SPRING 2014

# Design Day

## COLLEGE OF ENGINEERING


MICHIGAN STATE UNIVERSITY

EXECUTIVE PARTNER SPONSOR

GM


WE ARE THE DRIVING FORCE

GM

**Dear Students, Family Members, Company Representatives,
Alumni, Faculty & Staff:**

On behalf of General Motors, and in partnership with Michigan State University (MSU), it gives us great pleasure to welcome you to the beautiful MSU campus and to the MSU College of Engineering Design Day. GM is proud to partner with Michigan State University on this event, which highlights the talents and capabilities of many outstanding students.

Design Day demonstrates the intellect, ingenuity, teamwork and core engineering skills of current MSU College of Engineering students in delivering their Design Day projects. Without fail, the students provide inspiration to us all as they raise the bar on what can and should be possible. It also gives us great confidence that we have a bright future as these students move into the workforce and help shape the industry.

We wish everyone in attendance today a wonderful and exciting day here on the MSU campus. Along with family members, sponsors and representatives, GM congratulates the participants of today's event. Best of luck to all!

Sincerely,

Fred Killeen,
Chief Technology Officer, Information Technology, General Motors

# LEAD. LEARN. DO BOTH AT GM.

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# Table of Contents: April 25, 2014



*Table of Contents continued on the next page*

# Table of Contents: April 25, 2014

# Welcome from the Dean

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

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

We are pleased to acknowledge General Motors as our Design Day Executive Partner Sponsor and the MSU Federal Credit Union as our Design Day Directing Partner Sponsor. Our Design Day Supporting Partner Sponsors include Auto-Owners Insurance, Bosch, Dow, Meijer, Nielsen, Urban Science, and Whirlpool. We thank all of our sponsors for their generosity and their ongoing commitment to Design Day.

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

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

Another exciting part of Design Day is the Dart Foundation Day of Engineering Innovation and Creativity for 7th-12th Grade Students, which involves some 200 local junior high and high school students. On Design Day, these future engineers explore design principles with hands-on projects requiring the application of their creativity and ingenuity.

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

Our capstone programs and Design Day would not be possible without the continued support of our capstone project sponsors who provide both funding and a professional experience for our capstone design teams. We appreciate their generosity and their time. Please join us for the Design Day Awards Ceremony in Anthony Hall Room 1281 at 1:15 pm when we will honor all of our talented Spartans, the best of the best.

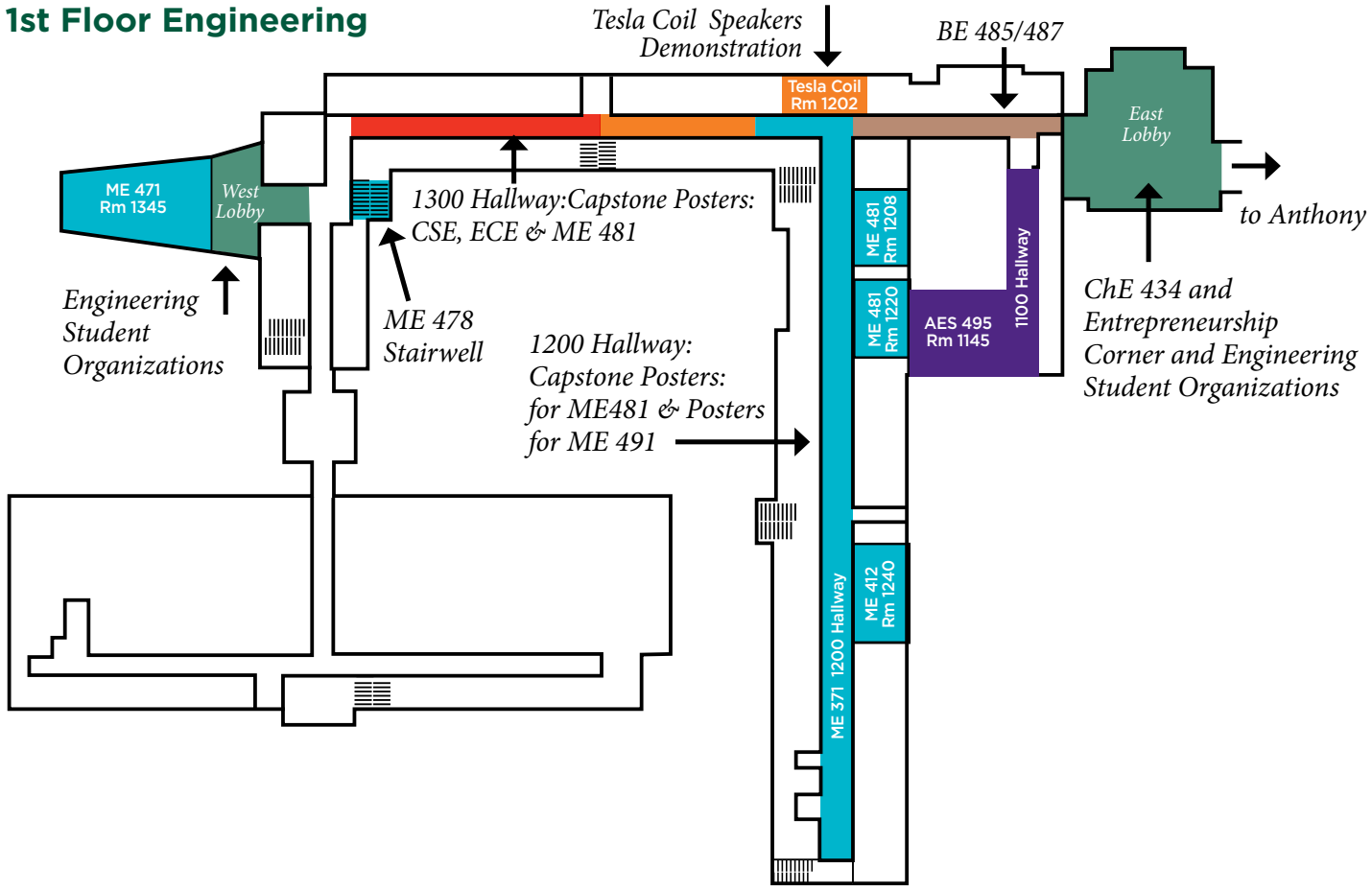
**Dr. Leo Kempel**

Acting Dean of the College of Engineering

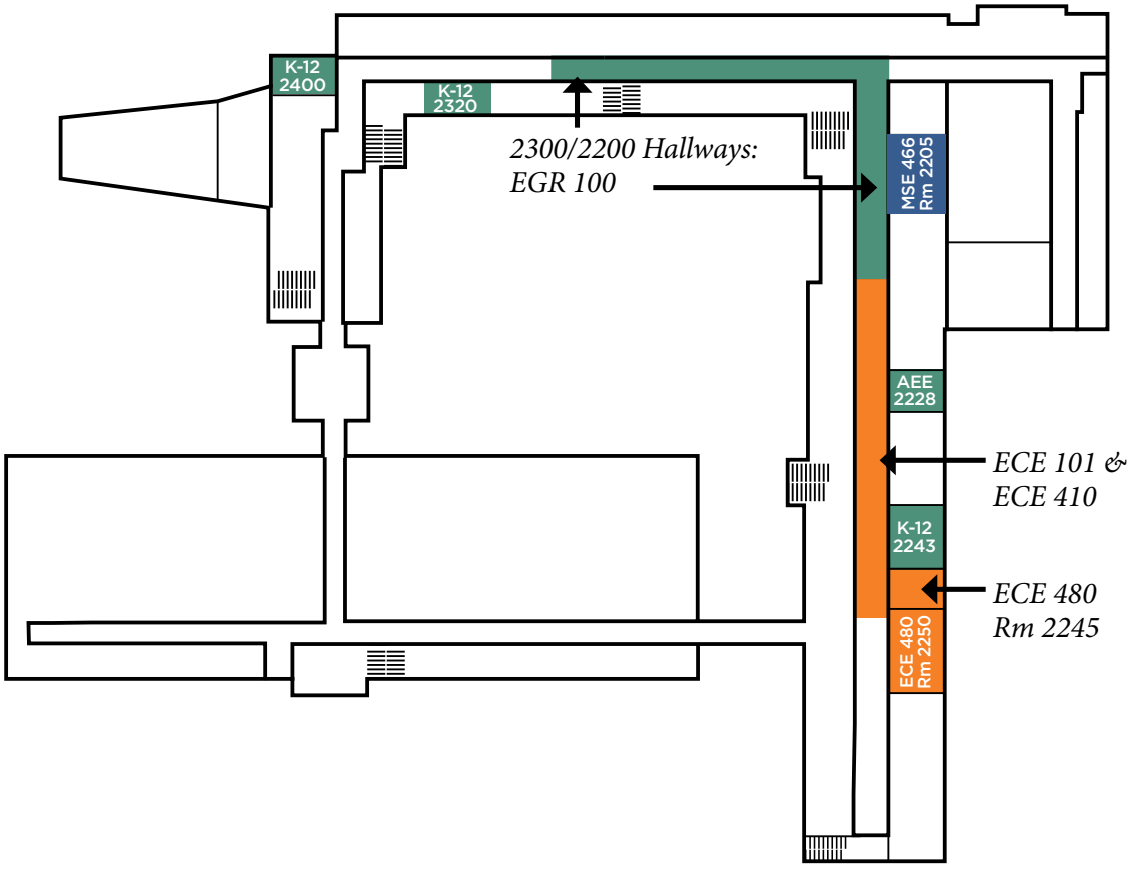
Professor of Electrical and Computer Engineering

Michigan State University

## 1st Floor Engineering

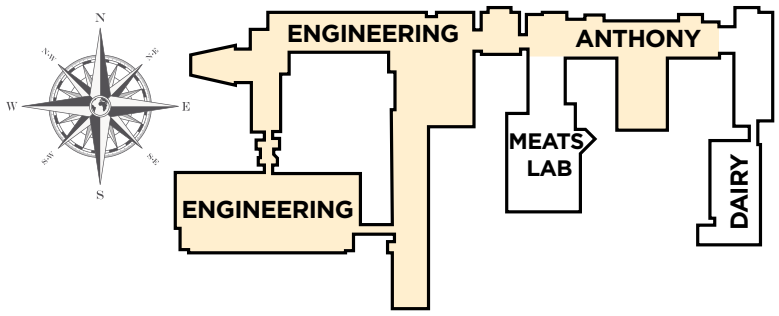



## 2nd Floor Engineering

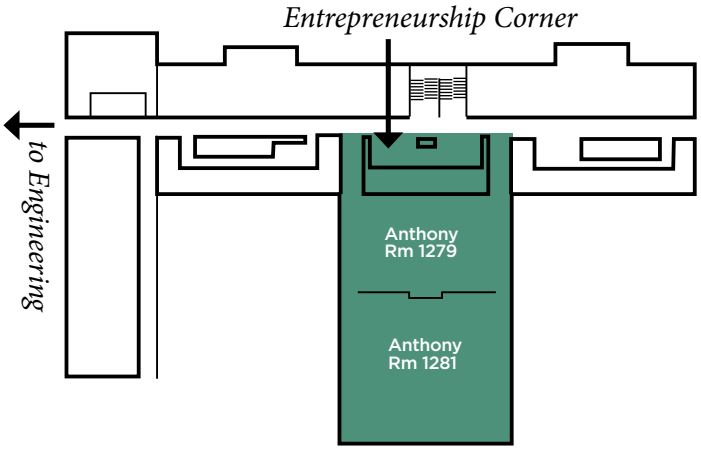


# Design Day Floor Plans of the MSU Engineering Building

## Overview



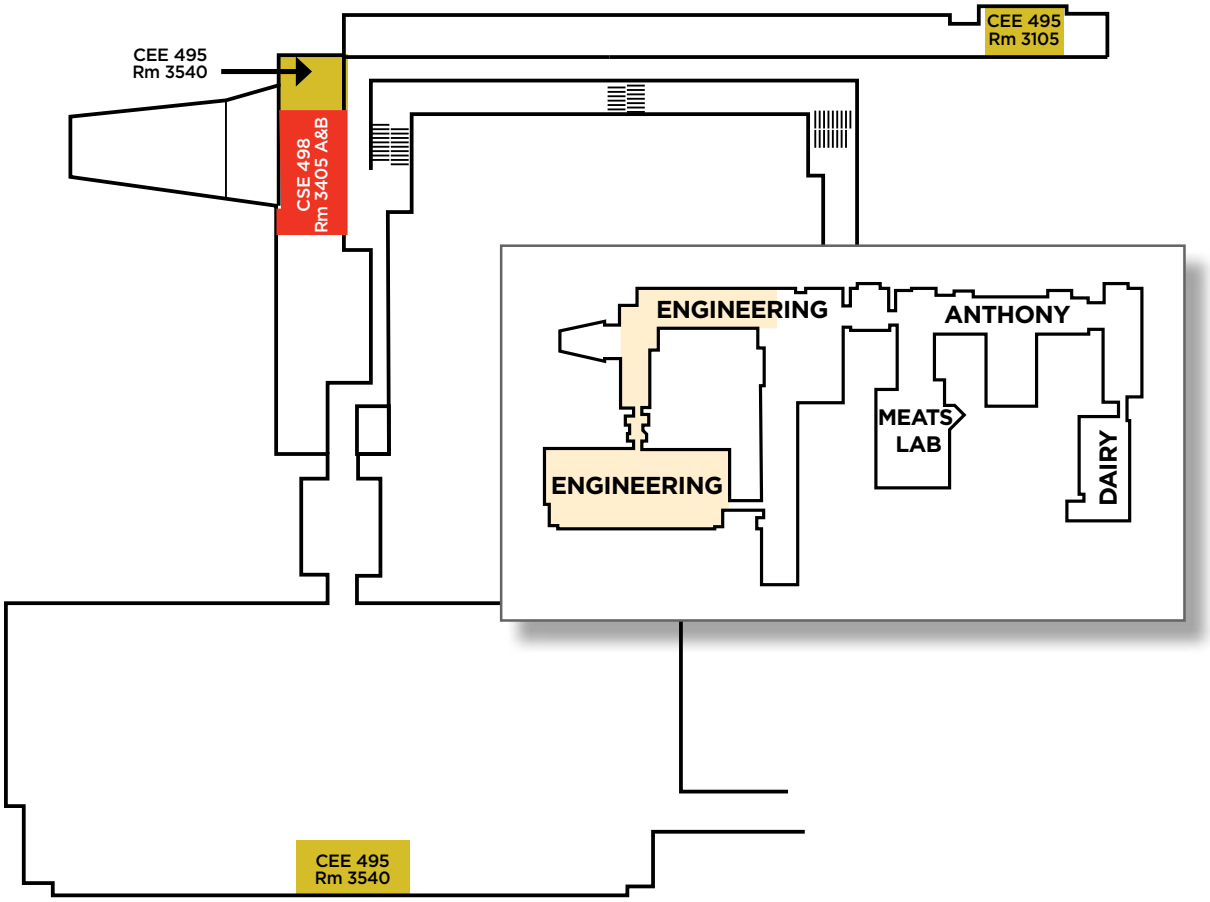

## 1st Floor Anthony




**Color Legend:**

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

## 3rd Floor Engineering



# Design Day Events Schedule
# Friday, April 25, 2014

| 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 Room 2228<br>8:00 a.m. – Noon | | | | | |
| Engineering Student Organizations | | 1st Floor Lobby (West & East)<br>8:00 a.m. – Noon | | | | | |
| Tesla Coil Speakers Demonstration | | | 1st Floor Room 1202<br>9:00 a.m. – Noon | | | | |
| ECE 101 & ECE 410 Presentations | | | 2nd Floor 2200 Hallway<br>9:00 a.m. – Noon | | | | |
| EGR 100 Presentations | | | 2nd Floor 2300/2200 Hallway<br>9:00 a.m. – Noon | | | | |
| ME 371 Demonstrations | | | 1st Floor 1200 Hallway<br>9:00 a.m. - Noon | | | | |
| ME 412 Competition | | 1st Floor Room 1240<br>8:00 a.m. - 11:00 a.m. | | | | | |
| ME 471 Competition | | 1st Floor Room 1345<br>8:00 a.m. - 11:48 a.m. | | | | | |
| ME 478 Competition | 1st Floor West Lobby Stairwell<br>10:00 a.m. - 11:00 a.m | | | | | | |
| ME 491 Demonstrations | | | 1st Floor 1200 Hallway<br>9:00 a.m. - Noon | | | | |

| CAPSTONE COURSES | | | | | | | |
|---|---|---|---|---|---|---|---|
| All Capstone Posters for most projects, including BE485/487, ChE 434 | | 1st Floor 1300 to West Lobby<br>8:00 a.m. - Noon | | | | | |
| AES 410 Project Presentations | | | 1st Floor 1100 Hallway/Room 1145<br>8:30 a.m. - Noon | | | | |
| CE 495 Project Presentations | | 3rd Floor 3105, 3400, 3540<br>8:00 a.m. - Noon | | | | | |
| CSE 498 Project Presentations | | 3rd Floor 3405 A & B<br>7:30 a.m. - Noon | | | | | |
| ECE 480 Project Presentations | | | 2nd Floor Room 2250 & 2245<br>8:15 a.m. - 11:05 a.m. | | | | |
| ME 481 Project Presentations | | 1st Floor 1200 Hallway/Rooms 1208 & 1220<br>8:00 a.m. - Noon | | | | | |
| MSE 466 Project Presentations | | | 2nd Floor Room 2205<br>9:00 a.m. - 11:30 a.m. | | | | |

| LUNCH AND AWARDS | | | | | | | |
|---|---|---|---|---|---|---|---|
| High School Opening | | | 1st Floor Anthony, Room 1279<br>8:00 a.m. - 8:40 a.m. | | | | |
| High School Award | | | | 1st Floor Anthony, Room 1279<br>Noon - 12:10 p.m. | | | |
| MSU Awards | | | | 1st Floor Anthony, Room 1281<br>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

# Thank you!

Roy Bailiff, Department of Mechanical Engineering
Denise Barnsted, College of Engineering
Dean Buggia, K-12 Outreach
Career Peers, Center for Spartan Engineering
Linda Clifford, Department of Electrical and Computer Engineering
Kelly Climer, Department of Computer Science and Engineering
Judy Cordes, Women in Engineering
Sandy Christlieb, College of Engineering
Jeff Curtiss, College of Engineering
Barb Delong, Department of Biosystems Engineering
Cathy Davison, Department of Computer Science and Engineering
Malcolm Doering, Department of Computer Science and Engineering
Ethan Fahy, K-12 Outreach
Bernadette Friedrich, Center for Spartan Engineering
Craig Gunn, Department of Mechanical Engineering
Phil Hill, Department of Biosystems Engineering
Leo Kempel, College of Engineering
Debbie Kruch, Department of Computer Science and Engineering
Kyle Liechty, Center for Spartan Engineering
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Garth Motschenbacher, Center for Spartan Engineering
Mary Mroz, Department of Civil Engineering
Pat Mroczek, College of Engineering
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Roxanne Peacock, Department of Electrical and Computer Engineering
Adam Pitcher, Department of Computer Science and Engineering
Jeanette Robertson, College of Engineering
Laura Taylor, Department of Civil Engineering
Norma Teague, Department of Computer Science and Engineering
Francie Todd, College of Engineering
Tom Wolff, College of Engineering
Brian Wright, Department of Electrical and Computer Engineering

Jill Bielawski, Editor, Design Day Book
Iain Bogle, Graphic Designer, Design Day Book

Thanks to all of you for making Design Day a success.

*Wayne Dyksen, Executive Director, Design Day*

*Jennifer Jennings, Director, Design Day*


EXIT

# Dart Day of Innovation and Creativity

## *for 7th-12th Grade Students*

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

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

Funded by the Dart Foundation

DART FOUNDATION

MICHIGAN STATE UNIVERSITY | College of Engineering

# The Dart Foundation

# Middle and High School Innovation and Creativity Day

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

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

DART FOUNDATION

Office for Inclusion and Intercultural Initiatives

NSF

| | Room 1279 Anthony Check in | C.E./M.E. Team Build Room 2243 | VEX Robotics Room 2400 | 1st & 2nd Floor Voting/ project viewing | Center for Highway Pavement Preservation Room 2320 |
|---|---|---|---|---|---|
| 8:00–8:40 | All Schools 1 thru 8 | | | | |
| 8:40–9:30 | | Schools 1 & 2 | Schools 5 & 6 | Schools 3 & 4 | Schools 7 & 8 |
| 9:30–10:20 | | Schools 7 & 8 | Schools 1 & 2 | Schools 5 & 6 | Schools 3 & 4 |
| 10:20-11:10 | | Schools 3 & 4 | Schools 7 & 8 | Schools 1 & 2 | Schools 5 & 6 |
| 11:10-12:00 | | Schools 5 & 6 | Schools 3 & 4 | Schools 7 & 8 | Schools 1 & 2 |
| 12:00–12:20 | All students in Room 1279 Anthony for the awards ceremony. Lunch will immediately follow. | | | | |

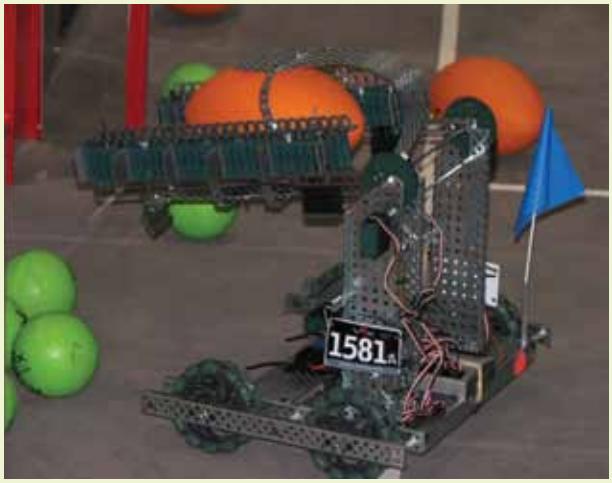
**http://www.egr.msu.edu/future-engineer/** **LIKE US: https://www.facebook.com/futurespartanengineers**

## UNIVERSITY TRANSPORTATION CENTER FOR HIGHWAY PAVEMENT PRESERVATION (CHPP)

The need to protect the massive national highway infrastructure investment is recognized by Congress and clearly cited in the "Moving Ahead for Progress in the 21st Century Act" or the "MAP–21". The establishment of CHPP is consistent with the U.S. Secretary of Transportation's strategic goal of "State of Good Repair." The mission of CHPP is aimed at providing a new platform for accelerating innovation in highway pavement preservation. The center will assist in meeting the increasing demand for highway pavement preservation research and will further the goal of increasing the reliability and performance of the nation's highways. Encouraging the best and brightest future engineers pursuing degrees and careers in transportation-related engineering disciplines should be a big priority. This CHPP session will center on showcasing innovative, creative, and fun challenges, as well as opportunities for participating high school students and teachers.

## 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.

## MEMBERS OF THE ORGANIZING COMMITTEE SPRING 2014

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

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

**Rachel Esch**
K-12 Outreach Administrative Assisant

**Russ Pline**
Okemos High School and MSU Engineering Recruitment and K-12 Outreach Design Day Coordinator

**Samantha Pohlen**
K-12 Outreach Design Student Coordinator

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

**Imen Zaabar**
UTC Faculty and Outreach Team

## EGR 100 Introduction to Engineering Design

**Mr. Timothy Hinds**
**Academic Director**

## 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 659 students are enrolled in EGR 100 this semester.

For the final course project, the student teams selected from five project types: (i) Robotics Challenge, (ii) Solar Car Competition, (iii) Cell Phone App Inventor, (iv) Thermal Insulator Design, and (v) MSU Resource Center for Persons with Disabilities (RCPD) Designs. There were four RCPD projects including Assistive Tools for Understanding Multivariable Calculus, Assistive Tools for Understanding Physics, Basic Electronics Assistive Tools and Accessible MSU Campus Maps. 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.

**Fall 2013 EGR 100 Project Poster Award Winners:**

l-r: Pat Walton, Austin Mashburn, Alex Green, Kalie Collins, Valbona Vulaj, Leo Kempel, Tim Hinds, Claudia Deschaine

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

Ford Community Corps

Resource Center for Persons with Disabilities

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Applied Engineering Sciences

# Capstone Course Sponsors

We gratefully acknowledge Eaton and Chrysler for their financial support of the 2014 AES Capstone Program. We also gratefully acknowledge the corporate scholarship from Eaton to support students in the AES Technical Sales Concentration.

## Capstone Project Sponsors and Award Sponsor

Bath Township

Chrysler

Habitat for Humanity

Michigan Biotechnology Institute

MSU Office of Sustainability

Peckham Industries

XG Sciences

Dr. Phil Fioravante, alumni (BS '84) of our program, winner of the 2004 AES Distinguished Alumni Award and the 2013 College of Engineering Erikson Award, is the 2014 sponsor of awards for AES Capstone projects. Winners are determined 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 event.

# Applied Engineering Sciences

**Dr. Jon Sticklen**
**Director of Applied Engineering Sciences**

**Kalpana Prabhu MBA (2014) Marketing**
**The Eli Broad Graduate School of Management**

**Zach Tomlinson MBA (2014) Marketing**
**The Eli Broad Graduate School of Management**

## Presentation Schedule – 1st Floor, 1100 Hallway / Room 1145

| | Time | Company | Project Title |
|---|---|---|---|
| Non-Profits | 8:30 a.m. | Bath Township | Road Extension: An Enabler for Bath Township |
| | 8:55 a.m. | Habitat for Humanity | Redesigning MRDC Basic Operating Premise |
| MSU Internal | 9:20 a.m. | MSU Office of Sustainability | MSU Sustainability Eco Rep Program |
| | 9:45 a.m. | MSU Office of Sustainability | MSU Sustainable Incentive Plan |
| | 10:00 a.m. | Break | |
| MSU Spinoff Companies | 10:30 a.m. | Michigan Biotechnology Institute | Value Chain for Thermo Polyurethane Foam |
| | 10:55 a.m. | XG Sciences | Applications of Graphene Nanoplatelets as a Heat Spreader |
| Corporate | 11:20 a.m. | Chrysler | Standard Part Classification and Movement |
| | 11:45 a.m. | Peckham | Increasing Efficiency: The Patagonia Jungle Shirt |

# AES 410 Capstone Course
# Senior Capstone Project

The AES capstone is the culmination of the entire program. The course covers content new to the students on professional ethics, project management methods, and concepts of six sigma methods. But the strong thrust of the program is the capstone project itself. The capstone project ...

