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Civilizing the Civil Engineer: How a History Course Can Serve as a Curriculum Capstone

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Abstract

Beginning in 1989 and then every other year thereafter, a unique course dealing specifically with the History of Civil Engineering has been taught to all Civil Engineering majors at the University of Dayton. What has evolved over time -- in response to student feedback, ongoing reform in the curriculum, and a maturing of faculty expertise -- is a course in the history of civilization that has as its major focus the discipline of civil engineering.

In reality, what happens in the classroom is a far broader learning experience than either the disciplines of history or civil engineering could provide standing alone. A true body of coherent interdisciplinary knowledge has crystallized -- a synergistic product -- that brings together both non-verbal and verbal thinking. And as the semester unfolds, students develop a chronological perspective concerning the ideas, practices, and institutions associated with civil engineering.

The substantial and visible works of civil engineers --bridges, buildings, and transport technologies -- are artifacts that both reflect the specific culture out of which they were created and simultaneously serve as focal points to the definition of that culture. And it is these structures that are the starting point for the discussion of important themes that transcend time, space and indeed the material world. Thus, such topics as the significance of societal priorities; the place of people within their environment; the role of mathematics within the design process; the balance between the functional and the aesthetic; and the significance of organizational structures to the creation of new technologies, are lectured upon and discussed throughout the term.

In sum, this historical course serves as a catalyst to unify areas of knowledge that have typically been presented to students in discrete "chunks," during their academic careers. With a better sense of themselves and their profession, it is hoped that they will be better prepared to lead and to make the difficult decisions that undoubtedly await them.

Introduction

In 1983, the University of Dayton Faculty Senate approved a far-reaching curriculum reform document calling for a new structure of the undergraduate curriculum that had as one major focal point a General Education component. This component, required of all students at the University, consisted of a base of ten 3 credit hour courses, including 2 courses in history. Typically, the first history course that a student enrolled in was a Western Civilization offering, while the second was an upper level history course that was directly linked to a student's major. In this way, students were to gain a fuller and more complete sense of their chosen professions and the place of these professions in our culture over the broad sweep of time. Some of the upper level offerings that were developed in response to this mandate included courses in the History of Science and Technology, Economic and Business History, History of Psychology, and the History of Mathematics. While the History Department was at the hub of much of this 2nd course development, occasionally departments in the social sciences or the arts developed their own courses in consultation with the History Department.

During the first few years of implementation, the Civil Engineering Department registered its juniors and seniors into the History of Science and Technology offerings and, if necessary, other courses. Under the leadership of its Chairman, Dr. Fred Bogner, this unit desired for a more specific, meaningful and integrated 3 credit hour offering, and contacts with the History Department followed. In 1987 I was asked to develop a course in the History of Civil Engineering that was to be offered every other year to approximately 50 Juniors and Seniors. With a background in chemistry and Ph.D. in the History of Science, I knew very little about structures, bridges, loads, and building materials, and found myself in deep waters without knowing how to swim. But with the financial assistance of a Provost-funded General Education Course Development Grant, allocated specifically for such needs, the course was developed during the summer of 1988 and then first offered for the first time during the 1988-89 academic year. This "History of Civil Engineering " course has now been taught 4 times during the past 8 years, and has evolved to its current state in response to changes internal to the Civil Engineering disciple, the availability of published materials and multi-media, as well as student feedback.

To complicate matters a bit, General Education within the University has evolved considerably during the decade 1983 to 1993, with a call made in the early 1990s for revisions in which professionalism was deemphasized and the notion of "values" emphasized. In actuality little was changed in classroom practice, but certainly ideas, issues and themes once more implicit were now made more explicit, and indeed served as focal points or reference(and relevance) touchstones.[1]

Course Structure and the Selection of Readings

When I began designing this course, little was available in terms of models to use as an initial template. I first contacted the American Society of Civil Engineering, and corresponded with Neale FitzSimons, who had played a leading role from the 1960s to the 1980s in developing historical programs within the ASCE. I learned from FitzSimons that while a "History of Civil Engineering" had been taught at one time at Iowa State University, that course was no longer offered and hence my

course, if developed and implemented, would be unique among history courses taught at American universities. I also quickly discovered that while FitzSimons had arranged for the publication of many articles that touched upon the heritage associated with the field of Civil Engineering, these works would not, in my judgement, be well received by the typical undergraduate who demanded readable prose.[iii]

In surveying the historical literature on civil engineering beyond leads provided by the ASCE, I quickly discovered that precious little has ever been written by anyone -- historians of technology or engineers -- and if something was written, one could almost wager that it was overly detailed in terms of technology and at the same time weak with regards to broad historical context. That said, an excellent bibliography on the history of Civil engineering had just appeared in print as I started my project, and that work, prepared by Darwin Stapleton, was the starting point for my efforts. Even if many of the citations could not be used as readings in an undergraduate class, they often provided the foundation for the development of my knowledge on this subject, and could be used in the preparation of lectures.[iv]

