

NINTH SYMPOSIUM ON ENGINEERING AND LIBERAL EDUCATION

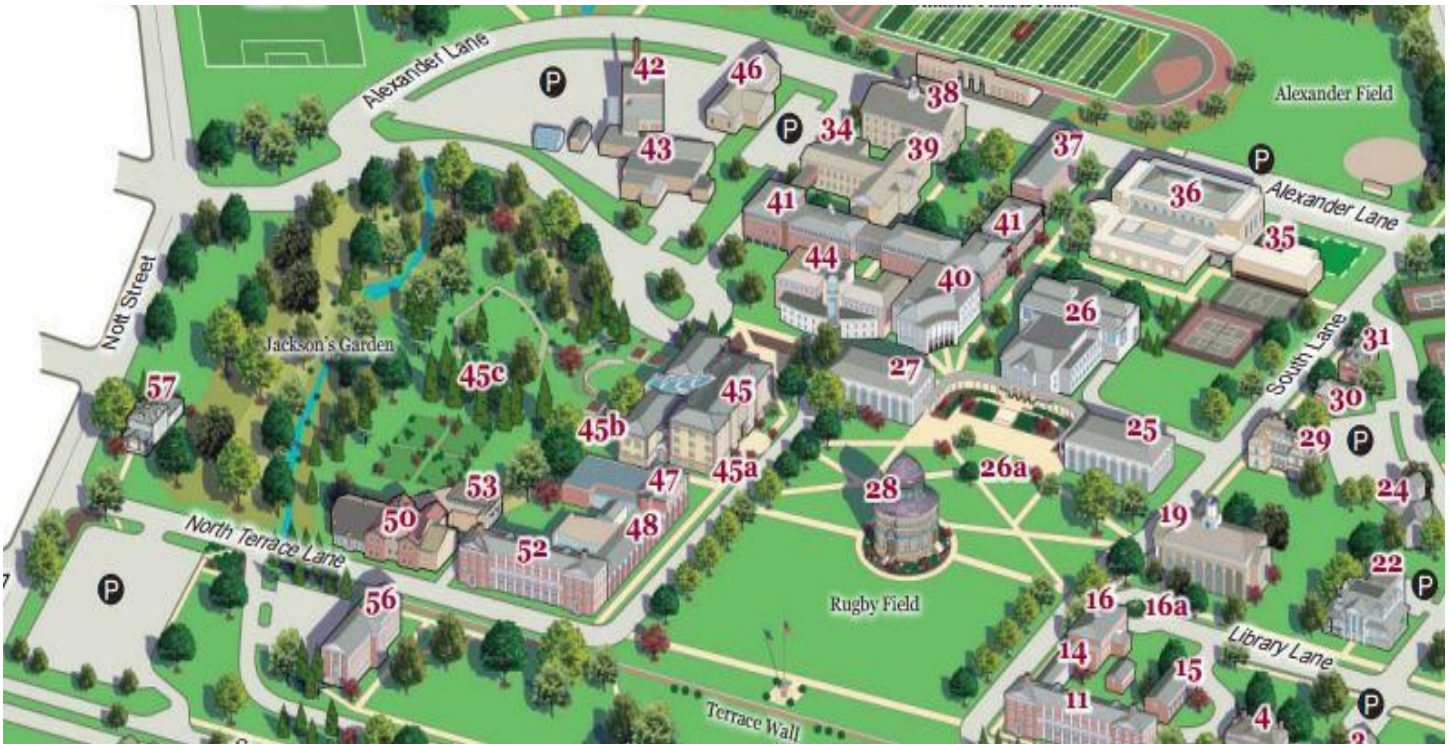


3-4 JUNE 2016

UNION COLLEGE

SCHENECTADY, NEW YORK

CAMPUS MAP



14 Hale House

25 Karp Hall

28 Nott Memorial

40 Wold Center

TROLLEY SCHEDULE

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

Friday 3 June

11:00 am Hampton Inn to Old Chapel Circle
8:30 pm Old Chapel Circle to the Hampton Inn

Saturday 4 June

7:45 am Hampton Inn to Old Chapel Circle
5:30 pm Old Chapel Circle to Hampton Inn
6:30 pm Hampton Inn to Post-Symposium restaurant (one trip)
8:30 pm Post-Symposium restaurant to Hampton Inn (one trip)

On the cover: The cover figure was created as a Word Cloud from the abstracts submitted to the ELE Symposium using the website <http://www.wordclouds.com>

WELCOME

Welcome to the Ninth Symposium on Engineering and Liberal Education, hosted by Union College in Schenectady, New York.

We are incredibly grateful to have Dr. Freeman A. Hrabowski, President of The University of Maryland, Baltimore County, with us to present the keynote address. We have an outstanding array of papers and exciting interactive sessions 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.

— Shane Cotter, Symposium Chair

PROGRAM COMMITTEE

Chair

Shane Cotter
Director of Engineering
Associate Professor of Electrical Engineering
Union College

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

Dave Hans
Manager, z/OS User Technologies
IBM Systems Group

Christine Henseler
Professor of Spanish & Hispanic Studies
Chair of Modern Languages & Literatures
Union College

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

John Rieffel
Associate Professor
Department of Computer Science
Union College

Symposium Staff

Karen Crosby, Administrative Assistant for Academic Affairs

ACKNOWLEDGEMENT OF SUPPORT

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.

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

SYMPOSIUM PROGRAM

Friday 3 June

11-1:00pm	Check-in	<i>Hale House</i>
12-1:00pm	Lunch	<i>Hale House</i>
1-2:00pm	Engineering & Liberal Education: Part I What Has Worked and Is Working (and How Do We Know)?	<i>Hale House</i>
	Mapping ELE Initiatives	
	<i>Dean Nieusma, RPI</i>	
	<i>Donna Riley, Virginia Tech</i>	
	Our Shared Humanities	
	<i>Wendy Sternberg, Union College</i>	
	Integration: Defining the Value of the “Hard to Measure”	
	<i>Jenn Rossman, Lafayette College</i>	
	<i>Hannah Stewart-Gambino, Lafayette College</i>	
2-2:15pm	Short Break	<i>Everest Lounge</i>
2:15-3:15pm	Engineering & Liberal Education: Part II Where Are We Heading?	<i>Hale House</i>
	Humanitarian Engineering, Past and Present	
	<i>David DiBiasio, Kristin Boudreau, Leslie Dodson, Paul Kirby,</i>	
	<i>Joseph Cullon, Curtis Abel, John Sullivan, John Bergendahl,</i>	
	<i>Laura Hanlan, and Glenn Gaudette, WPI</i>	

Bridging the Divide: Pathways to Building Engineering Education & Leadership at a Public, Urban University Having a 21st Century Demographic

Peter Golding, Roger V Gonzalez, Meagan Kendall, Gilbert Moreno Jr,

Richard T Schoephoerster, and Scott Starks, University of Texas at El Paso

Engineering and the Liberal Arts: Oil and Water; Dogs and Fleas or Obligate Symbiosis? A Modular Approach

Louis Bucciarelli, MIT

Sarah Kuhn, UMass Lowell

3:15-3:45pm **Long Break** *Everest Lounge*

3:45-5:00pm **Engineering & Liberal Education: Part III** *Hale House*
What's Missing?

