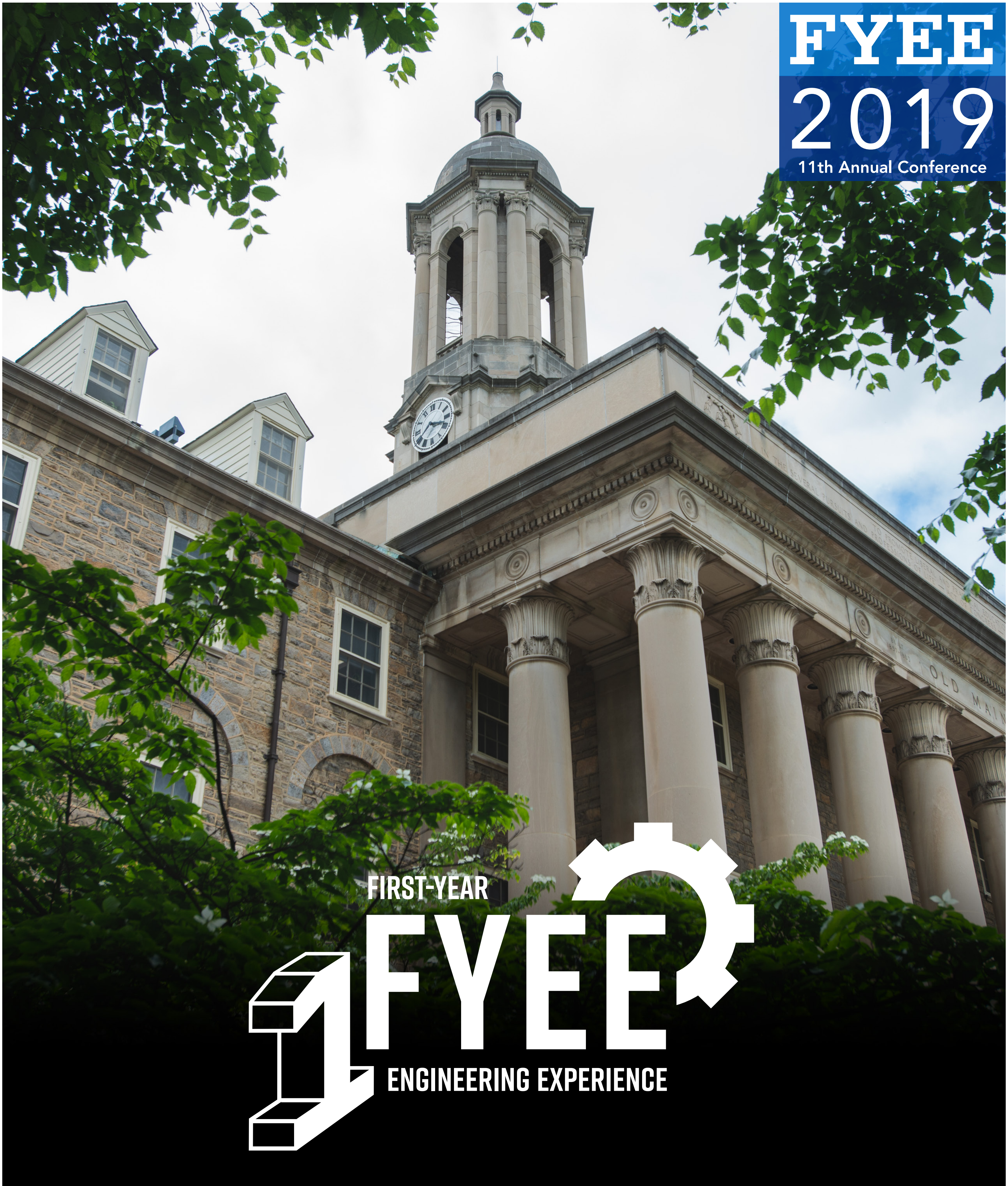

JULY 28-30, 2019

Penn Stater Hotel and Conference Center

Hosted by The Leonhard Center for the Enhancement of Engineering Education, College of Engineering, Penn State

PennState
College of Engineering

Welcome from the General Chairs

Tom Litzinger, Ph.D.
Head, The Leonhard Center for the Enhancement of Engineering Education; Assistant Dean, Educational Innovation, Accreditation, and Digital Learning; Professor, Mechanical Engineering, Penn State

Stephanie Cutler, Ph.D.
Instructional Specialist, The Leonhard Center for the Enhancement of Engineering Education; Assistant Research Professor, Penn State

We are thrilled to welcome you to the 11th Annual First-Year Engineering Experience Conference held at Penn State! The conference seeks to bring continued exuberance to the dialogue that began at the University of Notre Dame in 2005.

The experience of first-year engineering students has been a major focus at Penn State since the ECSEL Coalition when we first implemented our first-year design course. The first-year experience has since been enhanced by the implementation of first-year seminars as part of our General Education Curriculum. Our Engineering Equity Initiative, begun in 2017, is bringing new attention to the experiences of our students in the first-year.

FYEE represents a unique opportunity to better understand the complexities associated with educating first-year engineering students. Through combinations of keynote addresses, workshops, and technical sessions, conference attendees are encouraged to share best practices and innovative ideas for improving first-year engineering education. We hope all attendees will engage with the conference program and each other to encourage continued excitement and motivation for enhancing the first-year engineering experiences around the country.

The FYEE conference will take place in the Penn Stater Hotel and Conference Center, starting with workshops and a Tailgate reception/dinner on Sunday. Monday will feature two keynote addresses and, along with Tuesday, will be filled with workshops and technical sessions.

With the continued focus on the connection between all elements of the first-year engineering experience, we hope to see old friends and new faces at FYEE 2019.

We look forward to seeing you all!

Conference Committee

The FYEE conference is made possible by the dedication of many volunteers.
Penn State General Co-Chairs: Stephanie Cutler and Tom Litzinger, Penn State
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Rich Whalen, Northeastern University

Welcome from the Dean

Dear Colleagues,

Welcome to the Penn State College of Engineering! We are delighted to host the 11th annual First-Year Engineering Experience Conference.

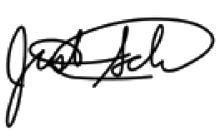
Penn State has one of the largest and most complex first-year engineering experiences in the U.S. We enroll approximately 3,700 first-year students annually. We offer more than 100 sections of our first-year design course across more than a dozen campuses. At our University Park campus, we also offer nearly 80 sections of first-year seminars that are designed to help our new students engage with each other and the college.

Increasing enrollments and changing demographics have led to new challenges in engaging and supporting our first-year engineering students. We have launched the Engineering Equity Initiative to meet these challenges and opportunities, with the goal of increasing the composition of the undergraduate class to 50 percent women, while also increasing the number of under-represented minority students enrolled.

A critical piece of recruitment and retainment of traditionally under-represented groups in engineering is building community through the first-year experience students have in engineering. Dr. Tonya Peeples, our inaugural associate dean of equity and inclusion and Monday's keynote speaker, is leading this effort. Tuesday's keynote speaker, Dr. Walter Lee, is an assistant professor of engineering education at Virginia Tech and the assistant director for research in Virginia Tech's Center for the Enhancement of Engineering Diversity.

The FYEE Conference offers a tremendous opportunity for us to learn from our colleagues and to share some of our best practices to ensure all students have the best first-year experience. I wish you all an enjoyable and engaging conference!

Sincerely,



Justin Schwartz
Harold and Inge Marcus Dean of Engineering

Table of Contents

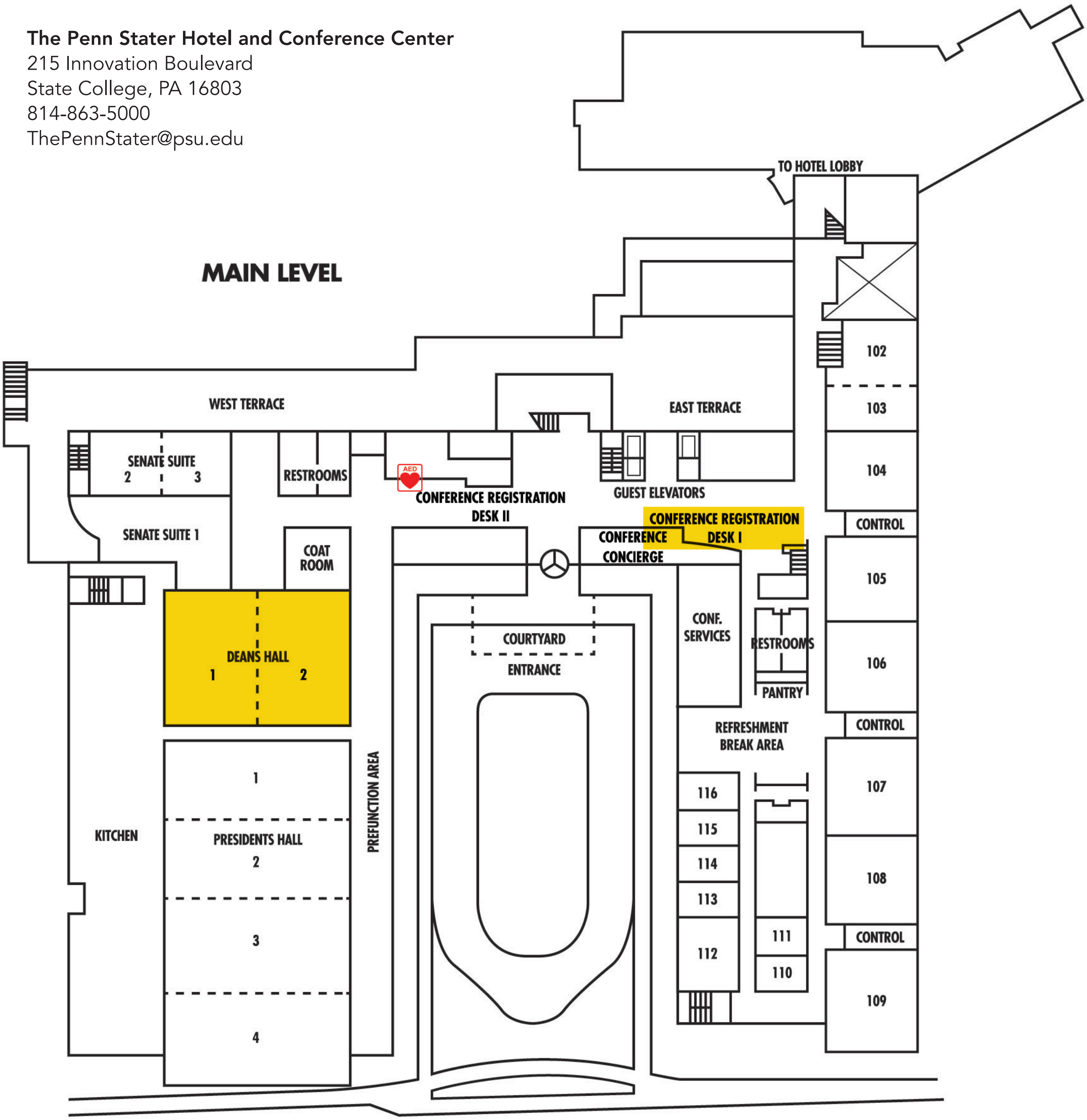
Sunday, July 28	Event		Location
12:00-7:00 pm	**REGISTRATION**		**Registration Desk**
2:30- 4:00 PM Workshop S1	Workshops S1	Facilitator	
	Growth & Grit: Encouraging a growth mindset and grit for first year students	Stephanie Cutler and Sarah Zappe	206
	Deployment of Educational Modules in a First-Year Engineering Design Course	Sarah C. Ritter	207
	Focus Group: Engaging first year engineering students with Cengage's digital learning tools	Brenna McNally and Tim Anderson	208
4:15-5:45 PM Workshops S2	Workshops S2	Facilitator	
	Workshop: Creating the Entrepreneurial Mindset in First-Year Engineering Design Courses	Peter Rogers and Krista Kecskemety	206
	Training students to become better peer teamwork behavior raters:	Dan Ferguson	207
	Introduction to the Multiple Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD): Focusing on First Year Engineering	Hossein Ebrahiminejad	208
6:00 - 8:00 pm	**Conference Tailgate Receptions and Dinner**		**Deans Hall 1&2**
Monday, July 29	**Event**		**Location**
7:00 am - 7:00 pm	**REGISTRATION**		**Registration Desk**
7:00 - 8:30 am	**Breakfast**		**Dean's Hall 1&2**
8:00 - 8:30 am	**Keynote by Dr. Tonya Peeples, Associate Dean for Engineering Equity and Inclusion**		**Dean's Hall 1&2**
8:45 -10:15 PM WIP	M1A - Learning experiences 1	Presenting Author	
	Inspiring and Engaging First-Year Engineering Students at a Small Campus Through International Team Design Projects	Maria Jane Evans	206
	Developing a Primer for First-Year Engineering Educators	Jack Bringardner	
	Physical Computing Design Project to Promote Equity and Community in an Introductory Engineering Course	Jennifer Mullin	
	Use of kite based measurement systems for service-learning in informal settings	Jonathan Elliot Gaines	
	Work-in-Progress: The Development of a Co-Taught Student Success Course for Freshmen	Bonnie S. Boardman	
	An Introduction to Computer Vision for First-Year Electrical and Computer Engineering Students	Daniel Klawson	
	Flip-J instructional strategies in the first-year engineering design classroom	Jonathan Elliot Gaines	
	M1B - Learning experiences 2		
	Enhancing experience and learning of first-year surveying engineering student with immersive virtual reality	Dimitrios Bolkas	207
	We AR...DUINO! a project-based first-year experience, collaborative with the IEEE student chapter	Tim Kane	
	Work-In-Progress: Addressing Student Attitudes and General Study Skills through a new hybrid distance learning model, or NHDLM	Robert V. Pieri	
	Exploring instructors decision-making processes on the use of evidence-based instructional practices (EBIPs) in first-year engineering courses	Nicole P. Pitterson	
	Work-In-Progress: What is engineering? First-year students' preconceptions about their chosen profession	Brianna L Dorie	
	Work in Progress: Analyzing a Distributed Expertise Model in an Undergraduate Engineering Course	Sara Willner-Giwerc	
	The effectiveness of writing interventions on first-year engineering reports.	Kimberlyn Gray	
	Integrating Makerspace in First-Year Engineering Curriculum	Ashish D Borgaonkar	
	M1C - Readiness and Professional Development		
	Work-In-Progress: Recruitment of Pre-Engineering Students via an Advanced Manufacturing Pathway	Robert V. Pieri	208
	Facilitating the Success of Academically Under-Prepared Students	Matthew Cavalli	
	WIP - Living-Learning Programs: A Model for Student Success and Engagement	Emily Sandvall	
	Work-in-Progress: Examining Engineering Community and Identity in FYE Pathways: Case Study of Two Veterans' Experiences	Rachel Louis Kajfez	
	Work-in-Progress: Investigation of a Fall-to-Spring Performance Drop in a First-year Experience	Todd France	
	Work-in-Progress: A Professional Learning Community Experience in Developing Teamwork Teaching Materials	Bonnie S. Boardman	
	Helping Transfer Students Succeed: Establishing Pathways to Include Transfer Students in a First Year Engineering Program	Janet K. Lumpp	
	Work in Progress: Peer-based Programming in Undergraduate Engineering	Jennifer L Johrendt	
	Work-in-Progress: Using First Year Engineering Laboratory to Improve a Student's Readiness to Pursue an Engineering Degree.	Reginald Perry	

