



**CASCE**



Proceedings of the Workshops on the Creative Art of Structural and Civil Engineering



Structure: Sunniberg Bridge (Klosters-Serneus, Switzerland) | Designer: Christian Menn

(Front cover) Structure: Forth of Firth Railway Bridge (Scotland)  
Designers: Sir John Fowler and Sir Benjamin Baker

Images derived from the lecture presentation "Structural Art: From Robert Maillart to Fazlur Khan" by Professor David Billington, as well as other course materials provided by Princeton University - except pages 8, 14 and 17 provided by the CUREE staff.

Booklet layout by Reed Helgens and Darryl Wong (CUREE)

## Acknowledgments

The planning for the workshop held in 2015 at Princeton University was coordinated with the invaluable assistance of Princeton University's Council on Science and Technology (CST). The CST fosters education, research, and intellectual exchange that deepen and broaden understanding, experience, and appreciation of science, technology, engineering, and mathematics (STEM).

The CST partners with faculty in engineering, mathematics, natural sciences, the arts, humanities, and social sciences to explore and promote the relation of STEM with culture and the course of public affairs. The workshop's opening reception was co-sponsored by the Princeton University Office of the Dean of the College.

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Structure: Barqueta Bridge (Sevilla, Spain) | Designers: Juan José Arenas and Marcos Pantaleón

## Overview - The Creative Art of Civil and Structural Engineering (CASCE)

Recent reports from the Office of the President of the United States and the National Academy of Engineering urge the nation to increase student retention in science, technology, engineering and mathematics, and to educate a STEM-literate populace. Uninspiring introductory courses, poor teaching, and lack of effective dissemination of best-practices are major obstacles that stand in the way of achieving these goals.

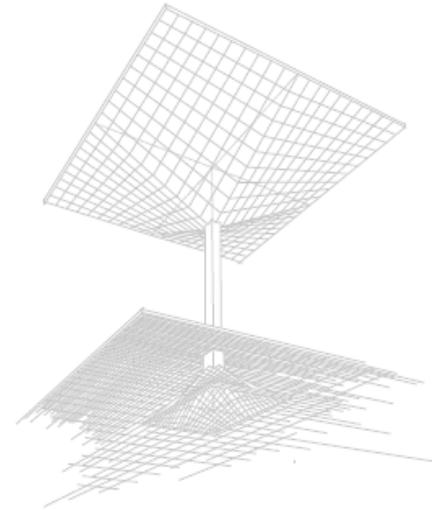
The National Science Foundation recently awarded an Improving Undergraduate STEM Education grant (DUE 14-32426) to Professor Maria Garlock (Princeton University), Professor Cris Moen (Virginia Polytechnic and State University), and Professor Sanjay Arwade (the University of Massachusetts - Amherst). These faculty members from these three universities are part of a multi-institutional, collaborative research project aimed at Advancing the Dissemination of the Creative Art of Civil and Structural Engineering (CASCE). The project's goal is to overcome these obstacles through supporting the dissemination and implementation of introductory civil engineering courses that are enhanced with research-based pedagogy.

These courses emphasize the creativity of the engineer along with the technical content. They demonstrate that engineering design involves “discipline and play”, where discipline refers to technical skills, and play refers to creative and aesthetic exploration.

## What is Structural Art?

To answer the question what is structural art, we need to reflect upon the question, what is art? The Merriam Webster dictionary defines art as, "...something that is created with imagination and skill, that is beautiful or that expresses important ideas or feelings." Beauty may indeed be in the eye of the beholder, however, most can agree there is an appreciation for clean lines, balance, and elegance in the form of a work of art, and in a civil structure.

In 1983, David P. Billington, a civil engineering professor from Princeton University published a book "*The Tower and the Bridge*." He presented well-known civil structures and their engineers, defining these structures as works of art through their design, which successfully integrated the three principles of economy, efficiency, and elegance.



Structure: Support design for Mexican Textile Mill  
Designer: Félix Candela

Economy refers to achieving a competitive construction cost consistent with minimal maintenance requirements, efficiency strives to use the minimum amount of material needed for adequate performance and safety; and elegance is defined as emphasizing aesthetics to the greatest degree consistent with efficiency and economy.

