# Contents

# Welcome

As a continuation of the dialogue started in 2005 at the University of Notre Dame and on behalf of the Department of Engineering Education and College of Engineering at The Ohio State University (OSU), we welcome you to the First Year Engineering Experience. This 8th Annual First Year Engineering Experience Conference is being held at the Hilton Garden Inn Hotel and on the OSU campus. The program committee welcomes you to Columbus, Ohio, and hopes that you will find your time here enjoyable and valuable as you participate in the broad range of experiences that have been planned.

FYEE is a unique opportunity that allows attendees and presenters to discuss ideas, reflect on the topics and issues from the sessions, and chart new directions and collaborations. Invited facilitators from around the country will hold short workshops and discussion groups on important topics. Conference attendees are encouraged to share best practices through technical sessions.

The FYEE conference begins on Sunday afternoon with several invited workshops concluding that evening with a welcome reception at the Hilton Garden Inn Hotel. Monday morning begins with a breakfast buffet on campus and a keynote presentation by Bernie Savarese. These are followed by interactive workshops, lively presentations, and networking. Following lunch, we continue with workshops and best practices paper presentations. We will then travel to our beautiful student union for a dinner evening reception and enlightening words from Dr. Susan Freeman from Northeastern University.

Tuesday's events will take place once again on the OSU campus. It is a day of "best practice" presentations, where the attendees will present their work and show how they fit into the discussions from the previous day's activities.

With the continued focus on the connection between academic advising, K-12 preparation, and first year engineering experiences, we hope to see many old friends as well as lots of new faces at FYEE 2016.

We look forward to seeing you all,
FYEE 2016 General Chairs

Krista Kecskemety, Ph.D., The Ohio State University
Senior Lecturer, Department of Engineering Education

Lisa Abrams, Ph.D., The Ohio State University
Associate Chair, Department of Engineering Education

# Dean's Welcome

THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

Dear Colleagues:

Welcome to The Ohio State University! The College of Engineering is excited that our Department of Engineering Education will serve as host for the 8th Annual First Year Engineering Experience Conference. We're excited to have you here in Columbus.

Ohio State's College of Engineering is dedicated to providing students with an innovative and cutting-edge education. We are nationally recognized for our commitment to undergraduate education, and our teaching methods – including practical, hands-on experience through project-based design course, a focus on providing opportunities for undergraduate research experiences and individualized attention to students – have proven effective in facilitating students' academic and, ultimately, career success.

The Department of Engineering Education advances the engineering profession and enables student success by developing and delivering state-of-the-art, innovative, multidisciplinary engineering courses and programs, by modeling and advocating scholarly, evidence-based teaching within the College of Engineering and by integrating pedagogical discovery and practice through world-class engineering education research.

I invite you to learn more about Ohio State, the College of Engineering, and the Department of Engineering Education during your visit to our campus.

This year, we are especially pleased to have Bernie Savarese, Director of First Year Experience (FYE) at Ohio State, as this year's Monday morning keynote speaker. Bernie provides leadership for the university's First Year Experience programs and coordinates personnel. He leads the FYE team's planning, promotion, implementation and evaluation of the program to maximize the success of first-year students at the university. Please join us at 9:00am on Monday in the Blackwell Inn Ballroom to hear Bernie's address. We look forward to a productive and exciting conference!

Sincerely,

David B. Williams, Ph.D., Sc.D.
Monte Ahuja Endowed Dean's Chair
Executive Dean of the Professional Colleges
Dean of the College of Engineering

# Conference Daily Schedule

| | |
|---|---|
| **Sunday, July 31** | |
| 2:30 - 4:00 pm | **Invited Workshop – Hilton Garden Inn** |
| 2:00 – 7:00 pm | **Registration** in the Hilton Garden Inn Hotel Lobby |
| 5:00 – 7:00 pm | **Reception** in the Hilton Garden Inn Hotel |
| **Monday, August 1** | |
| 7:15 – 8:45 am | **Travel to Ohio State Campus**<br>Bus Pick-up: Hilton Garden Inn, Hampton Inn and Suites<br>Bus Drop-off: The Blackwell Inn |
| 7:30 – 10:00 am | **Registration** at the Blackwell Inn 2nd Floor. |
| 7:30 – 9:00 am | **Good Morning: Breakfast Buffet**<br>Blackwell Inn Ballroom |
| 9:00 – 10:00 am | **Welcome and Keynote by Bernie Savarese, The Ohio State University**<br>Blackwell Inn Ballroom |
| 10:00 – 10:30 am | **Travel to Scott Laboratory** |
| 10:30 – 5:30 pm | **Registration** in Scott Laboratory E100<br>**Networking and Meeting Space** in Scott Laboratory E100 |
| 10:30 am – Noon | **Invited Workshops**<br>Location: Scott Laboratory |
| Noon – 1:30 pm | **Box Lunches in Scott Laboratory E100 and Campus Tours** |
| 1:30 – 3:00 pm | **Invited Workshops**<br>Location: Scott Laboratory and Hitchcock Hall |
| 3:00 – 3:30 pm | **Networking Break**<br>Room: Scott Laboratory E100 |
| 3:30 – 5:00 pm | **Paper Presentation Session 1**<br>Location: Scott Laboratory |
| 5:00 – 5:30 pm | **Travel to the Ohio Union** |
| 5:30 – 7:30 pm | **Dinner Reception and Keynote by Dr. Susan Freeman, Northeastern University**<br>Location: The Ohio Union Performance Hall and Potter Plaza |
| 7:00 – 8:30 pm | **Return to Hotels**<br>Bus Pickup: The Ohio Union<br>Bus Drop-off: Hilton Garden Inn, Hampton Inn and Suites |

| Tuesday, August 2 | |
|---|---|
| 7:15 – 8:45 am | **Travel to Ohio State Campus**<br>Bus Pick-up: Hilton Garden Inn, Hampton Inn and Suites<br>Bus Drop-off: Hitchcock Hall |
| 7:30 – 3:00 pm | **Registration** in Scott Laboratory E100<br>**Networking and Meeting Space** in Scott Laboratory E100 |
| 7:30 – 8:30 am | **Good Morning: Breakfast Buffet**<br>Room: Scott Laboratory E100 |
| 8:30 – 10:00 am | **Paper Presentation Session 2**<br>Location: Scott Laboratory |
| 10:00 – 10:30 am | **Networking Break**<br>Room: Scott Laboratory E100 |
| 10:30 am – Noon | **Paper Presentation Session 3**<br>Location: Scott Laboratory |
| Noon – 1:30 pm | **Lunch in Scott Laboratory E100**<br>Location: Scott Laboratory |
| 1:30 – 3:00 pm | **Paper Presentation Session 4**<br>Location: Scott Laboratory |
| 3:30 – 4:00 pm | **Wrap-up Session**<br>Room: Knowlton Hall 250 |
| 3:30 – 5:15 pm | **Return to Hotels**<br>Bus Pick-up: Hitchcock Hall<br>Bus Drop-off: Hilton Garden Inn, Hampton Inn and Suites |

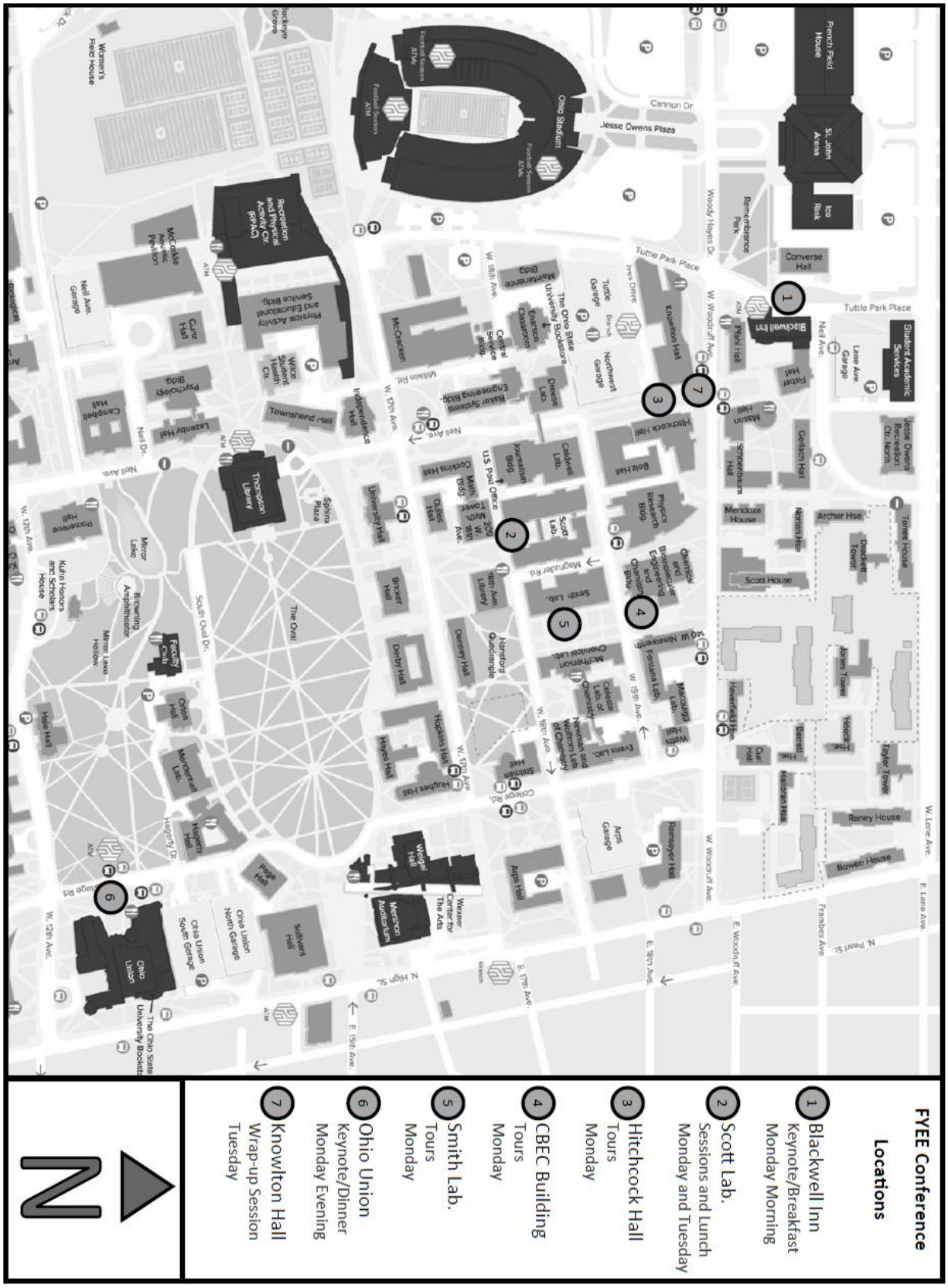
# Transportation from Hotels to OSU Campus

Participants will be transported by bus to and from the hotels to OSU campus (10 min. drive each way). Two buses, which each accommodate approximately 40 riders, will run for approximately 1-2 hrs. at the start and end of each day. Pick-up and Drop-off times and locations are provided below. Buses will run every 10-15 minutes in the window shown below. There are over 200 participants registered so please be aware that not everyone will be able to ride together.

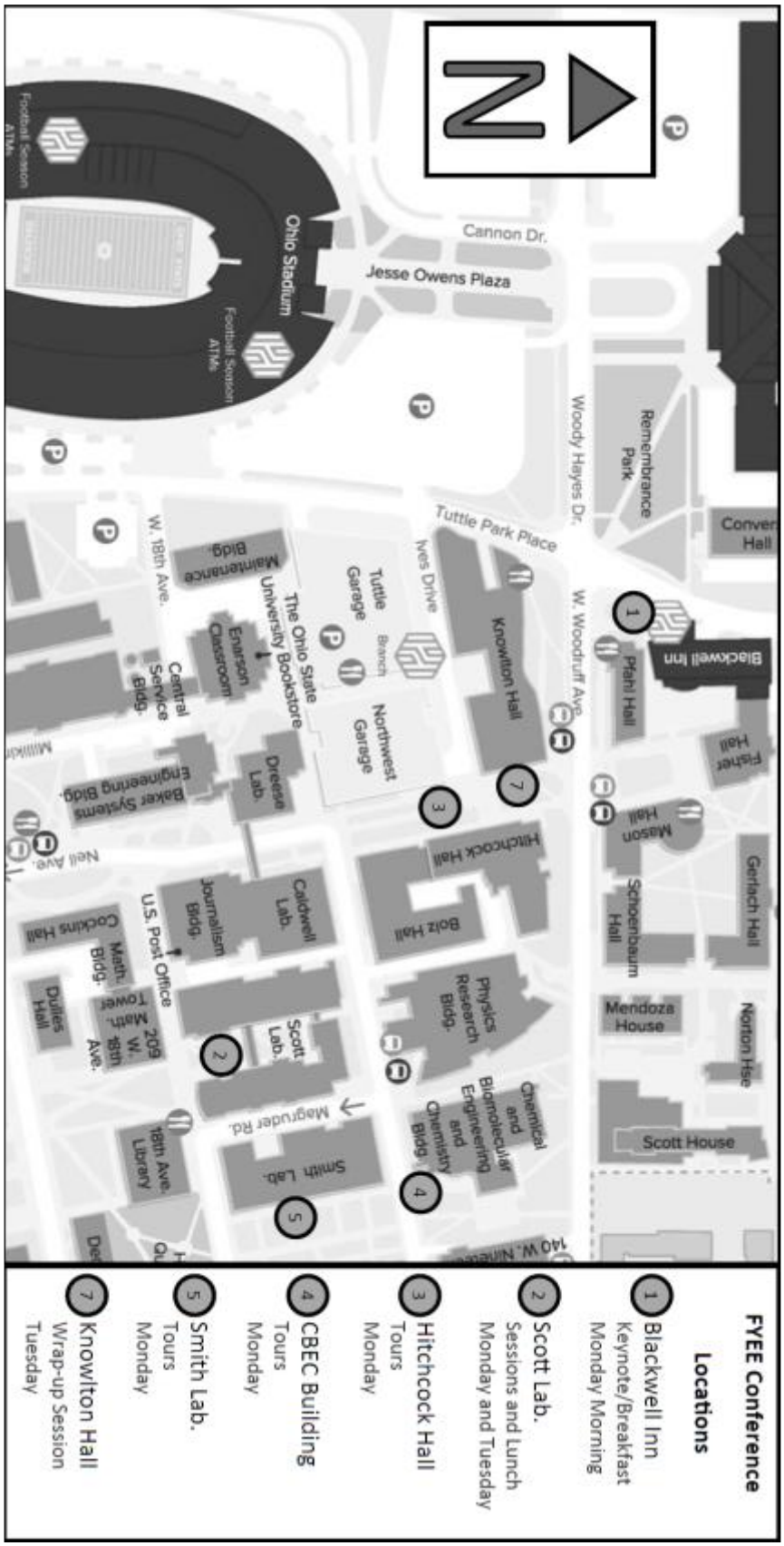
If additional transportation is required outside of the times listed below, each hotel has an area shuttle that can be used to arrange transportation. Please contact your hotel directly to arrange this. If you choose to drive to campus, please note that there are pay garages and pay-and-display surface lots available. See osu.campusparc.com for more information.

| Date/Time | First Bus Pickup | Last Bus Pickup | Pick-Up Location | Drop-Off Location |
|---|---|---|---|---|
| Monday, August 1<br>7:15 – 8:45 am | 7:15 am | 8:45 am | Hilton Garden Inn<br>Hampton Inn and Suites | The Blackwell Inn |
| Monday, August 1<br>7:00 – 8:30 pm | 7:00 pm | 8:30 pm | The Ohio Union | Hilton Garden Inn<br>Hampton Inn and Suites |
| Tuesday, August 2<br>7:15 – 8:45 am | 7:15 am | 8:45 am | Hilton Garden Inn<br>Hampton Inn and Suites | Hitchcock Hall |
| Tuesday, August 2<br>3:30 – 5:15 pm | 3:30 pm | 5:15 pm | Hitchcock Hall | Hilton Garden Inn<br>Hampton Inn and Suites |