Design Thinking Workshop

Dave Hans et al., IBM

5:00-6:00pm **Reception** *Nott Memorial*

6:00-7:00pm **Welcome Remarks and Introduction** *Nott Memorial*

Stephen C. Ainlay, President, Union College

Therese A. McCarty, Dean of the Faculty and Vice President for Academic Affairs, Union College

Keynote Address: Inclusive Excellence Across the Disciplines *Nott Memorial*

Freeman A. Hrabowski III, President, University of Maryland, Baltimore County

7:15-9:00pm **Dinner** *Hale House*

Saturday 4 June

8-9:00am **Continental Breakfast** *Wold Building*

9:00-9:30 **National Science Foundation Opportunities** *Wold Building*

National Science Foundation Programs That Support Engineering Education
Research

John Krupczak, NSF

9:30-11:30 **ELE Integration; International Collaborations;
Industry Perspective** *Karp Hall 005*

The Olmsted Report: 50 Years Later

Ruth Olmsted, Excelsior College

Teaching About Engineering to Liberal Arts Students

Sheila Tobias

Cornerstone Multidisciplinary Design: A First Semester Collaboration

Jenn Rossmann, Lafayette College

Hannah Stewart-Gambino, Lafayette College

The Humanities and the Social Sciences in Preparing Students for Urban
Engineering Projects in Morocco

Bland Addison, WPI

A Voyage of Alien Escape: Devising Effective Learning Assessment for an International Game/Design and Production Project Connecting Engineering, Liberal Arts and Stem Puzzles With Two Universities on Opposite Sides of the Globe.

*David Gillette, Michael Haungs, Lee McGowan
California Polytechnic State University*

Educating Global Engineers: Liberal Arts Education for Engineers in China

Denver Tang, Pennsylvania State University

BS and BA: A Viable Path to Obtaining Both Skill Sets

Stan Wilczek Jr., Keuka College

University's Role in the Information Age

Kevin Bruckner, IBM

Molly Stevens, IBM

IBM Design Bootcamp

Theresa Hans, IBM

11:30-12:30 **Proposed Changes to ABET Engineering Accreditation Criteria** *Wold Building*

Historical Perspectives and Asee Member Input on Proposed Changes to ABET Engineering Accreditation Criteria

Atsushi Akera, RPI

12:30-1:30 **Lunch** *Wold Atrium*

1:30-2:30 **Two Parallel Sessions** *Wold Building*

Etextiles, Haptic Feedback as a Convincing Interface (Design Sprint)

Amanda Ervin, Union College *[Location: Wold 128]*

Understanding Design: A Course to Introduce First-Year Students to the Language of Design

Mary Roth, Lafayette College *[Location: Wold 010]*

2:30-4:30 **Making; Innovation; Urban & Infrastructure Projects** *Karp Hall 005*

Making as Scholarly Activity: Using Critical Design and Engineering Tools to Perform Humanistic Critique

James Malazita, RPI

Creating an App in 60 Minutes

Edrian Irizarry, IBM

Maker Education in an ABET Curriculum

Amanda Ervin, Union College

Innovation and Sustainability as New ABET Outcomes

David Kent, Milwaukee School of Engineering

Bridging Engineering and Liberal Arts in an Augmented Reality Design Course

Jacky Doll, IBM

Rebecca Rouse, RPI

The Resilient Communities Design Challenge By Engineers for a Sustainable World

Erin Lennox, Engineers for Sustainable World

Nichole Heil, Engineers for Sustainable World

Using Water to Teach Paradox

Ashraf Ghaly, Union College

Using an Interdisciplinary Approach to Teach Students About Urban Infrastructure

Laura Steinberg, Syracuse University

Creating Passages of Light, Shadow, Media & Safety: Connecting Liberal Arts, Engineering and Architecture in a Civic Reclamation and Urban Informatics Project for the City of Sacramento

David Gillette, Michael Haungs, Thomas Fowler

California Polytechnic State University

4:30-5:30

Symposium Wrap-Up

Mrs. Perkins' Gardens

6:30-8:30

Post Symposium Dinner

TBA



KEYNOTE ADDRESS

Inclusive Excellence Across the Disciplines

*Dr. Freeman A. Hrabowski, III
President, The University of Maryland
Baltimore County*

Brief Biography

Dr. Freeman A. Hrabowski, President of UMBC (University of Maryland, Baltimore County) since 1992, is a consultant on science and math education to national agencies, universities, and school systems. He was named by President Obama to chair the newly created President's Advisory Commission on Educational Excellence for African Americans. He also chaired the National Academies' committee that produced the report, *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads* (2011).

Named one of the 100 Most Influential People in the World by *TIME* (2012) and one of America's Best Leaders by *U.S. News & World Report* (2008), he also received TIAA-CREF's *Theodore M. Hesburgh Award for Leadership Excellence* (2011), the Carnegie Corporation's *Academic Leadership Award* (2011), and the *Heinz Award* (2012) for contributions to improving the "Human Condition." UMBC has been recognized as a model for inclusive excellence by such publications as *U.S. News*, which the past seven years has recognized UMBC as a national leader in academic innovation and undergraduate teaching.

ENGINEERING & LIBERAL EDUCATION ABSTRACTS

FRIDAY ABSTRACTS

PART 1: WHAT HAS WORKED AND IS WORKING (AND HOW DO WE KNOW)?

