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History and Heritage as a Vehicle for Contemporary Issues

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History and Heritage as a Vehicle for Contemporary Issues

Abstract
At the University of Utah, the required introductory course for students seeking major status in civil and environmental engineering utilizes the history and heritage of civil engineering to begin developing professional knowledge and skill sets. Topical areas include contemporary issues, leadership, ethics, professionalism, and the significant interactions of society and engineering. This paper describes the organization and delivery of the course, its connection to ASCE's Body of Knowledge, and the means of assessment of student achievement.

Introduction

At the University of Utah, students interested in civil and environmental engineering enroll in CvEEN 1000, Introduction to Civil and Environmental Engineering. The course is required of all BSCE seeking students. General goals of typical university introductory courses exist in CvEEN 1000 as well, including: (a) build community within the student cohort and with the department, (b) introduce students to relevant campus and professional organizations, (c) acclimate students to university life, and (d) provide a broad understanding of a profession and its associated field of study. As such, the course satisfies several of the general university requirements for introductory courses. For the Civil and Environmental Engineering Program, the course specifically supports achievement of selected BOK outcomes including the areas of communication, teamwork, contemporary issues, leadership, ethics, and the broader interactions of society and engineering.

Since its inception in the early 2000's, CvEEN 1000 has consistently used the history and heritage of the profession as a vehicle for course delivery. In recent years, the course has more deeply integrated contemporary issues and history and heritage via two primary class activities: an instructor-guided study of an historic civil engineering project or event (the Example Project), and a team-based student research project of a different historic or significant contemporary project. The instructor-guided project introduces the students to a large variety of civil engineering related topics. It also provides a role model and example by which student groups then research and present (orally and in written form) an assigned out-of-class historic project. For much of the life of the course, the Panama Canal served as the Example Project. More recently, the Great Flood of 1927 on the lower Mississippi River was the Example Project.

Student activities throughout the course are designed to not only create positive engagement in the course material but are also specifically designed to enable measurement (assessment) of student achievement. Integral elements include student presentations (written and oral), incorporation of leadership and ethics, discussion of the broader interactions of society and engineering practice, and a professional practice perspective of civil engineering projects. This paper discusses assessment of the top-down design of the course and assessment measures, how

this course fits into a larger BOK-inspired program (a structure that has been in place for nearly 15 years), and presents the analysis of student products including direct and indirect methods.

Background – University of Utah's 3 Course Sequence that creates a Professional Spine

In the early 2000's, the Department of Civil & Environmental Engineering at the University of Utah refocused their undergraduate program to more integrally support professional skill set related outcomes. These outcomes included communication, public policy, business, public administration, globalization, leadership, teamwork, professional ethics and responsibility, and the context of professional practice and design. Driven perhaps more directly by local stake holders in the program, the new direction inherently aligned with the national vision expressed by ASCE in early draft versions of ASCE's Body of Knowledge 1[1] (BOK1) and ASCE's Policy 465[2]. Although developed independently of BOK 1 and its second edition (BOK 2)[3], the implementation of the curricular changes and improvements tracked closely to that of the ASCE vision. (To avoid unnecessary delineation between BOK 1 and BOK 2, this paper refers hereafter to them collectively as the BOK, being more specific only as needed.)

Table 1 illustrates how a three course sequence in the CvEEN program contributes towards BOK-related outcomes. This paper is predominantly about the first course in the sequence: CvEEN 1000 Introduction to Civil and Environmental Engineering, CvEEN 3100 Technical Communications for Civil Engineers, and CvEEN 4910 Professional Practice & Design. CvEEN 4910 is the capstone course for the program. All three classes are required for graduates of the department's baccalaureate programs. Each is a one semester experience.

