



# Civil Engineering Education Summit

Mapping the Future of  
Civil Engineering Education

May 28-30, 2019 | Dallas, Texas



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Civil Engineering Education

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[www.asce.org/education-Summit](http://www.asce.org/education-Summit)

Southern Methodist University in Dallas, Texas  
[www.smu.edu](http://www.smu.edu)

Summit Program Committee Co-Chairs:  
Kevin Hall, University of Arkansas  
Daniel Linzell, University of Nebraska

Summit Organization Committee Chair:  
Barbara Minsker, Southern Methodist University

ASCE Committee on Education Chair:  
Camilla M. Saviz, University of the Pacific

ASCE Department Heads Coordinating Council Chair:  
Jerome F. Hajjar, Northeastern University

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# Executive Summary

It has long been recognized that engineering education should mirror the profession itself – as a dynamic, ever-evolving field. Indeed, in its 1955 Report on Evaluation of Engineering Education, a panel sponsored by the American Society for Engineering Education (ASEE) stated:

***“Engineering is far from static, for it is essentially a creative profession.”***

This sentiment is echoed in the Summary Report of the 1995 Civil Engineering Education Conference (ASCE):

***“...civil engineering education should be continually evolving to higher levels of quality and at all times incorporating new technologies and practices into the civil engineering education process.”***

In keeping with these statements, the engineering profession has witnessed an acceleration of the breadth, depth, and magnitude of change – not only to the complexity of challenges engineers must address but also to the tools available to address those challenges and to the people who will address them. This accelerating pace of change necessitates revisiting our basic understanding of civil engineering education currently, and through the middle of the 21st century.

Over 200 civil engineering educators, practitioners, and guests convened at the Civil Engineering Education Summit in Dallas, Texas, in May 2019 to consider the future—our future populations, engineering challenges presented by those populations, and opportunities and challenges related to preparing civil engineers to address and meet those challenges. Participants at the 2019 Civil Engineering Education Summit considered visions of the future, examined current efforts by the profession and across universities to advance education in the context of those visions, and identified opportunities to

transform the civil engineering educational experience to prepare students for the future. The theme for the Summit was “Empowered to Innovate,” emphasizing the goal to provide civil engineering educators with ideas, examples, and encouragement to undertake the curricular innovation and other changes needed to meet the needs of our rapidly evolving profession, and highlighting the importance of promoting a culture of innovation within the civil engineering field.

During the first part of the Summit, participants heard from a series of experts, including ASCE President-Elect K. N. Gunalan, about the current state of the civil engineering profession (“Connecting the Future”). The second part, “Conceiving the Future,” featured vision presentations from innovators who are pushing the frontiers of the profession, including Chris Luebke of Arup Foresight and Jerry Buckwalter of Northrop Grumman. These speakers set the stage for the participants to generate “opportunity statements” and “Big Ideas” for the profession to pursue change. Finally, participants discussed these draft Summit outputs and rank ordered the opportunity statements during the third session (“Constructing the Future”).

## Summit Findings

### Opportunity Statements

Defining civil engineering as a people-focused profession, participants linked people/stakeholder groups with actions addressing future needs. This exercise fostered the creation of “Opportunity Statements,” in the form of “(People/Group) need to (need) so that (result).”

One example is: “Students need to learn systems thinking so that they are prepared for current and future societal challenges.”

Summit participants generated a total of 186 Opportunity Statements. These statements were then grouped

by the identified people, the need(s), and the opportunity/ result. The groupings allowed for the identification of common themes. The Summit Program Committee used these themes to identify a list of the “top 20” statements to move forward for possible action. As a final step in this development process, Summit participants “ranked” the “top 20” Opportunity Statements by priority and brainstormed “Big Ideas” for implementing each statement. Although the participants prioritized opportunities for action, the full collection of Opportunity Statements developed at the Summit represents a rich database of ideas worthy of consideration by the profession and individual educational programs.

### The Future of Civil Engineering Education

The Summit proposed a vision of civil engineering, defined at its most basic level:

***Civil Engineering is a global, holistic profession that serves the needs of all people.***

In the future-oriented focus of the Summit, it was agreed that the needs of people, and the contexts related to meeting those needs, are becoming increasingly complex in our ever-evolving world. Thus, our educational systems, which prepare future engineers, must also evolve to address this complexity.

Three primary goals emerged from synthesizing the opportunity statements. The field of civil engineering needs to:

1. Be a **Profession** that serves people;
2. Have a **Culture** that includes people; and
3. Provide an **Education** that prepares people.

Four major objectives emerged from the discussions and workshop activities as initial pathways toward achieving these goals:

#### **OBJECTIVE 1:**

##### **Reexamine, and potentially redefine, the domain of Civil Engineering.**

A clear consensus among Summit participants is that the world is becoming increasingly complex – thus, the challenges faced by engineers are becoming increasingly complex. One aspect of this complexity relates to the interconnected nature of infrastructure, environmental, political, and social systems. Such interconnectedness is a major driver of the dissolution of traditional “boundaries”

that define a particular engineering discipline. Summit participants dared to ask the question, “In the context of the mid-21st century, what is a civil engineer?” Two elements related to this most fundamental question reflect the impact of technological advancement and the evolving role of the civil engineer in society.

ASCE’s *The Vision for Civil Engineering in 2025* (published in 2006) anticipates the evolutionary, holistic nature of the role of civil engineers:

***“In 2025, civil engineers will serve as master builders, environmental stewards, innovators and integrators, managers of risk and uncertainty, and leaders in shaping public policy.”***

An undergraduate civil engineering program is not sufficient to fully prepare a graduate to be a master builder, steward, innovator, manager, and leader. This is recognized in the *Civil Engineering Body of Knowledge, 3rd Edition (CEBOK3)*, which calls for a combination of formal education, structured mentoring, and self-directed learning to position the civil engineer for career success. However, an undergraduate civil engineering curriculum provides the foundation on which to build the knowledge, skills, and attitudes of the future civil engineer.

It is clear that the already rapid pace of technological change and advancement will continue unabated – and very possibly accelerate. In his plenary remarks, Arup Foresight engineer/futurist Chris Luebke observed the megatrend “if it can be automated, it will be automated ...” New tools and new computational and analysis techniques are being introduced into the profession at a rate beyond that to which most engineering education programs can react and adapt. Although this issue is not necessarily new, Summit participants struggled with the disparity between the current and anticipated pace of innovation in the profession versus that in education.

Therefore, a major topic that emerged from the Summit is the need to expand the domain of civil engineering to address technological advancement. Two other topics related to this theme also received significant attention by Summit participants, resulting in the following major recommendations:

1. Learning new competencies related to emerging **technologies** that are rapidly changing civil engineering (e.g., data science, robotics, sensors, drones, and virtual reality), as well as the knowledge and skills needed to use those technologies.

2. Integrating more **systems thinking** into civil engineering education to support global stewardship, emphasize the importance of increased stakeholder engagement, and evaluate the potential for unintended consequences. Systems thinking skills can be enhanced through experiences such as real-world problem solving, project-based education, and high-impact experiences like internships, service learning, study abroad, student organizations, and competitions.
3. Promoting a **culture of innovation** within the profession through more directed teaching of creative processes, entrepreneurship, and evaluation of risk as an integral part of curricula and mentored practice.

These Summit discussions give rise to a major implication for 21st-century civil engineering education: curricular flexibility. Indeed, “flexibility” emerged as another primary theme among Opportunity Statements related to civil engineering curricula, with five (5) of the “top 20” Opportunity Statements addressing the issue. Summit participants called for civil engineering departments to define for themselves a program of study to meet the needs of their stakeholders within very broad overarching guidelines. Such flexibility enables a more rapid response to technological changes in the profession; an integration of instruction addressing future roles of civil engineers; and an elevation of professional skills as a requirement of civil engineering education. These benefits must be balanced by a recognition of the benefit of having some degree of uniformity in education across the profession.

## **OBJECTIVE 2:**

### **Elevate professional skills to a truly equal footing with technical skills.**

Certainly, the need for strong professional skills has long been recognized by both civil engineering educators and practitioners.

The ASEE “Grinter Report” (1955) included two outcomes related to this concept:

1. “An insistence upon the development of a high level of performance in the oral, written, and graphical communication of ideas”

2. “A continuing, concentrated effort to strengthen and integrate work from the humanistic and social sciences into engineering programs”

The Summary Report of the 1995 Civil Engineering Education Conference contained numerous recommendations related to professional skills; for example:

1. “Emphasize the need for sensitivity to culturally diverse groups”
2. “Encourage students to convey the importance of engineering works to non-engineering students on campus”
3. “Recognize communication skills, leadership skills, management, and teamwork by creating awards for students”
4. “Provide learning from non-verbal communication and listening skills”
5. “Provide industry speakers to emphasize the importance of communication skills, leadership, management, and teamwork”

The CEBOOK3, published in 2019, also recognizes this need. It includes six outcomes related to professional skills: communication, teamwork and leadership, lifelong learning, professional attitudes, professional responsibilities, and ethical responsibilities.

Multiple generations of educators and practitioners (1955, 1995, 2019) have thus recognized the necessity for professional skills in the successful civil engineer. It is curious, however, that these multiple generations were all moved to emphasize the need for increasing the level of professional skills in graduates – suggesting that the profession continues to lag in the development of these skills in our students.

Summit participants placed significant emphasis on this topic; of the 20 prioritized Opportunity Statements, seven (7) address professional skills and abilities. Moving forward, topics related to professional skills should be elevated in importance within curricula – to be thought of not as “desirable,” but “required,” on an equal basis with the various technical/design skills currently emphasized in undergraduate programs.

### OBJECTIVE 3:

#### **Develop a diverse, inclusive, equitable, and engaging culture within the civil engineering profession.**

Summit participants engaged in significant discussion regarding “professional culture” and related topics in the context of civil engineering. Although it may be tempting to place these topics and discussions within the realm of professional skills and attitudes, this subject rose to represent a major theme of the event. At least four (4) of the “top 20” prioritized Opportunity Statements address the concept of civil engineering culture. Participants explored the distinct yet interconnected nature of diversity, inclusion, and equity; the need to engage students at all levels; and the concept of permeating the student educational experience with these concepts. Summit participants suggested that the following elements need to be addressed by the entire profession, within both the education and practitioner communities:

- Dedicated and intentional instruction and training related to diversity, inclusion, and equity;
- Increasing representation within the profession – including student bodies, faculty ranks, and practitioners (at all levels);
- Modeling inclusivity and equity in the classroom and in the workplace; and
- Engaging students at all levels (K-12, college/ university), to demonstrate the value of a civil engineering degree.

### OBJECTIVE 4:

#### **Implement a regular schedule of national/ international civil engineering education events, and dedicate resources to address findings.**

Planners of the 2019 Civil Engineering Education Summit consulted a significant body of literature to explore topics and themes arising from previous assessments of engineering education. As noted earlier in this summary, there have been remarkable similarities in topical areas and themes arising from these efforts. Issues identified in the 1955 ASEE report continued to be identified 40 years later at the 1995 ASCE Conference.

Summit participants agreed that the 2019 Civil Engineering Education Summit was highly worthwhile, and expressed both hope and confidence that real and significant change could result from the work accomplished during the Summit. Change will require:

- Ongoing commitment of the civil engineering community – educators and practitioners – to collaborate on developing, implementing, and monitoring actions arising from the Summit recommendations.
- A regular schedule of events to advance civil engineering education.
- Support of academia and the profession, including ASCE, to dedicate resources to the priorities identified at the Summit.

Summit participants recognized that change in civil engineering education will require dedication to a shared vision and a collective willingness to work for it. As presented in summary remarks at the conclusion of the Summit, advancement of civil engineering education will require three elements to TAP the innovation opportunities identified by participants:

- **Tenacity** to ensure that needed change occurs;
- **Audacity** to propose bold actions and tactics to fully realize necessary change; and
- **Practicality** to understand that necessary change can and must occur over different time scales.

Collectively, the vision proposed by the Summit participants is bold and far-reaching. The Opportunity Statements identify both near-term and long-term action areas that will position the civil engineering profession for continued advancement and leadership through the mid-21st century. As such, the findings of the Summit provide vital input to future initiatives such as revisions to the *Civil Engineering Body of Knowledge, 3rd Edition (CEBOK3)*, future formulations of the ABET Civil Engineering Program Criteria (CEPC), ASCE’s Future World Vision, and civil engineering curricula.

# Introduction

In May 2019, participants at the American Society of Civil Engineers (ASCE) Engineering Education Summit considered the future – our future populations, engineering challenges presented by those populations, and opportunities and challenges related to preparing civil engineers to address and meet those challenges. It has long been recognized that engineering education should mirror the profession itself – as a dynamic, ever-evolving field. Indeed, in its 1955 Report on Evaluation of Engineering Education, a panel sponsored by the American Society for Engineering Education (ASEE) stated:

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This sentiment is echoed in the Summary Report of the 1995 Civil Engineering Education Conference (ASCE):

***“...civil engineering education should be continually evolving to higher levels of quality and at all times incorporating new technologies and practices into the civil engineering education process.”***

In keeping with these statements, the engineering profession has witnessed an acceleration of the breadth, depth, and magnitude of change – not only to the complexity of challenges engineers must address but also to the tools available to address those challenges and to the people who will address them. This accelerating pace of change necessitates revisiting our basic understanding of civil engineering education currently, and through the middle of the 21st century.