MAPPING ELE INITIATIVES

DEAN NIEUSMA, RPI

DONNA RILEY, VIRGINIA TECH

This paper investigates a range of approaches to ELE integration identifying the strategic and conceptual dimensions that drive them and some of their associated underlying assumptions. The analysis will start by providing a mapping of diverse ELE approaches, organized according to implementation modalities, pedagogical frameworks, and learning goals. Drawing on theoretical insights from STS and Engineering Studies, the paper will then consider how various ELE approaches manifest or resist (or both) some of the conceptual trappings of traditional engineering epistemologies, such as those around positivism, instrumentalism, technical-social dualisms, and depoliticization. The paper's empirical material will be drawn primarily from current and proposed engineering programs that explicitly highlight ELE integration. However, select content will also be drawn from participation in and proceedings of Union College's annual Engineering and Liberal Education Symposium, ASEE Liberal Education/Engineering and Society Division, and the related set of initiatives around the theme of engineering and social justice.

OUR SHARED HUMANITIES

WENDY STERNBERG, UNION COLLEGE

The fundamental mission of the Andrew W. Mellon Foundation is to support and advance the arts and humanities. Mellon's educational grants programs accomplish this goal by helping institutions respond to the "economic, demographic, financial, and technological challenges affecting higher education" and by actively engaging institutional structures to "promote the social value of the humanities." Institutions like Union are in a unique position to leverage resources provided by the Mellon Foundation to support interdisciplinary efforts and to build strong bridges between and among the arts and humanities and science and technology disciplines. This talk will briefly summarize Union's experience with the Foundation's funding mechanisms, culminating in our recent \$800,000 institutional grant entitled, "Our Shared Humanities."

INTEGRATION: DEFINING THE VALUE OF THE “HARD TO MEASURE”

JENN ROSSMAN, LAFAYETTE COLLEGE

HANNAH STEWART-GAMBINO, LAFAYETTE COLLEGE

“Integration” of STEM and liberal arts holds tantalizing promise for administrators and policy-makers yet can prove vexing for faculty who attempt to achieve, assess, and sustain it. What should we really expect from integration? What is the (disciplinary, interdisciplinary, transdisciplinary) value of “integration,” and what should measures of success look like for both STEM and liberal arts students? We will share research (commissioned by the National Academies) on integrative activities at a wide range of institutions. We will identify obstacles and opportunities for further integration efforts in modern higher education, with particular focus on the way assessment can serve as both obstacle and opportunity, and created by participants.

PART 2: WHERE ARE WE HEADING?

HUMANITARIAN ENGINEERING, PAST AND PRESENT

**DAVID DIBIASIO, KRISTIN BOUDREAU, LESLIE DODSON, PAUL KIRBY,
JOSEPH CULLON, CURTIS ABEL, JOHN SULLIVAN, JOHN BERGENDAHL,
LAURA HANLAN, GLENN GAUDETTE, WPI**

A team of WPI humanities and engineering faculty piloted an interdisciplinary two-course sequence in Humanitarian Engineering using role-playing and immersive, transdisciplinary pedagogy to teach complex engineering problems in context. Cited by the National Academy of Engineering as one of twenty-five exemplary education activities and programs combining ethics and engineering, this course introduces students to the multiple perspectives and disciplines needed to solve complex, open-ended problems. Students learn to identify answerable questions and select and evaluate solutions, work effectively on teams, research and use sources, communicate effectively with appropriate evidence, understand and articulate different points of view, and navigate diverse values concerning engineering problems.

In the first course they role-play a historic 1890’s urban sanitation project from Worcester, MA. They discover the context of labor dissatisfaction, social inequality, rapid urbanization, and cutting-edge engineering practices of the day. Asking whether and how to mitigate the extreme pollution in the Blackstone River, they explore the social, environmental, and economic difficulties surrounding professional engineering practices.

The following term, working in teams to design engineering solutions to current-day sanitation problems, they consider the trade-offs between economics and social and environmental well-being. A team might design a sanitation station (laundry, toilets) for a Namibian village, combining engineering technology with sensitivity to cultural practices. Taking a particular perspective and mastering the information behind it, students learn their subject matter deeply, teach and learn from classmates, and experience the world as ambiguous and complex, not clear-cut like a textbook problem. As they determine the scope of the problem, design, communicate, and assess solutions, they learn that contextual issues (economic, ethical, social, legal, cultural, political, and geographical) matter as much as technical considerations.

Our presentation will detail the course philosophy, pedagogy, and instructional design, and present assessment results.

BRIDGING THE DIVIDE: PATHWAYS TO BUILDING ENGINEERING EDUCATION & LEADERSHIP AT A PUBLIC, URBAN UNIVERSITY HAVING A 21ST CENTURY DEMOGRAPHIC

**PETER GOLDING, ROGER V GONZALEX, MEAGAN KENDALL,
GILBERT MORENO JR, RICHARD T SCHOEPHOERSTER, AND
SCOTT STARKS, UNIVERSITY OF TEXAS AT EL PASO**

We recount the major milestones for establishing an innovative engineering education department at UTEP, a major Hispanic-serving university. The process of initiating a new paradigm for STEM education and leadership is presented as a historical narrative, from initial conception in 2007 through achieving state authorization, occurring in late 2014.

New undergraduate and graduate programs have been established, enabled through partnership with major US companies, who have provided encouragement, direct input, and support for the new programs. The commencement of the UTEP project kicked into high-gear during 2008, with James Duderstadt presenting his approach to engineering for a changing world (Duderstadt 2008), which provides a roadmap to the future of engineering practice, research and education in the USA.

Our new programs are shared through experiential practice-centric engineering education. Concomitantly, this has been enabled through new technology utilization. Additionally, we have been fortunate to proceed with our initiatives in the wake of other ground-breaking and landmark new US engineering programs, such as the one initiated at Olin College. We have worked in partnership with Olin to translate their methods and practices across to our own cultural and educational setting, in a own public, urban institution, knowing that if we can achieve success in doing thereupon, the approach can well become a model for similar institutions across the USA.

We guide stakeholders through the process needed to establish our new programs, and share the experience of implementation and scale-up. The purpose of the contribution is to share strategic planning, project leadership and management, and to provide ideas, best practices, and lessons learnt, which may benefit institutions following the pathway to their own destiny of serving students in the 21st century. ESW and created by participants.

ENGINEERING AND THE LIBERAL ARTS: OIL AND WATER; DOGS AND FLEAS OR OBLIGATE SYMBIOSIS? A MODULAR APPROACH.