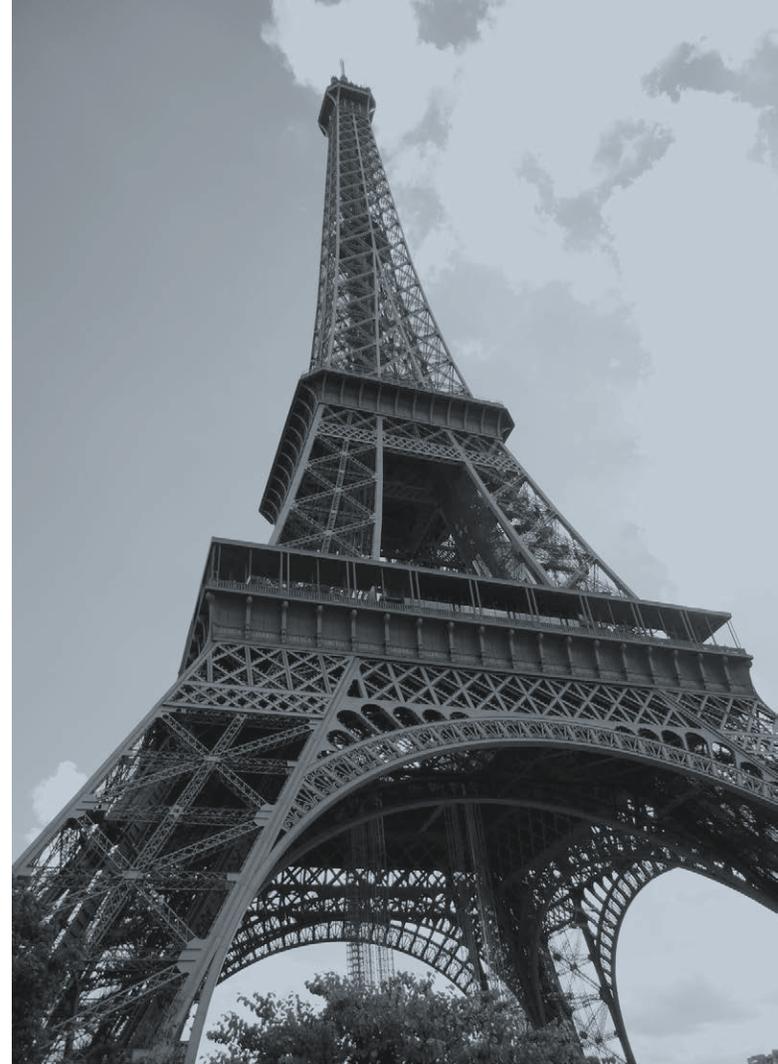
Civil and structural engineers design and build the systems that give us shelter (buildings), enable transportation (roads, bridges, ports, and airports), and bring us water and power (dams and reservoirs). These structures enable modern life, as we know it; Billington advocated they should also enhance it through the making of artistic choices available to an engineer.

Three perspectives essential to understanding design from an engineering viewpoint are the scientific, the social, and the symbolic. The most creative engineers are free to explore designs that represent a freedom of expression, yet they are disciplined by nature and by society. Technological advances in materials and construction methods can enable design concepts not previously thought possible, while the social and cultural conditions in which an engineer operates, influence design.



## Why Teach Structural Art and Civil Engineering

Engineering is one of the key subject areas within STEM, the acronym for the program created by the by the National Science Foundation that is looking to improve how the subjects of Science, Technology, Engineering and Mathematics education is being taught within the classroom by incorporating technology and engineering into the regular curriculum. Through the introduction of problem-solving scenarios and exploratory learning, students will be engaged in finding solutions, allowing for a deeper examination of a subject and the development of critical thinking skills.