To this end, over 200 civil engineering educators, practitioners, and guests convened at Southern Methodist University (SMU) in Dallas, Texas, in May 2019 to consider visions of the future, examine current efforts by the profession and across universities to advance education

in the context of those visions, and identify opportunities to transform the civil engineering educational experience to prepare students for the future. The theme for the Summit was “Empowered to Innovate,” emphasizing the goal to provide civil engineering educators with ideas, examples, and encouragement to undertake the curricular innovation and other changes needed to meet the needs of our rapidly evolving profession, and highlighting the importance of promoting a culture of innovation within the civil engineering field. This event was the first ASCE gathering focused on the future of CE education since the 1995 Civil Engineering Education Conference (CEEC '95) [ASCE (1995)].

During the first session of the Summit, participants heard from a series of experts about the current state of the civil engineering profession (“Connecting the Future”). The second session, “Conceiving the Future,” featured vision presentations from innovators who are pushing the frontiers of the profession. These speakers set the stage for the highly participatory “Moving Vision to Action” engagement, led by a team from SMU’s Lyle School of Engineering Design and Innovation Program, in which participants developed 156 “opportunity statements” and “Big Ideas” for the profession to pursue change. The Summit Program Committee then synthesized these ideas into “top 20” opportunity statements and four objectives for the future of CE education. Finally, participants discussed these draft Summit outputs and rank ordered the opportunity statements during the third session (“Constructing the Future”).

More details on the process and outcomes of these three sessions are given below, followed by conclusions, acknowledgments, and a sponsor list. Finally, Appendix A lists all 156 opportunity statements generated during the Summit and Appendix B provides a bibliography of references that the program committee and participants consulted as background for their work.



# Speakers



## Caroline Bennett | University of Kansas

Dr. Caroline Bennett is a Professor in Civil, Environmental, and Architectural Engineering at the University of Kansas (KU). She is the Lead for the School of Engineering's Engaged Learning Initiative, and previously served as a Faculty Fellow with the KU Center for Teaching Excellence. Caroline works in multiple leadership roles at KU focused on bringing about change in higher educational practices, including co-leading the NSF-funded TRESTLE network. Caroline joined KU faculty in 2006 after earning her doctorate from the University of Cincinnati. She is a licensed Professional Engineer in Kansas.



## Jerry Buckwalter | ASCE

Gerald (Jerry) Buckwalter is the chief operating and strategy officer responsible for helping to shape the strategic direction and operational effectiveness of ASCE. Additionally, he oversees the Future World Vision initiative and several areas of internal operations. With over 35 years of experience as a process-minded leader, he came to ASCE from Northrop Grumman, where he most recently served as Director of Corporate Strategy. Jerry earned a bachelor's degree in physics from Monmouth University and completed advanced coursework in technology systems at The George Washington University and in international business management at the Massachusetts Institute of Technology.



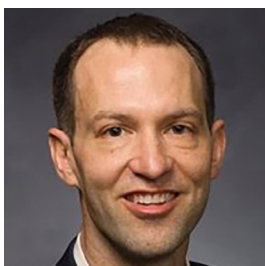
## Sarah Christian | Carnegie Mellon University

Sarah Christian is an Assistant Teaching Professor in the Department of Civil and Environmental Engineering at Carnegie Mellon University. She earned her B.S. in Civil Engineering at Carnegie Mellon University, MCE at Johns Hopkins University, and Ph.D. in Civil and Environmental Engineering with a focus on Structural Engineering and Materials at Stanford University in 2009. Sarah has practiced as a structural engineer and building envelope engineer in Washington, D.C., and Pittsburgh. She teaches courses on Engineering Design, Materials, Structural Engineering, and Soil Mechanics. Sarah's interests include interactive and student-centered learning, design education, and curricula of the future.



## David A. Dzombak | Carnegie Mellon University

David Dzombak is the Hamerschlag University Professor and Head of the Department of Civil and Environmental Engineering at Carnegie Mellon University. The emphasis of his research and teaching is on water quality engineering, water resource sustainability, and energy-environment issues. He has served on ASCE's Department Heads Coordinating Council since 2018. He received his Ph.D. in Civil Engineering from the Massachusetts Institute of Technology and holds a B.S. and M.S. in Civil Engineering from Carnegie Mellon. He is a registered Professional Engineer in Pennsylvania, a Board-Certified Environmental Engineer, a Diplomate Water Resources Engineer, and a member of the National Academy of Engineering.



## Clifton Farnsworth | Brigham Young University

Clifton B. Farnsworth is an Associate Professor in the Construction and Facilities Management Program at Brigham Young University. He graduated with B.S. and M.S. degrees in Civil Engineering from Brigham Young University and a Ph.D. in Civil Engineering from the University of Utah. He is a licensed Professional Engineer in Utah. Prior to his academic appointment, he worked as a civil engineer for the Utah Department of Transportation in geotechnical and construction-related roles. His research interests include heavy civil and infrastructure construction, disaster reconstruction, and construction and engineering education.



## Tiago Forin | Rowan University

Tiago Forin is an instructor at Rowan University, responsible for teaching Engineering Clinic courses. As the Project Coordinator for RevED (Revolutionizing Engineering Diversity), Tiago is the point of contact for Rowan University within the cohort of participating institutions. RevED focuses on increasing representation in engineering across visible and non-visible elements of diversity. This five-year longitudinal project uses qualitative research methods to collect data regarding diversity in Rowan's Civil and Environmental Engineering Department. That data is analyzed and reported on in order to engage university administrators and faculty to influence change in admissions criteria and curricular design.



## Ken Fridley | University of Alabama

Dr. Ken Fridley joined The University of Alabama in 2003 as professor and head of the department of civil, construction, and environmental engineering and became the senior associate dean in the College of Engineering in 2015. He has also served as the founding director of the University's Center for Sustainable Infrastructure. Fridley earned his bachelor's degree in civil engineering from Washington State University, master's in architectural engineering from the University of Texas, and doctorate in civil engineering from Auburn University. Prior to joining The University of Alabama, Fridley served on the faculty at several other national flagship universities. He has extensive experience in the area of structural wood engineering, including load-duration behavior (creep-rupture) of wood and wood-based materials, structural connections, and response and protection of wood-frame buildings to natural hazards, including wind and seismic actions.



## K. N. Gunalan | ASCE 2019 President-Elect

K. N. Gunalan (Guna) is the senior vice president, transportation, alternative delivery, Americas at AECOM, based in Salt Lake City, UT. Guna has managed large complex infrastructure projects, providing technical advice on civil, structural, geotechnical, pavement, and materials issues on a variety of projects around the world. His collaborative approach has contributed to many successful programs and projects ranging from a few thousand dollars to more than 3 billion dollars. Guna has been active in ASCE for many years, including leadership roles as Region 8 director (2009-2012), Region 8 governor (2005-2007), Utah Section president (2002-2003), and Texas Section High Plains Branch president (1992). Most recently, he served as a governor for the Geo-Institute and was a member of the steering committee for the 2017 ASCE India Conference.



## Kevin Hall | University of Arkansas

Dr. Kevin D. Hall is the Hicks Endowed Professor of Infrastructure Engineering at the University of Arkansas, where he has served on the faculty for 27 years, including 11 years as the Head of the Department of Civil Engineering. Hall is very active in the Civil Engineering education community, having served on the ASCE Committee on Education, as the Chair of the Civil Engineering Division of the American Society for Engineering Education (ASEE), and as the Chair of the ASCE Department Heads Coordinating Council (DHCC). His research and teaching interests include pavement materials, design, construction, and rehabilitation, as well as professional practice issues. He is a member of ASCE and is a licensed Professional Engineer in Arkansas.



## Marc Hoit | North Carolina State University

In 2008 Marc Hoit became NC State's first vice-chancellor for information technology and Chief Information Officer. Dr. Hoit is a professor of Civil Engineering. Prior to NC State he was at the University of Florida. Hoit was the co-principal investigator for the U.S. Department of Homeland Security grant to develop an early warning system for health-security. He was also the Principal Investigator for DIGGS, an international-XML standard for transferring transportation information. He is a Fellow of the American Society of Civil Engineers and the Structural Engineering Institute. He earned his B.S. from Purdue and his M.S. and Ph.D. from the University of California at Berkeley.



## Keith B. Jackson | HNTB

Keith B. Jackson, P.E., has more than 38 years of civil engineering and project management experience as a top consultant to state departments of transportation in Texas, Oklahoma, and Arkansas. Keith is a Senior Vice President with HNTB and is responsible for growth of the firm's business across Texas. Prior to joining HNTB, Keith served as a vice president of transportation and infrastructure for another consulting firm, building and managing a staff of 30 people that led to an increase of \$32 million in sales over a five-year period. Jackson has a wide range of engineering experience with municipal and educational projects including due diligence, major utilities construction, site permitting and entitlements.



## Daniel Linzell | University of Nebraska-Lincoln

Daniel Linzell was appointed Associate Dean for Graduate and International Programs at the University Nebraska Lincoln (UNL) College of Engineering (COE) in October 2018. Previously, he served as Chair of the Department of Civil Engineering (CIVE) from August 2013 to September 2018 and concurrently held the Donald R. Voelte, Jr. and Nancy A. Keegan Professorship in Engineering in November of 2013. Prior to joining UNL, he was an Assistant, Associate and the inaugural John A. and Harriette K. Shaw Professor of Civil Engineering at the Pennsylvania State University (PSU). Daniel received his M.S. and Ph.D. from the Georgia Institute of Technology. He received his Bachelor of Science in Civil Engineering from the Ohio State University in 1990. Daniel is a Fellow of the American Society of Civil Engineers (ASCE).



## Chris Luebke | ARUP Foresight

Arup Fellow and Director of Global Foresight + Research + Innovation, Dr. Chris Luebke works with some of the world's leading companies to develop a better understanding of the opportunities created by change in our built environment. Since joining Arup in 1999, Chris has initiated research projects on the designer's desktop of the future. He is an active participant and speaker in Summits ranging from those of the Design Futures Council to the World Economic Forum. Chris's engaging, interactive talks foster the thoughts on which forces drive change and how we can co-build our future city.



## Jerome P. Lynch | University of Michigan

Prof. Jerome Lynch, Ph.D., is the Donald Maloure Department Chair of Civil and Environmental Engineering at the University of Michigan. He is also Professor of Civil and Environmental Engineering and Professor of Electrical Engineering and Computer Science. Lynch received his M.S. degrees in Civil and Environmental Engineering and in Electrical Engineering and his Ph.D. in Civil and Environmental Engineering from Stanford University. He received his B.E. in Civil and Environmental Engineering from the Cooper Union in New York City. Lynch has been awarded the 2005 Office of Naval Research Young Investigator Award, the 2012 ASCE EMI Leonardo da Vinci Award, and the 2014 ASCE Walter L. Huber Civil Engineering Research Prize.



## Barbara E. Minsker | Southern Methodist University

Barbara E. Minsker, Ph.D., P.E., is the Bobby B. Lyle Endowed Professor of Leadership and Global Entrepreneurship at Southern Methodist University. She serves as Chair of the Department of Civil and Environmental Engineering and Senior Fellow in the Hunt Institute for Engineering and Humanity. Dr. Minsker's research area is environmental informatics and systems analysis. Prior to joining SMU in 2016, Minsker was Professor in the Department of Civil and Environmental Engineering at the University of Illinois Urbana-Champaign. She earned a B.S. in Operations Research and Industrial Engineering with Distinction and a Ph.D. in Civil and Environmental Engineering from Cornell University.



## Audra Morse | Michigan Technological University

Dr. Audra Morse, P.E., BCEE, F.ASCE, ENV SP, is Professor and Chair of the Civil and Environmental Engineering Department at Michigan Technological University. Her research focuses on wastewater reuse and engineering education. Prior to Michigan Tech, Dr. Morse was a professor in the Department of Civil, Environmental, and Construction Engineering at Texas Tech University, where she served as Associate Dean. She received the two highest teaching honors and the President's Excellence in Gender Equity Award. She is an ABET EAC Commissioner, Chair of the ASCE Committee on Accreditation Committee, and a *Civil Engineering Body of Knowledge, 3rd Edition*, committee member.



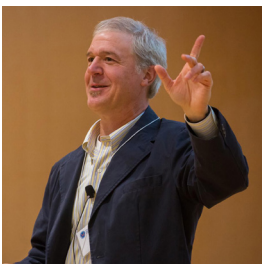
## Rebekah Oulton | California Polytechnic University, San Luis Obispo

Rebekah Oulton, Ph.D., PE, LEED AP, ENV SP is an Associate Professor at California Polytechnic University, San Luis Obispo, in the Civil and Environmental Engineering Department. Prior to Cal Poly, she worked as a professional engineer and project manager for a civil engineering consulting firm. Her technical research addresses advanced treatment methods to target emerging contaminants during water and wastewater treatment, and optimization of green infrastructure for stormwater management and pollutant control. She teaches water resources engineering, water treatment and reuse, and sustainable practices in civil and environmental design.



## Yvette E. Pearson | Rice University

Dr. Yvette E. Pearson is Associate Dean for Accreditation, Assessment, and Strategic Initiatives in the George R. Brown School of Engineering at Rice University and Founder of The Pearson Evaluation and Education Research Group. An ASCE Fellow, she has been recognized for more than two decades of contributions to engineering education and research. Among her numerous awards and honors are ABET's Claire L. Felbinger Award for Diversity and Inclusion and ASCE's Professional Practice Ethics and Leadership Award for her achievements toward diversity, equity, and inclusion in engineering. Dr. Pearson is the Inaugural Chair of Members of Society Advancing an Inclusive Culture (MOSAIC), ASCE's Board-level advisory council on diversity, equity, and inclusion. She is a registered Professional Engineer, has served seven years as a Program Evaluator for the ABET Engineering Accreditation Commission (EAC), and will join the EAC as a Commissioner in July 2020.