LOUIS BUCCIARELLI, MIT

SARAH KUHN, UMASS LOWELL

The Liberal Studies in Engineering project aims to encourage the development of an undergraduate major that would serve students with broad interests. This Bachelor of Arts in Liberal Studies in Engineering would be especially well suited for those inclined to enroll in a program that keeps open the possibility that they might pursue a career in engineering. It would take exemplary, substantive content of the *traditional* undergraduate engineering program – the engineering sciences, the laboratory tests, the design projects – and infuse this content into

courses in the liberal arts to be taught from the perspective of the latter.

To illustrate “infusion of engineering content into courses in the liberal arts” we have developed, and posted online, two “modules”- Science and the Courts and Galileo and the Resistance of Beams. The modules are designed for “dual use” – in engineering as well as in the liberal arts.

In this discussion session the leaders will explain their “meta engineering” approach to module design and development and the challenge of mixing engineering and the liberal arts in a harmonious, sympathetic, mutually respectful way. For those who intend to join the discussion, we ask that you view the modules prior to our meeting. For access to the modules online, email Louis Bucciarelli at llbjr@mit.edu or follow the instructions on the symposium website.

PART 3: WHAT’S MISSING?

DESIGN THINKING WORKSHOP

DAVE HANS ET AL.

IBM

Using the presentations from the first two sessions as inspiration, participants will break into groups and brainstorm on what’s currently missing and finding new paths forward.

SATURDAY ABSTRACTS

NATIONAL SCIENCE FOUNDATION PROGRAMS THAT SUPPORT ENGINEERING EDUCATION RESEARCH

JOHN KRUPCZAK JR., NSF

The goal of this presentation is to increase the participants' knowledge of current funding opportunities at the National Science Foundation (NSF) to support excellence in undergraduate science, technology, engineering, and mathematics (STEM) education. In particular, the discussion will focus on new and on-going programs in the Division of Undergraduate Education. Examples of specific project activities that support current opportunities will be highlighted. Interactive discussions will aim to foster the sharing of ideas, clarify misconceptions, and potentially initiate new ideas in engineering education innovations and research. NSF undergraduate STEM education programs will be reviewed to allow participants to identify potential programs that might match their ideas and interests.

THE OLMSTED REPORT: 50 YEARS LATER

RUTH OLMSTED, EXCELSIOR COLLEGE

Change initiatives, if not actual change, are ironically a constant in academe, and it is valuable periodically to examine a particular landmark change initiative against current state without dwelling on all the other initiatives that have come and gone in between. This presentation will use current programs of Excelsior College to examine how the recommendations of the Liberal Learning for the Engineer Report of the ASEE Humanistic-Social Research Project (Journal of Engineering Education, Vol 59, number 4, Dec. 1968) play out against the 21st century realities of distance education, degree completion, and competency-based education as expressed at Excelsior College. Students in Excelsior's Engineering Technology programs who must satisfy specific arts and sciences requirements, and other students with engineering and technical aspirations, fill many slots in School of Liberal Arts courses. In keeping with the original report, the presentation will focus on the status of the humanities and social sciences, as math and science requirements are much more closely tied to the technical side of the degree. We hope to address the following queries: Is a commitment to infusing the liberal arts into the curriculum manifested in the technical component of the degree and the graduates it produces? Is cross-disciplinary expertise considered when identifying staff for both Technology and Liberal Arts? Are we improving the level at which engineering students approach their humanities and social sciences learning? How are liberal arts course offerings perceived by engineering students and faculty? Specific points from the 1968 report will be aligned with examples of curricular and strategic initiatives from both Technology and Liberal Arts at Excelsior.

TEACHING ABOUT ENGINEERING TO LIBERAL ARTS STUDENTS

SHEILA TOBIAS

There is a growing consensus that “technological literacy” cannot stand alone, but has to be grounded in the intellectual discipline of engineering. Starting from that premise, the speaker set out to identify, locate, and write in detail about a dozen extant courses and in some instances entire programs that teach liberal arts students about engineering. The collection which she calls “case studies” are as of March 15, 2016 accessible from the ASEE.org web site. What they have in common are: significant faculty commitment and student enrollment. The mainly new courses and programs stem from no single source: from the dream and long-term commitment of individual faculty members (Princeton) to the initiative by a college president (Wesleyan), a college-wide commitment to include engineering in a newly constituted set of General Education “I” course offerings (University of Maryland) and a university-wide one-course Tech graduation requirement at Stony Brook, originating in the College of Engineering and Applied Sciences that supports new course offerings in any department of engineering.

In collaboration with ASEE, the 12 case studies including syllabi and commentary on pedagogy that works, together with a review of an earlier effort to redefine The New Liberal Arts, and a background paper by President Emeritus James Duderstadt, are meant to become the stimulus and the core of a growing inventory of courses, programs, and commentary.

CORNERSTONE MULTIDISCIPLINARY DESIGN: A FIRST SEMESTER COLLABORATION

JENN ROSSMAN, LAFAYETTE COLLEGE

HANNAH STEWART-GAMBINO, LAFAYETTE COLLEGE

A linked pair of first-year seminars addressing the problem of global hunger culminated in projects completed by multidisciplinary student teams. Building on the WPI Great Problems model, these two First Year Seminars were team taught by a mechanical engineer and political scientist, each addressing the problem of global hunger. Students from both sections combined in project teams and for interdisciplinary discussions of course topics. The course included a community-based learning component as well as the development of a research & development plan for future engagement. Introducing students to the multidisciplinary complexity of such “Grand Challenges” as hunger lays a foundation for integrative education and a felt need for interdisciplinarity.

THE HUMANITIES AND THE SOCIAL SCIENCES IN PREPARING STUDENTS FOR URBAN ENGINEERING PROJECTS IN MOROCCO

BLAND ADDISON, WPI

WPI has some 50 project centers throughout the world and the United States. Students at these locations, working in teams, carry out a degree requirement known as the Interactive Qualifying Project, which challenges students to resolve an engineering or technical problem by taking fully into account the social and cultural context of the problem. Prior to their on-site work, students take a course (ID 2050, 1/3rd credit) devoted to preparing them to do project work. (The students also have 1/6th credit Independent Study Project with their future on-site advisors to prepare a “proposal” for their sponsors.) ID 2050 instructors do a wonderful job of equipping students with social scientific tools for field project work—survey procedures, cost-benefit analysis, case study methodologies, and so forth. This paper will argue that there is also an important role for more humanistic instruction in such student preparation, but that such instruction has different, less easily specified functions in project preparation. While basic social science methods can be introduced to students so that they can select those that are most appropriate to the problem they are to address. It is a more difficult task to determine which pieces of literature, or which aspect of local religious practices, or which historical events should be presented to students to inform their technical-engineering work. It’s an old question: What are the USES of the Humanities and Arts? I will argue that the answer lies in showing how the humanities can be used creatively to enhance understanding. While social scientific methods have a functional importance in resolving social issues, the purpose of the humanities is to open imaginative ways of explanation of human connections among peoples and their environment. This paper will be illustrated with student projects done on the rehabilitation of the medinas in Fes and Rabat.

