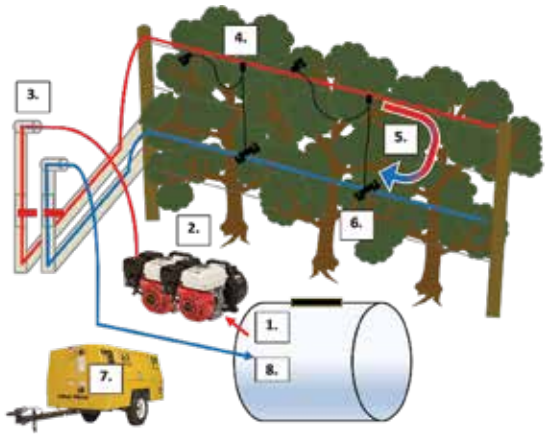

Figure 1. SSCDS Schematic: 1) Agrochemical tank; 2) Pumps for pressurizing and delivering agrochemical; 3) Spray system manifold; 4) Spray supply line; 5) Microsprayers placed at top and middle of canopy; 6) residual return line; 7) Air compressor for returning residual and cleaning system; 8) Residual material returned to tank

Department of Entomology
MICHIGAN STATE UNIVERSITY

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Ahmed Naguib

College of Engineering
MICHIGAN STATE UNIVERSITY

ENGINEERING SUMMER CAMPS 2019

www.egr.msu.edu/future-engineer/summer-programs

STUDENTS ENTERING GRADES 10 - 12

HIGH SCHOOL ENGINEERING INSTITUTE

A hands-on exploration of engineering majors and careers with MSU faculty & student mentors.

RESIDENTIAL
Session 1: June 16-20
Session 2: June 23-27
Session 3: July 7-11
Session 4: July 14-18

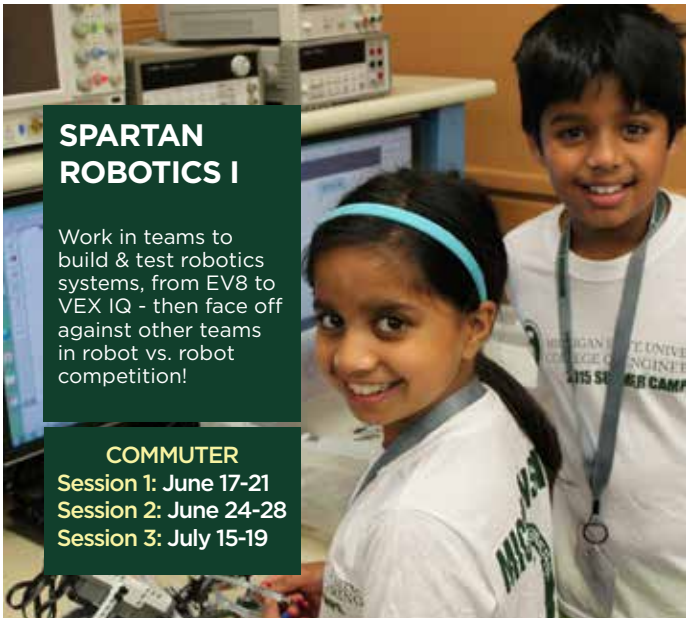
STUDENTS ENTERING GRADES 11 - 12

MAKING A GAME OF IT

Learn coding skills from MSU faculty and students, then develop your own video games in Python.

