

Civil Engineering: A Liberal Education Degree of the 21st Century

Dr. Emily F. Cutrer, Texas A&M University-Texarkana

Emily F. Cutrer is President of Texas A&M University-Texarkana. Prior to this appointment in 2013, she served as Provost and Vice President of Academic Affairs at California State University San Marcos and dean of the New College of Interdisciplinary Arts and Sciences at Arizona State. She earned B.A., M.A., and Ph.D. degrees in American Studies at the University of Texas at Austin.

Miss Melissa M. Nelson,

Ms. Melissa Nelson has received a Bachelor of Science in Political Science with a minor in International Relations, from the University of Texas at Tyler in 2016. She received a Master of Arts in Human Rights and Global Ethics from the University of Leicester in the United Kingdom in January 2019. Her research interests are in the area of government, policy, and international relations.

Dr. James K. Nelson Jr. P.E., Texas A&M University System

Dr. James K. Nelson received a Bachelor of Civil Engineering degree from the University of Dayton in 1974. He received the Master of Science and Doctor of Philosophy degrees in civil engineering from the University of Houston. During his graduate study, Dr. Nelson specialized in structural engineering. He is a registered professional engineer in three states, a Chartered Engineer in the United Kingdom, and a fellow of the American Society of Civil Engineers. He is also a member of the American Society for Engineering Education and the SAFE Association. Prior to receiving his Ph.D. in 1983, Dr. Nelson worked as a design engineer in industry and taught as an adjunct professor at the University of Houston and Texas A&M University at Galveston. In industry he was primarily involved in design of floating and fixed structures for the offshore petroleum industry. After receiving his Ph.D., Dr. Nelson joined the civil engineering faculty at Texas A&M University. He joined the civil engineering faculty at Clemson University in 1989 as Program Director and founder of the Clemson University Graduate Engineering Programs at The Citadel and became Chair of Civil Engineering in 1998. In July 2002, Dr. Nelson joined the faculty at Western Michigan University as Chair of Civil and Construction Engineering. At Western Michigan he started the civil engineering undergraduate and graduate degree programs and also chaired the Departments of Materials Science and Engineering and Industrial Design. In summer 2005 he joined the faculty at The University of Texas at Tyler. At UT Tyler he was the founding chair of the Department of Civil Engineering and instituted the bachelor's and master's degree programs. In 2006 he became the Dean of Engineering and Computer Science. Dr. Nelson returned to Texas A&M University in 2016 as the Director of Special Academic Initiatives for the Texas A&M University System. Dr. Nelson's primary technical research interest is the behavior of structural systems. For almost 25 years he has been actively involved in evaluating the behavior of free-fall lifeboats and the development of analytical tools to predict that behavior. His research has formed the basis for many of the regulations of the International Maritime Organization for free-fall lifeboat performance. Since 1988, Dr. Nelson has served as a technical advisor to the United States Delegation to the International Maritime Organization, which is a United Nations Treaty Organization. In that capacity, he is a primary author of the international recommendation for testing free-fall lifeboats and many of the international regulations regarding the launch of free-fall lifeboats. He has authored many technical papers that have been presented in national and international forums and co-authored three textbooks. Dr. Nelson chaired a national committee of the American Society of Civil Engineers for curriculum redesign supporting the civil engineering body of knowledge. He is actively engaged in developing strategies for enhancing the STEM education pipeline in Texas and nationally, and has testified before the Texas Senate and House Higher Education Committees in that regard. He served on a committee of the Texas Higher Education Coordinating Board to develop a statewide articulation compact for mechanical engineering and chaired the councils for developing articulation compacts in other engineering and science disciplines. He also served on the Texas State Board of Education committee preparing the standards for career and technical education.