A VOYAGE OF ALIEN ESCAPE: DESIGNING EFFECTIVE LEARNING ASSESSMENT FOR AN INTERNATIONAL GAME/DESIGN AND PRODUCTION PROJECT CONNECTING ENGINEERING, LIBERAL ARTS AND STEM PUZZLES WITH TWO UNIVERSITIES ON OPPOSITE SIDES OF THE GLOBE

**DAVID GILLETTE, MICHAEL HAUNGS, LEE MCGOWAN
CALIFORNIA POLYTECHNIC STATE UNIVERSITY**

Throughout the 2015-2016 academic year, students in the Liberal Arts and Engineering Studies program at Cal Poly designed, built and tested a series of escape rooms, finally resolving on a central story and final set of puzzles. Escape rooms are interactive play spaces where participants are locked into a room and must solve puzzles inside the room in order to escape in a given time frame. The LAES program was interested in creating the world’s first internationally-connected escape room experience connecting two escape rooms on different sides of the globe. The clues to solve the puzzles in the USA were hidden in a room in Australia, and visa versa. The rooms were connected by Skype, allowing participants to communicate and successfully escape. The puzzles were based on linguistics, astronomy,

physics, pop culture, and mathematics.

The primary goal of the project was to mimic the hybrid connections the LAES program makes between engineering and liberal arts problem solving methods, with a game-centered collaboration that encouraged participants to develop similar hybrid problem solving skills in a constrained time period. Assessment became a central concern of the project, as we needed to develop a method for assessing the student work and learning, while also developing a method to track the learning and collaborative activities of the room participants. This presentation will discuss this hybrid development and teaching process, and the failures and successes of the different forms of assessment used throughout the year when tracking this project.

EDUCATING GLOBAL ENGINEERS: LIBERAL ARTS EDUCATION FOR ENGINEERS IN CHINA

DENVER TANG, PENNSYLVANIA STATE UNIVERSITY

Although broad learning in the humanities, social sciences, and arts is considered an important strength of American engineers, the idea of educating engineers in the liberal arts has also gained traction in other countries. Since the mid-1990s, the Chinese government launched a national movement to enhance college students' cultural qualities. Motivated by the governmental initiative, universities and colleges in China have established a variety of programs to enrich science and engineering education with the teaching of humanities, social sciences, and arts.

This talk introduces the background and objectives of promoting liberal arts in China's higher education. It then takes a close look at the programs of liberal arts education at two of China's top engineering universities: Tsinghua University and Beijing Institute of Technology. Both universities have sought to educate well-rounded technical professionals through curricular development, institutional innovation, and extracurricular activities that transcend disciplinary boundaries. After reviewing the institutional and pedagogical strategies that are used at Tsinghua University and Beijing Institute of Technology to promote the liberal arts, the talk concludes with a comparison of the visions and strategies of liberal arts education for engineers in China and the U.S. The author suggests that a cross-national conversation among educators in engineering and the liberal arts will generate helpful insights and intellectual resources for educating holistic engineers and preparing them for addressing global challenges.

BS AND BA: A VIABLE PATH TO OBTAINING BOTH SKILL SETS

STAN WILCZEK JR., KEUKA COLLEGE

The merits of having both technical and liberal arts skills are becoming more apparent for driving innovation in the workplace. What is not so well defined is how a student should obtain these skills. Conventional thinking would dictate a strong liberal arts base prior to pursuing more technical related skills. Although this may have been the preferred approach in the past, the current potential cost for this path (including direct education expenses, lost earnings opportunity, lost on-the-job-training, and lost career mentoring) is now out of reach for most students and more importantly might never be recoverable over the students career/lifetime.

There may be a more viable and cost effective path to obtaining both sets of skills if the overall goal of the student is to pursue a more technically related field. By incorporating strategic liberal arts related curricula into the engineering format AND developing and implementing a lifelong plan of informal liberal arts related education, a student can embark on her career sooner, obtain experience and mentoring, and still reap the benefits of a technical education enhanced with a liberal arts spectrum.

The presentation will:

- summarize the importance of balancing technical and liberal arts skill sets in various professions
- review through case study examples how an imbalance of these skills has led to less than desirable results in society
- show why the conventional approach to integrating technical and liberal arts skills is no longer viable
- provide a plan to efficiently and effectively integrate strategic liberal arts curricula into an engineering education
- outline a lifelong plan for obtaining general knowledge of a wide range of subjects in an efficient and economical manner

UNIVERSITY'S ROLE IN THE INFORMATION AGE

KEVIN BRUCKNER, IBM

MOLLY STEVENS, IBM

In an effort to improve access to education on both skills and multidisciplinary topics within sustainability Engineers for a Sustainable World (ESW) has been piloting a series of digital short courses. Departing from the established Massively Open Online Course (MOOC) model, we have focused on small courses taught live and with a high degree of interactivity as part of course content. Topics at the time of this submission include Life-Cycle Assessment, Ecological Economics for Scientists and Engineers, and Introduction to Wicked Problems in Sustainability. Participants include students and professionals from around North America, and

registration is open to all.

We plan to present the successes and weaknesses of the course program so far, highlighting differences with the MOOC model as well as areas where our work could be improved. We have found a strong interest in sustainability skills from professionals, and a stronger interest in more abstract concepts from students. Identifying an appropriate technology platform is key, but a minimal approach can be as effective as a robust but hard-to-access system for student engagement. Charging a nominal fee for courses does decrease total registrations, but significantly increases the percentage of registrants that attend the course. We hope to leave participants with an understanding of an alternative model for digital education and prompt discussion of new topics for short courses both within ESW and created by participants.

IBM DESIGN BOOTCAMP

THERESA HANS, IBM

I attended a liberal arts school in Rhode Island and studied Graphic Design Communications. When I graduated last May and embarked on my career at IBM, I felt I was ready to hit the ground running. After my first week at the nationally recognized IBM Design Bootcamp, I realized I was back to square one.