## Mike Penn | University of Wisconsin-Platteville

Mike Penn is a professor of environmental and civil engineering at the University of Wisconsin-Platteville. He earned degrees from the University of Michigan (B.S., M.S.) and Michigan Technological University (Ph.D.). He teaches undergraduate courses including: Introduction to Engineering Projects, Introduction to Infrastructure, Environmental Engineering, Water Supply and Treatment, Wastewater Engineering, Air and Waste Management, Land Development, and Wetlands. His research interests include pedagogy, surface water quality, and waste management. He is involved with providing water management assistance to rural regions in developing nations through the Global Water Stewardship. He is the lead author of *Introduction to Infrastructure: An Introduction to Civil and Environmental Engineering*, published by Wiley. He is a licensed engineer in Wisconsin.



## Angel "Ari" Perez | Quinnipiac University

Ari Perez-Mejia earned his undergraduate degree in civil engineering at the Universidad Tecnológica Centroamericana (UNITEC) in Honduras and did his graduate work at the University of South Carolina. He received his Ph.D. in 2014 and joined the engineering faculty at Quinnipiac University that same year. His interests are in the conservation of archaeological sites, engineering education with a focus on civil and geotechnical engineering, and the musical stylings of Taylor Swift.



## Mary Roth | Lafayette College

Mary Roth is a Professor of Civil Engineering at Lafayette College. She received her degrees from Lafayette College (B.S.), Cornell University (M.S.), and the University of Maine (Ph.D.). Her teaching interests include foundation engineering, introduction to engineering, and courses designed to engage students from the arts and humanities with engineering topics. Her research interests include risk assessment for geotechnical structures, site investigation in karst, and the use of bacteria to modify the properties of soils. She has over 70 publications and has served as principal or co-principal on nine NSF grants. She is a licensed engineer in Maine and Pennsylvania.



## John Schemmel | Texas State University

Dr. John Schemmel is the Bruce and Gloria Ingram Endowed Chair in Engineering and Civil Engineering program Coordinator at Texas State University. Previously, John served as Director of the Concrete Industry Management Program at Texas State, founder of eTEC LLC, and Professor at Valparaiso University, South Dakota State University, and the University of Arkansas. Dr. Schemmel holds degrees from the University of Wisconsin (BSCE), Lehigh University (M.S.), and North Carolina State University (Ph.D.). He is a Fellow of ACI, recipient of ACI's Certification Award, and is Secretary for and an Honorary Member of ASTM Committee C09.



## Lucio Soibelman | University of Southern California

Professor Soibelman obtained his bachelor and master's degrees from UFRGS, Brazil. He worked as a construction manager for 10 years before obtaining his Ph.D. in 1998 at MIT. He was a faculty in UIUC and CMU before he joined USC as the Chair of the CEE department in 2012. During the last 25 years he focused his research on advanced data acquisition, management, visualization, and mining for construction and operations of advanced infrastructure systems. He has published over 150 books, book chapters, journal papers, Summit articles, and reports and performed research with funding from NSF, NASA, DOE, US Army, NIST, IBM, Bosch, IDOT, and RedZone Robotics among many others funding agencies.



## Brett Story | Southern Methodist University

Brett Story joined the SMU faculty in 2013 as a professor of Civil and Environmental Engineering in the Lyle School of Engineering. Professor Story is involved in numerous programs and initiatives, including the Smart Infrastructure Innovation Initiative with Garland Independent School District. Dr. Story encourages student involvement and leadership in his work.



## Alison Wood | Olin College of Engineering

Dr. Alison Wood is an assistant professor of Environmental Engineering at Olin College of Engineering. She is a distinguished researcher in the fields of both water and sanitation, as well as a researcher and practitioner in using interdisciplinary thinking and approaches to solving environmental and sustainability problems. Dr. Wood is also pursuing her interests in the areas of equity and justice through education and engagement with context and values. She earned a B.S. in Civil Engineering from Rutgers University. Dr. Wood then went on to earn a Master of Science in Engineering in Environmental and Water Resources Engineering and a Ph.D. in Civil Engineering from The University of Texas at Austin.

# Connecting the Future

## PLENARY 1

**Chris Luebke**

Arup Foresight

## ENGAGEMENT 1

**The Decades in Review**

Dan Linzell University of Nebraska-Lincoln

Mary Roth, Lafayette College

## PANEL DISCUSSION

**The State of the Profession**

**ASCE Perspective:** K. N. Gunalan, President-Elect, ASCE

**Industry Perspective:** Keith Jackson, HNTB

**Diversity, Inclusion, and Equity:** Yvette E. Pearson, Rice University

## ENGAGEMENT 2

**CE Curriculum Development**

David Dzombak, Carnegie Mellon University

**BOK / ABET CEPC ABET Calendar**

Ken Fridley, University of Alabama

**Quick Look: The BOK3**

Audra Morse, Michigan Technological School

The “Connecting the Future” session outlined the Summit objectives and provided perspectives on the history of CE education, current state of the CE profession, and emerging future trends. A brief summary of the speakers’ recommendations is given below, but the reader is strongly encouraged to read the full summaries in the following sub-sections.

Summit Program Committee Co-Chair Kevin Hall, Summit Organization Committee Chair Barbara Minsker, and SMU Provost Steven Currall opened the session with brief welcome statements. Chris Luebke, Foresight, Research, and Innovation Leader at Arup Foresight, then gave a keynote about several emerging trends, including: the rapid pace of world change and the difficulties of predicting unintended consequences; the need for global stewardship; increasing automation; expanded stakeholder participation through social computing; new design criteria and the lack of uniform design solutions; decaying infrastructure condition; and the importance of critical thinking and reflection, communication and leadership skills, and systems analysis to address these challenges.

Next, Dr. Hall delivered the Summit charge:

***Generating ideas, examples, and enthusiasm to spur the innovation needed in the CE profession for our rapidly evolving world.***

Dan Linzell and Mary Roth, Co-Chair and Member of the Summit Program Committee, respectively, then gave historical perspectives on CE education. Drs. Linzell and Roth reviewed the history of CE curricula, changes made to reflect technology improvements, and previous reports and activities relevant to CE education.

After a networking break, a panel discussion on the state of the CE profession featured ASCE President-Elect K. N. Gunalan, Keith Jackson (then Vice Chair of the American Council on Engineering Companies), and Yvette E. Pearson (Chair of ASCE’s Members of Society Advancing Inclusion Council). The panel’s key observations included the:

- Need for emerging technologies and innovative approaches to address society's complex challenges, including sustainable infrastructure in a global environment;
- Importance of conveying the relevance of civil engineering to these challenges;
- Necessity of diverse perspectives, fostered by inclusive organizational and educational cultures; and
- Increasing significance of oral communication skills.

Finally, David Dzombak, member of the Summit Program Committee, led the last "Connecting the Future" session that was focused on CE curriculum development. Dr. Dzombak made an opening statement asserting that innovation is possible within the current accreditation framework and that curricular flexibility

is essential to advancing the field. Ken Fridley (Chair of ASCE's Civil Engineering Body of Knowledge 3 [BOK3] Task Committee) provided an overview of the recently released BOK3. He said that universities and industry must partner on educational changes and educators must initiate that process. He also stressed that the BOK and accreditation criteria are not solely focused on licensure, as not all CEs pursue licensing as a professional engineer (PE).

Next, Audra Morse (Chair of the ASCE Committee on Accreditation Operations and an ABET Engineering Accreditation Commissioner) provided a more detailed overview of the BOK3. She emphasized that BOK3 added achievements in the affective (emotional) domain and broadened specialty education beyond formal undergraduate programs to graduate programs, mentoring experiences, and self-development beyond formal education.

# PLENARY 1

## Chris Luebke

Arup Foresight

**D**r. Chris Luebke, Foresight, Research and Innovation Leader for Arup, kicked off the event with a thoughtful discussion on what is driving change around the world and how those drivers relate to the topics raised at the Civil Engineering Education Summit. He questioned whether society is learning as fast as the world is changing and, if not, postulated that byproducts caused by a gap between change and knowledge should be deeply thought about and tracked in some way.

Luebke presented items of interest to attendees that he's learned as a thought- and innovation-leader in the engineering and architecture profession:

1. Change is constant; understanding its context is critical.
2. The future is always oversold and under-imagined. We must understand people and what they need from a temporal perspective.
3. Everything that is inconvenient will change and anything that can be automated will be. Humans innovate to eliminate and 70-75 percent of what is currently taught and done will become automated.
4. Participation is what shapes today's world.

In his role at Arup, Luebke strives to maintain a culture of innovation. His group identifies and tracks disruptive technologies at the global, regional, national, and local levels, and determines if they are systemic, elemental, or fundamental. They focus on understanding higher order impacts of these technologies and he feels that educators should also be tracking these disruptive technologies.

Luebke presented 10 things he was thinking about:

1. **Critical Thinking** - he will hire a critical thinker over a booksmart candidate;
2. **Communication** - idea does not matter unless it can be explained;
3. **Regenerative Design** - need to focus on restoring what was unintentionally destroyed;
4. **Expanded Optimization Criteria** - focus on optimizing tools to reduce impact, such as carbon emissions;
5. **Design Strategies** - consider solution sets or families as no single solution or practice exists;
6. **Infrastructure Oncology** - need to restore infrastructure to restore society;
7. **Systems Interaction** - teach and understand how our systems interact with others;
8. **Digital Transformation** - the "buy/build it now" button for construction projects will be available in a few years;
9. **Relevance** - know how to maintain in a time of profound change; and
10. **Leadership** - must make responsible decisions at every level.

He continued by stating that, even in our technology-centered society where systems are being decentralized, augmentation is affecting more aspects of everyday life, and tasks are expected to be completed quickly, moments of "slowness" foster creativity. An engineer who couples creative thinking with augmented reality, scripting, and leadership skills and also recognizes the importance of global stewardship will be able to adapt to change and use their knowledge to innovate and produce results. These qualities will define future professionals.



# ENGAGEMENT 1

## The Decades in Review

Dan Linzell, University of Nebraska-Lincoln

Mary Roth, Lafayette College

**D**r. Daniel Linzell, University of Nebraska-Lincoln, and Dr. Mary Roth, Lafayette College, provided historical perspective, briefly touching on the history of civil and environmental curricula, using their own schools as case studies, and on ASCE conferences and activities focused on higher education.

Roth compared Lafayette College course catalogs from 1873 and 1980 to speak to a reduced focus on the humanities and social sciences. Linzell compared University of Nebraska-Lincoln curricula in 1980 and 2019, noting inclusion of profession-focused freshman seminars and senior capstone courses. He also highlighted additional, albeit limited, changes reflecting technology improvements and that additional requirements of curricula may result in a loss of flexibility.

Roth and Linzell provided excerpts from the 1995 Conference report, including recommendations that focused on faculty pedagogical training, industry engagement, and project-based learning. These recommendations ultimately led to development of the ExCEED program, formation of industry advisory boards, and emphasis on creating a senior capstone course.

Other important engineering education activities by other groups between 1995 and 2019 highlighted non-technical skill goals and requirements, including:

1. ABET 2000 Engineering Criteria, 2016 revisions to the Program Criteria for Civil Engineering, and 2019 revisions to ABET EAC Student Outcomes: These collectively addressed the need for (a) student understanding of engineering solutions in a global, economic, environmental, and societal

context; (b) student exposure to an additional area of science, as well as management, business, public policy, and leadership concepts; (c) application of probability and statistics to address uncertainty; and (d) including principles of sustainability in design.

2. ASCE's Civil Engineering Body of Knowledge, Editions 1-3: These works demonstrate the continuous evolution of topics that should be taught in civil engineering, how they should be categorized, and expected student levels of attainment. In addition, the CEBOK has a continuing emphasis on understanding business, policy, and leadership principles, and more recently focuses on professionalism, ethics, sustainability, data analysis, and risk and uncertainty.
3. NAEs Educating the Engineer of 2020: Showed the importance of producing engineers who are technically creative, agile, resilient, and flexible to address societal challenges, and the subsequent need to "reengineer" engineering education to address how students learn as well as what they learn.
4. ASCE's Vision for Civil Engineering in 2025: These reports illustrated the desire to have higher education produce master builders who are: (a) mentored by practitioners, come from diverse demographics and disciplines, are able to work in a distributed global setting, and vocally advocate for economic growth; (b) stewards of the

environment who focus on sustaining the natural environment, consider resource consumption impacts and cross-border environmental effects, focus on social equity, and consider financial impacts of environmental actions; (c) innovators who facilitate multi-disciplinary research into civil engineering issues; (d) managers of risk who embed risk assessment and management methodologies as core knowledge and skills; and (e) leaders in public policy by utilizing continuing education, mentoring, and workplace opportunities to improve knowledge and skills.

5. MIT's Global State of the Art in Engineering Education: Emphasized the need for students to be provided with a range of opportunities to work across nationalities and cultures.

## PANEL DISCUSSION

# The State of the Profession

**ASCE Perspective:** K. N. Gunalan, President-Elect, ASCE

**Industry Perspective:** Keith Jackson, HNTB

**Diversity, Inclusion, and Equity:** Yvette E. Pearson, Rice University

The first panel discussion focused on the state of the profession featured K. N. Gunalan, ASCE President-Elect, Keith Jackson, American Council of Engineering Companies, and Dr. Yvette E. Pearson, Rice University. Dr. Kevin Hall served as moderator of the session.