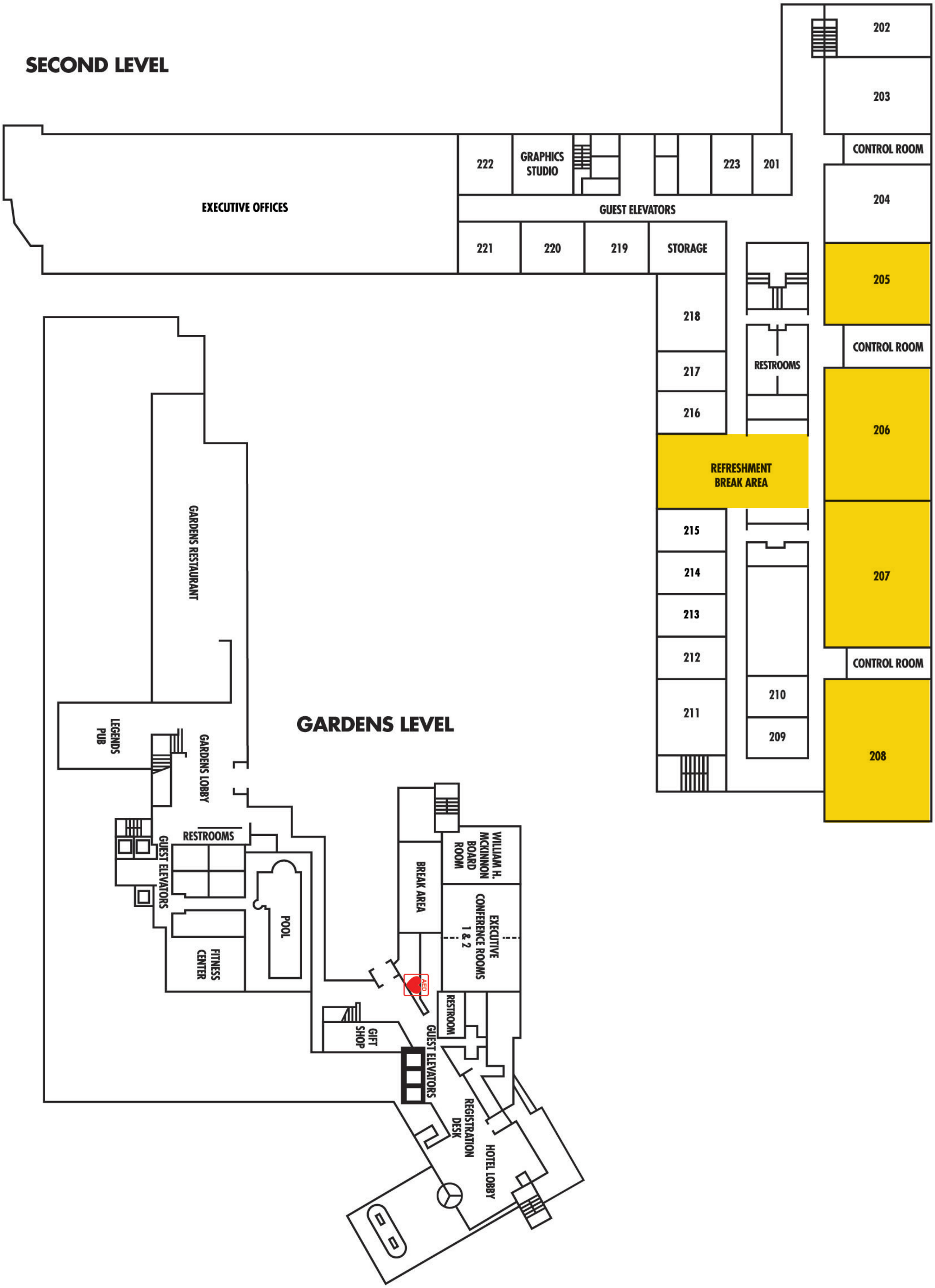
10:15-10:45 am	**Networking Time**		**Break Area 2nd floor**
10:45 - 12:00 - Technical Session M2	M2A: Learning By Design	Presenting Author	Room
	Proto-tripping: How to prototype with minimal tools and resources	Charlotte de Vries	206
	The Development of a First Year Design Project: Focusing on Creativity, Independence, and Design Understanding	Breigh Nonte Roszelle	
	A Flexible, Portable Making Solution to Enable Hands-On Learning with Additive Manufacturing in Cornerstone Engineering Design	Nicholas Meisel	
	EDSGN 100: A first-year cornerstone engineering design course	Sarah C Ritter	
	M2B: Learning in Teams		
	Partnering with Occupational Therapists for First-Year Design Projects	Todd France	207
	The influence of percentage of female or international students on the psychological safety of team	Behzad Beigpourian	
	An Evaluation of a First-Year Civil Engineering Student Group Dynamics Intervention	Anna Norris	
	Comparing Teamwork Peer Evaluations Between Culturally Homogenous Teams and Culturally Diverse Teams	Siqing Wei	
	M2C: Learning By Design		
	Creating Engaging Escape Rooms in First Year Engineering Courses: A Pilot Study	Scott Streiner	208
	Full Paper: Can a First Day Activity Help Raise Customer Awareness, an Important Attribute of an Entrepreneurially Minded Engineer?	Haolin Zhu	
	Full Paper: Implementing Classroom-Scale Virtual Reality into a Freshman Engineering Visuospatial Skills Course	Jonathan R. Brown	
	Full Paper: A Makerspace Project for New Transfer Students	Bonnie S. Boardman	
12:15-1:15 PM	**Lunch**		**Deans Hall 1 &2**
1:15 - 2:00 PM	**Keynote by Dr. Walter Lee from Virginia Tech**		**Deans Hall 1 &2**
2:00 - 2:30 PM	**Networking Time**		**Break Area 2nd floor**
2:30 - 3:45 pm - Technical Session M3	M3A: Learning in Context 1	Presenting Author	Room
	Assessment Analysis Results of How Freshman Engineering Students Build an Entrepreneurial Mindset through Freshman Engineering Discovery Courses	Hyunjae Park	206
	Promoting Student Confidence by Increasing the Breadth of Content in a First Year Electrical and Computer Engineering Course	Jennifer Marley	
	Implement Hands-on Activity for Statics Course into Student Success Program	Xiaohong Wang	
	Hands-on Laboratory Exercises for Engineering Applications of Mathematics Course	Aysa Galbraith	
	M3B: Learning and Context 2		
	Probability and Statistics: Early Exposure in the Engineering Curriculum	Roger J Marino	207
	Increasing first-year student motivation and core technical knowledge through case studies	Geoff Rideout	
	Full Paper: Assessment of Entrepreneurial Mindset Coverage in an Online First Year Design Course	Haolin Zhu	
	Leveraging Algae to Inspire Curiosity, Develop Connections, and Demonstrate Value Creation for First Year Engineering Students	Kevin D. Dahm	
	M3C: Mentoring into a profession		
	Tackling Real-World Problems in First-Year Electrical Engineering Experiences	Michael Cross	208
	Advice from a First Year	Michelle E Jarvie-Eggart	
	Creating an Effective Retention Program	Whitney Gaskins	
	Helping Undeclared Engineering Students Find Their Best-Fit Major	Roger J Marino	
4:00 - 5:30 pm - Workshops M4	M4: Workshops	Facilitor	
	Fusion 360 takes your ideas and makes them real	David Taylor	205
	MATLAB - Mathwork	Jerry Brusher	206
	(Dis)connected: Low-tech teaching strategies for engaging first-year engineering students	Kristine Craven	207
	Virtual Product Dissection Educational Modules - A Tool for Learning and Creativity During Engineering Design Projects	Elizabeth Marie Starkey	208
6:30-8:30 PM	**Dinner - Conference Photograph**		**Deans Hall 1 &2**

Tuesday, July 30th	Event		Location
7:00 am - 12:00 pm	**REGISTRATION**		**Registration Desk**
7:00 - 8:30 am	**Breakfast**		**Dean's Hall 1&2**
8:30 - 9:45 am- Technical Session T1	T1A: Learning and Multiple Perspectives	Corresponding Author	Room
	First-Year Engineering Service Learning Projects Can Play Large Role on Global Issues	David Gee	206
	Reflection on the Road: How Recent First Year Students Exhibit Reflection During a Short-Term Study Abroad Experience	Natalie C.T. Van Tyne	
	Understanding Global Perspective Development in First-Year Engineering Students: Determining Educational Impact	Scott Streiner	
	Creation and Implementation of a Project Framework to Improve Cornerstone Engineering Design	Nicholas Meisel	
	T1B: Developing foundations in Science	Corresponding Author	Room
	Full Paper: Creating and Assessing STEM Kits for P-12 Teacher Use	Stephany Coffman-Wolph	207
	Combining basic tool training and an introduction to physical sciences for freshmen engineering students	Bradley A. Striebig	
	An Investigation on the Effects of Supplemental Instruction and Just-in-Time Tutoring Methods on Student Success and Retention in First Year Engineering Course	David Joseph Ewing	
	T1C: Developing Foundations in Mathematics		
	Strengthening Math Skills of Incoming Engineering Freshmen through a Bridge Program	Jacquelyn Huff	208
	Benefits and Challenges of Teaching a First-Year Engineering Experience Course at a Small Campus	Asad Azemi	
	Undergraduate Academic Policy Trends Across Institutions Over the Last Thirty Years	Hossein Ebrahiminejad	
	Analyzing and Comparing First-Year Engineering Course Requirements among Institutions	Hossein Ebrahiminejad	
9:45-10:15 am	**Networking Time**		**Break Area 2nd floor**
10:15 - 11:30 am- Technical Session T2	T2A: GIFTS Session A	Corresponding Author	Room
	Engineers and Entrepreneurial Thinking	Frank T. Koe	206
	A Systems Engineering Approach to Conceptual Design in a 1st-Year Engineering Program	Michael Elmore	
	Energy-Efficiency Assessment of Windows using Temperature Sensors	Jean Carlos Batista Abreu	
	Sketching, Building & 3D Printing: Implementation of a Non-Discipline Specific Making Activity in a First-Year Engineering Design Course	Sarah C Ritter	
	Inquiry-based Learning for First-Year Engineering Students	Tracey Carbonetto	
	GIFTS: Introduction to Technical Graphics and Hand Sketching Using a Tablet and Stylus	William Cohen	
	GIFTS - Utilizing MATLAB's Online Tutorial in First-Year Engineering Courses	Chizhong Wang	
	Reconsidering Approaches to Advising Male Engineering Students and Implications for Inclusivity	Laura Angell Hennessey	
	T2A: GIFTS Session B		
	Creating a Peer Advising Program to Increase Engagement with Pre-major Engineering Students	Jennifer Saltsgiver	207
	GIFTS: MAJOR exposure through engineering innovations	Brianna L Dorie	
	Fostering Racial Identity Development, Self-Efficacy, and Institutional Integration to Promote the Success of Black Male First Year Students	Karl W Reid	
	Global classroom project: Bringing global competency to the STEM classroom	Sridevi Rao	
	Big E Little e, What begins with Ee's? - Ethics	Kurt M DeGoede	
	Strengthening Inclusive Group Dynamics	Kurt M DeGoede	
	Going Circular: Re-Using a First-Year Design Project	Kurt M DeGoede	
	GIFTS: Working with Local Retirement Communities for Freshman Design Experiences	Jacob Preston Moore	
	Mindfulness in Engineering	Tracey Carbonetto	
11:30 - 1:00 pm	**Closing Session and Box Lunch**		**Dean's Hall 1&2**

Conference Location and Map

The Penn Stater Hotel and Conference Center
215 Innovation Boulevard
State College, PA 16803
814-863-5000
ThePennStater@psu.edu




SECOND LEVEL
EXECUTIVE OFFICES
222
GRAPHICS STUDIO
223
201
202
203
CONTROL ROOM
204
GUEST ELEVATORS
221
220
219
STORAGE
205
218
CONTROL ROOM
RESTROOMS
217
216
206
REFRESHMENT BREAK AREA
215
214
207
213
212
CONTROL ROOM
210
211
209
208
GARDENS RESTAURANT
GARDENS LEVEL
LEGENDS PUB
GARDENS LOBBY
RESTROOMS
GUEST ELEVATORS
POOL
FITNESS CENTER
BREAK AREA
WILLIAM H. MCKINNON BOARD ROOM
EXECUTIVE CONFERENCE ROOMS 1 & 2
AED
RESTROOM
GIFT SHOP
GUEST ELEVATORS
REGISTRATION DESK
HOTEL LOBBY

Conference Sponsors

Conference sponsors and affiliates play an important role in supporting the FYEE conference. We are grateful to these organizations whose support of the FYEE 2018 conference enhances the experience for all attendees! Please visit our exhibits area and attend the sponsored workshops to express our appreciation.

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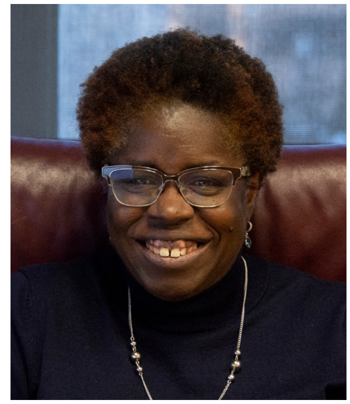
Monday Morning Keynote



Engineering Equity Initiative in Penn State College of Engineering

Tonya L. Peeples, Ph.D.
Associate Dean, Equity and Inclusion
Professor of Chemical Engineering
Penn State

Abstract: In 2017, shortly after becoming Dean of the College of Engineering at Penn State, Justin Schwartz announced an aggressive goal of achieving equal representation of female and male students at the undergraduate level and substantially increasting the fraction of students from underrepresented groups. Dean Peeples is leading the design and implementation of a comprehensive set of actions to meet the Dean's vision, which includes a longitudinal assessment study. In her remarks, she will present an overview of the Engineering Equity Implementation and Assessment Plans.

Speaker Bio: Tonya Peeples joined Penn State in August 2018 to assume the newly created position of Associate Dean for Equity and Inclusion in the College of Engineering and to join the faculty of the Chemical Engineering. Prior to coming to Penn State, she served as the Associate Dean for Diversity and Outreach in College of Engineering and a Professor of Chemical Engineering at the University of Iowa. As an individual researcher and administrator and through her involvement in national partnerships, Dean Peeples has worked to advance diversity and promote opportunities for all students to pursue education and careers in Science Technology Engineering and Mathematics (STEM). She is a member of the leadership team for a new NSF INCLUDES ALLIANCE, Aspire: The National Alliance for Inclusive and Diverse STEM Faculty (NAIDSF).

Dean Peeples conducts research in biochemical engineering. Her group applies an understanding of biological systems to engineer stability in enzyme and cell systems in green chemical process applications. Her specific areas of expertise are in the application of biological systems in interfacial catalysis for oxidative conversions in complex molecules. Dean Peeples obtained her B. S. in Chemical Engineering from North Carolina State University and earned her Ph.D. in Engineering from Johns Hopkins University.

Monday Afternoon Keynote

Inclusion Considerations for the First-Year Engineering Experience

Walter C. Lee, Ph.D.
Assistant Professor of Engineering Education
Virginia Tech

Abstract: Who counts when we're talking about diversity? What does it mean to be inclusive? What can you do to enhance diversity and inclusion? Advancing diversity and inclusion have been and continue to be challenges in engineering. Consequently, there remains an urgent need to improve engineering learning environments, including first-year engineering experiences. Because these terms are fuzzy, often viewed as buzzwords, answering the aforementioned questions and finding meaningful ways to contribute can be quite challenging. In his keynote, Dr. Lee will take you on a journey to explore diversity, inclusion, and what they may mean for a first-year engineering experience. He will discuss his thoughts and efforts, past and present. Dr. Lee will focus on what he refers to as inclusion considerations, or opportunities for exclusion, with hopes of contributing to the conversation around diversity and inclusion at FYEE 2019.

Speaker Bio:
Dr. Walter Lee is an Assistant Professor in the Department of Engineering Education and the Assistant Director for Research in the Center for the Enhancement of Engineering Diversity, both at Virginia Tech. In addition to teaching a first-year engineering course, Dr. Lee has also directed a summer bridge program for incoming first-year students, worked with a living-learning community for first-year engineering students, and taught a graduate-level course focused on diversity in engineering. His research interests include co-curricular support, student success, and diversity in STEM. Dr. Lee has a BS in Industrial Engineering from Clemson University, an MS in Industrial & Systems Engineering from Virginia Tech, and a Ph.D. in Engineering Education from Virginia Tech.

Sunday July 28, 2:30 – 4:00 PM – Session S1: Workshops

Workshops S1	Facilitator	Location
Growth & Grit: Encouraging a Growth Mindset and Grit for First-Year Students	Stephanie Cutler and Sarah Zappe	206
Deployment of Educational Modules in a First-Year Engineering Design Course	Sarah C. Ritter	207
Focus Group: Engaging First-Year Engineering Students with Cengage's Digital Learning Tools	Brenna McNally and Tim Anderson	208

S1A: Growth & Grit: Encouraging a Growth Mindset and Grit for First-Year Students
Room: 206
Facilitator: Stephanie Leigh Cutler (slc5822@psu.edu) and Sarah Zappe, The Leonhard Center for the Enhancement of Engineering Education, Penn State

As students begin their journey in higher education, they can face new challenges and opportunities that will impact their success. How students react to those challenges can be influenced by their mindset (fixed or growth) and grit. As defined by the psychology literature, mindset refers to an individual's beliefs about the flexibility of human characteristics (Yeager & Dweck, 2012). For individuals with a growth mindset, they believe characteristics (like intelligence) can be enhanced through practice and effort. In contrast, individuals with a fixed mindset believe that one's characteristics are innate and unchangeable. Grit is defined in the literature "as perseverance and passion for long-term goals" (Duckworth, et al. 2007). Grit can be conceptualized as the confluence of three components "(a) having interest or passion in a given area; (b) preferring long-term, rather than short-term, goals; and (c) overcoming obstacles or setbacks." (Almeida, 2016). Students with a growth mindset and grit are more likely to overcome obstacles and failures in their academic careers (Aguilar, et al., 2014).

In the classroom, unintentional messages can be communicated to students that promote a fixed mindset making it less likely that students will take on new challenges in their academic journey. Given that students likely experience their first engineering class during their freshman year, first-year instructors should be cognizant about unintended messages that they may implicitly communicate through their teaching and interactions with students. The goal of this workshop is to help first-year engineering instructors to become aware of mindset and grit to see how their teaching strategies can promote perspectives that encourage the continuous success of their students.

Workshop Goals:
Following this workshop, participants will:
- Gain an understanding of grit and fixed versus growth mindset as defined in the literature.
- Identify strategies to promote fixed versus growth mindset and grit within first-year courses.
- Reflect on their own teaching to discover current practices that promote a fixed versus growth mindset and grit, then explore opportunities for adapting their teaching practices.

This workshop will be interactive using a puzzle activity, group discussions, and reflection. The workshop will focus on practical instructional strategies for participants to walk away with concrete strategies they can use when interacting with their students.

Aguilar, L., Walton, G., & Wieman, C. (2014) Physics Today, 67(5), 43-49.
Almeida, D. J. (2016)In Higher education: Handbook of theory and research (pp. 559-609).
Duckworth, A. L., et al. (2007). Journal of personality and social psychology, 92(6), 1087.
Dweck, C. S. (2008). Mindset: The new psychology of success.
Yeager, D. S., & Dweck, C. S. (2012) Educational psychologist, 47(4), 302-314.

S1B: Deployment of Educational Modules in a First-Year Engineering Design Course
Room: 207
Facilitator: Sarah C. Ritter (scr15@psu.edu) including Andrew M. Erdman, Sean D. Knecht, Andy S. Lau, Nicholas A. Meisel, Scarlett R. Miller, Matthew B. Parkinson, and Sven G. Bilén; School of Engineering Design, Technology and Professional Programs, Penn State

This workshop provides an overview of six educational modules that have been developed over the past three years with support from the Leonhard Center for the Enhancement of Engineering Education and deployed in EDSGN 100 – the cornerstone engineering design course at Penn State. These modules focus on the six core topics, which align with competencies required for engineering students: World-Class Engineering Attributes; Big Picture (Systems) Thinking; Innovation Processes;

Communication; Making; and Grand Challenges. For each of these modules, a series of lessons, which rely heavily on hands-on activities and reflections to engage students in the content, have been developed by faculty across six Penn State campuses. To provide easy access by EDSGN 100 instructors across the 20 Penn State campuses offering EDSGN 100, the modules have been integrated into a common location in Canvas, Penn State's learning management software. The content of this workshop is broadly applicable for faculty teaching project-based courses and, more specifically, "cornerstone design" courses for first-year engineering students. This workshop will overview the topics covered in the six modules and provide best practices for presenting the content in an online platform. Additionally, the workshop will provide a framework for integrating the lessons into already established courses to support student learning. Workshop attendees will be provided with some example materials developed for the described modules.

S1C: Focus Group: Engaging First-Year Engineering Students with Cengage's Digital Learning Tools
Room: 208
Facilitator: Brenna McNally and Tim Anderson

Our goal is for this focus group to be both interactive and beneficial to you. This is an opportunity for our team to showcase what we've been developing for Engineering and to hear feedback directly from you about the direction we're heading with WebAssign! The session will feature an overview of our new WebAssign product which will be available for Fall '19. We'll then discuss your needs and the benefits of Cengage Unlimited!