# Conference Locations – Maps and Floor Plans



## Zoomed-in Conference Location Map



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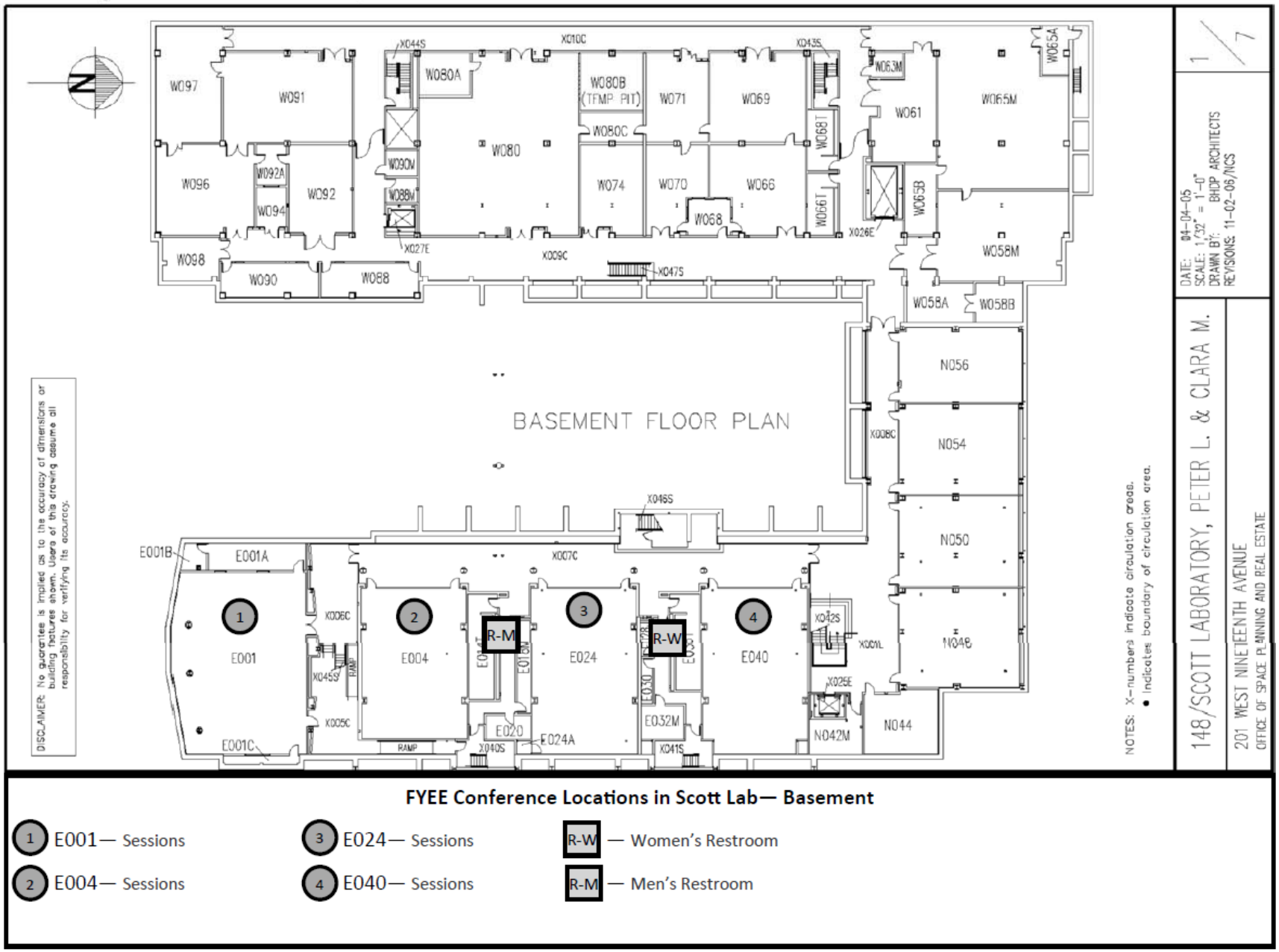

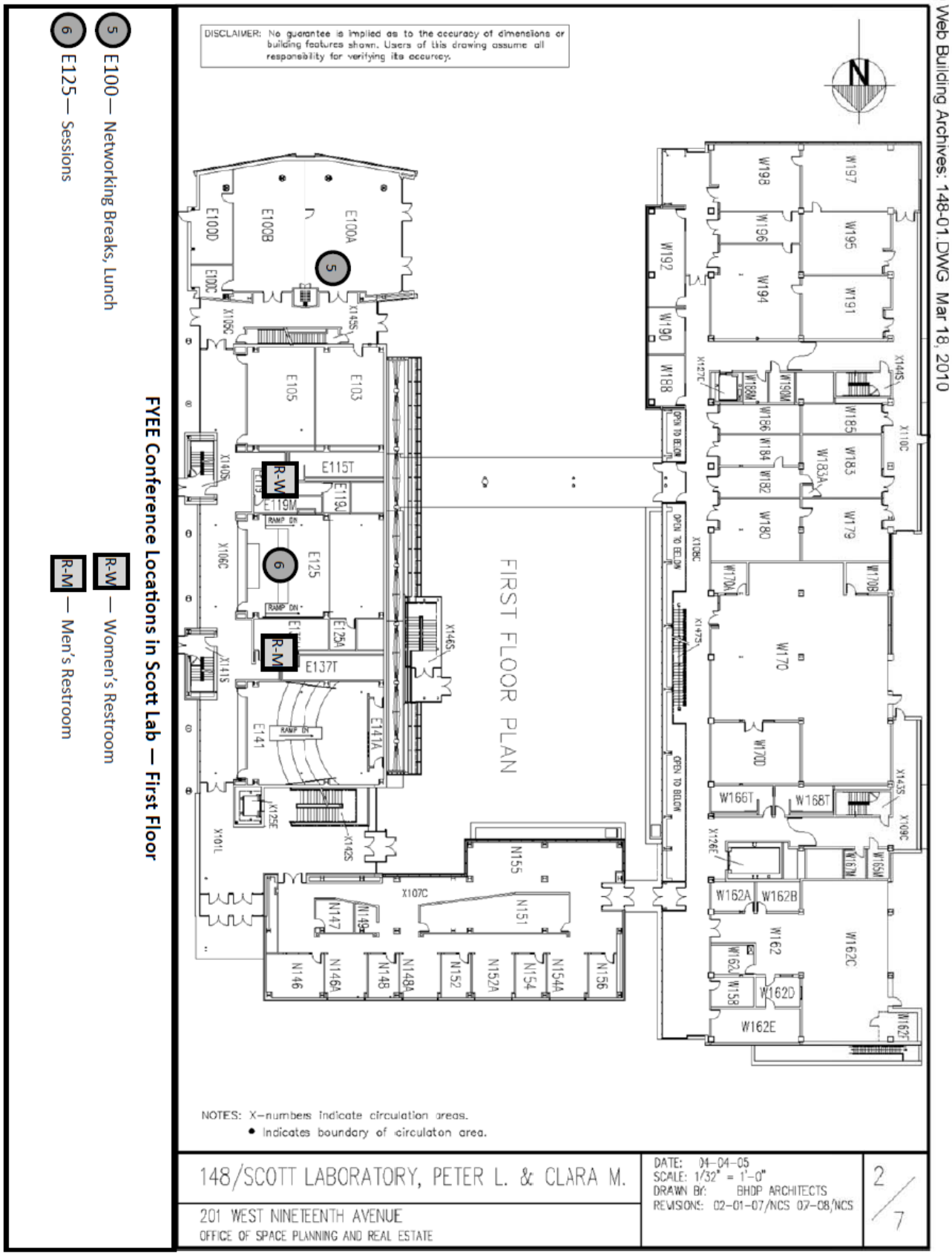
FOD Web Building Archives: 148-01.DWG Mar 18, 2010
DISCLAIMER: No guarantee is implied as to the accuracy of dimensions or building features shown. Users of this drawing assume all responsibility for verifying its accuracy.
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FIRST FLOOR PLAN
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E100D
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RAMP DN
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R-M
NOTES: X-numbers indicate circulation areas.
• Indicates boundary of circulaton area.
148/SCOTT LABORATORY, PETER L. & CLARA M.
201 WEST NINETEENTH AVENUE
OFFICE OF SPACE PLANNING AND REAL ESTATE
DATE: 04-04-05
SCALE: 1/32" = 1'-0"
DRAWN BY: BHDP ARCHITECTS
REVISIONS: 02-01-07/NCS 07-08/NCS
2/7
5 E100— Networking Breaks, Lunch
6 E125— Sessions
R-W — Women's Restroom
R-M — Men's Restroom
FYEE Conference Locations in Scott Lab — First Floor

# Conference Sponsors and Committee

Conference sponsors and affiliates play an important role in supporting the FYEE conference. This support subsidizes the cost of the meal functions and special events. We appreciate these supporters and the part they play in making the 2016 FYEE conference an outstanding event.

The 2016 First Year Engineering Experience Conference is supported financially by The Ohio State University Department of Engineering Education and the First-Year Programs Division of the American Society for Engineering Education. Additional conference support was received by AEP Credits Count program and Dassault Systemes SolidWorks Corp.

This annual conference is also supported by the University of Pittsburgh, Youngstown State University, California State University, Los Angeles, and Notre Dame University. The conference received start-up money in 2012 from the National Science Foundation to help develop the mission of the conference.

The 2016 General Chairs, Local Planning Committee, and Steering Committee noted below were instrumental in the planning and execution of this conference.

THE OHIO STATE UNIVERSITY
COLLEGE OF ENGINEERING

**FYEE 2016 Conference General Chairs**

Krista Kecskemety, Ph.D.
*The Ohio State University*

Lisa Abrams, Ph.D.
*The Ohio State University*

**Local Planning Committee**

Sally Lindeboom
*The Ohio State University*

Lynn Hall
*The Ohio State University*

Rachel Kajfez, Ph.D.
*The Ohio State University*

Kathleen Harper, Ph.D.
*The Ohio State University*

Patrick Herak, Ph.D.
*The Ohio State University*

Howard Greene, Ph.D.
*The Ohio State University*

**Steering Committee**

Dan Budny, Ph.D.
*University of Pittsburgh*

Kerry Meyers, Ph.D.
*Youngstown State University*

Ray Landis, Ph.D.
*California State University, Los Angeles*

John Uhran, Ph.D.
*University of Notre Dame*

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

# Monday Welcome and Keynote

**Bernie Savarese,** The Ohio State University, Director of University Orientation and First Year Experience

**Keynote Title:** Not Leaving Success Up to Chance: Moving from Best Practice to High Impact

**Abstract:** Much has been written about the first year experience movement over the past three decades. Research has identified best practices that demonstrate increased engagement and lead to a more successful college transition. But if achieving these outcomes were that simple, why are so many schools still searching for the next big idea to improve the student experience and deliver on key performance metrics like retention, persistence and graduation? Success can be even more elusive for those student populations who should benefit most from our efforts, namely first-generation, low-income and under-represented students. Over the last decade, campuses have turned to initiatives that have been deemed high impact practices, yet to ensure their success, universities must also focus on the nature and the quality of those efforts. Given shrinking state support and limited resources, it is necessary to ensure that our assets are being brought to bear on those students who need us most. It is no longer enough to roll out large, one-size-fits-all initiatives, simply hoping that the "right students" show up or choose to engage. We'll discuss what happens when campuses embrace data-informed approaches to student achievement, coupled with strategies and tactics that ensure we're not leaving success up to chance. And while our approaches should be data informed, this does not require that they be impersonal. To the contrary, a high-touch, personalized approach to the first year experience is what is needed to ensure that institutions are delivering on the promises made on the recruitment trail.

## Biography

Bernie Savarese is the Director of University Orientation and First Year Experience at The Ohio State University. He provides leadership for the unit's communication, implementation, and evaluation to maximize the success and retention of new students at the university. In this role, Bernie also oversees efforts for first-generation college student and the outreach and support of new students from at-risk populations. Bernie offers campus leadership on issues related to new student transition and success, including the university's Standing Committee on Student Success and Retention and the university's Undergraduate Co-Curricular Competencies initiative.

Before his time in First Year Experience, Bernie spent many years in Residence Life, first at Bowling Green State University and then at Ohio State, serving in the roles of Residence Hall Director, Assistant Director of Residence Life and Director of Residential Learning Communities. Following his time in Residence Life, Bernie transitioned to Ohio State's Ohio Union and Student Activities office where he served on the leadership team in the *Keith B. Key Center for Student Leadership and Service* where he oversaw campus and community-based partnerships focused on sustained student volunteerism and civic engagement.

Bernie received his Bachelor of Arts in Political Science, with Honors in the Liberal Arts, from Ohio State University, his Masters in College Student Personnel from Bowling Green State University, and his Masters of Business Administration, with an emphasis in marketing and organizational strategy, from Ohio State University's Max M. Fisher College of Business. He has been recognized with honors such as the President's Award for Distinguished Service and, most recently, was inducted into the 2016 Class of "Forty under 40" by Columbus Business First.

# Monday Evening Keynote

**Dr. Susan F. Freeman,** Northeastern University, College of Engineering, Director of First-year Engineering

**Keynote Title:** Leveraging our Resources to bring Continuous Improvement in First-year Engineering Programs

**Abstract:** When we approach our teaching, our planning, our course design and our curriculum design, we cannot help but incorporate who we are and what we are learning each day to the plans we make for our classes and programs. As we teach our students, what can we then apply to the classroom and our programs from what we know and do? Practically everything! Recent research on grit has transformed thinking about student success in K-12; how about engineering undergraduates? Industrial engineers work on continuous improvement, why not in our programs and courses? Systems thinking and critical thinking are vital skills for engineers, why not make it a practice to apply them to engineering course design? This talk will focus on taking a look at using the skills and traits you already possess to transform classes and programs in first-year engineering. By reflecting on some lessons learned and projecting to future visions and plans, this talk is hoping to encourage everyone to supplement content by using what you know and what you do to keep moving forward.

## Biography

Susan F. Freeman received her bachelor's, master's degrees and PhD in Industrial Engineering from Northeastern University. After graduating from Northeastern with her master's, she worked at Eastman Kodak in Rochester, New York as a senior industrial engineer in manufacturing and production planning.

Ms. Freeman returned to Northeastern in 1990 to complete her PhD. She has taught both undergraduate and graduate level courses at Northeastern and Worcester Polytechnic Institute. She continues to teach IE courses such as Introduction to Industrial Engineering, Engineering Economy and Stochastic Modeling, bringing the industrial and research experience to the classroom, also as an advisor for numerous IE Capstone projects. She is one of the original full-time first-year instructors in the College of Engineering teaching freshmen engineering courses, along with IE courses. This team of Teaching Professors is now at ten and Susan is the Director of First-year Engineering. She has won teaching awards in the College of Engineering and the University.

In addition to teaching, Susan is involved in coordinating freshman engineering courses and developing curriculum to meet the student and program's needs; both for IE's and first-year students. She is active in ASEE, publishing and presenting on educational research in the first-year program division, as program chair of the First-year Programs Division (FPD) and is currently the FPD Chairman.

# Session and Presentation Timing

Technical sessions are 90 minutes long. All of the paper sessions within the same time slot will maintain the same starting time for papers as shown in the table below. This is to enable "session hopping," where papers of interest are in different sessions but are not presented at the same time.

If there is a "no-show" author in a session, the moderator will conduct an open forum on the session's theme between the presenters and the audience during this empty time slot. **Papers MUST be presented at their scheduled time. No papers will be rescheduled.**

Each technical paper session will consist of four or five (4-5) 15-minute segments. Each paper will be allotted 15 minutes for the presentation and questions. The moderator will use part of each of the 15-minute segments for introductions and instructions. The final time in each session (at least 15 minutes) will be a group discussion. The design of the FYEE conference is to promote discussion and interaction. Thus, the sessions are not just people presenting material, but also a place for people to share their insights on an issue. The discussion should be based on the theme of each session. The presentations should present ideas that the group can then discuss. Come to the session prepared to provide your insight.

Paper times for sessions are shown in the table below. H designates the session starting hour: mm designates the session starting minutes. (For example, if the session starts at 3:30 p.m., then H=3 and mm=30.) The starting time of each paper is indicated by H:mm + X where X denotes the number of minutes to add to the session starting time. (For example, in a 90-minute session that begins at 10:30 a.m., the fourth paper, begins at H:mm + 45 so that H=10, mm=30 and X=45; the starting time is 11:15 a.m.)

| SESSIONS | 1 hour 30 mins | EXAMPLE 1 | EXAMPLE 2 | EXAMPLE 3 | EXAMPLE 4 |
|---|---|---|---|---|---|
| First Paper | H:mm | 8:30 | 10:30 | 1:30 | 3:30 |
| Second paper | (H:mm) + 15 min | 8:45 | 10:45 | 1:45 | 3:45 |
| Third paper | (H:mm) + 30 min | 9:00 | 11:00 | 2:00 | 4:00 |
| Fourth paper | (H:mm) + 45 min | 9:15 | 11:15 | 2:15 | 4:15 |
| Fifth paper or Discussion | (H:mm) + 60 min | 9:30 | 11:30 | 2:30 | 4:30 |
| Discussion | (H:mm) + 75 min | 9:45 | 11:45 | 2:45 | 4:45 |

**A few specific items for presenters:**

1. The time allotted for both full and work-in-progress papers at FYEE is 15 minutes for your talk, including questions. You should rehearse your presentation to ensure that it will fit within these time limits.
2. The final 15 minutes of each session with for a group discussion.
3. Each of the session rooms will have an LCD projector, screen, and computer. It is recommended that presenters use the computer in the session room. If you are bringing your own computer, please have the appropriate cables to connect. The session moderator will help presenters load all their presentations on the session room computer. Please have a back-up copy of your presentation, just in case.
4. Please be at your session room 15 minutes prior to the scheduled starting time. This will allow time to meet the session chair and other speakers, discuss session procedures, and preload all of the electronic presentations onto the computer in the session room.