Civil Engineering: A Liberal Education Degree of the 21st Century

Abstract

In the 2004 report “The Engineer of 2020,” the National Academy of Engineering makes the bold contention that engineering is the liberal education of the 21st-Century. This contention stands in contrast to more widespread notions about engineers, in general, and civil engineers, in particular. A 2010 article entitled “Engineering Perception” in *AICHE ChEnected* indicates that engineers see themselves as "book-smart," "socially challenged," and "myopic," hardly the characteristics of a liberally educated individual. A 2011 article in *IEEE Insights* entitled “Engineers: Public Perception Matters” states that “In the US, however, almost no engineers or scientists are engaged in high-level politics, and there is a virtual absence of engineers in our public policy debates.” And yet another editorial in *Leadership and Management in Engineering* in 2004 indicates that many perceive civil engineering in particular as no longer being considered a serious field of pursuit, that it does not have the cutting edge cachet of other fields more popular in the 21st century. The authors of this paper, while taking exception to the negative popular perceptions of civil engineering, offer a refinement on the National Academy’s view by contending, that civil engineering is not just a liberal education, but that it might well be seen as the archetypal liberal education degree of the 21st century. This contention, the authors believe, is supported by the Civil Engineering Body of Knowledge, the ASCE Code of Ethics, and state licensing laws for engineering. In this paper the authors discuss a 21st-Century liberal education and its historic roots and then demonstrate why civil engineering is indeed a liberal education of the 21st-Century.

Genesis and Introduction

The 21st century presents challenges for students that have not been seen before. For the first time in decades, students graduating from high school may not be in a better economic position than their parents. Further, the challenges students face include:

- ◆ A more ethnically, culturally, and theologically diverse population;
- ◆ A diminishing middle class; and
- ◆ Employment prospects that did not exist when they entered grade school.

Students graduating with marketable skills is a topic discussed in many state legislatures and national educational circles. Marketable skills are those needed for successful (?)employment and career development. The Texas Higher Education Coordinating Board (THECB) has implemented an initiative to ensure that all students attain marketable skills as part of their higher education. 60x30TX is a statewide plan developed by the THECB to enhance the workforce of the state through higher education. As stated in the introduction to the plan:

“Texas has become increasingly engaged in a global economy dependent on skilled and knowledgeable workers. Most of those workers come from higher education. Although Texas is improving at increasing college completions for students from groups that traditionally have not earned certificates or degrees

in large numbers, the state has not improved quickly or broadly enough to keep up with the changes in demographics. Completions in Higher education must reflect the population as a whole. [1].

The report continues to state that:

While continuing to pursue increased knowledge and higher standards of excellence in teaching, research and innovation, two- and four-year colleges in Texas will need to consider more explicitly the primary reason most students attend college: to get a better job and achieve a better life. [1]

A primary outcome of the 60x30TX initiative relevant to our discussion is the following:

By 2030, all graduates from Texas public institutions of higher education will have completed programs with identified marketable skills: The marketable skills goal emphasizes the value of higher education in the workforce. Students need to be aware of the marketable skills embedded in their academic programs, and institutions must make certain that students graduate with marketable skills.

Industry is also weighing in criticizing the skills being taught versus the skills that are needed. There is a significant skills gap. Soffel [2] reported that:

“The gap between the skills people learn and the skills people need is becoming more obvious, as traditional learning falls short of equipping students with the knowledge they need to thrive.” [2]

In light of this, the natural question arises as to what educational experiences a student should have in the 21st century and what are the skills expected by industry? The World Economic Forum (WEF) reports that:

To thrive in the 21st century, students need more than traditional academic learning. They must be adept at collaboration, communication and problem-solving, which are some of the skills developed through social and emotional learning (SEL). Coupled with mastery of traditional skills, social and emotional proficiency will equip students to succeed in the swiftly evolving digital economy [3]

Table 1: Top 10 skills for success [4]

In 2015	In 2020
Complex problem solving	Complex problem solving
Coordinating with others	Critical thinking
People management	Creativity
Critical thinking	People management
Negotiation	Coordinating with others
Quality control	Emotional intelligence
Service orientation	Judgement and decision making
Judgement and decision making	Service orientation
Active listening	Negotiation
Creativity	Cognitive flexibility

The skills a young man or woman needs for success are evolving. Alex Gray referenced how the skills needed for success will change in the period from 2015 to 2020 [4]. This evolution is presented in Table 1. Two skills have come onto the list for 2020, Cognitive Flexibility and Emotional Intelligence, while two others have dropped off the 2015 list, Quality Control and Active Listening. Others are expected to change priority between 2015 and 2020.

