

# FRONTIERS IN EDUCATION CONFERENCE

E-IN-STEM



SCIENCE ✦ TECHNOLOGY ✦ ENGINEERING ✦ MATH

**BRINGING ENGINEERING  
INTO YOUR K-12 CLASSROOM**

SATURDAY | OCTOBER 15, 2016



| BREAKOUT SESSION 1   8:30-10 a.m. |  | GRADE LEVELS | SHERATON      |
|-----------------------------------|--|--------------|---------------|
| 1.1                               | Projects that Motivate the Learning of Concepts through Circuits.<br><i>Presenter: Gannon University</i>   | H            | Harlequin C   |
| 1.2                               | Linking Engineering to Learning<br><i>Presenter: North Carolina State University</i>   | E-M          | Otter         |
| 1.3                               | Transdisciplinary Integration of Creative Robotics for Identification of Student STEM Affinities<br><i>Presenter: Carnegie Mellon University</i> | M            | Safe Harbor   |
| 1.4                               | The Play's the Thing!<br>Supporting Computational Thinking Through Robotics and Coding<br><i>Presenter: University of Southern California</i>    | E            | Harlequin A+B |

## SESSION 1.1

### TITLE: E = MC<sup>2</sup>: Excite Interest in Electronics Through Projects that Motivate the Learning of Concepts through Circuits

**Presenter:** Dr. Ramakrishnan Sundaram is a Professor in the Electrical and Computer Engineering Department at Gannon University. His areas of research include computational architectures for signal and image processing as well as novel methods to improve engineering education pedagogy.

**Level:** High School (9-12)

**Abstract:** This workshop will actively engage the participants in the concept-to-product process which forms an integral part of electronic circuit design, assembly, test, and validation. Electronic circuit design requires knowledge of STEM concepts ranging from fundamental to advanced. The hands-on laboratory and project-based experiences are deemed to be among the most effective means to introduce and reinforce these concepts.

The following are the primary goals or expected learning outcomes of this workshop.

- Understand the application of electrical engineering concepts through projects in electronic circuit design
- Assemble, test and validate simple and complex electronic circuits
- Gain vital hands-on laboratory experiences working as individual and on teams
- Learn ways to incorporate the workshop experiences and engineering content into K-12 STEM curricula

## SESSION 1.2

### Title: Linking Engineering to Learning

**Presenter 1:** Dr. Laura Bottomley has taught every grade from kindergarten through graduate school at one point in her life. Now she spends her time with younger college students during part of the day and working with teachers and students in K-12 for the rest of it. She is a passionate advocate of using engineering as a platform for the integration of STEM subjects, which she has been doing since 1997. Her favorite discipline, however, is electrical engineering. Just ask her.

**Presenter 2:** Beth Cady is a Program Officer at the National Academy of Engineering, where she facilitates the deployment of innovative policies, practices, and tools designed to enhance the effectiveness and efficiency of systems for the formal, informal, and lifelong education of engineers. She is the co-director for the LinkEngineering project.

**Level:** Elementary (EC-4) and Middle School (5-8)

**Abstract:** The National Academy of Engineering has created a new resource for teachers of engineering, as a part of integrated STEM or as a stand-alone, in grades K-12! This workshop will explore the new resource, LinkEngineering, using hands on activities and examples found on the site. Participants will locate an activity on the web site, then execute that activity with guidance from the facilitators. The workshop will highlight using engineering to teach mathematics and science objectives, with an activity designed for elementary grades; however, all attendees will learn ways to productively use failure, creativity, teamwork and other habits of mind to engage their students in an engineering design activity and creative ways to assess student learning. Come learn what this new resource can do to support you in your teaching, and walk away with practical ideas and activities that you can put to use easily.

## SESSION 1.3

### Title: Transdisciplinary Integration of Creative Robotics for Identification of Student STEM Affinities

**Presenter 1:** Jennifer Cross graduated from F. W. Olin College of Engineering with a B.S. in Electrical and Computer Engineering and is now working toward her doctorate in Robotics at Carnegie Mellon University. A fellow of both the NSF's Graduate Research Program and IES's Program for Interdisciplinary Educational Research, Jennifer's research focuses on the impacts of integrating creative robotics into cross-curricular learning environments and the development of the Arts & Bots program.