RESIDENTIAL
June 23 - 28

STUDENTS ENTERING GRADES 3-6

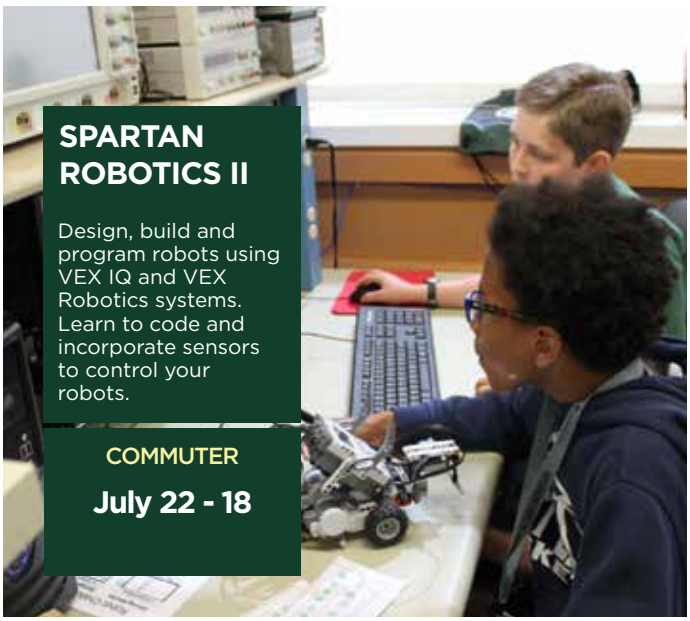


SPARTAN ROBOTICS I

Work in teams to build & test robotics systems, from EV8 to VEX IQ - then face off against other teams in robot vs. robot competition!

COMMUTER
Session 1: June 17-21
Session 2: June 24-28
Session 3: July 15-19

STUDENTS ENTERING GRADES 7-9



SPARTAN ROBOTICS II

Design, build and program robots using VEX IQ and VEX Robotics systems. Learn to code and incorporate sensors to control your robots.

COMMUTER
July 22 - 18

The Capstone Projects

Dr. William Resh
Professor of Mechanical Engineering

Faculty Advisors: Benard, Engeda, Lillehoj, Segalman, Wichman, Wright, Zhu


Benard


Engeda


Lillehoj


Segalman


Wichman


Wright


Zhu

Presentation Schedule – Engineering Building, Room 1300

Time	Team Sponsor	Project Title
7:30 a.m.	Salt Yoga	Yoga Tone Yoga Belt
8:00 a.m.	MSU Department of Theatre	Revolving Stage Turntable
8:30 a.m.	McLaren Greater Lansing	Rehabilitation Gym Adjustable Car
9:00 a.m.	Fiat Chrysler Automobiles	Multi-Body Simulation of Tire/Soft Soil Interface
9:30 a.m.	MSU Recycling Center (Joint with ECE 480)	Automated Recycling Collection
10:00 a.m.	Gerdau Special Steel North America	Heat Treat Furnace Rolls
10:30 a.m.	Hitachi Automotive Systems Inc.	Tabletop Wind Tunnel
11:00 a.m.	Whirlpool Corporation	Small Space Dryer
11:30 a.m.	TERPHANE	New Packaging Design Development

Mechanical Engineering Design Program Awards

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

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

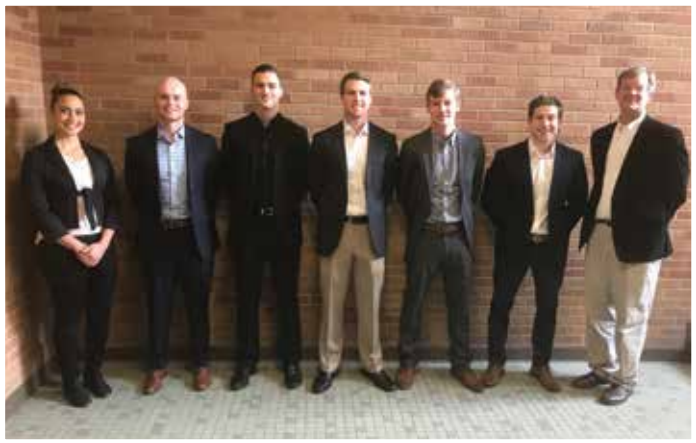
The ME Design Program also presents the Leonardo da Vinci Machine Design Award to the winners of its ME 470 Machine Design competition. The specific design problem and criteria for this competition change from semester to semester.

Salt Yoga
Yoga Tone Yoga Belt

Toni Thomas, the owner of Salt Yoga in East Lansing, Michigan, is looking to revolutionize the yoga industry. The grand opening of her studio is this Spring 2019, and she is looking for ways to bring in new customers and challenge her existing clients. Her studio offers a certain brand of hot yoga that involves halo therapy. Halo therapy is a dry salt therapy that aids in general wellness by removing toxicity from the respiratory system while also invigorating the body with increased lung capacity and oxygen intake. She conceived of the Yoga Tone Yoga Belt to add resistance and increase the challenge of a typical salt yoga session.

