
AC 2011-1304: INTEGRATION OF HUMANITIES AND SOCIAL SCIENCES INTO CIVIL ENGINEERING EDUCATION

Jeffrey C. Evans, Bucknell University

Jeffrey Evans is Professor and Chair of the Department of Civil and Environmental Engineering at Bucknell University. He joined Bucknell in 1985 after professional experience with Woodward-Clyde Consultants and serving as an officer in the US Army Corps of Engineers (Reserves). He earned his BSCE from Clarkson University, his MSCE from Purdue University and his PhD in Civil Engineering from Lehigh University.

Humanities and Social Sciences in Civil Engineering Curricula

Abstract

In the current edition of the Body of Knowledge, the Civil Engineering profession recognizes the careers of the future civil engineer need to be underpinned by education in the humanities and social sciences as well as mathematics and natural sciences. While civil engineering is a technical discipline and the strong technical education must continue, two new program outcomes, one each in humanities and social sciences have been included. The inclusion of these two outcomes in the second edition of the Body of Knowledge now makes explicit that the contributions of civil engineers are largely to and for human society. Humanities include subjects such as art, philosophy and literature while social sciences include subjects such as political science, economics, sociology and psychology.

But how is education in social sciences and humanities currently incorporated into a student's undergraduate education? This paper compares and analyzes the approach to humanities and social science education taken by several different universities in their civil engineering programs. The most common approach can be termed cafeteria style, where students pick and choose courses that meet program criteria for "approved" social science and humanities electives. Also common is the requirement for some depth in one area as well as breadth through studies in several areas.

This study, while limited in scope, confirms what perhaps was already known through anecdotal information available to those interested in civil engineering education. That is, an analysis of the programs examined for this paper finds that civil engineering curricula are rather uniform in their course requirements in the humanities and social sciences. Further the study affirms that current curricular requirements are consistent with the older ABET criteria (prior to EC 2000) that included a requirement for a minimum of one-half year of humanities and social science courses and a requirement for both "breadth and depth."

Introduction

Recent reports have affirmed the importance of humanities and social sciences for the 21st century engineer. The National Academy of Engineering Report, *The Engineer of 2020*¹ identified three visions for the profession, one of which states "We aspire to engineers who will remain well-grounded in the basics of mathematics and science and who will expand their vision of design through solid grounding in humanities, social sciences and economics." The American Society of Civil Engineers, in the first edition of the Body of Knowledge (BOK)², identified the requirement for a broad education. In the second BOK, ASCE promulgated specific foundational outcomes for mathematics, natural sciences, humanities and social sciences.^{3,4} This paper explores the curriculum of selected civil engineering programs as it relates to program requirements in the humanities and social sciences.

Humanities and social sciences, along with mathematics and natural sciences, are at the core of liberal learning. The humanities include subjects such as art, history and literature while the social sciences include subjects such as economics, political science, sociology and psychology. Traditional engineering education emphasizes mathematics and sciences and the role of humanities and social sciences has not been emphasized. Currently, out of ABET's eleven educational outcomes, only one relates directly to humanities and social sciences ("the broad education necessary to understand the impact of engineering solutions in a global and societal context").

The humanities and social sciences are an essential part of an engineering education because they contribute to understanding the context of problems. The solution to any given engineering problem depends, in part, on the richness of the engineer's understanding of context. Thinking must be systematic and guided by analysis and assessment of relevant information (i.e. critical thinking). As noted elsewhere⁵, a critical thinker⁶:

- 1) raises vital questions and problems, formulating them clearly and precisely;
- 2) gathers and assesses relevant information, using abstract ideas to interpret it effectively, comes to well-reasoned conclusions and solutions, testing them against relevant criteria and standards;
- 3) thinks open-mindedly within alternative systems of thought, recognizing and assessing, as need be, their assumptions, implications, and practical consequences; and
- 4) communicates effectively with others in figuring out solutions to complex problems.

A civil engineer whose education includes substantial grounding in humanities and social sciences along with mathematics and natural sciences is more likely to recognize the impact of the engineering decisions upon both the mathematics, natural science and engineering questions as well as the more broadly framed questions informed by social sciences and the humanities.

