TENTH ANNUAL SYMPOSIUM
ENGINEERING AND LIBERAL EDUCATION

2-3 JUNE 2017
UNION COLLEGE
SCHENECTADY, NEW YORK
TROLLEY SCHEDULE

The Trolley will make several round trips throughout the hour, beginning with the times below:

**Friday, 2 June, 2017**
11:00 am: Hampton Inn to Old Chapel Circle
9:00 pm: Old Chapel Circle to the Hampton Inn

**Saturday, 3 June, 2017**
7:45 am: Hampton Inn to Old Chapel Circle
5:15 pm: Old Chapel Circle to Hampton Inn
6:15 pm: Hampton Inn to Post-Symposium restaurant (one trip)
8:30 pm: Post-Symposium restaurant to Hampton Inn (one trip)
WELCOME

Welcome to the Tenth Symposium on Engineering and Liberal Education, hosted by Union College in Schenectady, New York. We are grateful to have Dr. Henry Petroski, Aleksandar S. Vesic Professor of Civil Engineering, Duke University, with us to present the keynote address. We have an outstanding array of papers and stimulating workshops from researchers and practitioners at the interface of engineering and the liberal arts. We have integrated these into an exciting program that we hope will result in you bringing home some practical applications of this work. On behalf of the Program Committee, we welcome you to our beautiful campus and hope that you have an inspiring symposium.

Ashraf Ghaly, Symposium Chair

PROGRAM COMMITTEE

Chair
Ashraf Ghaly
Carl B. Jansen Professor of Engineering
Director of Engineering
Union College

Atsushi Akera
Associate Professor
Department of Science and Technology Studies
Rensselaer Polytechnic Institute

Christine Henseler
Professor of Spanish & Hispanic Studies
Union College

Shane Cotter
Associate Professor of Electrical Engineering
Union College

J. Douglass Klein
Kenneth B. Sharpe Professor of Economics
Director, Environmental Science, Policy and Engineering (ESPE)
Union College

David Hans
Manager, z/OS Content Design & Development
IBM z Systems

Symposium Staff
Karen Crosby
Administrative Assistant for Academic Affairs
ACKNOWLEDGEMENT

We gratefully acknowledge the support of the Laurence W. Levine ‘52 and Barry Traub ‘53 Endowed Lecture Fund on the Liberal Arts and Engineering. We further acknowledge the support of the Union College Office of Academic Affairs.

Ms. Karen Crosby, Administrative Assistant for Academic Affairs, spared no time or effort in helping with every aspect related to the planning of the Symposium. She made all arrangements that guarantee the smooth running of all activities. Her hard work is greatly appreciated.

Special thanks to Luke McCaffrey ‘18 for making the symposium name tags and to Union College Facilities, Media and Dining Services staff without whom this event would not be possible.

COVER PAGE

The artwork on the cover page outlines the shape of a key that is made of the three words “engineering”, “liberal”, and “education”. It incorporates the letter “U” to symbolize Union College’s effort in integrating engineering and liberal education. The Nott Memorial that appears inside the “U” is to add emphasis that Union College is proud of its history of integration.

The original idea of the design was inspired by Atsushi Akera and the artwork was developed by Ashraf Ghaly.

The program committee would like to thank Yu Chang Ou ‘19 whose submitted artwork received honorable mention.
## SYMPOSIUM PROGRAM AT A GLANCE

### Friday, June 2, 2017

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<td>Lunch (Wold Atrium)</td>
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<td>James Winebrake; Jason Barrett; Sarah Brownell; Hsiao-Ping Moore; Karen Oates; David Spanagel, Alison Wood; Yevgeniya Zastavker</td>
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<td>Integrating Engineering and Liberal Arts through the NAE Grand Challenge Scholars Program: Successes, Challenges, and Lessons Learned</td>
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<td>Leadership in Civic Engagement and Addressing Grand Challenges through the Art of Leadership Engineering</td>
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<td>Henry Petroski</td>
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<td>Bridges Between Engineering and the Liberal Arts</td>
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<td>SOS: Sense of Safety—An Interdisciplinary, hands-on project to initiate a national discussion about school shootings in the USA</td>
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<td>Water Workshops: Engaging Students and Local Stakeholders to Address Challenges in Water Resources</td>
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<td>Leveraging Engineering Curriculum Requirements for Student and Civic Engagement: A Project-Based Course on Technology and Society</td>
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<td>Building S.T.E.A.M with Critical Making, Design Thinking and an Entrepreneurial Mindset</td>
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<td>Creating Learning Environments for the Engineer of 2020</td>
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<td>Being an Architect in the Dear (Not-so-)Dead Days, or Teaching Architectural Engineers to Live with Architecture and its History</td>
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<td>Invisibility, Empathy, and Bridging Divides: Using Liberal Arts to Reveal Hidden Relationships in Socio-technical Systems</td>
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<td>Towards an Epistemology of Making: 21st Century “Hands-On” Projects in Engineering and Humanities Classrooms</td>
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<td>Maurice Aburdene, Laurie Frasher Aburdene</td>
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<td>An Historical Perspective on Re-Engineering Engineering Education and the Importance of the Liberal Arts</td>
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KEYNOTE ADDRESS

Bridges Between Engineering and the Liberal Arts

Dr. Henry Petroski

Aleksandar S. Vesic Professor of Civil Engineering, Duke University

ABSTRACT

Many engineers have spanned the sometimes exaggerated gap between engineering and liberal arts education and culture. This talk discusses several notable examples of individuals who can serve as exemplars of the liberally educated engineer who is not only influenced by the arts and humanities but also moved by them to produce outstandingly beautiful bridges and other works of infrastructure. These often monumental artifacts have brought to those who look upon and use them a sense of pride and joy at being part of the human enterprise, and they have served as inspiration to artists and scholars who interpret the world in so many different ways. These exemplars and their works also provide food for thought to all who reflect upon the meaning of being a participant in a civilized society.