After considerable effort, and some trial and error, a "canon" of readings emerged that are intimately tied to the following chronological course outline[v]:

I Introduction - Liberal Learning & Why Engineers Lose Touch[v]
II The Ancient World and its Mysteries
III The Roman Empire[vi]
IV From the Dark Ages to the Renaissance -- Castles & Cathedrals[vii]
V European Engineers during the Age of Absolutism
VI The Enlightenment and Industrial Revolution[viii]
VI Engineering and the Republic: Transportation in 19th c. America[ix]
VI The Emergence of the Professional Engineer[x]
VII Urbanization and Public Health in the 19th c.[xi]
VIII John Roebling and the "Great Bridge"[xii]
IX Technology and Imperialism -- Egypt, India and Panama[xiii]
X Skyscrapers[xiv]
XI Subways Highways, Tunnels in an Emerging "Car Culture"[xv]
XII The Age of Concrete[xvi]
XIII The TVA, Golden Gate, and the 1930s[xvii]
XIV New Structures and New Visions: Buckminster Fuller and Space[xviii]
XV Post WWII Environmentalism[xix]

Of course, the "canon" is never really fixed; new essays are introduced from year to year as they are discovered, and some materials are dropped due to changes in the fine structure of the course or student interests. The most important source of new readings is undoubtedly the quarterly American Heritage of Invention and Technology; these very lively and engaging articles can be supplemented by occasionally useful essays contained in the far more scholarly(and at times deadly!) Technology and Culture.

The Use of Multi-Media -- Film

From the beginning of teaching this course to the present, film has been a very significant pedagogical tool in the classroom. Used judiciously, video teaches students in ways that no lecturer using the printed page can. Since this generation of students has typically been one that has grown up with many hours of television watching, and also perhaps even more significantly, because engineering students possess such a strong component of non-verbal thought patterns, film makes a critical contribution to the achievement of positive learning outcomes in the classroom. And to avoid a "dog and pony show" mentality, the use of writing assignments after viewing forces students to connect what was seen with ideas derived from lectures and readings, thus completing an intellectual process that fosters critical thinking on several levels.

Films used in this course include:

"The Sacred & Mysterious: Stonehenge"(Readers'Digest)
"The Great Pyramids"(Discovery)
"Castle"(PBS)
"Cathedral"(PBS)
"I, Leonardo"
"The Great Bridge"(PBS)
"The Path Between the Seas"(PBS)
"Subway"(A&E)
"The Architecture of Frank Lloyd Wright"(BBC)
"America by Design"(PBS)
"Golden Gate"(Discovery)
"Roadsters, Rumbleseats and Country Drives"
"Secret Agent"(Max Gail)

Learning Objectives

What I hope students completing the course will take with them, includes the following: an understanding of how chronology and time are critical to formulating a sound historical understanding; a recognition of the subtle yet powerful relationship that existed between the needs, values and priorities of a society and the structures that are subsequently built; an appreciation for the practical techniques and knowledge that enabled the erection of remarkably sophisticated structures by seemingly "backward" civilizations; a sense of the evolution and role of mathematics and theory within the discipline of civil engineering; an awareness that the sponsors of technology have often influenced the course of civil engineering; and finally, that history civil engineering can be clearly articulated in verbal class discussions and in coherent essay and papers.

Student Evaluations

In my experience in teaching this course and others at the University of Dayton, the following conclusions about students and what we can learn from their evaluation responses can be summed up as follows. First, the civil engineering students tend to be better writers and far more interested in history than their counterparts from other disciplines, including perhaps history! Secondly, and with some exceptions, that while enthusiastic, these students do not like to read extensively, and are not accustomed to write under pressure in timed-test situations. That said, the students enrolled in the History of Civil Engineering at the University of Dayton have had an uncommon interest in improving the course for the next class two years down the road; in a sense, many have staked an ownership to the course that I have not found in any other offering.

While formal computed generated student evaluations point to several vague areas where students felt that improvements could take place, written comments tended to be far more explicit as to the offering's strengths and weaknesses. And, it is of interest to note that one very recent student written comment, authored by a non-traditional student who had just retired from a career in civil engineering, had this to say concerning what the course had potentially to offer those who have careers waiting in the future:

> You have masterfully explained how many subtle factors, beyond technical merit, influence construction projects. Political climate, social customs, personalities, economic situations, legal implications, religious beliefs, individual daring, societal desires and needs, timing of technical innovations, and judgement(poor) -- all these factors enter the big picture.
>
> Your course exposes students to these important realities, at their career starts. In my 40 year career as a civil engineer, I learned most of these matters by hard experience. I was 15 years into my career before many of them became clearly evident. Many of my early career mistakes could have been avoided, if I had been exposed to a course like yours in college.[xx]

In conclusion, civil engineering is the oldest of the engineering disciplines and also the first, beginning in the 19th century, to become fragmented by the professional forces demanding specialization. And with specialization and intensified professionalization holistic concepts about knowledge and its interrelatedness went out the window. But as we approach the end of the 20th century the very complexity of our times has enhanced the value of a broad-based liberal education, one in which the longer term rather than the immediate is taken into account. If flexibility is the key to the 20th century, then historical knowledge cannot be sacrificed, and indeed must be reinserted into the engineering curriculum, if coherency is to be gained, or regained, as the case may be.