Gunalan stated that our society depends on civil and environmental engineers as we are the stewards of infrastructure and collectively have substantial impact on society. He stated that the profession must be trusted to provide frank solutions to technical problems that are presented with confidence to our elected and appointed officials. Gunalan emphasized the importance of sustainable infrastructure in a global environment and the need to develop a diverse group of future engineers who can compete in the global environment. He indicated that ASCE is working to better prepare individuals for this environment via development of professional certifications and credentialing opportunities. Gunalan also provided an overview of ASCE activities focused on the future of the profession, including Dream Big, the Future World Vision, and Engineer Tomorrow, and stated that their focus is to “help you matter more and enable you to make a bigger difference.”

Jackson spoke to the future of the profession from an industry perspective, sharing a recent competition where a firm asked engineering staff employed for less than five years and under age 30 to design the building of the future. In the winning team’s process, the client provided the desired specifications and Artificial Intelligence was used to design, manufacture, and construct the building. Jackson wondered where engineers fit into this process

and, ultimately, what an engineer’s role in society will be moving forward. Jackson stated that exponential change is occurring and as a result, it becomes difficult to identify what is happening next week. Given this context, when hiring new engineers Jackson wants individuals who have a “sparkle in their eye,” exhibit fundamental levels of understanding of important concepts, and can use those skills in unique ways to “connect the dots” to solve problems using new and innovative approaches. He recognizes that dealing with rapid change is challenging for educators but ultimately feels that, if one topic could be taught, it should be verbal communication—be it with peers, unfamiliar individuals or groups, clients or the general public—as it is an essential skill both now and in the future. Attracting the engineer of the future to our profession necessitates clearly conveying that civilization needs civil and environmental engineers to survive and thrive while also demonstrating that we solve problems that require skills to “connect the dots.”

Pearson spoke to the importance of diversity, equity, and inclusion to the future of the profession. She stated that optimal solutions to major problems need diverse perspectives and that, given changing demographics and increasing need for engineers, ensuring that the field is diverse and inclusive is an imperative and is everyone’s job. Diversity goes beyond gender, age, race, and ethnicity, and should be an end goal, not just an initial goal. To accomplish this, diversity and inclusion must be embedded in civil engineering curricula. Pearson stated that true diversity will occur via development of an inclusive and equitable culture involving open communication and a climate conducive to success for

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all. She indicated that equity is different from equality in that equality focuses on treating everyone the same, while equity focuses on treating everyone fairly. Pearson reminded Summit attendees that: diversity and inclusion is part of the ASCE Code of Ethics; engineering teams are defined as diverse in the ABET Engineering Accreditation Commission's general criteria; and that reducing inequalities is United Nation's Sustainable Development Goal 10. To ensure that we are teaching engineers to engineer inclusively, educators can evaluate culture and climate, practice inclusive teaching, be transparent, require training, and identify and employ best practices now.

## ENGAGEMENT 2

# CE Curriculum Development

David Dzombak, Carnegie Mellon University

Ken Fridley, University of Alabama

Audra Morse, Michigan Technological University

The first day concluded with a session on civil and environmental engineering curricular development. Moderator Dr. David Dzombak, Carnegie Mellon University, emphasized that civil and environmental engineering educators should remember that they have the ability to innovate in the current accreditation framework, and that curricular flexibility is important to move pedagogical processes and, ultimately, the profession forward.

Dr. Ken Fridley, University of Alabama and chair of the Civil Engineering Body of Knowledge 3 Task Committee, provided an overview of how the Civil Engineering Body of Knowledge revision process related to the ABET Engineering Accreditation Commission (EAC) general criteria and the civil engineering program criteria, and ASCE's process and calendar for development and revision of the Civil Engineering Body of Knowledge and civil engineering program criteria. Fridley stated that adequate preparation of future civil and environmental engineers is ultimately a partnership between academia and industry but that educators initiate the process. Fridley also emphasized that we are a profession of practice, not one that emphasizes licensure. He expressed concern that educators interpret the CEBOK, ABET EAC, and CEPC as being solely focused on licensure and emphasized that those involved with the development of these recognize that not every civil and environmental engineer is on a path toward licensure.

Dr. Audra Morse, Michigan Technological University, provided an overview of how the *Civil Engineering Body of Knowledge, Third Edition*, is organized and how it was developed, reviewed, and revised. She stated that

the Task Committee charged with its creation identified essential foundational, fundamental, technical, and professional outcomes for future civil and environmental engineers. The Task Committee subsequently focused on appropriate levels of achievement for the specified outcomes. For some outcomes, levels of achievement were specified in the affective as well as cognitive domains. Morse stated that civil engineering education included both formal undergraduate and post-graduate education along with mentored experience and self-development. She also detailed the organization and progression toward achievement in the third edition of the CEBOK, and provided examples as to how that progression could fit into curricula. She emphasized three aspects related to the new Body of Knowledge: the importance of mentorship; the addition of affective domain levels of achievement for selected outcomes; and that individual civil and environmental engineers ultimately must commit to their own self-development as an essential part of achieving the full body of knowledge. Morse ended by stating that (a) a formal undergraduate curriculum can only teach so much, (b) mentoring and curiosity must be cultivated, and (3) innovation is a professional responsibility.

# Conceiving the Future

## **PLENARY 2**

### **ASCE Future World Vision**

Jerry Buckwalter, Northrop Grumman

## **ENGAGEMENT 3**

### **TABLETOP BREAKOUTS**

Education Opportunities and Challenges  
related to ASCE Future World Vision

### **MINI “TED” TALKS**

Innovations and Innovators

### **PECHAKUCHAS**

Curriculum Innovation

A second plenary session on ASCE’s Future World Vision kicked off “Conceiving the Future” on day 2 of the Summit. Tabletop breakouts to brainstorm education opportunities and challenges related to the Future World Vision followed. Two fast-paced sessions presented ideas and activities focused on civil and environmental engineering curricular innovation using provocative and nontraditional methods.

“Mini TED Talk” leaders provided their perspectives on how extracurricular contributions, holistic approaches

to the total educational experience, and full integration of classroom and out-of-classroom work would enhance student learning.

A PechaKucha session involved 10 institutions specifically describing how they are working to enhance innovation in their programs, and ultimately foster innovative thinking by students in those programs. More detailed recommendations from each speaker are given in the sub-sections below.

## PLENARY 2

# ASCE Future World Vision

Jerry Buckwalter, Northrop Grumman

Day two of the Summit began with Jerry Buckwalter, Northrop Grumman (now ASCE's chief operating and strategy officer), who outlined ASCE's Future World Vision initiative and associated educational opportunities and challenges.

Buckwalter stated that the profession is in the early stages of disruption from a number of technologies and advancements, including the Internet of Things, technological autonomy, machine learning, and transformative new materials. He stated that the aerospace industry adapted to accommodate these disruptors a number of years ago, and ASCE leaders recognized that similar adaptation needed to happen in civil and environmental engineering, leading to the creation of the Future World Vision. Buckwalter stated we live in a world of convergence and that civil and environmental engineering professionals must be able to collaborate with one another, with other engineering disciplines, and with non-engineering partners.

The Future World Vision development started with scenario planning, producing a number of future worlds involving phenomena that would overwhelm today's technology, and then postulated what it would take to arrive at those worlds. These exercises indicated that, for the profession to survive, civil and environmental engineers would urgently need to: prepare for resilience for diverse environments and changes in demographics and urbanization; incorporate advances in materials, computing tools, technologies, and engineering and construction processes; embrace digital models and big data use; increase the pace of innovation and lead change; understand systems dynamics and nature of systems and system integration; create linkages, alignments, and collaborations with varied engineering and non-engineering disciplines; and attract new talent while continuously training and growing careers.

The planning exercise identified six trends that would have the biggest influence on civil and environmental engineering over time: alternative energy; autonomous vehicles; climate change; high-tech construction; material sciences; and smart cities. Future worlds will be created by looking at a number of potential outcomes associated with each trend and grouping them into possible spaces. Buckwalter indicated that it was difficult to predict when things would happen, and as a result, exercises focused on identifying "signposts" where events could lead to multiple future scenarios and how each would be dealt with.

It was decided to create narratives and experiences associated with each future world so that science and engineering jargon could be translated into scenario impact. Buckwalter stated that five plausible cities were identified, each occurring at a set time in the future: a megacity; a rural city; a floating city; a frozen city; and an off-planet city. Prototypes for each future city will be created using virtual reality, with mega- and floating cities being completed to date. It is hoped that an operational construct will be created that looks at the impact of each prototype on civil and environmental engineering down to the street level. He indicated that immersive, 4D computer virtual labs are being created for each prototype that will become more robust as they simulate engineering challenges and support learning and development via use case activities. Buckwalter stated that, ultimately, these virtual labs will highlight civil and environmental engineering's role in addressing future world challenges, allow for crowd-sourced solutions, permit model growth and improvement, and integrate public policy optimization tools to include cost, social benefit, and return on investment information.

# ENGAGEMENT 3

## MINI “TED” TALKS

### Innovations and Innovators

Four 10-minute mini TED talks provided perspectives on innovation, particularly how to engage, excite, and enlighten the engineering student of today and tomorrow. Presenters hailed from different types of institutions across the country and were at different points in their

academic careers; as a result, they contributed a unique blend of perspectives and ideas. Participants shared a common passion for high-quality, holistic instruction and learning inside and outside the classroom.

### Outside the Academy

Marc Hoit, North Carolina State University

Dr. Hoit indicated that the impetus behind ASCE's Innovation Contest was to bring people together to develop and nurture forward-looking ideas to address major infrastructure issues. He stated that the profession self-selects thinkers who are not intrinsically creative and postulated that a large portion of the work civil and environmental engineers complete does not require a Professional Engineer's license. Dr. Hoit emphasized the contest is open to anyone and that developed ideas must be presented in a number of creative different forms, with the penultimate activity being a pitch contest. He stated that one of the contest goals was to develop engineers who can communicate an idea in three minutes.

### College/University Perspective

Alison Wood, Olin College

Dr. Wood indicated that current engineering curricula are organized in blocks and that the blocks are oftentimes disconnected. She stated that these blocks must disappear and emphasized the need for disciplinary integration in engineering higher education so that future engineers' systems and transdisciplinary skills can be developed and strengthened. Olin develops and strengthens these skills by offering a number of co-taught, transdisciplinary systems engineering courses and by integrating design thinking and science and the humanities throughout the curriculum. Dr. Wood indicated that Olin still has topics that are not well integrated into the transdisciplinary model, such as engineering ethics, and that they are working to address this issue. She stated that project-based learning is one way for integration to occur. Dr. Wood ended her talk by emphasizing that civil and environmental engineering's relevancy as a systems-based field can be demonstrated using a number of approaches, such as focusing on sustainable systems.

### Faculty Perspective

Brett Story, Southern Methodist University

A specific initiative focused on exposing future engineers to civil and environmental engineering innovation and on developing essential, systems thinking skills in high school students was summarized by Dr. Story. The Smart Infrastructure Innovation Initiative (S3i) helps produce high school students who are excited about the field and better prepared for engineering curricula through experiential learning and the creation of a continuum that attempts to blur the lines between secondary and higher education. Students focus on the development of solutions to real-world problems in an interdisciplinary way.



## NSF Workshop Perspective

Lucio Soibelman, University of Southern California

The final mini TED talk was given by Dr. Soibelman, who summarized the recently completed NSF workshop and listed identified issues and outcomes. The intent was to highlight how AI is affecting the civil and environmental engineering field and, subsequently, curricula. Dr. Soibelman stated that a number of issues associated with AI integration into the field and curricula were identified, including a professional culture that does not promote sharing data, other fields driving change, a lack of curricular emphasis on development of programming skills, a dramatic increase in data science programs and subsequent reduction in the number of civil and environmental engineering students who have an interest in programming and AI, and that our field is stuck on basic science skills while other engineering fields have advanced to development of new skills. Outcomes included suggesting changes to training and curriculum, such as offering programming and AI tutorials to students at technical conferences, classifying data science as a basic science, and working with other, similarly minded groups and organizations. Dr. Soibelman indicated that the group identified clear action items that included increasing data literacy by suggesting updates to curricula to include development of sensor technology and data literacy skills, creating faculty development opportunities in the machine learning, AI, and data science domains, developing relationships with key data science and AI industry partners, and development of co-curricular activities with data science programs.

# ENGAGEMENT 3

## PECHAKUCHAS

### Curriculum Innovation

A “PechaKucha” is a fast-paced type of presentation in which speakers have 20 slides timed and set to change over after 10 seconds. This format is good to cover a lot of information quickly and from multiple perspectives. These brief presentations were packed with information, delivered concisely and quickly. The following pages are the abstracts for each speakers’ presentation. These speakers were selected by the Conference Program Committee from submissions to a call for abstracts sent to civil engineering department heads in the United States.

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*“Using the Grand Challenges of Engineering to Complement a Civil Engineering Curriculum”*

**Angel Perez**  
**Assistant Professor of Civil Engineering**  
**Quinnipiac University**

The Civil Engineering department at Quinnipiac University designed a course sequence to integrate the non-technical aspects of engineering practice into the curriculum. This sequence parallels the technical content of the curriculum and uses the fourteen National Academy of Engineering (NAE) Grand Challenges as context. These complex and multi-disciplinary problems must be solved by engineers and non-engineers who have a thorough understanding of the technical and non-technical issues associated with the challenges. Civil Engineering programs traditionally dismiss non-technical issues and focus on technical content. Non-technical content may be treated only in general education courses or considered only as an afterthought for accreditation. In the Quinnipiac course sequence, students identify non-technical issues in the Grand Challenges in their introductory engineering course. Students then choose general education courses relevant to those issues. In their last semester, students take a non-technical, mixed enrollment capstone course which mirrors their Major Design Experience. Non-engineering students enrolled provide non-technical knowledge to help solve these issues. Engineering students are able to focus on societal, ethical, and economical

issues with the help of peers and the instructor. This develops skills necessary in engineering practice and valued by employers. We believe this approach best prepares students for their post-graduate careers.