BRIEF BIOGRAPHY

Workshop 1 (Wold 010)
1:00-2:30 PM
Integrating Engineering and Liberal Arts through the NAE Grand Challenge Scholars Program: Successes, Challenges, and Lessons Learned
James Winebrake (RIT), Jason Barrett (LTU), Sarah Brownell (RIT), Hsiao-Ping Moore (LTU), Karen Oates (WPI), David Spanagel (WPI), Alison Wood (Olin); Yevgeniya Zastavker (Olin)

In AY2015-16, three technological universities (RIT, WPI, LTU) began a process of integrating liberal arts and engineering by way of the NAE Grand Challenge Scholars Program (GCSP). With guidance from Olin College of Engineering (one of the first GCSP schools) and funding from the Teagle Foundation, these universities have learned a great deal about the challenges and opportunities that exist in integrating liberal arts and engineering curricula. This panel session will provide an overview of the approach that each college is taking to establish a “liberal arts + engineering” GCSP, and the lessons learned from their experiences. After an introductory presentation describing the overall initiative, each university (RIT, WPI, LTU) will speak about their GCSP experiences. Following these individual talks, Olin College will provide additional information to help other institutions that wish to establish a “liberal arts + engineering” GCSP. The overall goal of this panel session is to not only inspire other schools to explore their own GCSP, but also provide attendees strategies to overcome obstacles related to integrating the liberal arts and engineering.

Workshop 2 (Olin 106)
1:00-2:30 PM
Leadership in Civic Engagement and Addressing Grand Challenges through the Art of Leadership Engineering
Peter Golding (University of Texas at El Paso), Celena Arreola, Jared Gardea, Gilberto Moreno Jr, Crystal Fernandez Pêna, Scott Starks, and Tetyana Zhyvotovska

Students pursuing undergraduate degrees in engineering leadership are deeply committed to civic engagement and attaining a sharpened focus on global grand challenges. Specifically, all students in the novel Bachelor’s engineering leadership degree program complete civic + professional experiential
learning endeavors within their sophomore- and junior-undergraduate years. Examples of current student experiences include leadership in research for and implementation of a STEM Grow Program. Through this exemplary project students serve to advance opportunities for peers in STE(A)M education at partnering 2- and 4-year institutions. Further examples include undertaking cooperative and internship assignments with civic organizations such as Community en Acción, government organizations such as the Environmental Protection Agency (EPA), and assignment within leading engineering companies such as Halliburton and Lockheed Martin. Through these deep and varied assignments, students actively build skills and values that impact the “who, what, and – critically – why?” of their undertaking engineering. Concurrently, the students develop context, depth and breadth that supports preparing them for their professional careers.

In addition to completing civic and grand challenge focused endeavors by the start of their senior year, students in engineering leadership studies undertake a final year, two-semester sequence of business-centric, and entrepreneurial innovation projects, consummating their engineering and liberal education. Within the final year of studies, diverse student teams complete capstone projects that use their artistic and scientific learning to provide customer-centric service.

In 2017, a major milestone is being reached in the inauguration of a new discipline of leadership engineering: we are celebrating the graduation of our first cohort of students, completing the Bachelor degree in engineering leadership. We review this accomplishment – and the challenges of starting a revolutionary new degree program – through a most appropriate channel for feedback; through our students’ sharing of their experiential learning.

The opportunity to share “the student voice” provides great insight into the challenges in undertaking, ambiguities in doing, and opportunities arising from being undergraduate students in the nation’s first undergraduate degree program combining liberal arts, engineering sciences, and business acumen, including innovation thinking and entrepreneurial mindset influences.

Our pioneering students have a special place in the program, since they have persevered the introduction of entirely new courses, actively engaged in the testing of innovative teaching paradigms, participated first-hand and close-upfront in our failures and our successes, and provided uncanny feedback to all involved in the program; hence pioneering the way for future students to have smoother – yet ever-changing pathways – in leadership engineering undergraduate education.