# Sunday: Session Matrix

| Time | Location: Hilton Garden Inn |
|---|---|
| Sunday<br>2:00 – 7:00 pm | Registration in the Hilton Garden Inn Hotel Lobby |
| Sunday<br>2:30 – 4:00 pm | Invited Workshop<br>**S1** - Strategies for Improving Writing Outcomes in Engineering Technical Courses<br>Room: Hilton Garden Inn Hotel |
| Sunday<br>5:30 - 7:00 pm | Reception<br>Location: Hilton Garden Inn Hotel |

# Sunday: Invited Workshop

**Session S1: Strategies for Improving Writing Outcomes in Engineering Technical Courses**

***Lynn Hall, Jennifer Herman, and Leah Wahlin***

*Location: Hilton Garden Inn Hotel*

ABET counts effective communication as one of the eleven student outcomes of an accredited engineering program. This workshop, delivered by writing instructors within the Department of Engineering Education at The Ohio State University, begins with an understanding of writing as both a means for students to document their knowledge of technical concepts and an opportunity for practicing effective communication. The two-part workshop will offer strategies for and practice with improving student writing assignments within their engineering-based curriculum courses.

The first part of the workshop will share insights on developing assignment prompts that encourage students to practice an audience-based approach to communication. The second, "hands-on" part of the workshop asks participants to work in groups to workshop their own assignment descriptions in order to improve the learning outcomes and the quality of the work students produce.

Participants are encouraged to bring assignments or assignment ideas to work with during the second part of the workshop. Assignments can, but are not required to be writing or communication-based.

# Monday: Session Matrix

| Time | Location: Ohio State Campus | | | | | |
|---|---|---|---|---|---|---|
| Monday 7:30 - 10:00 am | Registration in the Blackwell Inn 2nd Floor | | | | | |
| Monday 7:30 - 9:00 am | Good Morning: Breakfast Buffet<br>Location: Blackwell Inn Ballroom | | | | | |
| Monday 9:00 - 10:00 am | **Welcome and Keynote**<br>Welcome by Dr. Krista Kecskemety, The Ohio State University, Conference General Chair and Dr. David Tomasko, The Ohio State University, Associate Dean, Undergraduate Education and Services<br><br>Keynote by Bernie Savarese, The Ohio State University, Director of University Orientation and First Year Experience<br>"Not Leaving Success Up to Chance: Moving from Best Practice to High Impact"<br>Location: Blackwell Inn Ballroom | | | | | |
| Monday 10:00 - 10:30 am | Travel to Scott Laboratory | | | | | |
| Monday 10:30 am - 5:30 pm | Registration in Scott Laboratory E100 | | | | | |
| Monday 10:30 am - 5:30 pm | Networking and Meeting Space in Scott Laboratory E100 | | | | | |
| Monday 10:30 am - Noon | **Invited Workshops** Location : Scott Laboratory | | | | | |
| | **Room: E001** | **Room: E004** | **Room: E024** | **Room: E040** | **Room: E125** | |
| | **M1** Workshop M1 - "Design Your Process of Becoming a World-Class Engineering Student"–A Powerful Project for Enhancing Student Success | **M2** Workshop M2- First Year Engineering Design Idea Generation with Design Heuristics | **M3** Workshop M3 - Rolling with the Tide: Retaining First Year Students through Quality Advising and Support Services | **M4** Workshop M4 - Concept Maps as Teaching, Learning, and Research Tools | **M15** Workshop M5 – K-12 Series - Pre-engineering Education: A Panel to Compare and Contrast Approaches in High School | |
| Monday Noon - 1:30 pm | **Lunch - Box Lunches in Scott Laboratory E100 and Campus Tours** | | | | | |
| Monday 1:30 - 3:00 pm | **Invited Workshops** Location : Scott Laboratory and Hitchcock Hall | | | | | |
| | **Room: E004** | **Room: E024** | **Room: E040** | **Room: Hitchcock 224** | **Room: E001** | **Room: E125** |
| | **M6** Workshop M6 - I'm an Academic Adviser - Now What? | **M7** Workshop M7- Incorporating Realistic Constraints into the First-Year Design Experience | **M8** Workshop M8 - Redshirting in Engineering - The Engineering GoldShirt Program: Creating Engineering Capacity and Expanding Diversity | **M9** Workshop M9 - Toy Adaptation Program Workshop: Enriching First-Year Engineers by Teaching the Electronic Toy Adaptation Process | **M10** Workshop M10 - Self-Regulated Learning: A Process Tool to Improve Student Success Skills Acquisition | **M11** Workshop M11 – K-12 Series - Strategies for Smooth Transitions from High School to First-Year Engineering |

<table>
<tr><td>Monday<br>3:00 - 3:30 pm</td><td colspan="5">Networking Break<br>Location: Scott Laboratory E100</td></tr>
<tr><td rowspan="3">Monday<br>3:30 - 5:00 pm</td><td colspan="5">Paper Sessions Location : Scott Laboratory</td></tr>
<tr><td>Room:<br>E001</td><td>Room:<br>E004</td><td>Room:<br>E024</td><td>Room:<br>E040</td><td>Room:<br>E125</td></tr>
<tr><td>M1A<br>Session M1A - Student Success and Development – 1 (Focus on academic support, at-risk students, comprehensive retention programs)</td><td>M1B<br>Session M1B - Current Technologies and Their Impact/Use for First Year Students</td><td>M1C<br>Session M1C - Engineering Education Research as it Applies to the First Year Experience – 1 (Focus on design process, problem solving, & hands-on activities (and their impact on retention))</td><td>M1D<br>Session M1D - Enrollment, Instruction, and Pedagogy – 1 (Focus on non-technical skills & interdisciplinary)</td><td>M1E<br>K-12 Invited Workshop - Activities to Introduce Engineering Design Processes</td></tr>
<tr><td>Monday<br>5:00 - 5:30 pm</td><td colspan="5">Travel to the Ohio Union</td></tr>
<tr><td>Monday<br>5:30 - 7:30 pm</td><td colspan="5">Dinner Reception and Keynote<br>Welcome by Dr. Monica Cox, The Ohio State University, Department of Engineering Education, Chair<br><br>Keynote by Dr. Susan Freeman, Northeastern University, Director of First-year Engineering<br>"Leveraging our Resources to bring Continuous Improvement in First-year Engineering Programs”<br><br>Location: The Ohio Union Performance Hall and Potter Plaza</td></tr>
</table>

# **M1 – M11:** Monday Invited Workshops

Monday Workshops 10:30 am to Noon

**Session M1: Design Your Process of Becoming a World-Class Engineering Student: A Powerful Project for Enhancing Student Success**

***Steffen Peuker and Raymond Landis***

*Location: Scott Laboratory, Room E001*

A new innovative approach has been developed to enhance engineering student success by strengthening students commitment to completing their degree in engineering and changing their attitudes and behaviors to those appropriate to success in math/science/engineering coursework. The approach involves implementation of a project titled "Design Your Process of Becoming a World-class Engineering Student" in which students look at where they are and where they would need to be in a number of important areas related to their learning process and academic success and develop a plan for moving from where they are to where they need to be. The approach, including the project, can be implemented in any first-year engineering course without major changes to the overall curriculum. Currently, over 30 institutions are implementing the project. Implementation and thorough assessment at two four-year institutions has shown an increase in cumulative first-year GPA of half a point and retention increase by 10%. Because this approach can be implemented virtually anywhere with minimal cost and change of curriculum, it is the low hanging fruit to improve engineering student success, retention rates, and time to graduation. Participants of the workshop will have the opportunity to learn about the approach through interactive exercises and will receive extensive support material. The main focus of the workshop will be on the implementation of the project at the participants' institutions.

**Session M2: First year Engineering Design Idea Generation with Design Heuristics**

***Keelin Leahy***

*Location: Scott Laboratory, Room E004*

The 77 cards: Design Heuristics for Inspiring Ideas is a tool that can be used to support students in generating more diverse and creative ideas in their product designs. This workshop will introduce participants to this research-grounded ideation tool and provide multiple lesson versions for integration into capstone first year engineering courses to support students in developing innovative ideas. Students often have difficulty generating multiple creative ideas for design problems. "Design Heuristics" is an empirically derived and validated approach to product design ideation; our research has shown that concepts created by engineering students who used Design Heuristics were more complex, creative designs. This workshop will include a review of relevant research on idea generation and an introduction to this research-grounded creativity tool. Participants will practice using the Design Heuristics to generate concepts for design tasks and discuss ways to implement it effectively in their classrooms.

**Session M3: Rolling with the Tide: Retaining First Year Students through Quality Advising and Support Services**

***Emili Alexander and Ashley Newsome***

*Location: Scott Laboratory, Room E024*

This workshop will focus on the efforts of the College of Engineering Advising Services' staff in increasing freshmen retention and enhancing the quality of services offered by the Freshmen Engineering Program at The University of Alabama. This session will review Appreciative Advising Techniques and creative advising strategies used by the Advising Services' staff with the purpose of teaching the curriculum and encouraging students to take ownership in their academic experiences. In addition, the workshop facilitators will inform participants of the goals of the Freshmen Engineering Program and how the Engineering Advising Services staff aspires to become more involved with the program through class and outside programming. Workshop participants will learn the importance of how quality interactions with students, faculty and staff are related to retention and how support services are integral to the undergraduate experience. In return, the workshop facilitators will encourage participants to share their advising practices and retention efforts so conference attendees can stay abreast to student retention and success initiatives.

**Session M4: Concept Maps as Teaching, Learning, and Research Tools**

***Mary Katherine Watson***

*Location: Scott Laboratory, Room E040*

Concept maps have been used in educational settings as a learning strategy, an instructional method, a curriculum planning guide, and an assessment tool. Their adoption as assessment tools, however, is limited by difficulty in administration and scoring of student constructs. A 90 minute workshop will be designed to facilitate use of concept mapping in engineering education.

**Session M5: K-12 Series – Pre-engineering Education: A Panel to Compare and Contrast Approaches in High School**

***Moderator: Matthew Kennedy***
***Panelists: Andy Harris, Jamie Doup, Jill Jacobs, Jackie Kane***

*Location: Scott Laboratory, Room E125*

Compare and contrast approaches to pre-engineering education at the high school level. Panelists will represent the full spectrum of approaches to pre-engineering education, including formal, nationally recognized pre-engineering curricula to local/district-developed curricula and after-school program-based models. There will be opportunity for participants to directly query the panel.

## Monday Workshops 1:30 pm to 3:00 pm

**Session M6: I'm an Academic Adviser – Now What?**

***Betsy Willis***

*Location: Scott Laboratory, Room E004*

The role of an academic adviser is to provide students with accurate information and guidance to assist students in their academic journey from first-year student to graduate. Each adviser brings a

unique skill set and background, and advising structures vary across institutions. Four key aspects of advising include degree requirements, academic policies and procedures, the students themselves and documentation. Each student brings unique strengths, goals and life experiences, so each student's college journey is different. Advisers with a network of colleagues across campus are best equipped to assist students with a variety of questions and issues that will arise. This workshop will discuss whom to include in a campus wide network, four aspects of advising and case studies on which to try out advising skills.

**Session M7: Incorporating Realistic Constraints into the First-Year Design Experience**

***John Estell and Ken Reid***

*Location: Scott Laboratory, Room E024*

The purpose of this workshop is to present the Constraint-Source Model framework to the first-year engineering community for review, discussion, and refinement. The Constraint-Source Model is conceptually based on four characteristics traditionally associated with the entrepreneurial engineering mindset: technical fundamentals, customer needs, business acumen, and societal values. Our hypotheses are that, by categorizing constraints such that the source of a constraint is also included, an engineering student can (1) examine each constraint from the point of view of a stakeholder from that source area, thereby allowing for a greater perspective on how such constraints can affect the design, and (2) gain an appreciation for the general education courses that provide that perspective. Resources developed to date in support of this framework will be provided. Attendees will have opportunities to apply the Constraint-Source Model towards different design scenarios, with facilitated discussion afterwards.

**Session M8: Redshirting in Engineering – The Engineering Gold Shirt Program: Creating Engineering Capacity and Expanding Diversity**

***Tanya Ennis, Beth Myers, Beverly Louie, Jana Milford, Sarah Miller, Amanda Parker, and Cara Lammey***

*Location: Scott Laboratory, Room E040*

The University of Colorado Boulder has pioneered an innovative, academic redshirt model to expand access to engineering. Like athletic redshirting provides a year of preparation for student athletes, academic redshirting provides a year for students to develop and prepare to succeed in challenging engineering programs. The Engineering GoldShirt Program, CU Boulder's academic redshirting program and first of its kind in the country, supports motivated and talented students who need additional math, science, or humanities preparation before diving into the full undergraduate engineering curriculum. For this five-year curriculum, students are directly admitted into the College of Engineering and Applied Science. The GoldShirt team provides mentoring, academic, and social support for all Engineering GoldShirt students. The goal of this workshop is to educate others about this program and equip them with information necessary to create a redshirt program at their institution, with a focus on the interview and selection process, the curricular components, and the unique design of the summer bridge program. Additional critical program features will be discussed. We encourage deans, faculty and staff from all engineering institutions interested in broadening participation of underrepresented groups to attend this workshop.

**Session M9: Toy Adaptation Program Workshop: Enriching First-Year Engineers by Teaching the Electronic Toy Adaptation Process***

***Rachel Kajfez, Peter Vuyk, Molly Mollica, Elizabeth Riter, and Meg West***

*Location: Hitchcock Hall, Room 224*
** Limited to 50 participants*

For many first-year engineering students, the efficacy and purpose of their degree is not always apparent when they take their initial engineering classes. The Toy Adaptation Program (TAP) teaches incoming students the procedure involved with reverse engineering an electronic toy so that it can be more easily activated by children with disabilities. By taking this approach to learning, the goal is to benefit the community by increasing the accessibility of these expensive toys while teaching first-year engineers soldering, basic circuitry, and problem-solving. In the end, we hope that students will be empowered to make a difference in the world with the skills and experiences they gain from their first year as engineering students.

**Session M10: Self-Regulated Learning: A Process Tool to Improve Student Success Skills Acquisition**

***Peter Schull***

*Location: Scott Laboratory, Room E001*
Today there is general agreement that student high school success skills do not readily translate to college success skills and, therefore, there is a need to train new college students. Typical college success training programs essentially provide a series of common success topics such as time management, test taking, communication, and motivation that if used would improve their learning. While these efforts have met with some success, I pose 3 questions regarding training methods, 1) Can they be more efficient? 2) Can they be more effective? and 3) Can they be design for life-long learning, i.e., success beyond college? The answer is emphatically yes! What is often missing in these success trainings is a robust implementation process that guides the student through the entire cycle of problem identification, solution development, implementation, and assessment. Self-Regulated Learning (SRL) offers such a process that not only is more efficient and effective in student success skill development but the method can be applied to any problem, i.e. it is not limited to this particular application.

The workshop is based on the results of an 8 year longitudinal study on effective methodologies to improve student success in college. The criterion of success for this study went beyond actual student success. First, the success training methods had to respect resource limitations of the students and of the faculty. This is particularly true for engineering programs that have restricted curriculums with little room to add additional programming no matter how valuable it might be.

The result of this effort combines Self-Regulated Learning and the engineering design process to create a robust metacognitive learning strategy. This strategy defines specific steps in a process for acquiring traditional success skills.

In this highly interactive workshop, participants with develop the basics of implementing this unique methodology and how it is implemented in coordination with student acquisition of traditional success skills.

**Session M11: K-12 Series - Strategies for Smooth Transitions from High School to First-Year Engineering**

***Patrick Herak***

*Location: Scott Laboratory, Room E125*

Participants will determine gaps between secondary instruction and post-secondary expectations through active interaction with various stakeholders in Engineering Education including (but not limited to) secondary-school teachers, secondary-school administrators, secondary-school guidance counselors, first-year instructors, first-year advisors, and first-year administrators. Areas explored will include topics such as mathematics/science content, computer skills, problem-solving & engineering design process skills, technical communication skills, teamwork skills, etc.

# **M1A:** Student Success and Development – 1

**Focus:** Academic Support, At-Risk Students, and Comprehensive Retention Plans
***Moderator:*** *Dr. Deb Grzybowski, The Ohio State University*
***Time:*** *Monday August 1, 3:30 to 5:00 pm*
***Location:*** *Scott Laboratory, Room E001*

***General Engineering Course for Freshman Students at Risk in Electrical Engineering***
**Nina Telang, Hayes Converse, and Nikki Stinnette**

This paper describes the implementation of an academic success program in the 2015-16 academic year for the incoming freshman students in the Electrical and Computer Engineering (ECE) department of the University of Texas at Austin who have been identified by the university as at-risk students. At-risk status is assigned based on factors related to previous academic performance and demonstrated financial need. The purpose of this program is to provide these students with resources needed to ensure a successful transition from high school to college, to equip them with study skills and a problem-solving mindset necessary for rigorous engineering coursework, and to keep them enthused about the engineering discipline. The merits of the program are determined using quantitative data such as exam scores and course grades, as well as qualitative data such as mid-semester and end-of-semester surveys.

***Supplemental Instruction Pilot Program for an Introductory Electrical Engineering Course***
**Jenell Wilmont, Krystal Peralez, Nina Telang**

Each fall over 400 incoming Cockrell School of Engineering students enroll in the University of Texas' EE302 Introduction to Electrical Engineering, a required course for all Electrical and Computer Engineering (ECE) majors. Many students are underprepared for the rigorous curriculum and difficult coursework; as a result this course has one of the highest rates of D's, F's, drops, and withdraws ("DFQW rate") in the department. Charged with improving four-year graduation rates, the ECE department partnered with the Sanger Learning Center to provide Supplemental Instruction (SI) sessions to support the academic success of students enrolled in this course. SI is a non-remedial model that emphasizes the development of study skills through the delivery of content review sessions. A fall 2015 pilot program employed two SI leaders, provided four study sessions per week, and reached 59% of the class population with 37% attending more than one session. A mixed-methods analysis reveals that session attendance positively impacted exam scores and DFQW rates, and that students held favorable perceptions of the SI program. Analysis

additionally revealed a need for further study of continued academic performance and retention within the engineering program. Index Terms – Academic support, Four-year graduation rates, Peer instruction, Student success and retention, Supplemental instruction.