**Presenter 2:** Emily Hamner is a Senior Research Associate at the Carnegie Mellon University Robotics Institute. She has developed a variety of robots and technology for schools and museums. Her research focus is on educational robotics and human-robot interaction with a particular focus on helping girls

to become more technologically empowered. Emily holds a B.S. in Computer Science from CMU.

**Presenter 3:** Sue Mellon serves as the K-12 Gifted Support Coordinator for the Allegheny Valley School District for the past 18 years. With over 25 years of experience, she is always looking for new ways to enrich her students' learning experience. She has developed core content units to implement robotics. She has a B.S. in Education from Indiana University of Pennsylvania and a M.S. in Education from the University of Pittsburgh.

**Presenter 4:** Brett Slezak teaches Health and Physical Education at AVSD. He holds a M.S. in Exercise Physiology from the University of Pittsburgh and is passionate about integrating STEAM learning in unexpected ways. Brett is co-creator of Rachel's Neighborhood STEAM Garden, a sustainable cross-curricular learning-space and is piloting a student wellness program that merges FitBits with social media. Additionally, Brett guides students in prototyping wearable technology and robots in his classes.

**Presenter 5:** Michele A. Welter is the Principal of Springdale Jr/Sr High School, part of the Allegheny Valley School District. She holds a Doctorate of Education in Administrative and Policy Studies from the University of Pittsburgh, a M.Ed. from Westminster College, a B.S. in Health and Physical Education from Slippery Rock University, and a B.S. in Exercise Science from the Pennsylvania State University.

**Level:** Middle School (5-8)

**Abstract:** Learn about using robotic technologies within non-technical courses as a means of supporting learning and identifying student STEM affinities. Such transdisciplinary projects can improve student technological fluency and increase exposure to engineering careers, while simultaneously deepening student engagement with disciplinary content. Learn about key features for successful integrations as well as how to recognize engineering design and computational thinking talents in students. You will learn about our transdisciplinary middle school project, Arts & Bots, which inserts robotics into classes such as English, health, art, and social studies. Participants will develop their own integrated technology curriculum ideas during the workshop.

## SESSION 1.4

**Title:** The Play's the Thing! Supporting Computational Thinking Through Robotics and Coding for Grades 3-5

**Presenter 1:** Dr. Gisele Ragusa is a professor at the University of Southern California (USC) in the Viterbi School of Engineering's Division of Engineering Education. She chairs USC's STEM Education and Research Consortium. Her research interests and areas of expertise include: engineering education, college access, STEM mentorship, STEM teacher education and retention, literacy education, content literacy, early childhood, special education and deaf education as well as assessment and measurement in STEM education.

**Presenter 2:** Dr. Katie Mills is USC Viterbi School of Engineering's Administrator of the PK-12 STEM Outreach program called VAST (Viterbi Adopt-a-School, Adopt-a-Teacher) Program. She initiates and manages programs, e.g., a Robotics and Coding Academy at three elementary schools and a 7-week summer high school research program, and develops collaborations between schools and junior faculty expanding their broader impacts. With a Ph.D. in Film and Literature, she taught college for 18 years.

**Level:** Elementary (EC-4)

**Abstract:** In a fun, hands-on workshop, participants will code using a "drag and drop" language that commands robots in a "technology-as-partner" curriculum (all equipment provided during the workshop; low-cost equipment suggestions provided). With activities and standards-aligned lessons developed in USC Viterbi School of Engineering's Robotics and Coding Academy for 3- 5th graders, teachers will be able to:

- Confidently introduce students to engineering design
- Use analog games to teach key concepts in coding coupled with reflective exercises (metacognition)
- Teach visual programming language on tablets through tested lesson plans – no prior coding experience necessary
- Execute codes with robots, stepwise challenges in lesson plans
- Use scaffolding to support the concepts, practices, perspectives computational thinking
- Assess student learning at each step