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*“Achieving Change in Civil Engineering Education: Building Community and Expertise to Change Educational Practices and Culture”*

**Caroline Bennett, Ph.D., P.E.**  
**Director, School of Engineering**  
**University of Kansas**

In this PechaKucha-style presentation, implementation strategies and results will be shared for a highly successful, multi-level change initiative at the University of Kansas. The change initiative has been aimed at encouraging and supporting shifts in teaching practices, culture, and curricular innovations toward evidence-based practices and approaches that have been shown to support student progression and retention, learning outcomes, and diversity.

The change model has relied on an approach that focuses on departments as the most influential locus for change. There have been two cornerstones to the approach: (1) discipline-situated experts were embedded into departments as change agents to collaborate with faculty, and (2) meaningful learning communities were built out around the embedded experts and departmental faculty to leverage efforts and accelerate change processes. In this model, the embedded experts were not instructional designers, but Ph.D.-holders in the discipline they were embedded within as change agents.

The transformation initiative has been led in Engineering by a faculty member from Civil Engineering (the presenter), and notable achievements have been particularly emergent from that department. Specific implementation strategies in Civil Engineering will be shared, along with results that have been achieved—transformed teaching culture and practices, curricular innovations, and improved student outcomes.

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### *“Developing Inclusive Content for Technical Courses”*

**Tiago Forin**  
**Engineering Clinic Instructor and RevED Project**  
**Coordinator, Rowan University**

The National Science Foundation awarded the Revolutionizing Engineering and Computer Science Departments (RED) grant to Rowan University’s Civil and Environmental Engineering (CEE) Department in 2016. The RED grant funds a five-year longitudinal study for examining the climate of diversity and inclusion in an engineering program and creating interventions and tools to improve that climate. The RED grant also enables the means to initiate broad institutional changes to the entire university modeled after the initiatives created by the engineering department. Now in the third year of the study, Rowan University has taken steps to improve the climate of diversity and inclusion through the use of developing course content that focuses on global/historical examples and students’ personal experiences. These particular pathways for developing inclusive content are based on a few concepts taken from a framework of critical pedagogy. In critical pedagogy, students are given an opportunity to make personal connections to the content being taught and develop a broader perspective of the applications of that content knowledge to the world around them. Our efforts have included multiple assignments and projects across different CEE courses in material science, transportation, construction materials, and statics that allow students to explore deeper connections with the technical engineering concepts.

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### *“An Engaging Introduction to Civil Engineering Design: An innovative format to improve curriculum accessibility for first-year civil engineering students”*

**Rebecca L. Oulton**  
**Assistant Professor, Environmental**  
**California Polytechnic State University**

One of the challenges with introducing first-year students to any engineering curriculum is making the material relateable and engaging before they have completed their fundamental courses in mathematics, physics, chemistry, etc. Students come to college eager to leap into their major and change the world, but without the

fundamentals yet to tackle engineering design challenges. This presentation describes an innovative format for a traditional Introduction to Civil Engineering course that focuses on engaging first-year students by making fundamental civil design concepts accessible from the beginning.

This course revision includes three pedagogical strategies for engaging first-year civil engineering students: experimental learning techniques to allow students to relate to the material, use of discipline-specific professional practitioners as instructors, and extensive use of case studies to keep the material relevant to the real world. The department also developed an innovative structure for the class, wherein students would attend three classes in a row with each of the six professional-practitioner instructors, shifting between instructors over the 18 class sessions offered during the quarter. This rotating structure allows for a focused introduction to six key civil engineering topics: construction engineering, geotechnical engineering, structural engineering, transportation engineering, water resources engineering, and sustainability in civil design.

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### *“A Four-Year Design(-Build-Test) Thread”*

**Sarah Christian**  
**Assistant Teaching Professor**  
**Carnegie Mellon University**

**David Dzombak**  
**Hammerslag University Professor and Department**  
**Head**  
**Carnegie Mellon University**

Through a sequence of four project courses threaded with key design-related themes, undergraduates gain hands-on engineering experience as they apply knowledge from core courses to projects in each year of the curriculum. The repeated opportunities to solve ill-defined, open-ended problems help students to become more comfortable with teamwork, self-guided learning, communication, and the ambiguity that permeates real projects. By building and testing their designs in each of these courses, students learn the importance of effective design communication, strategies for addressing uncertainty, planning, and constructibility. The project courses focus on the same design skills and processes, but the level of complexity of the learning objectives increases as students advance through the sequence. The projects span the breadth of the field, providing students with a sense of the diversity of challenges engaged by

civil engineers and their importance to communities and individuals. The opportunity to collaborate through these projects helps to build a strong cohort early in the curriculum. Both student agency in their learning, as well as their confidence increase as they frame and solve problems collaboratively. Students are able to build a portfolio to demonstrate specific experience on a range of projects and their ability to be flexible, adaptable, and creative in addressing modern challenges in civil engineering.

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### *“Bridging the Gap in Construction Education”*

**Clifton Farnsworth**  
**Assistant Professor**  
**Brigham Young University**

In some parts of the world (including within the US) construction management has somewhat evolved as a separate discipline away from civil engineering. In many ways this has created an academic gap, although the two disciplines are mutually dependent and necessarily complementary within the same industry. Construction education within academia takes many different forms: there are a few true construction engineering programs (including a few more recently established); some civil engineering programs have a construction track; and in some cases, construction management programs coexist with civil engineering programs. However, it is far more common for higher education institutions to have separate civil engineering and construction management programs that interact very little with each other. Unfortunately, this has created a general academic gap, especially regarding infrastructure and other heavy/civil-related construction curricula. When separated, neither construction management nor civil engineering programs tend to provide sufficient depth for the infrastructure and heavy/civil construction sub-discipline. This presentation is intended to define and demonstrate this gap, provide models of how a few institutions are currently bridging it, and ultimately begin a discussion on ways that this gap can be bridged collectively within civil engineering education at large.

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### *“Frontloading the civil engineering curriculum: Introduction to Infrastructure”*

**Mike Penn and Christina Curras**  
**Department of Civil and Environmental Engineering**  
**University of Wisconsin-Platteville**

Traditional curricula provide students with limited exposure to civil engineering in the first two years of study. The third year is typically when students enroll in core sub-discipline courses (e.g., construction, transportation), often as “silo” courses with no prescribed order. Shortcomings of this approach are: 1) students may not get exposure to some sub-disciplines until late in the third year, or perhaps even the fourth year, and 2) students do not gain appreciation of the interconnectedness of infrastructure as a system until later in the curriculum. With National Science Foundation funding, our department collaboratively developed and implemented a second-year Introduction to Infrastructure course. Students gain exposure to: the current condition of the nation’s infrastructure; the importance of infrastructure to the nation’s economy, security, and public welfare; infrastructure as a system; and engineering roles (design, analysis, planning, monitoring, and inspection). Emphasis is placed on how infrastructure decisions are influenced by engineering concerns (e.g., design codes, resilience, constructibility) and non-technical concerns (e.g., sustainability, social priorities, public-private partnerships). Student teams also perform field assessments of local stormwater and transportation infrastructure. The course has been successfully offered since 2012 and gives students a broad perspective before taking core sub-discipline and design courses.

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### *“For the Times They are a-Changin’: Curriculum Broadening to Keep Civil and Environmental Engineering Relevant”*

**Jerome P. Lynch, Ph.D.**  
**Donald Malloire Department Chair of Civil and  
Environmental Engineering**  
**University of Michigan**

How we train civil and environmental engineering (CEE) students is simply not keeping pace with the technological changes demanded by the profession. Freshman students often express strong enthusiasm for career paths focused on “sustainability” and “smart cities,” yet when they select

majors they are going to other engineering disciplines because they feel these disciplines better prepare them than does CEE. Seeing this trend as a canary in the coal mine, we have set off to transform our accredited undergraduate programs to empower our graduates with a broader set of tools necessary for career success. First, we have transformed many of our math and science sequences to teach traditional principles through the use of novel themes. For example, we converted our courses in probabilistic methods and computational methods to courses focused on teaching the same concepts but within the context of machine learning and data analytics. Second, we added new courses to the curriculum needed to expand the toolset of students. For example, we have a required course in sensors that teaches electrical circuits using embedded systems. Finally, we have partnered with other departments to create major-minor combinations that broaden the students' education. For example, we offer a program in smart cities that has students major in CEE but minor in computer science. These changes have driven strong growth in our undergraduate enrollments over the past five years.

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*“THINK-PLAY-HACK: A New Model for Teaching Data Science Skills to CEE Students”*

**Barbara Minsker**  
**Chair, Civil and Environmental Engineering**  
**Southern Methodist University**

“THINK-PLAY-HACK” (TPH) is a paradigm for innovation inspired by the group-dynamics research of University of Chicago sociologist James Evans. Over 3-5 days, observers and community experts embed themselves in the THINK-PLAY-HACK model, working on ideas and data analytics alongside faculty and students.

- THINK: Development of a conceptual model. Expert corners guide scope and problem definition.
- PLAY: Exploring available data, methods, algorithms, and theories. Ends with competitive team pitches on project ideas.
- HACK: Teams analyze and visualize data and present findings. Teams compete for the most insightful results.

The first TPH pilot focused on infrastructure equity and brought more than 30 participants to SMU for a 3-day

intensive session in January 2019. Their results brought new insights and directions to the infrastructure research, the seeds of new publications, and provided a significant educational experience for both undergraduate and graduate students.

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*“Mapping the Future of Civil Engineering Innovation”*

**John Schemmel, Ph.D., P.E., FACI**  
**Bruce and Gloria Ingram Endowed Chair in Engineering**  
**Texas State University**

With the fall 2019 semester, Texas State University will begin offering a new undergraduate Civil Engineering program with a holistic emphasis on urban-based, technology-enhanced infrastructure (TEI). The program curricula is transformative in that it combines a strong foundation in traditional Civil Engineering principles with a unique education in the emerging sub-discipline of smart infrastructure technologies. Embedded throughout the curriculum, extending longitudinally from first-year introductory courses through senior-level electives, are concepts and curricular components related to TEI. In addition to classic analysis and design of infrastructure assets, graduates will have experience with a wide range of sensor devices, data transmission and storage systems, big data and machine learning protocols, predictive modeling, and automated infrastructure management technologies. Moreover, the curriculum includes a five-course sequence addressing the breadth of concepts associated with technology-enhanced infrastructure. Developed in cooperation with Geography, Mathematics, Computer Science, Construction Science and Management, Biology, and Electrical Engineering, several of the program's required and elective courses are truly interdisciplinary. A panel of external reviewers, which included ASCE past President Andy Hermann, described the program in their final report as “distinguished from most, if not all” Civil Engineering programs in the nation by “forward thinking and proactive planning.”

# Constructing the Future

## ENGAGEMENT 4

### Moving Vision to Action 1 and 2

Jessica Burnham, M.F.A., Southern Methodist University

Gray Garmon, M.Arch., University of Texas at Austin

## DISCUSSION

### Major Topics and Wild Ideas

One of the goals of the Summit was for ASCE to walk away with actionable items as civil engineering looks to the future of education. ASCE partnered with Southern Methodist University's Master of Arts in Design and Innovation (MADI) program to develop a workshop that would allow Summit attendees to share their opinions regarding civil engineering education priorities.



# ENGAGEMENT 4

## Moving Vision to Action 1

Jessica Burnham, M.F.A., Southern Methodist University

Gray Garmon, M.Arch., University of Texas at Austin

### Rationale of the Process

Human-Centered Design is one of several processes for making sense of and improving complicated scenarios. When tasked with helping ASCE vision plan the future of civil engineering education, it was clear we needed to get each individual from the large group of attendees to feel accounted for and heard as a part of the entire process. One of the standard methods of Human-Centered Design is surfacing assumptions and allowing for personal reflection first. This allows for groups of people to work together to reveal commonalities and starting points.

The goal of the workshops was to allow everyone time from the beginning to reflect on what they had been learning from the Summit and what ideas they'd brought to the table on their own. After individual opinions and thoughts were captured, people shared those with others at their table. From there common themes based around the People and Needs emerged. Then those themes were put together as statements of opportunity that would be acted on in the future. This process of starting with the individual point of view and distilling down to a few sets of common ideas helped to keep every attendee engaged, validate multiple opinions, and kept the group focused on future planning.

---

### Point of View Statements

We started the process by asking all attendees to write out their own "Point of View" statements. Of the 193 people in attendance, 172 sheets were filled out. The goal of this activity was to capture a crowd-sourced perspective of the current state of civil engineering education and its future. This created an opportunity for individuals to

share their personal perspective before understanding the collective perspective of ASCE members as a whole. We prompted attendees with a series of questions that specifically addressed some of the larger, more abstract philosophies surrounding the experience of civil engineering education.

- To you, what is the purpose of civil engineering education and who is it for?
- What are the focus areas of civil engineering of the future?
- What are some aspirational wishes you have for the future of civil engineering education?
- What are some curiosities you have for the future of this field?
- What are some of the wildest ideas you have for the future of civil engineering education?