In order to ensure our session is tailored to attendees, please let us know if you'll be joining us by registering http://cengagebrm.ca1.qualtrics.com/jfe/form/SV_9NVbJtMGOg6PDJb

Sunday July 28, 4:15 – 5:45 PM Session S2: Workshops

Workshops S2	Facilitator	Location
Creating the Entrepreneurial Mindset in First-Year Engineering Design Courses	Peter Rogers and Krista Kecskemety	206
Best Practices in Managing Peer Teamwork Behavior and Peer Ratings	Dan Ferguson	207
Introduction to the Multiple Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD): Focusing on First Year Engineering	Hossein Ebrahiminejad	208

S2A: Creating the Entrepreneurial Mindset in First-Year Engineering Design Courses
Room: 206
Facilitators: Drs. Peter Rogers (rogers.693@osu.edu) and Krista Kecskemety (kecskemety.1@osu.edu) – Ohio State University

This workshop is an interactive session where participants learn how The Ohio State University has developed an Entrepreneurial Minded Learning (EML) curriculum framework and piloted the application of KEEN Skillsets in large sections of a first-year engineering design course and how they might apply this framework to their first-year engineering courses. The curriculum framework is shared with workshop attendees and has three overall program goals broken out into 32 learning objectives. Each objective includes three defined proficiency levels (beginner, intermediate, and advanced). This level of detail provides flexibility in designing courses to meet various objectives and proficiency levels. The proposed concept is to begin freshmen with beginner or intermediate levels of skills proficiency appropriate to first-year courses and provide a framework to map upper-level courses against using an increasing level of proficiency culminating with capstone design. Participants will have the opportunity to work with sample assignments to see how the curriculum framework can be applied and used to analyze current courses or develop materials for future courses.

S2B: Best Practices in Managing Peer Teamwork Behavior and Peer Ratings
Room: 207
Facilitator: Dr. Daniel Ferguson (dfergus@purdue.edu) – Purdue University

The goal of this workshop is to introduce participants to tools that can help them form and manage teams in their classes effectively and efficiently. We review factors that instructors should consider when constructing teams and focus on managing teams using and administering self and peer-evaluations. The benefits of using scientifically proven team formation tools and peer feedback as teamwork learning incentives are discussed. Attendees with wireless-network-capable laptop computers will interact with the CATME system in real-time.

S2C: Introduction to the Multiple Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD): Focusing on First Year Engineering
Room: 208
Facilitators: Hossein Ebrahiminejad (Purdue University)

The Multiple Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD) is expanding from 14 to nearly 100 U.S. academic institutions. MIDFIELD includes registrars' data including high school information, SAT, ACT, college coursework, terms attended, major, demographics, and graduation date for more than 200,000 engineering students since 1987. This session aims to familiarize participants to MIDFIELD as a resource to the academic community. This will include an introduction of the landscape for both current and future MIDFIELD, a glimpse into how the data looks like, historical research findings using the dataset, and an illustration on the process to access the dataset using an R package. The session is intended to be interactive where participants will be able to identify both new research questions of their interest and identify institutions which may be interested in joining MIDFIELD and using it as a resource.

Monday July 29, 8:45 – 10:45 AM Session M1: Works-In-Progress

Session M1: WIPs	Location
M1A - Learning Experiences 1	206
M1B - Learning Experiences 2	207
M1C - Readiness and Professional Development	208

M1A WIP

Room 206

28040: Inspiring and Engaging First-Year Engineering Students at a Small Campus Through International Team Design Projects

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This work-in-progress, innovative practice paper summarizes our first-year Introduction to Engineering Design course at a small campus, and our continuing efforts to improve student engagement, inspiration, and retention in engineering. The paper emphasizes the two major design projects used to teach the engineering design process. For the past thirteen years, one of these long-term design projects has been completed in collaboration with several international universities. The design teams have combined engineering students from diverse cultures and countries, as well as all levels of study, to work together towards a common design goal. The paper includes experiences from different instructors who have taught the course, as well as the experiences learned through collaborating with international schools. Specific examples of student inspiration derived from the experience will be included.

28073: Developing a Primer for First-Year Engineering Educators

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This Work-in-Progress paper lays the foundation for a primer for first-year engineering educators. A first-year engineering education primer is an introductory document on the fundamentals of research related to teaching, mentoring, and coordinating the first-year engineering experience. The motivations for the First-Year Programs Division to develop this primer is the transfer of research outcomes and facilitation of informed decision making for practicing professionals. Primers are often developed in fields of study to assist with the dissemination of evidence-based best practices. New engineering educators, administrators, and advisors who have little experience with first-year engineering programs or education research can use the empirical data from the primer to effectively transfer research findings into the classroom and student experience. This work-in-progress paper documents preliminary research to determine the scope of the thematic topics to be included in the primer. The preliminary research is bounded by the American Society for Engineering Education First-Year Programs Division and First-Year Engineering Experience conference sessions, best papers, and call for papers. The topics generated in this study may also be used to refine future calls for papers and session themes. In the future, a committee or workshop could be used to refine these findings.

28083: Physical Computing Design Project to Promote Equity and Community in an Introductory Engineering Course

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The Introduction to Engineering course is a hybrid oral communication elective developed to serve first-year students from all eight of the academic departments offering undergraduate degrees in the UC Davis College of Engineering (COE). Motivations for the course included lack of an appropriate communication elective at the university that adequately served the engineering curriculum, need for student access to communication courses prior to senior year due to impacted enrollment, the lack of hands-on design experiences offered early in the undergraduate curriculum along with persistent issues of retention in the COE programs at the large public university. "Physical Computing Design Solutions for Farmers" is a team-based open-ended project assignment developed by a faculty member assigned to lead course enhancements and expansion efforts through a culture of inclusivity and equity. Through a unique relationship with the self-sustaining campus-based UCD Student Farm, students enrolled in the project-based course visited, identified, consulted with and addressed issues on the farm using open-source digital technologies. Prior experience with these technologies (e.g., Arduino, Raspberry Pi, electronic circuits, etc.) were not required nor were these skills graded thus allowing for a more collaborative, learner-centered, tinkering and community-based approach. The design project was structured around a series of communication milestones leading to a Final Design Showcase event where, in lieu of a final exam, multidisciplinary teams presented their functional prototypes to invited university-affiliated guests (e.g. alumni, faculty, graduate students, university staff, etc.) who provided evaluation and feedback. Through this project experience first year students had opportunities to freely explore and learn new digital and prototyping technologies including laser cutting and 3D printing, to apply science and engineering theory and to collaborate with a broader community including upper division engineering students across majors and graduate student instructors. Guided instruction on use of the open-source technologies was provided in the smaller hands-on studio sessions, limited to 24 students, before teams were provided with take-home technology kits for prototyping purposes. Fall 2018 student reflections, enrollment demographics and design outcomes provide insight into project successes and inform future curriculum iterations.

28056: Use of Kite-based Measurement Systems for Service-learning in Informal Settings

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This is an abstract for a work-in-progress paper at the First Year Engineering Experience conference. Engineering (times) Community Engaged Learning, Education Research, Aeropod Technology, and Empowerment is a 3 year service-learning project that will begin in the Summer of 2019. This paper presents the structure of the project and curriculum to begin a conversation about how service-learning can be leveraged in formal and informal settings. The article presents the strategy for teaching of STEM to first-year undergraduate engineering students and pre-service teachers through kite-based instrumentation payloads called Aeropods. The project is a collaboration between engineering and education at SOUTHEASTERN UNIVERSITY and NASA.

During each academic year, engineering students will take engineering design classes to develop Aeropods, supporting tools, and educational experiences for Novice Math and/or Science Teachers (NMSTs). A subset of these students will then work collaboratively with real NMSTs during a 3-week, summer, service-learning-based outreach program targeting high school students. NMSTs that complete the outreach program will use the technologies and experience gained during the summer to help teach STEM concepts in formal classroom settings. As a result, the outreach program functions as a training and incubator of ideas so engineering students get a more realistic STEM learning experience and teachers are in the best position to be successful facilitating activities in their own classrooms. A project-based service-learning framework will be used to assess the impact of the project on both populations' mindset and skills with each population reflecting on how the collaboration increases learning.

Central to the program is Aeropod technology and mission protocols for data acquisition which were invented at Wallops Island Goddard Space Flight Center for earth science research as a low cost and logistically simpler alternative to traditional unmanned aerial systems. Faculty from SOUTHEASTERN UNIVERSITY helped to develop the technology and undergraduate curriculum as members of the AREN network (NASA AWARD) who's mission in part is to adapt the Aeropod technology for educational purposes. A primary strength of the Aeropod is accessibility of a meaningful and comprehensive STEM education experiences for students of all ages. The program will also produce strategies for STEM curriculum that can be replicated at other institutions through use of the Aeropod technology. Examples of educational materials for teachers also will provide resources for educators looking to infuse STEM lessons into their classrooms.

The AREN project itself only develops the learning tools and stops short of exploring the impact of the developed technology on learning or mindset. The research approach is also presented providing details on how learning and engineering identity development might be assessed.

28011: Work-in-Progress: The Development of a Co-Taught Student Success Course for Freshmen

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This is an abstract for a work-in-progress paper covering a new course developed at the University of Texas at Arlington (UTA). UTA is a designated Hispanic-Serving Institution with a global enrollment of over 58,000 located in the Dallas/Fort Worth metroplex of Texas. UTA, led by the Division of Student Success (DSS), developed the new course specifically for first-time freshmen across the university. The goal of the course was to increase retention by instilling a sense of belonging, promoting interaction with faculty, and providing an undergraduate

Peer Academic Leader (PAL) to aid new students in their transition to the university. Each College/School at the University developed a portion of the content for the course that would be taught by faculty from the College or School. The other portion of the content was standardized by the DSS and taught by a PAL. Colleges and Schools were given a choice of the percentage of class time that would be used to cover discipline-specific content. This portion could be anywhere from 10% to 50% of the total available class time. The COE opted to delegate the maximum 50% of the course content to engineering related topics. The COE and the School of Social Work were the only two academic units to choose to be responsible for the maximum amount of content. A committee of faculty from various departments in the College of Engineering (COE) developed the college-based content for the course. Colleges and Schools were also required to provide faculty for 25-student sections to deliver the discipline-specific content. The DSS hired and trained PALs to deliver the university standardized material. This work-in-progress paper will discuss this parallel content design and delivery of the course between the COE and the DSS. Lessons learned during the development and initial offering, first semester reflections and preliminary results will also be covered.

28067: An Introduction to Computer Vision for First-Year Electrical and Computer Engineering Students

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This work-in-progress paper will detail one of ENEE101's newest modules, computer vision. ENEE101 is the introductory course to electrical and computer engineering (ECE) at the University of Maryland (UMD). This course provides first-year students with a glimpse into the broad field of ECE through high-level hands-on labs, with the goal of increasing student retention rates and boosting performance in sophomore-year courses; preliminary results have shown an upward trend in major retention and a downward trend in failures. Faculty-proposed modules cover a wide range of sub-disciplines in ECE, including optical communications, internet of things, and computer vision. Computer vision has become a popular topic in academia and industry due to its applications in machine learning, artificial intelligence, image recognition, self-driving cars, and more. Through our computer vision module for ENEE101, we seek to answer the following question: how can freshmen students, with almost no prior knowledge of even basic programming, actively learn and engage with computer vision? Our solution is to present students with three hands-on labs using the familiar Microsoft Kinect hardware along with open source computer vision software libraries. The labs we introduce cover depth sensing, hand tracking, facial recognition, and body detection. Each topic covers a single day of lab where the students are taught the basics of each concept and complete a C++ template with simple but elegant solutions, built and executed with Microsoft Visual Studio. The goal is to expose students to complex computer vision topics through easily understandable, real-life scenarios to help students realize the impactful applications of computer vision. By achieving this goal, we better prepare students for lives as scientists and engineers.

28049: Flip-J Instructional Strategies in the First-Year Engineering Design Classroom

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This Work in Progress paper describes the active learning techniques adapted in a first-year interdisciplinary engineering course at a research university in the southeast region. This study evaluates the effectiveness of a combined learner-centered pedagogical model: the flipped classroom model and the Jigsaw strategy (flipped Jigsaw), called "Flip-J". Implementation of an active learning strategy such as this Flip-J technique allows for both acquisition of knowledge and applied learning pursuit that is focused on application, evaluation, analysis and synthesis of pertinent information. Freshmen-engineering students participate in a team-based design project curriculum in sections of up to 90 students with additional coursework for professional development. Students primarily learn about the engineering design process, including a variety of technical and professional skills on topics like computer aided design (CAD), 3D printing to memo writing and oral presentation.

Adapting the Flip-J technique encompasses both cooperative and collaborative learning strategies that are executable in four stages. The first stage is allocation of instructional materials, where a lesson module is divided into subsections identified by letters, and each student is assigned a letter and a reading assignment (to be completed outside of the classroom) that corresponds to the letter in the subsections. The second stage is formation of collaborative "expert" groups, where

students with the same letter assignments sit together to discuss individual main points and to formulate more points pertaining to the reading assignments in stage 1. In the third stage cooperative Jigsaw groups are formed by randomly assigning a number to students while in their expert groups. The students are then directed to sit in a newly formed group consisting of peers with different reading assignments. The fourth stage focuses on reflection on instructional materials, where the instructor poses higher-order thinking questions to students to assess comprehension and clarify any misconceptions. The expert groups discuss lessons learned from the reading assignments, clarify any misconceptions, reinforce important concepts and lastly prepare a presentation to the Jigsaw group. The objective of the Jigsaw groups is to learn instructional materials from each expert member in the number group by actively listening, intentionally taking notes and asking questions for clarity.
An assessment of the Flip-J learning strategy may have shown an effective method for knowledge retention, promotion of student engagement and development of professional skills in freshman engineering course. The ability to synthesize thoughts and form collaborative solutions deemed practical with the implementation of this learner-centered model. Based on the midterm course evaluations, students reported that the Flip-J activities provided an opportunity to learn engineering concepts, foster team building, conduct interactive lectures, encourage creative thinking and helped strengthen their communication skills. Feedback from students also highlighted minor areas for improvement, such as time spent on letter groups versus number groups, and the opportunity to switch number groups in subsequent classes to allow more peer interactions. Corrective actions would be applied in forthcoming classes to reflect students' feedback.

M1B WIP

Room 207

28062: Enhancing Experience and Learning of First-Year Surveying Engineering Student with Immersive Virtual Reality

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This paper, a work in progress, focuses on the application of virtual reality on first-year Surveying Engineering laboratories. Students enrolled in the Surveying Engineering major at Penn State Wilkes-Barre take SUR 111 in the fall and SUR 162 in the spring. These courses have a primary objective to introduce students to surveying equipment, practices, and techniques for 3D data collection. Both courses contain an outdoor laboratory component with extensive use of surveying equipment. These activities are frequently affected by inclement weather (rain and snow), which leads to cancelled classes. This disrupts the educational process and limits the time students spend with the instruments. In addition, student training is constrained to the area surrounding the campus due to safety and transportation issues. This reduces students' comprehension on how to apply techniques and use surveying instruments in real-world environments.

To address these unique challenges, we are developing realistic surveying engineering laboratories in immersive virtual reality. Virtual reality can place students in imaginary or realistic environments. These environments create the feeling of being there while introducing students to new and diverse locations. Students can therefore interact with the same surveying equipment they use in the real-world. These environments can create scenarios typical students may not have have an opportunity to interact with.

This paper focuses on data collection and modeling, using modern instrumentation and technologies such as 3D laser scanners and unmanned aerial systems, to create realistic environments that will be digital recreations of real ones. In addition, this paper discusses the creation of the surveying laboratories in virtual reality, including the challenges encountered in replicating surveying instruments. These virtual instruments need to be modeled to closely represent the appearance and functionality of their real-world counterparts. Furthermore, these virtual instruments must allow a student to intuitively interact with them given the primitive virtual reality user interface input options currently available.

Supplementing and enhancing real laboratories with virtual ones can aid students with increasing their learning engagement and enhancing their surveying and engineering skills. A long-term goal of this study is to identify the role of virtual reality in surveying education and how it should be implemented to increase instructional efficiency. 3D data acquisition and modeling is an integral part of surveying education, therefore, exposure of students to virtual reality environments, created using modern surveying equipment and technologies (such as terrestrial laser scanning and unmanned aerial systems) can broaden the student's awareness of the career capabilities of the surveying profession.

28037: We AR...DUINO! A Project-based First-Year Experience, Collaborative with the IEEE Student Chapter

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In this work-in-progress paper, we will invite discussion about our recent and ongoing efforts in developing a first-year experience for Electrical Engineering (EE). A common desire of undergraduates in EE (and we suspect across engineering in general) is for more "hands-on" experiences. What little they get tends to be later in their college career; however, as the Do-It-Yourself (DIY)/ Make culture continues to grow, more of our students are walking in the door ready and willing to "get their hands dirty" on day one. Couple this with an old One-Room-Schoolhouse approach and we have the crux behind this project: Guiding established students (associated with IEEE) to assist in instruction focused on "getting hands dirty" EE style! The goal is to inspire a generation to work with their hands, as well as attract a subset into the EE fold.

A hands-on first-year engineering experience seminar (FYS) has been developed here at Penn State, based around acquainting students with the usage of an Arduino microcontroller (a major building block for many a DIY project). It has been taught since Fall 2017 (Fa17). The Fa17/Sp18 classes were led by IEEE student leader Josh Cetnar. Each semester has included team project development and presentations, which has seemed to up enthusiasm levels markedly. Final Fa17 project demo day was attended by the dean, department, and school heads. Two of the students from Fa18 were recruited and have become active members of the IEEE. The course continues to evolve under the new teaching intern (and co-author of this paper) Erica Venkatesulu for Fa18-Sp19, with additional freshman joining in on IEEE activities. Erica will also return for Fa19-Sp20.

Our premise for this effort is that peer instruction at the entry level is more effective at inspiring/motivating new students to choose an experimental engineering career path (with an obviously hopeful bias towards EE, of course). In other words, the novelty of this work isn't necessarily the hands-on aspect (though that was our original driving factor), it's the ownership of the seminar by potential peers.

Assessment is currently our primary challenge, hence this WIP paper with its implied solicitation of ideas. Some methodologies are being explored. For example, anecdotal in-class evidence has been collected over these original 4 semesters. In addition to this, we will discuss results of outreach to former students as we begin to see what long-term impact the seminar has on their subsequent college and career choices. Our hope is to expand to multiple seminars, each based on technologies useful to the DIY ethic (e.g., Raspberry Pi, Wearable Tech, etc.). Finally, we look forward to brainstorming ideas for future/further directions at the conference

28038: Work-In-Progress: Addressing Student Attitudes and General Study Skills through a New Hybrid Distance Learning Model, or NHDLM

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This paper is a "Work-in-Progress." The paper will describe efforts to impact first semester engineering student attitudes and basic study skills through the application of a new hybrid distance learning model, or NHDLM. The program tries to impact Native American students participating in a pre-engineering program while attending geographically widely separated Tribally Controlled Colleges, TCC's. The critical factor is not only the advancement of students along Bloom's taxonomy, from memorization to synthesis, in the particular engineering and basic sciences but it also includes the development of an intrinsic reward system leading to perseverance and adaptability within the environment not always controlled by the engineering-student. Compounding this challenge is the under resourced status of the students involved, that is to say many of the students started in a school system with resource problems. The application of NHDLM is a way to get across the fundamentals of engineering sciences to these students at locations that could not support the required resources. Although having some characteristics comparable to a YouTube podcast, this application adds interaction with direct communication, a dimension of personalization and relatively quick feedback. The utilization of NHDLM in this context, celebrates personal efforts while maintaining system wide standards and professional attainments. Opportunities and challenges for assessing efficacy of the model will be discussed

28000: Exploring Instructors Decision-Making Processes on the Use of Evidence-Based Instructional Practices (EBIPs) in First-Year Engineering Courses

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Evidence-based instructional practices (EBIPs) are pedagogical practices demonstrated by validated research findings to have a significant impact on student learning. These practices encompass learner-centered learning environments, including guided inquiry, frequent formative feedback, guided notes, and demonstrations, and knowledge-centered learning environments, including problem-based learning, and just-in-time teaching. Over the last twenty years, engineering educators have sought to create engaging learning experiences for students. However, while some educators have had small scale impact on the design of engineering learning systems, previous research have shown that teaching in engineering classes remains largely unchanged. This work in progress (WIP) seeks to highlight how first-year engineering instructors decide what types of instructional practices to use in their classes and how they incorporate these strategies in their course design and content delivery. As part of a much larger study, this paper will explore some of the practices used in first-year engineering courses, how instructors decide on which practices to use based on their experience teaching first-year engineering courses. We will also highlight challenges instructors face in incorporating EBIPs in their classes and share useful strategies they have used to overcome these challenges.