The expectation of the Texas Higher Education Coordinating Board and the skills that have been identified by the World Education Forum (WEF), Soffel, and others have all the earmarks of a liberal education. In this context, the concept of a liberal education should not be confused with political concepts of liberal versus conservative, of left-wing versus right-wing, nor should it be conflated with liberal arts (which may or may not provide a liberal education). A liberal education provides the education and skills necessary for employment, as well as life as a socially responsible citizen.

In this paper, the concept of a 21st-century liberal education is explored and then compared to a civil engineering education. The objective of the exercise is to demonstrate that civil engineering is not only a technical education but is also a liberal education, a liberal education for the 21st century. If so, then the observation of several individuals that engineers are not engaged in other than technical matters and that civil engineering is a dying profession not worthy of scholarly study should be seen as stereotypes to be overcome.

What is a Liberal Education?

The concept of a liberal education is not new and originated with the Greeks. Sarah Bronson notes:

The ancient Greeks identified seven "artes liberales," areas of study which they considered to be important for all educated citizens to know: the "trivium," or three lesser disciplines (studied first) were grammar, logic and rhetoric; students then went on to the "quadrivium" of arithmetic, geometry, astronomy and music. The Greeks therefore founded the principle that people in an educated society should have exposure to a broad range of studies including communication, math, science and arts, and that all these studies should have an underpinning of logic and critical thinking [5].

Over time, the content of a liberal education has changed, as the needs of the broad workforce have changed. The Association of American Colleges and Universities (AACU) defines a liberal education as:

Liberal Education is an approach to learning that empowers individuals and prepares them to deal with complexity, diversity, and change. It provides students with broad knowledge of the wider world (e.g. science, culture, and society) as well as in-depth study in a specific area of interest. A liberal education helps students develop a sense of social responsibility, as well as strong and transferable intellectual and practical skills such as communication, analytical and problem-solving skills, and a demonstrated ability to apply knowledge and skills in real world settings. [6]

To begin a discussion of liberal education, and of civil engineering in the context of a liberal education, the difference between a liberal education and a liberal arts education must be understood. In this regard:

The term liberal education in the modern sense should not be confused with liberal arts education; the latter deals with academic subjects, while the former deals with ideological subjects. Indeed, a liberal arts education does not necessarily include a liberal education... [7]

The AACU further states that:

“The broad goals of liberal education have been enduring even as the courses and requirements that comprise a liberal education have changed over the years” [6].

Bronson [5] put a liberal education into a more global perspective when he said:

“A student who earns a B.A. in Liberal Studies has demonstrated an interest in exposing himself to as wide a variety of disciplines as possible and learning as much as he can about the world and the ways people experience it” [5]

Flannery [8] noted the value of a liberal education when he wrote:

However much America—and the world—needs technically skilled workers and professionals, there can be no doubt of the critically greater need for liberally educated citizens and human beings, who can distinguish good from evil, justice from injustice, what is noble and beautiful from what is base and degrading [8].

Upon examination, the knowledge and skills that appear to be captured in these descriptions of a liberal education are:

- ◆ Communication,
- ◆ Culture and society,
- ◆ Social responsibility,
- ◆ Mathematics,
- ◆ Science,
- ◆ Arts,
- ◆ Logic,
- ◆ Critical thinking,
- ◆ In-depth study in an area of interest, and
- ◆ Demonstrated ability to apply knowledge in a real-world setting.

Notice that the last item is ability to apply. That is a skill, not just knowledge, and it is an ability that is at the heart of the Civil Engineering Body of Knowledge.

The WEF identified 16 skills in three areas that students should develop. These skills, which are shown in Figure 1, embrace and can be developed through a liberal education. This would be the liberal education of the 21st century. Interestingly, the grouping of these skills parallel words used by the American Society of Civil Engineers (ASCE) when describing the content of the

Civil Engineering Body of Knowledge (CEBOK): the knowledge, skills, and attitudes necessary. Foundational literacies parallels knowledge, competencies parallels skills, and character qualities parallels attitudes.

