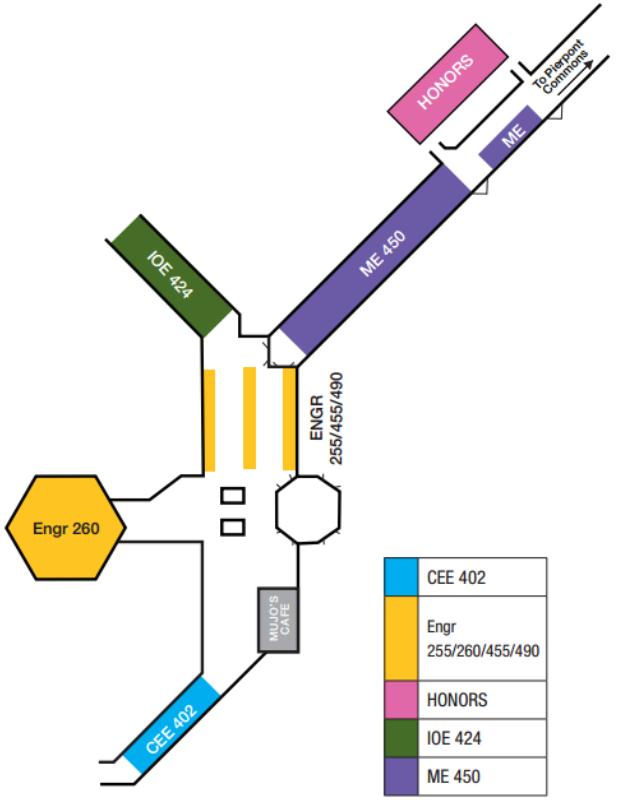
MECHANICAL ENGINEERING
UNIVERSITY OF MICHIGAN

# MECHANICAL ENGINEERING UNDERGRADUATE SYMPOSIUM

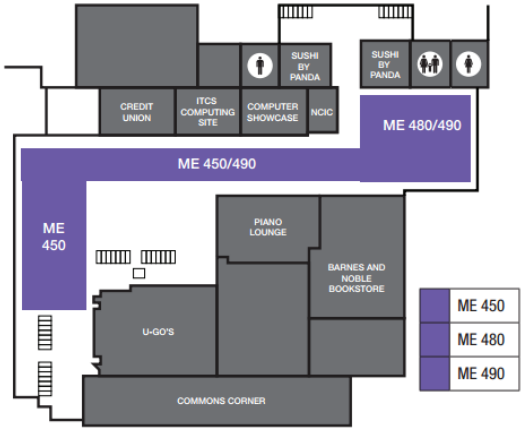

## APRIL 16, 2015

COLLEGE OF ENGINEERING
MECHANICAL ENGINEERING
UNIVERSITY OF MICHIGAN

## Duderstadt Center



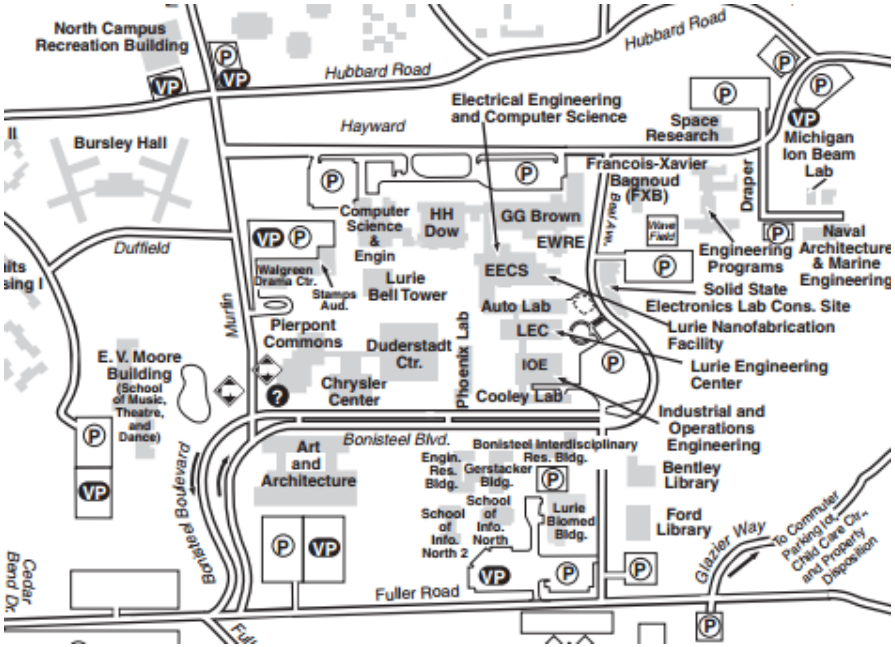

## Pierpont Commons



# Maps

### GG Brown BorgWarner Galleria


### U of M North Campus






# Table of Contents

# Welcome

On behalf of the Mechanical Engineering Department at the University of Michigan, we would like to welcome you to the inaugural Mechanical Engineering Undergraduate Symposium (MEUS).

MEUS provides a venue for our exceptional undergraduate students to showcase their projects from RISE (Research, Innovation, Service and Entrepreneurship) as well as their Design and Manufacturing X50 courses.

In RISE, our undergraduate students leverage our state-of-art facilities working side-by-side with internationally-renowned faculty to tackle cutting edge projects that impact our society. Projects range from health, energy, robotics & mechatronic systems, nano-materials and amazing enablers and Rubik's Cube!

Running concurrent to the MEUS poster and presentation sessions is Design Expo. Have an exciting day cheering for the ME 250 teams in their ping-pong ball squash competition, view the ME 350 four-bar linkage that automatically positions a mirror to reflect several laser beams onto a target, and engage with our seniors as they display their ME 450 capstone design projects.