Key words: evidence-based instructional practices, first-year engineering, engaged student learning,

28031: Work-In-Progress: What is Engineering? First-Year Students' Preconceptions about their Chosen Profession

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The formation of an engineering identity is a key indicator for persistence within academic and professional spaces. However, this formation is often multi-faceted and complex, prompting investigations to understand specifically how engineering students form their engineering identity within the constructs of the first-year experience. This exploratory qualitative study utilizes content analysis to analyze engineering preconceptions in a first-year course. Data was collected from a medium-sized private university located in the Pacific Northwest and consisted of essays from 543 first-year engineering students. Students' preconceptions of engineering centered around five key thematic areas: knowledge, perception, impact, method and performance. Results from this analysis indicate that students come into engineering with a variety of different preconceptions about engineering.

28004: Work in Progress: Analyzing a Distributed Expertise Model in an Undergraduate Engineering Course

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This work in progress presents an analysis of a distributed expertise approach to teaching computational thinking in a first-year undergraduate engineering course. The distributed expertise model is an instructional approach in which each student specializes in one topic area that falls within the broader content goals of the course. Students spend a portion of the course gaining expertise in their focused topic area, and then join together with one student from every area to form a mixed-expertise group for a major culminating project. This final project is designed to require knowledge developed in each of the specializations, thus leveraging and requiring the expertise distributed throughout the group. This is distinctly different from a traditional content delivery model where the goal is to teach all of the students the same content throughout the duration of the course. In a distributed expertise model, the goal is to enable all students to develop the same fundamental skills and content awareness, but allow them to specialize and gain deeper expertise in just one content application area. In other fields, distributed expertise and jigsaw learning are used to promote authentic student discussions and increase active learning. However, these techniques have not yet been widely applied to teach computational thinking. This study analyzes four sections of the Introduction to Computing in Engineering course, which is required of first-year engineering students at a research university in Massachusetts. The overall objective of the course is to teach students how to apply computational tools to engineering problems and tasks. The course was taught by four different professors. One professor used a distributed expertise model and the other three used traditional content delivery methods. In the distributed expertise course, students were broken up into four specialty groups: computer vision and image processing, sensing and actuating, data acquisition and processing, and data analytics and visualization. Students spent the beginning of the semester learning as one large group and then broke into their specialty groups for the middle portion of the semester. They then spent the remainder of the semester working in final project groups that consisted of one student from each of the specialty groups.

This mixed methods comparative case study explores the following two research questions: (1) In a course that uses a distributed expertise model, in what ways do students demonstrate knowledge and competency in computer science fundamentals, data collection methods, data analysis techniques, and data communication, and how does this compare to students taught in a traditional model? and (2) How does the complexity, solution diversity, functionality, and emotional investment in students' final projects compare between a distributed expertise model and a traditional content delivery model? Data sources include student surveys taken before and after the course, student coursework, and in class observations. We hypothesize that students taught using the distributed expertise model will show an increase in inclusion, engagement, and mechanistic reasoning. This paper will discuss data collection methods, preliminary findings from the data, and plans for future work.

28001: The Effectiveness of Writing Interventions on First-Year Engineering Reports

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This abstract is for a work-in-progress paper. First-year engineering students often struggle to compose effective technical reports despite taking an English composition course concurrently. Many students do not seem to see the connection between the information presented in their English course and the reports they are asked to create in their engineering courses. This lack of ability to transfer knowledge from one context to another has been documented by scholars such as Perkins and Salomon [1]. Perkins and Salomon term the ability to apply knowledge to a new set of circumstances as transfer.[1]. In their study of transfer, they argue that students fail to apply what they learn in new contexts for various reasons, including the difference between local knowledge and general knowledge, where local knowledge is that which is viewed as being more specific [1]. However, teachers can address this issue by being aware of transfer and using strategies that encourage transfer [1]. Enhancing transfer is the goal of the current research project. The authors, an engineering professor teaching an introduction to engineering course, and an English professor with experience teaching English composition and technical writing, are working together to improve writing outcomes in a first-year engineering course. The scope of this project is two-fold: 1) students will receive additional feedback on their writing and 2) the engineering professor will improve provided materials and in-class course content (e.g,, lectures, activities, practice) on writing with guidance from the English professor. This project began with a spring first-year engineering class, while students are concurrently taking their second composition course. The two courses are not linked in any other way. For their first writing assignment in the engineering course, the students did not receive interventions or additional writing information. This assignment will be used as a baseline for the students. The subsequent assignments will be assessed by both faculty members with additional feedback being provided specific to writing skills with the goal of improving writing quality in the technical reports.

D. N. Perkins and G. Salomon, "Teaching for transfer," Educational Leadership, vol. 46, no. 1, pp. 22-32, Sep. 1988. [Online]. Available: ERIC, http://eric.ed.gov. [Accessed Feb. 6, 2019].

28079: Integrating Makerspace in First-Year Engineering Curriculum

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Makerspace and similar advanced manufacturing labs are becoming commonplace at engineering colleges and universities throughout the United States. Although these spaces are hugely popular with students and faculty, only a select few students take full advantage of the opportunities available through such spaces. In order to get more students to utilize Makerspace and similar high-tech labs, it is important to introduce them to such spaces as early as possible. New Jersey Institute of Technology (NJIT), a mid-size polytechnic university, recently opened a large Makerspace. Students in select few sections of the first-year fundamentals of engineering design (FED) course participated. The idea was to (1) teach students what Makerspace can offer to them; and (2) have them complete one or two simple 3D printing projects. Project 1 served primarily to get students to complete the required training and to learn about the Makerspace and 3D printing, whereas, Project 2 focused on engaging students in a competition based on the products they have designed and 3D printed. The winners of the competition from each of the participating section were allowed to 3D print a medium-sized object of their choice. This initiative was very successful as evidenced by strong satisfaction reported by the students in a post-activity survey. We have since made it a permanent part of the course.

M1C WIP
Room 208

28091: Work-In-Progress: Recruitment of Pre-Engineering Students via an Advanced Manufacturing Pathway

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Students that have been involved in the Advanced Manufacturing Initiative (AMI) through a Department of Energy Grant have supported the overall pathway into the Pre-Engineering Educational Consortium (PEEC) program. Using engineering related activities presented in the Advanced Manufacturing Summer Institute and the Advanced Manufacturing Course AMI-101 “3D modeling for advanced manufacturing” offered at Cankdeska Cikana Community College and Turtle Mountain Community College and available to other TCU’s via Telecom, AMI has increased the interest in Engineering and has resulted in students becoming a part of the PEEC program.

28096: Facilitating the Success of Academically Under-Prepared Students

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From 2004 through 2018, the College of Engineering and Applied Sciences at a midwestern university received funding through various iterations of the NSF STEP (STEM Talent Expansion Program) to improve retention and student success. A cohort model was implemented that now covers over 95% of incoming first-year students in the college. Members of each cohort have almost identical schedules for the first two semesters in the college. Student services, including tutoring, a living-learning community, and one-on-one student interventions, were implemented. Results have shown significant increases in first-to-second year retention as well as graduation rates. However, students entering the college at the low end of the mathematics spectrum, in particular, continue to be retained and succeed at a much lower rate than first-year students in general. This cohort of students tends to have a higher proportion of underrepresented minority students and a higher portion of students with financial need. It has also been the fastest growing portion of the first-year student class for the past several years. This paper discusses past, current, and planned efforts to increase the success of incoming first year students at the lower end of the mathematical skill spectrum. Suggestions are welcomed regarding both specific interventions as well data that might be the most effective in judging success. Potential collaborators working with similar student groups are also sought to investigate outcomes across multiple campuses.

28046: WIP - Living-Learning Programs: A Model for Student Success and Engagement

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Academically-focused living-learning programs provide students with a unique opportunity to live among peers with similar scholastic interests and goals. These programs encourage increased frequency and meaningfulness of student-to-student interactions (Wawrzynski, M. & Jessup-Anger, J., 2010), higher student satisfaction with the college experience, and can have a positive impact on retention of first-year students. In 2004, the School of Engineering and Computer Science at Baylor University opened its first living-learning program in response to conversation among students who expressed a desire to live with others embarking on a similar academic journey. Since then, the program has evolved into Teal Residential College and now serves 350 students through the residential college model.

One core tenant of the residential college model is to engage students at each level of their academic experience, freshman through senior year. At Teal, mixing classifications of students within the residential experience allows younger students to form mentoring relationships with upper-division students in both structured and organic ways. These connections can form through formal roommate arrangements, as some first year students live with upperclassmen, or through more informal contact – living on the same floor, meeting at a hall program, or sharing a common space. These mentorships, whether formal or informal, are critical for first-year students as they transition so that they are able to see a model of academic expectation which can set them up success for the future.

A unique element of the residential college model is an opportunity for students to engage with a faculty member, known as the Faculty Steward, who lives and works among students in the residence hall. The Faculty Steward at Teal crafted a vision to guide community, and this vision is used as the basis for a six-week programming model that begins the first week of class. With at least one program taking place each week, the programs introduce students to one or multiple of the following tenants: relationship with God, relationship with others, relationship with self (or self-understanding), and relationship with creation. Examples of previous programs include, but are not limited to, community garden kick-off, discipline-specific study skills session, community dinner, worship and chapel, and various social programs. Through these programs, students begin to form relationships with each other and with the Faculty Steward.

In addition to peer mentorship, interaction with faculty, and a shared vision, Teal offers opportunities for first-year students to be leaders in the community. Students can apply to participate in Teal College Council, the student governing body of the living-learning program, as a Freshman Representative. This opportunity is granted to a number of first-year students each year, depending on interest, and provides these students with immediate leadership opportunities and informal mentoring from the upper-division College Council members. College Council members plan and facilitate a calendar of holistic programming as well as address concerns brought forth by residents. Engaging first-year students in these meaningful ways provides enhanced opportunities for connection within the academic experience.

Wawrzynski, M. R., & Jessup-Anger, J. E. (2010). From expectations to experiences: Using a structural typology to understand first-year student outcomes in academically-based living-learning environments. Journal of College Student Development, 51, 2. 201-217.

27993: Work-in-Progress: Examining Engineering Community and Identity in FYE Pathways: Case Study of Two Veterans' Experiences

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This is a Work-in-Progress paper. As students begin their journey to become an engineer, first-year engineering (FYE) courses serve as an introduction to the profession. FYE courses provide numerous benefits including improving retention from the first to second year. For practitioners considering adding a new FYE course, the literature presents multiple possibilities for structuring the course. However, there is limited knowledge about how the various FYE program structures impact the student experience. Our work focuses on examining the development of engineering identity and engineering communities as students pursue engineering degrees through various pathways. We conducted interviews with students from two different universities that employ different FYE models. Institution 1 is a large southern land-grant university that uses a direct matriculation model with major-specific FYE courses. Institution 2 is a large midwestern land-grant university that uses a pre-major first year experience model. Interviews were conducted during the students' second year of engineering (i.e., the year immediately after completing an FYE program/course). During the initial interviews, students were asked questions including 1) What kinds of groups did you associate with during your first year? 2) In what ways are you connected to these groups? 3) What was your greatest struggle during your first year? 4) Are you an engineer? Our analysis is guided by Wenger's Communities of Practice framework and Gee's identity frameworks. In this paper, we focus on the case of two veterans and their experiences as FYE students in different FYE pathways. Jacob is a transfer student pursuing a computer engineering degree through a post-general education FYE pathway. Malcolm is a transfer student pursuing a computer science degree through a pre-major common FYE pathway. We focus on similarities and differences in Jacob and Malcom's engineering identity and engineering communities while considering the impact of their FYE programs. Our findings are relevant to practitioners who are creating a new FYE course, and to engineering education researchers who are examining the student experience specifically consider students' who are veterans.

28042: Work-in-Progress: Investigation of a Fall-to-Spring Performance Drop in a First-year Experience

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This work-in-progress centers on the fall/spring semester juncture of a two-course first-year engineering experience. As a means to provide continuity to the multidisciplinary from one term to the next, the comprehensive final exam in the fall semester is used as the initial homework assignment in the spring. These assessments cover the key content areas of the fall course, namely the engineering design process, mathematical modeling, CAD drawing and technical

writing standards, and other foundational areas.
In order to provide timely feedback and mitigate the burden or re-assessing the students on this content, the spring semester homework assignment is delivered by means of a Google Form, whereby the use of an add-on script allows for student submissions to be auto-graded. The add-on script necessitates the use of easily-evaluated question types, including multiple-choice, matching, true/false, and short answer. Student averages for the first-semester exams and associated second-semester homeworks are shown below:
- 2017-18: exam = 74%, homework = 68%
- 2018-19: exam = 73%, homework = 71%

While the scores are similar, the students have on average fared worse on the homework assignment for the past two iterations. This is particularly troubling given all of the advantages afforded to students on this assignment. In addition to the aforementioned selected-response style of the questions, students are a) encouraged to work with classmates, b) encouraged to ask teaching assistants and their instructors for help, c) have a full week to complete the assignment, and d) have full access to their notes and the fall course's slide deck.

The purpose of initiating this work-in-progress paper is to investigate the fundamental reason(s) behind this noticeable drop in student performance after the 3- to 4- week winter break. The investigation will focus on identifying the most challenging content areas and potential relationships between student scores and their motivations. In addition to assessment data, students will be surveyed for their own reflections on this anomaly. This initial study is intended to serve as a potential starting point for other educators facing similar performance drops.

28012: Work-in-Progress: A Professional Learning Community Experience in Developing Teamwork Teaching Materials
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This is a work-in-progress paper describing the development of teamwork materials and lessons for an introductory industrial engineering class that is a required as part of the BS Industrial Engineering (BSIE) degree at the University of Texas at Arlington (UTA). The materials and lessons were developed as part of a Professional Learning Community (PLC) entitled: Collaborate UTA: Focus on Teamwork. The PLC was part of UTA's Quality Enhancement Plan (QEP). The central focus of UTA's current QEP is on teamwork, with the goal of innovating and re-conceptualizing teaching based on intellectual growth on this topic. Participation in the PLC included structured meetings, shared dialogue (both face to face and virtual, including a shared blog), reading and discussing a shared book, and engagement in individual research grounded in the scholarship of teaching and learning and a teamwork focus towards a research project. The PLC, consisted of faculty from across campus, and culminated with members implementing, evaluating, and presenting findings of their research projects. The BSIE degree at UTA is accredited by ABET. ABET bases their accreditation on seven student outcomes one of which is "An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives." For accreditation purposes it is necessary to show that the program assesses students abilities on this ABET outcome. While the BSIE degree provides many opportunities for students to work and be assessed in groups, there was very little instruction in how to actually be a good group member. As part of the PLC, materials and lessons on how to be a good team member were developed and delivered to a first-semester Introduction to Engineering class. This work-in-progress paper describes the PLC experience and the materials and lessons developed, discusses their use in the class, and reports on lessons learned in the first use of the materials.

28050: Helping Transfer Students Succeed: Establishing Pathways to Include Transfer Students in a First Year Engineering Program
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This Work-In-Progress Paper will describe the effort being made by a large public institution to better ensure the success of the students who are transferring into the College of Engineering (COE). Transfer students in the COE enter from across the state or across campus with diverse work, life and military backgrounds. This diversity of experiences brings real world talent into the classroom, but the academic success of our transfer students was limited. The COE has a transfer cohort of 150 - 200 students/year. From 2011-2017, we lost an average of 31% of those in their first year. Less than 60% of those students were deemed successful in their first

2 years. This resulted in the development a transfer student course within the First-Year-Engineering program (FYE), to address how we might aid the success of our transfer students.

In Fall 2016, the COE established their first-year engineering program as a two semester sequence. During the first FYE semester, the transfer students and freshman were given essentially the same classes. This was not well-received, and we did not see any increase in retention or success with the transfer students. It was clear that the common first-year experience was geared more toward students coming out of high school and that something different would be needed to attract and retain transfer students. These differences were difficult to define and have required more substantial iterations from semester to semester to develop the current one semester transfer student course.

The first iteration of the course material involved removing the more exploratory parts of the content and including more career readiness topics, as most transfer students have already identified a discipline within the COE, and they have work experience making them more ready for internships and co-op opportunities. We continued to have the transfer students complete the second semester design projects teamed with freshman. The two semester sequence was not popular among the transfer students who prefer to move more quickly into the courses in their majors. Subsequently, the pre-requisites were adjusted to allow transfer students to complete the FYE courses in one semester and then two of the courses were merged into a three-credit course to pair the transferrable skills content with the team design projects for transfer students only. The FYE curriculum now addresses the needs of transfer students to have relevant classroom experiences, become familiar with the resources available in the university environment and build a cohort within the COE. These changes have resulted in our first semester retention increasing significantly. After the first year of this modified transfer student course, only 15% of the transfer students earned below a 2.0 in their first year.

28070: Work in Progress: Peer-based Programming in Undergraduate Engineering

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The University of Windsor, located in Windsor, Ontario, Canada, is a mid-size comprehensive university. The Faculty of Engineering currently has a cohort of approximately 1,500 full and part time undergraduate students, 25% of which are international students. This diverse group of students creates a rich environment for faculty and students. Offering programs that create a supportive faculty community is the responsibility of the WINONE Office of First Year Engineering. Since WINONE's inception in 2007, when engineering undergraduate enrollment was approximately 1000 full and part time students, it has served as the home department for all first-year students enrolled in our common first year program and has spearheaded recruitment efforts for all undergraduate programs in the Faculty of Engineering, including extensive outreach programming to local schools and community organizations. The University of Windsor, like other post-secondary institutions, has a specific focus on student experience as described in the University's Strategic Mandate Agreement (SMA) with the Government of Ontario, and has dedicated resources to support programming that will improve students' perception of their experience. In addition to institutional retention metrics, the National Survey of Student Engagement (NSSE) is a tool that is useful in gauging the long-term effectiveness of the proposed initiatives.