Our design team brought the idea to fruition and developed the prototype starting from the customer needs identified by Ms. Thomas. The team identified materials that were compatible with the hot yoga environment, which can be warmer than 90 °F with high humidity. The team used biomechanical analysis to determine the resistance bands needed. The fixture points and attachment methods were developed empirically. The result should be compatible with a variety of body sizes and abilities of the yoga practitioners. Our team designed the belt to integrate smoothly into the workout without inhibiting required motions or causing discomfort at the attachment points. The design incorporated a modular philosophy so that the bands, belt, and wrist and ankle straps can be cleaned or replaced as required.

SALT yoga



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Matthew Forsyth
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Kellen Scott Michael
South Lyon, Michigan

Marc Veihl
New Lenox, Illinois

Tyler Piotrowski
Livonia, Michigan

Neil Wright (Faculty Advisor)

Salt Yoga
Project Sponsor

Toni Thomas
East Lansing, Michigan

ME Faculty Advisor

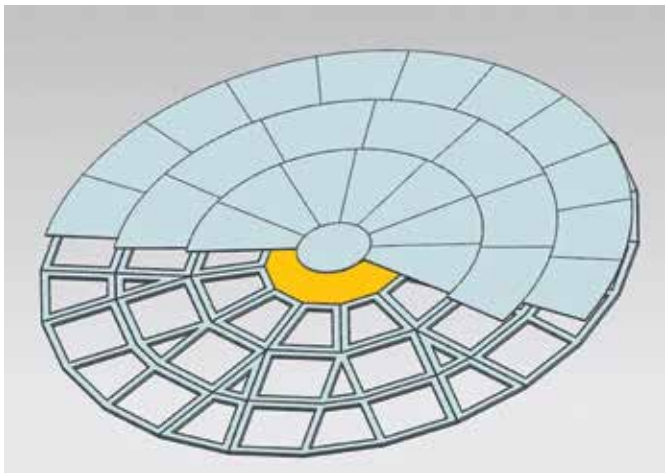
Neil Wright

MSU Department of Theatre
Revolving Stage Turntable

The Michigan State University Department of Theatre offers MSU students many academic courses and degree programs from acting to production design. The department also produces a wide range of different theatrical productions every season and often designs and builds its own sets for the shows.

The department is interested in having a large revolving turntable stage piece designed. The turntable would be driven by a friction drive motor and be variable in size from 12 to 24 feet in diameter with 6-foot increments. The surface of the turntable must allow for the customizable attachment of sets anywhere on its surface. In addition, the entire assembly must be simple and lightweight enough for two people to assemble in a few hours using few tools. The Department of Theatre requires the ability to run electrical power from the stage to the turntable to allow for set lighting. The turntable must be able to rotate at a maximum rate of 30 degrees per second angular speed and a minimum rate of 1 degree per second.

This lightweight adjustable turntable stage piece will expand the capabilities of the MSU Department of Theatre and allow for many interesting and versatile stage designs. The Departments of Mechanical Engineering and Theatre will both benefit from a closer relationship encouraging future collaboration.



DEPARTMENT OF THEATRE
www.theatre.msu.edu

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McLaren Greater Lansing
Rehabilitation Gym Adjustable Car

McLaren Greater Lansing is the leader in hospital, medical, and healthcare for Lansing and surrounding areas. McLaren's services include patient rehabilitation centers for cardiology, pulmonary, sports medicine, and physical and occupational therapy. Physical and occupational therapy are critical for patients who have undergone total knee replacement or total hip replacement to adjust to everyday life with new limitations. A new McLaren hospital facility is in the process of being built adjacent to Michigan State University and is slated to open in 2021.

Our team designed a rehabilitation car for patients undergoing occupational therapy at McLaren Hospital. The car will emulate a realistic car environment in which patients can practice safe transfers while remaining in the hospital. To accommodate the variety of vehicles used by rehabilitation patients, the car will be height-adjustable and include a retractable running board. This project will aid in the transition from therapy to everyday life for patients in the rehabilitation gym of the new McLaren facility.