The need for humanities and social sciences is thus well established and the conversation is not new. In 1951 Sawyer, in a paper entitled *Humanities for Engineering Students*, wrote "What happened to the languages, literature, history, and social studies - cornerstones of a college education when engineering was first introduced?" More recently, our current approach is arguably captured in 2004 by Olken⁷ when he writes "Let's see...math; science; a few hours of history, humanities, and social sciences; a quick course or two in economics, and presto-chango-an engineer is born." In 2002 Grasso noted⁸ "Engineering faculty members cannot simply consign young students to the other side of campus for humanities classes and consider our obligation for providing a broad and liberal education fulfilled." Given the long-standing recognition of the need for humanities and social sciences in engineering (by some at least), the more recent affirmations of the need by ASCE and NAE, and the changes in ABET requirements now in place for over ten years, an examination of current curricula is in order.

Curricula in Humanities and Social Sciences

An examination of the curricula of five top-rated⁹ (USNEWS, 2010) civil engineering programs was undertaken. Schools were chosen from the top 10 programs in the various categories to include a cross-section of programs including:

- Program A: a private school whose highest degree is a BSCE (Rose-Hulman)
- Program B: a private school whose highest degree is an MSCE (Bucknell University)
- Program C: a public school whose highest degree is an MSCE (Cal Poly San Luis Obispo)
- Program D: a private school whose highest degree is a Ph.D. (Cornell University)
- Program E: a public school whose highest degree is a Ph.D. (UC-Berkeley)

It must first be noted that programs use various means and methods to achieve their outcomes and achieving outcomes in humanities and social sciences is no different. Any review of program curricula is therefore limited to an examination of courses offered and any other specifically identified curricular requirements and does not capture teaching means and methods that no doubt vary from course to course and program to program. With these limitations in mind, it is still useful to examine course requirements in the curricula of selected programs.

Program A: A total of 32 quarter credit hours consisting of eight courses in humanities and social sciences are required in this program on the quarter system. This represents 16% of the program since the program requires a total of 194 quarter credits. All students are required to take a specified first-year course called Rhetoric and Composition. Half of the humanities and social science courses are in the first two years of the curriculum and the other half are in the senior year. This approach would seemingly provide the opportunity for both foundational knowledge in humanities and social sciences as well as later integration of engineering education with humanities and social sciences. This approach can be termed cafeteria style.

Program B: A total of five courses of four credit hours each (20 credit hours) in humanities and social sciences are required in this program. This represents 15% of the program since the program requires 32 courses (128 credit hours). All students are required to take a first year course in literature and composition (students choose among several such courses) as well as at least one more course in the humanities. The program also requires a minimum of two courses in the social sciences. Of the five courses, two must be from the same department or at least one course must be at the 200 level or above. Finally, one of the courses must satisfy the University's Global and Societal Perspectives requirement. Courses can be chosen from a list of approved humanities and social science courses approved for all engineering students. Courses are approved (or not-approved) by the Curriculum Committee of the Engineering College and generally speaking, skills courses are not approved (i.e. piano lessons, painting, etc.). Humanities and social science courses are concentrated in the first two years of the curriculum on the basis that these are foundation courses to civil engineering. The literature and composition course is designated a "W" or writing course which fulfills the one of the three writing across the curriculum requirements. Others writing intensive courses are delivered within the engineering courses. This approach can be termed cafeteria style where students can

pick and choose albeit with some constraints. These constraints are aimed at requiring breadth and depth as well as instruction in writing and an awareness of Global and Societal Perspectives.

Program C: A total of 40 quarter credit hours consisting of eight courses in humanities and social sciences plus two courses in communications are required in this program on the quarter system. This represents 16% (or 20% with the communication skills courses) of the program since the program requires a total of 196 quarter credits. The communication requirement includes a course in expository writing and another in oral communication. Within the humanities, students must take a literature course, a philosophy course, a fine or performing arts course and an upper division humanities elective. Within the social sciences, students must take a specified course called the American Experience, a political economy course, a comparative social institutions course and a self-development course. This program has a higher degree of specificity than those at Schools A or B in that the areas of study of humanities and social sciences are specified. This approach can also be termed cafeteria style, as students choose humanities and social science electives within various categories.