### S2 TECHNICAL SESSION | at the Frontiers in Education Conference | 10:30 a.m.

| CODE | TITLE  | BAYFRONT CONVENTION CENTER |
|------|--|----------------------------|
| S2A  | Special Session: Making the Multiple Institution Database for Investigating Engineering Longitudinal Development (MIDFIELD) More Accessible to Researchers | 170A                       |
| S2B  | Special Session: Designing The Engineer's Way  | 170B                       |
| S2C  | Computer-Based Learning and Courseware Technologies II   | 130B                       |
| S2D  | Diversity: Women and Girls   | 130C                       |
| S2E  | PK-12: Perceptions of STEM   | 140A                       |
| S2F  | Computing Discipline Specific  | 140B                       |
| S2G  | Student Approaches to Learning   | 140C                       |
| S2H  | Peer Tutoring and Mentoring  | 160A                       |
| S2I  | Retention of First Year Students   | 160B                       |



| BREAKOUT SESSION 2   1-2:30 p.m. |   | GRADE LEVELS | SHERATON          |
|----------------------------------|---|--------------|-------------------|
| 2.1                              | 3D Printing Made Accessible: Managing the 3D for Today's Classroom<br><i>Presenter: Fairview School District</i>                          | H            | Harlequin A+B     |
| 2.2                              | Sound Thinking!: Engineering Invention and Innovation with Middle School Youth.<br><i>Presenter: University of Virginia</i>               | E-M          | Harlequin C       |
| 2.3                              | Exploring Electrical Engineering through Movement: Going with the Flow and Programming Puzzles<br><i>Presenter: University of Calgary</i> | E            | Otter Safe Harbor |
| 2.4                              | PictureSTEM: Curricula for K-2 Literacy and STEM Integration<br><i>Presenter: Purdue University</i>                                       | E            | Safe Harbor       |

## SESSION 2.1

### Title: 3D Printing Made Accessible: Managing the 3D for Today's Classroom

**Presenter:** Ryan Bookhamer is the STEM Integrator with the Fairview School District. He is responsible for the development, and implementation of the school's K-12 STEM Program. Ryan infuses STEM projects with hands-on, real world problem solving that creates innovative learners. Apart from education, Ryan works in industry as a product development specialist, designing, engineering, and managing manufacturing around the world.

**Level:** Elementary - High School (EC-12)

**Abstract:** The 3D Printing Made Accessible Workshop is designed to give participants an overview of 3D Printing, Software, and Online Resources that will assist in implementing 3D printing into the modern classroom. The workshop will introduce the participants to a 3D Printer, and discuss how the machines operate, and build parts.

The workshop will explore 3D Printing in the classroom and present both the challenges and ways to implement 3D printing into curriculums to enhance the learning environment. Workshop participants will receive sample parts, resources for creating projects, and an outline to assist in the development of classroom curriculum geared towards 3D Printing.

## SESSION 2.2

### Title: Sound Thinking!: Engineering Invention and Innovation with Middle School Youth

**Presenter 1:** Dr. Ann Reimers is a faculty Lecturer at the University of Virginia teaching Introduction to Engineering. A 2014-15 Albert Einstein Distinguished Educator Fellow at DOE, she is currently the Energy Content Area Expert for the National Science Bowl. She holds BSc and MME degrees in mechanical engineering from the University of Pennsylvania and the University of Delaware. Her DSc degree is in electrical engineering from The George Washington University.

**Presenter 2:** Trey Smith is a teacher consultant with the Philadelphia Writing Project at the University of Pennsylvania and recently served as the 2015-16 Science Teacher-in-Residence at the Library of Congress. He taught science and engineering in Philadelphia public schools, co-founded the Philadelphia Engineering and Math Challenge, and was a 2014-15 Albert Einstein Distinguished Educator Fellow. He earned dual BA degrees from Louisiana State University and MSEd from the University of Pennsylvania.

**Level:** Middle School (5-8)

**Abstract:** Workshop participants will analyze historical primary sources related to 19th century sound recording and playback technology with a focus on structure, function, and systems; design and test physical gramophone models; and explore the differences between innovations and inventions in intellectual property. The workshop activities are part of a summer STEM session for middle school girls. By participating in learning activities designed for youth, participants will expand their own visions for the ways in which academic content, engineering practices, historical thinking, collaborative learning, making, and literacy converge to create ideal learning 21st century conditions. Participants will consider the particulars of the modeled learning activities with a theoretical framework that can be used to design future learning experiences for learners.