Table 1 Professional Skills Outcomes and Courses in the Utah CvEEN Program

U. of Utah CvEEN Course ID	**Semester Credit Hours** (Contact hours including group work)	**Course Title**	**BOK Professional Related Outcomes***									
			Communication	Business	Public Policy	Globalization	Contemporary	Leadership	Teamwork	Attitudes	Lifelong Learning	Responsibility
1000	2 (3)	Introduction to Civil and Env. Engr.	C	K	K	K	K	K	K			K
3100	3 (3)	Tech. Comm. for Civil Engineers	Ap				C	Ap	Ap	K	C	C
4910	3 (6)	Professional Practice & Design	ES	Ap	Ap	An	An	An	An	Ap	ES	Ap

* Desired student performance level using Bloom's Taxonomy: K = Knowledge, C = Comprehension, Ap = Application, An = Analysis, ES = Evaluation and/or Synthesis

The contact time exceeds the course credit in the 1000 and 4910 courses to reflect the organized time made available for group work. A fourth course, MG EN 1050 Technical Communications is not included here as it solely addresses the technical skill of using a computer drawing tool (CAD) and does not address the broader issues that are encompassed in the professional "spine."

In essence, these three courses create a "vertical" professional spine through the curriculum. Specifically, three courses were designated as the vehicle for delivering and assessing learning experiences for most of the professional skill sets identified in the BOK. Table 1 identifies the related BOK outcomes for each course and the desired level of achievement using Bloom's Taxonomy of Educational Objectives[4] as a basis for performance. The sequence was designed to begin development of skills in the first semester (CvEEN 1000), broaden and deepen them in the fifth or sixth semester (CvEEN 3100), and culminate the development in the eighth semester (CvEEN 4910).

In each of the three courses, a learn-by-doing paradigm is implemented. The culminating course, CvEEN 4910, is similar to many senior-level capstone design courses now common throughout the nation. A centralized design project with external contacts (clients) and authentic design constraints drives the learning experiences. Primary student products include an Engineering Proposal, Engineering Feasibility Study, and a Preliminary Engineering Report. The 3100 and 1000 courses are critical in developing the professional skills that the students are expected to implement in 4910. This is reflected in Table 1 where the performance levels are generally lower in these two courses as they prepare the students for the culminating 4910 experience.

Several items of note in the assignment of Bloom's Taxonomy-based achievement levels in Table 1: The definitions of each performance follow that of the BOK2[3] and are adapted to the specific engineering learning environment and from the perspective of program-level achievement. The Evaluation and Synthesis levels have been combined here in recognition of the debate and dialogue that followed the initial publication of Bloom's model. In Bloom's hierarchical model, to perform at any one level directly means that one can perform at all of the "lower" levels. It has been argued that to create something new (synthesize or design) requires one to also be able to evaluate.[5,6]

For engineering education purposes, the paramount concern is that students are able to function at both levels with less importance being attached to which is a higher level.[7] The authors for this paper have adopted a similar argument here. Further, the authors have taken the perspective that when students create an engineering report for a specific class project, they utilize high level evaluative and synthesis skills, even when they are following a fairly well established template for that report. We are not suggesting that students are operating at a level where they are creating new types of reports not yet known to the engineering profession.

Table 2 Class Size and Original Instructor Team Model

Course ID	Typical Enrollment in one term	Number of times offered in Academic Year	Instructor Team Model
1000	80 to 100	1	• Lead Instructor (Departmental Faculty) • Teaching Assistant (Departmental Grad. Student.) • Writing Consultant (CLEAR) • Oral Presentation Consultant (CLEAR)
3100	25 to 35	2	
4910	15 to 30	3	

Original Instructor Team Model within the Professional Skills Spine

As initially conceived, each of the three courses utilized an instructional team to organize, facilitate and delivery instruction, and provide feedback to the students. Table 2 shows typical class sizes, the number of times that the class has been offered in an academic year, and the instructor team in each of the courses. The instructor teams and the courses were specifically designed to integrate with the Communications, Leadership, Ethics, and Research (CLEAR) Program in the College of Engineering at University of Utah.