Program D: A total of 18 semester credit hours consisting of six courses in liberal studies are required in this program. This represents 14% of the program since the program requires a total of 126 semester credits. Liberal studies courses consist of humanities and social sciences organized in seven different groupings such as cultural analysis, literature and the arts, and social and behavioral analysis. The six courses must be chosen from at least three of the seven groups and at least two of the six courses must be at the second year level or higher. This approach can be termed cafeteria style where students can pick and choose albeit with some constraints. These constraints are aimed at requiring breadth and depth.

School E: A total of 24 semester credit hours consisting of six courses in humanities and social Sciences are required in this program. This represents 20% of the program since the program requires a total of 120 semester credits. Of these six courses, two must be approved reading and composition courses and the remainder from a listing of approved courses. Two of the courses must be upper division courses. In a sample curriculum, the humanities and social science courses are spread uniformly across the four year curriculum. This approach can be termed cafeteria style where students can pick and choose albeit with some constraints. These constraints are aimed at requiring breadth and depth.

Additional schools: In addition to the five schools whose programs are detailed above, the curricula at six other schools was examined and found to be consistent with the findings above and the following assessment of curricular approaches. Details of the curricula at the additional schools add no value to the paper and have not been included.

Assessment of Curricular Approaches

The five schools selected are very different institutions ranging from private to public, from BS only to Ph.D. granting and from east to west coast. However, their approaches to humanities and social science course requirements are very similar. The commonalities include:

1. A requirement for humanities and social sciences coursework that is between 14% and 20% of the overall student's course requirement.
2. A first year course involving literature and composition.

3. A constrained choice of electives in humanities and social sciences.
4. Constraints that assured students were instructed in a variety of areas within the humanities and social sciences.
5. Constraints that assured students were instructed at a level beyond introductory level.

As noted earlier in this paper, ASCE's Body of Knowledge, 2nd edition, identifies four foundational outcomes. There is one outcome each in mathematics, natural sciences, humanities and social sciences. Relevant to this paper, students, at the time of graduation, must:

1. Demonstrate the importance of humanities in the professional practice of engineering.
2. Demonstrate the incorporation of social sciences knowledge into the professional practice of engineering.

The action verbs for these outcomes indicate that students, upon graduation, will achieve Level 3 (Application) of Bloom's taxonomy.

The assessment of curricula conducted for this paper provides no insight into how individual programs enable their students to make the connections between their course requirements in humanities and social sciences and the professional practice of engineering. Presumably, those connections are made in engineering classes. One obvious difficulty (if a common knowledge base is expected in humanities and social sciences) is that individuals within any group of students in a civil engineering class will have studied a variety of different topics in their humanities and social science electives. There is a lack of a common experience upon which to draw. Alternatively, if the goal is to facilitate critical thinking that incorporates a human and social context, then the specific topic of study is not important. The current approach, at least as taken by the five programs examined, leans more towards the latter.

It is important to note that the ABET criteria prior to EC 2000 required a minimum of one-half year of humanities and social science courses and a corresponding requirement for both "breadth and depth." An analysis of the programs examined for this paper leads to the conclusion that little has changed in civil engineering programs from the perspective of coursework in the humanities and social sciences.

Summary and Conclusions

An examination of the humanities and social science requirements in the curricula of selected civil engineering programs was undertaken. The study revealed most students are required to take one or two specific courses along with a selection of additional electives from a menu of approved courses. These approved courses do not usually include skills courses but rather the courses that explore the discipline. Humanities and social sciences courses appear to constitute between 14% and 20% of the courses required for an undergraduate degree in civil engineering. Requirements are established to guide student choices for instruction that encompasses both breadth and depth. The explicit connection between student learning in humanities and social science courses to BOK2 outcomes, if any, were not revealed in this study.

This study, while limited in scope, confirms what was likely already considered known through anecdotal information available to those interested in civil engineering education. That is, an analysis of the programs examined for this paper finds that civil engineering curricula are rather

uniform in their course requirements in the humanities and social sciences. Further the study affirms that current curricular requirements are consistent with the older ABET criteria (prior to EC 2000) that included a requirement for a minimum of one-half year of humanities and social science courses and a requirement for both “breadth and depth.” From these findings it appears there has been little curricular change with respect to humanities and social sciences.