McLaren GREATER LANSING

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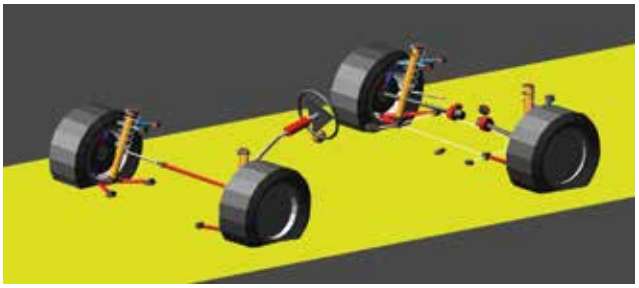
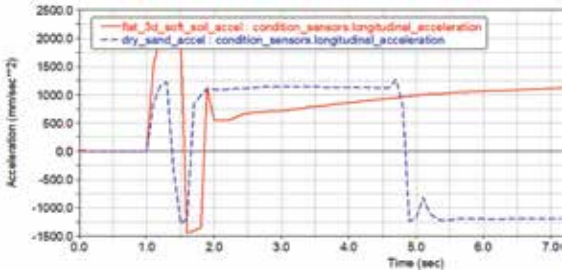
Fiat Chrysler Automobiles
Multi-Body Simulation of Tire/Soft Soil Interface

Fiat Chrysler Automobiles (FCA) designs, engineers, manufactures, and sells vehicles and related parts and services, components, and production systems worldwide through 159 manufacturing facilities, 87 R&D centers, and dealers and distributors in more than 140 countries. Its brands include Abarth, Alfa Romeo, Chrysler, Dodge, Fiat, Fiat Professional, Jeep, Lancia, Ram, Maserati, and Mopar - the parts and service brand.

Our team focused on construction of a full-vehicle multi-body simulation model, in particular to understand the behavior of an interface between a vehicle tire and a soft sand/loose soil road profile. Tire parameters, including normal tire load, vertical stiffness, damping, and rolling resistance were considered. In addition, various vehicle maneuvers within straight-line and open-loop steering events were used as testing maneuvers in the simulation. Such simulation and vehicle dynamics studies were completed with ADAMS/Car provided by MSC Software. The project primarily focused on using multi-body simulation software rather than other conventional Finite Element Method-based simulation software on tire and soil interface analysis. This offers simplicity and new insight into vehicle dynamics analysis on off-road simulations.





FCA
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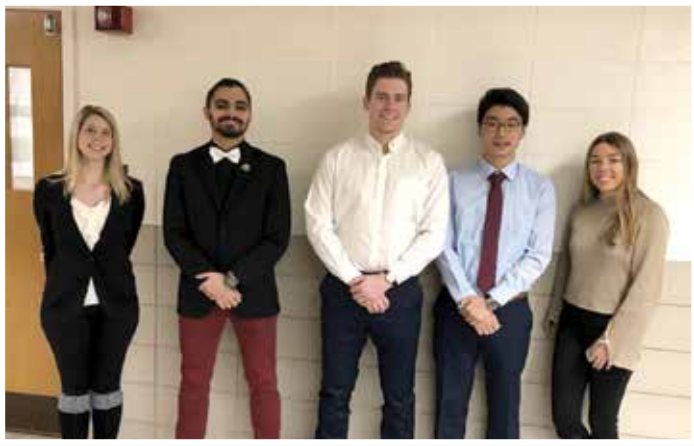
MSU Recycling Center
Automated Recycling Collection

Environmental sustainability is the ability to meet the needs of present and future generations. The Michigan State University Recycling Center is responsible for helping MSU become an environmentally sustainable campus. The primary responsibility of the recycling center is to maintain the recycling bins around MSU. Currently, there are 200 recycling bins set up throughout campus. During football season, the number of bins increases to 800. Managing all of these bins can be challenging.

Twice weekly, a two-person team travels to monitor all of the bins. During these travels, most of the bins are found to be less than 50% full and do not need emptying. This results in multiple costs: increased labor, increased required materials, and increased carbon dioxide emissions are a few examples.

Continuing last semester's project, our team focused on designing and creating a device that could measure the fullness of each recycling bin and send the results to a database each morning for analysis. Because there is a surplus of recycling on home football game days, our team also focused on each device having the ability to be programmed in order to alter minor issues such as how many times the fullness is read, change of location, and GPS tracking. The success of this project will save the university money and resources, as well as help to make campus run more efficiently.