This is also the sixth anniversary of our first proffering leadership engineering at the Union College Symposium on Engineering and Liberal Education. We are ever thankful to the community of scholars who have through this forum helped us in our journey to integrate civic engagement, world-class education, and a sharpened focus on creating ingenious graduates who have high-hopes of addressing global grand challenges. With this theme in mind, and following our prior contributions, we come to the Symposium community in 2017 to share student voices. We find them able to provide a unique “insider view” of the program we are building, and we know that everyone attending will appreciate the “lessons learnt” by us from them; accomplished through listening to our students and how they perceive we are all progressing.
Workshop 3 (Wold 010)
3:00-4:30 PM

Uniting the Local and Global via a First-Year Humanitarian Engineering Sequence
David DiBiasio (WPI), L. Dodson, K. Boudreau, C. Abel, J. Sullivan, J. Bergendahl, G. Gaudette

We propose a workshop based upon WPI’s two-course Humanitarian Engineering sequence that blends STEM and humanities content in an interdisciplinary sequence with an emphasis on global perspectives. The first course addresses the local and historical problem of untreated domestic and industrial wastewater in Worcester, MA in the 1890s, when the city was quickly industrializing, waste was proliferating and the population was swelling with immigrants. The second course addresses contemporary sanitation problems in the developing world, where marginalization and waste management collide. Here, engineering occurs in the context of civil society, and technical requirements are embedded in the realities of life in communities lacking access to sanitation. Non-traditional teaching methods convey the complexities and ambiguities of global problems, and the ethically infused subject of sanitation.

By linking the local with the global and – importantly – the past with the present, we challenge students to connect history to contemporary problems, thereby grounding their knowledge of global problems in multiple contexts: historical, social and technical.

Taught by an interdisciplinary team of faculty, both courses are team/project-based. Integrative learning occurs through theatre-based role-playing activities, field trips, and facilitated sessions highlighting stakeholder, gender and cultural issues. Both courses culminate in the design of sanitation systems that simultaneously address technical, social, financial and cultural concerns. An extensive, triangulated assessment plan used direct/indirect and qualitative/quantitative instruments to probe achievement of learning outcomes.

Participants will learn which non-conventional instructional methods worked (or didn’t) in this unique learning course sequence. This includes defining global/societal learning outcomes for students from diverse backgrounds and majors, and techniques for implementing significant project-based experiences within traditional course formats. Attendees will leave with knowledge about a variety of assessments designed to document novel student learning outcomes. They will also learn how to adapt our approaches and tools to their own context.

Workshop 4 (Olin 106)
3:00-4:30 PM

How Entrepreneurs See the World: teaching our liberal arts and engineering students to share the same journey
Daniel Sabatino (Lafayette College), Jennifer Kelly

A cross-disciplinary faculty group at Lafayette College is going beyond the integration of Liberal Arts and Engineering by illuminating the meaningful and identifiable commonalities among disciplines. To this end, Lafayette has developed the Meta Mindset Model. The Model is a graphical construct that describes and clarifies the non-linear, iterative process of entrepreneurial thinking, broadly conceived,
in the pursuit of creating and delivering personal, economic, and societal value. The construct offers a common language that amplifies what we do within our own disciplines, clarifying our connection with colleagues of differing disciplines and what we hope to help our students accomplish.

The Model begins with the idea of inspiration - the conviction that something is possible. Immediately, a person who is inspired to create something new has to consider the limits of her/his understanding of the challenge. The disciplined process necessary to achieve the value creation (e.g. the engineering design process, the creative process, etc.) is deployed along with the intent of discovery and taking deliberate risks. The value created is in the form of academic, monetary, artistic, or social value, etc. Creativity, collaboration, and a range of skills are critical in developing solutions and overcoming challenges of any real problem. The Meta Mindset Model describes this iterative process in any context and shows that value creation is measured both extrinsically and intrinsically.

This workshop includes a presentation of the Model and its applicability to student, faculty and institutional mindset. Participants reflect on their own teaching experiences, both successful and less so, through guided exercises. Participants further identify their approach and process within the context of the Model. With the Meta Mindset Model as facilitator, participants discuss in cross-disciplinary groups how the Model is a useful tool to navigate challenges they and their students encounter in their respective disciplines.

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**Saturday, June 3, 2017**

**Session: Civic Engagement (Karp 105)**

9:00-9:15 AM

**SOS: Sense of Safety — An Interdisciplinary, hands-on project to initiate a national discussion about school shootings in the USA**

David Gillette (Cal Poly), James Werner, Emily Dunlap

In the fall of 2016, at California Polytechnic State University (San Luis Obispo), the Liberal Arts and Engineering Studies program, in collaboration with the Architecture program, asked students to work together as engineers, designers, architects, and as engaged citizens to design and build a structural response to the mass shooting in Orlando at the Pulse Nightclub (June 12th, 2016). The structure needed to be small, portable, and easily cut-out by machine, using materials costing less than $1,000. The goal was to start a national discussion on gun violence by allowing the project’s final plans and directions to be freely downloaded by community groups around the country for their own civic discussion/engagement projects.

Through an iterative development process, the students produced their final product: an arc of six wood and plexiglass panels that ask visitors to comment on how safe they feel on campus in the presence of our nation’s ongoing epidemic of school shootings. The students call this work SOS, which stands for Sense of Safety. The inner side of the arc asks visitors: “How many school shootings have occurred in the last 12 years?” The panels answer this question through hundreds of holes piercing the plexiglass; each hole representing a school shooting, with over 90 holes, alone, for the 2015-2016 panel. Visitors
leave finger prints on the outside of the project, indicating the degree to which they feel safe on campus in the presence of all this violence.