Endnotes

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[i] Beginning in 1995 this offering was part of a so-called "cluster" of 3 selected courses to be selected from a number of different disciplines that center about the theme of Values, Technology and Society. And while much could be discussed here about the injection of values into the course, the theme of societal values and their expression in the dominant structures of a specific culture is an idea that transcends time and space, and therefore can be used to link one period and place to another. Professional integrity also is discussed on several occasions, with the comparisons between John Roebling and Theodore Cooper and John Wallace and John Stevens as two good examples of how to and not to pursue one's professional career.

[ii] Among the materials I received from the ASCE -- all useful in lecture preparation but not as course readings – were ASCE Guide to History and Heritage Programs(ASCE, 1984) and "Engineer as Historian: A Series of Historical Columns written by Neal FitzSimons that Appeared in Civil Engineering magazine from 1965 to 1973." Other ASCE publications of note include A Biographical Dictionary of American Civil Engineers(ASCE, 1972); The Civil Engineer: His Origins(ASCE, 1970); and Augustine J. Fredrich, Sons of Martha: Civil Engineering Readings in Modern Literature(ASCE, 1989).

[iii] Darwin H. Stapleton and Roger L. Shumaker, The History of Civil Engineering Since 1600: An Annotated Bibliography(Garland, 1986).

[iv] See Appendix for an attached syllabus listing a typical schedule of lectures, discussions, readings and assignments.

[v] Samuel Florman, The Civilized Engineer, pp. 1-17; Eugene Ferguson, "How Engineers Lose Touch," American Heritage of Invention and Technology(Hereafter referred to as AHIT), (Winter, 1993), 16-24.

[vi] J.G. Landels, Engineering in the Ancient World, chapters 2 and 7.

[vii] Jean Gimple, The Medieval Machine, chapters 6 and 7; Aurelia C. Scott, "Ancient Tech," AHIT(Summer, 1993), 35-44.

[viii] William Keener, "The Great Iron Bridge," Timeline(May, 1986), 34-38; Joseph Gies, "The Genius of Oliver Evans," AHIT(Fall, 1990), 50-57.

[ix] R.S. Allen, Covered Bridges of the Northeast, chapters 1 and 2; Edith McCall, "The Attack of the Great Raft," AHIT(1988), 10-17; John Tabor, "Engineering the Erie Canal," AHIT, 50-57.

[x] David Noble, America By Design, pp. 20-49.

[xi] Gerald Koeppel, "A Struggle for Water," AHIT(Winter, 1994), 19-31; Sebastian Junger, "The Pumps of New Orleans," AHIT(Fall, 1992), 42-48; T.A. Heppenheimer, "The Man Who Made Los Angeles Possible," AHIT(Summer, 1991), 11-18.

[xii] David McCullough, The Great Bridge, pp. 21-121; John Tabor, "A Disaster in the Making," AHIT(Spring, 1986), 10-17.

[xiii] David McCullough, The Path Between the Seas: The Creation of the Panama Canal, pp. 403-618.

[xiv] Carl Condit, "Sullivan's Skyscrapers as the Expression of Nineteenth Century Technology," Technology and Culture, (1959), 78-93; Tom F. Peters, "The Rise of the Skyscraper from the Ashes of Chicago," AHIT(Fall, 1987), 14-23.

[xv] Bruce Seely, "The Scientific Mystique in Engineering: Highway Research at the Bureau of Public Roads, 1918-1946," Technology and Culture, 25(1984), 798-831; Ernest A. McKay, "Tunnelling to New York," AHIT(1988), 22-33; T.A. Heppenheimer, "The Rise of the Interstates," AHIT(Fall, 1991), 8-18.

[xvi] Carl Condit, "The Ingalls Building in Cincinnati and Its Place in Structural History," Technology and Culture, 9(1968), 1-33.

[xvii] Christopher Bonanos, "The Father of Modern Bridges," AHIT(Summer, 1992), 8-20; Margaret Coel, "A Bridge that Speaks for Itself," AHIT(Summer, 1987), 8-17.

[xviii] Amy Edmonson, "Who was Buckminster Fuller, Anyway?," AHIT(Winter, 1988), 18-25; "Maxime Faget,", in Michael Brown, Inventors at Work.

[xix] Rachel Carson, Silent Spring, chapters 1-4 and 17.

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[xx] William F. Klosterman to author, April 24, 1995.