The goal of the MEUS is to provide an intimate forum for a vibrant exchange of ideas and results within our UM ME Community. We are thrilled with the exceptional response. Our sincere appreciation goes to all the students and their RISE/X50 mentors for choosing to share their very best work at MEUS. The planning of MEUS has been a significant team effort of faculty, staff and students. Our thanks go to them for assembling such an outstanding event.

Kon-Well Wang, PhD
Tim Manganello/BorgWarner Department Chair and
Stephen P. Timoshenko Collegiate Professor of Mechanical Engineering



# ME Reception and Poster Session

BorgWarner Galleria
4:00 PM - 6:00 PM

Mechanical Engineering (ME) is pleased to conclude the day's activities with a reception to celebrate a successful semester for the ME Community and announce the RISE and X50 Award winners.

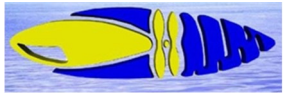
ME Community members are invited to join us in the BorgWarner Galleria from 4:00 PM – 6:00 PM.

# ME 450 Sponsors (continued)







Human Powered Submarine Team










# MEUS Planning Committee

## MEUS Technical Planning Committee

| | |
|---|---|
| Diann Brei | MEUS Chair |
| Claus Borgnakke | Session Chair |
| Amy Hortop | ME 450 Course Coordinator |
| Chinedum Okwudire | Session Chair |
| Kenn Oldham | Session Chair |
| Gabor Orosz | Session Chair |
| Jwo Pan | Session Chair |
| Alan Wineman | Session Chair |
| Mike Umbriac | ME 250 Course Coordinator / ME 350 Course Coordinator |

## MEUS / RISE Organizers

| | |
|---|---|
| CJ Anslow | Paige Jackson |
| Ken Arbogast-Wilson | Michele Mahler |
| Marc Brigolin | Katie Morningstar |
| Melissa Cooper | Sarah Sobek |
| Angela Fichera | Nikki Taylor-Vargo |
| Jacob Hayward | Michele Wong |
| Linh Huynh | |

# Schedule at a Glance


# ME 450 Sponsors

The Mechanical Engineering Department would like to thank our Winter 2015 ME 450 project sponsors:

Professor Brian Gilchrist
Professor Brent Gillespie
Grocoff Family
Professor Elijah Kannatey-Asibu
Professor Art Kuo
Dr. Greg Less
Professor Wei Lu
Professor Moses Musaazi
Professor Chinedum Okwudire
Professor David Remy
Professor Kathleen Sienko
Professor Steven J. Skerlos
Dr. Luis Savastano, MD
Prof. Huei Peng
Dr. James Sayer
Mr. Mike Umbriac
Dr. Ronald Chervin
Dr. Jeffrey Stanley
Dr. Erin McKean
Dr. Aaron Faber
Dr. Paul Cederna
Dr. William Meurer
Mr. Matthew Weber
Dr. John Arnedt
Dr. Christine Nelson
Dr. Gary Fisher
U-M Laboratory for Innovation in Global Health Technology
U-M Institute for Humanitarian Technology

**ME 450 Design and Manufacturing III**
Duderstadt / Pierpont Commons
12:00 PM - 4:00 PM

ME 450 is the capstone in our unique design and manufacturing sequence. Students are taught to approach open-ended design challenges through processes, to manage and work in collaborative teams, and to synthesize and apply diverse engineering knowledge to the design and manufacturing of real mechanical systems. Teams of 4-5 students work together on a semester-long design problem, typically from industry, or faculty research, and present a working prototype at Design Expo. Students are exposed to the design process from eliciting user needs and generating concepts through to prototype validation.

ME 450 projects can be viewed in the Duderstadt and Pierpont Commons as part of Design Expo from 12-4pm and an encore of the posters can be viewed in the Lee Iacocca Room (1504 GGB) from 4:45 PM -6:00 PM.

# April 16, 2015

**1a. Robotic & Mechatronic Systems**
Session Chair: Kenn Oldham
Room: 1642 GGBA
10:40 AM - 11:40 PM

**2b. Nano-material Investigations**
Session Chair: Alan Wineman
Room: 1642 GGBA
12:10 PM - 1:10 PM

**3b. Actuation and Control of Legged Systems**
Session Chair: Chinedum Okwudire
Room: 2636 GGBA
1:30 PM - 2:30 PM

**4b. Rubik's Cube**
Session Chair: Claus Borgnakke
Room: 2636 GGBA
2:45 PM - 4:00 PM

**on and Poster Session**
r Galleria
Design Expo or ME UG Symposium)

# RISE: Research, Innovation, Service, Entrepreneurship Projects

Through the RISE program, mechanical engineering undergraduate students leverage our state-of-the-art facilities working alongside internationally-renowned faculty to tackle cutting edge projects that impact our society. The Mechanical Engineering Undergraduate Symposium (MEUS) is the accumulation of the students' work.

During the day, seniors in ME 490 will present their RISE projects in 20 minute presentations. Everyone is welcome to attend these sessions and ask probing questions!

Sophomores and juniors conclude their projects with a poster session during the evening reception, where students will be available to discuss their projects in detail. The posters will also be on display during the day, if you are unable to attend the reception.

The public is invited to peruse the posters, attend presentations, and interact with the students throughout the day.



**ME 350 Design and Manufacturing II**
BorgWarner Galleria
1:00 PM - 3:00 PM

In ME 350, the emphasis is on the model-based design of mechanical and mechatronic systems. The students learn the design of mechanisms, the design of mechanical elements for strength, and mechatronics. Mechatronics is the synergistic integration of mechanics, electronics, control theory, and computer science within product design and manufacturing, in order to improve and/or optimize its functionality.

In the course project, students work in teams of four to design, build, and test a four-bar linkage to automatically position a mirror to reflect several laser beams onto a target. The students use a motor and transmission to move the linkage, an infrared sensor to stop the motion if an object is in the way, limit switches to calibrate the linkage position, and an encoder to keep track of the position. The students learn to program an Arduino microcontroller board (running a PID controller) to receive the signals from the sensors and make decisions based on these signals, and send the output to the motor driver to position the mirror for each firing of the lasers.