In the original model, the lead instructor was a full-time departmental faculty member in most cases. The junior-level 3100 class was the exception where often an adjunct faculty member was utilized. The adjunct faculty members have been, in most cases, full- or part-time engineering practitioners and thereby added inherent value by maintaining a professional practice focus to that communications course. The lead instructor was supported by a teaching assistant (typically a departmental graduate student), who managed the administrative aspects of the course (attendance, homework assignments, grade reporting, etc.). The writing consultant provided instruction in and feedback of writing elements of the course. The oral presentation consultant provided similar support. These tasks were specifically allocated across multiple personnel to provide a variety of perspectives and to manage what would otherwise become a significant grading load for each consultant.

The writing and oral presentation consultants were typically graduate students in the English program at the university. They were hired specifically in the College of Engineering's CLEAR Program to provide instructional support for the variety of professional skill oriented classes across the entire college. The CvEEN program was perhaps the first and primary program to fully integrate the CLEAR support throughout its undergraduate curriculum.

Revised Instructor Team

In response to re-allocation of resources and to bring a more consistent instructional message to the students, the Summer of 2014 term saw a change in the CLEAR support of the CvEEN program. In the original model, both of the presentation consultants were grad students. The

undergraduate students often perceived the consultants' feedback as not having the same standing as the lead instructor's feedback. In addition, rather than seeing a variety of perspectives as adding a larger and more complete picture, the students tended to look for and desire only a single "voice" for feedback. End-of-semester and exit interview data consistently showed that students neither appreciated the multiple voices nor understood that as civil engineers that they would need to be able to communicate with both technical and non-technical personnel. Instead, the students consistently showed that they "missed the points" that the CLEAR consultants provided. The students especially misunderstood or did not value how the CLEAR consultants provided an important non-technical perspective of the students' work. Hence, the College of Engineering decided that the CLEAR program model would change to that of full-time instructor, one for each department. The effect of that change and its associated financial support meant that direct CLEAR involvement in the three-course spine was changed.

Currently, CvEEN 1000 has an instructor team comprised of one faculty member and two teaching assistants. One assistant is the same as before, a departmental graduate student. The other is hired directly from the English department. The lead instructor now takes on a greater portion of instruction for the writing and presentation segments than in the previous model. In the senior-level 4910 course, there are no more external consultants, only the faculty member and the typical departmental graduate teaching assistant. The junior-level 3100 course is now taught exclusively by the CLEAR instructor with no direct involvement of departmental faculty.

Basic Set-up of the CvEEN 1000 Introduction to Civil Engineering

The course meets twice each week for 15 weeks. Although a 2-credit hour course, the class meets for two 80-minute sessions. Hence, the contact time might appear as though it is a 3-credit hour course. However, the goal is to provide on average about 20 minutes during each lesson for group work. The group work may be associated with directed in-class activities, or it may be generally free for the groups to work on their research project.

Learning Outcomes of CvEEN 1000 Introduction to Civil Engineering

At the end of the course experience, students are expected to be able to:

1. Describe the core disciplines that comprise the civil and environmental engineering professions.
2. Discuss the relationship of the practice of the profession to society, the inherent service nature of the profession, and how the nature of that service influences the nature of practice.
3. Define the attributes of a profession and how a profession differs from an occupation.
4. Define the characteristics of effective teams and team members.
5. Discuss the role and type of communication skills required in the profession.
6. Define the knowledge, skills, and attitudes necessary for success in the profession.

Structure of CvEEN 1000 Introduction to Civil Engineering

The course is designed to use the history and heritage of civil engineering as a delivery mechanism for the professional skill sets of the BOK. The broad structure of the course follows the ASCE ExCEEd Model[8] and its associated Model Instructional Strategy shown below.

ASCE ETW Model Instructional Strategy

- Provide an orientation:
  - Why is this important?
  - How does it relate to prior knowledge?
- Provide learning objectives.
- Provide information.
- Stimulate critical thinking about the subject.
- Provide models.
- Provide opportunities to apply the knowledge:
  - In a familiar context.
  - In new and unfamiliar contexts.
- Assess the learners' performance and provide feedback.
- Provide opportunities for self-assessment.