***Learning Resource Center: Building Community to Increase Student Success***

**Billy Baker, Zandra Cook, Allison Everett, Emily Sandvall, and Carolyn Skurla**

Success interventions allow students to supplement their in-class experiences with rich interactions outside the classroom. Students that utilize these kinds of resources reap optimal benefits. An analysis of retention to graduation data found that over half of the engineering majors at Baylor University never experienced living-learning programming. The six-year graduation rate of the students living in the living-learning program was much higher than those who did not experience that kind of living environment. This underserved population was targeted with a new retention initiative, the Engineering and Computer Science (ECS) Learning Resource Center (LRC). The intent of this center was to provide academic support and a sense of community and connection to the population of students living outside the living-learning program. A team of ECS faculty and staff joined with three graduate students in the Higher Education and Student Affairs program to staff the LRC and to design programming. The Power of Two Mentoring Program was formed with 5 peer mentors and 30 mentees, and student workers were hired to provide tutoring. We were very encouraged by the results of this year's pilot program, and Computer Science has committed to enroll all first-year computer science students in The Power of Two in the 2016-2017 academic year. We continue to pursue additional funding to expand support services at the ECS LRC.

***School Based Academic Support Resource Assessment: Student Usage, Motivation, Academic Outcome, Behavioral and Attitudinal Impacts***

**Bridget Mearns, Lisa Lampe, and Brian Paljug**

In this evidence-based work-in-progress paper, we examine the student usage and varied impact—behavior, attitude, and academic outcome—of academic support in a mid-sized engineering school within a large East Coast public, four-year university. The data includes the complete set of data on engineering student usage for private tutoring, the APMA workshops (a graduate student-run applied math tutoring center, available weekday evenings), Crunchtime Reviews (a student-run, scheduled on-demand session for students in STEM courses), and academic coaching (mainly instructor referred, student scheduled session with a professional) in applied mathematics courses for fall 2014. The students who utilized these academic support resources were surveyed and interviewed to capture self-reported (1) anxiety level, (2) confidence, and (3) motivation associated with their choice in support resource. Our findings suggest that students consume academic support at a higher rate "just-in-time," in other words, the two days leading up to a test, rather than proactive and prolonged support. In this paper we provide a robust description of the strengths and shortcomings of each academic support service based on this tension of educational ideals and student usage from the perspective of a professional in the Engineering School and a graduate student in Higher Education. With on-going data collection, we hope to use this assessment to help other Engineering School's assess their programs as well as to continue to improve our current academic resources, create new supports, and gain a more informed understanding of our student population.

***Eos: A comprehensive approach to the retention of first and second year engineering students***

**Kristina Lenn and Jeffrey Potoff**

This paper describes the Eos program at Wayne State University, and summarizes the effectiveness of various retention activities pursued by the College of Engineering. Eos is designed to increase the commitment of students to the pursuit of Engineering degrees, promote engagement between students and the College of Engineering, and provide academic and financial support that enables students to do their best work. This program supports students through the two points in the curriculum that are crucial to retention in Engineering: 1) their first semester on campus, and 2) their entry to discipline specific engineering coursework. From the moment students enter the university, they form learning/design teams of three students. These student teams register for the same mathematics, English and chemistry courses, study together and complete a number of hands-on design projects. Peer mentors act as advisors to the learning/design teams, help students develop skills necessary for success in college, and provide academic support. A learning community coordinator oversees the peer mentors, and provides additional academic support to students. The program coordinates with faculty in the mathematics, chemistry and English departments and uses feedback from these instructors to stage early interventions for students who are falling behind in their courses. Financial support is provided to subsidize the cost of meals, parking and/or transportation to and from campus, enabling students to spend more time on campus, which has been shown to increase academic achievement and ultimately retention.

## **M1B:** Current Technologies and Their Impact/Use for First Year Students

***Moderator:*** *Mary Faure, The Ohio State University*
***Time:*** *Monday August 1, 3:30 to 5:00 pm*
***Location:*** *Scott Laboratory, Room E004*

***An Improved "Intuitive Calculus" Project, Using Electronic Filters, for a First-Year Engineering Math Laboratory***

**Rod Foist and Anthony Donaldson**

According to National Science Foundation (NSF) research, engineering mathematics courses with a laboratory ("hands-on") component are more effective in helping students grasp concepts, than lecture-only approaches. Beginning in 2008, California Baptist University (CBU) received NSF funding through Wright State University to develop a first-year Engineering Math course (EGR 182) with laboratory projects. Our new College of Engineering currently offers nine degrees and all freshmen must take this course. The lab projects aim to illustrate key mathematic concepts via hands-on experiments representing each discipline. In a previous FYEE paper (2014), we reported on a calculus-themed project using electronic filters to illustrate calculus' two fundamental operations: integration and differentiation. The "intuitive calculus" lab's primary objective is to help students see a simple and applied way of understanding these two operations. Simply put, integration is a "smoothing" function, and differentiation is a "roughening" function. In engineering language, they're known as a low-pass filter (LPF) and a high-pass filter (HPF), respectively. Following a novel pre-lab assignment, students build and evaluate simple low- and high-pass "RC filters" (using one Resistor, one Capacitor). Next, they repeat the experiments, but using equivalent digital filters. In all cases, the smoothing and roughening operations are observed, via an oscilloscope, by applying filter input signals and noting how the output is affected—as a function of

frequency. In this paper, we introduce a new, lower-cost, easier-to-use implementation of the digital filters and an overall improved lab project. Our new design uses the microcontroller-based "Programmable System on Chip" (PSoC) technology. Included is a built-in, easy-to-configure digital filter block. We also use PSoC's ability to generate a sum-of-2-sinusoids signal (at two different frequencies) for filter input that nicely illustrates the filtering process. Compared to our previous design, we show that the PSoC-based lab project is much cheaper (less than $30 per lab station), easier to create, and easier to pass on to colleagues at other universities who have little or no electronics background.

***Effect on compliance with required learning outcomes through the introduction of state-of-the-art technologies and industry-standard EDA tools into the digital logic design laboratory sequence***

**Akhan Almagambetov, Matt Pavlina, Austin Kempf, David Olson, and Holly Ross**

As part of a concerted effort to bring greater relevancy to an existing first year digital circuit design lecture and lab course on a campus comprised primarily of Aerospace and Mechanical Engineering (AE/ME) undergraduates, student learning and material retention were studied when current state-of-the-art technologies used in industry replaced previous teaching strategies involving a "cookbook lab" approach and manual wir-ing. This is in response to low motivation and overall outlook on the digital circuits course from students in non-Electrical or Computer Engineering majors. Four digital circuit design laboratory sections were targeted as part of this project (two control sections), all with similar academic major breakdowns. A total of 171 students served as subjects for the study. Data show that students attained a greater under-standing of digital logic design concepts and were more comfortable using industry-standard tools compared to students who learned via "cookbook labs". There was a significant increase in relevance of topics studied in digi-tal circuits, subjectively perceived by the students, as a direct result of the redesign of the laboratory sequence, which may provide a positive impact on future capstone design courses for students in the AE/ME disciplines.

***ENEE 101: On a gadgets driven freshman course for improving first year retention rates***

**Romel Gomez, Behtash Babadi, Shuvra Bhattacharyya, Julius Goldhar, Alireza Khaligh, Nicole Mogul, William Levine, Min Wu, and Rama Chellappa,**

We introduced a hands-on course on "Introduction to Electrical and Computer Engineering", to improve first-year student retention rates in our department. It is a one semester course taught to all incoming Electrical Engineering (EE) and Computer Engineering (CpE) first-year students and undeclared students. The material is comprised of 8 applications-based modules that span the core disciplinary concepts for our electrical and computer engineering curricula. The rationale, course structure and brief descriptions of the modules are presented.

***Embedded System Based First-Year Engineering Course with Aid of Online Simulation and Social Media***

**Nansong Wu and Kaiman Zeng**

Experiments and projects have been added to the curriculum in the Department of Electrical and Computer Engineering at a large southeastern university as part of a First-Year "Engineering Orientation" course. The goal is to enhance educational experience for engineering freshman with early introduction to research projects. In the course, students will gain introductory experience of hardware and software codesign with the focus on embedded system and robotics development. We used project-based learning to facilitate students' curiosities to explore the practical problems and challenges from the real-world for a deeper understanding on the cutting-edge knowledge in

computer engineering. The students conducted 8 experiment-based collaborative works and two projects. Both the online simulator and real development boards are leveraged to validate those designs by the group of students. The online simulator provides students an integrated development environment, and realistic simulation with graphics. The experiments and projects developed online can be easily shared using social media such as Twitter, which made collaboration in groups very convenient in and outside the classroom. This paper will provide the implementation details of this course, and assessments of the students' work. We will discuss the feedback obtained from the class, and then explore for improvements and future plans.

# **M1C:** Engineering Education Research as it Applies to the First Year Experience – 1

**Focus:** Design Process, Problem Solving, and Hands-On Activities
***Moderator:*** *Lauren Corrigan, The Ohio State University*
***Time:*** *Monday August 1, 3:30 to 5:00 pm*
***Location:*** *Scott Laboratory, Room E024*

### *Evaluation and Recommendation for Improving Engineering Design Process Assessment*

**Sami Ainane, Ali Bouabid, and Wael El Sokkary**

The effective assessment of student understanding of engineering design is an essential part of engineering education and is a key factor in the accreditation of engineering programs. The systematic review of such engineering design assessments is crucial for the improvement of engineering programs. This paper aims to present an assessment review process that provides effective feedback for the continuous improvement of engineering design education through analyzing the assessment tools used. The review process also provides useful insight into the evaluation of engineering design education. According to ABET Engineering Criteria 2000, graduates have to be able to design a system, component, or process to meet desired needs [1]. Therefore, educators in the field of engineering need to provide evidence of continuous efforts to improve the way they assess how well their graduates understand the principles of engineering design. At the Petroleum Institute in Abu Dhabi, UAE, the engineering design course (STPS201) is offered by the General Studies Department, which also offers the introduction to engineering courses (ENGR110-150), and oversees the assessment of student participation in the Freshman Year Experience (FYE) program at the university. This paper uses data gained from the engineering design exam in STPS201 course to investigate the usefulness of such exams given the complex, creative nature of engineering design. The items used in this exam and the grade distributions and correlations of different test items are examined to look for the best indicators of student achievement on such an exam. Some of the research questions scrutinize certain assumptions and common practices in engineering programs looking for possible ways to improve the way educators measure success in satisfying the stated program learning outcomes. An example of such common practices is relying on the mean scores to measure success in meeting the learning outcome. The findings have the potential to be utilized in other courses and across different engineering disciplines. Keywords – Assessment, Continuous improvement, Engineering design process, Learning outcomes.

***Fostering an Engineering Entrepreneurial Mindset through the Engineering Problem-Solving Module in the Freshman Engineering Discovery Course***

**Hyunjae Park**

In order for new engineering students to clearly grab and be equipped with the philosophy of engineering problem solving, the Freshman Engineering Discovery course developed and currently running at the Marquette University – Opus College of Engineering provides an engineering problem-solving module session for four weeks in which students explicitly practice how to estimate and predict the engineering analysis results for real-life problems, while incorporating the elements included in the engineering entrepreneurial mindset defined by the 3C's of Curiosity, Connections and Creating Value. Instead of solving the well-defined problems through the engineering problem-solving module, the student teams (4-5 students per team) are asked to find, select and identify a problem from within the space (or campus) they live in. They are also asked to perform proper engineering calculations by following the engineering problem-solving steps and procedures to estimate and predict the amount of heat/energy transfer/loss from a system or region and the corresponding energy usage efficiency and costs. As a consequence, the students are able to experience and foster the engineering entrepreneurial mindset defined by the 3C's of Curiosity, Connections and Creating Value, in which they are curious about the environment where they live, gain insight through connections and information, and practice to create value by performing proper engineering calculations.

***Improving Freshman Student Success through Undergraduate Research Projects***

**Andrew Assadollahi, R. Eugene McGinnis, and Christine Moore**

Christian Brothers University is a small private, primarily undergraduate institution located in Memphis, TN that primarily focuses on teaching. The Department of Civil and Environmental Engineering at Christian Brothers University has faced several challenges over the years with student retention during the freshman year. Many of these challenges have been attributed to lack of student success through traditional classroom instruction. One solution that was implemented by the Department of Civil and Environmental Engineering, after consultation with current undergraduate students, alumni, and practitioners, was the involvement of freshman-level students in undergraduate technical research projects. This research shows how the morale, success, and retention of the freshman-level students have been impacted by involving these students in undergraduate technical research projects at Christian Brothers University. Students have shown an increased sense of pride and belonging within both their major and the university. This research also shows how student performance in other courses improved through the involvement in undergraduate research projects during the freshman level. Students have shown an increased speed in thought, rationality, and problem solving capabilities in their technical courses (engineering, mathematics, and science).

***Incorporating Open-Ended Design Projects in a First year Engineering Course***

**Jack Bringardner, Gunter Georgi, and Victoria Bill**

A first year engineering program with a multidisciplinary introduction to engineering course is developing an open-ended design project. This course is designed to teach the basics of each engineering discipline through labs, lectures, and a course project. It is a one semester course offered in the fall and spring, and all engineering majors are required to take it. Around 300 students take the course each semester, and they are broken into 21 sections with a maximum of 18 students per section. The current project offerings include robotics courses, building design, and programming autonomous train control. The goal of adding an open-ended design project is twofold: 1) to give students the chance to explore their own interests and 2) to provide motivated

students with an appropriate challenge for their skill level. Adding an open-ended project to the first year engineering experience is a common practice, but several issues must be considered to provide a fair experience to all students. Plans for deploying a pilot section in the fall of 2016 have been made. Based on the success of the pilot section, open-ended projects may be offered in more sections. The authors seek the insight from the first year engineering community to create the most effective version of this pilot section.

***Implement Hands-on Activities into Engineering Living and Learning Communities***

**Xiaohong Wang, Tammy Salmon-Stephens, and Abulkhair Masoom**

Living and Learning Communities are a high-impact practice where first-year college students are placed in a common living area and are connected by major or interest. There are compelling reasons to initiate and maintain a Living and Learning Community for first-year engineering students at the University of Wisconsin -Platteville. Early engagement of engineering students into a community environment can have a positive impact on students and the recruitment and retention at the College of Engineering Mathematics and Science at University of Wisconsin - Platteville. In this project, we will work with a team who are involved with the College of Engineering Mathematics and Science Student Success Programs and Residence Life and University Academic Support Programs to create an academic cohort experience for first-year engineering students. It will be focused on implementing some fundamental engineering hands-on activities into the Living and Learning Communities for first-year engineering students. Statics is one of the first courses taken by students from the fundamental engineering courses. It is an essential prerequisite for many branches of engineering, such as mechanical, civil, aeronautical, and bioengineering, which addresses the various aspects of forces. One of hands-on activities in our Living and Learning Communities will demonstrate how to measure forces using "Hooke's Law". This activity will help students to better understand how a force could be simply a push or pull. It will also be a beneficial practice to implement some hands-on activities based on fundamental principles of mechanics into the Living and Learning Communities for first-year engineering students. These hands-on activities will allow students to engage and explore the subject they will study in the near future and develop connections and networking between students and faculty members.

## **M1D:** Enrollment, Instruction, and Pedagogy – 1

**Focus:** Non-Technical Skills & Interdisciplinary
***Moderator:*** *Jamie Paulson, The Ohio State University*
***Time:*** *Monday August 1, 3:30 to 5:00 pm*
***Location:*** *Scott Laboratory, Room E040*

***A Transition in Progress: Building the Foundation for KEEN Outcomes in First-Year Engineering***

**James Hylton and Todd France**

Recent years have seen a dramatic growth in the number of first-year engineering programs. With that growth has come a broad discussion of what exactly that experience should entail and how it is best delivered to our students. Several on-going efforts seek to formalize this discussion, developing comprehensive maps of first-year engineering content. Broadly, however, the current consensus seems to align along some combination of engineering design, modeling, and analysis

coupled with the non-technical skill areas of communication and teaming. In a separate effort, several institutions have come together under the Kern Entrepreneurial Engineering Network (KEEN). This cohort seeks to embed into the curriculum particular student outcomes including the Entrepreneurial Mindset (with three core components of Curiosity, Connections, and Creating Value), Communication, Collaboration, and Character. The goal at this institution is to incorporate these aspects broadly throughout the curriculum, gradually advancing student abilities along each thread through repeated exposure and practice. Within this framework, the first-year engineering program is a foundational experience. In this paper, we discuss the first steps in a holistic redesign of the first year engineering experience to better align with both of the above mentioned frameworks – to bring the program into alignment with established best-practices for first-year content and to provide the critical foundation for the KEEN student outcomes. We also communicate the lessons learned and the results of some preliminary analysis of student success. The effort was undertaken at a small, private mid-western university where the first-year engineering program consists of three courses – two college-wide Introduction to Engineering courses and a department-specific orientation course. The focus of this paper is on the two-course sequence. The result was an experiential course sequence built around two central, semester-long projects. A series of content units covering engineering design, modeling, and experimentation were utilized to scaffold this project. To evaluate the changes, surveys were administered to current freshmen, who experienced the redesigned courses. These surveys will collect student feedback on the course structure and pedagogy as well as self-assessments of the course impact on their learning and understanding in several content areas. Preliminary results of these studies are discussed, along with their implications for future adjustments to the redesigned course sequence.