Recently, student requests for personal tutoring referrals have increased. As well, requests from prospective students to shadow undergraduate students on a one-to-one basis have multiplied. To date, WINONE relies on undergraduate volunteers to respond to these individual requests. The need for more structured programming that promotes undergraduate peer-mentors can benefit the students and WINONE as the facilitator of these types of programs. By managing these peer-mentoring programs, WINONE can ensure that students can receive official recognition of their involvement.

This paper provides background and status of current and planned initiatives in the Faculty of Engineering at the University of Windsor building a peer-mentoring program by way of individual modules that together benefit our undergraduate students as mentors and mentees. Our new Iron Pin ceremony instills a sense of community and reminds engineering students about their duties to work ethically and practice equity from their first day of classes. Our new WINONE Tutorial program provides peer-tutoring services free of charge to first- and second-year students by senior students who excelled in their courses and have expressed a desire to mentor their juniors. Future plans include development of a system to officially recognize students for their consistent participation as volunteers for faculty outreach and recruiting events, local engineering and leadership conferences, serving on faculty student societies, and the like from their first to fourth years of study. Their individual successes, first as mentees then as peer-mentors and finally as graduates and alumni will result in positive outcomes for the University's Engineering programs and ultimately bolster retention and future recruiting efforts.

28051: Work-in-Progress: Using First Year Engineering Laboratory to Improve a Student's Readiness to Pursue an Engineering Degree.

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First Year Engineering Laboratory (FYEL) is a course usually taken by freshman engineering students during one semester of their first year at the FAMU"FSU College of Engineering. The course is designed to meet three primary objectives: (1) inspire students by reinforcing their desire to pursue engineering as a professional career, (2) orient students to the university environment by presenting information designed to ease their transition from high school, and (3) introduce students to a set of technical and social skills which are needed to complete an engineering degree program. Although the technical content of our course is not overly difficult, we still find that some students are unable to complete it with a satisfactory grade. This is troubling since we have previously reported that good performance in this course correlated well to degree completion in engineering. Academic preparedness as measured by high school grade point average and college placement test scores are some obvious factors to consider. However, others may also be just as important. These may include the high school a student attended, a student's access to technology, and the intrinsic motivation or mindset of a student.

This work-in-progress will report on some of our findings as we examine the firstyear students who completed the course during a fall semester between 2013 and 2017. We especially look at the performance of these students on the FYEL midterm. This is a multiple choice test which is worth 20% of a student's overall grade and is normally given around week 8 or 9 in the semester. We are using Bloom's Taxonomy to classify each question to determine if a relationship exists between the type of questions which separate the top students from those in the bottom quartile. We also examine factors such as race/ethnicity, gender, instructional method, and course instructor. With these results, it may be possible to develop specific interventions to assist students in closing the preparation gap thus improving their likelihood of completing an engineering degree program.

Monday July 29 – 10:45 AM – 12:00 PM - Technical Session M2

Time	M2A: Learning By Design – ROOM 206	Presenting Author
10:45-11:00	Proto-Tripping: How to Prototype with Minimal Tools and Resources	Charlotte de Vries
11:00-11:15	The Development of a First Year Design Project: Focusing on Creativity, Independence, and Design Understanding	Breigh Nonte Roszelle
11:15-11:30	A Flexible, Portable Making Solution to Enable Hands-On Learning with Additive Manufacturing in Cornerstone Engineering Design	Nicholas Meisel
11:30-11:45	EDSGN 100: A First-Year cornerstone Engineering Design Course	Sarah C Ritter
11:45-12:00	Group Discussion	

Time	M2B: Learning in Teams - ROOM 207	Presenting Author
10:45-11:00	Partnering with Occupational Therapists for First-Year Design Projects	Todd France
11:00-11:15	The Influence of Percentage of Female or International Students on the Psychological Safety of Team	Behzad Beigpourian
11:15-11:30	An Evaluation of a First-Year Civil Engineering Student Group Dynamics Intervention	Anna Norris
11:30-11:45	Comparing Teamwork Peer Evaluations Between Culturally Homogenous Teams and Culturally Diverse Teams	Siqing Wei
11:45-12:00	Group Discussion	

Time	M2C: Learning By Design - ROOM 208	Presenting Author
10:45-11:00	Creating Engaging Escape Rooms in First Year Engineering Courses: A Pilot Study	Scott Streiner
11:00-11:15	Full Paper: Can a First Day Activity Help Raise Customer Awareness, an Important Attribute of an Entrepreneurially Minded Engineer?	Haolin Zhu
11:15-11:30	Full Paper: Implementing Classroom-Scale Virtual Reality into a Freshman Engineering Visuospatial Skills Course	Jonathan R. Brown
11:30-11:45	Full Paper: A Makerspace Project for New Transfer Students	Bonnie S. Boardman
11:45-12:00	Group Discussion	

M2A LEARNING BY DESIGN
Room 206

28053: Proto-Tripping: How to Prototype with Minimal Tools and Resources

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This full paper describes the design, implementation, and reception of a prototype-based design project for first-year engineering students in an introductory course. This project was introduced in a course that previously lacked any physical design elements due to the limited access to prototyping equipment. Prior student projects were limited to design and computer modeling and simulation elements only, with hands-on activities restricted to measurement-based labs. The new project incorporated concept development by the students along with physical prototyping of their design using and a combination of reusable components and disposable inexpensive supplies. The project was created based on research findings on the effectiveness of experiential learning, particularly hands-on and project-based learning.

The new project consisted of a line-following robot using Arduino kits and a custom made chassis designed by the students. The students needed to assemble the components, calibrate the sensors, update and install the code, and design and build the chassis for the robot. The students were encouraged to minimize their design according to cost, weight, and time required for the robot to navigate along a course. The open-ended nature of the project allowed for students to optimize the code, improve the aesthetics of their design, or change up the circuitry of the robot in order to have the best performance. Students in the honors sections of the course were able to produce 3D printed parts for their robot chassis, while students in the standard sections used beta prototyping to make their chassis out of low fidelity materials, such as cardboard, popsicle sticks, duct tape, and glue.

At this point in time the project is in its third semester of implementation. Over 300 students and 12 separate faculty members have undertaken this project. Students were surveyed to see the short-term impact of the project on student learning, and eventually the long term impact on student retention. The students who have opted in to the study will be tracked to see the effect of this project on student retention rates compared to engineering students who participated in the previous computer-only design projects in this course.

This paper describes the project in detail, the results of student surveys and impact the project had on students and faculty reception. Suggestions for how similar projects can be implemented at other schools are shared.

27994: The Development of a First Year Design Project: Focusing on Creativity, Independence, and Design Understanding

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The goal of many first-year courses is to engage and inspire students to continue with a degree in engineering. Other goals from our faculty include that students be accountable for their own learning and engage specifically in the engineering design process. In order to take on all of the above goals, the first-year design project in our Introduction to Mechanical Systems course has been re-developed over the past few years to focus on creativity, independence, and design understanding.

The original project, which was developed in 2012, required students to design a child's "shooting toy" that was tasked at launching a given object the maximum distance possible. For this task the students were given a list of design requirements for their toy, including limits on size, material, etc. Students went through an abbreviated version of the engineering design process in a three-week period. While students enjoyed the project overall, they commented that they would appreciate more time, more design freedom, an ability to prototype, and a more hands-on experience with the printing process, as teaching assistants printed the parts for them.

Over the past seven years changes were made to help address the desires of the students and faculty, and also take advantage of the new innovation floor. The current project, which takes place over seven-weeks, requires students to design and build a high-fidelity prototype of a children's toy. The only requirements are that the toy should be appropriate for 3-5 year-old children, contain at least one simple machine, and contain at least one part that the students designed in SolidWorks and 3D printed themselves. This more open-ended project means that students have to go through parts of the design process not previously required, including developing their own constraints and criteria, building and testing prototypes, and manufacturing 3D printed parts themselves.

An exit project evaluation survey has been given to the students over the past 5 years in order to measure the students' feelings towards certain aspects of the project. In 2018 students indicated stronger agreement for statements including After the final project my understanding of engineering design improved and

Overall I liked the final project. Additionally students showed stronger agreement for the statement I found the final project to be frustrating in 2018, showing that students had an increase in frustration from the project, however the comments from students also indicated that their frustrations came from wanting the design to work well and learning their own current limitations as first-year students, traits that could help them grow as they continue in their studies. While the development of this project, and the rest of the associated course, to meet the needs of first-year students is an ongoing process, the lessons learned over the past several years have helped develop a project that allows for design freedom, student independence, and experience with the full engineering design process.

27997: A Flexible, Portable Making Solution to Enable Hands-On Learning with Additive Manufacturing in Cornerstone Engineering Design

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Additive manufacturing, colloquially 3D printing, is rising in prominence as a tool to support hands-on "making" education in cornerstone engineering design. While many universities are implementing centrally-located facilities to process printed designs for students, such centers often limit student access to the printers. This, in turn, limits a student's ability to understand how the manufacturing process influences the viability of printing their digital design. To address this concern, this paper discusses the creation of a flexible, portable making solution that offers students the chance to gain familiarity with the 3D printing process in a way that complements the high throughput offered by centrally located facilities. The proposed making solution incorporates low-cost equipment intended to expose students to a variety of elements associated with 3D printing, including digital design, 3D scanning, print preparation, material extrusion, and manufacturability constraints. The integration of the proposed solution with existing manufacturing lessons and faculty skillsets is also discussed.

28018: EDSGN 100: A First-Year Cornerstone Engineering Design Course

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Introduction to Engineering Design (EDSGN 100) is a first-year "cornerstone" engineering design course taught to over 3600 students annually across 20 Penn State campuses. EDSGN 100 is a hands-on, project-based course in which students work in teams to apply an engineering design process to a variety of instructor-led and client-sponsored design projects. In support of these design projects, the students learn design tools and techniques, such as hand sketching, both formal and informal communication techniques, and computer-aided design software. Through the lens of systems, or "big picture," thinking, students begin to understand the role of engineering to deliver solutions that are technically feasible, economically viable, and desirable to improve the global community. Over the past two years, the course has been significantly updated to reflect changing academic and industry needs. This paper describes the course updates, highlighting newly developed course modules that leverage the expertise of a team of interdisciplinary instructors.

M2B LEARNING IN TEAMS

Room 207

28041: Partnering with Occupational Therapists for First-Year Design Projects

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This full paper presents findings from a pilot project initiated in a multidisciplinary, team-based first-year engineering course. The course, focused on the design process and technical skill building (e.g., CAD, Excel, prototyping), is structured to support student teams as they pursue unique solutions to identified needs in a given hypothetical context. In spring 2018, an alternative project was offered in two of five course sections that partnered student teams with a school whose mission is to support those with developmental disabilities. Specifically, the project "client" was an occupational therapist at the school; her primary needs were tools designed to foster her students' fine motor development by means of manipulative devices.

After having been facilitated for two semesters as an EPICS (Engineering Projects In Community Service) elective course, this project was incorporated into the first-year sequence to engage students with real, local societal problems earlier in their undergraduate studies. The project focuses on human-centered design, allowing students to be creative in their solutions while compelling them to remain cognizant of the specific needs of the intended users (in this case, primarily pre-K to 5th graders). Both individual responsibility and team interdependence have been noted as strengths of the project, key learning outcomes that are often lacking in team-based projects.

Both survey and interview data from the pilot project's participants (12 students in total), along with comparative data from other first-year students in the course, will be collected. Analysis will include a mixed methods approach to highlight key project benefits and drawbacks, and will focus on answering the following research questions:

- How did the occupational therapy project impact students' motivations?
- How has the occupational therapy project shaped the way students' view the engineering profession?

This paper is intended to offer well-informed insights for those interested in running similar service-learning projects.

28069: The Influence of Percentage of Female or International Students on the Psychological Safety of Team

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This research paper investigates team composition affects psychological safety in first-year engineering teams.

Background: Psychological safety provides safe environment for team members to easily express their opinions and make decision without being worry about the consequences. Team composition can affect the psychological safety of teams and individual students. To promote a more inclusive classroom, faculty need advice on team formation strategies that lead to the optimum composition when the class includes gender diversity and international students.

Purpose/Hypothesis: We want to know how the individual's perception of psychological safety and how it aggregates within their team.

Design/Method: We categorized teams of a first-year engineering class based on the percent of female students in teams and conducted one-way ANOVA. We also used ANOVA to study the experience of international students.

Results: Teams with no female students had significantly higher psychological safety than teams with 50 percent female students. Also, teams with no international students had significantly higher psychological safety than teams with 50-67% international students.

Conclusions: Forming teams based on gender and citizenship can significantly affect the psychological safety of students in engineering teams, which gives hints to important team dynamics that instructors should watch for. Keywords Psychological safety, gender, international students, teamwork, team composition

28075: An Evaluation of a First-Year Civil Engineering Student Group Dynamics Intervention

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This full paper evaluates first year civil engineering students' responses to a series of reflective questions based on a group dynamics intervention presented halfway through their first semester introduction to civil engineering course. The intervention is sponsored through an NSF project and involved students watching a group conflict scenario presented in class by professional actors role-playing three college students. The scenario is designed to illustrate biases that can negatively impact group dynamics – including both racial-based and gender-based biases. The intervention included interactive components where the presenters led the students in a discussion and reflection exercise. As part of the interactive component, several students volunteered to intervene as a fourth group member and attempt to improve the group dynamic in a re-running of the scenario. The effectiveness of the intervention strategies were discussed within the group and with the entire class.

In the week following the in-class intervention students completed a reflection assignment by answering the following questions: 1) What types of conflicts did you see in the role-playing presentation?, 2) What types of conflict resolution did you see tried in the exercise? Did you think they were good?, 3) Have you experienced team conflicts? If so, what was the source of the conflict?, and 4) What approach would you try to resolve team conflict? This paper presents the results of an evaluation of these student responses. In the first pass through the data NVIVO was used to automatically code responses to identify global themes in the responses. The results were disaggregated by responders' self-identified sex. A total of 60 students, 19 female and 41 male students provided consent to the project out of a class of 94 students. The results of this analysis indicated that 68.4% females and 70.7 % males referenced gender, sex, girl, or female in their response to question 1, regarding types of conflict. In responses to question 2, regarding the conflict resolution, 57.8% of females, and 53.7% of males referenced gender, sex, girl, or female in their response.

These results indicate that both the males and females were equally aware of sexism in the conflict and conflict resolution attempts in the group dynamics intervention. In the analysis of responses to all four questions, only 5.2% of females and 9.7% of males mentioned race or ethnicity in their responses despite this bias being present in a minor manner in the scenario. This result implies that the students focused more heavily on conflict based on gender and not on race or ethnicity. In response to question 3, 80% of the first year civil engineering students indicated they had not experienced team conflicts before. A second manual coding of the responses was performed to look at more subtle themes -specifically students' preferences in conflict resolution strategies based on responders' sex. This paper presents these results regarding the theme of preferred strategies.

28064: Comparing Teamwork Peer Evaluations Between Culturally Homogenous Teams and Culturally Diverse Teams

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This Teaching and Learning Experiences in Engineering Education work-in-progress paper examines cultural influences on engineering student teamwork and peer assessment behavior. Teamwork skills are considered an important competency of engineering students and a learning objective of ABET. Students from all over the world come to developed countries like the U.S., U.K., and Australia for their college education and more than one fifth of these students major in engineering disciplines. These non-domestic or international students possess unique cultures and their unique cultures potentially impact their cross-cultural interactions. For example, working in a team context often requires communication and collaborative behavior with team members. If these cultural differences influence team interactions, they potentially impact a team's engineering problem solving and design processes and their teamwork peer assessment behavior. In this research study we focus on the teamwork and peer assessment behavior of a large sample of first year engineering students from China, India and South Korea [T3] as compared to domestic [U.S.] students both matriculating in a large Midwestern U.S. engineering program.
Our Research questions is: do teams of four students containing one or more T3 students have, on average, different peer rating behavior and comment pattern from teams containing only domestic students?

M2C LEARNING BY DESIGN

Room 206

27998: Creating Engaging Escape Rooms in First Year Engineering Courses: A Pilot Study

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The value of games in education has been established with serious educational games, games designed to teach a topic, gamification, and game-based learning (either using commercial games or self-developed games). Educational games can provide immediate feedback and incentives to progress, foster communication skills, and encourage experimentation and creative problem solving. Live-action games, such as escape rooms, are ideal for in-person classrooms as they require little technology and can take advantage of the shared environment of the classroom. Nicholson defines escape rooms as "live-action team-based games where players discover clues, solve puzzles, and accomplish tasks in one or more rooms in order to accomplish a specific goal (usually escaping from the room) in a limited time." Deep learning comes with dynamic immersion amid complex, realistic, and inherently social situations that produce opportunities for active learning. Escape rooms allow students to cooperate under a time limit, which creates an urgency that drives student teams to engage with content in a way that traditional learning activities may not.

This full paper presents the development and implementation of escape room design projects in first-year engineering courses at Rowan University and Northeastern University. In these pilot projects, first-year engineering students worked together to design, build, and fabricate their own class-wide escape rooms motivated by "learning by design." Students explored the characteristics of design thinking that are non-linear, iterative, generative, and creative. In this project, students were tasked to collaboratively design an escape room, requiring the various student teams to contribute to the room in unique ways. In part, each team was responsible for making a fabricated object, two puzzles, and a 3D printed object. Additionally, a jigsaw method was utilized to split the teams into committees that were responsible for connecting the escape room elements together. This included narrative, flow, infrastructure, and marketing committees that all had different roles in creating the final escape room product. This paper will additionally highlight themes around motivation and student accountability, teamwork, and project management. The authors believe that having first-year engineering students design and play through escape rooms provides a holistic, student-centered approach for teaching design thinking with an emphasis on art and creativity.

27988: Full Paper: Can a First Day Activity Help Raise Customer Awareness, an Important Attribute of an Entrepreneurially Minded Engineer?

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This abstract for a full paper describes an Entrepreneurial Mindset (EM) infused first day team based hands-on design activity for the introduction to engineering course and its effectiveness at raising customer awareness. During the recent years, many institutions across the nation have joined the Kern Entrepreneurial Education Network (KEEN) that aims to promote entrepreneurial mindset in engineering education[1]. The attributes of an entrepreneurially minded engineer depicted by KEEN involves technical skillset, customer awareness, business acumen, and societal value[2]. Quite a few authors have also emphasized the importance of incorporating customers in course activities especially design projects in order to instill the entrepreneurial mindset in the curriculum[3-5].