## SESSION 2.3

### Title: Exploring Electrical Engineering through Movement: Going with the Flow and Programming Puzzles

**Presenter 1:** Emily Marasco is a Ph.D. student at the University of Calgary. Her research focuses on creativity and cross-disciplinary curriculum development for engineering students, as well as for K-12 and community outreach programs. Emily is co-founder and chair of the University of Calgary Engineering Education Students' Society, and has a passion for the connections between fine arts and engineering.

**Presenter 2:** Stephanie Hladik is an M.Sc student in Electrical and Computer Engineering at the University of Calgary. Through her research she is exploring topics related to the integration of engineering into K-12 curricula. In particular, she is interested in bringing electrical engineering, programming, and the engineering design process into K-12 education. Aside from her research, Stephanie also participates regularly in outreach programs to promote STEM topics in classrooms and beyond.

**Level:** Elementary (EC–4) and Middle School (5-8)

**Abstract:** The Exploring Electrical Engineering program will electrify your understanding of engineering! This workshop will details two activities for exploring electrical and computer engineering concepts for grade 3-5 students through the use of cross-disciplinary concepts in physical education and movement.

**Activity 1:** Going with the Flow uses human electrons and circuit components to demonstrate electron behaviour in parallel and series circuits.

**Activity 2:** Programming Puzzles introduces code design through life-size maze creation and completion. These creative activities have been tested as part of on-going research work in several classrooms, with over 350 elementary school students participating, and have resulted in an increased interest in electrical engineering as a future career.

## SESSION 2.4

### Title: PictureSTEM: Curricula for K-2 Literacy and STEM Integration

**Presenter 1:** Elizabeth Gajdzik is the Assistant Director of the INSPIRE Research Institute for Pre-College Engineering in the School of Engineering Education at Purdue University. She received her B.S. in Interdisciplinary Studies with a specialization in mathematics and M.S.Ed. in Curriculum and Instruction with an emphasis in mathematics education from Baylor University. Prior to her work at INSPIRE, Elizabeth was a district mathematics instructional specialist and a middle school mathematics teacher.

**Presenter 2:** M. Terri Sanger is Research Data and Community Coordinator for INSPIRE Research Institute for Pre-College Engineering in the School of Engineering Education at Purdue University. She is part of PictureSTEM and STEM + C grant teams and manages INSPIRE's UPRISE Academy providing research and mentoring experiences for undergraduates working on research projects. She received her B.S in Elementary Education and M.S. Ed Clinical Reading from Illinois State University, Normal, Illinois.

**Presenter 3:** Brianna Dorie is a postdoctoral researcher with INSPIRE Research Institute for Pre-College Engineering in the School of Engineering Education at Purdue University. She received her B.S. from the University of Portland in Civil Engineering, M.Eng in Environmental Engineering from the University of Arizona, and obtained a dual doctoral degree in Engineering Education / Ecological Science & Engineering from Purdue University. Her research interests center around broadening participation in engineering, learning in informal environments, as well as STEM integration to improve learning. Brianna has also previously taught and developed engineering curriculum for summer camps, after-school programs, K-2 classrooms, and first year engineering experiences.

**Presenter 4:** Anastasia Rynearson is a Purdue Doctoral Fellow pursuing a degree in Engineering Education at Purdue University. She received a B.S. and M.Eng. in Mechanical Engineering at the Rochester Institute of Technology. Her teaching experience includes outreach activities at various age levels and undergraduate engineering courses. Her current research interests focus on early P-12 engineering education and identity development.