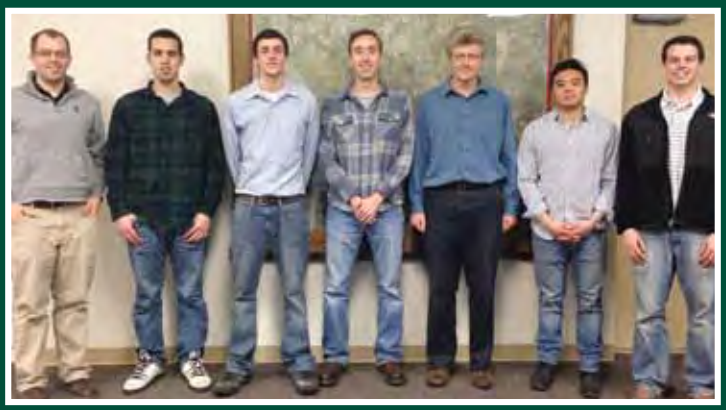
- Focuses on a problem from industry or a non-profit company typically at the confluence of modern business operations and engineering or technical issues,
- Is addressed by a group of 4 - 5 AES Capstone students, and
- Is intense, demands substantial time, and - most of all - is a transition for AES seniors from the world of the classroom to the world in which their careers will be built.

# Bath Township
## Road Extension: An Enabler for Bath Township

Bath Township is located just northeast of East Lansing and is currently seeking support in assessing the possibility of extending State Road through its township. State Road currently stops and starts as it runs east to west through Bath. State Road dead ends at Chandler Road, the Bath Township western border, making travel from the west difficult. Bath is also developing a park at the south end of Park Lake and a road or non-motorized trail would benefit access to the future park.

This project would provide a non-motorized trail or road connecting much of Bath's population to East Lansing's trail system which in turn connects to Lansing's River Trail system. Most of the extension would actually run across City of East Lansing property because the city annexed about 1,000 acres during the 1990s so any development will require involvement from both jurisdictions.

This project touches on several important issues. Areas addressed include economic development issues (bringing people to Bath, improving quality of life in Bath), recreational issues (a non-motorized path linking Bath's future park to a large trail system would benefit Bath residents and the region) and political issues (both Bath Township and the City of East Lansing would have to work together and agree on the plan).

**Michigan State University**
***Team Members***

**Joe Frustaci**
Buffalo, New York

**Aaron Klein**
Portland, Michigan

**Lucas Sproul**
Holt, Michigan

**Ben Caneba**
Houghton, Michigan

**Tevyn Gentile**
Haslett, Michigan

**Project Mentor**
**Kalpana Prabhu**
Bangalore, India

**Bath Township**
***Project Sponsors***

**Jeff Garrity**
Bath Township, Michigan

**Brian Kessey**
Bath Township, Michigan

# Habitat For Humanity
## Redesigning MRDC Basic Operating Premise

With over 50 restores spread across the state of MI, Habitat for Humanity faces challenges trying to distribute shipments in a cost-effective and efficient manner to stores where needed. The Michigan ReStore Distribution Centers (MRDC) is the solution Habitat has come up with. MRDC has been operating for 4 years.

The purpose of the MRDC is to help Habitat for Humanity handle and distribute large donation shipments for the restores. Currently companies will donate multiple semi truckloads of one material such as doors or windows. No restore is large enough to handle and sell one whole truckload of a single material. So the companies ship the material to the MRDC, which then notifies stores, and they come and pick up however much they need. This makes it easier for companies to donate to Habitat, because they always have a place to ship to. Also it makes it easier for the restores, because they don't have to handle such large inventory.

The MRDCs are running full and have no budget to expand. Also they can't afford commercial shipping to move inventory between MRDC locations.

Objectives

- Decide if MRDCs are feasible to keep
- Maximize floor space in MRDC
- Find a cost-effective way to move inventory
- Make it easier for Restores to pick what they need

### Michigan State University
***Team Members***

**Autumn Vassell**
Oak Park, Michigan

**Stephanie Seibert**
Midland, Michigan

**Micqueal Harris**
Southfield, Michigan

**Adam Dabkowski**
Livonia, Michigan

**Andrew Goins**
Rochester Hills, Michigan

**Project Mentor**
**Kalpana Prabhu**
Bangalore, India

### Habitat for Humanity
***Project Sponsor***

**Andy Anderson**
West Branch, Michigan

# MSU Office of Sustainability
## MSU Sustainability Eco Rep Program

Michigan State University is among the most sustainable universities in the nation and continues to improve sustainable practices. Among the many people influencing these processes are the Eco Representatives.

MSU's center of excellence for disseminating sustainability information across the university depends on the Eco Rep program. The Eco Rep program at MSU consists of a coordinated group of 381 faculty and staff representatives that promote environmentally friendly practices within their department to push MSU towards 100% renewable energy. However, there are currently no students involved in the program.

Our intent is to develop a student Eco Rep program based on the current staff and faculty program's core competencies. The project scope is to determine the awareness and interest of students in regards to "being Spartan green" and develop a plan for incorporating the student body.

Collaboration with the MSU Sustainability Office will help in the adaptation of our recommendations that we provide them for establishing a student Eco Rep program. Our contacts there provide us with information pertaining to the current program in place, and what they would like to see going forward. A recommendation will be delivered to our sponsor, based on the feedback received for students' interest in the program. The recommendation will provide a structure in establishing a student-driven Eco Rep program. We plan to use this knowledge for further application of sustainable practices.


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

**Chad Gierak**
Rochester Hills, Michigan

**Eric Mathes**
Wadsworth, Illinois

**Keri Keinath**
Dundee, Michigan

**Brad Kittel**
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**Claire Veit**
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**Project Mentor**
**Zach Tomlinson**
East Lansing, Michigan

**MSU Office of Sustainability**
***Project Sponsors***

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East Lansing, Michigan

**Ann Erhardt**
East Lansing, Michigan

**James Ives**
East Lansing, Michigan

# MSU Office of Sustainability
## MSU Sustainable Incentive Plan

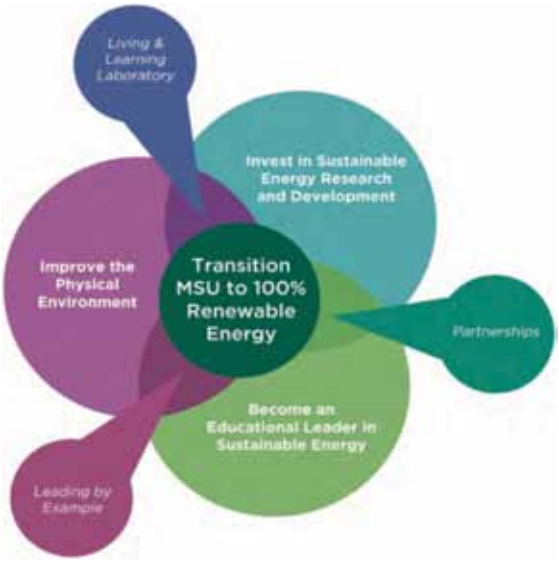
Michigan State University has been recognized as one of the most sustainable universities in the nation. In April 2012, an Energy Transition Plan was approved by the Board of Trustees which was designed to guide the university towards being powered by 100 percent renewable energy.

The Energy Transition Plan (ETP) has set goals and targets that look to balance important variables such as capacity, cost, environment, and reliability. A key component to the implementation of the ETP is the development of a sound financial and/or social incentive program. The incentive program looks to motivate decision-making units at department levels across campus to implement energy conservation recommendations.

Our group looks to thoroughly review the university's current energy conservation incentive program and document its present strengths and weaknesses. We are also reaching out to other universities to review and compare the benefits and drawbacks of systems that they are utilizing. Additionally, we will be contacting corporate organizations to see what energy conservation techniques and incentives are being implemented throughout various industries.

Interviews with MSU students, faculty, and professors will also provide us insight into how aware people are of the ETP, and what practices may have the largest impact on the MSU community.

Upon completion of our intensive research, we will be delivering an outline of best practices and potential recommendations for the University's consideration.





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**Trevor Patterson**
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**Project Mentor**
**Zach Tomlinson**
East Lansing, Michigan

**MSU Office of Sustainability**
***Project Sponsor***

**Jennifer Battle**
East Lansing, Michigan

# Michigan Biotechnology Institute

## Value Chain for Thermo Polyurethane Foam

MBI is a service based company assisting its clients in the commercialization of renewable products. Their laboratories and technical staff are available to accelerate the development and scaling of bio-based technologies. Currently, a division in MBI is developing a renewable foam product with the help of Dr. Narayan. This new foam could replace existing foam products in cars, furniture, and bed mattresses.

The assigned project is to conduct research on the value chain of furniture and automotive seat manufacturers. The chain will be focused around current thermo polyurethane foams the manufacturers are using. Once the value chain has been established, a cost analysis of the current foam will be conducted. With the cost analysis complete, the team will compare the difference between using a bio-renewable foam versus current standards.

This information can assist MBI in penetrating markets rich with opportunity. The advantage of these Biodegradable TPUs as they are referred to is reducing the carbon footprint left by many companies. At the end of a product's life cycle instead of being considered "toxic" in a landfill, it will biodegrade and return the carbon back to the environment, essentially reducing the carbon footprint left by the company and helping diminish the effects of global warming in the long-term. By finding the costs of other TPUs we will be able to have a target price for the biodegradable TPU. This knowledge will help Dr. Narayan make marketing decisions to get this product in as many possible different markets.

mbi | De-Risking and Scale-Up of Bio-Based Technologies

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

**Jonathan Elkins**
Grand Rapids, Michigan

**Ryan Jeffery**
Birmingham, Michigan

**Brendan Muir**
Plymouth, Michigan

**Jimmy Feiten**
Birmingham, Michigan

**Bradford Wallis**
Farmington Hills, Michigan

**Project Mentor**
**Kalpana Prabhu**
Bangalore, India

**MBI**
***Project Sponsor***

**Ramani Narayan**
Lansing, Michigan

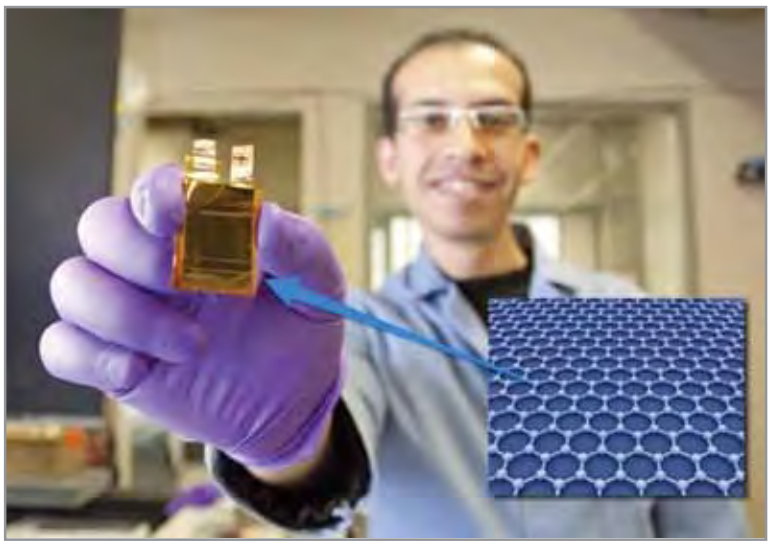
# XG Sciences

## Applications of Graphene Nanoplatelets as a Heat Spreader

XG Sciences Inc., founded in 2006, is a privately owned company headquartered in Lansing, MI. The company was formed to manufacture and sell large quantities of a material called XGnP Graphene Nanoplatelets using a cost-effective and unique manufacturing process pioneered by the Drzal research group at Michigan State University. XGnP Graphene Nanoplatelets exhibit many desirable thermal and electrical properties that make it a very competitive material. By 2010, XG Sciences achieved its quality goals to release the first commercial line of nanoplatelets called Grade H, with subsequent grades being released since then.

Team XG Sciences, through in-depth market analysis and implementation of effective business strategies, will provide a summary analyzing the practical applications of XGnP Nanoplatelets as a heat spreader in electronics. Our team will research current heat spreader technologies, indentify opportunities and weaknesses in the market, and isolate the parameters necessary to implement XGnP Graphene Nanoplatelets into the market.

Through our research process, our team will complete a market and business analysis necessary for XG Sciences to apply its XGnP Graphene Nanoplatelets to the large market of electronics. Ultimately XG Sciences may provide an alternative to current heat spreader technology. Our goal is to help XG Sciences accomplish this task and be a strong force in the competitive market of electronics.



XG sciences

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

**Alex Dmoch**
West Bloomfield Township, Michigan

**Norrin Jegla**
Midland, Michigan

**Sean Kenny**
Troy, Michigan

**Kristen Ballman**
Chesterfield, Michigan

**Alex Honey**
New Hyde Park, New York

**Project Mentor**
**Zach Tomlinson**
East Lansing, Michigan

**XG Sciences**
***Project Sponsor***

**Laurence Drzal**
Lansing, Michigan

# Chrysler – Prototype Build Engineering
## Standard Part Classification and Movement

Chrysler Group LLC is a subsidiary of Fiat S.p.A, an Italian automobile manufacturer. Headquartered in Auburn Hills, MI, it sells Chrysler, Dodge, Jeep and Ram branded vehicles worldwide. The Chrysler Corporation was founded by Walter Chrysler in 1925 and has experienced significant growth since. Currently, Chrysler employs over 65,000 people, producing over 1.6 million vehicles in 2012 and 2013 and generating over $65 billion of revenue in 2012.

Chrysler's Prototype Build Engineering department is responsible for testing vehicles and parts by either adding parts to an existing vehicle (a mule build) or building a brand new vehicle (a prototype build). Currently there is no consistent method for classifying and storing incoming parts and moving stored parts from stockrooms to prototype build garages at Chrysler's Auburn Hills facility. Using World Class Manufacturing standards, we will first categorize parts provided to us in a bill of materials. Once these parts are classified, we will develop a standardized system for storing parts and a process for moving parts throughout the Chrysler facility, ultimately eliminating non-value added activities and improving efficiency.

CHRYSLER


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

**Nick Brinker**
Shelby Township, Michigan

**Rebekah Koschmann**
Waterford, Michigan

**Megan Seavoy**
Shelby Township, Michigan

**Hannah McQuade**
Saline, Michigan

**Alexander Sims**
Saginaw, Michigan

**Project Mentor**
**Kalpana Prabhu**
Bangalore, India

**Chrysler**
***Project Sponsor***

**Lynn Ciarelli**
Auburn Hills, Michigan

# Peckham, Inc.

## Increasing Efficiency: The Patagonia Jungle Shirt

Peckham is a clothing-manufacturing company that is a unique business and human services agency that values quality, diversity, and performance. They manufacture clothing for military customers as well as a few commercial customers. Critical elements of Peckham's apparel business model include but are not limited to the following: cellular manufacturing (for optimized efficiency), LEAN manufacturing techniques, production goal setting, sewer training, assessment, and compensation, and preventative maintenance.

Our project focuses on decreasing inefficiencies on a particularly challenging product line: the Patagonia Jungle shirt. This piece involves more complicated sewing patterns than many other lines, and therefore requires more training for the sewers. Due to the complexity of this garment and the high standards placed on Peckham by the customer, the garment is more challenging to produce than other products on the Peckham floor. We will review the manufacture of the jungle shirt, analyze the production system for waste, and locate possible knowledge or process gaps. Our deliverables will be recommended changes that will improve the efficiency of manufacture for the Patagonia Jungle shirt.

PECKHAM
QUALITY • DIVERSITY • PERFORMANCE


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

**Brittney Heatherington**
Grand Haven, Michigan

**Aaron Uherek**
Independence, Minnesota

**Robin Lawson**
Sanford, Michigan

**Brennen Oberski**
Haslett, Michigan

**Tyler Deal**
Plymouth, Michigan

**Project Mentor**
**Zach Tomlinson**
East Lansing, Michigan

**Peckham**
***Project Sponsors***

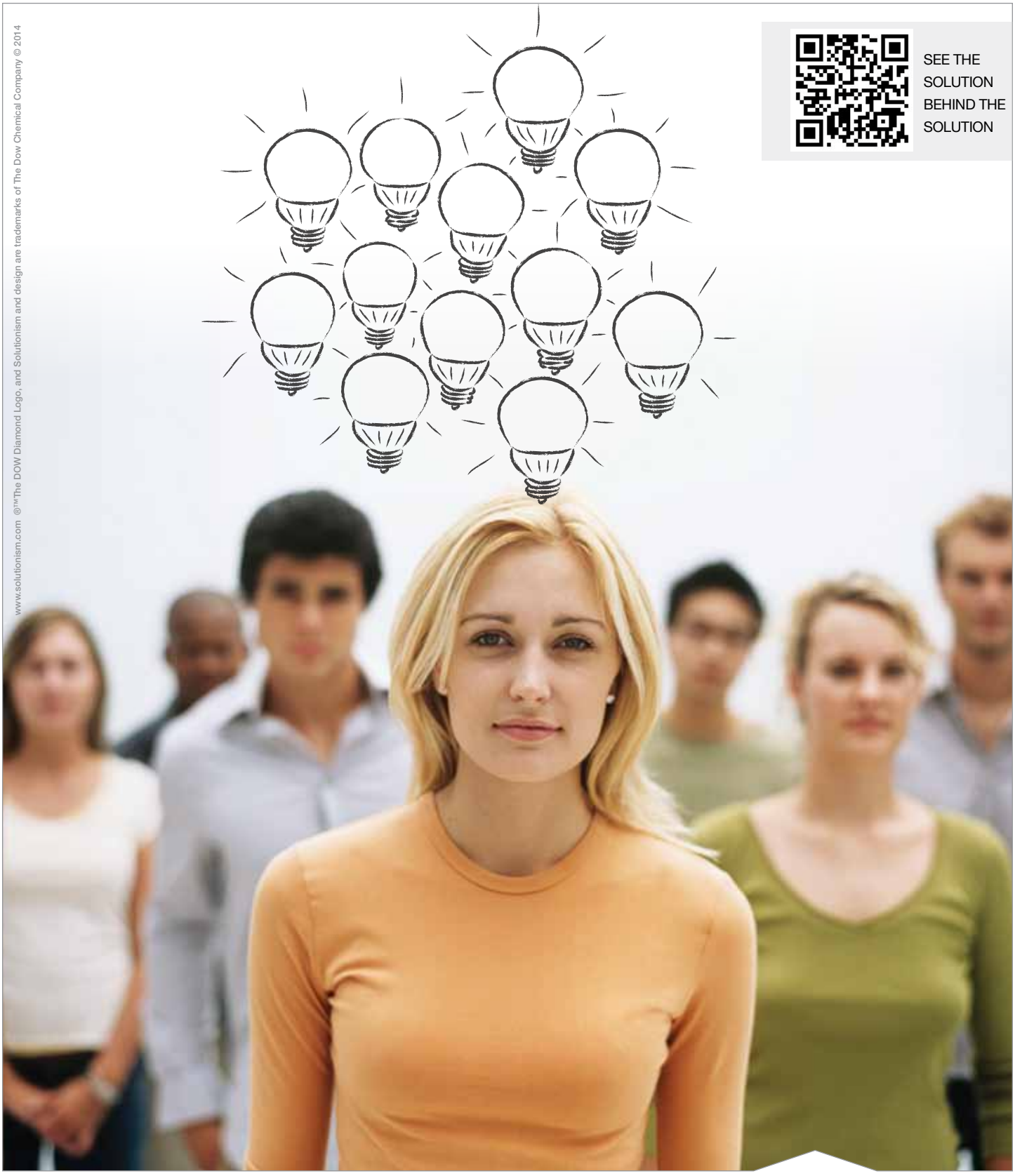
**Amy Heyboer**
Lansing, Michigan

**Christine Shepard**
Lansing, Michigan

**Forough Teji**
Lansing, Michigan

**Ed Terris**
Lansing, Michigan

**Lawrence Webb**
Lansing, Michigan



SEE THE SOLUTION BEHIND THE SOLUTION

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**Dr. Dana Kirk, PE**
**Assist. Professor**

**Biosystems Engineering**

**Dr. Luke Reese**
**Assoc. Professor**

**Biosystems Engineering**

# About the Program

The Biosystems Engineering (BE) undergraduate program prepares graduates who will integrate and apply principles of engineering and biology to a wide variety of globally important problems. To achieve that purpose, the primary objectives of the BE program are to prepare graduates to:

- Identify and solve problems at the interface of biology and engineering, using modern engineering techniques and the systems approach, and
- Analyze, design, and control components, systems, and processes that involve critical biological components.

Additionally, the Biosystems Engineering program is designed to help graduates succeed in diverse careers by developing a professional foundation that includes 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

# 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 continuously improve 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**
Michelle F. Crook, PE - MDA, Envir. Stewardship Division
Cassaundra Edwards - ConAgra Foods
Bryce Feighner, PE - MDEQ
Gene Ford - Nestlé Nutrition
Andrew Granskog, PE - USDA-Rural Development
Andrew Knowles - JBT FoodTech
Jeffrey Mathews, PhD - PepsiCo Global Beverage R&D
Juanita McCann, PE - USDA-NRCS
Mitch Miller - General Mills-Yoplait
Valerie M. Novaes, PE -Tetra Tech
Dave Prouty - Heat Transfer International
Steve Richey - Kellogg
Steve Steffes, PE - Perrigo
Larry D. Stephens, PE - Stephens Consulting Services, P.C.
Muluken Tilahun - Kraft Food

**Project Evaluators**
Ralph Elias - Terumo Cardiovascular Systems
Todd Forbush - Techmark
Danielle Habitz - Kellogg
Daniel Holcomb - ConAgra Foods
Bob Stacy - JBT FoodTech

# Biosystems BE 485/487

## Pork and Bean Process Optimization

Sponsor – ConAgra
Faculty Advisor – Dr. Kirk Dolan
Industry Evaluators – Cassaundra Edwards & Daniel Holcomb

"The Cool Beans" team project is to optimize the Van Camp's Pork & Beans manufacturing process in order to improve product quality and reduce system losses. Currently a brand leader in the value category, the Van Camp's lines produce 4 million cases per year.

Client deliverables for this project include a full assessment of the current Pork & Bean process, a statistical analysis of process variation and capability and a process optimization plan. Additionally the team will determine loss reduction solutions through experiments and full economic analysis.


(L to R) Charlsey Hoehn, Michael Gisler, Lisa Moncznik & Ashley Andreski

## Cherry Tomato Harvest Production Improvement

Sponsor – Mastronardi Produce
Faculty Advisor – Dr. Dan Guyer
Industry Evaluators – Juanita McCann & Andrew Knowles

The "Biosystems Loves Tomatoes (BLT)" team project is to increase operator productivity during the grape tomato harvest at the Mastronardi Produce facility in Coldwater, MI.

Client deliverables for this project include modified harvest cart prototype with automated drive train and a harvest assist device. Full AutoCAD modification drawings will be provided as well as a full economic analysis including implementation costs and Return on Investment.


(L to R) Daniel Holmes, Matthew Walch & Wilson Yee

## Value-Added Fruit Leather Process Line – Ghana

Sponsor – Blue Skies & USAID GFCSI Student Challenge Award
Faculty Advisor – Dr. Brad Marks
Industry Evaluators – Steve Richey & Danielle Habitz

The "Ghana Fruit" team project is to design a fruit leather processing line from raw material to final product, along with initial product formulations.

Client deliverables for this project include a product composition and recipes for both mango and pineapple fruit leathers, a design process flow with equipment specifications and a complete economic analysis with ROI and implementation costs. Team members spent Spring Break in Ghana conducting process research, product testing and presenting to Blue Skies company representatives.

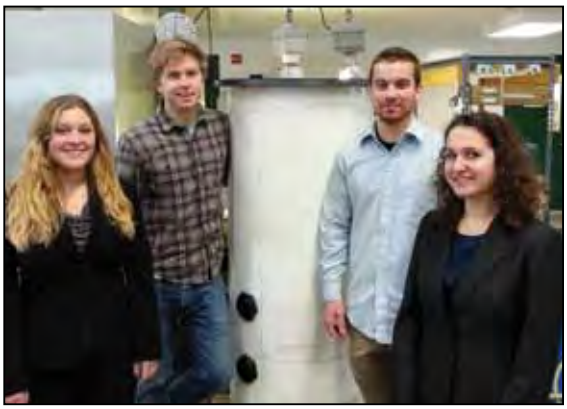

(L to R) Royce Sperry, Kelly Rossi & Matt Gammans

## Wastewater Treatment Using Anaerobic Digester

CoSponsor – Technova
Faculty Advisor – Dr. Wei Liao
Industry Evaluators – Michelle Crook & Bryce Feighner

The "AD Strong" team project is to design and develop a novel, efficient pilot-scale (.43 m3) up flow and fixed film anaerobic digester to later be connected to an integrated solar-bio-nano-based wastewater utilization system.

As part of a Department of Defense project, client deliverables include a functioning pilot reactor for system performance evaluation and full technical and economic feasibility analysis.



(L to R) Allison Vanderkolk, Matt Coleman, Evan Austin & Danielle Brickner

## Algal Photoreactor System for Nitrogen Removal

Sponsor – Quantalux, LLC & USAID GFCSI Student Challenge Award
Faculty Advisor – Dr. Susie Liu & Dr. Jeff Li
Industry Evaluators – Larry Stephens & Valerie Novaes

Current closed animal feeding operations generate emissions containing ammonia and other impurities. A wet scrubber system allows for treatment of this polluted air, however, this generates nitrogen-contaminated water.