Three primary learning activities anchor the course: (1) an Example Historic Project, (2) Guest Speakers talking about the multiple disciplines of the civil and environmental engineering profession, and (3) Student-Researched Historic Projects. Figure 1 displays the allocation of student efforts across the term. Their work is initially focused on understanding the example project, understanding the broad scope of the profession (via guest speakers) and building their teams. By Week 10, they are focused entirely on their own team projects.

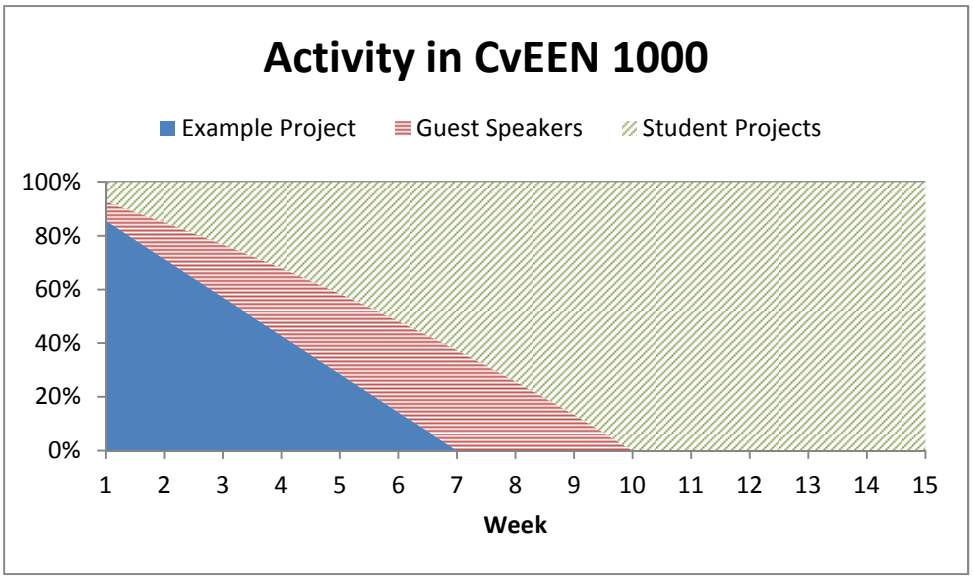

Figure 1 Percent of Weekly Time for the Primary Learning Activities

In the first phase, an example historic project or situation is presented to the class. For the first decade of the course, the historical development of the Panama Canal was the primary project discussed. The students' primary reference was McCullough's treatise on the subject *The Path between the Seas* [9]. Often perceived by the students as too didactic (in the students' vernacular as "too dry, boring, and theoretical"), the current course leader changed the subject for the Fall 2014 term to the Great Flood of 1927 on the lower Mississippi River Valley. A companion text by Barry[10] was the primary "delivery of content" for the technical details. That is, the students were given reading assignments and weekly writing prompts; this is the location of the primary student reflection and demonstration of learning. In-class time was devoted to other topics such as the practice of engineering, ethics, etc. Those topics provided opportunities to connect to the reading material, but it was not the intent of the in-class time to be devoted only to the example project.

In both cases, the use of historic civil engineering projects provided introductory experiences across nearly the entire professional skill set spectrum. In these stories, students are prompted to reflect upon the role of and impact of effective and ineffective communication amongst the protagonists and antagonists, leadership, ethics, globalization, etc. And, they observe the impacts in dramatic and globally changing ways. These projects provide a nearly ideal framework for which to provide an orientation to the discipline, stimulate critical thinking, and a model for what will eventually be the students' own project. Additionally, these texts help students comprehend the degree of difficulty in planning, designing and executing any engineering project. Significantly, they also point to the important dynamic within are large engineering endeavors of human interaction, communication and often—competition of egos and vision, which can lead to conflict, at best, failure at worst.

The course schedule, team assignments, and individual assignments are listed in Appendices A, B, and C respectively.

Simultaneous Phases of the Course and Associated Student Work

Phase 1: Example Project

In the originally conceived version of the course, students demonstrated "achievement" related to the Example Project by passing a multiple-choice exam. There were two exams, one for each portion of the required reading of the McCullough text (approximately 450 pages of the more than 600 pages). The exam questions were focused on knowledge level aspects, i.e., memorization of facts, figures, and people. Students were allowed to take each exam twice with their highest score being retained for each; the exam was static (did not change). The students expressed strong displeasure in regards to these exams, particularly the memorization of picayune details.