Surplus Store and Recycling
managing waste as a resource



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Gerdau Special Steel North America
Heat Treat Furnace Rolls

Gerdau Special Steel North America is an engineered bar producer headquartered in Jackson, Michigan with world-class steel manufacturing mills in Jackson, Michigan, Monroe, Michigan, and Fort Smith, Arkansas, as well as metal processing facilities in Huntington, Indiana. Gerdau steel mills takes 100% scrap steel, and melts, casts, and rolls it into round bars. Those bars are then sent through value added processing, including heat treatment, straightening, peeling, and non-destructive testing for internal and surface quality. Due to the large number of orders processed by Gerdau Special Steel North America, roll breakdowns and maintenance have detrimental effects upon order processing time and expected furnace life.

Our team was asked to investigate both material and design factors with respect to roll breaks in Gerdau's STC batch furnaces and to recommend changes to either design, material, or both, that will result in fewer breaks and longer operational life. Our team utilized Altair Inspire and ANSYS Finite Element Analysis (FEA) programs in conjunction with a material study of failed rolls to investigate the current design and to provide proposed solutions. Solutions were classified as minimal, moderate, or significant in scope to facilitate decision-making and implementation in a dynamic business environment.

GERDAU

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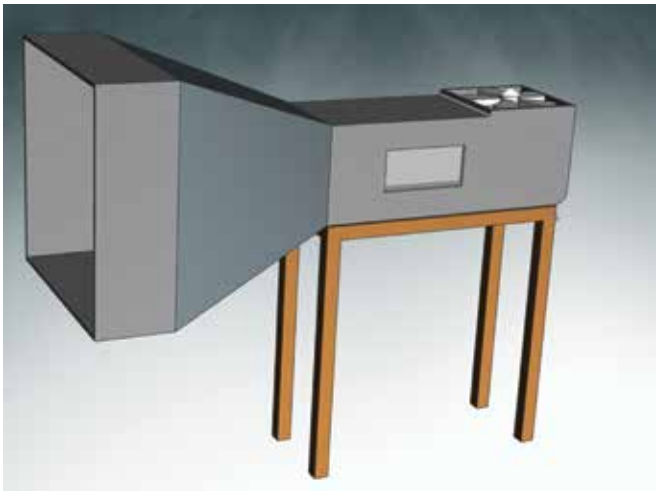
Hitachi Automotive Systems Americas Inc.
Tabletop Wind Tunnel

Hitachi Automotive Systems Americas Inc. (HIAMS) is a Tier 1 supplier of global automotive products. HIAMS manufactures and markets OE products such as engine management systems, electric powertrain systems, and drive control systems. When designing and developing electronic control units (ECUs) for the automotive industry, Hitachi must verify that the controller has the ability to reject thermal energy from the electronics to the ambient environment. Hitachi needed a method to validate the performance of prototype designs during the early development phase.

Our team was tasked with building and testing a reliable and affordable tabletop wind tunnel for ECUs. The solution requires variable control of airflow volumetric flow rate, air temperature, and a 12x12x6 test chamber. We successfully created a tabletop wind tunnel that validates the performance of laminar flow across airflow range, airflow volume and temperature in the test chamber. The solutions include instruction for use, calibration, CAD assembly, and a final BOM.



HITACHI
Inspire the Next
Hitachi Automotive Systems

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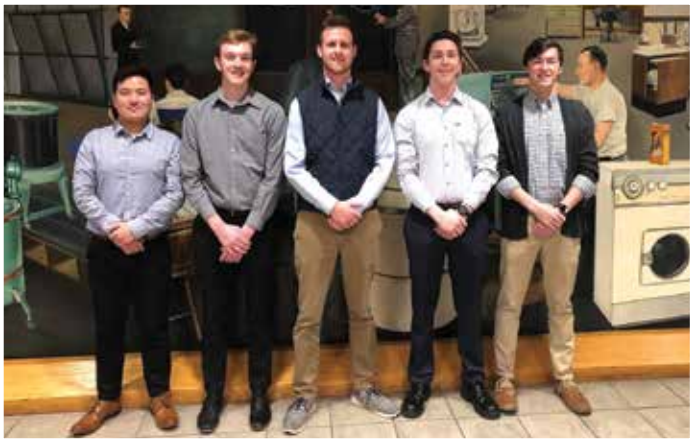
Whirlpool Corporation
Small Space Dryer

Whirlpool Corporation, headquartered in Benton Harbor, Michigan, is the world's leading major home appliance company. Whirlpool markets products worldwide, with approximately $21 billion in annual sales, and 92,000 employees across 65 manufacturing and research facilities. The company's global impact, combined with a commitment to innovative, sustainable and affordable solutions creates a potential for large markets and a wide range of products. The goal is not only designing for functionality but delivering an experience. While many clothes drying options are already available – ranging from storable drying racks to conventional tumble dryers – there is need for a mid-level solution that combines functionality and efficiency with usability and a positive experience.