The "Algaeneers" team project is to design an algal photoreactor system to uptake and balance the nutrient absorption rate in a wet scrubber system. Client deliverables for this project include constructing a functional reactor prototype including CAD drawings, bill of materials, system performance analysis, mass balance and complete economic feasibility analysis.

(L to R) Rick Avery, Anh Bui, Pat Sheridan & Julia Otwell

## JBT FoodTech ProMix/ABC-III Viscosity Control

Sponsor – JBT FoodTech
Faculty Advisor – Dr. Gail Bornhorst
Industry Evaluators – Mitch Miller & Bob Stacy

The "Better Batter" team project is to design a viscosity control system for the JBT ProMix/ABC-III automatic batter mixer to reduce the component cost in comparison to the current viscosity pump and pressure transducer control system.

Client deliverables for this project include design concept through lab testing, a complete modification budget with bill of material, pilot verification testing, a correlation curve of apparent viscosity and a measureable rheological property to implement into JBT's PLC configuration.

(L to R) Christopher Taylor, Keely Chandler & Kirk Gowen

## Value-Added Fruit Leather Process Line – Ghana

Sponsor – Heat Transfer International
Faculty Advisor – Dr. Chris Saffron
Industry Evaluators – Dave Prouty & Jeff Mathews

The "Thermal Edge Innovations" team project is to produce briquettes and pellets from torrefied hardwood without binder, and perform optimization and economic comparison studies to determine which has the hygroscopic, friability, and heating value properties that best approach that of coal.

Client deliverables for this project include a briquetting prototype, mass and energy balance data for process, property analysis of torrefied biomass, a supply chain economic model and a techno-economic model.

(L to R) Zach Carter, Rachael Sak, Nichole Erickson & Cody Matthews

## Design of a Fiber-optic Treatment for Infant Jaundice

Sponsor – Sygiene
Faculty Advisor – Dr. Tim Whitehead
Industry Evaluators – Steve Steffes

The "Bullish Biomeds" team project is to design a wearable treatment for infant jaundice using fiber-optic technology in order to reduce cost of treatment, allow for easy deployment in developing countries, and minimize impact to crucial maternal bonding.

Client deliverables include a working prototype using fiber-optic technology that maximizes maternal bonding, and a complete economic analysis for reduced treatment cost and easy deployment to developing countries.

(L to R) Vu Hoang, Alexa Jones & Oliver Bloom

## Design of a LED Treatment for Infant Jaundice

Sponsor – Sygiene
Faculty Advisor – Dr. Tim Whitehead
Industry Evaluators – Muluken Tilahun & Ralph Elias

The "Bright Ideas" team project is to design a portable, wearable, cost– efficient treatment for infant jaundice using LEDs as a light source that will reduce typical treatment time and not interrupt maternal-infant bonding and breastfeeding.

Client deliverables include a working prototype consisting of a wearable phototherapy device using LED lights allowing portable treatment of hyperbilirubinemia, an economic analysis of the manufacturing and treatment costs associated with the device, and a heat transfer analysis of device.


(L to R) David Stromberg, Jessica Palmer & Tim Lauth

## Solar Vapor-Absorption Refrigeration

Sponsor – Michigan Agricultural Electric Council (MAEC)
Faculty Advisor – Dr. Truman Surbrook & Mr. Aluel Go
Industry Evaluator – Gene Ford

The "Cool Runnings" team project is to design an efficient, cost effective solar thermal vapor-absorption refrigeration system capable of sustaining consistent temperatures between 2°C and 8°C while being operated off the grid.

Client deliverables for this project include a functional prototype; a feasibility assessment including location compatibility, economic constraints and medical impact; design blueprints for reproduction and a mathematical model for single unit scaling.


(L to R) Travis Collings, Jessica Warvel, Alex Rowland & Steven Cumming

## Student Organic Farm Cold Storage Design

Sponsor – MSU Student Organic Farm
Faculty Advisor – Dr. Tim Harrigan
Industry Evaluators – Andrew Granskog & Todd Forbush

To provide a diversity of vegetables over a long season, local farmers need to utilize energy efficient methods of cold storage to reduce costs and extend the revenue period while maintaining crop quality and freshness. Currently, 95% of the electricity used at the Student Organic Farm (SOF) is for maintaining cool/cold storage for crops.

The "Local Roots" team project is to design an efficient cold storage unit that will store a range of produce at a reduced energy cost for the SOF.

Client deliverables include a full analysis of SOF cold storage energy and ventilation requirements, a complete cool/cold storage unit design and a comparative economic analysis.


(L to R) Andrew Plouff, John Venn & Robert Kraemer

# The Capstone Projects

### Faculty Advisors:
### Professors Haider, Kodur, Kulay, Li, Lyles and Masten


Haider


Kodur


Kutay


Li


Lyles


Masten

### Presentation Schedule – Rooms 3105, 3400 and 3540

| Time | Team | Room |
|---|---|---|
| 8:00 a.m. | Team One | Third Floor Room 3400 EB |
| 9:20 a.m. | Team Two | Third Floor Room 3400 EB |
| 10:40 a.m. | Team Three | Third Floor Room 3400 EB |
| 9:00 a.m. | Team Four | Third Floor Room 3540 EB |
| 10:20 a.m. | Team Five | Third Floor Room 3540 EB |
| 9:00 a.m. | Team Six | Third Floor Room 3105 EB |
| 10:20 a.m. | Team Seven | Third Floor Room 3105 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

## PROFESSIONAL SEMINAR SPEAKERS

**Michele J. Buckler, PE**
Fishbeck, Thompson, Carr & Huber

**Paul M. Davis, PE**
City of Rochester Hills

**Daniel G. Fredendall, PE**
OHM Advisors

**Ryan D. Musch, PE**
Fishbeck, Thompson, Carr & Huber

**Cheryl A. Kehres-Dietrich, CGWP**
Soil & Materials Engineers, Inc.

**Robert D. Rayl, PE**
RS Engineering, LLC

**Charles Rolfe, PE**
OHM Advisors

**Scott K. Stowitts, PE**
Walbridge

**Leah Tapp, PE**
HNTB

**Michael J. Thelen, PE**
Soil & Materials Engineers, Inc.

**Daniel Thome, PE**
Nicholson Construction Company

**Roy D. Townsend, PE**
Washtenaw County Road Commission

**Mark A. VanPortfleet, PE**
Michigan Department of Transportation

**Christian G. Youngs, PE**
Michigan Department of Transportation

## PROFESSIONAL EVALUATORS

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

**Len Becker, PE**
HNTB

**David Bendert, PE**
URS Corp.

**Tom Boom, PE**
Barr Engineering Co.

**Rick Chelotti, PE**
Bergman Associates

**Daniel Christian, PE**
Tetra Tech MPS

**David Conklin, PE**
Fishbeck, Thompson, Carr & Huber

**Tyler Dawson**
NTH Consultants

**Holly Donoghue, PE**
NTH Consultants

**Lauren Fedak**
Harley Ellis Devereaux

**Kelly Ferencz, PE**
Wayne County Airport Authority

**Andrew Granskog, PE**
USDA

**Tim Greenleaf, PE**
Barr Engineering Co.

**Andrew Hermiz, EIT**
Harley Ellis Devereaux

**Matt Junek, PE**
HNTB

**Kelly Karll, PE**
SEMCOG

**Thomas Larder, PE**
Process Results, Inc.

**Peter Margules, PE**
NTH Consultants

**George McKenzie, PE**
Consumers Energy

**Doug Skylis, PE**
Rowe PSC

**Todd Sneathen, PE**
Director of Public Works

**Michael J. Thelen, PE**
Soil & Materials Engineers, Inc.

**Anthony Thomas, PE**
Soil & Materials Engineers, Inc.

**Geneva Vanlerberg, PE**
Fishbeck, Thompson, Carr & Huber

**Phillip Vogelsang, PE**
URS Corporation

**Lauren Warren, PE**
Parsons Brinckerhoff

## Rolla C. Carpenter Senior Design Award

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

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

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

# Michigan State University
## Mixed-use Development

Student-teams developed preliminary designs for elements of a 60-acre site located east of Hagadorn Rd. and south of the Red Cedar River. The site was to be designed as a mixed-use development following the Meridian Township Planned Unit Development (PUD) requirements.

The project development must include both residential and commercial land uses. The objective of this project was to provide Meridian Township Planning Commission with a Preliminary Engineering Design. Major goals were to maximize green space; create a walkable community and ensure pedestrian and bicycle access to campus, East Lansing, and Meridian Township; to protect as many of the existing trees on-site as possible; and to identify and protect any federally classified wetlands on-site.

**Team 1:** Back row, l-r: Tyler Jones (PM), Ash Iregbu (H) Shay Irving (E), Saeed Yadolahi (T). Front row, l-r: Danny Bensalem (P),Fang Gong (G), Sean Marti (S)

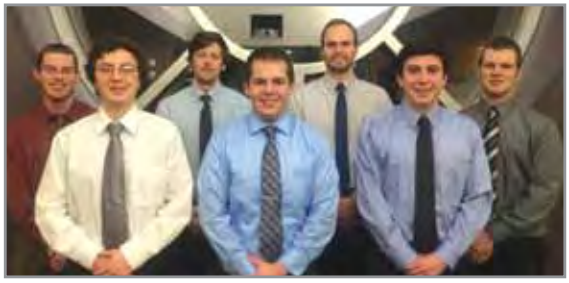
**Team 2:** Back row, l-r: Alex Guyon (S), Ryan McQuiqq (H), Adam Lalik (T), John Lovely (P). Front row, l-r: Yang Wang (G), Caroline Williams (PM), James Rice (E)

**Team 3:** Back row, l-r: Nicholas Soumis (PM), Neal Squibbs (E), Michael Norcia (G). Front row, l-r: Kelvin Esselink (P), Sam Jablonowski (H), Taylor Yasuda (S), Kevin Lancial (T)

**Team 4:** l-r: Ryan Khodl (H), Jacob Stepp (S), David Donaldson (E), James H. Smith (PM), Yi Zhao (T), Noor Aqel (P), and Jensen George (G)

**Team 5:** Back row, l-r: Benjamin Globke (S), Alex Parent (P), Tiancheng Qi (T), Brennan Thorn (G). Front row, l-r: Charifa Hejasebazzi (E), Roberto De Silva Reguera (PM), Laura Bailey (H)

**Team 6:** Back row, l-r: Zachary Danks (P), Yerbol Zhakupov (T), David Linn (S), George Williams (H). Front row, l-r: Alex Blehm (PM), Haley Celovsky (E), Aric Thorne (G)



**Team 7:** l-r: Back row, l-r: Robert Weir (E), Casey Bonner (H), Cory Smetana (S), Trevor Vincke (T). Front row, l-r: Bret Abraham (G), Steven Tate (PM), Matt Callaghan (P)

Key: E = Environmental, G = Geotechnical, H = Hydrology, P = Pavements, PM = Project Manager, S = Structures, and T = Transportation

## Process Design and Optimization II

**Professor Martin Hawley**
**Professor and Chairperson of Chemical Engineering and Materials Science**

**Chun Liu**
**Graduate Assistant Chemical Engineering and Materials Science**

# Course Description

ChE 434 is a logical extension of the first semester of chemical engineering senior design. The abilities developed over a wide range of chemical engineering courses are now applied to a problem extending over a somewhat longer period of time; requiring more initiative, enterprise, care and a greater measure of individual responsibility. For the 45th successive year, we have worked the American Institute of Chemical Engineering (AIChE) Student Contest Problem. We use these industry-designed problems for three reasons: 1) they are well-rounded problems, 2) they tell our students and our faculty something about the kind of abilities that industrial companies would like graduating chemical engineers to have, and 3) there is the advantage of seeing how well our students compare with graduates of other universities in a national competition of this quality.

For Design Day, four teams and four individuals were chosen to present their design via a poster presentation. From this final group, two teams of two, and two individuals will be chosen to compete in the national AIChE competition in the fall. Since 1968, about half of the students whose reports rated first or second at MSU also finished among the top six nationally.

## Last Year's Winner!

One student who presented at last Spring's Design Day received top honors in the 2012 AIChE National Student Design Competition. Logan Ryan Matthews was able to travel to San Francisco in November 2013 to present solutions at the AIChE National Meeting.

AIChE®

# Michigan State University

## Manufacturing the next generation of vaccines: Non-egg based platform for influenza vaccine

The objective of this year's AIChE Design Problem was to compare the economics of two bio-mass to bio-oil reactor systems. The first system is done by direct bio-mass pyrolysis, and the second system is done by "marrying" bio-mass to bio-oil to coal gasification.

The students were required to determine the capital equivalent of a yearly cash flow or the equivalent of a capital investment. Using a 5-year payout for converting capital investment to equivalent year cash flows, they need to calculate the final price of the product for each system, with well designed process flow and safety as well as environmental considerations.

Aaron Vigil

Allison Sutter & Aubrey Flint

Brian Lugo & Christopher Schwartz

Eric Vasko

Kyle Ivester & John Gaiser

Nirmalkumar Patel

# Senior Design Capstone in Materials Science and Engineering

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

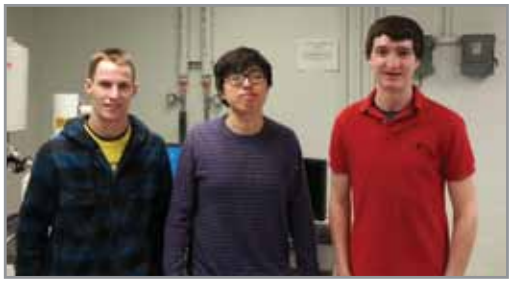
# Course Description

MSE466 is a senior level course for Materials Science & Engineering majors providing students with a team-based capstone design experience. A major aspect of this course is to have students apply their course-learned background knowledge and skills in materials science and other disciplines to real-life design problems. A failure analysis investigation (FAI) fits this context. Failures are a major motivating factor for promoting more innovative designs or design changes. A failure analysis investigation provides a unique platform to design and to solve real-world engineering problems via a systematic engineering approach. By focusing on a specific design failure, the student teams learn how to confront an open-ended problem that requires them to develop a strategic design plan and to execute the methodology for assessing how and why the failure occurred. The analysis is conducted using established investigative procedures and constraints for conducting failure analysis investigation. This semester, there are five 3-member teams working on five real engineering failures.

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 2014, the five teams are conducting the following failure analysis investigations:

## Presentation Schedule – Second Floor Room 2205

| Time | Team | Room |
|---|---|---|
| 9:00 a.m. | Marten Sight | Second Floor Room 2205 |
| 9:30 a.m. | Austen-Nights | Second Floor Room 2205 |
| 10:00 a.m. | The Spanners | Second Floor Room 2205 |
| 10:30 a.m. | Team SKM | Second Floor Room 2205 |
| 11:00 a.m. | Team Urea Tube | Second Floor Room 2205 |



(left to right) Chris Warda, Hongie Tang, Andrew Rolling

## Group Name: Marten Sight
## Project: Failed Eyeglass Frame
## Time: 9:00 a.m.

The sample that failed is the frame of eyeglasses that was manufactured from multiple alloys. However, the exact type of alloy used on the failed part remains unknown. The condition and amount of loading applied to the parts that led to failure is also unknown. Facing these multiple challenges, the failure analysis on this structure is interesting to work on. The failure of the eyeglass frame is located at the butt-strap, which holds the screw that connects the rim and temple. The failure shows plastic deformation, indicating that the material experienced a load larger than the yield stress. But the details of the loading condition are unknown. It is possible that multiple forces and deformation had happened over the lifetime of the eyeglasses. Even though the fracture was caused by a large load, the loading history may also be crucial because it may have changed the properties of the material.

(left to right) Austin Nelson, Mike Taylor, Trent Pasini

## Group Name: Austen-Knights
## Project: AHSS Steel Coil Failure Investigation
## Time: 9:30 a.m.

Edge cracks developed on AHSS steel coils during production. Failure occurs during the hot rolling process. A sample of the edge crack was removed from the coil and examined during the failure analysis. Economic losses are the main issue as the defect leads to wasted production. Background data has been analyzed along with many tests including ultrasonic, dye penetrant analysis, hardness testing, X-ray diffraction, chemical testing, and examination of exemplars.

(left to right) Troy Stewart, Colin Monroe, Nolan Feldpausch

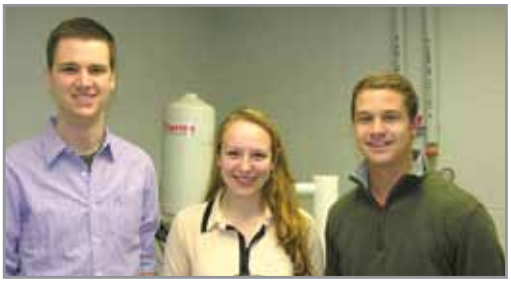
## Group Name: The Spanners
## Project: Universal Spanner Wrench Failure
## Time: 10:00 a.m.

The development of low-weight, mechanically tough materials is of great importance in many multi-purpose tools in active service that may not be used directly for firefighting but are in usage in auxiliary roles. The focus of this study is an Akron Brass Company Style 10 Universal Spanner Wrench, a tool that serves many roles in service. The tool was broken in service in October 2013. It was reportedly being used as a hammer and broke while being used to loosen a fire hydrant cap. Although the failure of the part can be attributed in large part to the impacts, there are other mechanisms at work that may have weakened the cross-sectional area. It is unlikely that the impacts alone were great enough to cause failure, and it is the goal of this experiment to search for evidence of secondary failure mechanisms in the spanner wrench.

(left to right) Stephanie Brown, Mike Wydrzynski, Katelyn Hendrick

## Group Name: Team SKM
## Project: Failure Analysis of a Structural Bolt
## Time: 10:30 a.m.

A large steel bolt fractured while being used as a structural component of a tandem mill at a large steel mill. The fracture surface of the bolt was submerged in concrete while the other end supported the frame. A tandem mill is used to cold work steel, which caused this bolt to be subject to large loads, ranging from 6000 to 10,000 pounds, and fatigue cycling. Fatigue of this bolt was also caused by the release of heat from these large slabs of steel that go down the tandem mill to be cold worked. Many different testing techniques and analysis have been done on this bolt such as dye penetrant, magnetic particle testing, SEM, and XRD. Destructive testing also provides useful information about the failure of the steel bolt. By studying the background information and performing tests along with analysis of this steel bolt, the team has determined the root causes of the failure.



(left to right) Josh Drost, Krista Lueck, Zach Tinkle

## Group Name: Team Urea Tube
## Project: Failure Analysis of a Urea Exhaust Tube Stamping
## Time: 11:00 a.m.

A failure analysis of a urea exchange tube has been carried out to find the root cause of the failure exhibited on the part. Since this failure occurred during production, there was minimal economic and societal damage that occurred. The team developed plans for testing and analysis aimed towards finding evidence of errors within the material or operation process. Destructive and nondestructive testing were performed on the part to record as much data and information as possible. The data and material were analyzed to support initial assumptions that were made regarding the failure of the part. The analysis included various methods such as ultrasonic testing, hardness testing, optical microscopy, scanning electron microscopy (SEM), and x-ray diffraction (XRD). This failure analysis provided an explanation of why the failure took place and offered steps for preventing similar issues from occurring in the future.

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Computer Science and Engineering

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**Urban Science**
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**Whirlpool Corporation**
Benton Harbor, Michigan

# The Capstone Projects

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

### Presentation Schedule – Engineering Building, Room 3405

| Time | Team | Project Title |
|---|---|---|
| 7:30 a.m. | Auto-Owners | Mobile Audit Itinerary and Worksheet |
| 7:50 a.m. | Boeing | Flight Simulator Suite |
| 8:10 a.m. | Ford | Mobile Approver |
| 8:30 a.m. | GM | The Matrix: Vehicle Simulator System |
| 8:50 a.m. | Google | Change Management Software |
| 9:10 a.m. | Meijer | Mobile Customer Satisfaction App |
| 9:30 a.m. | Break | |
| 9:45 a.m. | MSUFCU | Mobile Financial Education App |
| 10:05 a.m. | Quicken Loans | Mobile RFID Inventory Tracking System |
| 10:25 a.m. | Spectrum Health | Medications Shortages Dashboard |
| 10:45 a.m. | TechSmith | ClassView |
| 11:05 a.m. | Urban Science | Dealer Improvement Recommender System |
| 11:25 a.m. | Whirlpool | Virtual Appliance Simulator |

# CSE 498 Collaborative Design

CSE 498, Collaborative Design, provides the educational capstone experience for all students majoring in computer science. The course objectives include the following:

- Designing, developing, and delivering a comprehensive software system to a client;
- Learning to work effectively in a team environment;
- Developing written and oral communication skills;
- Becoming proficient with software development tools and environments;
- Learning about system building and system administration; and
- Considering issues of professionalism and ethics.

Project sponsors are local, regional, and national, and have included Auto-Owners Insurance, Boeing, Chrysler, Dow, Electronic Arts, Ford, GE Aviation, General Motors, Google, IBM, Meijer, Microsoft, Motorola Mobility, Mozilla, MSU Federal Credit Union, Quicken Loans, Spectrum Health System, TechSmith, Toro, Union Pacific Railroad, Urban Science and Whirlpool.

# Auto-Owners Insurance
## Mobile Audit Itinerary and Worksheet

Auto-Owners Insurance is a Fortune 500 company with written premiums of over $5 billion. Auto-Owners is recognized for exceptional financial strength and outstanding customer service as "The No Problem People."®

One key to Auto-Owners' excellent customer service is a group of mobile associates called "underwriting field service representatives" who meet in person with policyholders to audit and update policy information after a policy expires.

With our Mobile Audit Itinerary and Worksheet software, underwriting field service representatives can audit and update all of the policyholder information using a wide variety of mobile devices including laptops, tablets and smartphones.

Our system provides maps and directions to the list of customers to be visited each day. Underwriting field service representatives can re-order their visits, which causes their maps and directions to be updated automatically.

Even if an internet connection is temporarily not available, we provide most of the system's functionality. Auto-Owners' representatives are able to continue to update policyholder information, view their itinerary for the day, and generate reports summarizing all of their collected information.

Our Mobile Audit Itinerary and Worksheet software runs in most modern browsers. Our web server is Apache Tomcat with JSP (JavaServer Pages). Policyholder information is stored remotely in an IBM DB2 database. Local information is stored in XML format. The maps and directions are provided using the Google Maps API.


Auto-Owners Insurance
Life Home Car Business
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# The Boeing Company
## Flight Simulator Suite

With over 170,000 employees around the globe and a customer base spanning 150 countries, Boeing is the world's leading aerospace company and the largest manufacturer of commercial jetliners and military aircraft.

In order to develop state-of-the-art aircraft, Boeing relies heavily on flight simulation systems to test new designs and coordinate control, thereby saving time and money, and minimizing risks for test pilots.

Our Flight Simulator Suite enables Boeing to take full advantage of all facets of flight simulation by improving the extendibility and the modularity of the open source flight simulation software FlightGear (FG).

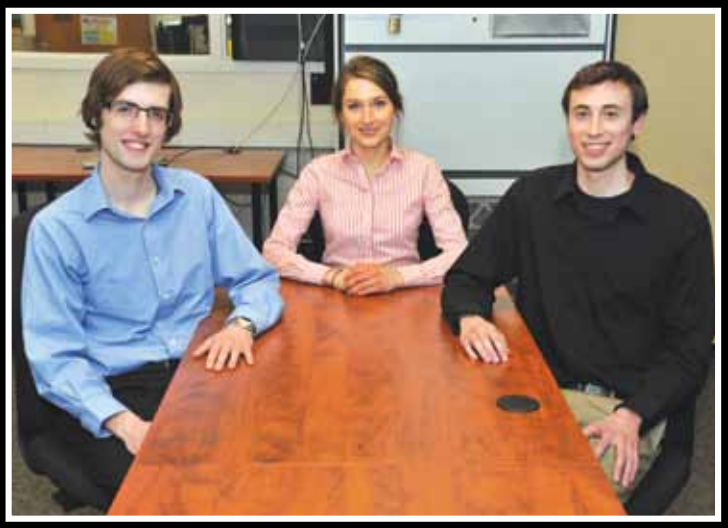
Our system extends FG's simulation engine by adding a message queuing subsystem that allows data exchange between FG and other software. For example, such data exchange is used to implement a GUI that communicates with FG to display information such as player positions.

In addition our Flight Simulator Suite features full menus and multiple views that enable users to take advantage of the full range of FG's many capabilities.

Finally, our suite utilizes FG's modular structure to improve the graphics system, incorporating an array of physics engines used to compute physically accurate flight simulations.

Our Flight Simulator Suite is written using C++ and Python. We are using the ActiveMQ library to handle the message passing and wxPython to display the Graphical User Interface.


BOEING



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# Ford Motor Company
## Mobile Approver

Ford Motor Company is an iconic American brand that has been producing automobiles for 110 years. Ford's workforce of 170,000 employees produced 2.5 million vehicles in 2013.

In order to run a large global company, Ford relies heavily on structured business processes. Many of these processes are computerized and require supervisors to review and approve actions or requests. Examples include: employee timekeeping, purchasing, expense reporting and product tracking.

While Ford's current approval systems do work, they require supervisors to use many different systems to approve different types of requests. Furthermore, these systems do not support mobile computing, which is common in the modern workplace.

Our Mobile Approver system replaces these disparate approval systems with a single, unified approval portal. Ford supervisors can approve any and all types of actions or requests simply by logging into a single system using their Ford credentials.

Once a supervisor is logged in, our system retrieves all actions and requests that have pending approvals and displays them in a single, easy-to-use interface. Supervisors can quickly approve or reject requests, providing comments when needed.

Our Mobile Approver system supports all modern web browsers and runs on desktops, laptops, tablets and phones.

Devices with cameras such as tablets and phones can use QR codes to interface with Ford's inventory tracking system.

Our system is implemented using HTML5, Java, Spring MVC, Microsoft SQL Server, Microsoft SharePoint and JavaScript.


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# General Motors
## The Matrix: Vehicle Simulator System

Headquartered in Detroit, Michigan, General Motors is a global Fortune 100 company with over 212,000 employees on six continents. For over a century, General Motors has developed innovative technologies and shaped the future of the automotive industry.