With the change in the Example Project and associated text, the student work for the first phase was changed. This phase (which ends at about Week 7) now concludes with an essay assignment. It requires that the students write an out-of-class, individual essay to specific prompts associated with the course outcomes.

For the Fall 2014 term, the Individual Essay prompts included:

1) James Buchanan Eads was one of America's most successful and world renowned engineers of the 19th-century. Describe Eads' character traits and professional competencies that made him successful. These might include *innovation*, *experimentation*, *modeling*, *testing*, *persistence, analytical* and *persuasive* abilities. You can choose from these or others that you feel describe and define this engineering "giant," and contributed to his success in the many different engineering projects he attempted. Discuss examples of his work that reflect these qualities.

2) Discuss Eads' plan to install jetties near the mouth of the Mississippi River. What was their theoretical value; what was their intended effect? What was the alternative plan? Did the jetty plan succeed? What were the results for New Orleans?

3) There were four methods proposed by the engineers to control flooding on the Mississippi River. Identify and describe 3 of the 4 methods. What are the theoretical advantages and disadvantages of each? Which of these are in use today? Are the methods used today sufficient to prevent a disaster of the magnitude of the 1927 flood?

4) There is an inherent *service nature* of civil engineering. Discuss the intended goals that Eads, Humphreys and Ellet wanted to accomplish by controlling the river and preventing flooding. Your discussion could include – *economic*, *agricultural*, *transportation*, *political* or *sociological* goals. Discuss at least two goals that the engineering solutions intended to achieve.

Phase 2: Guest Speakers

Simultaneously with the first phase of the course, guest speakers (departmental faculty) present the various sub-disciplines of civil engineering. The speakers are encouraged to make a direct connection to the primary historic project of the term. When that does not occur, the lead instructor supplements the daily lesson with a connection, or the students are asked to informally discuss and/or write about what that connection might be. In the second portion of the second phase, faculty return to discuss emerging areas of practice (research) in each of the sub-disciplines. Hence, there is a "past, present, and future" aspect to the guest speaker phase.

Other than group discussions and encouragement to reflect in individual journals, there is little to no direct student work in Phase 2. Normally, this might be a cause for concern. However, keep in mind that all three phases of the course occur at the same time during the first seven weeks. Students are constantly working on some task, often many "at the same time." In the first several weeks, they are working primarily as individuals, reading the text and writing about it. They are also beginning to get to know their team members via in-class activities and small out-of-class activities related to their assigned team project.

Phase 3: Student Research Projects

In the third phase of the course, students work in assigned groups to study and present a significant and/or historic project. The projects for the Fall 2013 and 2014 terms are shown in Table 3. Many projects were historic in a variety of manners including the magnitude of its societal impact, technological innovation, etc. Not all projects were from the distant past; some projects are contemporary and even, in some cases, ongoing. A more apt term than historic might be "significant." Key factors involved in the instructor's selection of the projects included visibility, access to information, and connection to the desired course outcomes.

Table 3 Student Significant (Historic) Projects

Project	Fall 2013	Fall 2014
1	Golden Gate Bridge	Erie Canal
2	Chicago Sanitary and Ship Canal	Trans-Siberian Railway
3	The Ghost Map and the London Sewer	Croton Water Supply System for NYC
4	Milwaukee Metropolitan Sewage Treatment Plant	Elephant Butte Dam
5	Netherlands Delta Works	Sydney Opera House
6	The First US Transcontinental Railroad	Panama Canal
7	Gatun Dam, Panama	St. Lawrence Seaway
8	St. Louis and Illinois Bridge (Eads Bridge)	Chesbroughs Water Supply System Chicago
9	Mormon Tabernacle	Florida Everglades Restoration
10	The Pantheon, Rome	Aswan Dam
11	Philadelphia Municipal Water Supply	SF-Oakland Bay Bridge
12	St. Louis Arch	Massachusetts Central Artery/Tunnel Project
13	Suez Canal	Chicago Deep Tunnel
14	The First New York Subway	Alaskan Pipeline
15	Buffalo Bill Dam, Cody, WY	NYC Combined Sewer Overflow Green Infrastructure
16	The Chunnel	I-70 Reconstruction through Glenwood