Structure: Eiffel Tower (Paris, France) | Designer: Gustave Eiffel

There are indicators that fewer than 40% of students who enter college intending to major in a STEM field complete a STEM degree. The goal of this project is to reduce this attrition of STEM students by utilizing student-active pedagogies that have been proven effective in promoting retention and cultivating an appreciation for the role of engineering in everyday life. It is important for all students to appreciate the importance of engineering in creating and sustaining modern life. It is the civil engineer that designs and builds the systems that give us shelter (buildings), enable transportation (roads, bridges, ports, airports), and bring us water and power (dams and reservoirs). The societal outcomes of more STEM professionals in the USA are an improved national economy and therefore vitality

STEM education should not be focused solely on producing STEM professionals. Students in non-STEM majors often transition in to leadership positions in government, education, civic administration, law and business, with significant influence in society. Thus it is our obligation to graduate students who can question, think, and analyze for themselves, and are scientifically and technically literate. Recognizing this, most universities require non-STEM students to take at least one STEM class.

A 2005 report by the National Academy of Education, *Educating the Engineer of 2020*, states: "It is in the enlightened self-interest of engineering schools to help the public understand what engineers do and the role that engineering plays in ensuring their quality of life. Moreover, a country weak in technological literacy will have increasing difficulty competing in the technology driven global economy of the 21st century. Thus we recommend that the engineering education establishment should participate in a coordinated national effort to promote public *understanding of engineering and technology literacy of the public.*"

## Goals of the Project

The overarching goal of the project is to transform introductory courses on civil engineering with research-based pedagogical techniques, and support the dissemination of the courses for STEM and non-STEM students at other colleges/universities.

This goal addresses the concerns about the lack of STEM education identified by the the National Academy of Engineering, the American Society of Engineering Education, and the President's Council of Advisors of Science and Technology.

The specific goals are:

- Transform an introductory engineering course with dramatically improved interactivity and accessibility for non-STEM students
- Ensure that the course takes a form that can be readily adopted into the engineering and general education curricula of many types of institutions of higher learning (e.g., undergraduate institutions, research universities, etc.)
- Facilitate dissemination, adoption, and continuous improvement of the courses beyond the audience already being reached.

## Goals of the Workshops

The goals of the workshops are to (1) understand the culture of various institutions and their challenges and barriers for adoption/adaption of the course content, (2) introduce learning objectives, course modules, and the various manners that the objectives and content can be taught; and (3) continue to build a community of educators around these educational objectives.

## Project Assessment

A mixed-method approach to collecting quantitative and qualitative data is utilized. Quantitative data is collected in the form of course grades and surveys to measure impact on cognition and affect, as well as feedback from faculty engaged in dissemination efforts. Focus groups, individual interviews and open-ended questions on surveys are designed to garner qualitative data to complement the mostly quantitative surveys. Existing student surveys are adapted to align with proposed project goals. For example, the Student Assessment of their Learning Gains (SALG) is utilized to assess impact on students' cognition and affect. For dissemination, the evaluator administers email and phone surveys to faculty who attend conference presentations. Follow-up surveys and interviews are conducted with those who express interest in adopting the course. Analysis is both formative and summative. Findings are widely disseminated to contribute to the growing body of literature on STEM teaching and learning.



**PRESENTATIONS (may vary with each workshop)**

*Evolution of the Course* – David P. Billington

History of course, course themes, summary of course.

*Evaluation Plan and Customer Service Questions* – Evelyn Laffey

The evaluation plan for the workshop is reviewed and participants are asked to break into small groups for discussion on the evaluation findings. Groups are later reconvened to report on their discussions. Large post-its and markers are available throughout the workshop for note taking and sharing of ideas.

*Debrief on Customer Service Questions* – Evelyn Laffey

The reconvened small groups present their objectives and their goals for the workshop that emerge from the discussions. Evelyn Laffey facilitates the discussion and summarizes emergent goals and objectives.

*Modular Approach to Adoption* – Cris Moen, Ignacio Paya-Zaforteza, and Sanjay Arwade

A presentation is made on the modular approach in the adaptation of a single class – rather than an entire course. Examples are provided of existing modules/objects and use of these modules in existing courses. Exercise: syllabus preparation.