This project was developed in the midst of the 2016 Presidential election, installed at the center of campus two weeks after a Campus Republicans’ Free Speech wall created a hate speech controversy on campus, and one week after Donald Trump won the election. The project was designed to bring people together with a united sense of purpose and community in the middle of national disunity and discord, serving as a learn-by-doing process of first-hand civic engagement. We will discuss the successful results of this work, and will encourage symposium participants to join us in spreading this project to other campuses and communities across the USA.

Session: Civic Engagement (Karp 105)
9:15-9:30 AM
Full STEAM Ahead: Experiences and Reflections Working with Students and Educators
Barbara Neumann (IBM)

Over the past year, I have had the pleasure of working with a diverse group of students, educators, and professionals to support critical work across the STEM / STEAM community. I have participated as an IBM Software Engineer in workshops at the University of Rochester (N.Y.), Vassar College, and Marist College. In addition, I have led programs for middle school students and educators at both the 2017 SUNY New Paltz STEM event for Master Teachers and students, and at the Poughkeepsie Middle School makers event.

In this presentation, I will briefly outline the activities I engaged in at the different events, but plan to use most of presentation to share my experiences and insight on the many discussion threads that evolved from each workshop. Some of these threads include: addressing diversity and gender acceptance, creating an inclusive maker space culture, developing critical communication skills, promoting technical competence, mentoring and coaching, using Math to fuel creativity, and establishing programs that are the cornerstone of the larger global STEM and STEAM Movement.

Session: Civic Engagement (Karp 105)
9:30-9:45 AM
How P-TECH is Advancing Youth Civic Engagement
Kevin Bruckner (IBM), Nicole Rae

Predominantly, Youth Civic Engagement (YCE) is accepted as the way in which young people can make valuable contributions to their schools and communities through collective action. The Pathways in Technology Early College High School (P-TECH) program is taking that form of service to a new level by transcending institutional and ideological silos and implementing effective, cross-disciplinary programming for youth engagement. Co-created by IBM, the P-TECH model promotes structured civic engagement opportunities for students to see themselves as resources for positive social change, allowing them to lead and contribute to the reconstruction of their communities. In this presentation, we will
discuss youth-adult partnerships and the other diverse forms of service that this program presents to solve community-facing issues, offering perspectives from students, teachers, mentors, and members of the community themselves.

Session: Civic Engagement (Karp 105)  
9:45-10:00 AM  
**Water Workshops: Engaging Students and Local Stakeholders to Address Challenges in Water Resources**  
Mason Stahl (Union College)

Access to safe drinking water remains beyond the reach of hundreds of millions of people world-wide and this lack of access is responsible for more than one million deaths annually. Developing solutions to this problem is one of the most pressing issues facing society, however dramatic differences in the physical environment, infrastructure, and culture from one region of the world to another often means that a ‘one size fits all’ approach will not suffice. Effective solutions require the integration of environmental sciences and engineering, public health, policy, and an understanding of the cultural setting where the solution is implemented.

The inherently interdisciplinary nature of this problem makes it engaging to students from a wide variety of disciplines and backgrounds. Involving students and local stakeholders in the development and testing of potential solutions not only serves as an excellent learning experience for all involved but also improves outcomes and facilitates the dissemination of the solutions developed.

One issue that can affect the delivery of safe drinking water is the impairment of water quality as a result of subsurface leaks in drinking water wells. In this presentation, I will discuss the development of a low-cost sensor and testing technique my colleagues and I developed to detect leaks in drinking water wells in Bangladesh, where the use of expensive and difficult to operate geophysical equipment is generally unavailable. The testing and refinement of the low-cost sensor and technique was conducted during a field workshop involving local university students and water resources professionals in Bangladesh. This approach allowed for students to get hands-on experience with environmental engineering, improved the testing technique through the incorporation of advice from the local workshop participants, and allowed for the dissemination of the approach to local engineers.

Session: Civic Engagement (Karp 105)  
10:00-10:15 AM  
**Pedestrian Dis/Order**  
Morgan Johnson (RPI)

The ways in which pedestrians engage with streets is not adequately reflected in the engineered urban streets of today. This can be seen in certain kinds of pedestrian behaviors, such as jaywalking, which are a consequence of the historical perceptions of pedestrians. Such historical perceptions are borne out of models that conceptualize pedestrians as a single ordered unit, able to be modeled in terms that urban engineers easily understand, such as fluid dynamics. Yet these models do not depict actually traveling
pedestrians, and as a result pedestrians are not effectively served by the structure of urban streets.

In this talk, I present the term "pedestrian disorder," the unpredictable, unordered, actual behavior of pedestrians which cannot be modeled by traditional urban planning practices, which serves as a launching point for a new vision of the urban street, one in which disorder is celebrated and pedestrians take precedence. Pedestrian disorder serves as a counterbalance to pedestrian order, the current status quo of understanding the organization of pedestrians, in which users of public spaces are controlled and policed internally and externally, ultimately being treated as less autonomous than automobile drivers.

By presenting vignettes of an ongoing ethnographic research project, I present evidence for pedestrian disorder through jaywalking and the unconventional use of sidewalks for non-traditional pedestrian use. The vignettes demonstrate that relief from the system of social control created under pedestrian order and a reclamation of public space for the public can be attained through pedestrian disorder, leading to an overall democratization of transportation. I will conclude by offering suggestions for future technological developments that will impact urban pedestrian street travel including autonomous vehicles, and an emphasis on public transportation and public infrastructure improvement.