GM customers today expect their cars to have a variety of "smart" capabilities including things like navigation, social media such as Facebook, and music streaming such as Pandora.

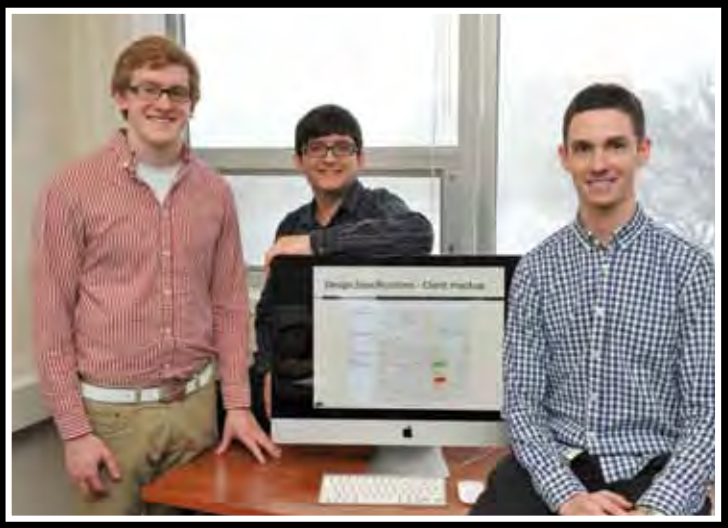
In addition to these smart capabilities, GM is developing more and more apps that enable their customers to interact with their smart cars directly from their mobile phones or computers.

Currently, in order to test a new mobile app, GM software developers must reserve and use actual cars, which can cause delays in testing and be very costly.

The Matrix is a vehicle simulator that creates virtual cars, which GM developers use to test their applications without the need of actual cars. GM can prototype and test their apps against real-world situations without real-world limitations.

Using The Matrix, GM app developers can create virtual cars traveling along specified map routes. The mobile app being tested receives regular updates of GPS coordinates along with other notifications such as a seat belt being buckled, the wipers being turned on or the air bags being deployed.

Our simulator runs on .NET, and clients connect to it via a RESTful API or through a WCF library. Our companion .NET WPF demo application shows off the features of the API.

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# Google
## Change Management Software

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

As such, Google operates a very large and very complex infrastructure of networks, databases and servers that store and distribute vast amounts of information throughout the world.

Google's complex data infrastructure must be maintained and customized to their needs. Naturally, all Google engineers need to be aware when services are down or have been changed in some way.

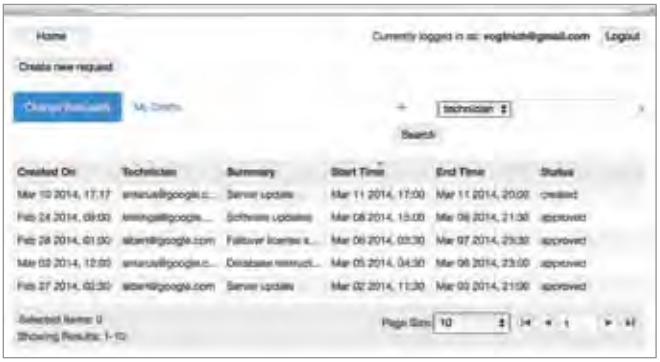
Our Change Management Software system schedules, approves and alerts users to computing infrastructure changes using a web app and email notifications.

Google's engineers use our system to create change requests, which include the purpose of the change along with a proposed date. The requesting engineer receives regular email updates about the status of their requests.

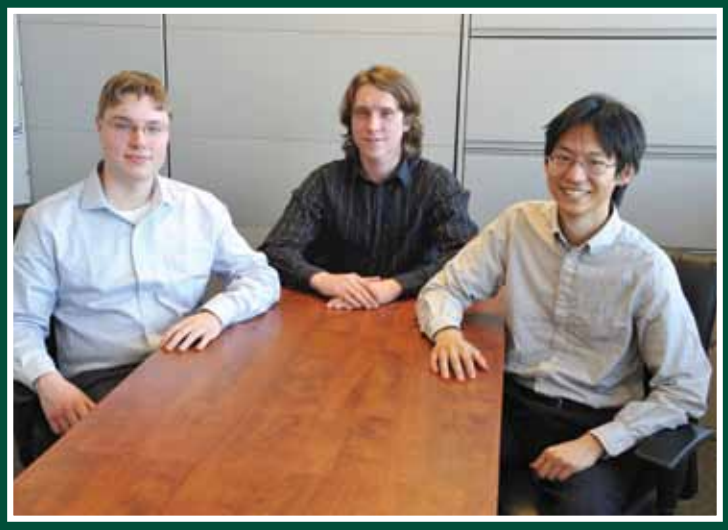
After requests are created, supervising engineers receive email notifications of pending requests, which they can approve, deny or edit.

Once requests are approved, email is sent to the requesting engineers and to all affected users. In addition, notices may be added to an online board called Google Helpdesk where users can view infrastructure changes affecting wide audiences.

Our Change Management Software is built using AngularJS and Python to communicate with Google App Engine's Datastore.







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# Meijer
## Mobile Customer Satisfaction App

Meijer is a family-owned chain of supercenters committed to providing quality food and general merchandise products to its customers throughout the Midwest. Headquartered in Grand Rapids, Michigan, Meijer has over 200 stores and approximately 60,000 employees.

Currently, Meijer collects feedback from its customers on their shopping experience through the corporate website.

Our Customer Satisfaction App is a mobile application that enables Meijer customers to give immediate feedback on their shopping experience while they are in the store. They can respond to a general survey, provide information about specific issues, view store details and view frequently asked questions. Feedback is automatically associated with a store by our app.

Using our mobile app while in the store, Meijer customers can provide feedback about their shopping experience in a timelier manner, thereby enabling a shorter delay between the time a problem arises and its resolution.

Our system includes a companion internal website that Meijer associates use to view the collected customer feedback. Issues can be sorted by severity and status.

Meijer team members can contact customers if requested using the email address they submitted. This way, Meijer can respond to customers faster and improve their experience.

Our Customer Satisfaction App is a native Android application written in Java using Eclipse. The companion website and database are hosted with Microsoft Azure.


meijer

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# MSU Federal Credit Union
## Mobile Financial Education App

Michigan State University Federal Credit Union is the largest university-based credit union in the world, serving more than 181,000 members. Many of their members are students and recent graduates of Michigan State University and Oakland University who are new to the complex world of finance.

Teaching students and recent alumni the importance of fiscal management and fiscal responsibility is very important, especially in our increasingly complex financial world with a wide variety of often complicated and confusing options.

Our Mobile Financial Education App provides students and recent graduates with concise information about a wide variety of timely financial topics quickly in the palm of their hand.

Students can personalize their use of our app while navigating through topical reference materials and financial tools relevant to their needs and challenges such as student loans, credit scores and travel expenses.

Additionally, our app includes an "Ask an Expert" feature, which enables users to email questions directly to experts at the MSU Federal Credit Union.

Our Mobile Financial Education App supports a wide variety of mobile devices providing native apps for iPhones and iPads as well as Android phones and tablets.

Our iPhone and iPad apps are written in Objective-C using Xcode. Our Android apps are written in Java using Android Studio. The content for the apps is served from a knowledge base curated by MSUFCU.


MICHIGAN STATE UNIVERSITY FEDERAL CREDIT UNION
Building Dreams Together

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# Quicken Loans
## Mobile RFID Inventory Tracking System

Founded in 1985, Quicken Loans is a financial institution headquartered in Detroit, Michigan. Quicken Loans is the nation's largest online mortgage lender.

As part of its commitment to innovation, Quicken Loans is continually developing new mobile apps. To test these apps, team members may borrow a wide variety of mobile devices.

Our Mobile RFID Inventory Tracking System uses RFID (Radio Frequency Identification) technology to automate the process by which team members check in and check out mobile devices.

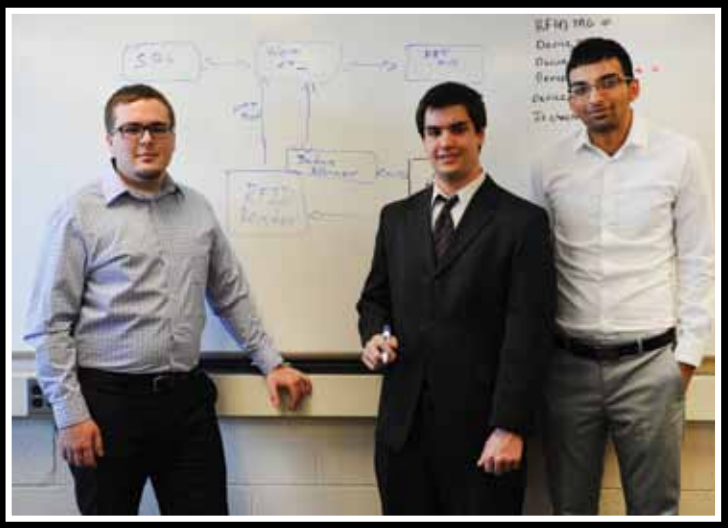
A team member's ID badge unlocks the cabinet where the mobile devices are stored. Devices are checked out simply by removing them from the cabinet, and devices are checked in simply by putting them back. Team members receive email notifications when devices are checked out or checked in, or if a device must be returned.

Our system identifies mobile devices wirelessly using an RFID scanner to read RFID tags attached to the devices. The scanner enables our system to determine what devices are in the cabinet and when devices are removed or returned to the cabinet.

Our Mobile RFID Inventory Tracking System is managed using a web app that supports desktops, laptops, tablets and phones. Users can view the checked-in/checked-out status of existing devices as well as add new ones.

Our web application is written in the .NET MVC framework, with a Windows Web API back end. Our system uses the Impinj Speedway Revolution R420 RFID reader.


Quicken Loans
Engineered to Amaze



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# Spectrum Health System
## Medications Shortages Dashboard

Spectrum Health System, located in Grand Rapids, Michigan, provides high quality, high value healthcare through its nine hospitals in West Michigan, which are maintained by 19,000 employees, 1,500 physicians, and 2,600 active volunteers.

Spectrum Health hospitals carry thousands of medications in various dosages. Having the right medication in the correct dosage at the right time is critical to providing high quality health care. One of Spectrum's many important day-to-day concerns is that of potential medication shortages.

Our Medication Shortages Dashboard provides Spectrum medical personnel with an at-a-glance overview of current national drug shortages. The dashboard displays a concise color-coded synopsis that is easy to process and easy to use.

Dashboard users add the medications that they care about most to their personal watch list, which is displayed at the top of their view of the dashboard.

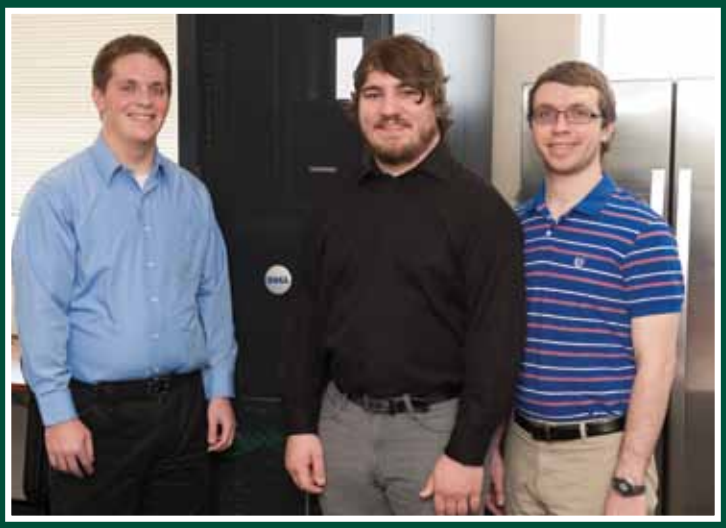
Our dashboard includes a details page about every medication carried by Spectrum Health's hospitals, thereby allowing medical personnel to track the history of a drug's shortage status and to display basic information about it.

Information about medication shortages is pulled in real time from the Food and Drug Administration (FDA) and the American Society of Hospital Pharmacists (ASHP).

Our Medication Shortages Dashboard is built on a Model-View-Controller architecture, using ASP.NET 4.5 with C#. Microsoft SQL server is used to store all shortage information.



SPECTRUM HEALTH



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# TechSmith
## ClassView

TechSmith is a software company based in Okemos, Michigan and is well-known for its screen capture and recording software, which is widely used in educational settings for computer-based learning activities.

TechSmith is using the latest technology to develop a wide variety of tools to make an impact on education.

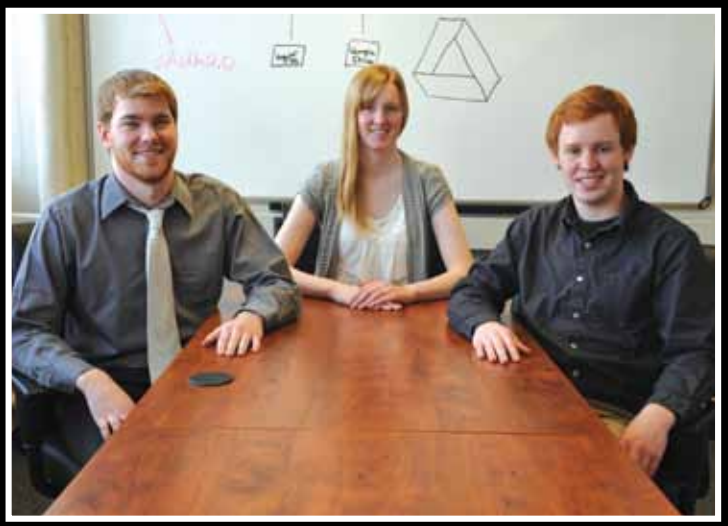
Our ClassView software models a classroom environment and is built on top of the cloud file storage provided by Google Drive. Our software is comprised of two distinct applications, the Teacher Dashboard and the Student Dashboard.

The Teacher Dashboard simplifies classroom management for teachers. Teachers have the ability to create and assign projects, and to review student progress on them. Teachers can create classes, add students to classes, and create groups within each class. Teachers are also able to monitor how students are sharing files via notifications in order to ensure file security.

While using the Student Dashboard, students can work on their assignments while having the necessary limited access to the Google Drive interface. Students are able to collaborate with classmates, view their progress on current assignments and receive reminders of homework due dates.

The ClassView Teacher Dashboard and Student Dashboard are Google Chrome applications that are written in HTML, CSS, and JavaScript. The Teacher Dashboard also uses the JavaScript framework AngularJS.


TechSmith



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# Urban Science
## Dealer Improvement Recommender System

Urban Science is an analytics consultant to the automotive industry. Using data-backed analysis of key performance indicators (KPIs), Urban Science increases dealer sales and profitability.

A recent addition to Urban Science analytics is the Logic Tree, which describes important KPIs, target values for dealers, potential reasons for poor performance and potential suggestions to address problems. As Urban Science consultants learn from consulting experiences, the Logic Tree must grow and evolve.

Our Dealer Improvement Recommender System provides tools to visualize and edit the Logic Tree through a robust web app. Authenticated users can create, edit and delete KPIs, causes, suggestions and relations between them. Furthermore, these relations can be weighted to generate analytically driven suggestions based on a specific dealer's data.

Urban Science's existing Dealer Assistant iPad app is able to query the Logic Tree to provide actionable suggestions to consultants in the field. These suggestions are used to create dealer action plans. Results from tracking the implementation of these suggestions are used to update the Logic Tree, improve the system, and yield better long term suggestions for Urban Science's dealers.

Our Dealer Improvement Recommender System is written in C# using ASP.NET MVC with a Microsoft SQL backend database accessed via the Entity Framework. Visualizations are implemented using D3.js.


URBAN SCIENCE

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# Whirlpool Corporation
## Virtual Appliance Simulator

Whirlpool Corporation, headquartered in Benton Harbor, Michigan, is a worldwide innovator in manufacturing a diverse range of household appliances and technologies.

Today there is much more to a Whirlpool appliance than what meets the eye. Cloud computing, digital sensor networks, and internet connectivity are but a few of the many tools used by Whirlpool to give customers a truly modern experience.

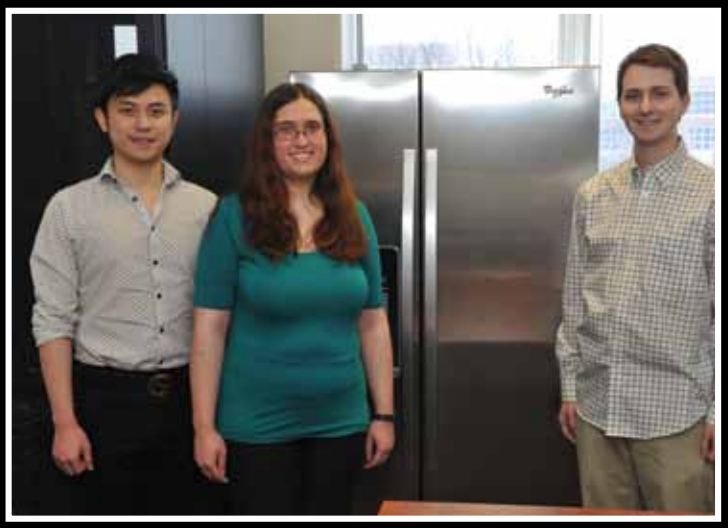
Yet, building connected appliances is challenging in an age when software can be written faster than its corresponding hardware can be built. Coding for a "smart appliance" often finishes well before a hardware prototype can be built.

Our Virtual Appliance Simulator allows Whirlpool software developers to create virtual connected appliances to test their software in a simulated environment. Instead of setting up several dozen actual appliances, an engineer can push a button and create tens of thousands of virtual appliances ready to do testing within seconds.

A Whirlpool dryer is shown at the right along with a virtual version of the exact same appliance. Using our web interface, a Whirlpool engineer is able to select the type, number of connected appliances to be simulated, and the behavior of each simulated machine.

Our Whirlpool Virtual Appliance Simulator is written in Java and is optimized for an Ubuntu Linux environment. All front end user interfaces are web based, written in PHP, to ensure cross platform compatibility with all popular operating systems and with all common web browsers.


Whirlpool CORPORATION



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***Team Members*** (left to right)

**Evan Liang**
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**Lisa Kelly**
DeWitt, Michigan

**Cody Littley**
Coldwater, Michigan

**Whirlpool**
***Project Sponsors***

**Fred Bellio**
Benton Harbor, Michigan

**Sudhanshu Nagar**
Benton Harbor, Michigan

**Jeffrey Stoller**
Benton Harbor, MI

**Carl Wendtland**
Benton Harbor, Michigan

# Design Day Awards

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

## Auto-Owners Exposition Award

Auto-Owners Insurance
Life Home Car Business
The "No Problem" People®

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 MSUFCU
Smart Start Savers

Allen Koppman, Mairin Chesney, Adam Proschek, Phil Getzen
Presented by Bob Buchanan and Scott Lake

## General Motors Praxis Award

GM

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 General Motors Praxis Award, which is sponsored by General Motors of Detroit, Michigan.

Team IBM
Information Technology Assessment Toolkit

Connor Gilbert, Adam Koshorek, Eunbong Yang, Alex Hanlon
Presented by Fred Killeen and Christian Stier

# Fall 2013

## Design Day Judges

Samantha Amburgey
*MSU Federal Credit Union*

Fred Killeen
*General Motors*

Kevin Ohl
*Michigan State University*

Mike Drazan
*Toro*

Keith Landau
*GENBAND*

Marty Strickler
*Rose Packing*

Rich Enbody
*Michigan State University*

Brian Loomis
*Microsoft*

Louise Hemond-Wilson
*IBM*

Patrick O'Hare
*Spectrum Health System*

## TechSmith Screencast Award

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

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

Team Urban Science
Dealership Consultant Mobile App

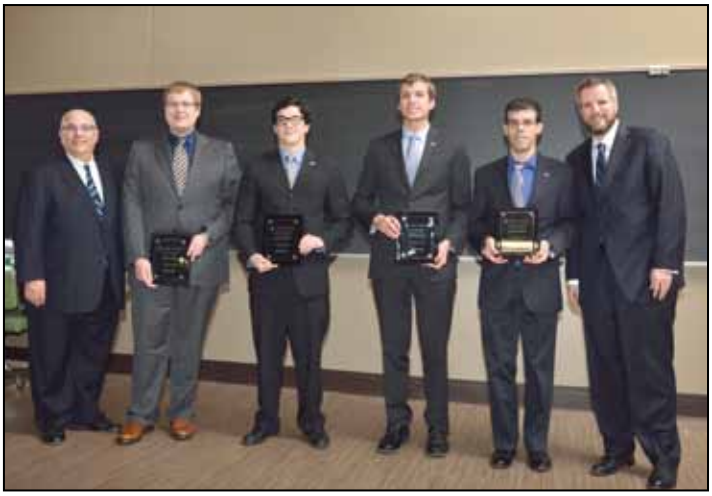
Matt Ao, Zach Kuzmanic, Ryan Tempas, Eric Zipple
Presented by Dean Craven

## Urban Science Sigma Award

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

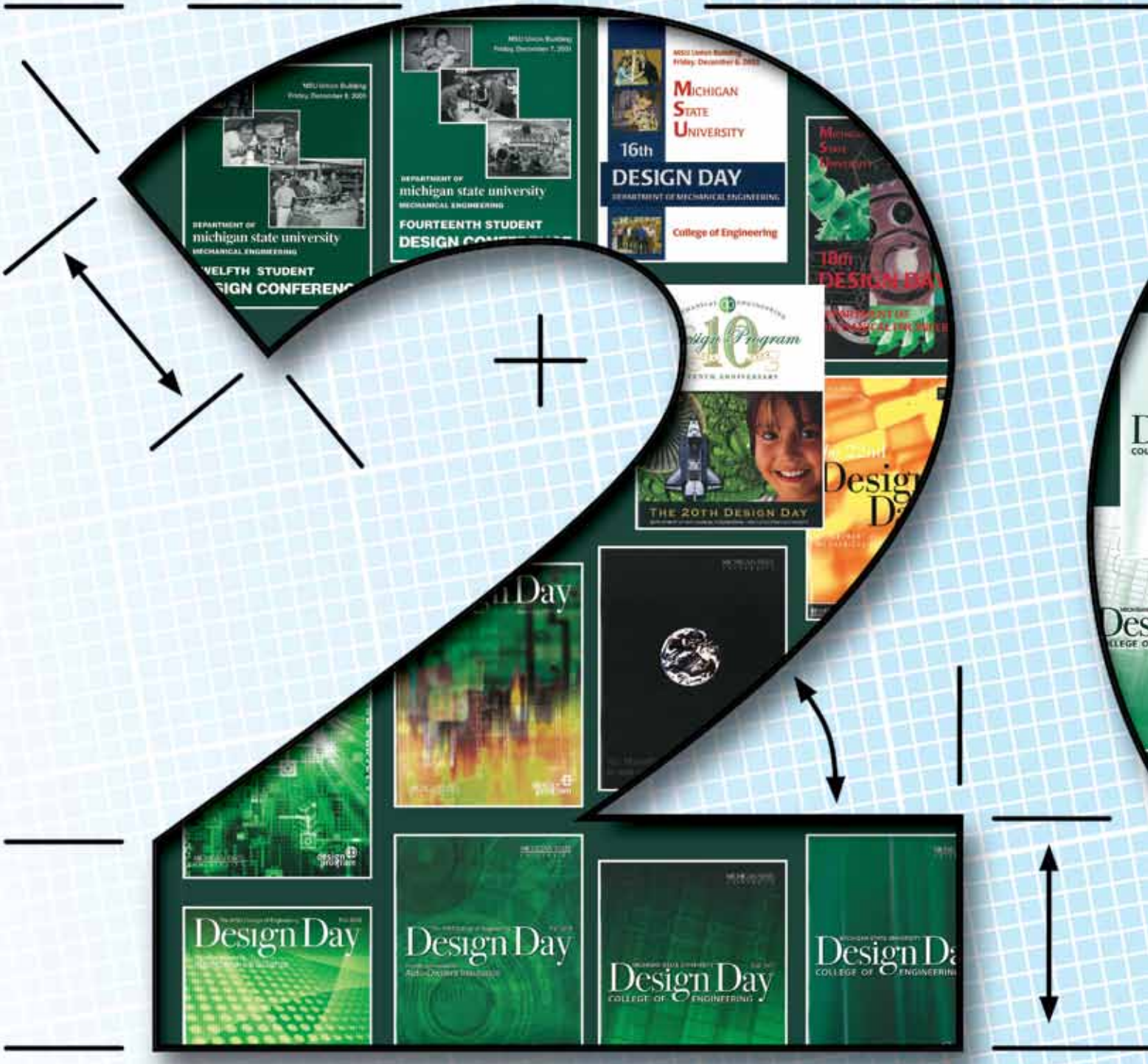
The capstone team that delivers the best overall capstone experience is recognized with the Urban Science Sigma Award, which is sponsored by Urban Science of Detroit, Michigan.