***A Freshman Seminar: "The Art and Science of Motorcycle Design"***

**Michael Littman**

This paper describes a Freshman Seminar that has been offered at Princeton University every spring semester since 2009. The course enrolls 15 first-year students and it satisfies Princeton University's Science and Technology Laboratory (STL) requirement. Students are from both liberal arts and engineering programs. The restoration of a vintage motorcycle is the focus of attention. In class students learn about technical ideas important in the design of a motorcycle. In laboratory they disassemble, restore, reassemble, and operate the motorcycle. The book, "Zen and the Art of Motorcycle Maintenance" by Robert Pirsig is one of two books that are read closely to stimulate discussion in bi-weekly classes. Colleagues (experts) in Fluid Mechanics, Material Science, and Combustion Science contribute as guest lecturers. The completed motorcycle is operated during reading period - shortly after the last instructional week of the semester.

***Non-cognitive Associations with Academic Achievement for First-Year Engineering and Computer Science Students at an HBCU***

**Faun Rockcliffe, Tori Rhoulac-Smith, and Todd Shurn**

Our study is a replication of the Tracey and Sedlacek study that demonstrated non-cognitive attributes (such as self-concept and realistic self-appraisal) to be predictive of collegiate academic achievement and retention for black and white students, with more of the non-cognitive variables being significant for black student retention than whites. Tracey and Sedlacek's work is based on a survey of students from across academic majors at a large, northeastern public university. Our investigation at a Historically Black University sought to determine the relationship between non-cognitive attributes, retention, and academic achievement within the undergraduate engineering and computer science disciplines. Tracey and Sedlacek's 23-item Non-Cognitive Questionnaire measured self-concept, realistic self-appraisal, racism understanding and response, long-range goal preferences, strong support person availability, successful leadership experience, community

involvement, and nontraditional knowledge acquired in the field. Results are reported on 108 FTIC US citizen and permanent resident engineering and computer science HBCU students. The majority of the surveyed students self-identified as African American/Black (90.7%, n = 98), male (59.3%, n = 64), ages ranging from 16 to 22 years, with an average age of 18 (61.1%, n = 66). None of non-cognitive attributes was associated with retention, determined by correlational analysis. However, self-concept showed positive, but small associations with second, third, and fifth semester GPAs for the students. Non-traditional knowledge acquired through life experiences showed positive but small associations with second through fourth semester GPA. Implications of using non-cognitive attributes in providing support to minority engineering students are discussed.

***Work in Progress: Synthesizing an Interdisciplinary Design Environment in First Year Engineering Education***

**James McCusker, Henderson Pritchard, and Julian Sosnik**

The engineering job market is becoming increasingly interdisciplinary in nature. In order to adequately prepare our students for the challenges of this evolving job market, interdisciplinary design environments have become commonplace in engineering education. This, however, presents a challenge in first year classes in that a vast majority of students enrolled in engineering programs have little or no experience in their selected disciplines. To address this constraint, in the spring of 2016 select sections in the course 'Introduction to Engineering Design' at Wentworth Institute of Technology in Boston, Massachusetts have adopted a skills-based synthesized interdisciplinary design environment. This approach assigns student groups based on each student's proficiency in skills that are typically applicable to first year engineering design. For this study, these selected sections are compared to the remaining sections that adopted the more traditional approach of forming groups based on the students' selected engineering disciplines. In this ongoing study, initial results from both, student surveys and direct assessments, indicates the promise of this approach in first-year engineering education.

## **M1E:** K-12 Invited Workshop – Activities to Introduce Engineering Design Processes

***Workshop Facilitators:*** Joe Griffith and Kathleen A. Harper
***Time:*** *Monday August 1, 3:30 to 5:00 pm*
***Location:*** *Scott Laboratory, Room E125*

A hallmark of engineering is design. This highly interactive workshop will allow participants to experience an activity appropriate in both K12 and first-year engineering settings to introduce students to elements of engineering design. Following the activity, participants will have the opportunity to discuss options for incorporating the ideas from the workshop into their own classes, as well as ways to modify the activity for their own environments and approaches.

# Tuesday: Session Matrix

| Time | Location: Ohio State Campus | | | |
|---|---|---|---|---|
| Tuesday<br>7:30 am - 3:00 pm | Registration in Scott Laboratory E100 | | | |
| Tuesday<br>7:30 - 8:30 am | Good Morning: Breakfast Buffet<br>Location: Scott Laboratory E100 | | | |
| Tuesday<br>7:30 - 3:00 pm | Networking and Meeting Space in Scott Laboratory E100 | | | |
| Tuesday<br>8:30 - 10:00 am | **Paper Sessions** Location: Scott Laboratory | | | |
| | **Room: E125** | **Room: E004** | **Room: E024** | **Room: E040** |
| | **T1A**<br>Student Success and Development – 2 (Focus on Mentorship & comprehensive retention programs) | **T1B**<br>Maker Spaces and Service Learning in the First Year and Beyond | **T1C**<br>Engineering Education Research as it Applies to the First Year Experience – 2 (Focus on interest, retention & success) | **T1D**<br>Enrollment, Instruction, and Pedagogy – 2 (Focus on design based projects) |
| Tuesday<br>10:00 - 10:30 am | Networking Break<br>Rooms: Scott Laboratory E100 | | | |
| Tuesday<br>10:30 am - Noon | **Paper Sessions** Location: Scott Laboratory | | | |
| | **Room: E125** | **Room: E004** | **Room: E024** | **Room: E040** |
| | **T2A**<br>Student Success and Development – 3 (Focus on preparedness, peer work, problem sets, classroom practices) | **T2B**<br>Academic & Career Advising | **T2C**<br>Engineering Education Research as it Applies to the First Year Experience – 3 (Focus on assessment, teamwork, and student success) | **T2D**<br>Enrollment, Instruction, and Pedagogy – 3 (Focus on retention & student success) |
| Tuesday<br>Noon - 1:30 pm | **Lunch in Scott Laboratory E100**<br>The focus of the lunch is to provide a networking opportunity. | | | |
| Tuesday<br>1:30 - 3:00 pm | **Paper Sessions** Location: Scott Laboratory | | | |
| | **Room: E125** | **Room: E004** | **Room: E024** | |
| | **T3A**<br>Student Success and Development – 4 (Focus on mathematics) | **T3B**<br>Other Topics that Address Issues in First Year Engineering Education (Focus on minorities, mentorship, entrepreneurial mindsets, societal issues) | **T3C**<br>Other Topics that Address Issues in First Year Engineering Education (Focus on mathematics & social consciousness) | |
| Tuesday<br>3:15 - 4:00 pm | Wrap-up Session<br>Room: Knowlton Hall 250 | | | |

## **T1A:** Student Success & Development - 2

**Focus:** Mentorship and Comprehensive Retention Plans
***Moderator:*** *Yvonne Burry, The Ohio State University*
***Time:*** *Tuesday August 2, 8:30 to 10:00 am*
***Location:*** *Scott Laboratory, Room E125*

***First Year Engineering Experiences of the STEM-Inc Project***
**Pradeep Nair, Jidong Huang, John Jackson, Amy Cox-Petersen, and Clay Elliot**

This paper presents the first-year engineering experience for "STEM-Inc: Science, Technology, Engineering and Mini-business Incubator", an after-school strategies program mainly targeting traditionally-underrepresented students in 7th and 8th grades. The STEM-Inc project combines engineering and business entrepreneurship concepts. STEM-Inc students work in teams and are mentored by college majors, in partnership with school teachers. The college majors are trained and supervised by faculty members at California State University Fullerton. The technical skills training component of the program for year-1 of the project included mobile application development, introduction to robotics, and 3D printing. It also involved enrichment activities such as industry speaker sessions, University field-trip, logo design and annual project showcase. Surveys were used to record project data and student perceptions. The program witnessed healthy participation at the end of the first year (83 students). 64.1% and 66.6% of responding students (N=81) gave a score of at least 8 on a 0-10 scale (highest=10) to indicate that, to them "engineering is interesting" and "means a lot", respectively. 68.2% of respondents (N=82) reported that they are interested in becoming an engineer or a scientist. At least 71% of the respondents (N=60) rated their University visit of November 2015 as either "helpful" or "very helpful" with regard to STEM content and interest in STEM careers. 68.2% of the respondents reported that they were at least somewhat interested in pursuing a career as a scientist or an engineer. The evaluation of the outcomes indicated that learning was taking place across most outcomes.

***Holistic Peer Mentoring: A Transformational Tool for Success in Engineering***
**Ida Jamshidi and Emily Sandvall**

Higher education institutions utilize peer mentoring to facilitate connections among students and commitment to an academic program, but what does it look like to create a culture of mentoring? Throughout the last decade, The School of Engineering and Computer Science at Baylor University has worked to create, implement, and assess multiple formats of peer mentoring to address the development of new students through the various stages of their first year. By intentionally analyzing the needs of new students at specific checkpoints during their first year, staff can recruit and train upper-division students to walk alongside and mentor first-year students. Focusing on the new student journey from various perspectives – academic, spiritual, social, etc. – allows staff to take a holistic approach to retaining and supporting first- year students. This philosophy also allows for the intentional development of upper-division students as they become competent, influential and prestigious leaders within the academic community. Holistic peer mentoring has been a transformational tool for Baylor's School of Engineering and Computer Science in an effort to increase student retention, success, and satisfaction.

***Work-in-Progress - Development of a student-based mentorship program for first-year environmental engineering students***

**R. Scott Summers and Finau-Starkey**

We have recently completed the second year of a mentorship program for first-year students (~50) in the environmental engineering (EVEN) program (~200 students), in which senior environmental engineering students volunteer their time to mentor the incoming students. The program is introduced through the fall semester Introduction to Environmental Engineering course which is required for all incoming students. The objective of the program is to support first-year and transfer EVEN students as they gain their footing in the EVEN Program and in life at CU Boulder. The approach is to assign each senior mentor five to six mentees. This is a volunteer effort. Mentors are also volunteering their time, but get a couple of free meals as a token. The mentor's objectives are to provide student-student mentoring, while increasing interactions between upper-class and newer EVEN students. In the first year of the program we divided up the first-year students by an academic measure: their interest in one of the seven EVEN tracks. The mentors were then assigned based on their EVEN track. In the second year of the program we divided up the first-year students by their residence hall assignment (including an off-campus category). The mentors were then assigned based on their first-year residence hall. The mentors are introduced to the first-year students in class. It is made clear to the first-year students that they are not required to participate. We have analyzed the results of both the mentee and mentor post-class surveys. We increased the participation from 20% the first year to 30% the second year, but we expect more.

***Work-In-Progress –Joint Senior and First-Year Student Design Projects for Student Retention***

**Kimberlyn Gray and Garth Thomas**

Many programs fail to tie concepts covered in fundamental mathematics and science courses with the application of these concepts to engineering fields; this disconnect increases the difficulty of retaining first-year engineering students. Design projects are one method to increase student understanding of the connection between these courses and engineering, but first-year students lack the necessary skills and knowledge to participate in many projects. This fall, we will began a pilot project that allows first-year students enrolled in the Introduction to Chemical Engineering course to work as project interns on senior chemical engineering student design teams. The senior design laboratory focuses on product design; and the seniors provide training, mentoring, and feedback to their assigned interns. The first-year and senior students meet in class weekly to discuss the project. The senior project consists of four phases: (1) initial product concept development, (2) product selections, (3) process design, and (4) final conceptual design and testing. Through this design project, we anticipate the first-year students will increase their understanding of the field of chemical engineering, the practical application of their coursework, and begin developing teamwork and oral and written communication skills.

***Experiential Learning Activities to Enhance Freshman Student Learning, Retention, and Success***

**Manoochehr Zoghi**

One of the key challenges in engineering education is retention of engineering students. It is well known that attrition is very high in engineering, particularly during the first year. Nationally, approximately one-half of students who enter engineering majors finish within six years. The attrition of minority and female students are even more acute. There have been a wide variety of efforts to improve the retention and graduation rates of engineering students in recent years. These have involved pre-college education, university/college education, improving the image/perception of engineering, etc. The present paper will review the implication of high impact educational

practices, or experiential learning activities, to enhance freshman engineering student learning, retention, and success. Specifically, we will elaborate on vertical integration of service-learning activities, peer-mentoring programs, supplemental instructions, relevant national student competitions, internship opportunities, and leadership/entrepreneurship development programs. Our Pathways Student Services Division in the Lyles College of Engineering has been administrating many of the aforementioned activities. We have devised a five-step intervention process to help students considered academically at risk. Accordingly, during the fall semester, all lower division-engineering students who are on the verge of going into probationary status are sent a notice to attend a mandatory informational session with both the Associate Dean and the Director of the Pathways Student Services. Following an interactive discussion about the possible challenges and general overview of how to succeed in college, students are directed to meet with their faculty advisors, department chairs, associate dean, or director of Pathways. During those assigned follow up meetings, specific needs of each student is identified. Subsequently, a series of workshops, tutoring, peer mentoring, and other helps are provided to assist the student to overcome his/her challenge and succeed. Other experiential learning opportunities that have been very beneficial involve internship programs that provide students real life perspective.

## **T1B:** Maker Spaces and Service Learning in the First Year and Beyond

***Moderator:*** *Dr. Howard Greene, The Ohio State University*
***Time:*** *Tuesday August 2, 8:30 to 10:00 am*
***Location:*** *Scott Laboratory, Room E004*

### *Makers on the Move: Constructing an Outreach Program with a Mobile Maker Space*

**Elizabeth Powell, Harry Ingle, Scott Eddins, and Nikolas McGehee**

This paper presents results of a pilot outreach and service-learning program, Makers on the Move. The Makers on the Move program was developed by the Clay N. Hixson Student Success Center for the College of Engineering at Tennessee Tech University. Makers on the Move is an outreach program where engineering students provide project-based STEM lessons in a mobile maker space to middle and high school students. These lessons are developed by the staff in the Millard Oakley STEM Center at Tennessee Tech and are based on the Legacy Cycle, emphasizing an optimal learning environment. Through the Makers on the Move program, the Student Success Center staff collaborated with the STEM Center staff to ensure that engineering students provided valuable experiences to middle and high school students. This paper discusses the collaborative efforts of the Success Center and the STEM Center, as well as an assessment of the first year. It was found that the outreach program was successful, with 5,000+ students and community members interacting with volunteers and a measurable improvement in students' understanding of STEM concepts. The authors discuss the value of the program regarding recruitment, retention, and persistence in STEM.

***Inexpensive Computer Numerical Controlled (CNC) Technology for Meaningful Hands-On Experiences in Introduction to Mechanical Engineering***

**Kristofer Tite, Marzana Fiedtkou, Farhan Azhar, Stephen Johnston, Christopher Hansen, Sammy Shina, and David Willis**

This paper presents the selection, deployment and use of (1) inexpensive, off-the-shelf, desktop Computer Numerical Control (CNC) technology and (2) an in-house Computer Numerical Control - Modular Block (CNC-MB) in the Introduction to Mechanical Engineer-ing course at the University of Massachusetts Lowell. The inexpensive, off-the-shelf CNC machines present a valuable hands-on introduction to advanced manufacturing and an accessible gateway to hands-on making. Due to lower complexity, these machines minimize intimidation, allowing students to independently engage in advanced machining explorations. The recently developed, in-house CNC-MB presents a unique platform with which students can engage in CNC machine design, assemble and test application-based computer programming, as well as explore advanced machining.

***Young Makers in the First-Year Engineering Classroom: Educational Pathways, Implementations and Implications***

**Aubrey Wigner, Micah Lande, and Shawn Jordan**

The rising popularity of the maker movement may increase the numbers of students interested in, and majoring in, engineering. For first year engineering students, engaging with the maker community and campus makerspaces could also serve to help form a basis for the broader student learning outcomes needed to succeed in engineering majors and careers, especially as identified by ABET. Our work investigates what engineering students learn from their educational pathways and engagement with making about (awareness) and during (context) the beginning of their engineering studies. We will share an operational framework of the attributes of making and how those can be supported with messaging about engineering programs and introductory projects. We have interviewed 36 young makers (ages 7-17) and 40 adult makers about the creations they brought to flagship Maker Faires to better understand what engineering skills makers are learning. From qualitative artifact elicitation interviews it can be shown that makers are gaining experience in a variety of ABET a-k (Student Outcomes) applicable experiences. Over three-quarters are learning effective communication skills (g), over half display traits associated with successful lifelong learning (i), and a third are identifying and solving engineering problems through system design with realistic constraints (a, c, e). Makers are exposed to a variety of types of engineering, half of our interviewees engaged in hardware and software design, half learned physical fabrication methods, and one-quarter learned CAD modeling. Finally, half of the young makers we interviewed are interested in pursuing engineering degrees. Makers learn broadly applicable engineering skills, a love of learning, and how to rapidly turn their ideas into physical artifacts. Courses introducing engineers to a maker mindset could introduce early engineering concepts across a variety of specialties, achieve ABET Student Outcomes, and instill life-long learning skills to aid their education.