Session: Civic Engagement (Karp 105)
10:15-10:30 AM
Leveraging Engineering Curriculum Requirements for Student and Civic Engagement: A Project-Based Course on Technology and Society
Sandy Chang (University of Calgary)

All too often engineering courses, filled with formulas and calculations for manufacture objects, are dissociated with the people these equations are meant to serve. The education is technical, but the motivation needs to be reasserted, even within the confines of a heavy course load. We have adopted a project-based version of the Technology and Society course at the University of Calgary, with emphasis on dissecting a social problem followed by innovating a solution rather than creating a technical solution then finding a problem to fit it. The students struggled with this order of problem-solving and numerous lectures, meetings, and exercises were implemented to familiarize them with the concept. The project required them to go out into their community and directly talk to their clients, may it be the homeless, non-profits, students, or minority groups. They utilized their “soft-skills,” learning how to connect to people, ask questions, and listen while keeping in mind the technical feasibility, economic viability, social benefit, and environmental impact of their solution. The goal of the course was not only to educate the students about the embedded nature of technology in society, but also to concretely demonstrate to the students that they are able to a positive difference to their community with their technical skills. This semester long course has been taught in this form three times, and 250 students were surveyed on their assessment of the two aforementioned goals. The result showed positive learning outcomes as a direct consequence of the course.
Session: Sharpening Focus on Grand Challenges (Karp 105)  
11:00-11:15 AM  
**Using Global Grand Challenges to Showcase the Integration of Engineering and Liberal Education**  
Ashraf Ghaly (Union College)

With explosive population increase and unbearable demand for natural resources, humanity and planet Earth face unprecedented challenges. The National Academy for Engineering (NAE) identified fourteen major grand challenges that required serious thought toward finding solutions. The fourteen major grand challenges are: Advance Personalized Learning; Make Solar Energy Economical; Enhance Virtual Reality; Reverse-Engineer the Brain; Engineer Better Medicines; Advance Health Informatics; Restore and Improve Urban Infrastructure; Secure Cyberspace; Provide Access to Clean Water; Provide Energy from Fusion; Prevent Nuclear Terror; Manage the Nitrogen Cycle; Develop Carbon Sequestration Methods; and Engineer the Tools of Scientific Discovery. Each and every one of these grand challenges present a subject that requires the cooperation of both engineers and non-engineers to address. The richness of these subjects make them amenable to collaboration of experts from a wide variety of technical and non-technical fields. This is a marvelous opportunity that educators should take advantage of to teach students lessons on how different fields of knowledge come together to make contribution to advance a common goal and help humanity. Addressing these grand challenges from a multitude of angles could inspire students to think globally of issues that have far reaching effect beyond the local communities in which these students live. The future of planet Earth and its inhabitants depend on the efforts of those thinking of solutions to the above grand challenges. Health, welfare, and joy of living are all products of how humans treat the environment in which they live, and whether this is sustainable or not. This presentation will demonstrate how a few of the above grand challenges were used in a course to illustrate to students how to approach a multi-faceted subject in rational and realistic ways. This course was open to all students from any major and the class was split almost evenly between engineering, sciences, and the liberal arts. This mixture made it clear to all students that no solution could be found without the contribution that other disciplines make. It was gratifying to observe how students competed to make their thoughtful contribution to the issues being discussed and how the discussion evolved to the realization that various fields of study need to be integrated in order to achieve the desired success.

Session: Sharpening Focus on Grand Challenges (Karp 105)  
11:15-11:30 AM  
**Building S.T.E.A.M with Critical Making, Design Thinking and an Entrepreneurial Mindset**  
Lorraine Morales Cox (Union College)

The urgency for a real paradigm shift in higher education, that moves from teaching to transformative learning, continues to grow and accelerate. The ever increasing speed to which social, political and technological forces advance, flux and change necessitates a critical reflection on how educational institutions are themselves “keeping up.” How are we, as educators and facilitators of student learning, preparing and empowering students to be problem seekers and solution designers for an unknown future? How do our courses provoke students to empathize, reflect, think ethically, communicate, collaborate and work across cultural differences, a few of the critical skills needed to succeed in a globally networked society and workforce. How can S.T.E.A.M play a role in this? Liberal Arts institutions pride themselves
on the flexibility students have to engage with a range of courses across disciplines and content areas. What are the possibilities for student learning opportunities that integrate S.T.E.A.M to advance the development of these important 21st century skills in a single course? How can problem and team based learning successfully bring students together from engineering and other areas of study, such as visual art, biology and political science? How do we assess students in this type of work and their ability to navigate ambiguity? My current pedagogical research looks at the role of design thinking, critical making, civic engagement and the entrepreneurial mindset as important methodologies in how students learn, make meaning, prototype and create solutions. My presentation will address these questions drawing on my research and insights gained from student self-assessments for team-based “creative campus intervention” projects in two iterations of my Environmentalism and Globalization in Contemporary Art course.