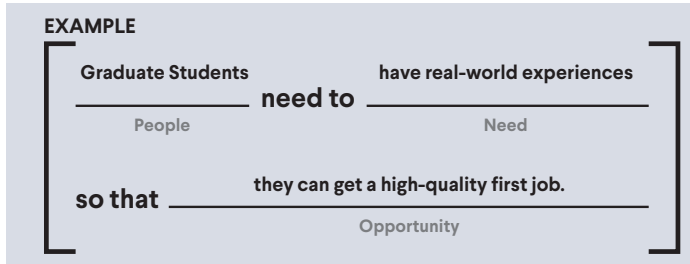
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### People + Needs

The next stage in the process was to have participants pair up with a table partner and share their Point of View statement sheets. Pairs were asked to articulate the "people" and the "needs" identified in their point of view statements. Once table partners had identified their people and needs, they were asked to reconvene with the rest of their table group (on average eight individuals) to combine and articulate common themes. An example of people and needs, and how they were synthesized into themes.

## Opportunity Statements

The next step of the process drops the “people” and “needs” into an opportunity statement that looks like this:



The goal for this section is to start identifying gaps and opportunities for the field of civil engineering and education development, as well as alignment of interest across tables.

## Synthesize Opportunity Statements

This synthesis of the Opportunity Statements was conducted by the ASCE Civil Engineering Summit Executive Committee and a team of facilitators from the Design and Innovation program at SMU. This team took the collection of 156 opportunity statements, as written by the table groups of attendees, and synthesized them down to 20 opportunity statements that are intended to inform future actions for ASCE.

The ASCE Executive Committee used the spreadsheet to do a first-round vote for which statements they felt were most relevant and useful; the MADl facilitators included their thoughts on which opportunities were viable for action and had the most promise for innovative ideas.

This left 28 opportunity statements. In order to reduce this list down to the 20 most relevant statements, each ASCE Executive Committee member was given three votes to narrow down the list. Both groups then worked together to refine the wording of the final statements.

## Ranking the Top 20 Statements

When the Summit reconvened on Day 3, the ASCE Civil Engineering Summit Executive Committee shared the 20 opportunity statements (listed in the next section). Each individual attendee was then asked to rank (via electronic survey) the 20 statements according to what they felt was the highest priority for ASCE. The results of this vote were projected in the room.

## Product Development: Table Brainstorms

Each table was randomly assigned one of the Top 20 statements (two tables were duplicates) and asked to generate potential solutions and recommendations. As they brainstormed, tables were asked to consider the following:

- **Who:** What people, organizations, or groups could be involved
- **Actions and verbs:** What actual actions need to take place and what needs to be done
- **Short- and long-term action items:** What could this wild idea look like in the short term (5-12 months) or long term (10-25 years)
- **Wild ideas that may surface during the process:** While brainstorming on some logistic ideas, wild ideas tend to pop up more organically and need to be captured and built upon.



# ENGAGEMENT 4

## Moving Vision to Action 2

### Top 20 Opportunity Statements with Wild Ideas

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From the workshop and committee group work, 20 opportunity statements were generated and then voted on in priority order. Once the priority order was determined, each statement was assigned to a table to brainstorm wild ideas that could be used to take that statement from vision to action. Below is each statement along with the wild ideas that were reported out.

- 1. Students need to learn systems thinking so that they are prepared for current and future societal challenges.**
  - Create “Smart Living Labs” that students engage in regularly
- 2. Students need to develop people-focused skills so that they can design infrastructure that is relevant to society.**
  - Promote empathy in students by having faculty provide the example. This can be achieved by providing empathy training for faculty (example through exec ed), prioritizing people skills in hiring, and having faculty without people skills lose tenure
  - Students need to develop people-focused skills so that they can design infrastructure that is relevant to society
  - Every course has a community-based project that includes a public forum of stakeholders
  - Leadership (including leading without formalized authority) is included in every CE curriculum
  - Empathy becomes an essential student/ABET outcome and is an essential criteria in hiring, promoting, and faculty development
  - Faculty integrate professional skills into existing curriculum in order to ensure CE's ability to drive societal change
  - Schools provide and faculty engage in professional development to build capacity for teaching and applying people-focused skills
  - Schools and faculty value people-driven research and education to show the value in various ways, including incentivizing it
- 3. Faculty need to emphasize systems thinking so that sustainable, socially just infrastructure can be designed.**
  - Require community service as part of the engineering curriculum early on so they can see the socio-economic impact our projects have
  - Require students to attend public meetings to gain a better understanding of the critical component and the non-technical components impacts of a project
  - Engage non-engineers to teach systems thinking
  - Freshmen find global problems to solve as engineers with social/enviro/systems awareness

#### **4. Civil Engineering faculty need to integrate creativity into the curriculum to build thought leaders and innovators.**

- End tenure
- In-department peer review of course contents and teaching methods, to identify opportunities for innovation
- Employ more open-ended problem-based learning incorporating ambiguity and uncertainty
- CE departments teach our own service courses (e.g., math, physics) to include CE context and applications
- CE faculty need to integrate creativity into the curriculum to build thought leaders and innovators
- Faculty need to emphasize systems thinking so that sustainable, socially just infrastructure can be designed.

#### **5. Faculty need to adopt evidence-based instructional methods so that students can develop critical thinking skills in order to evaluate alternative approaches of civil engineering like sustainability and equity.**

- Promotion and tenure should be based on teaching innovation and effectiveness as much as it is on research scholarship
- All courses, throughout the curriculum, should have project-based learning

#### **6. K-12 students need to be exposed to the challenges of the future so that as future Civil Engineers they are equipped to solve them.**

- Netflix CE reality series about educators and practicing professionals to create excitement and outreach around the profession
- Develop CE infrastructure video game
- Eliminate CE (and other engineering) majors and organize by problems
- Replace concrete canoe and steel bridge competition with spark by ramboll
- Develop CE-centric K-12 curriculum that is aligned with teaching standards

#### **7. Faculty need to provide learning opportunities inside and outside the classroom so that students can build portfolios of life experiences.**

- Create an entire semester of courses (on campus/off campus) that allow students to focus on a major engineering challenge, such as a “Grand Challenge,” Sustainable Development Goal, or Future Vision scenario
- Turn the classroom into a community resource to provide real-world data (sensors/measurement) for CE studies/projects (preliminary/exploratory-type work)

## **8. Civil Engineering students need to exhibit the attitudes and behaviors of innovation so that they can respond to future challenges.**

- Structural engineering will drop prescriptive codes and adopt performance-based design
- ASCE develops and funds “Go Fund Me”-type student innovation projects
- Freshmen find global problems to solve as engineers with social/environmental/systems awareness

## **9. University administrators need to be adaptable and offer resources so that new curricular approaches are encouraged.**

- New curriculum approaches supported by eliminating departments
- Industry endows/supports a course–“Faculty as Race Car Drivers”
- Apple wallet (discount) by class
- Funding/endowment to support teaching ASCE and other opportunities
- National CE curriculum–1 individual who teaches class

## **10. Faculty need to emphasize systems thinking so that sustainable, socially just infrastructure can be designed.**

- Bring in clusters/cohorts of people who represent an underrepresented group (at multiple levels, e.g., faculty, students, etc.)
- Focus on inclusion/retention once you have them
- Provide facilities: daycare, lactation rooms, gender neutral bathrooms
- Continue to increase the pipeline at all levels and rethink (really rethink) admission requirements and processes
- Work to change the campus climate/culture

## **11. Underprepared students need access to supplementary education so that they can be successful in Civil Engineering and careers.**

- Take Engineering supplemental education to the street, on wheels, in libraries, in boys/girls clubs
- Flip Bloom’s Taxonomy -- start at top of pyramid with the problem/opportunity
- Bring math/writing supplemental to kids
- Industry gap year/time (arranged by university)

## **12. Universities need to develop a culture of equity and inclusion so that we produce a more diverse future workforce.**

- ABET requires each student to have at least one high-impact experience (e.g., service-learning, internship, co-op, study abroad, EWB)
- Engineers need help from experts to do diversity and inclusion correctly-partner with experts to get it right
- Faculty work to create a sense of community by being open and welcoming

**13. Civil Engineering faculty need to develop more flexible assessment criteria so that curricula can respond to worldwide challenges and opportunities.**

- Incorporate self-assessment and meta-cognition training for students to assess themselves, identify gaps, and fill these gaps to address emerging problems
- Do away with grades so that students can embrace failure as part of learning

**14. Accrediting bodies need to foster adaptive programs so that curricula can rapidly address current and future societal needs.**

- Mandate large-scale change regularly
- Eliminate tenure
- Eliminate accreditation
- Require accreditation training as part of Ph.D. programs
- Have teaching-faculty take lead in curriculum

**15. ASCE needs to provide a repository of global teaching best practices so that the rate of innovation is increased.**

- ASCE/faculty/industry professionals develop a mobile app that serves as a repository for best practices
- Create 1-minute videos on innovative teaching methods and push to phones via ASCE
- Faculty get paid for creating innovative content for repository
- Industry will develop content for repository
- Online content for Intro to Civil Engineering course
- CE Division of ASCE come out from their comfort zone and gather Best Practices on CE innovation

**16. Civil Engineering departments need to better communicate the application of a CEBS degree so that students see its value in any career path.**

- Civil Engineers are in movies, TV series, and/or are a Muppet on Sesame Street to give instant recognition and awareness to a wide audience.
- CE departments need to better communicate the application of CE degrees so that students see its value in any career path
- Expand our definition of CE and Engineers—include computer scientists, software engineers, political scientists, policymakers.
- CE degree is a springboard
- CEs should organize to elect CEs to public offices to provide creative solutions to infrastructure needs as well as raise the profile of CE for potential CE students

## **17. Faculty need to identify new metrics for scholarly productivity so that promotions are awarded to those addressing society's future needs.**

- University leaders need to develop better ways to measure teaching to create alternatives for tenure and promotion
- Government gives \$10B to CE department
- Eliminate tenure/replacement
- Don't adopt #17 as is

## **18. Decision-makers need to remove regulatory roadblocks so that innovation can flourish.**

- In 2020, first civil engineer elected president.
- Government commits to a "Man on the Moon" emphasis on infrastructure renewal and promises to commit resources to support that initiative
- Forced sabbaticals with industry
- Start a PAC for supporting CE running for office
- Eliminate tenure
- Secondary education not supported by property tax

## **19. Industry-University consortia need to provide startup opportunities with funding so that students can be energized (sparkle) by an entrepreneurial pipeline.**

- Provide opportunity for all students to build and design projects to solve community problems
- Integrate entrepreneurship into other design projects (not just senior design)
- Recognize that students create IP value -- manage those issues to focus on created value

## **20. Higher Ed Institutions need to form consortia so that emergent topics can be team-taught with virtual technology.**

- Organize a CE systems walkout for 1 day to convey the value of CE professionals
- Re-brand CE as Systems Engineering

## DISCUSSION

# Major Topics and Themes

The Summit proposed a vision of civil engineering, defined at its most basic level:

***Civil Engineering is a global, holistic profession that serves the needs of all people.***

In the future-oriented focus of the Summit, it was agreed that the needs of people, and the contexts related to meeting those needs, are becoming increasingly complex in our ever-evolving world. Thus, the educational systems that prepare future engineers must also evolve to address this complexity.

Thematically, three goals emerged from synthesizing the opportunity statements. The field of civil engineering needs to:

1. Be a **Profession** that serves people;
2. Have a **Culture** that includes people; and
3. Provide an **Education** that prepares people to innovate.

As a pathway to achieving these goals, four major objectives emerged from the discussions and workshop activities. These objectives are described in detail below.

---

### OBJECTIVE 1:

#### **Reexamine, and potentially redefine, the domain of Civil Engineering.**

A clear consensus among Summit participants is that the world is becoming increasingly complex – thus, the challenges faced by engineers are becoming increasingly complex. One aspect of this complexity relates to the interconnected nature of infrastructure, environmental, political, and social systems. Such interconnectedness is

a major driver of the dissolution of traditional "boundaries" that define a particular engineering discipline. Summit participants dared to ask the question: "In the context of the mid-21st century, what is a civil engineer?" Two elements related to this most fundamental question reflect the impact of technological advancement and the evolving role of the civil engineer in society.

ASCE's *The Vision for Civil Engineering in 2025* (published in 2006) anticipates the evolutionary, holistic nature of the role of civil engineers:

***"In 2025, civil engineers will serve as master builders, environmental stewards, innovators and integrators, managers of risk and uncertainty, and leaders in shaping public policy."***

An undergraduate civil engineering program is not sufficient to fully prepare a graduate to be a master builder, steward, innovator, manager, and leader. This is recognized in the *Civil Engineering Body of Knowledge, 3rd Edition* (CEBOK3), which calls for a combination of formal education, structured mentoring, and self-directed learning to position the civil engineer for career success. However, an undergraduate civil engineering curriculum provides the foundation on which to build the knowledge, skills, and attitudes of the future civil engineer.

It is clear that the already rapid pace of technological change and advancement will continue unabated – and very possibly accelerate. In his plenary remarks, Arup Foresight engineer/futurist Chris Leubkeman observed the mega-trend if it can be automated, it will be automated..." New tools and new computational and analysis techniques are being introduced into the profession at a rate beyond that to which most engineering education

programs can react and adapt. Although this issue is not necessarily new, Summit participants struggled with the disparity between the current and anticipated pace of innovation in the profession versus that in education.