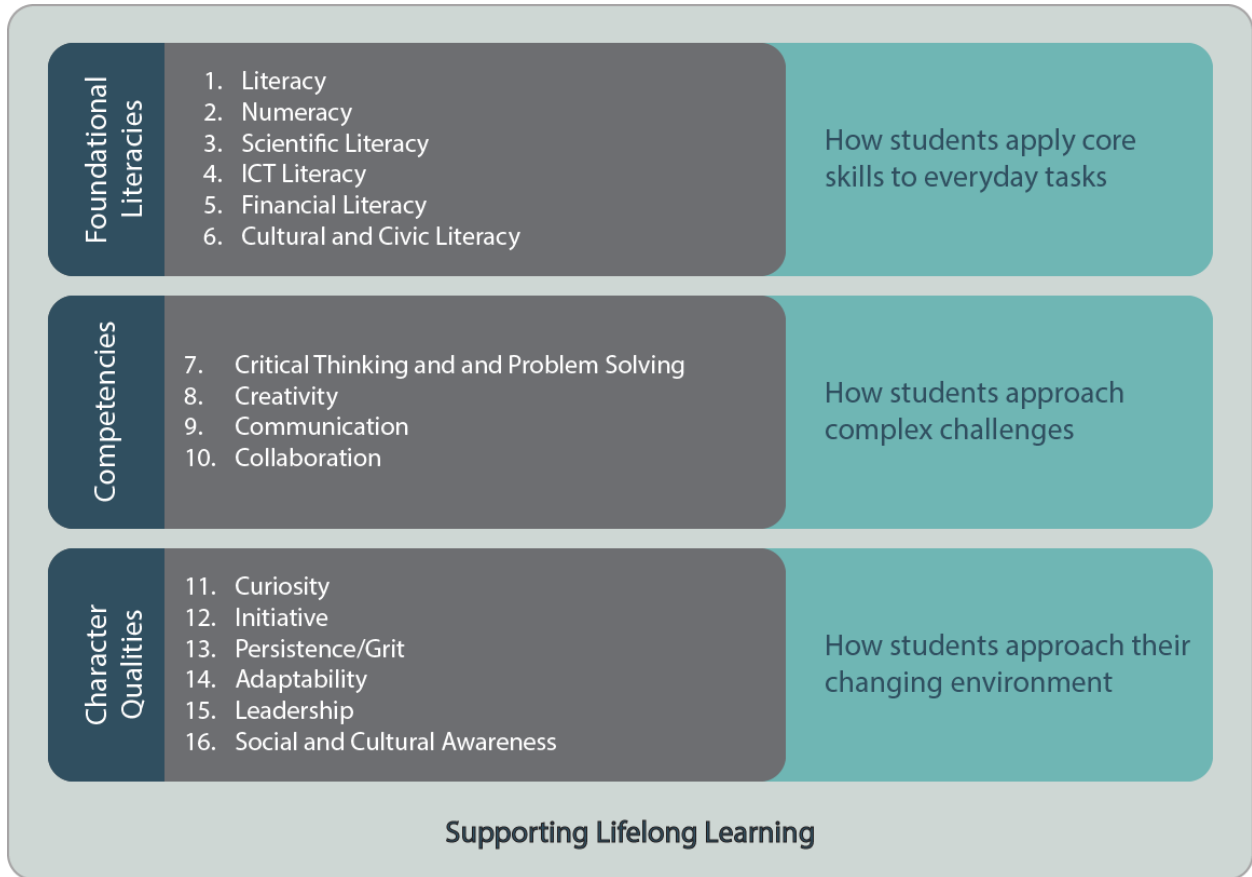


Figure 1: Skills for the 21st century [3]

Some would contend that these skills are taught through the core curriculum, which is often housed in a College of Liberal Arts. But there is a question: Does the core curriculum provide the skills needed for success as some would contend? Presented in Table 2 are the core curriculum requirements of institution in three different states: Texas, Illinois, and South Carolina.