Team Spectrum Health
Talent Connections Careers Mobile Site

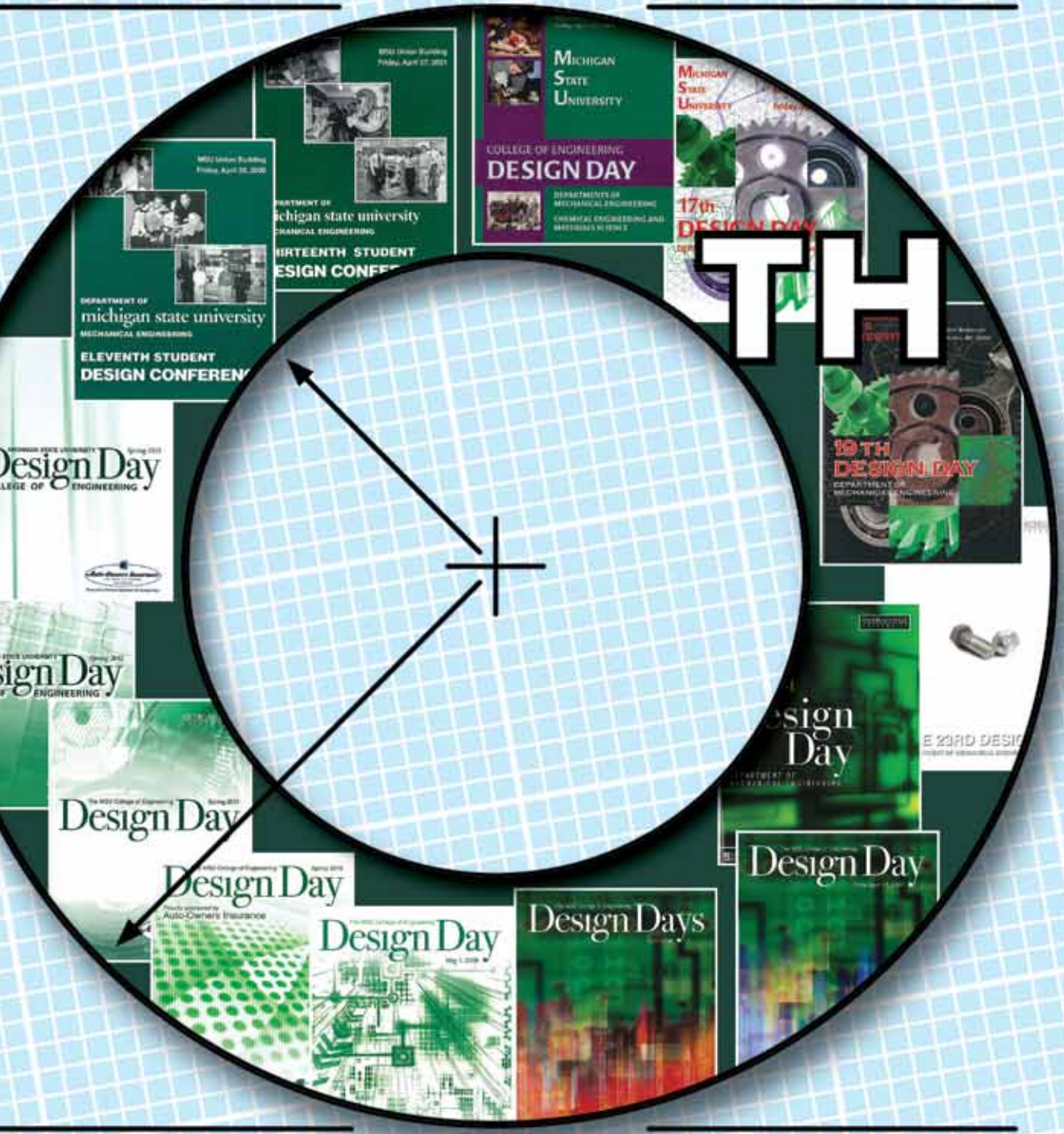


Hayden Boroski, Max Sweet, Nate Langolf, Chris Cheaney
Presented by Mike DeRiso and Matt Bejin

# DESIGN DAY


MICHIGAN STATE UNIVERSITY
16th
DESIGN DAY
DEPARTMENT OF MECHANICAL ENGINEERING
College of Engineering
DEPARTMENT OF
michigan state university
MECHANICAL ENGINEERING
FOURTEENTH STUDENT
THE 20TH DESIGN DAY
Design Day
Design Day
Design Day
COLLEGE OF ENGINEERING
Design Day
COLLEGE OF ENGINEERING

# SPRING 2014




# ANNIVERSARY

# AUDIO ENTHUSIASTS & ENGINEERS

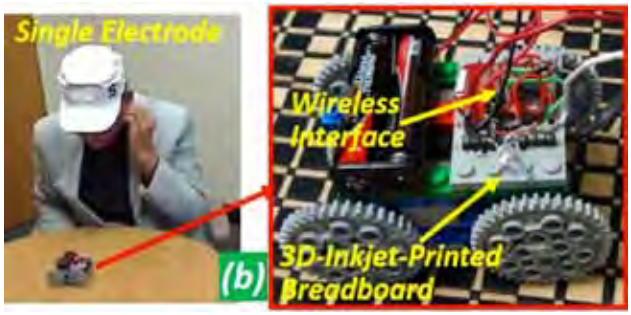
We are students,
with a broad range
of interests and majors,
who have a passion for
audio and audio engineering
at its finest.

Learn more on Design Day
2nd Floor, Room 2228

# ECE 101
## Introduction to Electrical and Computer Engineering

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

## Thrills for Pre-collegiates: Mechanisms that fascinate, captivate, stimulate and entice




ECE 101 is an elective course introducing freshman students to Electrical and Computer Engineering through a series of innovative hands-on laboratory experiments linked to new research and teaching areas. These experiments include (a) maple-seed robotic fliers (MRF) with onboard electronics, (b) brainwaves-I; mind-controlled games and robots using EEG sensors, (c) C programming of robots based on MSP430 microcontrollers and NXT LEGO controllers, (d) computer switches, (e) pH measurement using NXT sensors, (f ) nanotechnology study using a LEGO gear-train, (g) brainwaves-II; mind-controlled games using MATLAB programming, (h) renewable energy resources using windmill and solar cells, (i) location of bio-molecules using RFID.

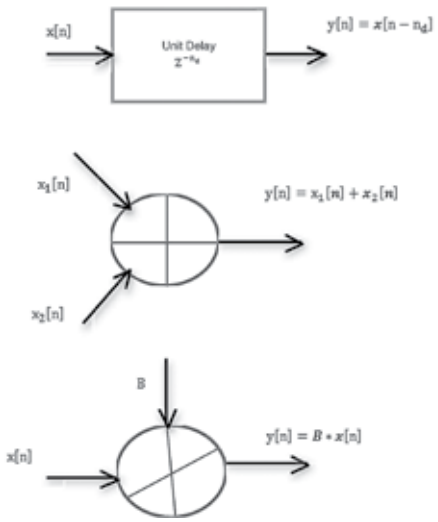
| Team Members | Project Title |
|---|---|
| Ziqing Cao<br>Jahanzaib Nadeem<br>David Sredich | Remote-Controlled Robot |
| Peter Jones<br>Sung Min Lee<br>Ryan Sajkowski | Hazmat Robot |
| Jin Chen<br>Ben Lauzon | Inter-Robotic Communication Using Piezoelectric Trigger |
| Nate Baughman<br>Cody Kelly<br>Jayce Dupuis | Traffic Light Controller for Emergency Vehicles |
| Caleb Doerr<br>Steffany Ellenstein<br>Alexandria Marone<br>Charlie Nguyen | Musical Tuner |

# ECE 410
# VLSI Design

**Fathi M. Salem**
**Professor of Electrical and Computer Engineering**

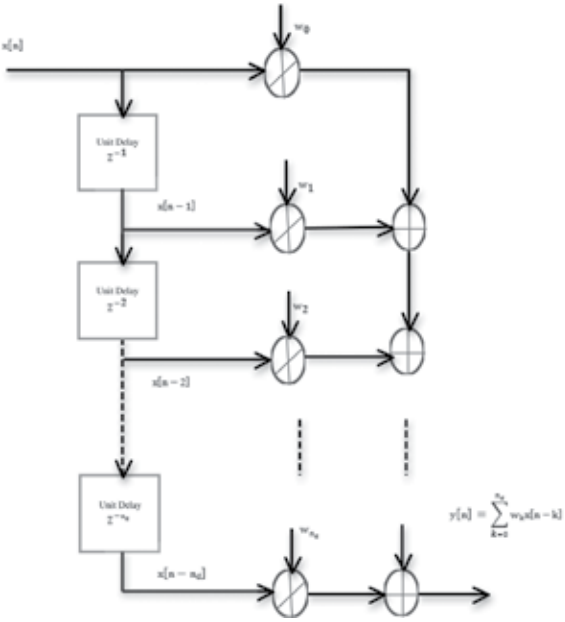
## A Programmable FIR Filter

Students in ECE 410 will be challenged to design the schematic and physical layout of a programmable FIR filter. FIR (Finite Impulse Response) filters are one of two main types of digital filters used in Digital Signal Processing (DSP) applications (the other type being IIR). In this semester, an FIR filter will be designed and constructed in terms of power, area and also delay. The elementary structures of an FIR filter are a combination of multipliers and delays, which represent the combination of adders. However, adders serve as the basic components in the implementation of an FIR filter. Moreover, it is one of the fundamental arithmetic operations used extensively in many VLSI systems such as microprocessors and application specific DSP architectures. It participates in many other useful operations such as subtraction, multiplication, division etc. Thus, a programmable FIR Filter will be implemented, including "programming" (e.g. download/upload) memory tapes using CMOS circuitry and Cadence VLSI design tools.




Their Results will be judged on their ability to satisfy several competing goals:

1. Minimization of the total area
2. Power
3. Speed




| Team 1 | Team 2 | Team 3 |
|---|---|---|
| Team Members | Team Members | Team Members |
| Richard Hendrick | Michael Burch | Annalin Davis |
| Nolan Holmes | Crystal Caddell | Joshua Johnson |
| Madi Kassymbekov | Steven Chao | Shuangfei Liu |
| Nicholas Mancuso | Qiaosen Huang | Pedro Rodriguez |
| Gerald Saumier | Taoping Zhu | |

# The Capstone Projects

**Dr. Timothy Grotjohn**
**Chairperson and Professor of Electrical and Computer Engineering**

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

## Presentation Schedule – Rooms 2245 and 2250 Engineering Building, Second Floor

| Room 2245 | Team Sponsor | Project Title |
|---|---|---|
| 8:15 a.m. | Fitness Metrics, LLC | Sensor Technology Interface |
| 8:40 a.m. | MSU ECE Department | Test-bed Development for Geo-location of RF Emitter |
| 9:05 a.m. | ECE Shop | Ballistic Chronograph |
| 9:30 a.m. | GM | Rapid Prototyping Environment: Climate Control |
| 9:55 a.m. | Break | |
| 10:15 a.m. | MSU Resource Center for Persons with Disabilities | Refreshable 3D Braille Display |

| Room 2250 | Team Sponsor | Project Title |
|---|---|---|
| 8:15 a.m. | MSU Solar Car Team | Battery Management System |
| 8:40 a.m. | MSU Resource Center for Persons with Disabilities | Accessible Tactile Graphic Printer |
| 9:05 a.m. | Bosch | Navigation and Infotainment System Monitor |
| 9:30 a.m. | Bosch | iOS Application for Test Drive Error Reports |
| 9:55 a.m. | Break | |
| 10:15 a.m. | Texas Instruments | Electronic Parachute Deployment System |
| 10:40 a.m. | Fraunhofer Center for Coatings and Laser Applications | Diamond Optical Properties Measurement System |

To view these presentations live please visit the Design Day website: http://designday.egr.msu.edu and click the *Watch Live* tab in left side menu bar.

# 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 legal intellectual property, accommodation issues and entrepreneurship.
- Polishing their communication skills – individual and team – on proposals, reports, resumes, evaluations, posters, web pages, and oral presentations.
- Requiring each student to complete four individual hardware/software laboratory assignments.

Team sponsors are local and national, including, Fitness Metric LLC, Fraunhofer Center for Coatings and Laser Applications, General Motors, MSU ECE Department and ECE Shop, MSU Solar Car Team, Resource Center for Persons with Disabilities, Robert Bosch LLC, and Texas Instruments. Thank you to each of these team sponsors.

**ECE 480** Room 2245 | 2nd Floor **8:15 a.m.**

# Fitness Metrics, LLC
## Sensor Technology Interface

Sensors are becoming more prevalent in our everyday lives. These sensors' protocols can vary drastically, such as being wired, wireless, analog, or digital. One consequence of this is that viewing the data from all of these sensors at once is inconvenient.

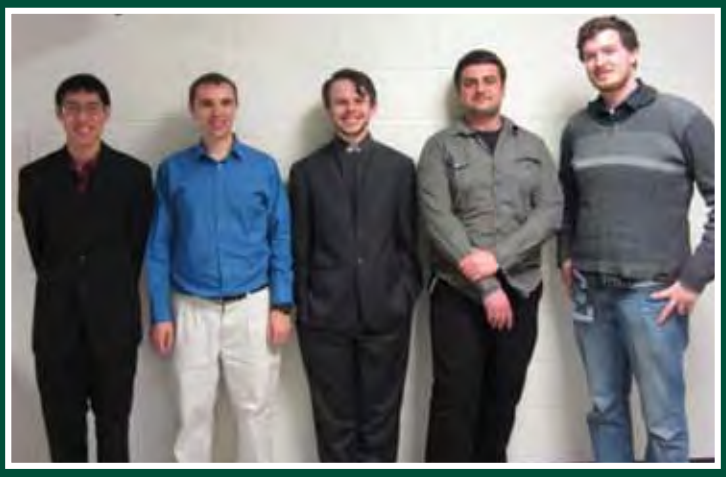
An elegant solution to this problem is to consolidate the information from these sensors onto one platform, which can then display all of the sensors' data in one UI. This platform consists of two components: a sensor interface (SI) to receive the sensor information, and an Android app to display the information to the user.

The SI is capable of receiving information from both wired and wireless sensors. It can also store up to 1 hour of this sensor input on an SD card. Finally, when it is connected to an Android device via Bluetooth, the SI transmits the sensor data to the app.

The Android app has several features. It lists all of the sensors that are being monitored, along with their current reading. It also allows the user to add new sensors to display. Furthermore, the app can display a graphical history of a sensor's readings.

This platform will provide users with a convenient way to read the sensors all around them. Now, they can have all of this information in the palm of their hand.


East Lansing Technology Innovation Center



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**FItness Metrics, LLC**
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**Bernie Holmes**
East Lansing, Michigan

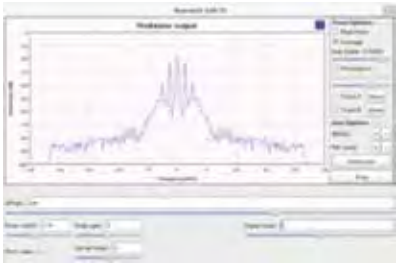
# MSU Department of ECE

## Test-bed Development for Geo-location of RF Emitter

The ability to accurately detect the location of radio signals provides a wide variety of uses ranging from determining the location of a distress signal from a party or individual in need of help to locating an interfering signal that is jamming communications.

A relatively new technology known as Software Controlled Radios now exists which gives the user a wide range of options and tools for receiving radio signals. With a small, lightweight interface unit, known as a Universal Software Radio Peripheral (USRP), coupled with GPS data and a computer, one has the ability to dynamically receive a wide range of radio signals. By using software scripts to extract information from these signals, RF signal information is put into a database file. These data files can then be queried by scripts and numerical analysis software, such as IPython, to create RF signal strength diagrams and maps for a particular area.

Our project creates a test-bed which is fully functional; the field unit can operate on a battery and send gathered RF signal information back to a host computer using Wi-Fi technology. Further, we demonstrate how the radio software can be used to create helpful information in a user interface, such as: time of measurement, GPS coordinates of the antenna and strength, and approximate direction of the signal. This system will serve as a test-bed for researchers, such as the Military, to write more sophisticated algorithms to use on the captured database intelligence to a more advanced degree.

DEPARTMENT OF ECE
ELECTRICAL AND COMPUTER ENGINEERING

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**Joe Godby**
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**Matt Roach**
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**Department of ECE**
***Project Sponsor***

**Timothy Grotjohn**
East Lansing, Michigan

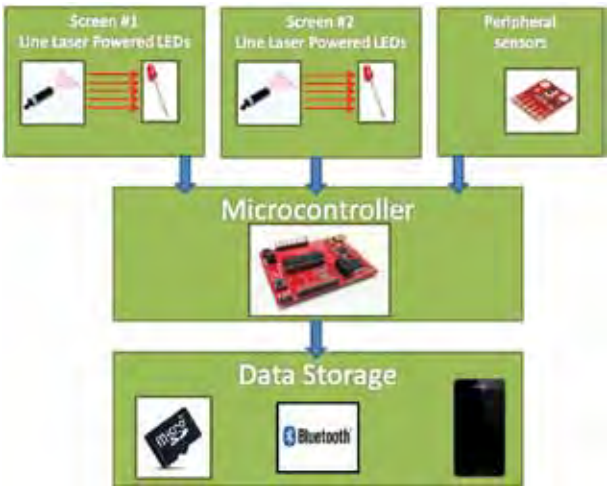
# ECE Shop
## Ballistic Chronograph

Ballistic Chronographs are used to measure the velocity of projectiles. Our chronograph is designed to assess the projectile mid-flight.

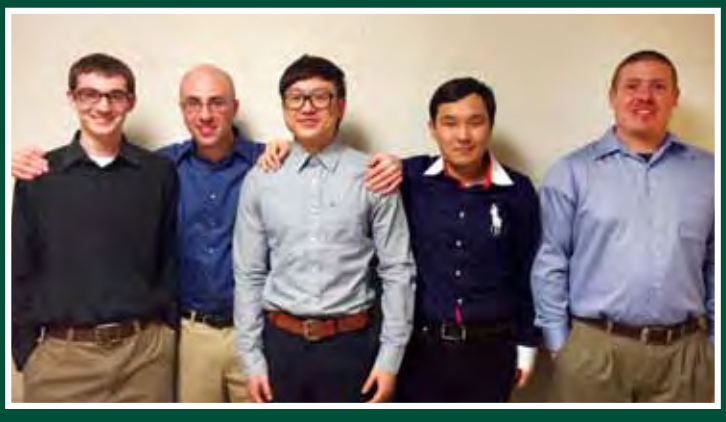
Our design incorporates two 14 inch x 14 inch square screens, creating a large detection area for the users' convenience. Each screen consists of two line lasers and two banks of reverse-biased LEDs, creating a virtual sensing plane. When projectiles cross each screen, the line lasers are interrupted and a microcontroller detects the change in voltage across the LEDs. The most common implementation for screens use infrared sensors to do projectile detection. While infrared sensors are a working option, they are often unreliable due to changing light conditions that cause the readings to be inaccurate. Part of the project description was to investigate alternatives to infrared sensors, and explore a line laser detection scheme.

Environmental factors can influence projectile velocity. Our design will incorporate peripheral sensors to record factors such as atmospheric pressure, altitude, humidity, and temperature. These factors, as well as the projectile velocity can be displayed on an LCD screen.

Additionally, the chronograph will be saving every data set displayed on the LCD to an SD card. For convenience, all data from the chronograph will be reported back to the user over Bluetooth to an Android application where the user can monitor or save the information.




DEPARTMENT OF ECE
ELECTRICAL AND COMPUTER ENGINEERING



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**Steve Kanitz**
Saint Johns, Michigan

**ECE Shop**
***Project Sponsor***

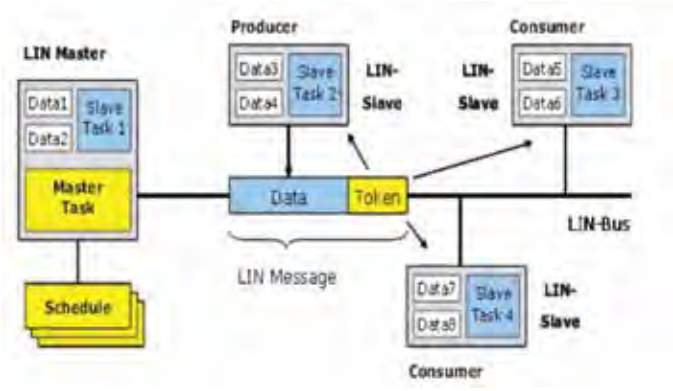
**Brian Wright**
Mason, Michigan

# General Motors
## Rapid Prototyping Environment: Climate Control

During the development of a climate control system in a vehicle, Rapid Control Prototyping (RCP) must be done in order to ensure that the optimal design is chosen. Accomplishing this is a timely task, so software is used to virtually design the system for the ease of modifying parameters in the developmental stage thus saving time and money. Due to the benefits that RCP offers, General Motors is focusing their resources into developing an RCP climate control system through the software dSPACE. This software allows for the virtual design of an Electrical Control Unit (ECU) for the handling of a real time signal communicated through a Local Interconnect Network (LIN) which then controls actuators and sensors to modulate and detect the lighting and temperature in an automobile.

With the requirements for signal systems increasing, analog data transfer techniques are showing their limitations. LIN permits General Motors to transition from analog to digital communication which allows for the advanced processing of signals sent from the ECU and delivered to the actuators and sensors. This system is represented in the figure to the right with the ECU represented as the LIN Master and the actuators and sensors represented as the LIN Slaves.

After designing, implementing and testing the RCP climate control environment, the system will provide greater accuracy and control of LIN based actuators and sensors to modulate temperature, save on wiring costs, and offer the ability for real-time correction during signal acquisition.

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**Weihan Yan**
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**Omar Ali**
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**Ricardo Johnson**
Detroit, Michigan

**Guiseppe Ferro**
Macomb, Michigan

**General Motors**
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**Nedra Johnson**
Warren, Michigan

**Elliot Keen**
Warren, Michigan

**Jim Kovach**
Wixom, Michigan

**Todd Tumas**
Warren, Michigan

**ECE 480** Room 2245 | 2nd Floor **10:15 a.m.**

# MSU Resource Center for Persons with Disabilities

## Refreshable 3D Braille Display

In an age of forever increasing digitization, issues arise with equalizing opportunities for the blind. As universities push for the adoption of new technologies such as braille printers, blind students may be left behind other students. This presents a lack of resources for blind students, especially when it comes to situations which require 3D images (e.g. 3D curves in calculus, maps, etc.). Currently, there are no existing devices that utilize a refreshable display in order to display 3D images.

Team 5 will construct a device that will be able to receive image files, analyze and process the image in terms of color intensity, and then output these results via a 3D pin matrix display, with color intensity determining the height of each pin.

The device will feature a 64x64 pin matrix display that will be adjustable from zero to one inch. This resolution was picked so that users will be able to utilize their entire hands to feel the image, creating a more immersive experience. The pins will be held captive by independent grooved panels and will be set by a servo which moves along rails for XY axes motion. The servo will have a mechanism to convert rotational motion to Z axis motion, which will set pins to the desired height. Pins will then be "locked" into place by increasing pressure on the pins. This will all be controlled by an Arduino microcontroller.

The refreshable nature of this device means that the device has numerous practical applications with functionality that is currently unavailable in the marketplace. It will also be far less costly than the use of non-refreshable technology.

Resource Center for Persons with Disabilities


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

**Daniel Olbrys**
Bloomfield Hills, Michigan

**Steven Chao**
Grosse Ile, Michigan

**Terry Pharaon**
Port-Au-Prince, Haiti

**Michael Wang**
Troy, Michigan

**Kodai Ishikawa**
Monroe, Michigan

**MSU RCPD**
***Project Sponsors***

**Stephen Blosser**
East Lansing, Michigan

**Satish Udpa**
East Lansing, Michigan

# MSU Resource Center for Persons with Disabilities

## Bluetooth Low Energy Beacon

The Michigan State University campus in East Lansing consists of 538 buildings spread out over 8.125 square miles. For the blind or visually-impaired members of the Michigan State community, navigating campus can be a challenging task. The Resource Center for Persons with Disabilities at Michigan State University has proposed to use a new interactive positioning interface, a Bluetooth Low Energy (BLE) beacon to assist blind people in navigating around campus.

With the release of iOS 7, Apple announced iBeacons, a feature that allows an iOS device to calculate its location relative to Bluetooth beacons. The MSU RCPD is looking to utilize this technology for assistive navigation by placing Bluetooth Low Energy (BLE) beacons inside building entrances and hallways. These beacons will allow iOS 7 and Android based smart phones to precisely calculate their position inside a building.

This project's focus is to develop a low-cost Bluetooth Low Energy beacon compatible with Apple's iBeacon technology. The beacons broadcast a unique identifier allowing the receiver to triangulate its position based on the known locations of the beacons. Bluetooth Low Energy-enabled Android and iOS devices will be able to detect the beacons, calculate distance from the beacons based on the received signal strength, and display notifications and navigation information based on their location. Text-to-speech functionality built into both iOS and Android is used to read the navigation information aloud.


Resource Center for Persons with Disabilities

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**Bowei Yu**
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**Matt Smania**
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**Steven Le**
Grand Rapids, Michigan

**MSU RCPD**
***Project Sponsors***

**Stephen Blosser**
East Lansing, Michigan

**Aditya Mathew**
East Lansing, Michigan

**ECE 480** Room 2250 | 2nd Floor **8:15 a.m.**

# Michigan State University Solar Car Team
## Battery Management System

Our design team is tasked to build a battery management system for the Michigan State University Solar Car Team. The Solar Car team is one of the newest racing teams at Michigan State. In the past years the solar car has had issues with many components. A way to improve the car is to create a customizable battery management system.

A battery management system (BMS) is an electronically controlled system that manages rechargeable battery cells. The system protects the battery cells by monitoring the voltage, the current, and the temperature of the battery cells. When any of these measurements falls outside the specified design limits, the BMS will take corrective actions to ensure system stability and safety. The basic design of our system can be seen modeled in CAD on the right.

A customized battery management system is one of the most important aspects of a solar car. Batteries contain a large amount of energy, and any sort of problem with the batteries can have disastrous consequences. Problems with the voltage, current, and temperature of the batteries can destroy the batteries and need to be controlled in order to be safe. By using sensors, battery balancing, and an emergency cut-off switch, the driver of the car can be sure that any problems will be handled properly, and that the battery packs will be safe from any failures.