Our team was tasked with developing a product to meet this tailored market. After defining the primary design intent and problem constraints, a systematic process was implemented to establish and compare potential solutions. Factors such as the intended customer audience and system primary functions were identified. Technical documents, such as concept selection matrices (CSM), tradeoff diagrams, and P-diagrams, aided in organizing and tracking development progress. With the frontend development completed, next steps can be taken to prototype and test the most promising solutions.



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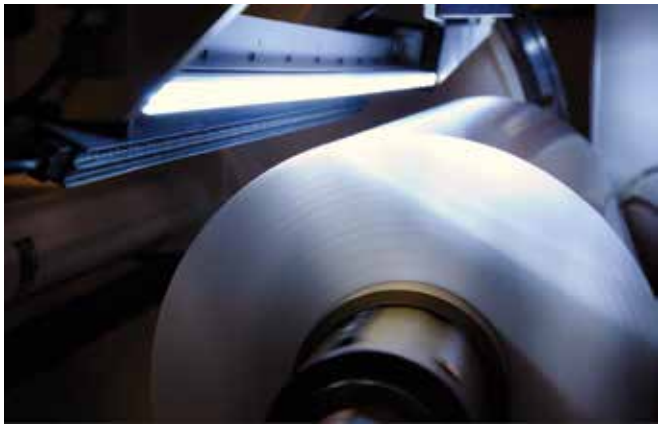
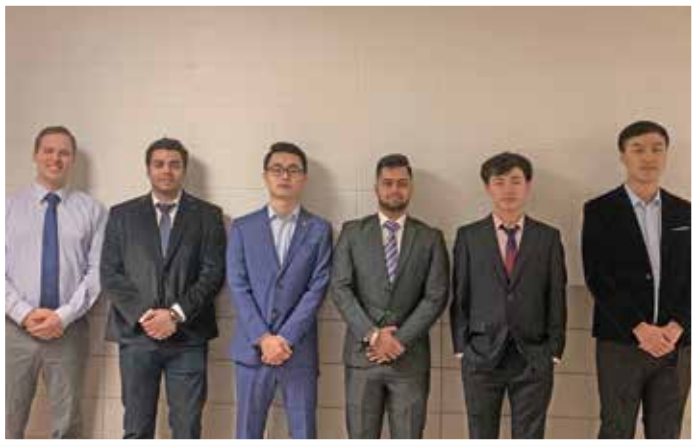
TERPHANE
New Packaging Design Development

TERPHANE is a company that designs and manufactures polyester products, such as heat sensitive films, in North and South America. The combination of TERPHANE polymer formulations and additives with a co-extrusion and stretching process, together with other special treatments (coatings, corona treatment, metallization), is designed to meet the demanding packaging and industrial needs of its customers. Since the addition of its new state-of-the-art P3 line in Brazil, TERPHANE currently produces over 38,000 tons of product per year. TERPHANE's plant in Brazil is the only bi-oriented polyester film producer in South America, providing a full line of advanced polyester films and specialty products.

In recent years, there has been a growing demand for food deliveriy services However, in many cases, food may become cold or contaminated during transport due to long delivery times or poor handling practices. For example, it can take more than an hour to deliver food to some restaurants. The food sometimes arrives in various conditions after it has left the kitchen. Our team has been asked to design a disposable delivery box that is fully sealable, low-cost, and easy to manufacture. The design will help people get better quality takeout food. In addition, we designed and developed a prototype machine to automate the construction of the food container.