In an effort to incorporate the entrepreneurial mindset into the introduction to engineering course, a first day team based hands-on design activity was developed, among many other activities and projects. And it was implemented during the fall 2018 semester in a section of the course with 37 students during the first lab before students were introduced to any topics or concepts. The activity involves two rounds. Most teams failed to consider who the customers and what their needs were and created designs based on their own assumptions about the problem. Designs were tested at the end of the first round and to students' surprising, what they thought would be great designs turned out to be not successful. Discussions led to students realizing why their designs did not work. During the second round, students properly identified customer needs and created new designs to address customer needs.

Can this first day activity help raise customer awareness, an important attribute of an entrepreneurially minded engineer in first year students? To answer this question, a survey was conducted prior to the activity to gauge students' understanding of how to approach design problems. Not surprisingly, only one out of thirty one students who provided consent to participate mentioned "one would have to question and research those who are affected by the problem' in their pre-survey response. After the first lab, students individually submitted reflections about their first lab experience and these reflections were analyzed. It was found out that twenty four out of the thirty one students mentioned the importance of asking customers questions and learning about their needs without being prompted to talk about customers. Out of these twenty four students, eleven mentioned this in more than one places in their reflections.

In the full paper, the activity will be described and the findings will be presented. Tips to successfully implement this activity will also be discussed and suggested changes will be shared.

[1] https://engineeringunleashed.com/
[2] Kriewall, T. J., and K. Mekemson. 2010. Instilling the entrepreneurial mindset into engineering undergraduates, Journal of Engineering Entrepreneurship no. 1 (1):5-19.
[3] Gerhart, A. L., & Melton, D. E. (2016, June), Entrepreneurially Minded Learning: Incorporating Stakeholders, Discovery, Opportunity Identification, and Value Creation into Problem-Based Learning Modules with Examples and Assessment Specific to Fluid Mechanics, Paper presented at 2016 ASEE Annual Conference & Exposition, New Orleans, Louisiana. 10.18260/p.26724
[4] Bell-Huff, C., & Morano, H. L. (2017, June), Using Simulation Experiences, Real Customers, and Outcome Driven Innovation to Foster Empathy and an Entrepreneurial Mindset in a Sophomore Engineering Design Studio, Paper presented at 2017 ASEE Annual Conference & Exposition, Columbus, Ohio. https://peer.asee.org/27425
[5] Zhu, H., & Mertz, B. E. (2017, June), Work In Progress: Incorporation of the Entrepreneurial Mindset into the Introduction to Engineering Course, Paper presented at 2017 ASEE Annual Conference & Exposition, Columbus, Ohio. https://peer.asee.org/29164

28033: Full Paper: Implementing Classroom-Scale Virtual Reality into a Freshman Engineering Visuospatial Skills Course

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In this study, our team developed a virtual reality (VR) integrated curriculum for a freshmen engineering visuospatial thinking course. Visuospatial skills, especially understanding how a 2D image represents a 3D object, are known to be an important part of student success in engineering. To ensure a minimum level of visuospatial skills in later courses, the Ohio State University offers a course on visuospatial thinking for incoming engineering freshmen; it is required for students that score below 18/30 on the Purdue Spatial Visualization Test: Visualization of Rotations (PSVT:R). To help these students interrelate 2D images and 3D representations, we created a set of collaborative and analytical activities that the students engaged in with the help of VR technology. For this, we built custom smartphone VR applications for several of the modules in the Developing Spatial Thinking Workbook by Sheryl Sorby (ISBN 978-1-111-13906-3). Using hardware supplied by us (Google Cardboard headsets and smartphones), students completed VR activities in pairs (or groups of 3). Each partner had a turn with the VR application and communicated with their non-VR partner to complete interactive visuospatial problems. We evaluated progress using pre- and post-module quizzes, and gains were significantly higher when students were given the experimental VR instruction than when they were not. Students were also interviewed at the beginning and end of the course, explaining their thinking as they worked visuospatial problems. By using this smartphone-based approach, we were able to implement a VR intervention on the classroom-scale, with each student having simultaneous access to the VR content.

28010: Full Paper: A Makerspace Project for New Transfer Students

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This is an abstract for a work-in-process paper covering a new class developed at the University of Texas at Arlington (UTA). UTA is a designated Hispanic-Serving Institution with a global enrollment of over 58,000 located in the Dallas/Fort Worth metroplex of Texas. The College of Engineering (COE) at UTA instituted a new introductory course, strictly for transfer students, in the fall 2018 semester. The course goals were to instill a sense of belonging to the COE and the University, introduce UTA-specific resources, introduce engineering disciplines, experience interdisciplinary teamwork, and recognize and develop an engineering entrepreneurship mindset. In order to accomplish the last two course goals, students had a choice of four group projects. Five-student teams were assigned based upon project choice. One of the project choices was to design and build an UTA branded object, using any two pieces of equipment in UTA's FabLab makerspace. The UTA FabLab is a creative hub for students, faculty and staff at UTA and is located in the Central Library. The space provides access to technologies, equipment, training, opportunities for interdisciplinary collaboration, and inspirational spaces in support of invention and entrepreneurship. In addition to regular progress reports, teams were required to keep and submit a blog of their activities and to reflect on the lessons they learned during the project work as their final deliverable for the project. Students were also given pre- and post-project surveys to assess two specific Maker Competencies. This work-in-process paper will describe the preliminary offering of the course. Specifically the paper will describe the FabLab project, summarize the student self-reported lessons learned, describe the Maker Competencies developed at UTA, analyze the results of the Maker Competencies student pre- and post-project surveys, and discuss the lessons learned by faculty in the administration of the FabLab project.

Monday July 29, 2:30 – 3:45 PM - Technical Session M3

Time	M3A: Broadening Perspectives – Room 206	Presenting Author
2:30 - 2:45	Assessment Analysis Results of How Freshman Engineering Students Build an Entrepreneurial Mindset through Freshman Engineering Discovery Courses	Hyunjae Park
2:45 - 3:00	Promoting Student Confidence by Increasing the Breadth of Content in a First Year Electrical and Computer Engineering Course	Jennifer Marley
3:00 - 3:15	Implement Hands-on Activity for Statics Course into Student Success Program	Xiaohong Wang
3:15 - 3:30	Hands-on Laboratory Exercises for Engineering Applications of Mathematics Course	Aysa Galbraith
3:30 - 3:45	Group Discussion	

Time	M3B: Learning and Contexts – Room 207	Presenting Author
2:30 - 2:45	Probability and Statistics: Early Exposure in the Engineering Curriculum	Roger J Marino
2:45 - 3:00	Increasing First-Year Student Motivation and Core Technical Knowledge Through Case Studies	Geoff Rideout
3:00 - 3:15	Full Paper: Assessment of Entrepreneurial Mindset Coverage in an Online First Year Design Course	Haolin Zhu
3:15 - 3:30	Leveraging Algae to Inspire Curiosity, Develop Connections, and Demonstrate Value Creation for First Year Engineering Students	Kevin D. Dahm
3:30 - 3:45	Group Discussion	

Time	M3C: Mentoring into a profession – Room 208	Presenting Author
2:30 - 2:45	Tackling Real-World Problems in First-Year Electrical Engineering Experiences	Michael Cross
2:45 - 3:00	Advice from a First Year	Michelle E Jarvie-Eggart
3:00 - 3:15	Creating an Effective Retention Program	Dewey Burnell Clark
3:15 - 3:30	Helping Undeclared Engineering Students Find Their Best-Fit Major	Roger J Marino
3:30 - 3:45	Group Discussion	

M3A BROADENING PERSPECTIVES

Room 206

28065: Assessment Analysis Results of How Freshman Engineering Students Build an Entrepreneurial Mindset through Freshman Engineering Discovery Courses

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The entrepreneurially minded learning (EML) pedagogical approach has been explicitly used and applied in the freshman engineering discovery courses developed at Marquette University's Opus College of Engineering. These two-semester long courses offer new engineering students the opportunity to discover and explore their potential through various course contents, topics, and activities integrated with the EML pedagogical approach. In order to indirectly assess and measure how freshman engineering students have built their engineering entrepreneurial mindset through these two semester courses, course surveys were given to students twice a semester for the last four years – once at the beginning of the first (fall) semester and another at the end of the second (spring) semester. The new survey results obtained for the last four years were then compared and analyzed to previously collected results. This analysis has provided insight on how freshman engineering students learn to identify an engineer's societal roles and responsibilities while creating new innovative ideas and concepts with the potential to investigate existing markets and technologies; furthering the ultimate goal of the engineering discovery courses of providing new engineering students with a vision of how to become a future engineer with an entrepreneurial mindset. After introducing the overall course structure, contents, topics, and the corresponding activities, this paper presents the survey analysis results that show how the freshman engineering students build their engineering entrepreneurial mindset during their first year of college.

28007: Promoting Student Confidence by Increasing the Breadth of Content in a First Year Electrical and Computer Engineering Course

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First-year electrical and computer engineering (ECE) students who have not yet encountered applications in their discipline often struggle to draw connections between the theoretical concepts from their introductory courses and those specific contexts in which they might apply those concepts in their future careers. As such, these students frequently struggle with relating to their courses and may become discouraged or doubt their ability to become an engineer. To address these challenges, the first ECE-specific course at Valparaiso University has been designed to increase the exposure of students to the various ECE sub-disciplines. The specific applications explored by students in this course range from programming microcontrollers to building amplifier circuits to designing and testing complex digital logic circuits, which are subjects not usually covered until the last two years of study. Results are presented that demonstrate several benefits of the wide range of topics covered in this course. These include helping students choose with greater confidence future elective courses and their major, improving the self-confidence of those students who may struggle with relating to more abstract engineering concepts, and maintaining student interest while providing them with the necessary theoretical background for their future studies.

28058: Implement Hands-on Activity for Statics Course into Student Success Program

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The University of Wisconsin-Platteville (UWP) has been educating engineers for more than 150 years, earning a national reputation as a prestigious institution. The College of Engineering Math and Science Student Success Programs (EMS SSP) plays a crucial role in helping students become the next generation of successful engineers. The mission of this program is to equip students for academic success by providing innovative learning strategies and to encourage students to connect with campus resources and to each other.

In EMS SSP program, there are three Living Learning Communities (LLC) for students pursing a degree in STEM fields. The Explore EMS LLC is available to all incoming freshman within the College of EMS. The Women in STEM LLC has two options available, one for incoming freshmen and one for sophomore and transfer students.

In this proposed project, a faculty from the Department of Civil and Environmental Engineering and people from EMS SSP programs will work as a team to integrate some fundamental engineering hands-on activities related to statics course into Women in STEM LLC.

Statics is the first course taken by students from the fundamental engineering courses. It will be a beneficial practice to implement some hands-on activities based on some fundamental principles of mechanics into the LLC programming. These hands-on activities will allow students to engage and explore the subject they will study in the near future. It will also be another beneficial opportunity to develop connections and networking between students and faculty members.

We have developed five hands-on activities based on Engineering Mechanics - Statics courses and will implement one activity of "Adding Forces - Resultants and Equilibrium" into the Women in STEM LLC on February and March 2019.

"Adding Forces - Resultants and Equilibrium" will be integrated into several groups with total 50 students. Using the kits acquired students are asked to work with a set of experiments in a small group with 2 or 3 students. There were total 18 groups' students and we will do this activity outside the lecture time. After this activity, we will do survey with 5 questions and will discuss the students' feedback in this proposed project.

Through these activities at the LLC for first-year engineering students, it will provide a bridge between the formal academic program and out-of-classroom learning of students. It will also promote personal and intellectual growth and development of students through contact with members of faculty. In addition, it will provide a transition between classroom and residence hall life leading into higher student retention, satisfaction, and success.

27995: Hands-on Laboratory Exercises for Engineering Applications of Mathematics Course

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In Fall 2007, the First-Year Engineering Program (FEP) was started with the intent of increasing student retention and success. One of the main hindrances to retention at a public university engineering program with open enrollment is the unpreparedness of students for rigorous curriculum requirements of the first year. In an effort to help first year engineering students who are one or two semesters behind Calculus I, FEP offers Engineering Applications of Mathematics (E-Math) course, which was inspired by the Wright State model for Engineering Mathematics Education. E-Math aims to teach College Algebra, Precalculus, and introductory Calculus I concepts using self-paced lectures focused on engineering applications and supported by hands-on laboratory exercises. FEP gained permission of the Department of Mathematical Sciences to have E-Math course count as a prerequisite to Calculus I, so successful students who finish the course with a "C" or better are able to enroll in Calculus I next semester.

This paper focuses on hands-on labs that support the mathematical concepts and incorporate immediate applications of these concepts so that students can relate what they learn to real-life situations. Also, most labs require students to turn in a lab write-up, which targets to develop students' scientific communication skills. There are ten hands-on labs developed for this course; we will discuss the following seven in detail. In One-Loop Circuits Lab (inspired by Wright State), students create a circuit, measure voltage and current, and find the unknown value of resistors using linear trendlines in Excel. In Falling Ball Lab, students use an ultrasonic sensor and the Lego Mindstorm EV3 software to create a quadratic graph of time versus height of a falling ball, and then they analyze their data to approximate the acceleration of gravity. In Pennywise Lab, students are given a clear vial containing an unknown distribution of pre- and post-1982 pennies and asked to incorporate systems of linear equations to determine the number of pre- and post-1982 pennies. In Height of Trees Lab, students are given limited materials, asked to make an apparatus, and apply right triangle trigonometry to measure the height of trees outside of the engineering building. In Wind Turbine Lab, students use Lego wind turbines attached to the Lego Mindstorm EV3 brick to measure rotation time for blades and make velocity calculations. In Orienteering Lab, first students use vectors to describe a path to get to a location on university campus, and as a follow-up they follow another group's directions to find and identify their location. Students repeat the Falling Ball Lab at the end of the course, but this time, they use derivatives instead of quadratic functions for their analyses and calculations.

We examine the course evaluation survey and end of semester results to evaluate the student response to hands-on labs. We also briefly discuss success of students in E-Math.

M3B LEARNING AND CONTEXTS

Room 207

28071: Probability and Statistics: Early Exposure in the Engineering Curriculum

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Probability and Statistics classes are often introduced in the second year of an Engineering Program. However, the benefits of students being exposed to these subjects during the Freshman Year have been identified. Some of these benefits are: students' early recognition of the presence and importance of probability and statistics in addressing engineering problems; students' recognition that statistics and engineering are not in fact two distinct, unrelated entities; and the students' early exposure will benefit them in subsequent courses in their academic career. Major constraints in exposing students to probability and statistics in their first year are: course-space availability, limited classroom time and the depth at which an instructor can delve into the material.

One option for infusing statistics into a First Year course is to integrate the material into a first term "Introduction to Freshman Design" course. In order to achieve this, lecture and recitation sections were added to an existing laboratory-based course to create"Introduction to Engineering Design and Data Analysis." (resulting in an increase of course credits). Four weeks of the ten-week course focused on probability and statistical concepts. Lectures highlighted relevant statistics topics, and recitations were dedicated to the students working in teams performing exercises that reinforced the lecture material. Instructional assistance was provided in the recitation sections by graduate teaching assistants.

During Fall 2018, 800 students were enrolled in the course in which there was one 50-minute lecture and one 50-minute recitation each week. Lectures contained 100-120 students and recitation sections were made up of a maximum of 30 students. Direct assessment of the impact of lecture and recitation activities on learning of statistical concepts was accomplished through homework assignments, grading of the recitation exercises and questions on the final exam. Further insight into student perceptions of the recitation activities was garnered from comments on the course evaluations. Results from the initiative were encouraging and are presented herein.

28076: Increasing First-Year Student Motivation and Core Technical Knowledge Through Case Studies

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In engineering programs with a common first year, students may feel like they are in Grade 13, rather than members of a fledgling community working towards entry into an exciting and impactful profession. Memorial University's Engineering One first year has three goals:

1. Educate students about what engineering is, in contrast to pure math or science. Students with good judgement, communication skills, and emotional intelligence; but lower math/physics self-efficacy, should become reassured that they can thrive. High-performing math/science students should become informed of other skills they may need to develop.
2. Inform students about the various disciplines, one of which they must select and enter in second year.
3. Prepare students for departmental specialization, with readiness in areas such as numerical literacy, ability to use spreadsheets, presentation and interpretation of data in graphical form, and ability to critically reflect on results.

A course called "Thinking Like an Engineer" (TLE) has been designed, driven by a collection of case studies from different departments. We present big-picture engineering problems to students in an analytically tractable form. The case studies i) show how real-world needs are turned into quantitative engineering problems with constraints, ii) give global learners a sense of the problems they will be able to tackle with more depth as they move through the program and beyond, iii) provide a context in which to learn computer tools, especially Microsoft Excel, iv) provide opportunities to give formative feedback on graphical communication and data analysis, significant figures, estimation, basic statistical analysis, and so on. In contrast to "typical" first-year engineering courses, TLE is intended to connect course work to career goals for global learners and social conscience-driven students.

The following methodology is proposed for case study development:

1. Set top-level goals for case studies at the Core (or equivalent) department level.
2. Engage junior co-op student "engagement partners" in the search for topics and relevant literature. Such students have proximity to the target audience in terms of maturity and technical ability.
3. Canvass faculty members for department-specific topics, while seeking interdisciplinary connections.

4. Connect engagement partners with faculty experts for first-draft technical vetting.
5. Focus group the first official draft by having
   – Core faculty work through it, ensuring connection with desired course outcomes.
   – Engagement partners' peers completing it, assessing time requirement and difficulty
6. Deliver within course, with reflection and continuous improvement enabled by student feedback.

Case studies are conducted in a small group setting, supported by online resources. The current complement of case studies include an analysis of engine shaking forces, electrical utility load leveling with renewable energy, optimization of solar panels for hot water heating, route selection for a proposed highway using mass diagrams, and a coffee manufacturing study with a hands-on component. Surveys are being conducted to assess students' confidence in their understanding of the engineering approach to real-world problem solving, the technical areas related to the case studies, and their confidence and desire to persist in engineering.