*Reflections from selected participants from prior workshops*

## PRESENTATIONS (continued)

### *Challenges in Adoption* – Sanjay Arwade, Cris Moen, and Ignacio Paya-Zaforteza

Advice is given on how to attain institution buy-in and on iterating the course over time. Description is given on how topics have been adapted to fit curricular goals at other institutions and on the alignment with overarching curricular goals for the engineering (or liberal arts) program. Both Professor Sanjay Arwade & Professor Cris Moen gave their perspectives/experiences on the development of the course material at their universities.

### *Demonstration of Active-learning Activities* – Maria Garlock, Aatish Bhatia, and Negar Elhami Khorasani

A presentation is made on the positive student response received to the incorporation of active-learning demonstrations used to support a lesson objective. Workshop Participants are given the experience of several of the active-learning techniques that are available for use in a course.

### *Individual Work & Small Group Discussion* – Maria Garlock, Sanjay Arwade, and Cris Moen

Time is given for the workshop participants to develop and implement a syllabus or lesson plan. The participants are matched with a mentor, either Professor Moen, Arwade, or Garlock, who provide feedback throughout the workshop. Each group is assigned to a room with their mentor. Workshop aids circulated among the groups to provide direction and to take notes on reports developed with the groups.

## PRESENTATIONS (continued)

### *Review of the CASCE Website*

A presentation is given on the design and content of the project webpages, as well as the overall website concept. At this stage of development, the focus for the group is on ease of access to content and navigation, as well as on the overall look of the website. Participants are invited to ask questions and allowed to surf the project website using their own devices.

### *Feedback on the Website*

Large group discussion on website feedback is facilitated by the web developer. Suggestions and comments are noted and recorded for consideration in future development of the website. Additional comments post-workshop are emailed to Evelyn Laffey.

### *History of and Visit to a Local Civic Structure*

A walking field trip to a local civic structure serves as an example of how to use a field trip to spur discussion and debate among students. On the Princeton University campus, the Streicker Bridge, a pedestrian walkway designed by Swiss engineer Christian Menn, was used as an example for discussion. The Bridge was designed with the intent that elements of its structure would branch out like a tree so as to enhance the wooded setting where it is installed.



Structure: Streicker Bridge (Princeton University) | Designer: Christian Menn

## PRESENTATIONS

### *Lesson presentation* – Sanjay Arwade / Ignacio Centrangolo

A lecture is presented from a course taught at the University of Massachusetts-Amherst that has incorporated the modules/objects presented at the workshop and that is open to non-engineering majors.

### *Individual work time* – Cris Moen, Sanjay Arwade, and Maria Garlock

Workshop participants are invited to gather into small groups to consider the lecture material and discuss how they can modify an existing course or incorporate the presented ideas into a new course. Mentors circulate among the groups to answer questions and provide direction as needed.

### *Presentation from Small Groups* – Cris Moen

Groups reconvene to report on their discussion on the development of their lessons. Chris Moen facilitates the discussion. Notes shared by the groups are recorded.

### *Articulating Elegance* – Maria Garlock

A presentation is given with slides of several examples of engineered works that present the qualities that define them as structural art. These qualities are highlighted and discussed in a presentation by Professor Garlock.

### *Closing Remarks* – Maria Garlock, Cris Moen, and Sanjay Arwade

Everyone is invited to provide any final comments. Workshop attendees are contacted after the workshop regarding their success in implementing the ideas developed at the workshop.

## Conclusions from Workshop

Within the particular discipline of civil engineering, in the first year, this project has demonstrated that inspiring teaching and research-based pedagogical techniques resulted in 89% of students reporting moderate to great gain in interest in engineering; 85% reported moderate to great gain in recognizing engineering as a creative profession; 83% reported moderate to great gain in understanding how engineering helps people address real world issues; and, on average, 78% of students reported a moderate to great gain in their STEM abilities. These findings were a result of data collection and analysis conducted at Princeton University during the Spring 2015 offering of the Structures and the Urban Environment course.

The workshops introduce new colleagues to an informal organization called "International Network for Structural Art" (INSA). This network is a resource for intellectual exchanges of ideas, opinions, experiences, and resources as related to the design, scholarship, and teaching of civil engineering from a technical, aesthetic, and creative perspective. INSA has a membership that numbers approximately thirty and consists of academics and practitioners from North America and Europe.