TERPHANE



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Peter Lillehoj

Design Day Awards Fall 2018

FALL 2018
ME 481 EDISON AWARD

Team Fraunhofer: "Cyclic Impact Tester for PVD Thin Film Coating Evaluation"

Left to right: Luke Crompton, Phillipp Waeltermann, Eli Broemer, Stuart Gadigian, Aaron Winter

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FALL 2018
ME 481 PROJECT PRESENTATION AWARD

Team MSU Adaptive Sports & Recreation Club: "Asymmetrical Arm Function Sports Wheelchair"

Left to right: Emily Duddles, Matt Rimanelli, Alexa Baylis, Kyle Bauer, Geneieve Kobrossi






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25
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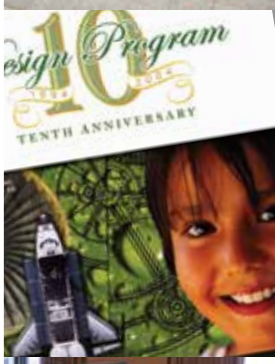

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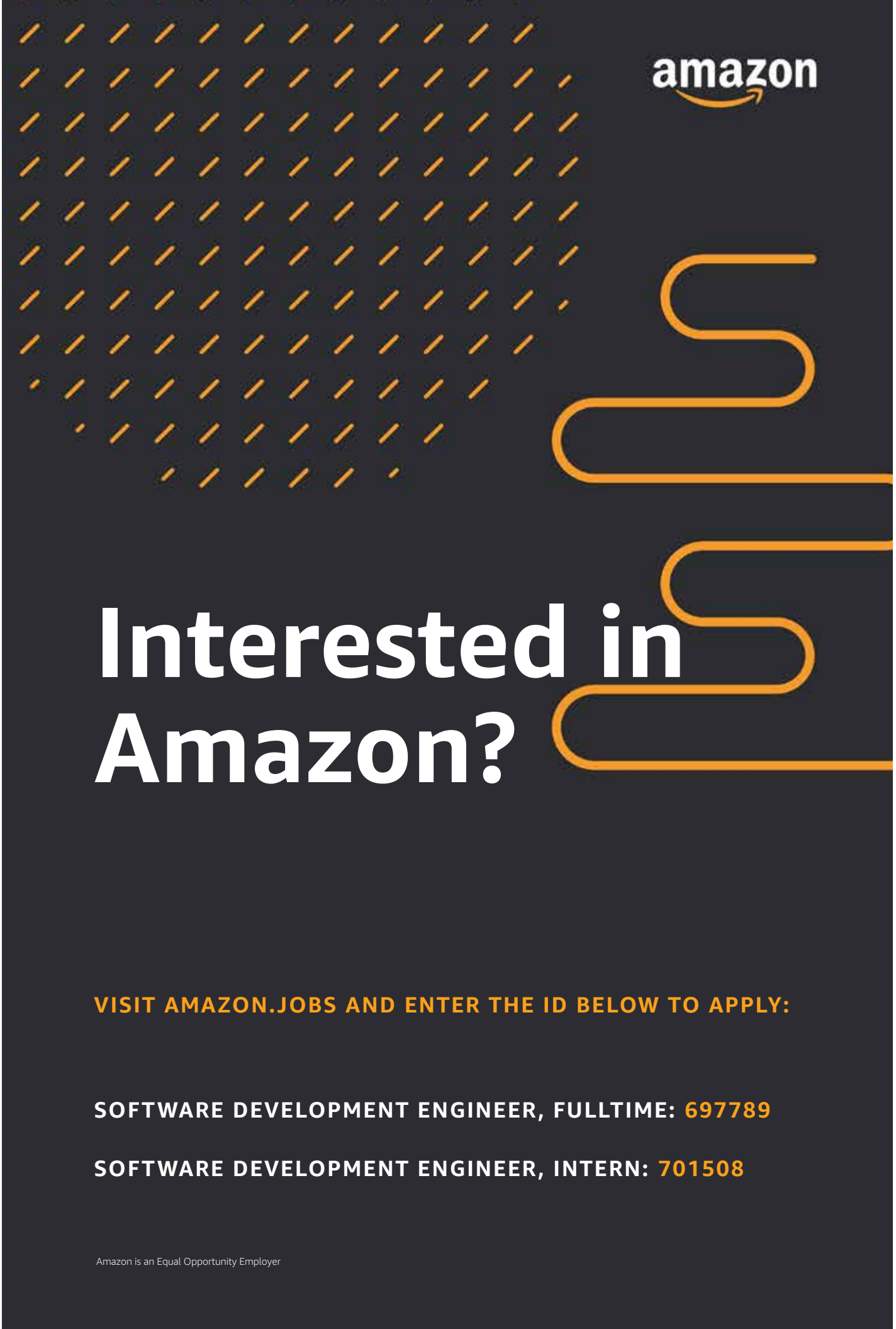
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