Table 2: A brief comparison of core curriculum requirements

Illinois [9] Public 4-Year 39 Semester Credit Hours	Texas [10] All Texas Public Universities 42 Semester Credit Hours	South Carolina [11] Public 4-Year 33 Semester Credit Hours
<ul style="list-style-type: none"> ◆ Foundation Skills (13) <ul style="list-style-type: none"> • Inquiry (1) • Communication (3) • Composition (6) • Mathematics (3) ◆ Disciplinary Studies (23) <ul style="list-style-type: none"> • Fine Arts (3) • Human Health (2) • Humanities (6) • Science (6) • Social Science (6) ◆ Integrative Studies (3) 	<ul style="list-style-type: none"> ◆ Communication (6) ◆ Mathematics (3) ◆ Life and Physical Sciences (6) ◆ Language, Philosophy and Culture (3) ◆ Creative Arts (3) ◆ American History (6) ◆ Government/Political Science (6) ◆ Social and Behavioral Sciences (3) ◆ Component Area (6) 	<ul style="list-style-type: none"> ◆ Communication (6) <ul style="list-style-type: none"> • English Composition (3) • Oral Communication (3) ◆ Mathematics, Scientific and Technological Literacy (10) <ul style="list-style-type: none"> • Mathematics (3) • Natural Science & Lab (4) • Math or Natural Science (3) ◆ Arts and Humanities (6) <ul style="list-style-type: none"> • Literature (3) • Non-Literature (3) ◆ Social Science (6) ◆ Cross-Cultural Awareness (3) ◆ Science and Technology in Society (3) ◆ Academic and Professional Development (2)

Although the number of credit hours varies, the contents of the core curricula are very similar. In Table 3 the 21st-century skills from Figure 1 are mapped with the core curricula where one might assume they are developed. When preparing this mapping there is a fundamental assumption that critical thinking is developed, which may or may not be accurate.

Table 3: Mapping 21st-century skills with core curriculum

21 st -Century Skills	Core Curriculum
Literacy	Communication
Numeracy	Mathematics
Scientific literacy	Laboratory science
ICT literacy	
Financial literacy	
Cultural and civic literacy	Social and behavioral science, History
Critical thinking / problem solving	Assumed developed
Creativity	Creative arts, Fine arts
Communication	Communication
Collaboration	
Curiosity	
Initiative	
Persistence / grit	
Adaptability	
Leadership	
Social and cultural awareness	Political science, Cultural awareness

Several of the 21st-century skills do not appear to be explicitly addressed through the core curriculum. Perhaps most importantly are those related to digital literacy, financial literacy, and the skills related to teamwork and leadership. The conclusion drawn is that completion of the

core curriculum does not explicitly assure achievement of a 21st-century liberal education. Several of the 21st-century skills are not explicitly addressed in the core curriculum.

Civil Engineering in the Context of Liberal Education

As this discussion begins, all should be able to accept that a civil engineering education provides a student with marketable skills. The focus of this section will be to demonstrate how a civil engineering education is a liberal education in addition to a technical education.

The expected outcomes of an engineering education are presented in the accreditation policies of ABET, Inc. [12]. Accredited programs must have documented student outcomes that prepare graduates to attain the program educational objectives. The student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

Table 4: Mapping ABET outcomes with 21st-century skills

ABET Outcomes	21 st Century Skills for Success
(a) an ability to apply knowledge of mathematics, science, and engineering	2. Numeracy 3. Scientific Literacy
(b) an ability to design and conduct experiments, as well as to analyze and interpret data	7. Critical Thinking/Problem Solving
(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability	6. Cultural and Civic Literacy 8. Creativity
(d) an ability to function on multidisciplinary teams	10. Collaboration 15. Leadership
(e) an ability to identify, formulate, and solve engineering problems	7. Critical Thinking/Problem Solving
(f) an understanding of professional and ethical responsibility	6. Cultural and Civic Literacy 16. Social and Cultural Awareness
(g) an ability to communicate effectively	9. Communication
(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context	16. Social and Cultural Awareness
(i) a recognition of the need for, and an ability to engage in life-long learning	11. Curiosity 12. Initiative
(j) a knowledge of contemporary issues	16. Social and Cultural Awareness
(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice	4. ICT Literacy 7. Critical Thinking/Problem Solving
	5. Financial Literacy
	13. Persistence / Grit
	14. Adaptability

As with the core curriculum, some of the skills identified as necessary in the 21st-century are not explicitly addressed. These include financial literacy, adaptability, and persistence. Simply by achieving the outcomes of ABET a student does not necessarily achieve a liberal education.

The student outcomes for programs to be accredited in the 2019-2020 have been changed [12]. Presented in Table 5 is a comparison of those modified skills as was presented in Table 4 for the current criteria. Observe that the same three skills are still missing, although it could be argued that adaptability is a skill for functioning as part of a team.