Although informal in its formation and structure, bi-annual conferences/workshops are organized and thus far one edited volume has been published under the INSA imprint. This grant is the first direct funding to members of INSA to pursue the goals of furthering the study of structural art throughout the Civil and Environmental Engineering curriculum and therefore presents opportunities for synergistic activities between this grant and INSA.

The workshop participants were eager to adopt the new practice of hands-on-activities in particular. This segment of the workshop generated the most enthusiasm and based on the mentoring and feedback, at least some of these activities will be adopted by most. On the website are post specific instructions on how to deliver these activities.

During the workshops, several hours of one-on-one mentoring were available and the mentoring has continued and will continue as these colleagues adapt the course or modules of the course.

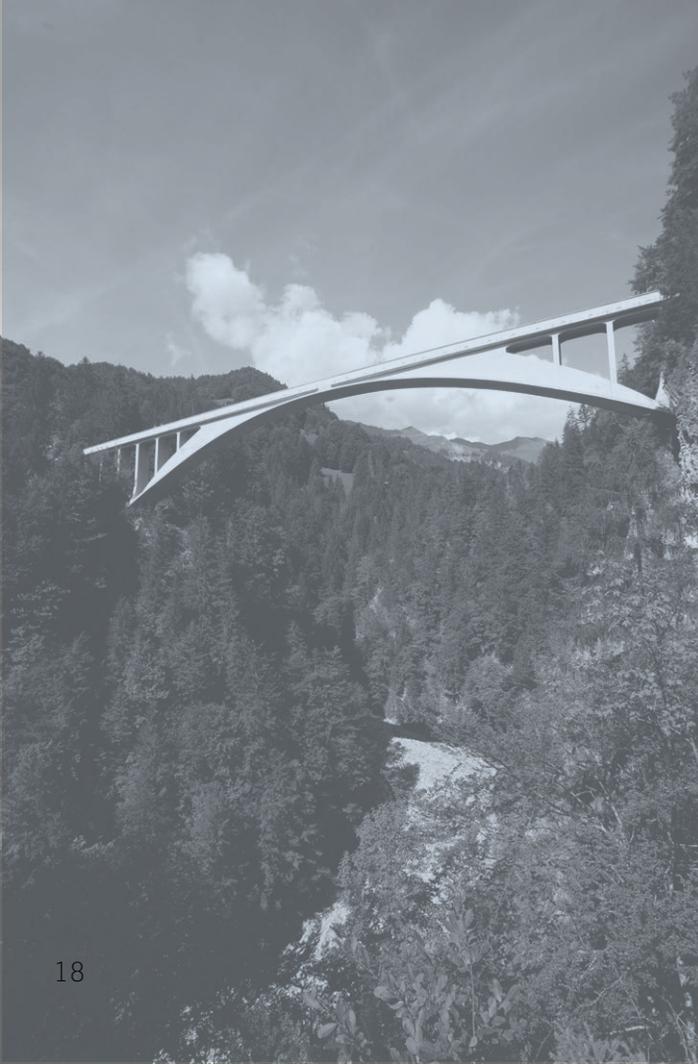
Photos from the 2015 CASCE Workshop (hosted by Princeton University)



(left to right) Professor Maria Garlock welcomes the many participants of the first CASCE workshop, held in the Princeton Architectural Library. • Professor David Billington gives a special presentation on the subject of Structural Art. • As part of the walking tour, the group is given the opportunity to explore some examples of structural art in a display of bridge models.



(left to right) In an active learning exercise, workshop participants test the stiffness of various shapes using paper and pieces of candy. • Professor Garlock demonstrates the concept of resonance using a simple tabletop model with wooden blocks. • This concept of resonance is also explored by the group in a hands-on exercise using marshmallows and sticks.



## Post Workshop Survey Results

*Did you receive enough information about the course prior to the workshop?*

All agreed that homework was beneficial because (1) gave thorough overview, and (2) motivated them to come to workshop.

*How can we improve the process of advertising and spreading the word about the course to a broad and diverse audience?*

Personal invitations to colleagues or entire department (use participants as “ambassadors”), presentations at conferences, advertisements in relevant magazines/publications/YouTube

*Were you able to reach a member of the management team when you had a question or comment?*

Yes!