Session: Sharpening Focus on Grand Challenges (Karp 105)
11:30-11:45 PM

On the Democratization of Artificial Intelligence
Colin Garvey (RPI)

What would it mean to take seriously the democratization of AI? Rather than offering developer tools online for free, I argue that addressing governance of the research and development process itself is the first step to democratization. Drawing on Woodhouse’s framework for democratic decision making through intelligent trial and error (ITE), a design-based approach to the governance of technological R&D that synthesizes the insights of critical technology scholars with democratic political decision theory, I evaluate AI R&D broadly to consider how it could be governed more democratically.

My initial analysis suggests the existence of considerable barriers to the democratization of AI. To name a few: (1) Public deliberation is impaired by deterministic framings of AI’s developmental trajectory, which prohibits partisan disagreement and restricts discussion to a narrow set of concerns. (2) Importantly, decision making processes are largely opaque, exclude most stakeholders, and allocate authority to technical experts and business executives. (3) The rapid pace of AI R&D and subsequent rush to deploy and monetize applications mitigates against stringent initial precautions and disallows time for governance institutions and other social organizations to learn and respond.

Finally, while several institutions have formed to investigate the ethics and safety of AI, these are primarily staffed by computer scientists and other technical experts, lack social scientific expertise, and have yet to provide substantial advisory assistance for those most likely to be negatively impacted by AI.

Adequately addressing these issues may require significant, unprecedented changes to the R&D process itself—but I would like to believe that the pioneers at the forefront of the field are capable of social innovations in addition to technological breakthroughs.
In our digital times, it is the media that matters. For whatever you like, you can expect today’s technology to extract your personalized lists, to draw out your recommended interests. These user-focused applications produce several varieties of data, at a rate too fast to control through traditional technology. Organizations have responded to the dilemma with a great effort to build a community of developer advocates, and to provide their teams with innovative ways to speed up application design and development.

In this presentation, I will share lessons learned during the IBM Code Off event, a cognitive hackathon and global exchange of ideas among IBM executives and developers. The purpose the Code Off was to enhance developer contributions by engaging the organization’s senior executives in hands-on labs, and cloud-computing technology challenges.

I will describe how the Code Off challenges were structured, how the developers and executives participating in the Code Off worked together to design real-world solutions using cognitive tools, and how the challenge structure gave participants a chance to get technical, and to learn how easy it is to connect to APIs.

This presentation will show how the Code Off was used to promote the development of chat bots to other IMBers, and will include information on the latest chat bot projects at IBM. I will explain how leadership teams used feedback from the challenge to enhance the company’s cloud platform architecture, and will describe how organizations can use hackathons, conferences, and team projects to drive innovation, and improve knowledge of cognitive technology.

In 2004, the National Academy of Engineering articulated its vision for generations of engineers in its book, “The Engineer of 2020.” This vision addressed the broadening complexity and scope of future societal challenges, and called upon the need for “collaborations with multidisciplinary teams of experts.” Characteristics that describe the Engineer of 2020? The ability to communicate to diverse audiences, as well as with technology, the perspective to place engineering problems in the proper social and economic context, adaptability, and respect.

To holistically address the engineer of 2020, these characteristics are considered in the content and approach to “traditional core engineering courses”, courses that address important skills for navigating the engineering process (what are often unfortunately termed “soft skills”), and courses that provide engineering perspectives to non-engineering majors. We intend to present on the the learning
environments we have created across a variety of courses that target all three kinds of courses. We will be presenting on some underlying philosophies behind these learning environments, and how these are implemented in our various courses. We will also discuss approaches to gaining student buy-in, as navigating “non-traditional” learning environments can be intimidating at first for students. Lastly, we will discuss what general student feedback and reactions have been, and how we see these methods being adopted in engineering and liberal arts curriculum.

Poster Display (Hale House)
12:00-1:00 PM
Get the Lead Out: Safe Drinking Water and Environmental Justice
Doug Klein (Union College), Mead Binhammer, Christy Brown, Michael Doherty, Anna Doran, Nia Francis, Rachel Fried, Matt Hacker, Sara Halsey, Maddie Lewis, David Olio, Katie Quinlan, Brandon Rosales, Michael Sciascia, Natalie Sullivan, Calvin Wiles, Kaylee Williams, Andy Zou

ENS 460 at Union College is the ESPE (Environmental Science, Policy and Engineering) Senior Seminar that brings together all senior ESPE majors to explore a topic from diverse perspectives. This year’s (2017) theme was safe drinking water, and was motivated by the ongoing water crises in Flint, Michigan.

In April, 2014, facing budget problems, and after considering alternatives, the city of Flint, MI changed the source of its city drinking water from Lake Huron to the Flint River. The consequences of that decision became clear only as lead levels in Flint’s drinking water rapidly rose to unacceptable levels. That the event happened is not in debate, but the root cause of the problem, the ways in which it was identified, the responses to it and allocation of blame are all still under intense discussion and litigation.

To explore how and why this problem arose, and the ways that it was (or was not) addressed, students in the seminar developed parts of a new “Reacting to the Past” (RTTP) game based on the facts and issues that arise in the Flint Water Crisis. Each student chose role from the Flint Water Crisis, and developed a poster and a “role sheet” introducing that character. Ultimately, the RTTP game will enable students to explore alternative outcomes.