Table 5: Mapping 2019-2020 ABET outcomes with 21st-century skills

ABET Outcomes	21 st Century Skills for Success
1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics	2. Numeracy 3. Scientific Literacy
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors	4. ICT Literacy 6. Cultural and Civic Literacy 7. Critical Thinking/Problem Solving 8. Creativity
3. an ability to communicate effectively with a range of audiences	9. Communication
4. an ability to recognize ethical and professional responsibilities in engineering situations and make informed judgments, which must consider the impact of engineering solutions in global, economic, environmental, and societal contexts	6. Cultural and Civic Literacy 16. Social and Cultural Awareness
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives	10. Collaboration 15. Leadership 16. Social and Cultural Awareness
6. an ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions	7. Critical Thinking/Problem Solving
7. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies.	11. Curiosity 12. Initiative
	5. Financial Literacy
	13. Persistence / Grit
	14. Adaptability

Civil engineering is one of the professions that has explicitly defined its needed body of knowledge [13]. Further, this body of knowledge is periodically reviewed to ensure that it

remains relevant. Within its Body of Knowledge, ASCE defines the knowledge, skills and attitudes necessary for professional practice. Because of this three-pronged focus, ASCE defines a liberal education for civil engineers.

Table 6: Mapping ASCE BOK with 21st-century skills

21 st -Century Skills	ASCE Body of Knowledge
Literacy	1. Mathematics 2. Natural Sciences 3. Humanities 16. Communication
Numeracy	1. Mathematics
Scientific literacy	2. Natural sciences 5. Materials science 6. Mechanics 7. Experiments
ICT literacy	8. Problem recognition and solving
Financial literacy	18. Business and public administration
Cultural and civic literacy	3. Humanities 4. Social sciences 17. Public policy 24. Professional and ethical responsibility
Critical thinking / problem solving	8. Problem recognition and solving
Creativity	9. Design 12. Risk and uncertainty
Communication	16. Communication
Collaboration	21. Teamwork
Curiosity	8. Problem recognition and solving 23. Lifelong learning
Initiative	22. Attitudes
Persistence / grit	22. Attitudes
Adaptability	21. Teamwork 22. Attitudes
Leadership	13. Project management 20. Leadership 21. Teamwork 22. Attitudes
Social and cultural awareness	10. Sustainability 11. Contemporary issues & historical perspectives 19. Globalization

Outcomes 14 and 15, breadth in civil engineering areas and technical specialization, are implicitly included in multiple 21st-century skills. Further, these two outcomes are explicit in the in-depth study in an area of interest, one of the characteristics of a liberal education previously identified. The 23rd outcome, lifelong learning, is associated with curiosity, but it is an underpinning of the 21st-century skills as was shown on Figure 1.

In the 2004 report “The Engineer of 2020,” the National Academy of Engineering makes the bold contention that engineering is the liberal education of the 21st-Century. Despite the fact that this contention stands in contrast to more widespread notions about engineers, in general, and civil engineers, in particular, the data presented herein shows that civil engineering, in addition

to being a technical education, is a liberal education providing the necessary skills for success in the 21st-century. A significant reason for this is that civil engineering through its Body of Knowledge addresses all three legs of the stool: knowledge, skills, and attitudes.

Negative Perceptions of Engineering

A 2010 article entitled “Engineering Perception” in *AICHE ChEnected* indicates that engineers see themselves as "book-smart", "socially challenged," and "myopic," hardly the characteristics of a liberally educated individual. A 2011 article in *IEEE Insights* entitled “Engineers: Public Perception Matters” states “In the US, however, almost no engineers or scientists are engaged in high-level politics, and there is a virtual absence of engineers in our public policy debates.” Another editorial in *Leadership and Management in Engineering* in 2004 indicates that many perceive civil engineering in particular as no longer being considered a serious field of pursuit, that it does not have the cutting edge cachet of other fields more popular in the 21st century.



Figure 2: Civil engineering employment profile [14]

The negative perceptions of civil engineering are unfounded when one considers the liberal education that civil engineering provides and the breadth of employment for civil engineers. Consider the civil engineering employment profile in Figure 2 developed by the Texas Higher

Education Coordinating Board [14]. A civil engineer, by nature of his or her education, is prepared for multiple industry sectors ranging from private practice to technical sales to public administration.