*To what extent are you ready to adopt/adapt the course, or modules of the course?*

Five out of seven are ready to adapt content to existing courses. One will infuse into a new course. One will use hands-on activities in existing course.



*What would help you to be “more” ready?*

Continuing the network that formed during the conference; a syllabus to use as guide; working one-on-one with mentors; more modularized activities with specific objectives, procedures and outcomes; the complete website

*How will your institution support you in adopting/adapting the course (modules)?*

Most will have the support of the institution or chair; easier to adopt a module than an entire course; some will not have course support (graders, TAs, lab manager); MSU offer to partner on continuing grant to disseminate to HBCU/MSI

*How can the management team support the continued networking and faculty community that formed during the workshop?*

Maintain communication - email updates on website, relevant publications, and case studies on implementation; share findings from evaluation on course(s); opportunities to reconnect in-person; circulate list of participant contact info

*Please comment on the CASCE website. What works well? What needs to be improved?*

Wide array of responses - make website more interactive; like the layout of the webpages, easy to view.

## Resources: Project Team

**Dr. Maria Garlock** is an associate professor in the department of civil and environmental engineering at Princeton. Her scholarship is in resilient building design for large earthquakes and fires, as isolated and as combined multi-hazard events. In addition, Dr. Garlock studies the best examples of structural designs of the present and past, which encompass the ideals of efficiency, economy, and elegance. She has co-authored a book on the subject with David Billington (Felix Candela: Engineer, Builder, Structural Artist), and co-curated three exhibitions with scale models and instructional displays that teach about exemplary structural engineering designs. She is the recipient of the 2012 President's Award for Distinguished Teaching, which is the highest teaching award at Princeton. In 2013 she was selected to participate in the National Academy of Engineering's 2013 Frontiers in Engineering Education Symposium where she discussed the topic of this proposal with colleagues all around the nation.

**Dr. Sanjay Arwade** is an associate professor in the department of civil & environmental engineering at the University of Massachusetts Amherst. He has taught or co-taught his version of the 'structures and the urban environment' course 6 times and has had the course approved as meeting university requirements for the general education (distribution requirements) curriculum in historical studies and quantitative reasoning. He conducts research, funded by the National Science Foundation and industry, in structural mechanics and behavior and on the use of historic structures in civil engineering education. Dr. Arwade is the leader of the Teaching Materials working group of the International Network for Structural Art, who has started a database/collection of teaching materials.

**Dr. Cristopher D. Moen** is an associate professor in the Charles E. Via, Jr. Department of Civil & Environmental Engineering at Virginia Tech. He completed the Bachelor and Masters of Civil Engineering at the University of Virginia in 1995 and 1997 respectively and a doctorate in Civil Engineering at Johns Hopkins University in 2008. Dr. Moen worked from 1997 to 2005 as a senior engineer at an international bridge engineering consulting firm and he is a registered Professional Engineer in the Commonwealth of Virginia. In 2013 he led the redevelopment of Virginia Tech's CEE 2804 Introduction to Civil Engineering curriculum, adding socio-economic context and criticism inspired by the teachings and writings of Prof. David Billington at Princeton and by his academic mentors Dr. Sanjay Arwade and Dr. Ben Schafer at JHU. Prof. Moen's primary research interests are in lifecycle reliability and engineering for endurance applied to building structural systems and transportation infrastructure.

Dr. Evelyn Laffey is the current Associate Director of the Princeton Council on Science and Technology. Evelyn has a doctorate in mathematics education and bachelor's in mathematics from Rutgers University. Her research and teaching are focused on understanding the interesting intersections of cognition, affect, and identity within the realm of STEM education. Prior to joining Princeton, Evelyn was the Assistant Dean for Engineering Education at Rutgers School of Engineering where she developed engineering education programs to enhance the learning and teaching of STEM. Relevant to this proposal, she led the team responsible for the implementation of an ENGAGE Faculty-Student Interaction mini-grant and two NSF grants (Robert E. Noyce Teacher Scholarship Program and a Research Experience for Teachers).