About Reacting to the Past: “Reacting to the Past (RTTP) consists of elaborate games, set in the past, in which students are assigned roles informed by classic texts in the history of ideas. Class sessions are run entirely by students; instructors advise and guide students and grade their oral and written work. It seeks to draw students into the past, promote engagement with big ideas, and improve intellectual and academic skills. Reacting to the Past was honored with the 2004 Theodore Hesburgh Award (TIAA-CREF) for outstanding innovation in higher education.” _From the Reacting to the Past website, https://reacting.barnard.edu/._

Poster Display (Hale House)
12:00-1:00 PM
Introducing First-year Liberal Arts Undergraduates to Engineering and Design Thinking
Diane Michelfelder (Macalester College), Taylor Allen
This poster highlights features and assessment of two first year courses taught in Fall 2016 at Macalester and Oberlin, liberal arts colleges without degree programs in engineering. The courses were designed to respond to the challenge of introducing incoming students to some key aspects of engineering and design thinking. In emphasizing the process of thinking like an engineer, rather than the making of engineered objects themselves, the courses incorporated readings and design projects readily accessible to students with a wide range of academic interests. One course emphasized how technical and social/political/ethical perspectives are joined together in engineering problem framing and problem solving. In this course, for example, students were exposed to differences and similarities in problem solving among engineering, studio arts, and philosophy. The other course sought to illuminate the creative process inherent in design thinking and innovation. Students studied aspects of problem solving such as incubation, insight, ideation, and prototyping; they then identified and analyzed cases, ranging from bio-mimetics to the bra’s evolution. Both courses engaged students in multiple design projects requiring minimal resources. Students in both classes also collaborated with one another on one of the course assignments: designing winter-time shelters for feral cats and equipping them with a solar-powered devices. The assessment of students’ gains involved both quantitative (direct and indirect) and qualitative approaches. Analysis of the data showed documented gains in epistemological understanding of science and in confidence in engineering design. Two prominent themes that emerged from analysis of students’ written reflections concerned the role of ethics in engineering and the complexity of engineering thinking. Overall, the courses can be seen as broadening the repertoire of approaches of infusing engineering ways of thinking and doing into the liberal arts, particularly at liberal arts colleges without engineering programs themselves.

Session: The Humanities Mindset and Engineering Education (Karp 105)
1:30-1:45 PM
Toward a Techno-Creative Habit of Mind
Jonathan Dickstein (University of Connecticut)

As Thomas Patterson and Philip Seib argue in “Informing the Public,” since there is no actual public sphere where all people in a given community do and/or can come together to discuss, debate, refine, and transform opinion about present states of affairs into pure information, a conception of how we forge our opinions must take into account our habits of mind (Patterson and Seib, 2006). Thus, insecurities we experience when confronted with complex objects (like machines) must have their roots not simply in the complexities themselves but moreover and more importantly in our capacity to engage with these complexities, insofar as this capacity has been cultivated by, as Patterson and Seib explain, “families and schools” (i.e., upbringing and education). With this point in mind, I suggest that there are two functions at stake in these insecurities: (1) an absence of knowledge of the principles undergirding clear, consistent, and precise logical judgment; (2) a lack of appreciation of what these principles mean in terms of novelty and the creative act. The liberal arts as not distinct from but rather in conjunction with engineering education has the unique ability to teach alternatives to both functions. Specifically, reviewing Edgar Allan Poe’s “The Purloined Letter” (1844) as well as some of its chief interpretations (Jacques Lacan’s, Jacques Derrida’s, Barbara Johnson’s, and Lydia Liu’s), I aim to explore how one might come to understand the rule-based apparatus of cybernetics not as the limit of human engagement but rather as the precise site of its possibility. This exploration I hope will inspire a more general dialogue about the part humanities ought to play in the teaching of technological production and likewise the part technological production must play in the teaching of humanities.
Being an Architect in the Dear (Not-so-)Dead Days, or Teaching Architectural Engineers to Live with Architecture and its History  
Miles Samson (WPI)

This talk describes a design exercise assigned to architectural engineering majors enrolled in an architectural history course at Worcester Polytechnic Institute (WPI). Students are organized into teams whose members collaborate to design buildings for WPI as they might have been designed at a given year in the institute's 150-year history. Teams are told to design the outside of the building, its technical structure; they are asked to research what formal qualities and/or references to past or new styles an architect would be expected to make use of in 1865, 1899, 1950 or other assigned year. In class presentations, teams must not only "pitch" their drawings as to a client, they must explain to the class the influences acting on architects in their assigned year. The exercise is designed to make students apply architectural history in "real" case study situations and understand how architects must mediate between technical means, client desires, and cultural expectations.