28019: Full Paper: Assessment of Entrepreneurial Mindset Coverage in an Online First Year Design Course

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This abstract for a full paper describes the rubric developed at [Institution] for a set of three entrepreneurial mindset competencies and eight student outcome indicators. Today's engineering graduates need to possess both strong technical skills and an entrepreneurial mindset in order to be able to identify opportunities to create value for society[1]. The Kern Entrepreneurial Engineering Network (KEEN), the National Science Foundation, and VentureWell are among the leaders in promoting development of entrepreneurially minded engineers[2]. As one of the KEEN network institutions, [Institution] has established a framework designed to guide faculty in incorporating and assessing entrepreneurial mindset in engineering courses. This framework is comprised of eight entrepreneurial mindset outcomes organized into three competency areas: Practicing Human-Centered Design, Accepting Calculated Risk, and Demonstrating Basic Business Acumen. Faculty are challenged to cover entrepreneurial mindset material in an already packed curriculum. In order to assess the effectiveness of the EM initiative, evaluators must determine the extent to which outcomes have been integrated into classes. Working with instructional faculty, the College developed a simple rubric to determine coverage of outcome indicators. The rubric asks faculty to note the instructional mode of coverage by determining whether the topic was introduced, applied (by students), or assessed. The determination of mode is followed by extent of coverage, noted as a level of either low, medium, or high. The EM coverage rubric was applied during a redesign of a first-year design course. This course was chosen as an example because the course is delivered online, so all material is available in an immediate online format. The rubric will be used in program evaluation to assess the level of coverage of entrepreneurial mindset outcome indicators. The rubric also facilitates comparison of outcome coverage across courses and within sections of the same course. Ultimately, entire programs can be evaluated for integration of entrepreneurial mindset concepts. The same approach could be used to determine coverage of ABET student outcomes as well. In the full paper, the three entrepreneurial competencies and eight student outcome indicators will be introduced and examples provided of different mode and extent of coverage.

[1] Kriewall, T. J., & Mekemson, K. (2010). Instilling the entrepreneurial mindset into engineering undergraduates. The journal of engineering entrepreneurship, 1(1), 5-19.
[2] McKenna, A.F., Lichtenstein, G., Weilerstein, P., Monroe-White, T.M. (2018). Entrepreneurial Mindset: Using questions of What, Why, and How as an organizing framework. Advances in Engineering Education, Special Issue on Entrepreneurial Mindset, Fall 2018, v7, n1.

27970: Leveraging Algae to Inspire Curiosity, Develop Connections, and Demonstrate Value Creation for First Year Engineering Students

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This full paper describes a first-year engineering student design project that leverages algae as a system for building entrepreneurial mindset in students. In this project students represent engineers working for an algae biofuels company that is seeking to expand their operations globally. As such, each student team is assigned to a country within different geographic regions to explore the feasibility of this expansion. In their analysis, students must not only consider technical elements associated with algae growth and harvesting but must also examine how this type of operation would impact the local economy, government, environment, and society. The project consists of four phases where students learn about algae growth through experimentation and mathematical modeling with MATLAB, describe ethical implications associated with algae growth, develop a broader appreciation for the

diverse types of applications within which algae may be used, and investigate the broader impacts that algae growth can have within a specific context.

This project leverages KEEN's entrepreneurially minded learning (EML) framework which focuses on students developing curiosity about the project they are working on, having the ability to connect information from a variety of sources and disciplines to guide their analysis, and creating a final product that will provide value to the targeted customer population. In the algae project, students are encouraged to be curious about the benefits and drawbacks that are associated with this form of alternative energy. They are prompted to ask why algae biofuels may be beneficial for the region in question, what benefits they could provide to the region, what potential drawbacks may exist, and what conditions will be necessary to ensure success with their algae growth plans. Students then leveraged the information gained as part of their experiments and classwork to make connections to how this could impact their assigned country. For instance, students learned through the hands-on algae growth experiment what types of conditions are necessary to optimize algae growth. They combined this knowledge with the results from mathematical modeling using MATLAB to determine whether their assigned country has the resources necessary to grow algae at a large scale. Students then learned about the value this algae expansion could have in their country through an exploration of the global, societal, economical, environmental, and ethical impacts. The goal of the project is to help students think about creating value in society as engineers, which often involves more than solving problems. Rather, it involves learning how to discover, identify, and dig deeper into authentic problems in an experiential way.

M3C MENTORING INTO A PROFESSION

Room 208

27989: Tackling Real-World Problems in First-Year Electrical Engineering Experiences

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Engaging first-year engineering students with projects rooted in real-world problems can help keep the students engaged both in the project as well as the course overall. In their work studying intrinsic motivation[1], Deci and Ryan found that connecting one's work to greater contexts of significance or social import is a key factor in motivating better understanding and connecting one's work to other experiences. They also found that it results in improved commitment, effort, and performance. The work in[2] underscores the importance of active, discipline-based lab-learning on student retention and further supports the use of such activities. Situative learning and other learner-centered approaches[3-4] are frequently developed around exercises with real-world context grounded in experiences the learner can relate to; they have also been linked to improved student learning outcomes and persistence.

For the past three years, first-year students in the Electrical and Computer Engineering program at the University have contributed to the development of a water quality measurement device intended to serve as an inexpensive, reliable, hand-held replacement for the conventional bench-top water quality measurement system. Students in this introductory course have tested design concepts and developed the user interface for the system which consists of an Arduino and an LCD shield with buttons to help the user navigate through the data collection process. The work performed by the students in this course constitutes a portion of the overall project, shared with third-year ECE students as well as Chemistry students at the University. While much of the design was ultimately the responsibility of key ECE and Chemistry faculty members, the designs were developed to serve as examples/case studies of the engineering design process as well as to provide opportunities for the students to practice their design skills and contribute to the project by testing design iterations and variations.

In this paper, we will discuss this project in detail, describing how this project allows the students to further develop the embedded system programming skills that they have developed in this course[5], and how the project is used to introduced more advanced electrical engineering concepts. Following the presentation of the project details, a discussion of student attitudes and lessons learned from multiple project executions will be presented. The discussion will explore the impacts on student commitment, effort, and performance.

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[4] Johri, A. and Olds, B.M.,"Situated Engineering Learning: Bridging Engineering Education Research and the Learning Sciences," Journal of Engineering Education, 100: 151-185.
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28006: Advice from a First Year

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Much attention is paid to the transition from high school to college. Students who have recently gone through this transition may have some of the best advice to offer in-coming first year students. With this in mind, 152 students completing the second course of a common first year engineering program were given team assignments (for a total of 42 teams) asking them to provide approximately 6 pieces of advice for next year's first year students. Major advice offered by the students included the following themes: time management, utilizing resources, hard work, preparation (the importance of which may be emphasized by the "flipped" class format), teaming (which may have arisen due to the team-nature of the first year program projects), class attendance, social activities, self-care, and persevering through lower grades. These recommendations were then provided to first year students the following fall.

28092: Creating an Effective Retention Program

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The Choose Ohio First Scholarship program is designed to significantly strengthen Ohio's competitiveness within STEMM disciplines and STEMM education.

The Choose Ohio First Program is the University of Cincinnati College of Engineering and Applied Science's retention program for first year students. There are 36 freshman engineering students currently enrolled in the cohort of STEMM students. Through the program the students receive competitive scholarship funding and professional development workshops which help prepare them to enter into the STEMM workforce.

Prior to their Freshman year, students participate in a summer bridge program. The students spend seven weeks in a real-life college environment. They live in a residence hall and are enrolled in courses such as Pre-Calculus/Calculus, Physics, Chemistry, English and Engineering Models. Upon arrival on campus for the residential program, the students take assessment examinations to determine the courses in which they will be placed in the Fall and/or Spring semesters.

At the beginning of each semester of their first year, students are enrolled in Collaborative courses for Calculus. These classes meet for one-two hours per week. The students are also required to attend monthly workshops and/or socials which are facilitated by corporate partners who provide the students with guidance on being successful in their courses and their co-op experiences.

As part of the retention program, students are required to perform fifteen (15) hours of community service each semester, complete and essay related to their experience, complete reflections after the monthly socials to share their learned experiences, meet once per semester with their Choose Ohio First Program coaches and track their progress using our e-portfolio system. We monitor the students' experiences through surveys and self-reflections and well as through progress reports from their professors. Our results are then compared to other students in the College of Engineering.

Successes and opportunities for improvement, program compliance data and next steps will be shared in the conference paper.

28088: Helping Undeclared Engineering Students Find Their Best-Fit Major

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Factors relating to the potential for First-Year Engineering student success have been well considered, and continue to be evaluated. Areas of study include: self-efficacy, persistence, confidence, math and science readiness, resources available, a sense of belonging at the University, and "best-fit major" for retention purposes. For many students, these factors are intensified by the uncertainty in choosing a major. It is not uncommon for an incoming student to have selected "engineering" as a career goal without understanding the specific disciplines within the field. Therefore, choosing the right major may lead to student success (and improved retention).

During the fall of 2018, a total of 738 students entered Drexel University's College of Engineering. This population included all new freshmen plus transfer students. Of the total, 175 students (23.7%) were Undeclared in their engineering major. All of the 738 students were required to enroll in a section of UNIV E101"The Drexel Experience." This first-year course is designed to help students acclimate to life at the University, and topics such as time management, course registration, and campus resources are covered. A total of 31 sections were offered and were designated by special populations (Engineering Learning Community, Peer Mentor, transfer, specific major, and Undeclared). Typical classroom sizes were no more than 30 students for all populations, with the exception of the Undeclared sections, whose classrooms contained no more than 18 students. This was the first academic year that the Undeclared students were separated into their own cohort. The intent of this action of separation was to provide those Undecided students with specialized attention and resources to assist them in the selection of their major. Since Drexel has a co-op training component built into its curriculum, it is important for undecided students to choose their major before the start of the third quarter of the academic year so they can stay "on-cycle".

The course was taught by Undergraduate Advisors, and was focused weekly on exposure of the students to the various engineering disciplines. This was accomplished through: in-class exercises, lectures, guest lectures, and external exercises and written reflection papers. A description of those efforts (as well as student survey results) is described within the body of this paper. A focus group of UNIV E101 Advisors met bi-weekly to reflect on course assignments, lesson plans, and policies, and to tailor the material to meet the needs of each section. The course was also complemented by a first year Introduction to Engineering Design and Data Analysis course (ENGR 111) in which the Undeclared students worked in groups having students with declared majors. Additionally, the course material presented in ENGR 111 was multi-disciplinary therefore providing undeclared students with exposure to all disciplines offered by the College of Engineering. The efforts of the separation of (and specialized attention to) Undeclared students this year in UNIV E101 appeared to yield positive results – with student survey responses chiefly attributing their subsequent choice of major to the weekly faculty and advisor visits throughout the term.

Monday July 29 – 4:00 – 5:30 PM –Session M4: Workshops

M4: Workshops	Facilitator	Location
Fusion 360 Takes Your Ideas and Makes Them Real	David Taylor	205
MATLAB - Mathwork	Jerry Brusher	206
(Dis)connected: Low-tech Teaching Strategies for Engaging First-Year Engineering Students	Kristine Craven	207
Virtual Product Dissection Educational Modules - A Tool for Learning and Creativity During Engineering Design Projects	Elizabeth Marie Starkey	208

M4A: Fusion 360 Takes Your Ideas and Makes Them Real
Room: 205
Facilitators: David Taylor, Synergis Technologies EDS
david.taylor@synergis.com https://www.synergis.com/press_release/synergis-welcomes-david-taylor/

Fusion 360 helps students and educators prepare for the future of design. It's the first 3D CAD, CAM, and CAE tool of its kind, connecting your entire product development process into one cloud-based platform. You should attend this workshop If you're looking for foundational concepts explaining software features and skills. This workshop provides you with training on specific Fusion 360 skills and vocabulary that will help you get started with the software in your classroom while showcasing the latest software applications.

Additionally, Fusion 360 is free for students and educators. Get your free copy before the workshop here: https://www.autodesk.com/products/fusion-360/students-teachers-educators

M4B: Teaching with MATLAB: Instructor Hands-On Workshop
Room: 206
Facilitator: Jerry Brusher, Ph.D. – Mathworks (jbrusher@mathworks.com)

MATLAB is rooted in education, historically enabling students to implement, evaluate, and explore their understanding of course concepts. To continue to meet the ever-increasing demand for graduates with strong technical and problem-solving skills, MathWorks has developed several cloud-based tools to afford instructors and students anytime, anywhere access to their course content. In this 90-minute, hands-on, self-paced workshop, you will learn how these tools fit together to support your course development and delivery workflow, and how to enlist their immediate use in the classroom.

Upon completion of this workshop, participants will have
- Created an interactive Live Script;
- Uploaded and run files in MATLAB Online;
- Synced their cloud-based MATLAB Drive files with a local folder;
- Used MATLAB Drive to share files with collaborators and students;
- Learned how to incorporate MathWorks learning resources into their courses;
- Developed automated assessment problems with feedback in MATLAB Grader.

Pre-requisites:
- The workshop assumes participants are familiar with MATLAB and already use or are considering using MATLAB content in their courses.
- The workshop assumes participants have a MathWorks Account and have access to MATLAB Online through their institution's Campus-Wide License.
- Create a MathWorks Account here.
- Associate a MathWorks Account to a license here.
- For those who do not have access to MATLAB Online, we will make a trial license available for the duration of the workshop.
- Please bring your laptop!

M4C: (Dis)connected: Low-tech Teaching Strategies for Engaging First-Year Engineering Students
Room: 207
Facilitator: Kristine Craven – Tennessee Tech

Recent research has suggested that although the integration of technology into teaching and learning has enabled many benefits; there have also been opportunity costs associated with it; i.e. key features or skills that we may have (perhaps unintentionally) lessened, given up, or omitted in order to embrace technological change. One seminal study concluded, for example, that students are less able to retain and receive course content if they take notes using an electronic device, versus doing so by hand (Mueller & Oppenheimer, 2014). Similarly, others have noted that graphic design and computer science students exhibit lower ability to do creative problem-solving when they spend significant amounts of classroom time learning to use necessary software tools (Alhajri, 2016). There is growing recognition across a number of disciplines that students, especially in the novice stages of their education, would benefit from a more intentional balance between low-tech and high-tech approaches to learning (Meijer, 2016; Shaver, 2019). That balance would enable them to master the best of both worlds; and with each approach allow them to gain distinctive skills, knowledge and perspectives.

In this interactive workshop, participants will enhance their ability to identify opportunities for re-framing the content of their first-year engineering courses to integrate new, evidence-based low-tech teaching and learning strategies.

- Strengthen their ability to identify opportunities for integrating low-tech teaching and learning strategies
- Increase their instructional toolkit to include a number of evidence-based, active, low-tech teaching and learning strategies
- Assess new models of technology-mediated instruction for first-year engineering courses (especially larger ones)
- Creating and applying their own low-tech teaching and learning strategies to address persistent challenges in student learning for their own classrooms

M4D: Virtual Product Dissection Educational Modules - A Tool for Learning and Creativity During Engineering Design Projects
Room: 208
Facilitator: Elizabeth Starkey, Ph.D. – Penn State

Physical product dissection has been utilized in engineering classrooms for the last 30 years to guide student learning about how products work and assist in engineering design as a tool for redesign. Although physical product dissection has been a part of engineering design courses in the past, limitations exist such as recurring costs and laboratory requirements. These expenses can be mitigated by turning to a virtualized product dissection where students can take apart products on a computer, tablet, or smartphone. Due to the monetary and accessibility advantages of virtualizing product dissection, recent research has investigated the differences between virtual and physical dissection. These studies have found that virtual dissection can be used as a proxy for physical dissection when used as a tool for conceptual understanding of a product or as a tool to encourage creativity during idea generation. This workshop will provide an overview of the research conducted by the authors over the last 3 years through an NSF funded project and disseminate curricular activities and materials developed for engineering design classrooms. This will be accomplished through presentation, discussion, and active participation in product dissection activities. The workshop facilitators will provide techniques, lessons learned, and copies of course materials for participants. Participants should bring a laptop with SolidWorks eDrawings installed.

Tuesday July 30 – 8:30 – 9:45 AM – Session T1: Technical Papers

Time	T1A: Learning and Multiple Perspectives – Room 206	Presenting Author
8:30 - 8:45	First-Year Engineering Service-Learning Projects Can Play Large Role on Global Issues	David Gee
8:45 - 9:00	Reflection on the Road: How Recent First Year Students Exhibit Reflection During a Short-Term Study Abroad Experience	Natalie C.T. Van Tyne
9:00-9:15	Understanding Global Perspective Development in First-Year Engineering Students: Determining Educational Impact	Brian Robert Moore
9:15-9:30	Creation and Implementation of a Project Framework to Improve Cornerstone Engineering Design	Nicholas Meisel
9:30-9:45	Group Discussion	

Time	T1B: Developing STEM foundations – Room 207	Presenting Author
8:30 - 8:45	Full Paper: Creating and Assessing STEM Kits for P-12 Teacher Use	Stephany Coffman-Wolph
8:45 - 9:00	Combining Basic Tool Training and an Introduction to Physical Sciences for Freshmen Engineering Students	Bradley A. Striebig
9:00-9:15	An Investigation on the Effects of Supplemental Instruction and Just-in-Time Tutoring Methods on Student Success and Retention in First Year Engineering Course	David Joseph Ewing
9:15-9:45	Group Discussion	

Time	T1C: Developing Math Foundations – Room 208	Presenting Author
8:30 - 8:45	Strengthening Math Skills of Incoming Engineering Freshmen through a Bridge Program	Jacquelyn Huff
8:45 - 9:00	Benefits and Challenges of Teaching a First-Year Engineering Experience Course at a Small Campus	Asad Azemi
9:00-9:15	Undergraduate Academic Policy Trends Across Institutions Over the Last Thirty Years	Hossein Ebrahiminejad
9:15-9:30	Analyzing and Comparing First-Year Engineering Course Requirements among Institutions	Hossein Ebrahiminejad
9:30-9:45	Group Discussion	

T1A LEARNING AND MULTIPLE PERSPECTIVES

Room 206

28078: First-Year Engineering Service Learning Projects Can Play Large Role on Global Issues

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Service-learning projects associated with food availability, literacy, and habitat construction are just a few of the many service opportunities available to first-year students. Recent first-year engineering students have had the opportunity to participate in a project with greater potential for global reach. In response to the United Nations Development Programme Sustainable Development Goal for zero hunger, first-year engineering students were tasked with designing and building a solar-powered food dehydrator that could be built on location with minimal resources other than the primary building materials. The actual design here was implemented at one-third scale. The project was targeted for implementation in regions of emerging development including areas with chronic widespread hunger and, simultaneously, lacking in material resources and infrastructure – including access to electrical power. In practice, using a food dehydrator makes it possible to extend the period for which fresh food can be safely prepared and stored for later consumption when food sources are scarcer. The design is powered by solar energy, and by merging the energy collecting and dehydrating chambers into the same volume, a compact design is achieved. Sunlight enters the drying chamber via a roof that is covered with semi-transparent plastic sheeting. Incident radiation striking the walls of the dehydrator also contributes to the solar energy input. Air circulation through the unit occurs via natural convection as the relatively dry outside air can enter the drying chamber through an adjustable height door and/or via several mesh covered holes located on the floor of the drying chamber. Subsequently, the warmer moisture-laden air exits through a mesh-covered roof vent. Testing of the dehydrator in early summer in the Northeastern United States on sunny and/or partly sunny days with outside air temperatures in the 88-91 oF range revealed that the internal air temperature will approach 115 ^{o}F.