Dr. Aatish Bhatia is an Associate Director and Engineering Education Specialist in Princeton University's Council on Science and Technology. He holds a doctorate in physics from Rutgers University and a bachelor's in physics from Swarthmore College. At Rutgers University, he transformed and co-taught a 100+ student enrollment introductory physics course for non-science majors, to incorporate active learning techniques and to focus on the relevance of physics to society. He has taught in the New Jersey Governor's School of Engineering and Technology and was a recipient of the Richard J. Plano Outstanding Teaching Assistant Award. His popular science writing is published online by Wired magazine, accessed over 800,000 times, and is included in The Best Online Science Writing 2012 (Scientific American Books). He has co-developed online educational videos that have been accessed over 2.5 million times.

**Consortium of Universities for Research in Earthquake Engineering (CUREE) -**  
As a subaward to Princeton University, Reed Helgens and Darryl Wong (CUREE) along with John-Michael Wong (KPF Engineers) provide an essential service to the project by designing and creating a website that is at the core of the dissemination of our work – where dissemination is a major objective as stated in the proposal. They are studying and thinking about the best means of collecting and organizing the significant amount of information that we are producing.

## The Council on Science and Technology

The Council on Science and Technology (CST) fosters research, education, and intellectual exchange that deepen and broaden understanding, experience, and appreciation of science, technology, engineering, and mathematics (STEM). The Council partners with colleagues in engineering, mathematics, natural sciences, the arts, humanities, and social sciences to explore and promote the relation of STEM with culture and the course of public affairs.

The Council is guided by the following overarching goals to:

- Collaborate with university colleagues to educate a STEM-literate society through formal and informal learning experiences.
- Engage in and support research that explores STEM education and interdisciplinary collaborations.
- Cultivate synergies among a broad and diverse community that bridge STEM, the arts, humanities and social sciences.
- Serve as a clearinghouse on innovations that promote excellent, equitable, and innovative STEM research and education.

The Council has launched an educational research agenda focused on understanding the STEM educational experience of undergraduates, as well as the faculty perspective on STEM education at Princeton University. Research findings will assess the impact of the Council, inform future work, and contribute to the growing body of literature on excellent and equitable STEM education. Additionally, the Council supports synergistic activities that explore and promote the relation of STEM with culture and the course of public affairs. Activities include workshops, seminars, projects, informal learning opportunities, or events for faculty, post-doctoral fellows, graduate and undergraduate students, and community members. Please visit our Projects page to further explore our synergistic activities. For more information on the Council, please visit: <http://cst.princeton.edu>.



Structure: Bayonne Bridge (Staten Island, New York) | Designers: Othmar Ammann and Cass Gilbert

### The McGraw Center for Teaching and Learning (Princeton University)

The McGraw Center supports faculty members and instructors as they advance as teachers, graduate students as they begin their teaching practice and progress as teachers and professionals, and undergraduates as they develop as learners and scholars. The Center offers extensive programs and services for faculty, graduate students and post-doctoral associates related to their development as professional scholars and teachers. All of the programs are based in current research and discussions on effective teaching and student learning and are led by either trained and experienced graduate student fellows or by professional staff.

The McGraw Center views teaching and learning as processes of inquiry. For teachers, that inquiry entails reflecting on what they want students to learn and deciding how to advance and assess that learning. For students, that inquiry involves the self-conscious questioning and awareness of their approaches to learning. Thus effective teaching and successful learning depend on an understanding of the research on human learning.

The Virginia Tech Engineering Communication Center brings faculty, students, and professionals together to explore, design, practice, and teach communication and collaboration in support of engineering work. The lab provides a creative think space for engineering students and faculty to break through disciplinary molds and collaborate across boundaries.

The Institute for Creativity, Arts, and Technology (ICAT) is a university-level research institute positioned at the nexus of the arts, design, engineering and science. ICAT works to foster the creative process to create new possibilities for exploration and expression through learning, discovery, and engagement. Educational and research resources available to this proposed project through ICAT include: IDEA- studio for exploring transdisciplinary learning environments, IMAGE – visual studio and galleries revealing science and engineering through the arts, IMPACT – multimedia facility for defining the continuum between body, computation, and imagination, IMPLEMENT - a fully equipped lab for exploring new materials, objects, and methods for creativity, and INTERACT - an outreach center for stimulating local innovation and cultural awareness in Southwest Virginia.