	Canyon, CO
17	Yucca Mountain Nuclear Waste Repository
18	Shell Bullwinkle Platform
19	Great Falls Raceway and Power System, Paterson, New Jersey
20	Ingalls Building, Cincinnati
21	Design and Construction of the World Trade Center Twin Towers

The framework for the team projects corresponds directly with the course outcomes and with the BOK Professional Skills Outcomes. Key components are shown in Table 4; a complete template provided to the students is shown in Appendix D. In addition, since one of the outcomes of the course relates to professional communication (and that means preparation of engineering reports), the template for the report follows a fairly standard style (to which the students are first introduced in this course). Note that student teams must successfully adapt the template for their own project. Note also that the template inherently teaches them about the structure and impacts of engineering projects. Although it may be possible for a student team to initially complete their research in a check-list approach, the course is now designed to initiate reflection and achieve higher levels of performance via an in-class essay.

Table 4 Project Template Provided to Students

- Project Team Page (with Honor Pledge written and signed by each member)
- Executive Summary
- Project Description
  - Location
  - Type of Facility
  - Size, Scope, etc.
  - Design and/or Construction Timeline
  - Design and Development Cost (in both construction period and current dollars)
- Project Need
  - Function
  - Societal Need
  - Culture Significance
- Engineering Challenges
- Engineering Solutions
  - Alternative engineering solutions considered (if applicable)
  - Description of Selected Solution (along with criteria)
  - Innovations and/or Technologies implemented
- Historic Significance and Existing Relevance
  - Long-term Impact of Project (on society, engineering community, etc.)
  - Success of Project
  - Major Repairs or Renovations to the facility to keep it in service

The students prepare both a written report within their adapted framework and orally present their work to the class. Approximately 8 to10 lessons are allocated to the oral presentations. Depending on the total number of teams during the term, the presentation lengths vary from 20 to 35 minutes (either 2 per day or 3 depending on the term). Deadlines for the written and oral reports are staggered. Some teams complete their written reports prior to presenting it, and vice versa. Hence, some teams use the report to receive feedback and improve the oral presentation to be conducted two or three weeks later. Of course, others reverse that sequence.

Assessment

The course was built with assessment of student performance in mind, to permit efficient feedback of student work, and to provide direct means of achievement of course outcomes. The latter aspect is particularly important as the course fits within the department's ABET Program Outcomes-based Assessment Plan (see Table 5). Of these, the course provides assessment data for the outcomes related to (f) responsibilities and (j) contemporary issues.

The final student product was developed with the Program and Course "grading" in mind. On the last day of class, each student responded to a variety of essay prompts. Course notes constituted the sole authorized aid; students were also required to submit those notes. As originally conceived by the instructors, the students were to create their own organization to the notes. This would have enabled a means by which the instructors could analyze the students' understanding of the course material beyond the essay. In response to student questions and discussions, instead a template was provided. Not surprisingly, most students chose to use the template and, obviously, the additional assessment opportunity was lost.

Table 5 Contribution of CvEEN 1000 to ABET Program Outcomes

Program Outcome	**Expected Level of Achievement Based upon Bloom's Taxonomy**
d. an ability to function on multi-disciplinary teams.	Program-level by graduation: Application Course-level: Application
f. an understanding of professional, and ethical responsibility, and ability to explain the importance of professional licensure.	Program-level by graduation: Comprehension Course-level: Knowledge
g. an ability to communicate effectively using verbal, written, and graphical skills.	Program-level by graduation: Analysis Course-level: Application
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context.	Program-level by graduation: Comprehension Course-level: Knowledge
i. a recognition of the need for, and an ability to engage in life-long learning	Program-level by graduation: Application Course-level: Application
j. a knowledge of contemporary issues	Program-level by graduation: Application Course-level: Knowledge

The prompts for the final essay were focused on the primary theme for the course: the interaction of society with the practice of engineering. Additional themes included how those interactions influenced the technical aspects of engineering, the role of other factors than technical for making decisions (finances, public policy, uncertainty, societal values, etc.), ethical and professional responsibilities, etc.