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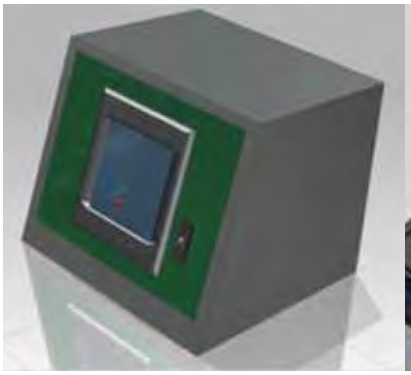

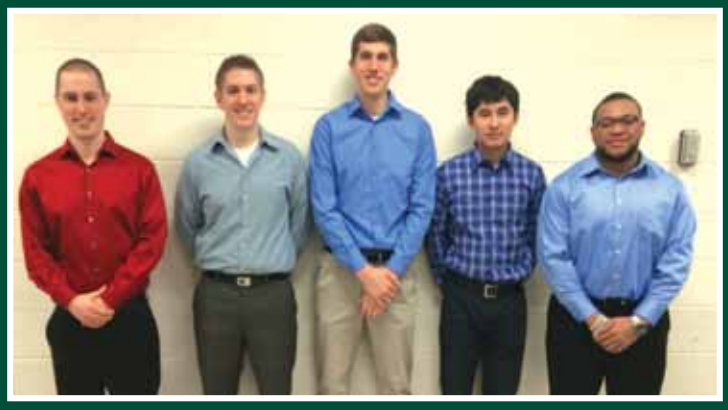

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Okemos, Michigan

**Michael Burch**
Muskegon, Michigan

**Auez Ryskhanov**
Semey, Kazakhstan

**Albert Ware**
West Bloomfield, Michigan

**MSU Solar Car Team**
***Project Sponsors***

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Ann Arbor, Michigan

**Matthew Myers**
Bath, Michigan

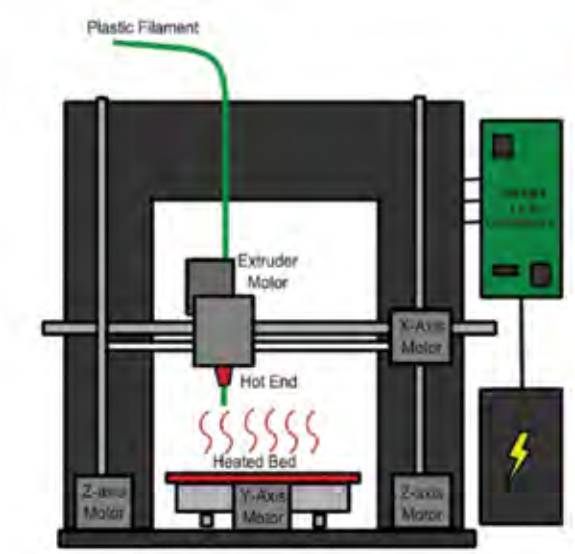
**Scott O'Connor**
Plymouth, Michigan

# MSU Resource Center for Persons with Disabilities

## Accessible Tactile Graphic Printer

Tactile graphics and Braille are essential components to making education accessible to the visually impaired. The Resource Center for Persons with Disabilities (RCPD) on MSU's campus currently preserves two tactile graphic embossers that produce pictures, charts and drawings to assist blind students in their studies. The downfall to these embossers however, is that the images that it produces are quite frail and are eventually pressed down after repeated use, which in turn makes it difficult for a blind student to identify the image. Thus, the team was assigned the responsibility of designing a specialty printer that can be used to produce tactile graphics and maps for blind users/students at MSU. If successful, a duplicate design will be created for a school for the blind in India. This designed tactile graphic printer should produce more durable images and cost significantly less.

Stephen Blosser of the RCPD, along with the team, proposed the idea of designing a 3D printer in order to address these concerns. The image will be created using a Computer-Aided Design program (CAD) and then saving this file as a STereoLithography (STL) file. This file will be transferred to a g-code generator program such as slic3r which will convert the file into a set of instructions that the printer will understand. This 3D printer will consist of a heatbed and an extruder which will extrude a filament onto an 11x17 inch glass surface, one layer after the other, creating the required image. Once the printing process is finished, the heated surface begins to cool down and the figure is available for detachment.




Resource Center for Persons with Disabilities

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

**Maram Sulimani**
Jeddah, Saudi Arabia

**Caroline Kerbelis**
Oxford, Michigan

**Martez Steverson**
Detroit, Michigan

**Bryan Cotton**
Jackson, Michigan

**Eman Aljabr**
Qatif, Saudi Arabia

**Changqing Yang**
Shanghai, China

**MSU RCPD**
***Project Sponsor***

**Stephen Blosser**
East Lansing, Michigan

# Robert Bosch, LLC
## Navigation and Infotainment System Monitor

Have you ever wondered how the GPS system in your car works? The process for developing such a system takes countless hours of testing and debugging. In order to make this process easier, we are developing a monitoring system to record bugs while testing these systems.

This system developed at Bosch's Automobile department is aimed to record videos during the driving test without disturbing driver's attention. It is not a simple machine anymore, but a system that combines the video recorder, computer processor, and a data storage system; which can support hot plug and play. The goal of this system is to provide a safe and reliable error recording system for test drivers, ensuring all entertainment and navigation functions operate successfully, and further improving the system. The system must properly work in variable situations, like short travel on a snowy day or crossing multiple states. It also has to record all the errors about software bugs or misuse.

In this project, the design team will improve the original system, and provide a video monitor for the testing driver. The video monitor will show the four camera angles, timestamp, GPS coordinates, and memory left in storage. The possible solution that the design team wants to fulfill is to combine 4 cameras' input into a central microcontroller. The microcontroller will store all video recording into either a USB drive or SD card. When an error occurs, the tester presses a switch, and then the microcontroller generates a video from the last five minutes.


BOSCH

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

**Radhika Somayya**
Canton, Michigan

**Jianying Tang**
Chongqing, China

**Yan Gong**
Hangzhou, China

**Xinye Ji**
Farmington Hills, Michigan

**Shengzhe Gao**
Xi'an, China

**Kun Zhang**
Xi'an, China

**Bosch**
***Project Sponsor***

**Clark Smalley**
Novi, Michigan

# Robert Bosch, LLC
## iOS Application for Test Drive Error Reports

Bosch is well-known in industry for researching and developing in-car information systems. The company was awarded the "Best-of-CES Award 2013" at the Consumer Electronics Show for the Chevrolet My Link System.

In order to maintain the elite status of its infotainment systems, Bosch must constantly run diagnostic tests in order to debug and update its software.

To assist Bosch with recording error reports during automobile test drives, we have been enlisted to develop a mobile application for testing.

The key objective is to create a virtually hands-free iOS application that captures a structured speech input, logs all information, then outputs an Excel file. The application will collect failure information from the user by prompting questions, such as, "What component has failed?" The application will then record and transcribe the response using voice recognition software.

At the end of the test drive, the user will be able to edit the data. All data will be exported into a .CSV file and submitted via email from inside the app.

The final application will be written in Objective-c Coding using Xcode Software. AVSpeechSynthesizer Software will be used for voice prompts. The application will function on both Apple iPhone and iPad devices.


BOSCH

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

**Ryan Bliton**
East Lansing, Michigan

**Feifei Li**
Tianjin, China

**Mark Mudro**
Fowlerville, Michigan

**Kaichang Wang**
Yiwu, China

**Charlton Washington**
Detroit, Michigan

**Kyler Wilkins**
Ann Arbor, Michigan

**Bosch**
***Project Sponsors***

**Ryan Parent**
Novi, Michigan

**Soeren Wildemann**
Novi, Michigan

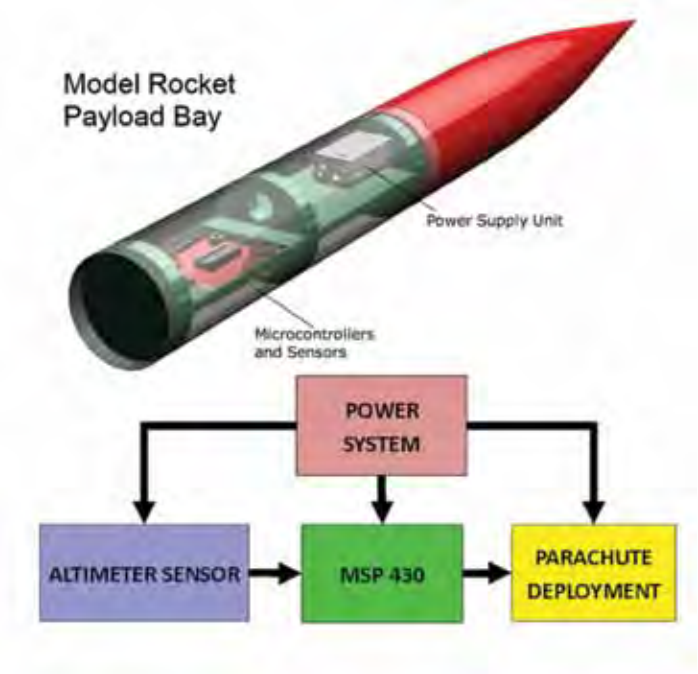
# Texas Instruments
## Electronic Parachute Deployment System

Model rocketry is a popular hobby enjoyed among several age groups. One essential component includes the ability to deploy parachutes for a safe landing and reuse of the rocket. This project presents the opportunity to evaluate and develop a multistage Electronic Parachute Deployment (EPD) system for large-scale model rockets.

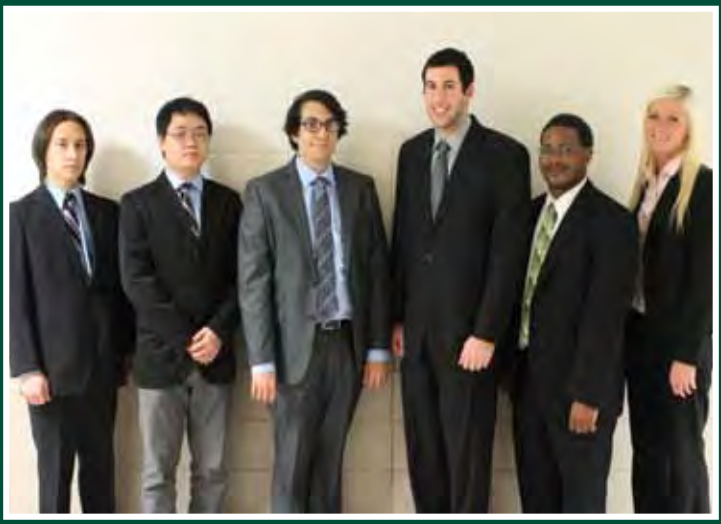
The primary function of the EPD system is to activate the parachute deployment process. Once the rocket reaches the apogee, the EPD system will initiate the return of the rocket to the ground by deploying the drogue chute. At a secondary point the EPD system will deploy a second parachute to reduce the impact force upon landing.

The EPD system consists of a sensor, microcontroller, and power supply unit. The sensor used is an altimeter to measure the altitude of the rocket based on absolute atmospheric pressure. The altimeter outputs the signal to a MSP430 microcontroller that detects the descent. The power supply demonstrates the capability to power the ignition fuse while also powering the other components.

The team designed, simulated, and fabricated each subsystem through creating a Printed Circuit Board (PCB) that incorporates all of the EPD system functionalities. The design of the PCB meets the physical constraints of the payload bay. The final solution allows for a flexible EPD system that can be used through various model rockets.




TEXAS INSTRUMENTS



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

**Michikazu Aono**
Saline, Michigan

**Qiaosen Huang**
Hunan, China

**Pedro Rodriguez**
Brighton, Michigan

**Max Cooper**
Bellevue, Washington

**Zane Crawford**
West Bloomfield, Michigan

**Jessica Shelby**
Tecumseh, Michigan

**Texas Instruments**
***Project Sponsors***

**Tim Claycomb**
Dallas, Texas

**Mike Mock**
Dallas, Texas

**Peter Semig**
Dallas, Texas

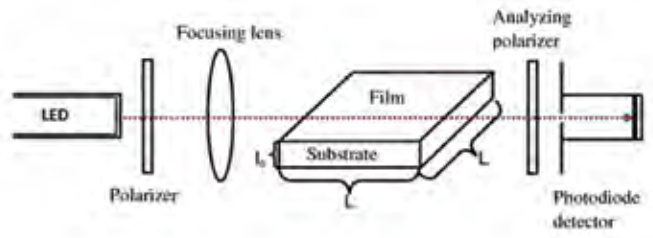
# Fraunhofer Center for Coatings/Laser Applications
## Diamond Optical Properties Measurement System

The Fraunhofer Center for Coatings and Laser Applications is responsible for growing synthetic diamonds. Diamond is a material with extreme properties including highest hardness, very chemically inert, highest thermal conductivity and has a wide spectral window for transmission of light. Therefore, it is very important that these artificially-grown diamonds are grown with as little impurities as possible.

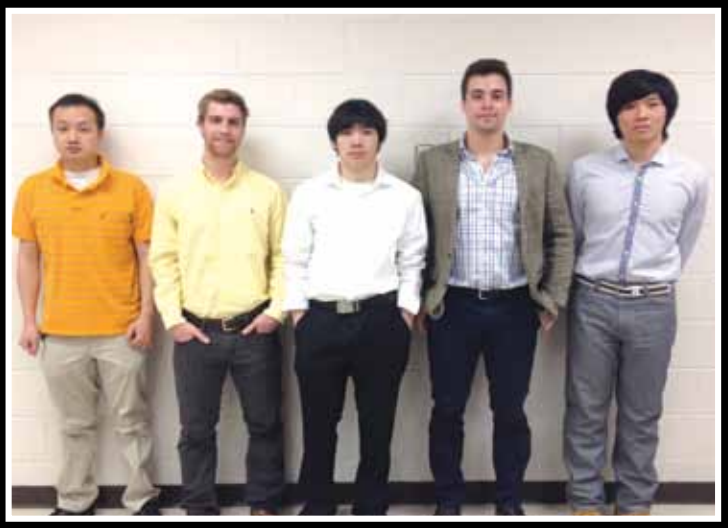
One of the more sensitive measurements of the quality of diamond is birefringence. Birefringence is an optical quality where linearly polarized light shining through a flat diamond piece is made non-polarized by imperfections in the diamond. The goal of this project is to develop a birefringence measurement system.

The proposed solution is to design a system where a linearly polarized LED shines through a diamond flat sample with the light exiting the diamond being filtered by a linear polarized filter. This will transmit only the light polarized 90 degrees with respect to the input light. The presence of defects and stress in the diamond causes the polarized light to exit the diamond partially non-polarized, and it is the strength of the non-polarized light that is to be measured. This system will meaure the light intensity of each pixel, calculate the birefringence, and display a quantifiable 2-D map.

This project will ultimately help Fraunhofer share their data related to diamond impurities in an effective and efficient manner.




Fraunhofer



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

**Daniel Kuang**
Livonia, Michigan

**Adam Tayloe**
Rochester, Michigan

**Allen Lin**
Beverly Hills, Michigan

**Daniel Schulz**
Houghton, Michigan

**Chunyu Li**
Beijing, China

**Fraunhofer**
***Project Sponsor***

**Shannon Demlow**
East Lansing, Michigan

# Design Day Awards Fall 2013

## Electrical & Computer Engineering Prism VentureWorks Prize & Winners, Fall 2013

The Prism VentureWorks Prizes ($1,500, $1,000, and $500, respectively), 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. The prizes are sponsored by Prism VentureWorks, a Boston-based venture capital firm, and Mr. William Seifert, an ECE alumnus, who is a partner in that firm. The faculty and students of Electrical and Computer Engineering are very grateful for this generous support.

### Prism VentureWorks First Prize: Michigan State Solar Car Team: Motor Controller for Sensored BLDC Motor

*left to right:*
Dr. Timothy Grotjohn, Matt Myers, Jaime Alvarez, Chris Sommer, and Scott O'Connor

### Prism VentureWorks Second Prize: U.S. Air Force Research Laboratory – Wireless Sensor Network Health Diagnostic

*left to right:*
Dr. Timothy Grotjohn, Stu Andrzejewski, David Rogers, Brad Garrod, and Kelly Desmond

### Prism VentureWorks Third Prize: Chrysler Group, LCC: Advanced Testing Breakout Board

*left to right:*
Dr. Timothy Grotjohn, Andrew Haumersen, Sana Siddique, Richard Hendrick, Meng Cao, Xuran An

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There's an unmistakable momentum happening at GM. Now, more than ever, we're poised to shape the future of tomorrow, today. From robust IT initiatives to shortened software development cycles, GM is defying convention to elevate the automotive industry as we know it. Bring your ideas and lend your experience to an international company that's as excited about your success as we are our own. Take the next step in your career at GM and discover what our employees already know — that together, there's no stopping us.

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## CONNECT WITH US:

If you'd like to have the opportunity to share why YOU should be part of our team, please contact your career center for information about our on-campus interviews this fall. Here are some ways to get plugged in:

nielsen.com/oncampus

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# ME 371
# Mechanical Design I

**Dr. Brian Thompson**
**Professor of Mechanical Engineering**

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

Teams of students were required to design and manufacture mechanisms that would thrill an audience of pre-collegiate students. The constraints imposed upon this assignment were that each mechanism must incorporate at least one linkage, one gear set and one cam-follower combination. These engineering marvels will be demonstrated and displayed with a complementary poster explaining the subtleties of each mechanism. The ME 371 teams will also be interviewed and rated by the pre-collegiate students. The most highly-rated team will be awarded the Sparty Plaque, which was designed and fabricated by students at Holt Junior High School over a decade ago.

## Teams and members

**Team 1**
Alexander Bibicoff
David Drake
Garret Dunn
Christopher Hardy
Duan Ni
Karan Takkallapally

**Team 2**
Evan Boyers
Michael Cieslik
Ryan Ferguson
Nathan Gill
Bradley LaBaere
Eric Peters

**Team 3**
Angela Bertolini
Toby Buckley
Austin Condra
Tyler Finses
Ashley Pomaville

**Team 4**
Ross Buckley
Aimee Griffin
Akiem Harshman
Alex Hock
Daehee Park
Daewoong Yang

**Team 5**
Micah Appel
Ben Carruthers
Andrew Gates
Laura Gumpper
Tyler Karp
Trevor McSween

**Team 6**
Omar Elsherif
Alexander Gore
Collin Hartman
Junior Kubata
Brandon Ogbonnaya
Koreco Wilkins-Webster

**Team 7**
Brian Cobus
Jay Heribacka
Greg Lott
Jinyang Qiu
Nick Theis
Basil Thurston

**Team 8**
Jessica Buschman
Jim Hargrove
Shannon Pinner
Madeline Roe
Steve Utz
Lisa Warner

**Team 9**
Steven Lund
Cody Neal
Anna Nham
Amanda Sliney
Mariya Titova
Bill Weiland

**Team 10**
Robert Cenowa
Nicholas Decker
Bradley McCauley
Chris Sehling
Joseph Senechal
Kevin Viguilla

**Team 11**
Benjamin Allen
Michael Campbell
Noelle Kahunguba
Amelia Karaba
Seth Rohr
Andrew Shih

**Team 12**
David Dudley
Lucas Steele
Travis Tehlirian
Stephen Town
Davis Trapp
Alex Zettler

**Team 13**
Tyler Gallant
Ryan Glynn
Matt Korolewicz
Michael McKinley
Rupinder Singh
Dominic Waldorf

**Team 14**
Ryan Clark
Ryan Kutcher
Anthony LaCross
Evan Meier
Mark Taylor
Geoff Todd

**Team 15**
Julian Diaz
Shen Gao
Alex Hoover
George Lewis
Tianlun Liang
Phil Skinkle
Chunlei Zhao

# ME 412
# Heat Transfer Laboratory

**Mark Gaustad**
**Instructor in Mechanical Engineering**

## The Solar Hot Dog Cooker

Each project team is to analyze, design, build and test a heat transfer device to raise the temperature of a hot dog using solar energy. The primary objective is to maximize the surface and center temperatures of the hot dog, after heating from ambient temperature for 30 minutes. A secondary objective is to minimize the weight of the cooker's solar collector. Temperature data for each team are recorded periodically to establish the transient performance of the solar collector and provide validation for an analytical model of the cooker that is developed as part of the final project report. Each team has 10 minutes to set up its cooker. In addition, each team prepares a YouTube video, shown to the audience during the competition that explains design decisions based on principles of heat transfer.

## Competition Schedule

| Time | Station | Team members | | | |
|---|---|---|---|---|---|
| **8:00** | Team 1 | Louis Dionise | Ryan Thompson | Peter Woodbridge | |
| ***thru*** | Team 2 | Zhijing Liu | Michael Uggeri | Kyle Watts | Susan Whitenight |
| **8:45** | Team 3 | Brinn Cochrane | Caitlyn Cubba | Jeffrey Vonlinsowe | |
| | Team 4 | Travis Collings | Matthew Nees | Stephen Tatangelo | |
| | Team 5 | Brandon Cameron | Nicholas Palazzolo | Justin Sagorski | |
| | Team 6 | Haoqi Liu | John Potts | Alan Seery | |
| **8:45** | Team 1 | Frank Kmet | Gregory Smiecinski | Qichen Xiao | Yongkang Zhou |
| ***thru*** | Team 2 | Hassan Alyousef | Vito Balsamo | Robert Jakubowski | |
| **9:30** | Team 3 | Hashim Aldabbagh | Samrawi Gebermedhin | Benjamin Oberski | Todd Wolverton |
| | Team 4 | Jin Ahn | Joshua Boerger | Todd Sabotta | |
| | Team 5 | Deonte Childress | Jason Gridley-Waters | Daniel Howarth | |
| **9:30** | Team 1 | Brooke Peruski | Eric Schendel | Miles Turrell | |
| ***thru*** | Team 2 | Elizabeth Brandon | Zhenyu Chen | Jessica Doody | |
| **10:15** | Team 3 | David Caples | Alexander Morita | Matthew Pingel | |
| | Team 4 | Megan Dmello | Jonathan Erickson | Casey Nicholson | |
| | Team 5 | Benjaman Bennetts | Daniel Delorme | Scott Schimp | |
| | Team 6 | Ronald Dewberry | Lauren Hart | Croix Jastrow | |
| **10:15** | Team 1 | Mohammed Alsinan | Thomas Dionne | William Driscoll | |
| ***thru*** | Team 2 | Margaret Moore | Jonathan Shapiro | Yubing Su | |
| **11:00** | Team 3 | Brett Hewitt | Hanna Vandermoere | Jonathan Woo | |
| | Team 4 | Garrett Baughman | Katherine Jansen | Timothy Najar | |
| | Team 5 | Peter Bensel | Grant Golasa | Thomas Hotari | |
| | Team 6 | Megan Blaszak | Jeffrey Philippart | Brittany Watton | |

# ME 471
# Mechanical Design II

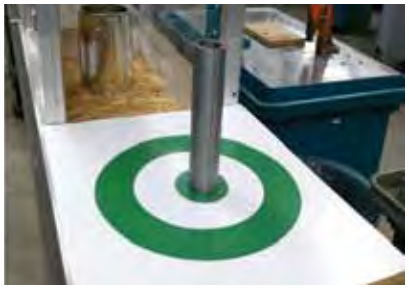
**Dr. Farhang Pourboghrat**
**Professor of Mechanical Engineering**

## Dip Paint & Blow Dry

The goal of this ME 471 project is to design, build, and test a system of mechanisms to pick up a 5 lb cylinder from the rest position, move it to a paint can, dip it inside, take it to the blow dryer, place the painted cylinder on a Bullseye, and finally return to the starting position. Student teams are allowed to design a device that utilizes electromagnets, mechanical grips, pulleys, and one or more other mechanisms. However, the device can be operated using a maximum of 4 discrete inputs to generate linear motion (X, Y, and Z displacements) and rotation. All motions must be generated by hand cranking, push/pull on a lever, electric motors, or their combinations. The device must be operated by only one member of the team standing at the base of the device. Once the cylinder enters the Plexiglas box, it cannot be touched or interfered with by any member of the team. The device should be designed with the requisite stiffness to navigate the cylinder through the box without excessive deflection of the links, or failure.

*a) Picture of the "Dip Paint & Blow Dry" box through which the cylindrical object will be moving with the help of a device comprised of one or more mechanisms*

*b) Blow Dry switch*



*c) The Bullseye.*

| Team | Time | Members |
|---|---|---|
| 1 | 8:00 | Reema Aldhaneem, Vito Balsamo, Juntai He, John Multer |
| 2 | 8:12 | Nassar Alhajri, Zhecheng Dong, Matthew Heimonen, Seium Teshome |
| 3 | 8:24 | Ralang Argi, Evan Bryant, Carl Kaspari, Marian Truttling |
| 4 | 8:36 | Mohammed Itani, Robert Jakubowski, Anthony Kazenko, Brandon Keener |
| 5 | 8:48 | Florian Chedron, Barrett Darius, Danielle Durocher, Aidan Hunter |
| 6 | 9:00 | Justin Fauntleroy, Eddie Franklin, Lauren Marino, David Miller |
| 7 | 9:12 | Kevin Betts, Stephen Marshall, Bansari Patel, Cody Paupert |
| 8 | 9:24 | Casey Nicholson, Paul Petrous, Hunter St. Pierre, Austin Trethewey |
| 9 | 9:36 | Michael Ray, Kuan-Ying Tao, Ethan Welzbacker, Charles Whiteside |
| 10 | 9:48 | Samuel Bekkers, Travis Schafer, David Thomas, Alexander Williams |
| 11 | 10:00 | Zachary Averill, Alexander Bonnen, Gabrielle Colby, Joshua Cresswell |
| 12 | 10:12 | William Freed, Sean Hand, Camden Harp, Andrew Poteracki |
| 13 | 10:24 | Robert Boomer, Brett Close, Arthur Paquier, Barrett Winrick |
| 14 | 10:36 | Kyle Griffiths, Joshua Haneline, Joseph Kim, Danielle Lapointe |
| 15 | 10:48 | Xue Jiang, Trent Johnson, Benjamin Lindemulder, Franklin Luchini |
| 16 | 11:00 | Tyler Jezowski, Frank Kmet, Adam Lyman, Dane Spillman |
| 17 | 11:12 | Nicholas Chase, Benjamin Rittinger, David Torres, Jason Wagnitz |
| 18 | 11:24 | Joshua Gann, Nicholas Garneau, Geoffrey Giese, Stephen Jurewicz |
| 19 | 11:36 | Scott Oldham, Jason Seely, Kyle Sherman |

## ME 478
## Product Development

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

## Stair Climbing Vehicle

The main objective for the course is to design and produce a stair-climbing vehicle for the track announced in class while integrating the engineering knowledge gained during the students' engineering education at MSU. Starting from an individual project and progressing to a team project, each team must produce a stair-climbing vehicle through a series of design and manufacturing tasks. Each student needs to contribute individually as well as collaboratively to accomplish a series of tasks with CAD/CAM packages, CNC machining, rapid prototyping, testing, etc. At the end of the semester, three teams will compete in a race on Design Day.