There likely are elements of truth, however, in that comments that there is a lack of engineering in public policy debates and high-level politics. Although civil engineers do serve as expert witnesses in these regards, greater engagement can and should occur. After all, a large part of the national infrastructure development and redevelopment, and the associated trillion-dollar cost, will be addressed by civil engineers. In that regard, there are two areas in which a civil engineering education can make change, namely:

- ◆ Reinforce the links between the core curriculum and the practice of civil engineering. Develop within the student a stronger integration between the technical and the non-technical subjects.
- ◆ Reinforce the concepts of public responsibility, of service in an elected office.

Concluding Remarks

In this paper, the authors have documented the relationship between an education in civil engineering and the need for individuals with liberal education in the 21st century workplace. They have concluded that a civil engineering education promises more thorough development of the knowledge, skill, and attitudes of a liberal education needed in the 21st century than either a traditional core curriculum required at many universities or even ABET's most recent accreditation criteria. Thus, they have concluded that civil engineering might well be seen as THE model for liberal education in the 21st century.

The benefits to the practice of civil engineering are significant. The thorough development of the knowledge, skills, and attitudes associated with liberal education encourages civil engineers to exercise innovative and creative approaches to design problems, while also ensuring that they are attuned to the cultural, social, and political ramifications of those approaches. It promises to benefit society by showing our young civil engineers that their work is not isolated from other problems needing creative approaches but that the work of a civil engineer can be an essential part of answers to pressing economic and cultural issues across the globe. Our job now is to ensure that our civil engineering students graduate with a deeply engrained recognition of these intentional connections.

Acknowledgements

The authors wish to thank the RELIS Liberal Education Task Committee for their comments during discussions regarding the 21st-century liberal education. Without question, those discussions have strengthened the arguments put forward in this paper.

References

- [1] THECB, "60x30TX," Texas Higher Education Coordinating Board, Austin, 2015.
- [2] J. Soffel, "What are the 21st-Century Skills Every Student Needs?," 10 March 2016. [Online]. Available: <https://www.weforum.org/agenda/2016/03/21st-century-skills-future-jobs-students/>.
- [3] World Economic Forum, "New Vision for Education: Fostering Social and Emotional Learning through Technology," 2016.
- [4] A. Gray, "10 skills you need to survive in the Fourth Industrial Revolution," 19 January 2016. [Online]. Available: <https://www.weforum.org/agenda/2016/01/the-10-skills-you-need-to-thrive-in-the-fourth-industrial-revolution/>.
- [5] S. Bronson, "Difference between Liberal Arts & Liberal Studies," [Online]. Available: <https://classroom.synonym.com/difference-arts-amp-liberal-studies-6504648.html>.
- [6] AACU, "American Association of Colleges and Universities," 2018. [Online]. Available: <https://www.aacu.org/leap/what-is-a-liberal-education>.
- [7] Wikipedia, "Liberal Education," 16 March 2018. [Online]. Available: https://en.wikipedia.org/wiki/Liberal_education.
- [8] C. Flannery, "Liberal Arts and Liberal Education," June 1998. [Online]. Available: <http://ashbrook.org/publications/onprin-v6n3-flannery/>.
- [9] Southern Illinois University, 2018-2019 Academic Catalog, Carbondale, 2018.
- [10] THECB, Texas Core Curriculum Application Guide, Austin: Texas Higher Education Coordinating Board, November 2015.
- [11] Clemson University, 2017-2018 Undergraduate Announcements, Clemson: Clemson University, 2017.
- [12] ABET, Inc., "Criteria for Accrediting Engineering Programs, 2018-2019.," 2018. [Online]. Available: <http://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2018-2019/>.
- [13] ASCE, Civil Engineering Body of Knowledge for the 21st Century, 2nd ed., Reston, VA: American Society of Civil Engineers, 2008.
- [14] THECB, "Tuning Civil Engineering," Texas Higher Education Coordinating Board, Austin, 2011.

[15] L. D. Shinn, "Liberal Education vs. Professional Education: The False Choice," 19 March 2018. [Online]. Available: <https://www.agb.org/trusteeship/2014/1/liberal-education-vs-professional-education-false-choice>.