***Work in Progress - Art, Design, and Community Service***

**Cecelia Wigal, Louie Elliott, and Christina Vogel**

Much of the research surrounding visual art and persons with disabilities emphasizes art as therapy. This project, however, focuses on breaking down the barriers experienced by those with physical and developmental disabilities. Specifically this project addresses the physical barriers that many with disabilities encounter when using art tools and resources of the able artist community. Freshman engineering students in an "Introduction to Engineering Design" course at the University of Tennessee at Chattanooga are, by using the engineering design process, designing

and adapting or building art tools to aid persons with disabilities to express themselves in various visual art forms. During the process the students learn the needs of their customer, brainstorm solutions for the needs, select the best solution, prototype the solution, test the solution, and build the final solution and deliver it to the customer or partnering client. The design of the tool is also documented so it can be reproduced. Some of the needs addressed aid a group of individuals while others are specific to an individual's disability. The ultimate goal of the project is to develop a library of assistive art tools that can help persons with disabilities express themselves in a variety of art forms. This library will be located at partner locations but be mobile and thus available throughout the community. Presently the partner locations include Signal Centers of Chattanooga TN, HART Gallery of Chattanooga TN, and Open Arms Care Corporation of Ooltewah TN.

***Impact of highlighting ethical considerations in the engineering design process through a service-learning based freshman-to-sophomore bridge***

**Deborah Won, Gisele Ragusa, Adel Sharif, Gustavo Menezes, and Arturo Pacheco-Vega**

Bridge Opportunities Offered for the Sophomore Transition (BOOST) is being developed for freshman Engineering students at California State University, Los Angeles (CSULA) as they transition into their core engineering courses, often first encountered during their sophomore year. The objective of BOOST is to provide a service learning based freshman-to sophomore bridge which exposes these students to engineering tools and gives them an opportunity to use these tools in a peer-mentored engineering design project which serves their local community. The students are required to take an Engineering Ethics and Professionalism course during the Spring term of their freshman year, before the summer bridge component of BOOST. During this course, students are taught to consider how ethical principles and professional guidelines can and should influence their project designs. Subjective results indicate that teaching ethics in the context of their service learning projects is shaping their view of the engineering profession to take on a more holistic perspective.

## **T1C:** Engineering Education Research as it Applies to the First Year Experience – 2

**Focus:** Interest, Retention, and Success
***Moderator:*** *Steven Nozaki, The Ohio State University*
***Time:*** *Tuesday August 2, 8:30 to 10:00 am*
***Location:*** *Scott Laboratory, Room E024*

***Current Events as a Means to Promote Interest in Engineering***

**Nora Honken**

Interest in engineering is cited as a major reason students choose to study engineering and lack/loss of interest is cited as a major reason for switching out of engineering. In an attempt to help students maintain or increase interest in engineering during their first year of college, engineering-related current events taken from the American Society of Engineering Education First Bell and other sources were presented at the beginning of each meeting of a freshman engineering class. On a survey completed by 125 students, 79% of students indicated the time spent on current events was worthwhile; 71% indicated learning about current events related to engineering helped them increase interest in engineering. The majority of the students also indicated additional

benefits such as learning about the type of work engineers do, gaining an understanding of the social and political environment engineers work in, and the need to be a lifelong learner.

***Student Persistence and Retention in Engineering***

**Fola Michael Ayokanmbi and Aaron Adams**

The national economic growth significantly depends on a technically skilled workforce that creates new goods and services, and new capital for U.S. competitiveness. Hence, increasing college attainment of science and engineering students is vital to the growing jobs of the economy and to the U.S. economic competitiveness. However, there is a growing concern about the adequacy of a strong, talented, and innovative science and technology workforce that can respond effectively to the challenges and opportunities necessary to maintain United States' technological progress and economic growth. Research has shown that more than half of the students who start out in science or engineering in their first year in college switch to other majors or do not earn a degree. Evidence indicates that first-year undergraduate students are most at-risk of switching to other majors or dropping out of college. A large part of the problem may lie in their performance in the college introductory courses, and the way these courses are traditionally taught. Their performance in the introductory courses tells them that they are not good enough in mathematics and/or science; they are not convinced about the relevance of what they are being taught, and therefore, decide to switch to other majors. The science and engineering curriculum should be designed to emphasize the application of learning to real life and stimulate transfer of learning. It is, therefore, imperative that efforts are made to support the retention of engineering students by address the issues that contribute to their low performance in their first year in college. Intrusive and intentional intervention strategies are needed to address the challenges that would promote their academic success in order to produce sufficient numbers of graduates necessary to meet the projected engineering workforce. This paper discusses strategies for transforming teaching and learning, and increasing students' curiosity and engagement in science and engineering with the objective of improving student persistence and completion.

***Work in Progress – Foundations for STEM Success: Implementing National Best Practices in a Liberal Arts College Setting***

**Mary Noonan, Cynthia McGowen, Maureen Sakakeeny, and Marc Veletzos**

The President's Council of Advisors on Science and Technology has indicated that the US Higher Education system needs to produce more graduates in STEM fields to maintain a competitive position in the global economy. Increasing student retention in STEM majors has been identified as an approach to achieve these objectives. The Foundation for STEM Success (FS2) program uses a student-centered approach to academic preparation and learning, and creates a network of supports for first-year students in engineering and computer science majors. The FS2 project was designed to improve retention and graduation by implementing strategies that contribute to: academic preparation and self-efficacy, particularly in first year mathematics courses; a sense of belonging to a major and social integration within an academic community, and; a belief that the targeted majors contribute to society. These are key factors that affect STEM retention. The FS2 program is composed of four initiatives: (1) summer bridge program, (2) revised gateway course, (3) peer and faculty mentor/tutoring program, and (4) affinity housing. The FS2 program is currently in Year 2 and has engaged a total of 213 first year engineering and computer science students. Preliminary results indicate that first year retention is 70% for gateway course participants, 83% for summer bridge participants and 87% for affinity housing participants. This is an improvement over the baseline first year retention of 67%.

***Work in Progress: Motivation, Non-Majors, and the Flipped Classroom: The Impact of Student Motivation on Performance in a Flipped Programming Course for Non-Majors***

**Rachel McCord and Isaac Jeldes**

This work in progress paper sought to answer the following research question: Does student motivation impact performance in a first year programming course for non-majors that utilizes a flipped classroom model? Previous work showed a decrease in performance on programming tasks when switching to a flipped classroom model, which was contrary to literature suggestions. In order to investigate this phenomenon further, this portion of the study sought to see if level of motivation played a role in the drop in performance. Using intrinsic motivation as our theoretical framework, we collected motivational data from students in a first year computer course using the Intrinsic Motivation Inventory as well as performance metrics from students' lab scores and final exams. Participants self-reported motivation in terms of interest, value and perceived choice were compared to performance data to determine a correlative relationship. Data analysis shows a strong positive correlation between student interest, value, and performance in the first year programming course.

***Engaging Students in a First Year Industrial Engineering Seminar Course***

**Paul Lynch and Elena Joshi**

All first year students at Penn State University Park must complete a 1- credit first year seminar course. Often times, students don't see the value in taking a first year seminar course and instructors may not put forth 100% effort in delivering the course. An active, engaging approach was taken in delivering a first year seminar course in industrial engineering (IE 100S). The IE 100S course was infused with active learning modules, laboratories, student tours, homework assignments, industry speakers, and the requirement for students to construct resumes and attend at least one career fair in search of an internship as freshmen. One of the main goals of the new curriculum and course emphasis was on the professional development of the freshmen students. At Penn State, students only apply to a major during their fourth semester. Engineering retention and industrial engineering retention data was collected over 8 semesters for students taking the IE 100S class. On average, 85% of the students taking the IE 100S class went on to major in an engineering major. On average, 53.2% of the students taking the IE 100S class majored in industrial engineering. The student ratings for teaching effectiveness have rated the industrial engineering first year seminar course as one of the highest rated courses in the entire college of engineering at Penn State University Park. The overall average rating for the course instructor was 6.85 out of a possible 7.0 over 8 semesters. The overall average rating for the quality of the course itself over 8 semesters was 6.78 out of 7.0. In addition to the details of the course lectures, homework assignment details and instructor learning initiatives are also provided.

# **T1D:** Enrollment, Instruction, and Pedagogy – 2

**Focus:** Design Based Projects

***Moderator:*** *Dr. Rick Freuler, The Ohio State University*
***Time:*** *Tuesday August 2, 8:30 to 10:00 am*
***Location:*** *Scott Laboratory, Room E040*

### *The Cornerstone Course: Projects and Progress*

**Susan Freeman, Richard Whalen, Courtney Pfluger, Mark Sivak, Josh Hertz, and Bala Maheswaran**

In the Fall of 2014, Northeastern University taught 2 pilot sections of what is now being called the Cornerstone of Engineering course, as support of the "Cornerstone to Capstone" approach in the College of Engineering's curriculum. The first 2 pilot sections integrated 2 existing 4-credit first year engineering courses in an intense 1-semester, 8-credit format. After the pilot sections were completed and reviewed, 4 sections of this 1-semester, 8-credit course were offered in 2015-2016. In addition, 13 sections of the cornerstone course were "split" into two 4-credit courses over the Fall and Spring semesters in order to address logistical and pedagogical issues with the intense 1-semester format. The results of student feedback and other results following the cornerstone approach are discussed in other papers, with more data currently becoming available1. The goal of the cornerstone approach was the integration of design, programming, graphical communication, and engineering analysis through real world, hands-on design projects previously taught in two separate courses. This paper will present some of the mechanics of offering the cornerstone approach, focusing on the projects themselves. Some examples of these are robot swarms that seek a chemical source and inform of the danger, museum-type exhibits that teach topics related to sustainability, open-ended robot designs for many goals such as working in dangerous areas or disasters, efficient energy transfer devices, sustainable home designs, and input devices for games that are tested on actual users. This paper's purpose is to present the themes and projects used in the cornerstone courses to date with sufficient detail and support to be considered by others and to show the success of this approach by the student built project results.

### *Zero Energy Homes: A Comprehensive Project-Based Learning Experience for 21st Century First-Year Engineering Students*

**Andrew S. Lau, Smita Bharti, Wallace Catanach, and Albert Gorta**

First-year design projects are a special challenge when they include students from many different disciplines. On top of that, there are many skills and abilities that first-year students should learn and experience, including designing (and its various steps), drawing, speaking, creating, teaming, experimenting, costing, analyzing, and caring for the future. Conceptually designing a Net Zero Energy Home (NZEH) provides all of these opportunities, and has elements relevant to all majors. Since first being used in 2010, major improvements have been made that focus on 1) balancing team and individual work so that all students learn the important concepts, 2) increasing active learning, 3) increasing and enhancing experimentation, and 4) understanding the relevance to sustainability. The hypothetical client is a low-income family of four with a limited budget. This results in house designs with about 1,200 ft2 of floor space. This paper is an overview of the new elements of the project along with insights gleaned from all of our experiences since its inception. The resources described are available for use and adaptation by any interested faculty.

***A Microcontroller based Computer Engineering Design Experience for First Year Students***

**Hugh Smith**

As part of Cal Poly's computing majors' curriculum an Introduction to Computer Science course is taken by the majority of the first year students. One of the purposes of this course is to introduce the students to the depth and breadth of their major. To fulfill this requirement, we implemented an Embedded Systems design course. This course includes a quarter long project. The focus of this project is to design and implement a prototype of an embedded system to help the elderly. The project requires the students to implement 3-milestones. These milestones consist of a hardware investigation, a functional specification presentation and a design review. Upon completing the project, the students produced a 3 to 5-minute video on the project and demoed the prototype in class. In order for the students to develop the technical skills necessary to implement this project we developed a flipped curriculum that provides an introduction to both hardware and software. The activities used in the lecture and lab to teach these concepts involves the implementation of a mobile robot.

***An Application-Based Freshman Introductory Programming Course using the Raspberry Pi***

**W. Lawson, S. Secules, and S. Bhattacharyya**

An innovative approach to teaching an introductory C programming course to freshman electrical engineering students has been developed. The innovation stems from the use of electrical engineering applications and projects to motivate students to master language syntax and implement key programming concepts and best practices. Two lectures per week cover programming concepts, introduce hardware and discuss applications. Weekly laboratory sessions center around writing C code on a Raspberry Pi (RPi) computer to interact with a variety of sensors, actuators, and electronic components and achieve laboratory goals. The laboratory experience culminates with two multi-week hardware projects designed to challenge the students' new knowledge and skills. The new course has been run in parallel with a traditional introductory C class. Program evaluation has been conducted by a research team which operates separately from but advises the team of instructors about course improvements. Results show that students in the alternative course find it more collaborative, less competitive, and having a greater sense of community than students in the traditional class.

***Continued Development and Implementation of a Two-Course Sequence Designed to Transform the First-Year Experience for Engineering***

**Dr. Brian S. Robinson, Dr. Jacqueline McNeil, Dr. Angela Thompson, and Dr. Patricia Ralston**

Further pedagogical development continues at the University of Louisville (UofL) for Engineering Methods, Tools, and Practice I and II, a two-course sequence that will commence in Fall 2016 and be required by all first-year engineering students. This paper gives an overview of the sequence structure, highlights pertinent steps taken to further develop the sequence since FYEE 2015, discusses key components identified to ensure successful sequence implementation, and provides detail pertaining to planned course assessment. The sequence has been structured in a manner in which fundamental engineering skills will be introduced and practiced in a primarily classroom setting during the first course. The second course will be set in UofL's new student makerspace, and it will focus on integration and application of the fundamental engineering skills established in the first course including (but not limited to): 1) engineering professionalism (ethics, culture, and risk), 2) basic computational and programming skills, 3) graphical, oral and written communication, 4) problem solving, 5) design analysis, 6) teamwork (emphasizing diversity and inclusion), and 7) project management. The Paul-Elder Critical Thinking Framework will also be

taught and used throughout both courses. The second-semester course will also provide the students with 3D printers for creating student-designed parts, and students will utilize Arduino components in conjunction with programming aspects of the curriculum. Primary means of instructional delivery (in both courses) will consist of in-class presentations and out-of-class videos, while students will practice and apply learned skills via written assignments, activities, construction, experimentation and design. Assessment for the two-course sequence will use both qualitative and quantitative analysis. The qualitative analysis will assess students' identification with engineering, critical thinking, and an understanding of the engineering design process. The quantitative assessment will include graded homework, team assignments, and designing and building products.

## **T2A:** Student Success and Development – 3

### **Focus:** Preparedness, Peer Work, Problem Sets, and Classroom Practices

***Moderator:*** *Dr. Kathy Harper, The Ohio State University*
***Time:*** *Tuesday August 2, 10:30 am to Noon*
***Location:*** *Scott Laboratory, Room E125*

***Computer Problem Solving using Matlab***

**Michael Parke**

The transition from small homework sets, which is how programming languages are traditionally introduced, to being able to use computers to solve complex problems is often a difficult challenge for students. It is a transition that is important to introduce before students become involved in more complex programming tasks in their majors and therefore fits appropriately in the second half of a first year program. This article describes an approach of using moderate complexity projects to both introduce how one approaches bigger program challenges and provide experiences for students to draw upon later.

***Students' perceptions in a first year engineering classroom and their relationship with behavioral and cognitive engagement***

**Lilianny Virguez and Ken Reid**

Motivation is considered as a strong predictor of student engagement and learning. The MUSIC model of Academic Motivation can be used by instructors and researchers to assess students' perceptions of the MUSIC model components (eMpowerment. Usefulness, Success, Interest, and Caring) for an activity or course. The purpose of this pilot study was to investigate the relationship between first year engineering students' perception of the MUSIC model of motivation components for an introductory engineering course and engagement. Methods of data collection included class observation and an online survey completed by 23 out of the 32 (72%) students in the class. Findings indicated that, for this class, the Interest component was positively correlated to both Behavioral and Cognitive engagement. In addition, data suggested that perception of the Caring component had the highest value while perception of Success had the lowest value. Factors supporting students' perception of each component were identified. Implications for practice in the classroom and overall conclusions were specified based on the findings of the study.

### *Work-in-Progress – A Program from Improving Student Preparedness for College*

**Rafic Bachnak and Susan Lemieux Eskin**

The shortage of STEM graduates in the United States has been the focus of numerous recent reports and various studies have been undertaken to determine ways to address this issue. A major concern is that engineering graduation rates in U.S. colleges and universities are low. Data compiled by the American College Testing demonstrates that the mean for the National 5-year graduation rate of 4-year public institutions is 37.9%, while the overall four-year engineering graduation rate is 22% in public schools and 45% in private schools. The rate varies greatly from one institution to another. At the University of Texas at Austin for example, the rate was 31% in 2012, while it was 51.5% at Texas A&M University and 66% at Santa Clara University in 2010. While there are many causes that result in low graduation rates, it is more likely that rates could be improved if students are well-prepared for college and have clear goals. This paper describes a two-week summer enrichment program that focuses on improving student preparedness for college, while promoting active learning through hands-on experiences and activities. Students will be introduced to various science and engineering disciplines through hands-on activities that include topics in chemistry, biology, physics, mathematics, computer science, electrical engineering, civil engineering, and mechanical engineering. The program also includes two field-trips where students tour local laboratories and manufacturing plants. This paper presents planning details and progress to date.