## Teams and Members

### Team Armed Tank

Oroje Agari
Zack Hoyle
Krista Lueck

### Team Tumbler

Brandon Cameron
Kate Henrick
Jeff Philippart
Todd Sabotta

### Team Stair Straightener

Zach Averill
Shenli Pei
Kyle Watts

### Team Tri Hard

Peter Bensel
Carl Kaspari
Justin Sagorski
Susan Whitenight

### Team Tristar Stair Slayer

Eric Bambach
Nick Chase
Joerg Husemann

# ME 491 International Humanitarian Engineering

**Brian Thompson**
**Professor of Mechanical Engineering**

W. H. Welch, MD (1850 – 1934) founder of the School of Public Health at Johns Hopkins University in Baltimore, Maryland, wrote, 'It is a well known fact that there are no social, no industrial, no economic problems which are not related to health.'

A truism indeed! Human health is one of the primary foci of the real-world Latin American project assignments embodied in this ME491 course. Please note carefully the titles of the semester-long inter-disciplinary team projects dedicated to solving bone fide problems confronting malnourished smallholder farmers. These authentic humanitarian problems motivate and accelerate undergraduate learning much more than the traditional hypothetical classroom exercises.

- **Guatemala: Aiding Guatemalans with Ultraviolet Absorption**
- **Guatemala: Portable Pigeonpea Thresher**
- **Honduras: Cost-effective Human-powered Fertilizer Applicator to Increase Crop Yields for Honduran Farmers**

The fabric of this design-intensive ME491 course is woven from a thread of ideas on humanitarian societal development that address the pressing needs of the 80 percent of the world's population living on less than US $2.00 each day, intertwined with a second orthogonal thread comprising a triumvirate of fundamental ideas on engineering problem-solving processes, entrepreneurship, and the diffusion of innovations that's relevant to every nation sharing our small planet. This warp and weft of interlaced fibers constitute the tapestry defining the biggest challenge confronting humanity today.

Students enrolled in this challenging ME491 course must maintain paradoxical balances. They are committed to the traditional engineering practice of creating revolutionary new products for enhancing the lives of the poor, yet they display personal panache; they are prepared to stand steadfastly alone while clinging to their own personal convictions, yet they are willing to unite philosophically because of their commitment to teamwork; and they are relentlessly driven to create waves of positive change in international marketplaces, yet they are also cognizant of social and ethical responsibilities. Yes this is indeed a complicated convoluted conundrum!

So please review the spectacular innovative devices devised and manufactured by these ME491 students. Marvel at their dedication to serving the poor, the marginalized, and also the under-represented at the base of the socio-economic pyramid. And ENJOY your conversations with these global citizens with a passion for life: these transnational leaders of the 21st Century!

*Never doubt that a small group of thoughtful committed citizens can change the world. Indeed it is the only thing that ever has.*
Margaret Meade (1901 – 1978)
American Cultural Anthropologist

**ME 491** 1200 Hallway | First Floor **9:00 a.m. - Noon**

# Appropriate Technology Collaborative:
## Aiding Guatemalans with Ultraviolet Absorption

In 2011, over 15% of the world's population didn't have access to potable drinking water. A consequence of this situation is the host of water-borne diseases that afflict men, women, and especially vulnerable children who suffer irreversibly from stunting and under-nutrition, and ultimately never achieve their potential, nor contribute effectively to society. Guatemala is one of planet Earth's worst countries manifesting this situation because 50% of the children under the age of five suffer from this medical condition. Currently Guatemalans employ simple filtration devices to remove sand and other impurities from their water supply, but these basic filters are ineffective against common medical ailments like Typhoid, Leptospira, and Schistosoma.

One enhanced approach to achieving potable water, is to kill the bacteria by subjecting it to ultra violet light in the 254nm spectrum. Ultra violet light destroys the DNA of bacteria and viruses and it has been proven to be effective in sanitizing water. Commercial products used by explorers and hikers typically cost a few hundred dollars, but the device developed by the MSU team will not exceed twenty dollars, because most Guatemalans do not have an income greater than two U.S. dollars a day.

By creating a portable device that can purify water, hundreds if not thousands of lives will be saved each year in this Latin American nation. Indeed many of these lives will be young children, the future of the country.

The Appropriate Technology Design Collaborative

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

**Scott Oldham**
Commack, New York

**Grant Golasa**
Shelby Township, Michigan

**Will Asherman**
Lansing, Michigan

**Shenli Pei**
Shanghai, China

**Appropriate Technology Collaborative**
***Project Sponsors***

**John Barrie**
Ann Arbor, Michigan

**Lori Hart**
Ann Arbor, Michigan

# Semilla Nueva:
## Portable Pigeonpea Thresher

Semilla Nueva is a non-governmental organization (NGO) in Quetzaltenango, Guatemala, that's dedicated to helping rural farmers discover a path to prosperity, health, and sustainability through sustainable agricultural technologies and farmer-to-farmer education. One of their numerous projects is the launching of an embryonic pigeonpea industry. This legume is being introduced to the local culture in order to serve as a permaculture crop that will provide an enhanced income stream for the smallholder farmers and it's also an excellent source of nutritious food.

Current harvesting practices are both brutally labor intensive and time-consuming because the pigeonpeas are threshed by beating the crop by hand in order to break open the pods and thereby release the peas for collection. The objectives of this humanitarian project are threefold: to provide impoverished farmers in Guatemala with an innovative, low-cost, human-powered portable thresher that will increase the current pigeonpea production; to develop a device that is not only affordable to smallholder farmers but that is also easily manufactured; and to visit Quetzaltenango in order to undertake field trials with local farmers.

Semilla Nueva

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

**Adam Lyman**
DeWitt, Michigan

**Adam Kluz,**
Wixom, Michigan

**Alex Morita**
Novi, Michigan

**Joe Aljajawi,**
Troy, Michigan

**Semilla Nueva**
***Project Sponsor***

**Curt Bowen**
Quetzaltenango, Guatemala

# Technoserve: Cost-effective Human-powered Fertilizer Applicator to Increase Crop Yields for Honduran Farmers

Did you know that the average Honduran farmer spends one-third of his or her annual income on fertilizer? Traditionally, this precious fertilizer has been distributed manually over arrays of plants by the handful, in an inefficient ad-hoc horticultural process. Some of the chemicals reach the desired target of each plant's root system, but a significant percentage is blown far-and-wide by the wind, or heavy rains wash away the powder on the steep slopes of the fields. In order to address this ineffective farming practice, and to improve the social-economic state of these smallholder farmers, an inexpensive, ergonomically-designed device has been developed to deliver the perfect micro-dosage of fertilizer to each plant's root system. This new applicator device will enable the farmers of Honduras to readily apply varying amounts of common fertilizers directly to the roots of coffee and bean plants throughout the nation. Consequently their lives will be enhanced because time and money will have been saved.

This new technology is an adaption of ideas that originated in Bangladesh under the auspices of the International Fertilizer Development Center (IFDC). There they created a "briquetter" that compacted powdered fertilizer into briquettes and they also created an applicator that delivered the briquettes to a depth of 7-10cm below the surface of rice fields. By utilizing this approach, crop yields increased by 15-20%, fertilizer consumption decreased by 40%, and efficiency increased by 25%. These impressive accomplishments were motivation to transition the ideas to radically different crops in the fields of Honduras. In order to reduce costs further, only one device was created with refined adaptions that permit varying amounts and types of fertilizer to be deployed during the application process. Working with the nonprofit organization, Technoserve in Honduras, similar increases in crop yields, efficiency, and an overall decrease in fertilizer consumption is anticipated for both legume and coffee production.

TECHNOSERVE
BUSINESS SOLUTIONS TO POVERTY

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

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**Technoserve**
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**Tomas Menbario**
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# The Capstone Projects

**Dr. Giles Brereton**
**Associate Professor of**
**Mechanical Engineering**

## Presentation Schedule – Room 1208

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:00 a.m. | Denso | Design of a Lean-Fuel Ignition System |
| 8:30 a.m. | GM | Design of Vehicle Hoods from Composite Materials |
| 9:00 a.m. | Eaton | Improved Electro-Mechanical Actuator Reliability |
| 9:30 a.m. | DTE | System to Analyze Electrostatic Precipitator Rapper Performance |
| 10:00 a.m. | Consumers Energy | New Design for Deploying Pipeline Inspection Gauges |
| 10:30 a.m. | Chrysler | Aerodynamic Drag Reduction of Automobiles |
| 11:00 a.m. | Bosch | Test System for a Diesel Particulate Sensor |
| 11:30 a.m. | Bosch | Removal Tool for the Circuit Board in a Throttle Body Sensor |
| 12:00 a.m. | Union Pacfic | Particle Filtering in Railcar Refurbishment |

To view these presentations live please visit the Design Day website: http://designday.egr.msu.edu and click the *Watch Live* tab in the left-side menu bar.

# ME 481 Mechanical Engineering Design Projects

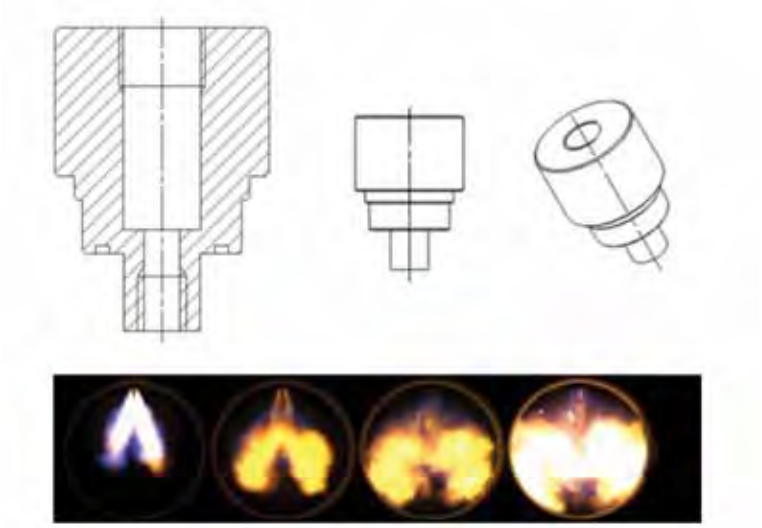
Mechanical engineers make the world move and provide the energy for it to do so. One goal of the MSU Mechanical Engineering Program is to educate engineers who are prepared to Lead, Create, and Innovate as their professional or graduate careers evolve. The Mechanical Engineering Design Program is the 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 may occasions and helps to distinguish the ME program as one of the best in the country.

*The faculty advisers for these projects are: Seungik Baek, Giles Brereton, Abraham Engeda, Brian Feeny, Patrick Kwon, Alfred Loos, Ranjan Mukherjee, Norbert Mueller, Farhang Pourboghrat, Craig Somerton, Rodney Tabaczynski, Elisa Toulson and Indrek Wichman.*

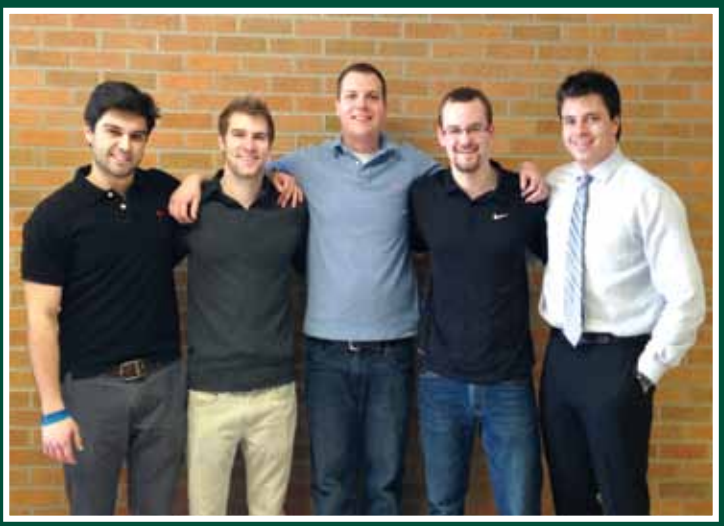
# Denso: Design of a Lean-Fuel Ignition System

Denso is a Tier I Japanese automotive supplier that specializes in a variety of products, from powertrain components to vehicle electronic systems. As automotive fuel efficiency grows in importance, the Denso North American Foundation has increased its research into lean-fuel ignition systems. A lean fuel mixture is one that has a higher air-fuel ratio than its standard stoichiometric ratio. Many industry specialists have begun investigating the use of jet-ignition systems, comprising a small pre-chamber and a nozzle to guide the propagation of the flame front throughout the primary combustion chamber. By developing a deeper understanding of the effects of the pre-chamber and nozzle geometries on the jet-ignition system, Denso hopes to be able to provide more fuel-efficient ignition options to its customers in the future.

The goal of the MSU Senior Design team is to improve the design of pre-chamber and nozzle geometries, by using a high-speed camera with UV-light filters to image OH radical formation during combustion. The team will do this by designing a new pre-chamber and nozzle and testing them in a rapid compression machine. The images of combustion processes will be analyzed comparatively to determine which geometric configurations result in better lean-fuel ignition and combustion.



DENSO



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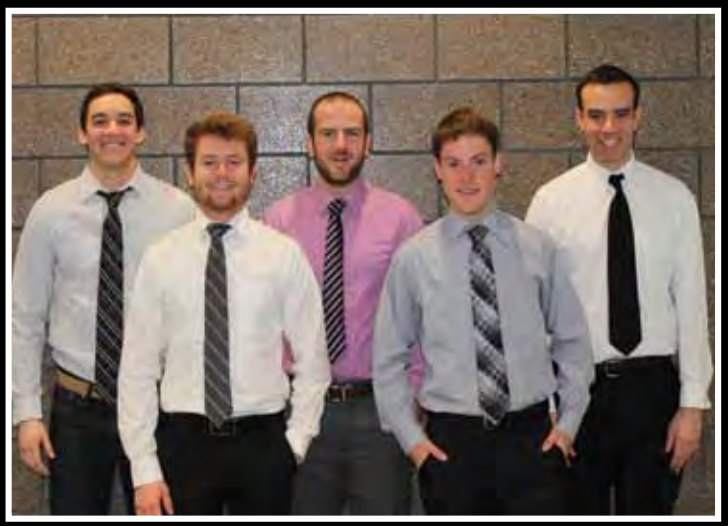
# General Motors: Design of Vehicle Hoods from Composite Materials

General Motors is a global automotive company that employs 212,000 people, produces vehicles in 35 countries, and has a vehicle portfolio of 11 different brands. GM is committed to providing exceptional vehicles for its customers around the world and, in order to do so, strives to develop innovative technologies in its quest to design, build, and sell the world's best vehicles. GM has recently intensified its emphasis on developing more fuel-efficient vehicles due to federal regulation and a growing customer demand for environmental sustainability. One approach for accomplishing this goal is to reduce vehicle mass. Therefore, GM is researching non-traditional manufacturing materials and methods, such as composites, to produce lighter vehicles. In this study, a new hood design was created using a carbon-fiber-reinforced polymer to replace the current steel hood used on the 7th Generation (2008-2012) Chevrolet Malibu. Using an Altair HyperMesh finite element analysis, the design will be optimized to decrease component weight, but retain the equivalent structural performance of a steel hood. The design utilizes a sandwich structure consisting of carbon fiber plies surrounding an internal core. This composite hood design will assist GM in the future with its goal of developing lightweight, fuel-efficient vehicles.

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# Eaton: Improved Electro-Mechanical Actuator Reliability

Eaton Corporation is a global leader and innovator in the aerospace industry, designing, manufacturing, and integrating some of the world's most advanced technologies. Eaton Aerospace in Grand Rapids, MI manufactures an actuator that works within an environmental system that controls the temperature inside the cabin of a Boeing 777. When the actuator fails in service, the airline must quickly replace the actuator so that the airplane stays on schedule and delivers its paying customers to their destination. Since the rate of warranty returns for this actuator is unacceptably high, Eaton is interested in improving the overall reliability of this device.

The goal of this project is to perform a root cause analysis to pinpoint the main cause(s) of failure and recommend potential solutions. After all possible causes have been identified the team will create a Pareto chart to identify the largest portion of failure causes. From this chart, the team will create qualification test procedures to verify or disqualify various proposed cause(s) of failure. Finally, the team will propose solutions for the cause(s) of failure.


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# DTE Energy: System to Analyze Electrostatic Precipitator Rapper Performance

DTE Energy is one of the nation's most diversified energy companies, with its headquarters located in Detroit, Michigan. DTE Energy provides electricity to 2.1 million customers in Southeast Michigan. One of its power plants is the Trenton Channel facility that burns coal, as a result of which significant amounts of ash and other particulates are produced. In order to reduce the emissions produced from the coal burning process, an electrostatic precipitator is used to collect the particulate matter. This matter is periodically removed from the precipitator by mechanical shaking or "rapping." Currently, DTE Energy has no baseline data to quantify the effectiveness of rapping the precipitator and no standard for a clean electrode tube in their Unit 9 precipitator at the Trenton Channel facility. An online monitoring system will allow DTE Energy to identify the difference between clean and dirty electrodes, which are currently not visible from outside the precipitator system. Such a system will help identify rappers in need of maintenance, which is important since effective rapping is essential to improved particulate collection efficiency.

The goal of the project is to design an online measuring system to quantify rapping effectiveness that utilizes MATLAB to rank particular rapper sections. This will be done by building a pilot scale model of the Unit 9 precipitator, from which the team will simulate the rapping process and collect vibration responses for dirty and clean electrodes. The data collected will then be used to write a MATLAB script which will inform DTE Energy of specific rappers in need of maintenance.

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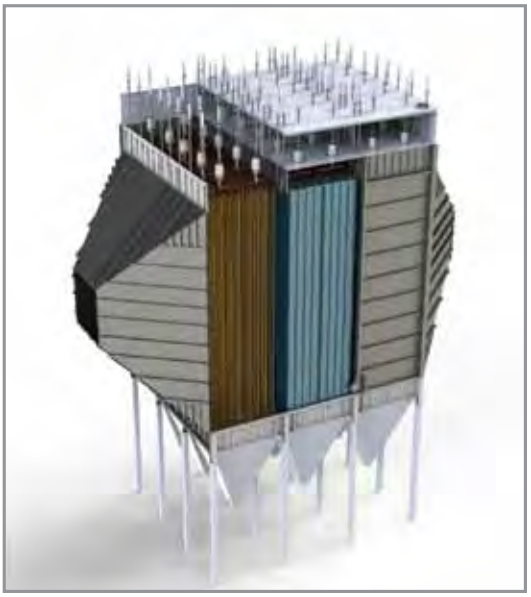

DTE Energy

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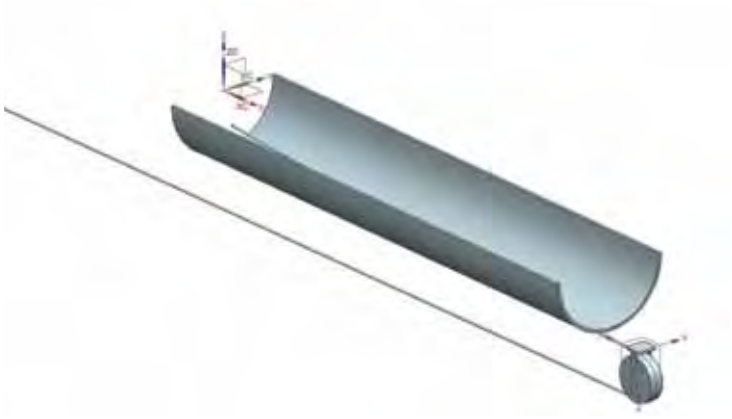
# Consumers Energy: New Design for Deploying Pipeline Inspection Gauges

Consumers Energy is a Michigan-based utility company that provides gas and electrical services throughout the state to domestic and industrial consumers. As a part of its pipeline maintenance program, Consumers Energy inserts Pipeline Inspection Gauges (PIGs) into and runs them along pipelines to carry out routine inspections of pipeline integrity. PIGs are currently placed in a launcher/receiver pipe, connected to the main pipeline, and "launched" by the "push method," using a backhoe loader. This operation can be time-consuming and unreliable, especially when there is limited space behind the launcher/receiver pipe. Several PIGs have been reported as broken during launching and their repair costs can be as much as $500,000.

The objective of this project is to redesign the launcher/receiver pipe to allow PIGs to be loaded by "pulling" the PIGs in for launch. The structure of the redesigned pipe must not be weakened as it is subjected to high pressurize during "launching." The new design must be reliable, simple, inexpensive, able to withstand ambient Michigan temperatures, and must not create sparks. The team is developing, as an optimal design, one which utilizes pulleys to pull the PIG into the launching position with a reduced amount of applied force, and potentially eliminates the need for a backhoe loader.



Consumers Energy
Count on Us

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**Consumers Energy**
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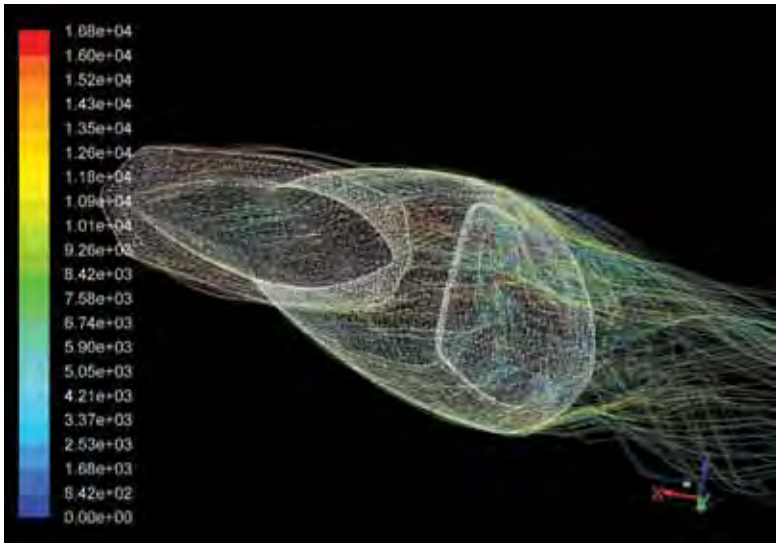
**April Pinkerton**
Jackson, Michigan

# Chrysler Group, LLC: Aerodynamic Drag Reduction of Automobiles

Chrysler Group, LLC is a global automobile manufacturer with headquarters in Auburn Hills, Michigan. Recently, Chrysler teamed with Fiat Group to design and manufacture some of the most technologically advanced vehicles on the road today. Consumer demands and government regulations require Chrysler to improve the fuel economy of its fleet, which can be achieved in various ways, including reducing the aerodynamic drag, the rolling resistance, and overall weight of the vehicle. Chrysler wishes to focus on reducing aerodynamic drag by altering surface texture. In this project, the texture of an exterior mirror will be optimized to induce a turbulent boundary layer which will delay the separation point of the flow. Delaying the point of flow separation will lead to a decrease in the overall drag force on both the mirror and the vehicle.

The goal of this project is to design a prototype surface texture that satisfies Chrysler's constraints. An optimal design will be selected by iteration on different mirror textures and shapes. Wind tunnel testing and computational fluid dynamics results will be used to confirm the validity of the proposed solution. Chrysler will be able to apply the results and techniques developed in this project to other components of the vehicle to further reduce aerodynamic drag.

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Auburn Hills, Michigan

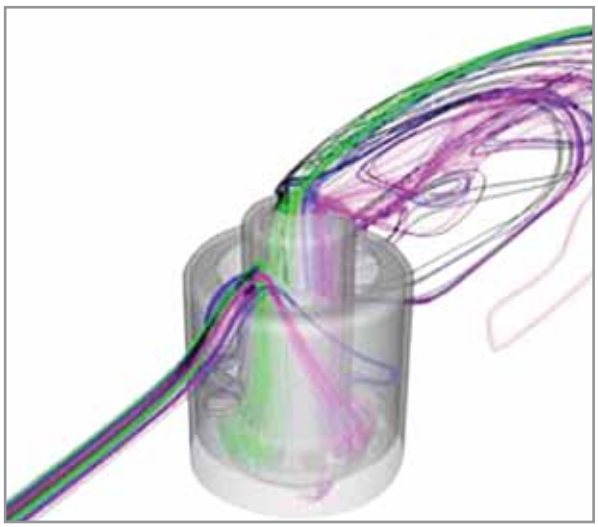
**John McGahey**
Auburn Hills, Michigan

**ME 481** Room 1208 | First Floor **11:00 a.m.**

# Robert Bosch, LLC:
## Test System for a Diesel Particulate Sensor

Robert Bosch, LLC is an engineering company with headquarters in Gerlingen, Germany that manufactures a wide range of products, from automotive components to dishwashers and hand-held power tools. Recent changes in federal regulations have lowered the exhaust gas emission standards for Diesel engines and, as a result, Bosch has developed several application-specific sensors to monitor the exhaust gas from Diesels. One such sensor detects the concentration of particulate matter (PM) in the exhaust stream, downstream of the Diesel particulate filter (DPF). Currently, the only way for the Bosch design team to test a PM sensor is to install it in a Diesel engine on a dynamometer, which is both time-consuming and expensive.

The MSU team will design, build, and test a bench-top Diesel particulate generator that can simulate Diesel particulate emissions without the need for running a Diesel engine. This generator must meet technical specifications defined by Bosch that include: particle size, particle concentration, and exhaust flow velocity.



BOSCH
Invented for life

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# Robert Bosch, LLC: Removal Tool for the Circuit Board in a Throttle Body Sensor

As one of the world's largest automotive components suppliers, Bosch provides a wide array of products to the automotive sector. This particular design project is concerned with Bosch's direct gasoline injection and gasoline port fuel injection engines, and specifically, the Electronic Throttle Body (ETB) component of these engines in the North American market. The ETB controls inflow of air into the engine and so is critical to engine combustion and emissions, and to vehicle fuel economy. Therefore it is important to be able to check its functionality. The inspection process involves the removal of the Printed Circuit Board (PCB), which is a part of the position sensor within the ETB and housed by a plastic cover. The current process requires clamping the plastic cover inside a cavity and using a set of prototype tools to pry the PCB from the plastic cover. This process can be both destructive and potentially damaging to the PCB.