**ME 250 Design and Manufacturing I**
BorgWarner Galleria
1:00 PM - 3:00 PM

In ME 250, the students learn engineering drawing; CAD and solid modeling; use of mechanical elements such as bearings, gears, and springs; engineering analysis; and manufacturing processes.  They get hands-on experience using machine tools such as a milling machine, lathe, laser cutter, and  water jet cutting machine, as well as a 3D printer.

In the course project, the students put their knowledge to use. They work in teams of four to design and build a remote-controlled machine that must compete to gather ping-pong balls and squash balls in an arena. The students learn to choose a strategy, generate concepts for the design, perform analysis on their concept, and then design the individual components. They are given a kit of materials which they can use to manufacture the components using the student machine shop. They test and validate their designs before the competition at the Design Expo.



# RISE Sessions

**Poster Judging**
BorgWarner Galleria

10:45 AM **Bubble Dynamics in Viscoelastic Media**
STUDENT: Carlos Barajas
INSTRUCTOR: Eric Johnsen

11:00 AM **Ford-Fluid Mechanics**
STUDENT: Sriram Sivakumar
INSTRUCTOR: Eric Johnsen

11:15 AM **Design, Fabrication, and Characterization of Dielectric Elastomer Artificial Muscle Actuators**
STUDENT: Gabrielle Zacks
INSTRUCTOR: Diann Brei

11:30 AM **Max Power Point of an Indoor Solar Cell**
STUDENT: Ian Raber
INSTRUCTOR: Kevin Pipe

11:45 AM **Development of a Controlled, Modular, and Multistable Structure**
STUDENT: Xiaowen Zhang
INSTRUCTOR: Kon-Well Wang

12:00 PM **Ignition Experiments On Surrogate Jet Fuel Mixtures**
STUDENT: Archit Gupta
INSTRUCTOR: Andre Boehman

12:15 PM **Orosz Ground Robot Experiment**
STUDENT: Wenxuan Zhou
INSTRUCTOR: Gabor Orosz



# ME X50 Projects

The Michigan Engineering Design Expo is held concurrently with the Mechanical Engineering Undergraduate Symposium (MEUS).

The Design Expo showcases the achievements of our students in engineering design and prototyping, and demonstrates applications of their studies that solve real-world problems.

Students in mechanical engineering design and manufacturing courses (ME 250, 350, and 450), will present their projects for the Design Expo during the ME Undergraduate Symposium.

# RISE Awards

We are pleased to hold two competition for this year's Mechanical Engineering Undergraduate Symposium: Best Poster and Best Presentation.

## Best Poster Award

All RISE ME 290 and ME 390 students will be automatically entered to compete for the Best Poster Award. The best poster will be judged by faculty based upon quality of project work, poster, and presentation of work.

## Best Presentation Award

All RISE ME 490 students will be automatically entered to compete for the Best Presentation Award. Faculty judges will attend the presentations and will judge each presentation on quality of project work and presentation.

Winners of each award will be honored with a certificate and $500 award.



## Session 1a. Robotic & Mechatronic Systems

Session Chair: Kenn Oldham

Room: 1642 GGBA

10:40 AM **Design and Characterization of a Piano Key Measurement Motor**
STUDENT: Robert Self
INSTRUCTOR: Brent Gillespie

11:00 AM **Dynamic Study and Analysis of Active Headrest Systems**
STUDENT: Robert Shone
INSTRUCTOR: Volker Sick

11:20 AM **Development of 2nd Generation Foambot**
STUDENT: Joseph Jang
INSTRUCTOR: C. David Remy

## Session 2a. Health & Energy

Session Chair: Gabor Orosz

Room: 2636 GGBA

12:10 PM **Sustainable Electricity Generation in Isolated Brazil**
STUDENT: Simon Trask
INSTRUCTOR: Margaret Wooldridge