**Level:** Elementary (EC–4)

**Abstract:** With the publication of the Next Generation Science Standards and the increasing attention being placed on the integration of engineering in elementary classrooms, it is important to continue to develop an understanding of what engineering looks like in the elementary setting. This hands-on session will present STEM integration units that use STEM trade books to build the context for an engineering design challenge while also integrating mathematics and science content throughout the unit for grades K-2. Participants will interact with the curriculum as well as receive copies of the units and lesson plans that have been developed. Participants will also be a part of an interactive discussion about how these modules could be implemented in their own K-2 curriculum.



| BREAKOUT SESSION 3   3 -4:30 p.m. |  | GRADE LEVELS | SHERATON    |
|-----------------------------------|--|--------------|-------------|
| 3.1                               | Applied Robotics in Discovery Learning<br><i>Presenter: Gannon University</i>  | H            | Safe Harbor |
| 3.2                               | Integration by Design: Using Engineering Design Challenges to Foster Integrative STEM Education<br><i>Presenter: University of Virginia</i>                                | M            | Harlequin C |
| 3.3                               | Storybook Engineering: How to bring favorite stories to life and engage K-5 students in engineering design projects<br><i>Presenter: University of Southern California</i> | E            | Otter       |

### SESSION 3.1

#### Title: Applied Robotics in Discovery Learning

**Presenter:** Mark Blair is an instructor in the Computer and Information Science Department at Gannon University.

**Level:** High School (9-12)

**Abstract:** The open-source community has changed the way we develop hardware and software. A robotics developer must be a programmer, electrical engineer, mechanical engineer, and mathematician. Contemporary programmers and engineers learn through the practical implementation of code and techniques contributed to the open source ether.

For educators, this means we must reevaluate how and what skill sets we teach, lending more importance to the ability to read and understand code, to self-learning, and debugging as core skills paramount to software development. This breakout session will discuss traditional discovery learning techniques along with some modified learning techniques to help bring the complex, technical world of programming robots into the reach of uninitiated students. Participants will learn how to develop teachable classroom modules utilizing open-source materials.

### SESSION 3.2

#### Title: Integration by Design: Using Engineering Design Challenges to Foster Integrative STEM Education

**Presenter 1:** Larry G. Richards is a professor of Mechanical and Aerospace Engineering at the University of Virginia. He leads the Virginia Middle School Engineering Education Initiative. Larry's research interests include creativity, entrepreneurship, innovation, and K-16 integrative engineering design. He is a founding member of the K-12 and Pre-College Engineering Division, the division's current Awards Chair, and a Fellow of ASEE.

**Presenter 2:** Susan Donohue is a lecturer, teaching sections of ENGR 1620, Introduction to Engineering, and serves as the course co-ordinator. Her research interests include the process and practice of engineering design, the assessment and development of spatial skills, the identification and remediation of misconceptions, and the development of alternative pathways to engineering studies.

**Level:** Elementary-High School (EC-12)

**Abstract:** In this workshop, we will emphasize the inherently integrative nature of engineering design and how that nature promotes learning in science and mathematics while developing man-made artifacts, the core of technology. By working through design challenges from selected Engineering Teaching Kits, participants will gain experience with the engineering design process, observe how the design challenges incorporate learning of relevant scientific and mathematics principles, and receive training and tools that will enable them to develop and incorporate engineering design challenges in their curriculum. These learning objectives will be addressed through the use of project-based collaborative and co-operative learning activities and large and small group discussion. While appropriate for P-12 educators, the focus will be on elementary and middle school grades.

### SESSION 3.3

#### Title: Storybook Engineering: How to bring favorite stories to life and engage K-5 students in engineering design projects

**Presenter:** Katie Busch, Ed. S., is the director of a STEM professional development organization out of the University of Alabama at Birmingham's Center for Community Outreach Development. She works with K-12 teachers, curriculum administrators, librarians, engineers, and informal educators to develop engaging cross-curricular lessons that integrate engineering into a variety of educational settings.

**Level:** Elementary (EC-4)

**Abstract:** From favorite fairy tales to modern-classics, every great story has some kind of problem or challenge. In this session we will try out a couple of engineering projects that bring well-loved children's books to life, explore digital resources, and go through how to find an engineering activity to correspond to almost any story. Participants will receive copies of activity protocols including standards alignment and handouts of instructions/lesson planning guides for developing an activity to connect to a chosen story. Come join us to find out how to guide students design their own fairy-tale endings!





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