IBM Design Bootcamp brings together teams of visual, research, UX, and front end designers as well as engineers and business stakeholders to work towards one common goal – to deliver amazing user experiences. My three months at design bootcamp taught me how to embrace customer problems by working collaboratively with everyone on our team. I no longer looked at problems from a single point of view, but learned how every team member contributed unique skills critical to the solution.

With a limited technical background, I joined IBM's z/TPF (Transaction Processing Facilities) lab at Poughkeepsie IBM. Utilizing IBM Design Thinking, I have worked with the team to break down problems into smaller steps, allowing me to more quickly understand technical concepts. My impact on the engineering team has been equally positive. The lab now takes more time to better understand the entire customer experience, and assess critical pain points, before they even start talking about a new function or solution.

Today, working closely with the engineers, testers, and the brand team, we have re-established our relationship with a number of customers. The journey is in front of us, but we are taking it one step at a time. In this presentation I will share some of the lessons I learned at IBM Design Bootcamp, and how I have applied them in a large systems development lab to engage all team members in a truly team based design process.

HISTORICAL PERSPECTIVES AND ASEE MEMBER INPUT ON PROPOSED CHANGES TO ABET ENGINEERING ACCREDITATION CRITERIA

ATSUSHI AKERA, RPI

In 2009, Engineering Accreditation Commission of ABET initiated an internal review of the EC 2000 criteria that it set up during the 1990s. Originally intended to be a reevaluation of Criterion 3 (student outcomes), and the difficulty that programs were experiencing meeting that criterion, the EAC Criteria Committee, and the task force established to advise that committee, came out with a broader set of recommended changes to Criterion 3 and Criterion 5 (curriculum), along with new aspirational language and definitions to be inserted into the preamble of the current Criteria for Accrediting Engineering Programs. The proposed changes, especially in their initial draft form, would have had dramatic consequences for those committed to engineering and liberal arts integration. While many of the liberal learning objectives have been restored in the latest version of the proposed changes, they have been reintroduced through combined outcomes that create both positive opportunities and difficult challenges for those interested in integration.

In this talk, I offer a brief historical perspective on engineering accreditation standards and what they have set out to accomplish; review the specific aims of EC 2000; and offer my analysis of the changes that have been built into the proposed new criteria. As one of the organizers of an ASEE Virtual Conference on the proposed changes held in March 2016, I will also offer an initial reading of the various views expressed by ASEE members with respect to the proposed changes. I am especially interested in sharing this data with everyone associated with the Union College E&LE Symposium, since this is a conversation that will continue at an ASEE Interdivisional Town Hall meeting convened to discuss the proposed changes at the ASEE annual meeting in New Orleans.

ETEXTILES, HAPTIC FEEDBACK AS A CONVINCING INTERFACE (DESIGN SPRINT)

AMANDA ERVIN, UNION COLLEGE

eTextiles, or wearable technology, are electronics sewn into soft, drapable materials. These materials often become the clothing we wear, but might also include blankets, toys, bedding, curtains, etc. Human-centered design positions itself at the forefront of this conversation, as we take a new look at the metal, glass and plastic devices we use to communicate with each other, and whether there are cases where remote communication would be more effective if done through soft materials.

As I experiment with human centered design through eTextiles, many design questions come up. The artificial sensation of touch we experience through haptic feedback is one. How convincing is this technology? Is it enough to know that someone wants you to know they are thinking about you, or does the user need to be firmly convinced that this device could replace a loved one? Is that the Maker's goal? Will users reject this technology no matter what? For this workshop, I will take 30 minutes to present several soft objects that participants can

squeeze as though it were a loved one's hand. As we squeeze this soft device, it responds with a moving haptic pulse that feels similar to a touch. I will vary the intensity of the touch, and participants can experience the variations as both convincing and unconvincing feedback.

Participants can then build their own squishy haptic feedback device using conductive and non-conductive fabrics, as well as electronics. Using conductive threads and fabrics, participants will learn how to stuff and sew switches that will be activated when pressure is applied. Using a sewable microcontroller, this switch will activate a series of small, flat vibrating motors, otherwise known as haptic feedback. Participants will learn how to vary the intensity of this vibration using computer code.

UNDERSTANDING DESIGN: A COURSE TO INTRODUCE FIRST-YEAR STUDENTS TO THE LANGUAGE OF DESIGN

MARY ROTH, LAFAYETTE COLLEGE

First-Year Seminars (FYS) at Lafayette College provide a curricular opportunity for faculty to take risks in their course content and their pedagogical approaches. With the goal of creating a curricular entry point to issues related to design for students planning to major in the arts, humanities, and social sciences, I decided to use the FYS platform to create a course where students would use observational drawing, journaling, discussion, and writing to individually and collectively explore and reflect on elements of good design. Specifically, I wanted to create a course where students who were not generally interested in taking classes in STEM could develop curiosity and empathy with respect to the design of objects and spaces. For Union College's Ninth Symposium on Engineering and Liberal Education, I propose offering participants an opportunity to learn about this newly developed course and to experience a selection of the types of exercises I used in the course to create the scaffolding for the students to meet the desired learning outcomes.

Tentative outline of session:

- Introduction (10 minutes) — motivation for course, student learning outcomes, course structure
- Sampling of foundational design principles (10 minutes) — mapping, feedback
- Survey exercise (10 minutes)
- Report out (5 minutes)
- Observational drawing and journaling exercise (15 minutes)
- Report out (5 minutes)
- Wrap up (10 minutes) — student feedback on course, recommendations for future offerings

MAKING AS SCHOLARLY ACTIVITY: USING CRITICAL DESIGN AND ENGINEERING TOOLS TO PERFORM HUMANISTIC CRITIQUE

JAMES MALAZITA, RPI

As in engineering (and STEM fields generally), making activities have also been embraced in the humanities and interpretive social sciences; these wide-ranging making activities have been generally grouped under the banner of the “digital humanities”. Though the subfield represents a diverse array of practices, recently, humanities scholars have embraced physical and physical-digital hybrid making tools, such as machine shopping and 3D printing.

While critical making and fabrication work has made important pedagogical contributions to the field, Alan Liu notes that “the digital humanities are noticeably missing in action on the cultural-critical scene”. The focus of the computational and maker arms of the Digital Humanities on presentation, curation, and creative, technology-centered pedagogy at the expense of critique and theory-generation, Liu argues, prevents digital humanists from being fully integrated and allied within the Humanities field. As such, Digital Humanities research has often been met with resistance by other humanistic scholars, who may characterize Digital Humanities work as a fad, or, worse still, as a cooptation of the humanities by STEM practices and epistemologies.