A major theme that emerged at the Summit related to technological advancement is the need to expand the domain of civil engineering. Three areas receiving significant attention by Summit participants included:

1. Learning new competencies related to emerging **technologies** that are rapidly changing civil engineering (e.g., data science, robotics, sensors, drones, and virtual reality), as well as the knowledge and skills needed to use those technologies.
1. Integrating more **systems thinking** into civil engineering education through real-world problem solving, project-based education, and high-impact experiences such as internships, service learning, study abroad, student organizations, and competitions.
1. Promoting a **culture of innovation** within the profession through more directed teaching of creative processes, entrepreneurship, and evaluation of risk as an integral part of curricula and mentored practice.

These Summit discussions give rise to a major implication for 21st-century civil engineering education: **curricular flexibility**. Indeed, “flexibility” emerged as another primary theme among Opportunity Statements related to civil engineering curricula, with five (5) of the “top 20” Opportunity Statements addressing the issue. Summit participants called for civil engineering departments to define for themselves a program of study to meet the needs of their stakeholders within very broad overarching guidelines. Such flexibility enables a more rapid response to technological changes in the profession; an integration of instruction addressing future roles of civil engineers; and an elevation of professional skills as a requirement of civil engineering education. These benefits must be balanced by a recognition of the benefit of having some degree of uniformity in education across the profession.

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## **OBJECTIVE 2:**

### **Elevate Professional Skills to a truly equal footing with technical skills.**

Certainly, the need for strong professional skills has long been recognized by both civil engineering educators and practitioners.

The ASEE “Grinter Report” (1955) included two outcomes related to this concept:

1. “An insistence upon the development of a high level of performance in the oral, written, and graphical communication of ideas”
2. “A continuing, concentrated effort to strengthen and integrate work in the humanistic and social sciences into engineering programs”

The Summary Report of the 1995 Civil Engineering Education Conference contained numerous recommendations related to professional skills, such as:

1. “Emphasize the need for sensitivity to culturally diverse groups”
2. “Encourage students to convey the importance of engineering works to non-engineering students on campus”
3. “Recognize communication skills, leadership skills, management, and teamwork by creating awards for students”
4. “Provide learning from non-verbal communication and listening skills”
5. “Provide industry speakers to emphasize the importance of communication skills, leadership, management, and teamwork”

The CEBOOK3, published in 2019, also recognizes this need. It includes six outcomes related to professional skills: communication, teamwork and leadership, lifelong learning, professional attitudes, professional responsibilities, and ethical responsibilities.

Multiple generations of educators and practitioners (1955, 1995, 2019) have thus recognized the necessity for professional skills in the successful civil engineer. It is curious, however, that these multiple generations were all moved to emphasize the need for increasing the level of professional skills in graduates – suggesting that the profession continues to lag in the development of these skills in our students.

Summit participants placed significant emphasis on this topic; of the 20 prioritized Opportunity Statements, seven (7) address professional skills and abilities. Moving forward, topics related to Professional Skills should be elevated in importance within curricula – to be thought

of not as "desirable," but "required," on an equal basis with the various technical/design skills currently emphasized in undergraduate programs.

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### **OBJECTIVE 3:**

#### **Develop a diverse, inclusive, equitable, and engaging culture within the civil engineering profession.**

Summit participants engaged in significant discussion regarding "professional culture" and related topics in the context of civil engineering. Although it may be tempting to place these topics and discussions within the realm of professional skills and attitudes, this subject rose to represent a major theme of the event. At least four (4) of the "top 20" prioritized Opportunity Statements address the concept of civil engineering culture. Participants explored the distinct yet interconnected nature of diversity, inclusion, and equity; the need to engage students at all levels; and the concept of permeating the student educational experience with these concepts. Summit participants suggested that the following elements need to be addressed by the entire profession, within both the education and practitioner communities:

- Dedicated and intentional instruction and training related to diversity, inclusion, and equity;
- Increasing representation within the profession—including student bodies, faculty ranks, and practitioners (at all levels);
- Modeling inclusivity and equity in the classroom and in the workplace; and
- Engaging students at all levels (K-12, college/university), and communicating the value of a civil engineering degree.

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### **OBJECTIVE 4:**

#### **Implement a regular schedule of national/international civil engineering education events and dedicate resources to address findings.**

Planners of the 2019 Civil Engineering Education Summit consulted a significant body of literature to explore topics and themes arising from previous assessments of engineering education. As noted earlier in this summary, there have been remarkable similarities in topical areas and themes arising from these efforts. Issues identified in the 1955 ASEE report continued to be identified 40 years later at the 1995 ASCE Conference.





# Conclusions

Summit participants agreed that the 2019 Civil Engineering Education Summit was highly worthwhile, and expressed both hope and confidence that real and significant change could result from the work accomplished during the Summit. Change will require:

- Ongoing commitment of the civil engineering community – educators and practitioners – to provide the time, effort, and resources necessary to develop, implement, and monitor actions arising from the Summit recommendations.
- A regular schedule of civil engineering education events, i.e., on a 6- to 8-year basis, to assess progress on initiatives from previous efforts and to address new challenges and opportunities.
- Support of academia and the profession, including ASCE, for resources required to develop and implement action items relating to the priorities identified at the Summit.

Continuing the momentum generated during the Summit will require time and resources from academia and the profession, including ASCE, to develop and implement action items relating to the priorities outlined above. To this end, the Committee on Education worked with the Summit Program Committee to approve and launch a CE Education Summit Working Group in April 2020. The working group, composed of leaders and participants of the 2019 Education Summit, is charged with generating ideas for specific action items related to the four Summit objectives and coordinating with ASCE to implement these actions through existing or new committees and initiatives.

In closing, Summit participants recognized that change in civil engineering education will require dedication to a shared vision and a collective willingness to work for it. As presented in summary remarks at

the conclusion of the Summit, advancement of civil engineering education will require three elements to TAP the innovation opportunities identified by participants:

- **Tenacity** to ensure that needed change occurs;
- **Audacity** to propose bold actions and tactics to fully realize necessary change; and
- **Practicality** to understand that necessary change can and must occur over different time scales.

Collectively, the vision proposed by the Summit participants is bold and far-reaching. The Opportunity Statements identify both near-term and long-term action areas that will position the civil engineering profession for continued advancement and leadership through the mid-21st century. As such, the findings of the Summit provide vital input to future initiatives such as revisions to the Civil Engineering Body of Knowledge (CEBOK), future formulations of the ABET Civil Engineering Program Criteria (CEPC), ASCE's Future World Vision, and to civil engineering curricula.



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The 2020 Civil Engineering Education Summit would not have been possible without the efforts of these volunteers and staff. Their dedication and hard work are greatly appreciated.

## Summit Program Planning Committee

- Kevin Hall (Co-Chair), University of Arkansas
- Dan Linzell (Co-Chair), University of Nebraska-Lincoln
- Barbara Minsker (Chair, Summit Local Organizing Committee), Southern Methodist University
- Robin Autenrieth, Texas AandM University
- Glenn Bell, Simpson, Gumpertz, and Heger
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- Stephen J. Ressler
- Matthew W. Roberts, Southern Utah University
- Leslie E. Nolen, ASCE

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Thanks also to the participants of the Summit who gave three days at the end of May 2019 to help envision a new path for civil engineering education. We look forward to following that path with you in the coming years!

## **Workshop Facilitators**

- Matthew Barkley
- Tina Barton
- Jessica Burnham
- Christina Donaldson
- Gray Garmon
- DiMitre Higginbotham
- Kindra Knight
- Edward Li
- Rae Van Parson
- Devon Skerritt
- Ginnie Snead Roark
- Victoria Sun Esparza
- Keya Tollossa

# Sponsors

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Sid and Reva Dewberry Department of Civil, Environmental, and Infrastructure Engineering



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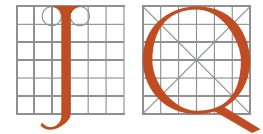
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# Appendix

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Appendix A: All Opportunity Statements . . 43

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Appendix B: Bibliography . . . . . 50

## Appendix A

# All Opportunity Statements

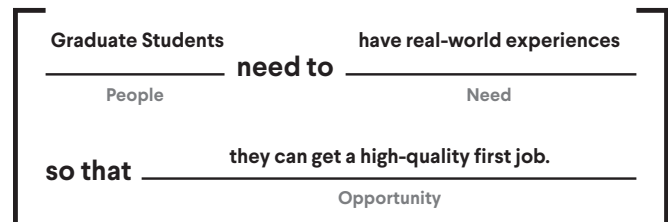
Note: This appendix has not been edited and may not reflect appropriate titles and terms.

Below are all of the opportunity statements that were created by the Summit attendees. The “Category” column indicates the general audience the statement is addressing, those who can take action on. The list is in alphabetical order by category.

The statements were created by using the example template to the right. This allowed attendees to take the needs and people surfaced from the previous activities and turn them into actionable statements. The statements

gathered below represent the ideas written by each table of attendees. The statements are to be read from left to right, broken up by the people, needs, and opportunity.

### EXAMPLE



Category	People	Need to	Opportunity
CE professionals	Civil engineering professionals	educate the public about infrastructure	government invests in infrastructure
CE professionals	Businesses / Industry	Collaborate with academia at a larger scale	Students are prepared to adapt to changing and evolving technologies
CE professionals	Civil engineering leaders	anticipate and leverage future needs	civil engineers are key decision makers in determining the future
CE professionals	CE professionals	well-developed power skills	they can be effective leaders
CE professionals	CE professionals	clear ethical sustainability guidelines	they make good decisions
CE professionals	Well-developed CE professional	fundamental understanding of cyber-security/tech	they can protect the built environment
CE professionals	Civil engineers	develop power skills	they are effective influencers of the decision makers
CE professionals	More engineers	assume public leadership roles and responsibilities	they can influence policy and funding decisions
CE professionals	Professionals	develop communication and marketing skills and technical skills	they value both equally and know the don't exist separately
CE professionals	Engineers	watch more cartoons	they are more creative
CE professionals	Civil engineers	adapt to emerging technologies	the discipline remains relevant
CE professionals	Problem solvers and all engineers	broaden participation	social inequities are eliminated and people can contribute to their full potential
CE professionals	CEs	get elected	so they can save the planet
CE professionals	Practicing civil engineers	be more people-focused	infrastructure meets the needs of all parts of society in equitable ways
CE professionals	Civil engineers	learn to play the policy game	they can foster rational infrastructure decision making
CE professionals	CE professionals	ensure inclusive practices	our solutions truly serve society's needs
CE professionals	Civil engineers	educate policymakers on implications of decisions	policymakers can choose reasonable policies

Category	People	Need to	Opportunity
CE professionals	Professionals	collaborate with educators	students are better prepared for a successful career in industry (public and/or private)
CE professionals	Civil engineers	embrace and lead change	as a profession we remain relevant
CE professionals	Civil engineering industry partners	provide experiential learning projects in the workplace	students can apply their knowledge learned in the classroom to solve real-world problems
Employers	Employers	need to create a work environment	employees have satisfying careers, retained long term, and fulfilled
Employers	CE employers and programs	adopt attractive culture and climate for all	we can attract and retain CEs who represent the society we serve
Employers	Employers	Provide scholarships and resources	Talented students are attracted to CEE
Employers	Employers	support lifelong learning through mentoring and financial support	student will continue to progress in the profession following graduation
Employers	Civil Engineering employers and industry	be accountable and upportive of high standards of practice	innovation can occur and communities are well served
Faculty	CE faculty	establish more visionary and flexible minimum standards	curricula can evolve more quickly and uniquely to enable embracing and addressing of worldwide challenges and opportunities
Faculty	Civil Engineering Faculty	Integrate and teach creativity and innovation into the curriculum	We can build a culture of innovation into the profession and create societal thought-leaders
Faculty	Faculty	adopt evidence-based instructional methods	critical thinking skills are developed by students to evaluate alternatives considering sustainability and equity for users
Faculty	Civil engineering faculty	equip students to understand equity and diversity	they can work inclusively in a global environment
Faculty	Faculty	new metrics for scholarly productivity	the promotions match those thinking forward and addressing the future needs of society
Faculty	Faculty, instructors, and CE supporters	Emphasize systems thinking	Sustainable, socially just infrastructure systems can be designed
Faculty	Faculty, practioners, and ASCE	appropriately and factually communicate to influencers and the public	they can impact policy infrastructure funding models and ensure implementation of long-lasting sustainable infrastructure
Faculty	Faculty	employ inclusive teaching practices	there is a diverse workforce to meet societal needs
Faculty	CE faculty	be able to work with faculty from other disciplines (EE, CS, geography...)	to develop relevant and exciting causes to retain students in CE and prepare them for the CE profession of the future
Faculty	Faculty	be provided incentives	our curriculum can evolve
Faculty	CE department chairs	develop a rubric	they recognize teaching, research, and service contributions
Faculty	All faculty	have critical conversations	they can work in multidisciplinary ways
Faculty	Faculty and CEE students	go into K-12	students can be exposed to and value CEE
Faculty	Faculty	create curriculum experiences	students appreciate global connectivity and engagement
Faculty	University faculty	remove barriers	they can meet transdisciplinary challenges
Faculty	Educators	modernize curriculum	students can meet new challenges
Faculty	Educators	modernize methods and materials	we can reach a diverse student population
Faculty	Civil engineering educators	be future-thinking	curriculum is flexible and adaptable to changing needs
Faculty	CE faculty	incorporate digital engineeering	students are prepared for emerging job opportunities