Recommendations

It is likely that a few programs have indeed altered their approach to their students’ education in humanities and social sciences. These changes in approach may not be reflected in curricular changes in humanities and social sciences but rather in the courses within the discipline. It is suggested that novel approaches can be revealed through an explicit call for papers on this topic for the next ASEE meeting. A session examining if, or how, programs are leading students to make the important connections between the technical dimension of engineering and the human and social dimension of engineering is recommended. As a supplement to the findings of this study it would be useful to collect more data and conduct a survey of department heads is recommended to more fully investigate if and how curricula and programs have responded to the call for greater integration of humanities and social sciences in their students’ civil engineering education.

Further, it would be useful to determine if there general agreement on why the humanities and social sciences are important¹⁰ to civil engineers. Also needed is an examination of learning outcomes in our student’s humanities and social sciences courses and how students are learning.¹¹ Then the educational goals could be matched to the education outcomes in a way that would point to areas of improvement in our students’ education. For example, based upon this study and other anecdotal information, it is believed there remains an strong need for greater integration of humanities and social sciences into the civil engineering curriculum. Ways to accomplish this integration need to be further explored including team teaching with humanities and social sciences faculty.

One of the most difficult aspects of this problem is the measurement of outcomes, both in the short-term and the long-term. For example, in the long-term, we might expect an increase in civil engineers in roles as public policy makers and in political positions.

Our profession has made an enormous leap forward in the establishment of explicit outcomes in humanities and social sciences in the 2nd edition of the Body of Knowledge. The next step is to explore how we can best educate our students for the civil engineering profession of the 21st century. In so doing, we can fulfill the Vision for Civil Engineering in 2025¹².

Acknowledgements

The author appreciates the input from Dr. Stephen Buonopane of Bucknell University and the helpful suggestions from the reviewers of the draft paper.

References

- ¹ National Academy of Engineering, *The Engineer of 2020*, The National Academies Press, Washington, DC 2004, 101 pp.
- ² Engineering Body of Knowledge for the 21st Century, ASCE, Reston, VA, 2004.
- ³ Civil Engineering Body of Knowledge for the 21st Century, 2nd edition, ASCE, Reston, VA, 2008.
- ⁴ Evans, J. C. and Lynch, D. R., “Foundational Outcomes of the New Civil Engineering Body of Knowledge, *Proceedings of the 2007 ASEE Annual Conference & Exposition*, Pittsburgh, PA, June 23-25, 2008.
- ⁵ Evans, J. C. and Lynch, D. and Lange, D. “The Role of Humanities and Social Sciences in the Civil Engineering Body of Knowledge,” *Proceedings of the 2007 ASEE Annual Conference & Exposition*, Honolulu, Hawaii, June 24-27, 2007
- ⁶ Foundation for Critical Thinking, “The Critical Thinking Community,” (<http://www.criticalthinking.org/>)
- ⁷ Olken, M., “Reengineering Education” IEE Power and Energy Magazines, May/June, 2004 pp. 85, 86, 88.
- ⁸ Grasso, D., “Engineering a Liberal Education,” ASEE Prism, Nov. 2002 pp. 76.
- ⁹ US News and World Reports <http://www.usnews.com/rankings>, 2010.
- ¹⁰ Lynch, D. R., Russell, J. S., Mason, J. M. and Evans, J. C. “Claims on the Foundation: Professionalism and its Liberal Base,” *ASCE Journal of Professional Issues in Engineering Education and Practice*, Volume 135, Issue 3, pp. 109-116 (July 2009).
- ¹¹ Lynch, D. R., Russell, J. S., Evans, J. C. and Sutterer, K. G. (2008), “Beyond the Cognitive: The Affective Domain, Values and Achievement of the Vision,” *ASCE J. of Professional Issues in Engineering Education and Practice*, Vol.135, No.1, pp.47-56. (January 2009).
- ¹² The Vision for Civil Engineering in 2025, ASCE, 2007.