This presentation aims to address these critiques by arguing for the transformation of the digital humanities through “critical design”. Critical Design, an admittedly loosely-defined set of practices and near-nonexistent methodologies, critically inverts the design process: rather than using design methods to solve problems, design methods are used to confront the user with social problems, often intending to complicate, rather than simplify, user experience. Thus, while most technological tools brought to the humanities are framed as ways of methodologically augmenting humanities work, critical design affords a venue to do humanistic critique and scholarship outside of (and in addition to) the written word. In addition, this presentation will showcase critical design research work undertaken by undergraduate humanities and engineering students at Rensselaer Polytechnic.

CREATING AN APP IN 60 MINUTES

EDRIAN IRIZARRY, IBM

“Creating an app in 60 minutes” is a Lab exercise that is suitable for high school level or higher. Lab setup on laptops will be needed with two programs installed:

Eclipse Luna can be downloaded from <https://eclipse.org/luna/>

IBM MobileFirst Platform Studio can be downloaded from eclipse marketplace
<https://marketplace.eclipse.org/content/ibm-mobilefirst-platformstudio>

Alternatively, participants can download the setup programs but this will need to be done in advance of the Lab, allowing enough time for the download (1-2 hours).

This exercise is a benefit to STEM students as it will provide an opportunity to create an app and preview it.

MAKER EDUCATION IN AN ABET CURRICULUM

AMANDA ERVIN, UNION COLLEGE

Makerspaces offer a great deal of hands on skill building for young engineers. Makerspaces are typically built around digital fabrication tools like 3D printing and laser cutting, but can certainly extend to sewing, electronics, rotocasting, woodworking and machinery. Having these tools on hand and ready to use gives all students the opportunity to apply the skills they are learning in their disciplined curriculums. One question that has come up many times, asked by higher ed schools from across the country, is “How do we get this into our curriculum when ABET standards don’t leave much room?” I am proposing a discussion group that will brainstorm ways to solve this problem. Some solutions have included two 101 level courses, simultaneously taught. One is taught traditionally, one integrates Maker skills, and both are assessed. Another proposed solution is Maker Labs/Badges, that will be brief (3-6 hours), will not be for credit, but will be prerequisites for classes that require these hands on skills. Finally, team teaching, and sharing these responsibilities across disciplines, minimizing the workload for each other. This discussion will address these solutions as viable possibilities as well as addressing any new possibilities introduced during the discussion.

INNOVATION AND SUSTAINABILITY AS NEW ABET OUTCOMES

DAVID KENT, MILWAUKEE SCHOOL OF ENGINEERING

In their 2008 book entitled *Designing Better Engineering Education Through Assessment*, Joni Spurlin, Sarah Rajala and Jerome Lavelle have a chapter on the Future of Assessment. Authored by Mary Besterfield-Sacre and Larry Shuman, the chapter argues that engineering education assessment will be “entering into a new period focused on student learning that is analogous to industry’s current period of ‘Building Quality into Products and Processes.’” Besterfield-Sacre and Shuman further maintain that “We also see ABET expanding the current minimum set of outcomes. For example, it is clear to us, and an increasing number of national experts and engineering ethicists, that engineers must consider the wider, long-term ramifications of their professional decisions... Thus we see Criterion 3.f, ‘an understanding of professional and ethical responsibility,’ being expanded to consider the impact of engineering solutions on the society at risk.” Besterfield-Sacre and Shuman further predict: “We also see innovation and sustainability being added as outcome criteria. The growing recognition of the earth’s limited resources and the consequent need to create sustainable alternatives will require engineers to take new approaches to the design of products and systems... As interest grows, we anticipate a point at which sustainability will be a routine design constraint. Another change will be the inclusion of innovation... To retain our competitive edge and standard of living, we will need to produce engineers who are more creative and who routinely think outside the box.” My presentation will expand the argument that sustainability and innovation should indeed be added as ABET outcome criteria. Using examples such as the work of the Kern Entrepreneurial Education Network (KEEN), I will argue that sustainability and innovation belong in any expansion of the ABET outcome criteria.

BRIDGING ENGINEERING AND LIBERAL ARTS IN AN AUGMENTED REALITY DESIGN COURSE

JACKY DOLL, IBM

REBECCA ROUSE, RPI

This presentation describes an undergraduate and graduate advanced special topics course, “Mobile Augmented Reality Design” as an example of intersectional engineering and liberal arts pedagogy in practice. Lessons learned from offering the course will be shared, as well as plans for the future. The course centers on a hands-on design experience, structured around collaboration with an outside client, which provides students with real-world design and development experience before graduation. Students work in teams to design, code, and create all aspects of functioning prototype mobile AR apps for museums and cultural heritage. AR is presented as a medium uniquely capable of making invisible history visible, and students are immersed not only in the project development process but also relevant media history and design theory. Students deep dive into the historical precedents of mixed reality technologies, are introduced to a variety of artistic and HCI design approaches, and also focus on the particular historical materials relevant to their team projects.

“Below Stairs: AR History Adventure”, one student project from the most recent cohort of this course, was selected by the client, The Rensselaer County Historical Society, for further development and permanent, public display at their historic house museum in downtown Troy, NY. “Below Stairs” is set in the 1850s when the Hart family was in residence and is based on extensive historical documentation. Users play the part of a new under-servant in the household on a trial day, and must interact with virtual characters and explore the house to complete a series of tasks, to determine if they will be offered the job. The AR application provides users an opportunity to develop a different relationship to the site, and to develop a kinesthetic understanding of the meaning of the site and the history represented there.

THE RESILIENT COMMUNITIES DESIGN CHALLENGE BY ENGINEERS FOR A SUSTAINABLE WORLD

ERIN LENNOX, ENGINEERS FOR SUSTAINABLE WORLD

NICHOLE HEIL, ENGINEERS FOR SUSTAINABLE WORLD

Engineers for a Sustainable World (ESW) is a national non-profit organization committed to building a better world. We believe engineers can be a vital part of the solutions needed to more effectively meet global human needs while providing sustainable access to the world’s resources for current and future generations. ESW operates as a network of 50 predominantly collegiate chapters translating to 1000 active members across North America. This year we have launched a new pilot program called the Resilient CommUnity Design Challenge. Through this challenge, collegiate chapters partner with local organizations and citizens to conduct a resilience assessment of a local community around the four key topic areas of energy, food, transportation, and public spaces. After this initial assessment chapters and their local

partners then propose a specific implementation project for one or more areas that will improve the overall sustainability and resilience of the community, as well as the quality of life of its residents. Challenge winners will receive funding and support from ESW-HQ to implement their projects beginning in year two.