Category	People	Need to	Opportunity
Faculty	Faculty	Use advance pedagogical tools	The future needs of civil engineers and society are met
Faculty	CE faculty	develop and incorporate novel learning techniques	students are driven to and remain interested in CE
Faculty	Faculty	innovate curricula	students are better prepared to meet the challenges of the future
Faculty	Faculty and educators	reorganize away from traditional silos	graduates can better meet the needs of an ever-changing world
Faculty	Educators	embrace programmatic changes and educational opportunities	students can develop KSAs to innovate and create value for current and future society
Faculty	Faculty	acquire knowledge and skills	they can integrate new technologies into the curriculum to keep CE relevant
Faculty	Faculty	broaden their horizons	they can advance civil engineering education
Faculty	Educators	reimagine curriculum	CE students can solve problems of the future
Faculty	Faculty	have a clear understanding of the future	they can meet the future needs of students and society
Faculty	Engineering faculty	have growth and support	they can vary structure and location of education
Faculty	Faculty	use systems approaches	students can be trained to engineer civil systems
Faculty	Faculty	have flexibility	students receive the progressive curriculum we think they need
Faculty	Educators	embrace future innovative knowledge	students become change agents
Faculty	Faculty educators	resources and future admin duties + more time w/ student	they can improve/implement innovative experiential learning
Faculty	Faculty and current CE students	feel empowered as technology innovators and integrators	future graduates can define new higher value business models for the profession
Faculty	Faculty	change	we can teach the students of the future
Misc	ASCE	provide repository for future world teaching	change will be encouraged within a reasonable time
Misc	K-12 students	be exposed to future challenges	they know how CE can help them solve them
Misc	Industry-university consortia	Sponsor blue sky competitions with startup bootcamps and funding	An entrepreneurial pipeline can be built and students can be energized (sparkle)
Misc	AEC constituents	rethink degree paths	students can receive the education needed in their lifetime to fully benefit society
Misc	Accrediting bodies	foster flexible and adaptive program innovation	programs and curricula can rapidly adapt to current/future societal needs
Misc	Owners	trust highly skilled practitioners	they can make more informed, sustainable decisions
Misc	Developing communities	see civil engineer as a profession and CE education as a potential avenue for...	addressing social and cultural norms that have adversely affect their development
Misc	Faculty and students	understand importance of CE	CEs can prioritize public safety and environmental stewardship
Misc	Non-civil engineering professionals	value CEs (and vice versa)	our rapidly changing ways to deliver infrastructure services to best provide for society's needs
Misc	Policymakers/Elected Officials	know the value of infrastructure services	we can meet societal challenges
Misc	AI machines	be socially conscious	they benefit society
Misc	Parents of undergraduates	work together with faculty	undergraduates can get better education



Category	People	Need to	Opportunity
Misc	PEVs of ABET	clarify what they want	everyone can stop guessing
Misc	Underrepresented Minorities	Need to receive affordable education	They are successful
Misc	The Civil Engineering Community	Be mindful of the need of vulnerable population and communities	Access to sustainable infrastructure can happen
Misc	Students and faculty	mentored experiences	they develop as leaders in the profession
Misc	CE Teachers	provide data-driven experiences	analytical skills and competencies are cultivated and incorporated in design
Misc	Students, families, counselors, and teachers from under-resourced K-12 schools	be exposed to STEM opportunities and what civil engineers do / could do	they see the benefits to themselves and their communities
Misc	Aspiring engineers	be creative	they produce innovative and sustainable designs
Misc	K-12	understand quality of-life issues	they become more interested in CE
Misc	High school students	be prepared with the fundamental concept of civil engineering	
Misc	Leaders (stakeholders, practitioners, educators)	collaborate	the rate of innovation is increased
Misc	K-12 educators	know what civil engineers contribute	they can better prepare students for programs
Misc	Construction companies	invest in and drive innovative curricula	they have professionals they will need in the future
Misc	Decision makers	remove regulatory roadblocks	innovation can flourish
Policymakers	Policy and government leaders	collaborate with CE educators and professionals	they understand and develop solutions to infrastructure and providers
Policymakers	Policymakers	be educated on infrastructure	they can make more informed decisions to improve quality of life
Policymakers	Policymakers	have the future vision of diversity and inclusivity	public policy includes equity as a social focus
Policymakers	Industry and government	fund CE education	there is a vibrant CE workforce to design infrastructure to meet society's needs for sustainable, resilient infrastructure
Policymakers	Policymakers	understand implication of not investing in sustainable infrastructure	they will support sustainable infrastructure investment
Policymakers	Politicians	understand the long-term nature of public works projects (civil design)	multiyear megafunding can be applied to the public benefit
Policymakers	Public/politicians	support funding for infrastructure	designs/projects can improve quality of life
Society and Humans	Everyone	understand the consequences of their actions	we can build a better, sustainable, resilient world
Society and Humans	Society	appreciate technical knowledge	we can achieve a more equal, resilient, sustainable society
Society and Humans	Society at large	embrace sustainability	humans and the environment have a viable future
Society and Humans	Society	sustainable and resilient solutions	they can thrive for the next seven generations
Society and Humans	Society	have sustainable sources of shelter, water, and energy	they have a better quality of life
Society and Humans	Humanity	a clean environment	it does not cease to exist

Category	People	Need to	Opportunity
Society and Humans	Taxpayers	understand implications of not investing in sustainable infrastructure	they support investment in sustainable infrastructure
Society and Humans	Society	future/new technologies	they develop resilient and sustainable infrastructure for the future
Society and Humans	Society	understand the impact of CE on the quality of life	we can elevate the industry and profession
Society and Humans	Society and public officials	Be educated about sustainability	Long-term, resilient infrastructure planning is supported
Society and Humans	Influencers and the public	have the right information	appropriate, sustainable decisions are made about investments and policy in infrastructure
Society and Humans	Society	value/appreciate the problems of today and tomorrow	they will support investment
Society and Humans	General public	live in sustainable cities	we can exist in an equitable society
Society and Humans	Society (beneficiaries)	embrace sustainable development concepts and practices	the needs of a changing world are addressed and people flourish
Society and Humans	Community leaders	find / provide funding to support use of future technology	society's needs are fully met
Society and Humans	Society	understand, appreciate, and assign a higher value on civil and environmental engineering contributions	civil and environmental engineers can continue to offer sustainable solutions for future generations
Students	Students	study emerging area (data science, machine learning, strategic communities, automated design, systems engineering...)	they can design resilient and sustainable infrastructure
Students	Students	Need to build portfolios of experiences and knowledge inside and outside the classroom	they can bring systems thinking to current and future societal challenges
Students	Students	use personalized learning tools	they can engage in continuous learning after graduation
Students	Prospective students, including those interested in other professions	recognize the value of a BSCE degree as a foundation for any career path	we attract diversity to programs and have people educated in CE in all different types of careers
Students	Students	Develop power skills and people focus	They can design infrastructure relevant to society
Students	CE students	more integrated curriculum	they can tackle problems of the 21st century
Students	Engineering Students	the ability to incorporate new things	designs are resilient, adaptive, sustainable, and innovative
Students	Inadequately prepared students	access to bridge education	they can be successful in CE education and careers
Students	Entering "underprepared" and underserved students	do not need calculus	they can still study engineering because they have that "spark" but not privileged school systems
Students	Civil engineering students	have the attitudes, values, drives, disposition, optimism, and innovative spirit	they can identify and respond to future challenges
Students	Students	be empowered to innovate	they can adopt and be creative to meet unknown challenges
Students	Students	develop necessary foundational skills	they can develop innovative modern design in topic areas of need
Students	Students	have more participation in the development of their curriculum	they can build a career path that meets their unique skillsets—bioandCivil engineering

Category	People	Need to	Opportunity
Students	Students	curriculum advancements	they can protect the environment
Students	URM students	need to have a welcoming, supportive environment	future CEs can more effectively address diverse societal needs
Students	CE Students	think globally	they can be prepared to solve problems
Students	CE students	be exposed to a broad educational experience	they can innovate to solve tomorrow's problems
Students	CE students	have inclusive perspective	needs of stakeholders can be served equitably
Students	Students	power skills	can be leaders
Students	CE students	more education and practice in identifying and acting on their values	they are prepared to deal with ethical dilemmas
Students	Recent CEE graduates	understand regulatory process and constraints	influence public policy decisions
Students	CE undergrad students	develop digital computer skills	they can be prepared for future interdisciplinary engineering challenges
Students	Underprivileged students	mentoring and financial aid	they are successful at school and work
Students	CE students	have knowledge, skills, experiences, attitudes, and tools	they can effectively respond to future challenges
Students	Students	Develop foundational skills	they can develop innovative modern design in topic areas of need
Students	Non-traditional and under-represented students	flexible educational pathways	they can access education and flourish in their careers
Students	Prospective students, including those interested in other professions	recognize the value of a CE BS as an educational foundation for any career path	we can attract diversity and have influence in all aspects of society
Students	Future problem-solving professionals	have systems thinking knowledge	they can consider societal needs in sustainable infrastructure
Students	Students	learn power skills	they effectively collaborate and communicate their ideas to their team and a variety of audiences.
Students	Students	take ownership of their education	they can attain an independent and sustainable lifestyle
Students	Undergraduate students	be trained in the fundamentals	they have the background needed to succeed in their chosen specialty
Students	Students	develop technical and power skills	they are prepared to solve problems of the future
Students	Students	an attitude and value system	enables them to efficiently serve society
Students	Learners	continuously seek new knowledge	new technologies are brought into the practice
Students	Engineering students	have intuition and social consciousness	they can have critical conversations
Students	High school students	be prepared with the fundamental concept of civil engineering	they know what skills they should learn as a qualified engineer
Students	CE students	develop a growth mindset	they can engage in lifelong learning
Students	Undergraduate and graduate students	have flexible curriculum (i.e., not over-constrained by ABET or faculty inertia or institutional hurdles)	they can manage change (e.g., climate change, demographics, and materials)
Students	CE undergrad students	create large-scale physical models along with classic calculations	have a deeper understanding of fundamental concepts

Category	People	Need to	Opportunity
Students	New minds	motivated and inspired	we have a diverse, engaged future civil engineering workforce
Students	Students	mature	they don't waste resources
Universities	Universities/colleges	form consortia	emerging topics can be team taught with holographic participation
Universities	University administrators	Need to be open to change and provide support (financial, administrative, structural)	New curricular approaches are encouraged
Universities	Universities	develop a culture of equity and inclusion	we produce a better prepared diverse workforce
Universities	Institutions	reward faculty for acquiring new skills	they will expend the effort to improve their knowledge base
Universities	Administrations	establish incentives	faculty can conduct transdisciplinary projects
Universities	Universities	reorganize and reincentivize	interdisciplinary collaboration will prosper
Universities	Universiites	create faculty positions	student needs for teaching and research are met

## Appendix B

# Bibliography

ASCE (1995) "Summary Report: 1995 Civil Engineering Education Conference (CEEC '95)." American Society of Civil Engineers, Denver, CO, June 8-11, 1995.

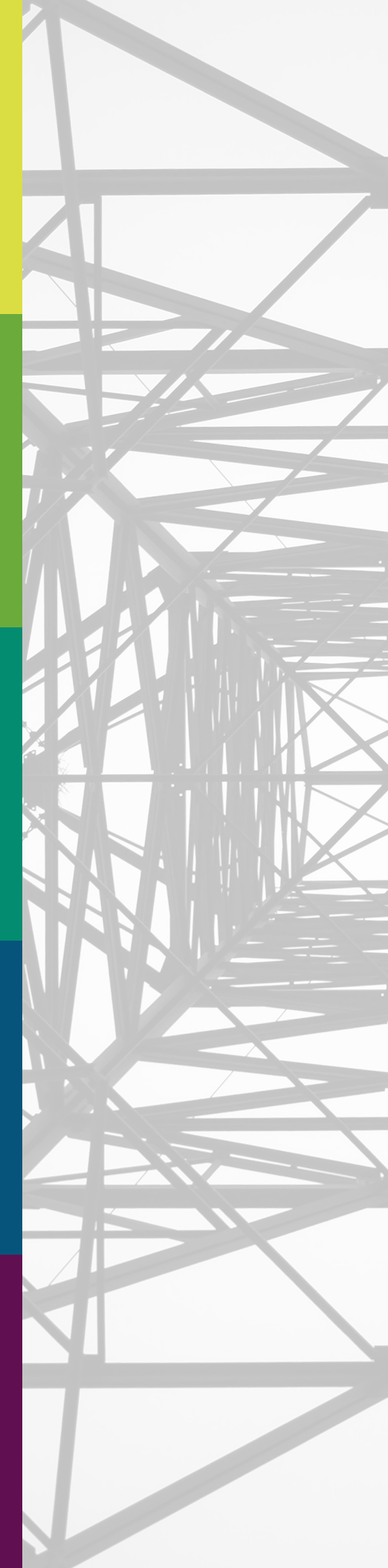
ASCE (2019) "Civil Engineering Body of Knowledge: Preparing the Future Civil Engineer," 3rd Edition, American Society of Civil Engineers, Reston, VA, 2019.

ASCE (2006) "The Vision for Civil Engineering in 2025," American Society of Civil Engineers, Reston, VA, 2006.

ASEE (1955) "Summary of the Report on Evaluation of Engineering Education," Journal of Engineering Education, American Society for Engineering Education, Washington, DC, September 1955, pp. 25-60.

NAE (2005) "Educating the Engineer of 2020: Adapting Engineering Education to the New Century." National Academy of Engineering, Washington, DC, 2005, pp. 1-5.

MIT (2018) "The Global State of the Art of Engineering Education." Graham, Ruth, Massachusetts Institute of Technology, Cambridge, MA, 2018, pp. ii-iv.



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