### *Work-in-progress – Dealing with "Formulaholic" – The formulae syndrome of the new generation engineering students*

**Ben Oni, Vimal Viswanathan, and David Baah**

Abstract - A fundamental skill set in the practice of the engineering profession is critical thinking skill. Over the years, peculiarities of generations of engineering students have become distinctively noticeable. The new generations of students enrolling in engineering programs have increasingly demonstrated unusual dependency on formulae for solving analytical problems. The dependency has reached the proportion to qualify for classification as addiction - labeled as "formulaholic" and defined as "the compulsive dependency on formulae to solve analytical problems to the subdual of critical thinking skills." Impact of subdual of critical thinking skills also manifests in students' reduced metacognition abilities. A new growing challenge in engineering education is to change the freshman's mindset from formulae dependency to critical thinking. The principal project that included this issue implemented a peer group tutorial program with strong emphases on social integration. A pilot study between a test group and control group respectively, showed that participants in the peer tutorial program performed much better in the common Math course that both groups took. The work presented in this paper is a follow-up on the participants to assess the extent to which participation in the peer group tutorial has moderated their initial formulae dependent mindset. Survey results show that by learning to develop their critical thinking skills, the students gained higher confidence in their abilities as well as performed better in their courses.
Index Terms - Peer Group Tutorial; Peer learning; Critical thinking skills, "formulaholic".

### *Work in Progress – Variations in Student Response to a Programming Class by Discipline and Gender*

**Michael Parke and Kathleen Harper**

Engineering 1221 is a two credit hour programming class taught through the Department of Engineering Education and accepted by eight of the departments in the College of Engineering as fulfillment of their programming requirement for graduation. The course is based on hands-on programming using MATLAB as the programming language. It is a follow-on to the introduction to

MATLAB that occurs in the first semester ENGR 1181 course as part of the regular and scholars tracks of the first year program at Ohio State. The intent of the course is to build upon prior instruction to introduce students to working with moderately big data sets and with modestly large programs so as to prepare students for the computing tasks they will face in their majors. Students in the spring semester include first year students and students who have either postponed the class or were unable to schedule earlier. Students in the autumn also include out-of-sequence students and a higher portion of transfer students. In AU 2015 the same instructor taught all six offered sections of ENGR 1221 and taught three of six sections in SP 2016. This presents the opportunity to remove one source of variation in student experience and investigate student success by gender and by discipline within these nine classes. It was shown that the Autumn and Spring classes were significantly different, so these were analyzed separately. No statistical significance in student success was found based on gender or discipline in either semester. The lack of difference by gender is thought to be a key result.

## **T2B:** Academic & Career Advising

***Moderator:*** *Richard Busick, The Ohio State University*
***Time:*** *Tuesday August 2, 10:30 am to Noon*
***Location:*** *Scott Laboratory, Room E004*

### *A personalized advisement mobile app suitable for group advisement*

**Harsh Gadhia, Chengyu Sun, and Deborah Won**

A holistic, developmental advisement tool, the Golden Eagle Flight Plan (or GEFP), was developed and piloted with the inaugural cohort of our College's new First-Year Experience (FYrE@ECST) as an online web version. GEFP-Online, while viewed by students as a useful advisement tool, is being underutilized. One of the advantages of the GEFP-online over other existing advisement practices in our College is GEFP-online provides students access to tracking of their own goals and milestones. It also provides them with convenient links to online resources. To encourage advisors and advisees to make use of what has been perceived as the potential benefits of the GEFP in improving advisement, mobile technology was leveraged to create a mobile version of the GEFP. Results indicating a discrepancy between the value of a tool such as the GEFP versus actual utilization of the tool are presented. The current implementation of the GEFP-mobile and a proposed use to encourage developmental advisement in a group advisement setting is presented.

### *First Year Engineering Advising: Shift from Transactional to Developmental*

**Lisa Lampe, James Groves, and Edward Berger**

This paper describes strategic changes in engineering first year advisor assignment over the last five years. We provide a comparison of our 2013 and 2016 advising surveys and suggested continuous improvements from the end of year advisor memo. The previous first year engineering advising model could be characterized as transactional with an emphasis on course selection and the new model as developmental with an emphasis on engagement and overall success of the student. When we compared student feedback across a set of questions contained in both surveys (advisor availability, advisor response time, advisor curricular knowledge, advisor policy knowledge, comfort in discussing career development with advisor, advisor's enjoyment of advising, and student's recommendation of advisor), we found a compelling improvement in each individual metric. In this paper, we highlight the importance of utilizing as advisors those faculty

and instructors who have regular, scheduled contact with students in the first semester, and provide rationale for centrally compensating them for this additional responsibility. Future research includes comparing those students that had an advisor who also taught one of their first semester courses to those that did not within this new model.

***The Effectiveness of Proactive Advising Interventions on First-Year Student Success and Retention***

**Julie Chiki**

With the creation of a full-time advising position focused on retention and persistence for first- and second-year students, the Russ College of Engineering and Technology at Ohio University has expanded its capacity to implement and assess proactive advising interventions designed to increase retention and reduce time to graduation. These interventions include 1) faculty referrals during the critical first few weeks of the semester, 2) outreach to students repeating coursework, 3) promotion of summer courses to accelerate progress through the curriculum, and 4) schedule audits to ensure appropriate course registration for the following term. This paper shares preliminary data from the first year of these advising interventions, including the impetus for their development and plans for future improvement. Each intervention has shown positive results for students who responded to the outreach compared with those who did not.

***Work in Progress – Developing Networks: Engaging First Year Students in Face-to-Face Networking and LinkedIn***

**David Richter, Elizabeth Glass, and Laurah Hagen**

This paper describes continued improvements to a twice annual (once each semester) First Year Engineering Event (FYEE), which connects first-year engineering students at Northern Arizona University (NAU) with professional engineers. Specifically, the improvements focus on an in-class, pre-FYEE workshop on LinkedIn and a related networking activity held during the FYEE.

## **T2C:** Engineering Education Research as it Applies to the First Year Experience – 3

### **Focus:** Assessment, Teamwork, and Student Success

***Moderator:*** *Andy Theiss, The Ohio State University*
***Time:*** *Tuesday August 2, 10:30 am to Noon*
***Location:*** *Scott Laboratory, Room E024*

***Using Frequent Low-Stakes Assessment (FLA) in a First Year Engineering Class***

**Lauren Corrigan, Krista Kecskemety, and Steven Nozaki**

The widespread use of the established pedagogical method of lecture based instruction in first year engineering (FYE) classrooms is declining in favor of more innovative effective strategies. It is more common to see novel methods that may be better suited toward communicating current curriculum. Frequent low-stakes assessment (FLA) refers to assessment methods that occur relatively often and the consequences associated with the outcome are low. For three sections of a course in an introductory engineering sequence, FLA was used as a primary form of formative assessment. It was also used as a main component of the instructional methods for the part of the

course that focused on programming. An inverted- , or flipped-classroom is the typical arrangement of the majority of the FYE courses at the host institution. For this study, in lieu of the standard instruction that preceded class work time, the material was often presented in a trivia-contest setting. There is a large amount of anecdotal evidence gathered from the sections that utilized trivia/activities as a form of FLA that suggest it to be an effective form of instruction. Students displayed an increased level of participation in class activities and interaction with instructional staff. More comprehensive data will be obtained as the semester ends.

***Reading matters in First Year Electrical Circuits Course***

**Ohbong Kwon, Chen Xu, and Juanita But**

In Fall 2015, over 30 percent of the 216 first year students who were enrolled in Electrical Circuits (EMT1150) did not pass the course, which is required for the Associate Degree in Applied Science (AAS) in Electromechanical Engineering Technology (EMT) at New York City College of Technology. The reason for the low pass rate is complex. Some students have insufficient skills in Math, while some cannot grasp the concepts of problem solving techniques, but the most fundamental problem is that students are under-prepared in learning through reading texts, even after they purchased the expensive textbook. On the other hand, instructors also struggle with teaching specialized concepts, formula, and technical terminologies because of various levels of their readability and the lack of strategies to engage students in active reading and learning. In this paper, we will examine the challenges students face in reading to learn in EMT 1150. First, we will review the correlation between students' reading proficiency and their performance in the course. We will analyze the results of reading assessments administered in two sections (N=41) of EMT1150 in Spring 2016, which reveal students' level of ability to comprehend, analyze, and evaluate information in their textbooks. This will allow us to identify the impact of students' reading skills on their ability to learn in EMT1150. Secondly, we will look at how students' reading habits affect their performance in the course, which will shed light on how they study outside of the classroom. We will also describe the Reading Effectively Across the Disciplines (READ) program, a college-wide initiative established in 2013 to train faculty to implement instructional strategies and develop assignments to facilitate reading to learn across the disciplines. In this program, participating EMT faculty work with reading faculty to enable students to become strategic and effective readers and improve their disciplinary literacy.

***You See it Your Way, and I See it Mine: How All-Male and Co-ed First Year Project Teams View Team Leadership***

**Natalie Van Tyne and Maria Brunhart-Lupo**

This study involves an evidence-based practice in which we discovered noticeable differences in the way men and women students perceive the behavior of their engineering design team over the course of a semester. While there are numerous factors that contributed to team success, we found it of particular interest to explore and compare perceptions of team leadership between all-male and co-ed teams. Trends in the data indicated a variety in type and depth of thought among the men and women students in our course population. Since this small, STEM-focused institution is actively involved in promoting diversity and inclusion, the campus culture ought to encourage students to be aware of the value of different points of view, and to apply them to teamwork, a fundamental engineering skill. Our results can begin to answer the question as to whether our campus culture has had this type of effect on first year students. This introductory engineering design course provides both an introduction to the engineering profession and an introduction to engineering design through a semester-long team project. Students were assigned to project teams by their instructors, using a skills and personality assessment. Effective and appropriate team leadership is often identified by students as a major factor in team success; we evaluated these

aspects through student feedback in team contracts, peer evaluations and self-identification. We formed the following research question as a basis for investigation: How do students identify and regard team leadership on an all-male team vs. a co-ed team? Our study population consisted of approximately 100 first year students during each of the fall 2014 and spring 2015 semesters, respectively. We also compared the final design report grades received by co-ed vs. all-men teams over the past five academic years, where a long time line can help to correct for confounding variables. Our results indicated that the most highly regarded leadership trait for an all-male team was reliability, even to the extent that a "team leader" was sometimes identified as one who leads by example rather than by initiating or directing team activities. By contrast, co-ed teams indicated positively that their team leaders were members who were highly organized and focused, and exhibited these traits by guiding team activities through either suggestion or delegation. It was also noted that the team leaders on co-ed teams were often women who exhibited a high degree of dedication, reliability and concern for team welfare. Many women team members, and not just women team leaders, also documented negative team member attitudes and the need to remedy them, in order to strengthen their teams.

***Work in Progress – Use of Multiple Tools to Evaluate Student Teamwork Skills***

**Patrick Herak and Kadri Parris**

Abstract - Teaching students the importance and ability of working effectively on a diverse team is often one of the course goals in First-Year Engineering programs. Teamwork skills are highly valued by employers and is one of the student outcomes of ABET accreditation. One tool used to assess teamwork skills is the Comprehensive Assessment of Team Member Effectiveness (CATME). Although, there are many articles in support of using CATME, there is always a risk involved in using one tool, especially when the data is based solely on student input. The goal of this study will be to use a multi-faceted approach to assess teamwork skills and determine if there is growth in teamwork skills throughout a semester. The evaluative tools will not only include CATME, but student self-reflection, team meeting minutes and instructor observation.

## **T2D:** Enrollment, Instruction, and Pedagogy – 3

**Focus:** Retention & Student Success

***Moderator:*** *Dr. John Merrill, The Ohio State University*
***Time:*** *Tuesday August 2, 8:30 to 10:00 am*
***Location:*** *Scott Laboratory, Room E040*

***Pedagogical Updates of the Civil Engineering Freshman Course Sequence***

**Andrew Assadollahi, Christine Moore, and R. Eugene McGinnis**

The Department of Civil and Environmental Engineering at Christian Brothers University has made several changes to its four year curriculum. The primary reason for these changes is due to the new format of the Fundamentals of Engineering Examination. The first phase of these major curriculum changes began with the freshman-level sequence of courses. Prior to the 2014-2015 academic year, the freshman sequence was comprised of three one-credit hour courses to be taken in the first three consecutive semesters of enrollment. After careful review of course evaluations, observation of student performance in later courses, consultation with current students, alumni, practitioners, and faculty at other universities which are accredited by the Accreditation Board for Engineering and Technology, Inc. (ABET); it was decided that a reorganization of these courses and their

contents was necessary. These three courses were eliminated from the paradigm and replaced with a sequence of two two-credit hour courses. This research shows how the freshman sequence modification has impacted the students' performance in the sophomore-level courses of: Statics, Mechanics of Materials, Structural Analysis, Hydraulics, and Geomatics.

***Work in Progress – Implementing a Differentiation Framework into Freshman Engineering Classes***

**Brenda Hutton-Prager and John O'Haver**

A Differentiation Framework has been developed at the University of Mississippi to address widespread student variation at freshman level in chemical engineering. It is hoped that implementation of this framework will increase student retention and maximize all students' learning outcomes. The framework consists of five broad (and usually progressive) categories that include understanding student need, providing students with challenging activities and eventually creating independent learners. It has been based on a detailed review of differentiation in the literature, mostly centering on educational instruction within the secondary school sector. While it is a common pedagogical technique used in K-12 environments, only a handful of studies appear in the literature regarding use of these techniques at higher-education levels. This is despite the fact that there are large drop-out rates of students at freshman level, and particularly in STEM-related courses. Differentiation techniques have proven very successful in many K-12 settings, and it is expected that this success can be transferred to freshman-level (and potentially beyond) chemical engineering courses. These techniques are to be trialed in ChE101 – Introduction to Chemical Engineering.

***Work-in-Progress – Are Students Properly Placed into their First-Year Engineering Course?***

**Amy Hamlin, Amber Kemppainen, Mary Fraley, Brett Hamlin, Amy Monte, Gretchen Hein, Jon Sticklen, and Nathan Manser**

Currently at Michigan Technological University, there are two pathways through the common first-year engineering program based on math placement. There is a two-semester sequence for students starting in Calculus I or higher and a three-semester sequence for students starting in Pre-Calculus. Traditionally, math placement was based on a student's math-ACT score. Beginning fall 2014, students have been placed using Assessment and LEarning in Knowledge Spaces (ALEKS) an online system that customizes each student's assessment and learning experience based on their knowledge and readiness to learn topics. The changes in the method used to place students into their beginning math course have provided both challenges and opportunities. The challenges include getting students to take the ALEKS assessment seriously and accommodating an upward shift in the number of students going through the two-semester sequence. This shift has provided an opportunity to begin to examine if two paths through the first-year engineering courses are necessary. If two paths are needed, can math placement be used for engineering course placement?

***Work in Progress – Rising to the Challenge: Revising a First-Year Engineering Course Around the Grand Challenges for Engineering***

**Sirena Hargrove-Leak, Scott Wolter, and Chris Arena**

Downward trends in the number of college students selecting STEM majors and graduating in those fields prompted a number of efforts to reverse the trends and student retention is a key measure of success. First-to-second year retention has been declining in our program over the last few years. Hands-on projects with connections to practical disciplinary application, community-building, and transformative first-year experiences are known to aid in improving student retention. One of the expected outcomes of our introductory course is to "Recognize contemporary and historic

engineering issues and technological advances, and their impact in a global, economic, environmental, and societal context." The National Academy of Engineering Grand Challenges for Engineering provides a framework for helping students to explore contemporary issues and societal needs. This work explores the incorporation of several small scale hands-on projects related to the Grand Challenges for Engineering. Preliminary data indicates that this approach enhances student retention.

***Work-in-Progress – Creating a Collaborative Community in a First-Year Engineering Design Project***

**Lauren Corrigan and Krista Kecskemety**

In many First-Year Engineering courses, students are often organized into groups when tasked with completing design projects. This type of team-based learning offers numerous benefits such as improving communication skills and problem solving abilities. Additionally, students are capable of completing tasks that exceed the skills of an individual student when working in a team. While team-based learning has been proven to be beneficial, structuring classes where the teams are encouraged to compete against one another may have detrimental impacts on students, especially females. Instead, by restructuring design projects so that classroom-wide collaboration is encouraged, student performance, as well as retention, may improve. A pilot study was conducted in spring 2016 to evaluate the effects of such a restructuring.