Here we present results from year one of this challenge: highlighting student experiences from our 14 participating chapters and showcasing our selected challenge winners. Our intent is to build and share a portfolio of sustainable, resilient interventions that will be an example for our chapters, their communities, and other neighborhoods and cities to quantifiably and cost-effectively improve their local environmental and social well-being.

USING WATER TO TEACH PARADOX

ASHRAF GHALY, UNION COLLEGE

Fresh water is a necessity for life. Humans, animals, birds, and almost all living creatures cannot live without water. Water has many paradoxical features. It is one of the cheapest materials yet it is the most precious commodity known to humanity. Water could be the source of peace and development yet it could be a reason for war and conflict. Water could be a force for good to generate hydropower yet unchecked or unregulated this force could be in the form of destructive floods. Water could be a weapon to combat desertification yet too much thereof could cause erosion. Floods come with loads of mud and silt that charge river deltas and keep them fertile yet weaker floods result in lesser deposits that could threaten river deltas with sea attacks. Fresh water is the basic building block for life yet contaminated water is a major life-threat in the form of water-borne disease. Water has always been a main reason for people to settle the land yet a shortage thereof could force people to migrate and leave their homeland. Water is a resource that is taken for granted. Little or no thought goes into how precious this liquid is, and how essential it is to any form of life. It is such an absurd paradox that such a vital material is used so carelessly. With such an array of contradicting features, water makes for a rich, interdisciplinary topic to study. In absence of proper management, disasters in the form of starvation, disease, and war are bound to happen. A course has been developed where its focus was to open eyes and minds to water-related facts that can no longer be ignored. This course aimed at helping the students appreciate the dimensions of extremely important environmental, social, and economical issues.

USING AN INTERDISCIPLINARY APPROACH TO TEACH STUDENTS ABOUT URBAN INFRASTRUCTURE

LAURA STEINBERG, SYRACUSE UNIVERSITY

This talk introduces a new course for seniors created and taught by the author called “Modern Urban Infrastructure: Theory and Practice”. Taking an interdisciplinary approach, the course introduces the concepts of economic impact, social capital, public participation, public-private partnerships, and disaster preparedness into the more common paradigm of teaching infrastructure through the linear and technically-based construct of project planning, design, and operation.

The course uses readings from history texts ; contemporary magazine journalism; textbook excerpts; engineering and social science journals; and current news articles, to provide students with a broad picture of how infrastructure can be conceived, built, and managed to achieve the greatest possible social good.

The course culminates in each student’s development of a case study exploring a major infrastructure project. One aim of the case study is to have the students apply key concepts to a single major project in a comprehensive and deeply researched manner. A second aim of the case study is to allow the students an opportunity to exercise and improve their writing skills; the first draft of their paper is closely read and critiqued by the author. The student is provided with in-depth suggestions for improvement and reminded of basic tenets of good writing (for example, the use of topic sentences and the need to avoid repetition) which typically not have been thoughtfully exercised since the freshman writing course. A third aim is to provide an opportunity to practice skills of lifelong learning by asking students to:

1. read one or more books
2. consult primary and secondary sources
3. synthesize information from many disciplines into a cohesive analysis using the breadth of ideas covered during the entire semester

The author looks forward to sharing her experience with the course and hopes to receive suggestions for improvement from the participants.

CREATING PASSAGES OF LIGHT, SHADOW, MEDIA & SAFETY: CONNECTING LIBERAL ARTS, ENGINEERING AND ARCHITECTURE IN A CIVIC RECLAMATION AND URBAN INFORMATICS PROJECT FOR THE CITY OF SACRAMENTO, CA.

**DAVID GILLETTE, MICHAEL HAUNGS, THOMAS FOWLER
CALIFORNIA POLYTECHNIC STATE UNIVERSITY**

From January-June 2016, students in the Liberal Arts and Engineering Studies program at Cal Poly will work with students from the Architecture college to re-design a set of pedestrian freeway underpasses for the city of Sacramento. These underpasses are currently under-used; many locals consider them to be unsafe and/or unwelcoming spaces. The LAES and Architecture students will work in a series of interdisciplinary teams to develop new designs for these civic spaces to make them more appealing, safe, and welcoming using different media display technologies, and innovative uses of light and shadow. The student teams will also devise methods to connect the spaces with each other, even though they are on opposite sides of the city. This design and development process begins with a multi-disciplinary workshop that concludes with presentations to faculty and the coordinating architecture firm in Sacramento. A winning design will be selected and that design team will be funded to refine their design for final presentation to the city of Sacramento in June 2016.

The primary goal of this project is to replicate (in an academic setting) the social, political and technical aspects of interdisciplinary civic design, resulting in a real-world outcome. We are currently developing new methods for assessing the hybrid student learning for this project. Since this is a work-in-progress, we don't now know how it will conclude, but we will discuss the results of our experiment with collaboration and assessment, no matter what happens by June.

NOTES

REDEFINING LIBERAL EDUCATION FOR THE 21ST CENTURY

**At Union College, we are guided by innovation
and inspired by tradition.**

Founded in 1795, Union College was the first college chartered by the Board of Regents of the State of New York. We are a small, independent liberal arts college committed to integrating the humanities and social sciences with science and engineering in new and exciting ways. Union's rigorous academics take place in a diverse, welcoming campus environment that supports your personal growth, provides you with a wealth of opportunities to find and pursue your passions, and inspires you to engage with the local and global community through meaningful projects and volunteer work.

At Union, you will find a vibrant community of learners and scholars, of leaders and change agents—people whose ambition, energy and desire to make things happen are contagious. The intellectual and creative spark can be felt in our academic buildings, Minerva Houses, labs, library, studios and recital rooms—anywhere you go on our historic campus. We have a long tradition of innovation and of educating creative problem-solvers, a tradition which continues to flourish and to define who we are today.

On the back cover: The Union College Logo (top) and Seal of Minerva (bottom). The adoption of the Seal of Minerva at the College's founding was a radical innovation in that it incorporated a French motto: "*Sous le lois de Minerve nous devenons tous freres et soeurs*"—"We all become brothers and sisters under the laws of Minerva".

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**NINTH SYMPOSIUM ON ENGINEERING
AND LIBERAL EDUCATION**

**3-4 JUNE 2016
UNION COLLEGE
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