12:30 PM **Bottom-Up Synthetic Biology for Building Artificial Platelets**
STUDENT: Christopher Coyne
INSTRUCTOR: Allen Liu

12:50 PM **Treating Primary Postpartum Hemorrhage in Low Resource Settings**
STUDENT: Bianca Pillarella
INSTRUCTOR: Kathleen Sienko



## Session 4b. Rubik's Cube

Session Chair: Claus Borgnakke

Room: 2636 GGBA

2:45 PM **Rubik Overview**

2:50 PM **Mechanical Art: Giant Rubik's Cube**
STUDENT: Samuelina Wright
INSTRUCTOR: Noel Perkins

3:00 PM **Mechanical Art: Giant Rubik's Cube**
STUDENT: Daniel Hiemstra
INSTRUCTOR: Noel Perkins

3:10 PM **Mechanical Art: Giant Rubik's Cube**
STUDENT: Martin Harris
INSTRUCTOR: Noel Perkins

3:20 PM **Mechanical Art: Giant Rubik's Cube**
STUDENT: Kelsey Hockstad
INSTRUCTOR: Noel Perkins

## Session 4a. Amazing Enablers

Session Chair: Kenn Oldham

Room: 2215 GGB

2:20 PM **Verification of Mode Coupling Effects on the Ultra-Precision Manufacturing Machine Using ADAMs**
STUDENT: Wei Hon Yap
INSTRUCTOR: Chinedum Okwudire

2:40 PM **SMA Pawl and Ratchet Mechanism Design**
STUDENT: Mary Molepske
INSTRUCTOR: Diann Brei

3:00 PM **Study of Silicon Nanowires Synthesis through VLS Process**
STUDENT: Hyunwoo Park
INSTRUCTOR: Neil Dasgupta

3:20 PM **11L Volvo MD11 Engine Configuration**
STUDENT: Lucas Marshall
INSTRUCTOR: Andre Boehman

3:40 PM **Installation and Testing of Turbo-generator on DD13 Engine**
STUDENT: Harvey Nelson
INSTRUCTOR: Anna Stefanopoulou



## Session 2b. Nano-material Investigations

Session Chair: Alan Wineman

Room: 1642 GGBA

12:10 PM **Induce Nanostructures with External Fields**
STUDENT: David Pei
INSTRUCTOR: Wei Lu

12:30 PM **Bio-Templated Hierarchical Nanomaterials with Atomic-Scale Interfacial Control**
STUDENT: Rachel Goubert
INSTRUCTOR: Neil Dasgupta

12:50 PM **Assessment of Electrical Output of Predetermined Material for Use in a Triboelectric Nanogenerator**
STUDENT: Qingtian Yin
INSTRUCTOR: Katsuo Kurabayashi

## Session 3a. Efficient Use of Energy Sources

Session Chair: Jwo Pan

Room: 1642 GGBA

1:30 PM **Efficiency of an Organic Rankine Cycle**
STUDENT: Yihao Zhang
INSTRUCTOR: Claus Borgnakke

1:50 PM **Substitution of Natural Gas for Electrical Industrial Drying Overview**

1:55 PM **Substitution of Natural Gas for Electric Industrial Drying**
STUDENT: Aditya Chintalapati
INSTRUCTOR: Claus Borgnakke

2:05 PM **Substitution of Natural Gas for Electric Industrial Drying**
STUDENT: Nicholas Myers
INSTRUCTOR: Claus Borgnakke



## 3b. Actuation and Control of Legged Systems

Session Chair: Chinedum Okwudire

Room: 2636 GGBA

1:30 PM **Understanding and Testing Self-Sensing McKibben Artificial Muscles**
STUDENT: Khai Yi Chin
INSTRUCTOR: C. David Remy

1:50 PM **Pneumatically Powered Lower Limb Exoskeletons**
STUDENT: Reilley Jones
INSTRUCTOR: C. David Remy

2:10 PM **Passive Dynamic Walking Robot Improvement**
STUDENT: Brian McCann
INSTRUCTOR: C. David Remy