## **T3A:** Student Success and Development – 4

### **Focus:** Mathematics

***Moderator:*** *Dr. Patrick Herak, The Ohio State University*
***Time:*** *Tuesday August 2, 1:30 to 3:00 pm*
***Location:*** *Scott Laboratory, Room E125*

***Engineering Student Success and High School ACT Math Scores***

**Sungwon Kim**

Engineering student retention related issues are receiving more and more attention as the nation tries to prepare for shortage of students graduating with engineering degrees. Much of the attention has been focused on making adjustments to the undergraduate curricula or providing alternative methods of content delivery. Although many of these adjustments are warranted and effective, these efforts are being made with the assumption that the students come to college ready to understand and receive a college level education. While this assumption may be true for certain institutions, it may not be for others. Calculus and calculus based physics courses that provide a foundation for all engineering fields of study are perhaps the most difficult courses that engineering freshman and sophomore students experience during the initial stages of their academic careers. Students who are able to understand and pass these courses generally tend to continue with their engineering studies. This paper attempts to create a correlation between high school ACT Math scores of students enrolled in a university freshman level "Introduction to Engineering" course and their level of success. A voluntary survey was conducted asking students enrolled in a university freshman level "Introduction to Engineering" course their anticipated grade in the course, their anticipated GPA in the semester, the current math course that they were registered for, the math course that they were planning to register for in the following semester, and their high school ACT Math score. Preliminary results show that students making good progress towards their engineering degree had ACT Math scores above 28. Continued research, both in terms of

longitudinal tracking of students and in terms of giving the survey to incoming students enrolled in the same class year after year, is expected to give more data points that should provide higher confidence in these preliminary results.

### *A Math Review's Impact on Freshman Engineering Retention and Success*

**Robert Rabb, Ally Martin, Kevin Bower, and Robert Barsanti**

Many students enter engineering programs with high levels of interest and excitement but change majors or leave early in the first two years. To assist the transition of students from high school to the rigor of college level engineering courses, The Citadel developed a math review program to retain more engineering students. Recent years had more enrollment than what was expected. The challenge was to provide appropriate levels of scaffolding and curriculum engagement to help students be successful and keep them in the program. During the past fall, the Math Review was offered and provided a two and a half week (10 sessions) review of Pre-Calculus designed to prepare students for the rigor of college freshman math courses. Faculty from the civil, electrical, and mechanical programs conducted one-hour math review sessions in the evenings during the first 10 days of classes. The sessions were designed to be active learning sessions where instructors worked example problems followed by students working problems on the board and discussed the solutions. Some goals of the program in addition to covering fundamental topics were to model and encourage good work habits early in the semester and provide resources where students could find help on their own. Implementation of the Math Review showed success in creating a sense of community among the engineering students and reducing both withdrawals from math courses and changes of major when compared to the same point the year before. Through these freshman engineering initiatives, students were able to see themselves as engineering students and understand the types of knowledge and abilities essential to succeed. The objectives of this paper are to explain these readiness initiatives, to assess the first year program results quantitatively and qualitatively through retention data and surveys, and to discuss the future potential of the program.

### *Emulating the Wright State Model for Engineering Mathematics Education: Improving First-Year Engineering Student Retention*

**Leroy Long, Lisa Abrams, Lisa Barclay, and Jamie Paulson**

In 2004, Wright State University developed an innovative mathematics course for first-year engineering undergraduates in order to increase student retention, motivation and academic success. To date, the Wright State model has had a positive impact on student retention, motivation and academic success by increasing graduation rates and GPAs among participants. During the fall of 2014 and 2015, one large public university in the Midwest with more selective admission criteria decided to pilot a course based on the Wright State Model for Engineering Mathematics Education. Using the Wright State model, a mathematics for engineering course was offered to prospective students so they could subsequently begin engineering classes without a traditional calculus prerequisite. Each semester, a cohort of 31 first-year engineering students enrolled in the course. Instructors distributed surveys to students at the beginning and end of each term. In addition, university administrators tracked student grades in subsequent math and engineering courses. This paper will outline the details of the course as well as the academic performance and retention of these students. Preliminary findings suggest first to second year retention is higher with students who have taken the mathematics for engineering course. First-year students who take the course also earn higher grades in algebra, trigonometry, and introductory engineering courses, but not in Calculus I.

***Improving Calculus Performance Using Workshop Collaborative Calculus***

**Whitney Gaskins**

In this study, Summer Bridge students participate in a Supplemental Cooperative Learning class (SCLC) structured as Peer-led teaching and learning (PLTL) in Calculus (Calc I) and Calculus II (Calc II) of their freshman year. The Emerging Ethnic Engineers (E3) Summer Bridge Scholars Program has been dedicated to increasing the number of underrepresented students who enroll in and graduate from the College of Engineering and Applied Science. The undergraduate students participated in the 7-week summer bridge program prior to the start of their freshman year and enrolled in the collaborative learning calculus course. This course is a 1- credit hour course which meets 2 hours per week to supplement regular courses. The Collaborative Calculus Course includes the following: 1. A weekly 1 hour peer-led study-group session that is integral to the course and coordinated with the course's other elements (e.g., lectures and recitations). 2. The course instructor closely involved in selecting materials to be covered by the students. 3. The students conduct workshop sessions in each class, highlighting a main concept covered in the regular class and then conducting an interactive problem solving activity in which students participate as a group. The instructor will give attention to content, leadership skills and the cooperative learning process. 4. The problems are challenging, and at the appropriate level for students, integrated with regular course components, and designed to encourage active and collaborative learning. Each week the class is split into groups and group leader responsibility is rotated to give each student leadership experience. The course was designed to have student instruction, collaborative projects, and engineering content modules. Student performance and mathematics self-efficacy were analyzed. Students Grades for the course are based on mandatory attendance and participation in the cooperative learning process.

***Work-In-Progress – First Year Engineering Experience of Under-prepared Students at the University of Akron***

**Julie Zhao and Donald Visco**

At The University of Akron, about 12% of the first-year engineering students are considered underprepared in math in that they must take their first mathematics at a level below Pre-Calculus. During the past five years, the first-year retention rate of this cohort at The University of Akron is about 52%, compared to the first-year retention rate of about 80% for the first-year engineering students placed into Pre-Calculus and above. Low student retention rates have a great impact on both student success and institutional strategic planning. Based on a successful program at University of Colorado at Boulder (GoldShirt Program), the Engineering Redshirt Learning Community was developed in 2014 at The University of Akron as a part of the First Year Engineering Experience (FYEE). This paper discusses the context of creating this first-year engineering experience in easing students' transition from high school to college, enhancing their study habits and equipping them for success in engineering and beyond. Student feedback and assessment results are presented to guide further development of the program and academic support of all first-year students.

# **T3B:** Other Topics that Address Issues in First Year Engineering Education

**Focus:** Minorities, Mentorship, Entrepreneurial Mindsets, and Societal Issues
***Moderator:*** *Dr. Phil Schlosser, The Ohio State University*
***Time:*** *Tuesday August 2, 1:30 to 3:00 pm*
***Location:*** *Scott Laboratory, Room E004*

### *The Motivations and Obstructions for Female Engineers*

**Danielle Grimes, Rachel McFalls-Brown, and Dr. Jean Mohammadi-Aragh**

Engineering educators have been researching diversity within engineering for decades. One popular area of research is females in engineering due to their historically low enrollment. Engineering currently has an enrollment rate of approximately 20% female and some research in the early 2000s showed enrollment rates decreasing. While researchers have examined quantitatively why women choose engineering, there has been less qualitative research to fully examine the phenomena. Using a critical theory paradigm, our work investigates three different female engineering students' perspectives on why they entered engineering. We explored how these females chose engineering through semi-structured interviews. The research questions driving our work were 1) What factors do female undergraduate engineering majors assert as the strongest influences in their major choice? 2) What barriers do female engineers perceive in their major choice? Our work is a first step into understanding how these three female engineers decided to major in engineering and what they perceived as the most influential factors their major choice. Some motivational studies have been done on female major choice, but our work is an attempt to engage female engineers in conversation and provide rich, thick descriptions of how they've experienced the engineering pipeline. This preliminary study is a portion of a larger interview project that will eventually be used to inform recruitment programs for women in engineering. The women in this study include two seniors and a freshmen currently enrolled in engineering programs at a large land grant institution in the southeast. All three participants in this study are from different engineering departments. The questions used in the semi structured interview were: 1) What is your engineering major and year in school? 2) When was the first time you heard of engineering? 3) Why do you think you chose engineering? 4) Why do you think your chose your engineering field in particular? 5) Why do you think girls lose interest in engineering (in between elementary and high school)? 6) What do you think is the hardest part of being a female engineer? 7) What parts of being an engineer do you enjoy? 8) Is there anything else that you want to tell me about what it's like being a female engineer or anything you feel like I didn't ask?

### *Incorporating an Entrepreneurial Mindset in a Freshman Mechanical Engineering Course*

**Chiradeep Sen and Pierre Larochelle**

This paper presents a case of incorporating Project-Based Learning (PBL) and Entrepreneurially-Minded Learning (EML) to foster an entrepreneurial mindset in a freshman-level, introductory course in mechanical engineering within an ABET accredited program. The course is designed to teach the basic tools and skills of engineering such as graphics communication, solid modeling, and programming, with a large term project where students design and build an engineering system. The teaching method included two novel elements that were introduced in Fall 2015: (1) the tools and methods for systems design were taught using a Project-Based Learning module, and (2) the term project was changed from a design and build project to an entrepreneurial engineering

project. The resulting designs were highly varied within the class and of higher quality than the more traditional approach, where the instructor assigned the same problem to each team.

***An Integrated Approach to Providing First Year Engineering Experience***
**M. Ronald Yeung and Cordelia Ontiveros**

The College of Engineering at the California State Polytechnic University, Pomona, uses an integrated approach to providing engineering students with a comprehensive and useful first year experience. It involves several elements including a Summer Orientation Program for incoming freshmen during the summer just prior to their entering the university; an engineering course, EGR 100/L, "Engineering, Society, and You," consisting of a three-unit lecture section and a one-unit laboratory section that satisfy the General Education requirement of "lifelong learning and self-development; an Engineering Freshman Advising Program provided by a dedicated Engineering Advising Center; a Maximizing Engineering Potential Program targeting traditionally underrepresented students; and a Women in Engineering Program that provides female students the resources and support services to succeed in engineering. Through integrating these various elements, the College of Engineering aims to provide students with a first year experience that would be useful throughout their college and professional careers.

***Ohio Researchers for Engineering Education: A Community of Practice***
**Rachel Kajfez, Krista Kecskemety, Kerry Meyers, and Greg Bucks**

An informal organization was created to bring together researchers from the State of Ohio to share best practices. This organization, Ohio Researchers for Engineering Education (OREE), has been collaborating for approximately 3 years. Through this Work-in-Progress paper, a background of the organization will be given as well as some reflections from its members about the strengths, weaknesses and opportunities for improvement of the group. The group's successes have included three collaborative conference research publications, curricular enhancements from shared ideas, and a shared sense of community. Most of the challenges and opportunities for improvement focus on scheduling and management of the group. It is the authors' hope that this paper and the reflections contained within it will provide guidance to anyone looking to create a similar community of practice within engineering education. Furthermore, the reflections contained within this paper will provide the group with a blueprint on how to proceed in the future.

***Work-in-Progress – Constructing a Diverse and Interdisciplinary Community of Learning and Mentoring: Developing Leadership and Emotional Intelligence through Here-and-Now projects***
**Jongmin Lee, William Johnson, and Marybeth Parker**

An interdisciplinary team of two engineers and a humanist aimed to create a community where a diverse group of students could learn to become active members of the engineering school and future leaders of society. This work-in-progress paper explores the challenges and rewards of student empowerment and experiential learning in an introductory engineering course at the University of Virginia. After reviewing the teamwork, leadership, and diversity learning outcomes at the conclusion of the first semester, the authors lay out remaining tasks and future goals, which include the potential redesigning of the overall first-year engineering curriculum, a longitudinal study of student-faculty relationships by annual semi-structured interviews, and empowering former students to become peer mentors for new students.
***Note: This paper will not be presented, but is included in the proceedings***

# **T3C:** Other Topics that Address Issues in First Year Engineering Education

**Focus:** Mathematics & Social Consciousness
***Moderator:*** *Dr. Kadri Parris, The Ohio State University*
***Time:*** *Tuesday August 2, 1:30 to 3:00 pm*
***Location:*** *Scott Laboratory, Room E024*

***Math-Proficiency Program for New Engineering Students***

**Hyunjae Park and Chris Perez**

It has been well recognized that many entry-level engineering students struggle with studying college-level math courses due to their lack of explicit experiences and opportunities reviewing and integrating basic mathematical fundamentals and principles that they have studied during their high school education. In response, the Marquette University – Opus College of Engineering has developed the math-proficiency program (in the areas of precalculus) to help new engineering students prepare for and study college-level math courses (such as calculus and differential equations) which are fundamental to engineering education. After running the math-proficiency program for the last five years, it was discovered that many new engineering students are clearly able to recognize and find the areas and topics in precalculus that they are weak and need to improve during their first semester at college. The math-proficiency test analysis results show that student performance in the course Freshman Engineering Discovery 1, which is taken during their freshman year at college, for the students who scored well above the minimum point level consistently maintained high marks throughout college-level courses, while some students who scored well below the set point somewhat struggled in studying college-level courses.

***Pre-Calculus Summer Boot Camp – Lessons Learned***

**Ashish Borgaonkar, Ryan Baldwin, Edwin Hou, and Moshe Kam**

New Jersey Institute of Technology (NJIT) administers a mathematics placement test to all incoming first year students. The only exceptions are students who have advanced placement credits or college level credits for calculus. A poor performance in the placement test will result in students being placed into one of the two pre-calculus (remedial) courses. Students who place in a pre-calculus course must catch up in their curriculum. In summer 2015, NJIT ran a pilot pre-calculus summer boot camp to provide students with an opportunity to catch up before their first semester (fall) at NJIT. The 2015 pilot of the pre-calculus summer boot camp produced very encouraging results with 77% of the students moving onto the next course in the math sequence. In addition to taking a pre-calculus math course, students also received supplemental instruction, breakfast, lunch, a chance to interact with faculty, staff, and academic advisors. The boot camp produced several positives and a few things that need to be worked on going forward. NJIT has decided that the program should continue and all efforts should be made to attract higher student participation for 2016. This paper covers information on details of the boot camp outcome and lessons learned from the 2015 pilot run. Several adjustments have been made to the program this year to increase the impact on the rate of student participation and success.

### *ENGR 101 – Application Oriented Course to Help First Year Students Make the Connection Between Engineering and Mathematics*

**Jaskirat Sodhi, Edwin Hou, Ashish Borgaonkar, and Moshe Kam**

A key factor in lower than expected retention and graduation rates in engineering schools across the country, including New Jersey Institute of Technology (NJIT), is the high failure rate in first year mathematics. A prime reason for this is that students are unable to see the connection between math and engineering and thus loose the drive to succeed especially in math courses. Wright State University has successfully utilized a model that helps increase student motivation and success in engineering through an application-oriented, hands-on introductory course in engineering analytical methods. The principal idea is to offer a first-year engineering mathematics course addressing only the salient math topics actually used in core engineering courses. This course will serve as a pre-requisite for some of the second year engineering courses and thereby remove the "first year calculus bottleneck". Our group at the NJIT proposes a Fall 2016 pilot using this model to help students succeed in mathematics and engineering courses. This paper will present information about the proposed plan, target population and the plan of action to set up such a pilot in STEM schools.

### *Teaching an Introductory Engineering Course that also Satisfies a Humanities General Education Requirement*

**Scott Munro**

The freshman engineering class at Southern Utah University, ENGR-1010: Engineering in the 21st Century, is an introduction to engineering methods and thought as well as an examination of the interaction of society and engineering. The engineering department uses the course to introduce engineering students to a variety of topics in engineering and to attract students considering engineering. To accomplish this, the course is required for engineering majors but also can be taken for humanities general education credit. While many of the non-engineering students are considering engineering as a major and therefore have a science and math background, many students majoring in non-science related areas also take the course. This broad range of student backgrounds poses unique challenges compared to other engineering courses. This paper describes the basic approach to teaching such a course, some of the advantages and disadvantages, examples of topics, an examination of the successes and failures. Given the fact that many students do not have the appropriate math and science background to complete an introduction-to-engineering course that introduces students to engineering problem solving, the course largely covers concepts and methods used in engineering. Additionally, the course overviews broad engineering technologies and examines them from two perspectives; the impact of the technology or discipline on society, and how society impacts how engineers design. The intent is to introduce engineering students to many of the concepts they will need to use during their studies and throughout their career early in the curriculum. The results from a student survey found that the non-engineering majors in the course find value in many of the topics more focused on engineering majors taking the course.

### *A Project Centered Course for Socially Conscious Engineering Freshman*

**Vernal Alford**

University students embark upon the new experience of higher education with hopes and dreams of their future. Freshman students are told they will be the new innovators, they will change the world. Freshman engineering students are no different. Freshman engineering courses are usually designed to introduce the "rookies" to their chosen field in a cursory way, that is, the courses look at various engineering disciplines, functions, history, ethics etc. Engineering projects are mechanisms

by which the freshmen are immersed into a quasi-design environment, complete with a modest budget (their own), multi-disciplinary teammates and deliverables to be submitted by a deadline. This institution's investigation was initiated to combat the perceived apathy of the freshman students towards learning more facts and studying for tests that may or may not hold relevance for them. Students at various universities and colleges nationally and internationally develop their own idiosyncrasies based on their caregivers, personal experiences, religious affiliations, etc. At this particular institution, one characteristic that has prevailed is one of socially-consciousness. This peculiarity may have its roots in the social upheavals of the 1960's and 1970's, of which, the caregivers of this generation of students are keenly aware. That social consciousness seems to be transferred to the students of this age. Recognizing the cohorts of engineering students at this institution as socially conscious, attempts were made to assign projects that awaken the passions of the students. The hypothesis is: as the students' passions increase, their involvement will also increase so that the quality of the deliverables is more appropriate to the professor.

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