Invisibility, Empathy, and Bridging Divides: Using Liberal Arts to Reveal Hidden Relationships in Socio-technical Systems  
David Tomblin (University of Maryland, College Park), Nicole Mogul and Matthew Aruch

The Science, Technology and Society (STS) program at the University of Maryland, College Park uses tools from the humanities and social sciences, with a primary focus on putting students in situations that will improve their social skills and strengthen their interpersonal relationships. Our goal is to build a community of reflexive STEM majors invested in socially responsible application of science and technology, and our work categorizes into three goals: making invisible visible, building empathy, and bridging divides. Students spend a significant portion of class time in active learning experiences and performances—activities that are designed to take advantage of engineering students’ comfort with building and doing while warming them to ones that are typically uncomfortable, such as social interactions and discussion. We want students to expand what counts as relevant (invisibility), that we will build better technologies when we understand social and cultural context (empathy), and that we will do this successfully by taking an interdisciplinary perspective (bridging divides). Students in the STS program are required to take one of three practicum courses designed to combine engineering experiences with tools from the humanities and social sciences: Infrastructure and Society, Contemporary Issues in STEM Education, and Sustainability and Design. These courses place an emphasis on understanding the socio-technical and ethical factors that influence the sustainability of urban and educational infrastructure. This paper describes how each of these courses speaks to the analytical themes of invisibility, empathy, and bridging divides as a way of understanding and designing socially responsible socio-technical systems.
A Tale of Two Codes: What Can the History of Codes of Ethics Tell About the Professional and Social Contexts of Engineering
Xiaofeng Tang (Penn State University)

While professional codes of ethics play a significant role in engineering students’ ethics education, ethics teaching that focuses on interpreting, memorizing, and compliance to the facial values of the ethics codes or “canons” misses important opportunities to introduce students to the professional and social contexts that help shape the ethical commitment of engineers. In particular, examining the historical origin of a professional organization’s code of ethics will yield rich insights about the social, professional, and organizational values that inspired or constrained what was codified in a profession’s ethical canons. This talk revisits the historical origins of two codes of ethics, adopted respectively by the American Society of Civil Engineers (ASCE) in 1914 and the Institute of Electrical and Electronics Engineers (IEEE) in 1974. While both codes marked important breakthroughs in professional ethics for engineers, the history leading to the creation and adoption of these codes also reveals engineers’ struggles to professional autonomy, and how a code of ethics acted as a tool against interference from actors outside the profession: state legislators in the case of ASCE, and employers in the case of IEEE. I conclude this talk by suggesting pedagogical strategies that enable students to use codes of ethics as a medium for reflecting on the relation between social ethos, professional concerns, and ethical engineering.

Towards an Epistemology of Making: 21st Century “Hands-On” Projects in Engineering and Humanities Classrooms
Travis Feldman (Choate Rosemary Hall)

In the opening chapter of The Savage Mind (1962) Claude Levi-Strauss contrasts the mythopoetic “savage” bricoleur against the scientific “civilized” engineer, arguing that a bricoleur’s makeshift method of building with “whatever is at hand” stands in opposition to an engineer’s teleological systemizing of the means to reach “the purpose of the project” (17). Jacques Derrida, in his essay “Structure, Sign and Play in the Discourse of the Human Sciences” (1966), famously points out that in such contrasts Levi-Strauss mythologizes the engineer into a caricature of scientific thought and inadvertently exemplifies the impossibility of any scientific discourse to reach a “center” of meaning or epistemological completeness. Levi-Strauss and his interest in understanding “pre-scientific” frameworks of meaning-making may have been somewhat overlooked in the turbulent wake of Deconstruction and “Post-Structuralism,” but since 2005 we have witnessed the emergence of world-wide Maker Culture, bricolage communities taking shape outside of formal educational institutions around DIY and Open Source projects. Online communities such as Wikipedia, GitHub, Instructables and Thingiverse, and “real world” communities such as DorkBot, Meet-Up groups and Maker Faires have effectively pointed to, on the one hand, new forms of social networking and information sharing, and, on the other hand, new problems for defining “knowledge.” Indeed, schools and educational institutions around the world are now undergoing intensive change, often driven by emergent
technologies and urgent uncertainties about the future of formal learning environments. It may be possible at the particular historical juncture of this change to recuperate that node of problems prior to the “linguistic turn” and intrinsic to methods and institutional orders of the “Discourse of the Human Sciences,” not as an attempt to revive Structuralism or some form of “mytho-science” but rather to clarify and articulate the meaning that project-based, hands-on approaches to engineering, design, and “creative coding” have within our schools.

Session: The Humanities Mindset and Engineering Education (Karp 105)
2:45-3:00 PM

An Historical Perspective on Re-Engineering Engineering Education and the Importance of the Liberal Arts
Maurice Aburdene (Bucknell University), Laurie Frasher Aburdene

We visited U.S. Presidential Libraries to research presidential decision making with respect to STEM issues and gathered original documents. This presentation will focus on the following topics: re-engineering engineering education, the importance and purpose of a liberal arts education, civic engagement and preparation to be a productive member of society, research opportunities at small colleges, the number and quality of science and engineering graduates, faculty research, and the recognition of science and engineering contributions to society. We will discuss the interesting documents we found related to each topic.

Session: Wrap-up and Discussion (Karp 105)
3:30-4:30

Retrospective and Wrap-up: What’s next?
David Hans (IBM)

Participate in an IBM Design led session to help identify, prioritize and summarize your feedback from this year's symposium. This exercise will help to capture critical takeaways and identify a list of actions for participants to focus on and share as we continue to develop solutions to challenges around Civic Engagement and Sharpening the Global Challenge.