The toolsLAB is the technology, open organizing and learning sciences lab. Research at toolsLAB is funded in part by the National Science Foundation (IIS, EEC), corporate partners, and ICTAS and Engineering Education at Virginia Tech. The lab accommodates the exploration of how digital tools afford new ways of reorganizing knowledge sharing and knowledge building and their impact on learning.

The LabVIEW Enabled Watershed Assessment System (LEWAS) integrates hardware and software components to develop learning modules and opportunities for water sustainability education and research. LEWAS brings real-time water data using wireless technology from the Webb branch of Stroubles creek, an on-campus stream, into our first year engineering class for water sustainability education. Integration of LEWAS into upper level engineering courses is in progress.



Structure: Garabit Viaduct (Ruynes-en-Margeride , France) | Designer: Gustave Eiffel

### The Design, Research, and Education for Additive Manufacturing Systems (DREAMS)

Laboratory employs layered fabrication techniques of today's "rapid prototyping" technologies. The lab allows students to explore the role in which additive manufacturing systems play in the processes of design and engineering education. In the case of this proposal, scale models of civil engineering works can be printed and evaluated to study, for example, stiffness of different arch and truss structural forms.

*Innovation Space* provides free consultations and one-on-one help on a wide range of software and equipment. From recording and editing video and audio to preparing graphics for print or digital output and building websites, this lab will be a useful resource for developing multimedia course content described in this proposal.

Invitations to the workshop were extended to a pool of educators and university representatives which included historically black colleges/ universities and women's colleges. Faculty representing diverse academic institutions attended the workshop:

#### 2015 Workshop Participants:

- Katherine A. Acton (University of St. Thomas)
- Gouranga Banik (Tennessee State University)
- Sherman Brown (Hampton University)
- David Corr (Northwestern University)
- Lindy Cranwell (Virginia Tech)
- Himangshu Das (Jackson State University)
- James Hanson (Rose Hulman Institute of Technology)
- James Hunter (Morgan State University)
- Roberto Leon (Virginia Tech)
- Beth McGinnis-Cavanaugh (Springfield Technology Community College)
- Emmanuel U. Nzewi (Prairie View A&M University)
- Moochul Shin (Western New England University)
- Mark Valenzuela (University of Evansville)
- Ignacio Paya-Zaforteza (Polytechnical University of Valencia;  
Visiting Faculty at Princeton University)
- Negar Elhami Khorasani (Post-doctoral Research Associate, Princeton University)
- Tracy Huynh (Graduate Student, Princeton University)
- Ignacio Centrangolo (Graduate Student, University of Massachusetts Amherst)
- Dolores Gomez Pulido (University of La Rioja)

#### 2016 Workshop Participants:

- Robert Dermody (Roger Williams University)
- Andrew Myers (Northeastern University)
- Jerome Hajjar (Northeastern University)
- Fernando Moreu (The University of New Mexico)
- Mazdak Tootkaboni (University of Massachusetts, Dartmouth)
- Tori Rhoulac (Howard University)
- Michael Seek (Old Dominion University)
- Mohammadreza Moradi (Old Dominion University)
- Mike Englehardt (University of Texas at Austin)
- Kyoung Moon (Yale Architecture)
- Andrea Surovek (South Dakota School of Mines & Tech.)
- Abbie Liel (University of Colorado, Boulder)
- Ashley Thrall (University of Notre Dame)
- Ross Corotis (University of Colorado, Boulder)



Structure: B.P. Station (Deitingen, Switzerland) | Designer: Heinz Isler

We intend to invite interested colleagues that we meet at FYEE and ASEE conferences to future workshops. If space is available, we will advertise these workshops to engineering deans, chairs, and colleagues, and will continue to make every effort to recruit faculty from historically black colleges/universities and women's colleges.

This project also mentors teachers and future teachers (the graduate students supported by this project). Recent surveys indicate that the students in the course we plan to disseminate are approximately 50% female and 20% from under-represented groups other than women.



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