The essay prompts for the Fall 2014 term required that students respond to 3 of the following 4 areas:

A. Discuss which project that you think had the most positive impact on society. Be sure to clearly articulate your metric (the factors that you are using to measure positive impact).
B. Discuss which project that you think had the largest negative trade-off for society, e.g., flooded a parrish by compromising (blowing up) a levy but saved a city. (*Rising Tide* is not eligible for this topic.)
C. Discuss which project illustrated to you the public service and responsibility of a civil engineer and why you selected that project rather than others.
D. Discuss the relevance of studying civil engineering heritage to the practice of civil engineering today, i.e., what did you learn by studying the past that will help you to be a better civil engineer today?

The rubric used for assessing student work is based upon the General Quality Rubric shown below in Table 6. A key feature to note is that a numeric equivalent of 70% represents the "irreducible minimum" of quality, or "minimally competent." The rubric cannot quite be termed a competency based rubric since it does not delineate in detail the competencies that are required to be demonstrated. It is intended, though, to be a simple means by which to communicate to students that the quality of their work is the key factor in \evaluating their work product.

Table 6 General Quality Rubric that formed the basis of the Assessment

Letter Grade	Numeric Equivalent	Level	Description
A	> 90%	Exemplar	Only one or two minor mistakes at most.
B	> 80%	Proficient	Several minor mistakes; almost no conceptual mistakes.
C	> 70%	Minimally Competent	Several mistakes, some major. Or, conceptual mistakes.
D	> 60%	Slightly Competent	Many significant mistakes and conceptual errors.
E	< 60%	Unsatisfactory	Non-response or completely incorrect response.

For the final essay, the rubric of Table 6 was refined with greater definition at each level and was applied to each prompt. That is, a student received a quality-based numerical score for each of the three essay prompts. The rubric for the final essay is shown in Table 7.

Discussion

At the beginning of the term, 88 students were registered for the course. By the mid-point (and the official withdrawal date), 83 students remained. Of those 83, six no longer participated and were "no-shows" although they did not officially withdraw. These six were encouraged to meet with the instructor sufficiently prior to the withdrawal deadline to discuss the barriers that they perceived towards their success, etc. None of those six students availed themselves of that opportunity and chose to receive a failing mark on their transcript rather than a withdrawal.

Table 7 Final Essay Quality Rubric

Assessment Level	Associated Bloom's Level	Description	Students Performing at Level
Exemplar	Evaluation, Synthesis, Analysis	Essay thoroughly addresses topic, is clear and direct in its argument, uses substantive connections to illustrate points. May have one or two minor flaws.	33 of 83
Proficient	Analysis	Adds value beyond the minimally competent level but contains several minor flaws perhaps in depth of argument, illustrations, etc.	36 of 83
Minimally Competent	Application	Directly addresses the topic but fails in any of the following areas: (a) clearly connecting the argument from the project discussed to a clearly defined metric, (b) providing sufficient depth to the discussion, (c) using substantive connections between the project and thesis statement, etc.	3 of 83
Slightly Competent	Comprehension, Knowledge	Elements may include: unclear thesis statements, lack of connection between the arguments and prompt, grammar and writing style that distracts, etc.	5 of 83
Unsatisfactory	-	Non-response or completely disconnected response.	6 of 83

More than 86% of the class performed at a minimally competent level or higher (72 of 83 students). Initially, this percentage may appear to be high, but keep in mind that this performance level only requires that the respondent functionally perform (or better), but not that the submitted work would be acceptable to be sent to a client in a professional context. Such a performance level would have been met by only about 10% of the work. The latter performance level may be the minimally competent level for the workplace, but not necessarily appropriate for undergraduate students "in progress" and certainly questionable for first semester students.