28005: Reflection on the Road: How Recent First Year Students Exhibit Reflection During a Short-Term Study Abroad Experience

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Study abroad experiences augment college and university curricula and expose students to an international setting with lectures, tours, and cultural activities. These studies raise awareness of professional, social and cultural differences among countries. Students recognize global challenges to the engineering profession when they discover that another country faces similar technical, social, cultural and resource-limiting challenges. They also learn that solutions to similar challenges in the U.S. may, or may not, be suitable in another country. Reflection provides the meaning behind the experience, which leads to our research question: how did first year students exhibit reflection during a two-week study abroad experience?

Our institution offers a second semester international studies course to first year engineering students, followed by a two-week early summer trip abroad. Students keep a travel journal describing their activities, thoughts, and impressions. They are prompted and encouraged to record new information, interesting or exciting experiences, uncomfortable or confusing situations, and key cultural differences found during their international travels. These journals are an instrument to facilitate the formation of meaning through reflection about events, observations and impressions, and their comparison to prior experiences and beliefs.

Under our four-stage model, reflection emerges first as an early attempt to find meaning without comparison to prior experience or potential application, expands to include links to prior experience or external ideas with self-questioning, and culminates in the validation of alternative views and potential transformation of beliefs. However, improvement in reflection may not be continuous, since the nature of particular events and the student's state of mind can influence their depth of reflection, as well as the details of the daily schedules. Moreover, prior studies with first year students and reflective journal writing have revealed that reflection is often embedded within a largely narrative context. Therefore, instructors need to evaluate what the student expresses through direct or indirect evidence involving feelings as well as logic.

Preliminary results suggest that students will uncover more meaningful impressions with increased practice, especially if and when they adhere to the suggested reflection prompts. Our results will also serve as a formative assessment of the effectiveness of the journal prompts in promoting reflection, as well as feedback about what students found to be the most meaningful aspects of their trip. Finally, the similarities and differences among the technical and cultural challenges faced in both the U.S. and other countries, as revealed through reflection, contribute deeper meaning to student self-awareness and identity within the engineering profession.

27972: Understanding Global Perspective Development in First-Year Engineering Students: Determining Educational Impact

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Developing and assessing global perspectives is becoming increasingly important due to the need for engineering graduates to enter a global workforce beyond 2020.[1,2] Engineering educators and higher education leadership believe those students who are able to work effectively with colleagues across national, cultural, and ethnic boundaries will be more prepared and successful post-graduation. Research has shown that international experiences like study abroad have a positive impact on students' global perspectives, especially when they engage in international programs and opportunities throughout college.[3,4] Unfortunately, engineering students have been underrepresented among study abroad participants (less than10%) historically, due to a variety of reasons (e.g., lack of preparation, structured curricula, lack of integration).[5-7] To promote global perspective development for the critical mass of engineering students who don't (or can't) participate in traditional international programs, determination of educational practices that promote global competency development is needed.

As part of a larger study on how global perspectives of engineering students can be developed through curricular and co-curricular educational opportunities throughout college, we administered the Global Perspective Inventory (GPI) to better understand the global perspectives of our incoming first-year students, and particularly, how it is influenced by prior educational opportunities and social experiences. The GPI is a nationally normed instrument that measures students' global learning and development through three major domains of human development – Cognitive, Intrapersonal, and Interpersonal. The Cognitive domain measure how a student thinks, the Intrapersonal domain measures how a student view themselves as an individual with a cultural heritage, and the Interpersonal domain measures how a student relates to people from other cultures, backgrounds, and values. The following research questions are addressed:

1. How do global perspective levels of first-year engineering students relate to prior educational opportunities?
2. How do global perspective of first-year engineering students relate to desired college educational opportunities?

In this full paper, we present our findings and provide initial recommendations for engineering faculty on how to better identify incoming first-year students with lower levels of global perspectives, as well as how global learning can be promoted in and around the first-year engineering classroom.

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27996: Creation and Implementation of a Project Framework to Improve Cornerstone Engineering Design

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Introduction to Engineering Design (EDSGN 100) acts as a gateway engineering course for over 3800 students across 20 Penn State campuses each year. Recently, the course has incorporated six educational modules, which cover topics from creativity to professional communication to making. However, these modules require a unifying experience so that the students are able to perceive how the content from the individual modules coalesces to form the unique identity of an engineer. To address this need, a new framework is proposed to guide the creation and implementation of an 8-week long design challenge within EDSGN 100. This framework identifies a series of 8 project characteristics necessary to create a clear connection between the content from each of the individual modules and the successful execution of a world-class engineering design project. This ensures that faculty-developed design projects are of an appropriate scope and context in order to provide proper scaffolding to support the six individual educational modules. This paper presents findings resulting from pilot studies conducted in five separate sections of EDSGN 100.

T1B DEVELOPING FOUNDATIONS

Room 207

28043: Full Paper: Creating and Assessing STEM Kits for P-12 Teacher Use

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With the continuing call for increased STEM (Science, Technology, Engineering, and Math) education at the pre-college level, teachers are expected to train students in these concepts. However, many teachers do not have the STEM educational background or experience to create opportunities for students to actively engage in learning STEM concepts [1]. Additionally, it is known that inquiry based instruction promotes learning, yet, a recent study revealed that teachers with science related degrees, as opposed to education only degrees, offer inquiry based learning at higher levels [2]. Therefore, there is a need to support teacher delivery of STEM educational concepts. While teachers may receive additional training through local universities or other professional development opportunities, it is challenging to learn from a day or week long crash course in a topic, be expected to create an effective lesson plan, or determine where the curriculum can be added to existing class requirements. However, creating a "kit" for teachers offers a solid starting point to assist teachers in STEM delivery [3]. Following this idea, we developed kits for teacher use; these kits are cost effective, with the materials being widely available. But, most importantly, the kits contain the background STEM information with easy-to-follow instructions that allow teachers to connect the STEM theoretical concepts to practical experiences. The kits also provide a list of frequently asked questions and answers to help teachers be confident in presenting the materials and links to additional interactive fun technology-based classroom content. To assist the teachers in successfully integrating the STEM-based materials into the course, each activity provides detailed learning objects and a detailed purpose statement. This paper will discuss (1) how to create the STEM based kits, (2) how to train teachers to use the kits in their classrooms, and (3) how to assess the kits from both the teacher and the student learning perspectives.

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27967: Combining Basic Tool Training and an Introduction to Physical Sciences for Freshmen Engineering Students

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The freshmen introduction to engineering course in the Department of Engineering at James Madison University is designed to introduce freshmen engineering majors to the tools and concepts used in engineering and reinforce the applications of math, physics and chemistry from the core curriculum.

The engineering programing at James Madison University was established in 2008.1 New programs have many challenges, some of which include unknown characteristics of students and a lack of established norms for both students and faculty. Many pieces of the curriculum were still being developed. Due to these challenging and changing circumstances, an iterative approach was used to refine the program's freshmen introduction to engineering course, ENGR 112. Students taking the freshmen engineering course at JMU were found to have significantly different levels of math, chemistry and physics backgrounds. One of the goals of the freshmen engineering course was to provide a chance to practice the applications of fundamental math and engineering science. The fundamental properties addressed through the development of an integrated experiential-learning approach for tool training and engineering science included applications of force and weight, force distribution, density, specific gravity, and applied geometry. Additional course goals for the freshmen engineering course discussed herein included exposing engineering students to modern engineering tools and understanding and practicing appropriate safety protocols.

There are twelve objectives for the freshmen course, which address 10 ABET a-k topics. As part of the described module:

- Students calculate the volume and density of various materials

- Students interpret engineering drawings to relate principles and equations in geometry.
- Students perform a force balance to balance a hinged load.
- Students create an engineering drawing to design and build a balance for two objects.
- Students receive an orientation to basic tools and safety in the machine shop.
- Students must successfully complete a competency based lab and shop safety quiz.
- Students build and test the mechanism they have designed to balance the point and distributed forces.

As a result of this approach, students gained confidence in relating abstract drawings to physical materials. Students also gained hands-on experience relating basic engineering concepts about density, materials, statics and dynamics. Students expressed increased confidence in using basic tools and relating those tools to engineering science principles. Many students who had no previous experience with basic tools and shop techniques went on to apply and work as undergraduate teaching assistants in the shop after completing this assignment.

28029: An Investigation on the Effects of Supplemental Instruction and Just-in-Time Tutoring Methods on Student Success and Retention in First Year Engineering Course

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The University of Texas at Arlington (UTA) embarked on a study to identify where their engineering students were struggling over three years ago in an effort to address student success, persistence, and retention. In this study, the committee identified that students were ill-equipped in engineering problem solving methodology and basic engineering computer programming. To address these concerns, a new course named Engineering Problem Solving was created utilizing the Student Centered Active Learning Environment with Upside-down Pedagogies (SCALE-Up) method. This class has aided in improving student retention and persistence in engineering. However, to further enhance this effect, Supplemental Instruction (SI) was added to the existing just-in-time tutoring model already being utilized in the class. This addition was made in an attempt to increase student success within the course, especially addressing the mathematically underprepared and underrepresented minority groups within UTA's diverse engineering student body. SI provides a more structured studying environment in which students are led by a peer group mentor, known as an SI leader, in solving problems, receiving tips on good study habits, and other student success strategies.

This is in contrast to the just-in-time tutoring sessions that are more "drop-in" in format, getting answer to specific questions the students have. This paper will assess the effects that these two different methods have on success rates in the course, defined as receiving an A, B, or C. Further, this paper will explore first semester retention data in order to assess the effects of these learning resources above the already effective retention rates shown in the class as a whole. Finally, this paper will explore the effect these methods have on particular student groups shown to struggle more in the class than their counterparts, including underprepared students, and underrepresented minorities. This paper will show all students benefit from these resources as evidenced by increased first semester retention and success rates.

T1C DEVELOPING MATH FOUNDATIONS

Room 208

28025: Strengthening Math Skills of Incoming Engineering Freshmen through a Bridge Program

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Fifty female first-generation incoming engineering students attended a summer bridge program at Texas A&M University in 2018 with a significant focus on improving math skills. As part of the program, all students took a no-credit supplemental math course that was designed to strengthen math skills and ease the transition to university-level math and engineering courses from high school. The designers and instructors of this course took an approach that worked to draw connections between math concepts. Instead of simply reviewing concepts or putting the students through a "drill-and-kill" bootcamp, participants worked together to forge understandings of fundamental mathematical concepts. An emphasis was placed on understanding mathematics as a system of ideas, rather than a set of rules that all had their own narrow application. In addition, students were asked to partake in several metacognitive exercises to examine how they learn and think about math and question if their assumptions about mathematics and the practice of mathematics were valid. Participants met with instructors for 2 hours each day, 5 days per week, and instruction was supplemented with small-group practice sessions (4-5 students) that were led by current engineering students at Texas A&M. As a result of the four-week course, many students saw significant gains in their math placement exam score, which is used to determine first-semester math course placement. This paper will discuss these outcomes and will also examine the performance of participants during their first semester in the College of Engineering.

28008: Benefits and Challenges of Teaching a First-Year Engineering Experience Course at a Small Campus

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This work, for a full paper consideration, covers our experience teaching a first-year engineering course at a small campus and our continuous effort in improving the course. The paper covers the main objectives of the course, which has remained fairly constant over the years, and includes helping students to better understand what engineers do, introduce them to the range of career opportunities related to the field, and exposing them to an academic experience that combines fundamental concepts of engineering design, practical experience, problem solving skills, management and communication skills, and teamwork through a hands on experience, but the methodology has changed to accommodate the external changes related to students' culture and the technology. Instructors who have taught this course have adopted the same course objectives but have used different approaches. For example, textbook was not required by all sections and sections had different hands-on project. The paper includes experiences from different instructors who have taught the course at our location, the changes that we have introduced and the reasons behind them, as well as a brief literature review. The paper also discusses challenges associated with offering the course from faculty and students prospective.

28094: Undergraduate Academic Policy Trends Across Institutions Over the Last Thirty Years

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This study sought to compare engineering undergraduate academic policies across universities in order to identify existing trends in the past 30 years. We conducted content analysis on institution catalogues using Nvivo and investigated the core courses required in engineering curricula, we also investigated the different probation policies and compared them across different institutions. We hypothesized that as time has progressed, colleges have better refined and specified their policies and catalogs, generally in such a way that has led to higher academic standards. We also expected to see an increase in the required math and science courses as the years went on. However, when we examined the data, there were more complex relationships than we had originally predicted. In conclusion, across multiple years, there is not much of a difference, but across colleges, more definitive trends can be observed. We used visualization methods to illustrate the differences among institutions and throughout the last thirty years.

28047: Analyzing and Comparing First-Year Engineering Course Requirements among Institutions

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There have been a number of studies investigating the factors effecting students choosing engineering in college, but very few discuss the effect of curricular pathways on students' engineering discipline choice after their first year engineering experience.

This study aims to analyze, and present different curricular patterns undergraduate students take before choosing an engineering discipline in an institution with first year engineering matriculation model. The study also investigates how these different clusters can influence students' major choice.

This research uses a longitudinal dataset dating from 1989 to 2011 and includes over 35,000 undergraduate students matriculating in one of the big Midwestern engineering universities. The dataset includes undergraduate students who have ever declared engineering as major. The study focuses on students who matriculate in one of the seven big engineering disciplines: Aero Space, Chemical, Civil, Computer, Electrical, Industrial, and Mechanical engineering. At the first step, the courses students take are categorized into different categories such as introductory to engineering courses, core science courses (math, physics, and chemistry), general courses, engineering courses, and general courses. Then, a cluster analysis is conducted on courses students take before choosing an engineering discipline. Then a regression model is applied to investigate the effect of these clusters on student's major choice.

The preliminary result show the variety of curricular clusters students take throughout their first semester. By considering the courses that are offered and recommended by the institution, we illustrate a comparison between courses that are offered, and courses students end up taking. The results also show the effect of curricular policies on students' curricular pathways.

This effort will lead in establishing a standard database for course classification in engineering curricula. The established classification can be the foundation for creating a common language for future cross institution studies. The findings can also provide useful information for students, institution administrators, and local and national policy makers.

Tuesday July 30 – 10:15 – 11:30 AM – Session T2: GIFTS

T2A GIFTS

Room 206

28028: Engineers and Entrepreneurial Thinking
Frank T. Koe (ftk2@psu.edu) Penn State, SEDTAPP

28055: A Systems Engineering Approach to Conceptual Design in a 1st-Year Engineering Program
Mike Elmore (melmore@binghamton.edu) Binghamton University

28017: Energy-Efficiency Assessment of Windows using Temperature Sensors
Jean BatistaAbreu (batistajc@etown.edu) Elizabethtown College
Brenda Read-Daily (readb@etown.edu) Elizabethtown College

28074: Sketching, Building & 3D Printing: Implementation of a Non-Discipline Specific Making Activity in a First-Year Engineering Design Course
Susan Beyerle (scb4@psu.edu) Penn State
Sarah Ritter (scr15@psu.edu) Penn State

28036: Inquiry-based Learning for First-Year Engineering Students
Tracey Carbonetto (tcarbonetto@psu.edu) Penn State, Allentown

28057: GIFTS: Introduction to Technical Graphics and Hand Sketching Using a Tablet and Stylus
William Cohen (cohen.507@osu.edu) The Ohio State University

28084: GIFTS: Utilizing MATLAB's Online Tutorial in First-Year Engineering Courses
Ashish Borgaonkar (ashish.borgaonkar@njit.edu) New Jersey Institute of Technology
Jaskirat Sodhi (jaskirat.sodhi@njit.edu) New Jersey Institute of Technology
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28020: Reconsidering Approaches to Advising Male Engineering Students and Implications for Inclusivity
Laura Hennessey (lah197@psu.edu) Engineering Advising Center, Penn State College of Engineering

T2B GIFTS
Room 207

28003: Creating a Peer Advising Program to Increase Engagement with Pre-major Engineering Students
Jennifer Saltsgiver (jlr46@psu.edu) Penn State, College of Engineering, Engineering Advising Center

28044: GIFTS: MAJOR Exposure Through Engineering Innovations
Brianna L Dorie (bridorie@gmail.com) Gonzaga University

28066: Fostering Racial Identity Development, Self-Efficacy, and Institutional Integration to Promote the Success of Black Male First Year Students
Karl W. Reid (kreid@nsbe.org)

28030: Global Classroom Project: Bringing Global Competency to the STEM Classroom
Sridevi Rao (Sxr98@psu.edu) Penn State
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28027: Big E Little e, What begins with Ee's? - Ethics
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28026: Strengthening Inclusive Group Dynamics
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28024: Going Circular: Re-Using a First-Year Design Project
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27999: GIFTS: Working with Local Retirement Communities for Freshman Design Experiences
Jacob Moore (jmoore@psu.edu) Penn State, Mont Alto

28082: Mindfulness in Engineering
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Author Index

Author	Session ID
Cheng Peng	M1A
Reginald Perry	M1C
Lynn Peterson	M1A
Jane Petrie	M1C
Robert Pieri	M1B, M1C
Nicole P. Pitterson	M1B
Marcia Pool	T1B
Christopher Porter	M2C
Michael Prairie	M3C
Robert Prins	T1B
Sridevi Rao	T2B
Brenda Read-Daily	T2A, T2B
Karl Reid	T2B
George Ricco	T1C
Geoff Rideout	M3B
Sarah Ritter	S1B, M2A, T1A, T2A
Peter Rogers	S2A
Breigh Roszelle	M2A
Jennifer Saltsgiver	T2B
Emily Sandvall	M1C
Soundouss Sassi	M1C
Jim Sauls	T2B
Heath Schluterman	M3A
John Schneider	T1A
Jennifer Sears	M1C
Cedric Shelby	T1B
Kristi Shryock	T1C
Todd Patrick S Shuba	M1B
Thomas Siller	M2B

Author	Session ID
Amanda Singer	M3C
Schinnel Small	M1A
Jaskirat Sodhi	M1B, T2A
Darlene Spracklin-Reid	M3B
Elizabeth Starkey	M4D
Danisha Stern	T1C
Scott Streiner	M2C, M3B, T1A
Bradley Striebig	T1B
Rosie Sullivan	M3C
David Taylor	M4A
Kenneth Tellis	M1C
Brandon Terranova	M3B
Nicholas Tomlin	T1C
Doug Tougaw	M3A
Edmund Tsang	M1C
Catherine Unite	T1B
Ann Vallie	M1B, M1C
Natalie C.T. Van Tyne	T1A
Erica Venkatesulu	M1B
Martin Wallace	M2C
Chizhong Wang	T2A
Xiaohong Wang	M3A
Siqing Wei	M2B
Kristen Wendell	M1B
Christopher Weyant	M3B
Julie Whitney	M1C
Sara Willner-Giwerc	M1B
Sarah Zappe	S1A
Haolin Zhu	M2C, M3B

FIRST-YEAR

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