Given the shortcomings of the current inspection process, Bosch has requested that the MSU team design a removal tool that can ensure the safe removal of the PCB from its housing. A prototype of the best design will then be manufactured and tested on various applications for the micro-strain it induces, and submitted to Bosch for approval.

BOSCH
Invented for life

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**Robert Bosch, LLC**
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**Blake Jarvis**
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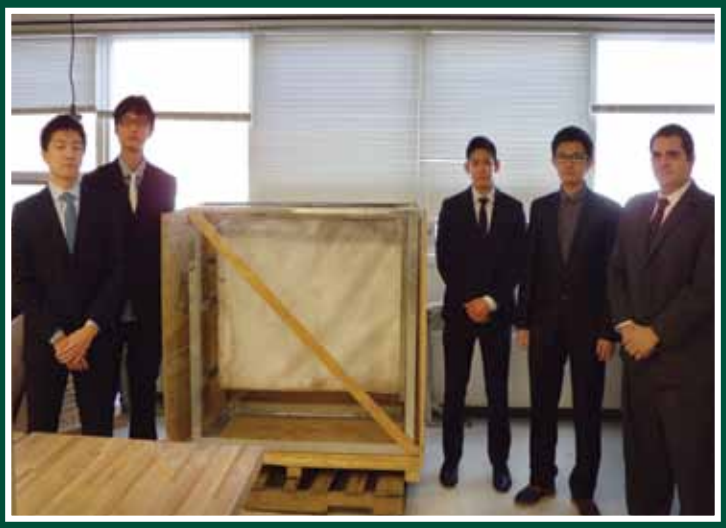
**ME 481** Room 1208 | First Floor **12:00 Noon**

# Union Pacific Corporation
## Particle Filtering in Railcar Refurbishment

Union Pacific Railroad owns the nation's largest railroad network and has provided freight services to customers since its establishment in 1862. In order to maintain the quality of these services, it regularly refurbishes railcars, using shot-blasting to remove old paint and debris. The refurbishment takes place in its De Soto, Missouri facility, where a bag-house system is used to filter particles and airborne pollutants from cleaning, shot-blasting, and other railcar repair processes. The current bag-house system is nearing obsolescence and requires excessive maintenance, costing many hours of labor and annual capital expenditures of over $140,000. Improvements to the current system will enhance productivity in the facility and enable the company to continue refurbishing rail cars to a high quality, while maintaining the highest standard of air purification.

The team has identified five design solutions that will be researched and analyzed to assist Union Pacific in deciding on the most efficient and cost-effective solution that satisfies safety and performance constraints.

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**Ge Zhu**
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**Union Pacific**
***Project Sponsor***

**Kyle Sheffler**
De Soto, Missouri


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# The Capstone Projects

**Dr. Giles Brereton**
**Associate Professor of**
**Mechanical Engineering**

## Presentation Schedule – Room 1220

| Time | Team Sponsor | Project Title |
|---|---|---|
| 8:00 a.m. | ArcelorMittal | Redesign of a Steering Roll Bellows |
| 8:30 a.m. | Ingersoll Rand | Vibration-Isolation Design for Plenum Fan |
| 9:00 a.m. | Whirlpool | A Low-Cost Steam-Cooking Appliance |
| 9:30 a.m. | U.S. Steel | Ladle-Weighing System for a Continuous Caster |
| 10:00 a.m. | U.S. Steel | Redesigned Automatic Scraper for Steel Galvanizing |
| 10:30 a.m. | Halliburton | Design Optimization Protocol for Oil and Gas Wells |
| 11:00 a.m. | Meritor | Optimized Design of a Transfer Case Housing |
| 11:30 a.m. | Lansing School District | Optimization of Wind Turbine Arrays |

To view these presentations live please visit the Design Day website: http://designday.egr.msu.edu and click the *Watch Live* tab in the left-side menu bar.

# 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:

- Using the technical expertise, communication skills, and teaming methodologies they have learned throughout their mechanical engineering curriculum, along with their creativity, to solve real world problems.
- Collaborating with practicing engineers to address problems sponsored by industry.
- Developing new products or re-designing existing products to reduce costs or enhance reliability.
- Interacting with large, medium and small companies in the automotive, defense, aerospace, consumer products, interior design and material processing industries.

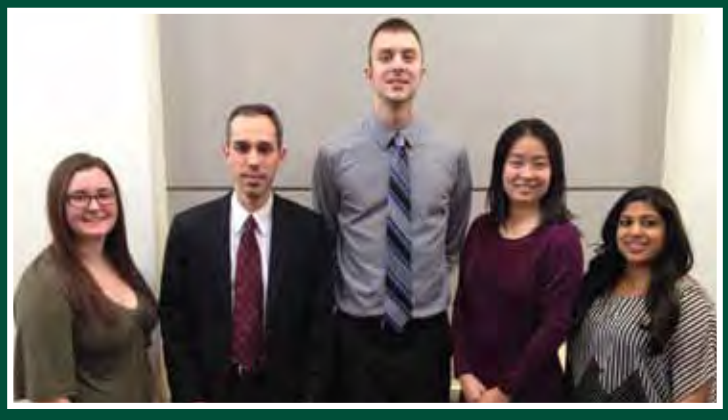
*Project sponsors include ArcelorMittal, Bosch, Consumers Energy, Chrysler, Denso, DTE, Eaton, GM, Halliburton, Ingersoll Rand, Meritor, Union Pacific, U.S. Steel and Whirlpool Corporation*

**ME 481** Room 1220 | First Floor **8:00 a.m.**

# ArcelorMittal:
## Redesign of a Steering Roll Bellows

ArcelorMittal is one of the world's leading steel and mining companies. Much of the steel produced in the Burns Harbor, IN facility is in the form of sheet metal which is annealed and galvanized on a Hot Dipped Galvanizing Line (HDGL). In this process, the sheet metal is guided and steered along the line on a series of pairs of rollers, several of which are critical to the alignment of the sheet metal inside the annealing furnace. These rollers steer using a hydraulic driveshaft that passes through the furnace wall via a flexible bellows that permits free movement of the roller and shielding from the furnace environment. These bellows are exposed to high temperatures and a wide range of motion, which often results in failure.

The MSU team will evaluate and improve the current bellows design in order to maximize longevity and minimize maintenance down-time. The best design will be chosen and adapted to ArcelorMittal's current driveshaft apparatus. A prototype will be designed and modeled, then presented to ArcelorMittal for further testing.



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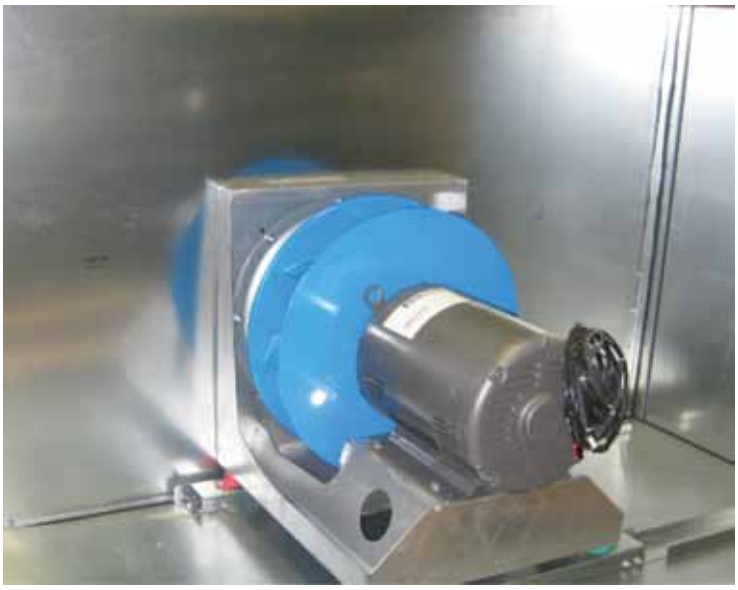
**ArcelorMittal**
***Project Sponsor***

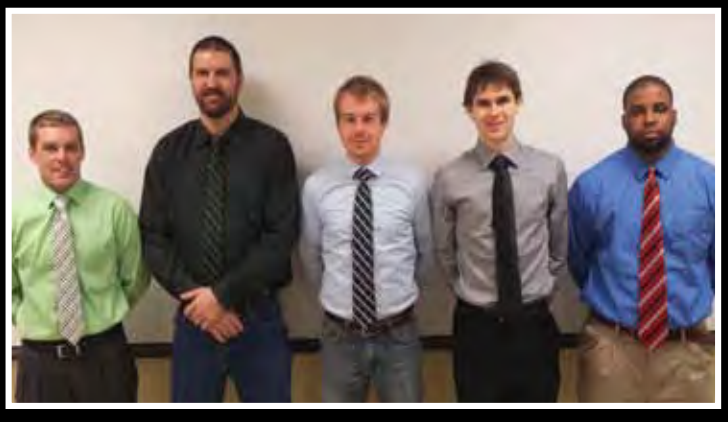
**Jonathan Layman**
Burns Harbor, Indiana

# Ingersoll Rand: Vibration-Isolation Design for a Plenum Fan

A subsidiary of Ingersoll Rand, Trane is a global provider of heating, ventilating, and air conditioning systems, building management systems and controls. As the "most recognized, most preferred and most highly rated brand of residential heating, cooling and ventilation," Trane prides itself on its ability to provide reliability while delivering maximum energy efficiency. One aspect of maintaining reliable products involves designing systems that require little maintenance over long lifetimes and, in many of Trane's products, involves designing products for vibration isolation, to reduce the transfer of damaging forces to the product's frame. Although Trane currently has vibration isolation and damping systems in place, the costs incurred to implement such devices are higher than the company desires.

The MSU design team's objective is to propose an alternative design for isolating the vibrations of a direct-drive plenum fan and motor assembly. Trane's desired solution will provide a similar reduction and isolation of vibrations as the current design, but at a lower total cost.





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**David Spear**
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**Ingersoll Rand**
***Project Sponsor***

**Mike Lewis**
Lexington, Kentucky

**ME 481** Room 1220 | First Floor **9:00 a.m.**

# Whirlpool Corporation:
## A Low-Cost Steam-Cooking Appliance

The Whirlpool Corporation, headquartered in Benton Harbor, Michigan is one of the world's leading manufacturers of household appliances. Whirlpool has kept at the forefront of a competitive industry by creating new appliance concepts and maintaining high quality products. It has recently added a steam cooking capability within the ovens of its home cooking appliances. The ability to cook with steam, in addition to traditional convective heating, is advantageous in many kinds of food preparation and is desirable to many homeowners. Currently, the price of ovens with this feature is too high for the average consumer. Therefore Whirlpool is interested in a design solution that incorporates steam cooking into its line of freestanding ranges, at an affordable price.

The objective of this project is to determine the optimal method of generating steam and the best location for the water reservoir in a freestanding range. The location of the water reservoir must not interfere with the current range design and must allow the consumer to empty and fill the reservoir when needed. In the course of this project, the team will also develop a method to quantify the improvement in taste of foods cooked with steam.

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**Amanda Ruhno**
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**Jason Schneemann,**
Benton Harbor, Michigan

# U.S. Steel Corporation: Ladle-Weighing System for a Continuous Caster

The United States Steel Corporation is an integrated steel producer with production plants throughout the world. Great Lakes Works (the U.S. Steel facility in Ecorse, Michigan) is a steelmaking and finishing facility with the capabilities to produce hot-rolled, cold-rolled, and coated-sheet steels. Great Lakes Works utilizes a continuous casting process in which molten steel is held in ladles that are continuously emptied into a mold, where it solidifies into slabs. These slabs of solidified steel are then rolled and finished in a finishing mill. There are two ladles, weighing approximately 250 tons when full, that sit on rotating arms to replace an empty ladle with a full ladle. U.S. Steel is interested in a process to measure the ladle weight as the molten steel is emptying. The ladle weight gives an indication of the small amount of residual steel that has either overcooled or contains undesirable impurities. This information can then be used to maximize the yield by exchanging ladles at the optimal time to consistently produce high-quality steel.

A range of sensors and sensor systems will be analyzed to design a durable solution that can withstand the extreme temperatures and hazards of the steel-making environment. Potential sensor solutions will be tested on the caster at the facility to determine the optimal choice for accurate and easily accessible data.

U. S. Steel

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# U.S. Steel Corporation: Redesigned Automatic Scraper for Steel Galvanizing

United States Steel Corporation is one of the leading manufacturers of galvanized sheet steel in the United States and has a long-standing commitment to safety that has become one of its core values. Ensuring a safe workplace also improves productivity, quality, reliability and financial performance. In order to meet everyday high quality demands, U.S. Steel utilizes a high-performance continuous galvanizing line. Steel galvanizing takes place in a pot rig comprising three rolls that guide a strip of steel into a bath containing a metallic mixture of zinc, iron, and aluminum. The iron in the steel strip reacts with the metallic mixture to form a compound known as dross. When dross collects on the rolls and makes contact with the steel strip, the quality of the galvanized finish may be compromised. Currently, dross is removed manually, which can be dangerous. It is also necessary to replace rolls that build up excessive amounts of dross, which is costly. U.S. Steel is interested in exploring and implementing design concepts for a new scraper system with a longer operating life that replaces manual scraping of the stabilizer roll (which keeps the sheet from bowing or bending) by an automated process.

The MSU team will evaluate several new scraper designs that satisfy U.S. Steel's requirements, objectives and constraints. An optimal design solution will be developed using 3D modeling. The best design will be chosen based on precision, functionality, and reliability and a prototype will be built and evaluated as a possible future full-scale model.

U. S. Steel

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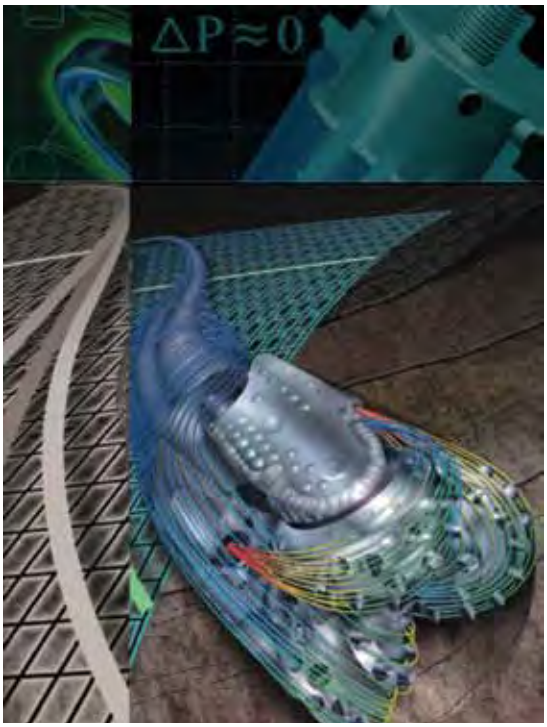
# Halliburton: Design Optimization Protocol for Oil and Gas Wells

Halliburton is one of the world's largest providers of products, services, and solutions for oil and gas exploration, development, and production. The company frequently designs wells and their installations, in situations in which technical factors must be complemented with considerations of safety, environmental effects, and sustainability. When designing wells, it is important for the company to avoid safety incidents, have minimum down-hole tool failures, drill 100% in-zone, and keep a reasonable rate of penetration. Halliburton is therefore interested in creating oil and gas well designs, bottom-hole assemblies, and hydraulics for a particular area within specified constraints.

The MSU team will create an optimized well-design protocol for drilling to completion, accompanied by well planning, drilling execution, post-well analysis, and future optimization plans. The team's goal is to meet these expectations and, in addition, include durability and functional performances of design for each project.




HALLIBURTON

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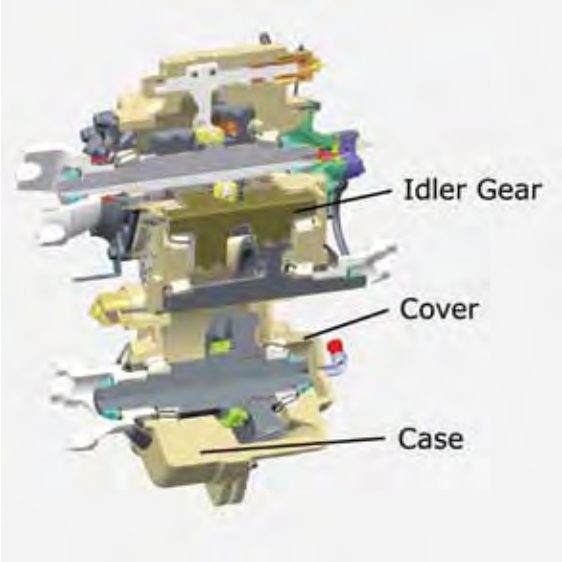
**Kyle Vrnak**
Houston, Texas

**ME 481** Room 1220 | First Floor **11:00 a.m.**

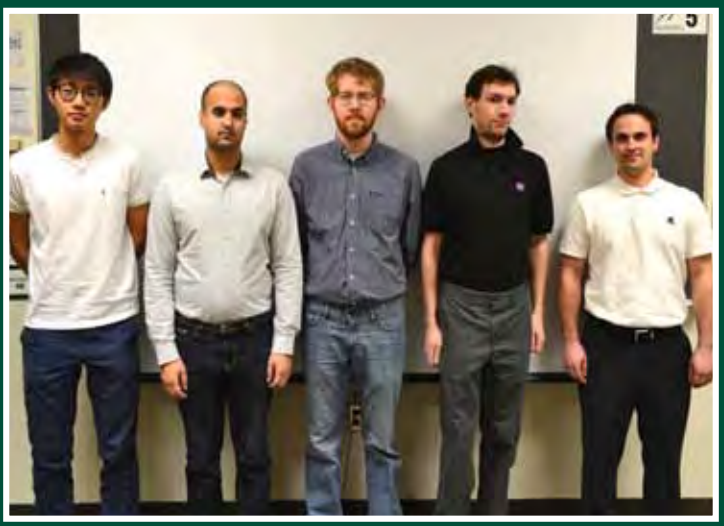
# Meritor: Optimized Design of a Transfer Case Housing

Meritor is a leading manufacturer of automotive components for heavyweight vehicles such as trucks, buses, and trailers. Their headquarters is located in Troy, Michigan, they have facilities worldwide and their products include axles, brake systems, drivelines, and suspensions. Meritor manufactures transfer cases--gearboxes that allow a driver to select between two-wheel and all-wheel drive--for the 30,000-40,000 lb gross-vehicle-weight all-wheel drive market. Many transfer cases also allow the driver to select between a high torque/low rpm and a low torque/high rpm configuration. Many of Meritor's transfer cases that are in use today have been on the market for 10-15 years and are exceptionably reliable. However, as computational optimization software has become available in recent years, there are opportunities to improve existing designs without sacrificing durability.

The MSU team's objective is to optimize the design of a transfer case housing and idler gear shaft using optimization software. The goal is to achieve as large a component mass reduction as possible without degrading performance or changing the locations of transfer-case interface points to the vehicle. This exercise should reduce the cost of manufacturing, improve cooling of the transfer case components, and improve fuel economy while maintaining support for vehicles using Meritor's current production models. Several designs for the transfer case and idler gear shaft will be developed using HEEDS optimization software and ANSYS Finite Element Analysis (FEA). The optimal design will then be chosen on the basis of least weight, best durability, and greatest ease of manufacturing.




MERITOR



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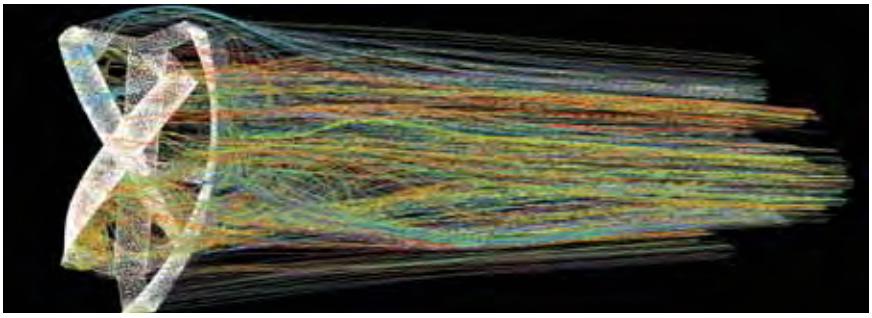
# Lansing School District
## Optimization of Wind Turbine Arrays

Consumers Energy, TechSmith, Union Pacific and Whirlpool regularly sponsor projects that advance and encourage education in science, technology, engineering, and mathematics and, in partnership with Lansing School District, are interested in alternative energy systems such a wind turbines. Horizontal-axis wind turbines are currently used as the main source of wind power for wind farms across the country. However, their large size has led to high unit cost, maintenance difficulties, and limited power output when placed close together. Therefore, there is much interest in alternative approaches to harvesting wind energy such as using vertical-axis wind turbines. These turbines can be significantly smaller and of lower overall complexity and cost, but also have the ability to produce large amounts of power when in close proximity to each other.

The team will develop models and designs of vertical-axis wind turbine arrays using patterns found in nature and patterns determined through computer-aided optimization. After evaluating the power output and turbine efficiency for each array, the best array will be optimized by varying the number and spacing of the wind turbines to maximize both power density and turbine efficiency.



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### Lansing School District and Educational Consortium
***Project Sponsors***

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Lansing, Michigan

**Consumers Energy**
Jackson, Michigan

**TechSmith**
Okemos, Michigan

**Union Pacific**
Omaha, Nebraska

**Whirlpool**
Benton Harbor, Michigan

# Design Day Awards

## ME 481 Thomas Alva Edison Undergraduate Design Award

Left to right: Professor Giles Brereton, Sarah Kurtz, Jared Lee, John Casuccio, Andrew Kaye. Not pictured: Mike Marshall

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

Last semester's winning Edison Scholars were John Casuccio, Andrew Kaye, Sarah Kurtz, Jared Lee, and Mike Marshall. They carried out a project sponsored by Whirlpool Corporation of Benton Harbor, MI in which they designed, manufactured a prototype of, and tested a food-processor extruder for vegetables and fruits. The project was supervised by Michael Conti and Steve Drees, and Dr. Seungik Baek at MSU.

## ME 481 Project Presentation Award

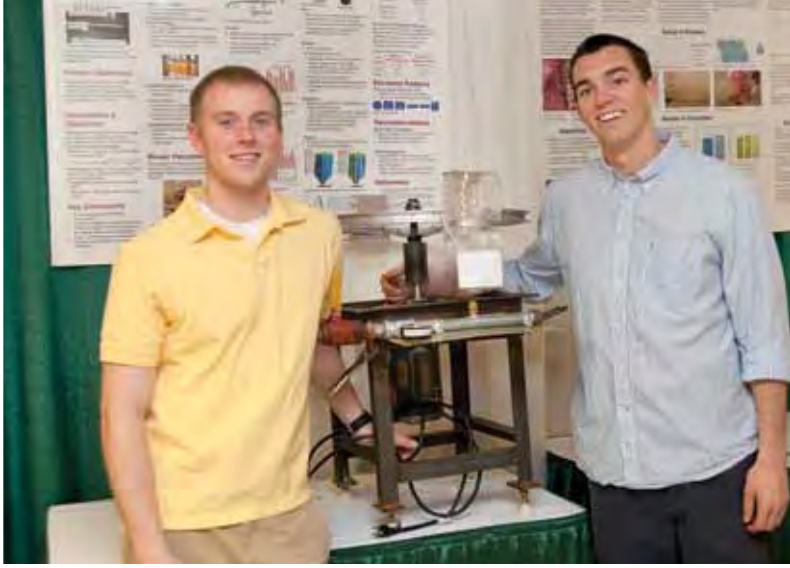
The ME 481 Project Presentation Award is given to the ME 481 Design Team that is judged to have given the best technical project presentation. Last semester's winning team comprised: Ben Bosworth, Amanda Boyd, Ben Dean, Dan Dokter and Jason Thelen. The team presented detailed computer-optimized designs of a transfer-case housing, in a project sponsored by Meritor. The project was supervised by Todd Ekonen at Meritor, and by Dr. Rodney Tabaczynski of MSU.

Left to right: Professor, Giles Brereton, Dan Dokter, Jason Thelen, Ben Bosworth, Ben Dean, Amanda Boyd

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

The Leonardo da Vinci Award is given to the winning team in the ME 471 machine design competition on Design Day. Last semester's winners, Louis Dionise, Justin Sagorski, Ryan Thompson and Peter Woodbridge, designed, built and demonstrated a hinge system for a refrigerator door, with the best strength and least weight.

Left to right: Louis Dionise, Peter Woodbridge, Justin Sagorski, Ryan Thompson, Professor Ronald Averill

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# Design Day

COLLEGE OF ENGINEERING

*Fall 2014*

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## Join us December 5, 2014, for another energetic celebration showcasing talented engineering students

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

*GO GREEN!!*


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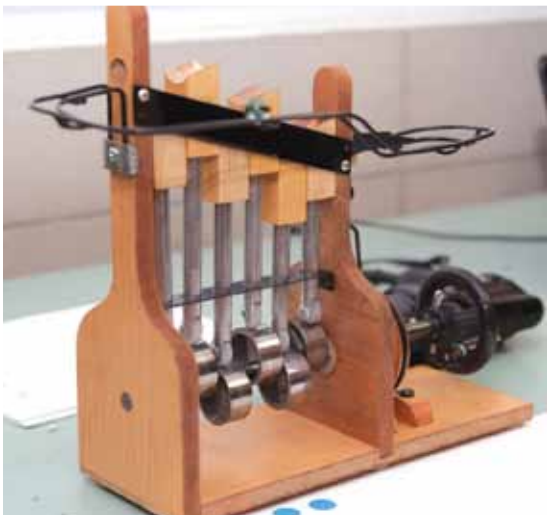


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