One might suspect that non-native English speaking students are at a disadvantage using this type of performance measure (writing with the English language), especially in a first semester course. About 20 of the 83 registered students were non-US citizens (self-identified). Of those 20, fifteen to seventeen were non-native English speaking students. Only 4 scored at the minimally competent or slightly competent levels. Of the "no-shows," 50% were non-US citizens, that is, 3 international students should have withdrawn but chose to remain in the course yet not attend nor otherwise participate. In other words, there was no appearance of a statistically significant correlation between the non-native language students and resident students.

For this first semester course, the standards for Exemplar and Proficient were admittedly more generous than what might be expected for senior-level work in the CvEEN 4910 course (a course taught by the lead authors). With such a rubric, it is inevitable that the distinction between grading and assessment becomes blurred, especially with a writing standard where the difference between an exemplary writer in their first-year and one in their final-year is perhaps one more of life experience than it is of writing skill (at least in the opinion of these authors).

In a similar manner, applying Bloom's Taxonomy to student achievement is felt by these authors to be a matter of context rather than an absolute standard. For example, a student who is asked to derive an equation (one which they have not yet previously seen) and is asked to evaluate the correctness of that derivation, that student is functioning at an Evaluation and Synthesis level. This despite whether the requested item is already known. The key is the context of the learner rather than that of the creator of the item. Although that explicitly brings in judgment of the assessor, it is in the mind of the authors precisely the type of judgment called for in high quality, student-centered instruction. Higher-level, critical thinking skills simply require judgment both from the examinee, the exam developer, and the assessor.

The desired level of performance noted in Table 1 with regard to Bloom's was established using the perspective of Program Outcomes. That is, using the standard of graduation, what level or quality would we expect of a first-year student? In that context, we can conclude that 86% of the students achieved a basic level in each of the course outcomes as evidenced by the performance on the final essay. There is, in some ways, more of a direct connection between the final essay

prompts and the Program Outcomes than there is to the Course Outcomes. That is because the final essay questions are intentionally phrased as higher level, broader, critical thinking prompts than the Course Outcomes that are more focused on knowledge and comprehension aspects. This is a matter pertinent for further review to bring the details of the course and program design into closer alignment and provide a more direct means of assessment at both Program and Course levels.

Student satisfaction and commentary has not been provided here, although available in the form of standard, university-level and administered end-of-semester surveys. The authors preferred instead to focus on the internal instruments used to measure student achievement rather than student perceptions of the learning experiences despite their potential utility. As well, longitudinal (retention) figures are not presented as the demographic context of the course and the program makes what would seem to be a direct and simple task instead quite complicated and somewhat intractable.

Summary

A first-semester course is described that focuses on integrating students into the college experience and introducing them to civil and environmental engineering. The delivery scheme is modeled both after ASCE's Body of Knowledge and ExCEEd Model. The course particularly focuses on the professional skill sets identified in the Body of Knowledge. Civil engineering history and heritage is used as a vehicle to directly immerse students into the broad field of practice, its challenges, and opportunities. Due to the structure of the course and its focus on specific and detailed learning objectives, successful students emerge with more than a simple survey of the profession, but substantively progress in their development of becoming prepared to practice as a civil engineer in the 21st century.

Bibliography

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Appendix A

Course Schedule (Fall 2014)

Week	Topic and Where Assignment is Discussed In-Class*
1	Course Organization, Instructional Team Profession 1 - ASCE, EWB, CvEEN (I1)
2	Profession 2 - BOK and Design (I2) Team Assignments, Team Charter (T1 and T2)
3	Transportation - 40 min (I3) Geotechnical - 40 min (T3)
4	Materials - 40 min (I4) Environmental - 40 min (T4)
5	Hydrology and Hydraulics - 40 min (I7a) Profession 3 - Are you a Pro? And Structures - 40 min (I8)
6	Profession 4 - What to Say (I6) Profession 5 - ASCE and the Future
7	Profession 6 - Consulting vs. City Engineering Transportation Future and Materials Future
	FALL BREAK
8	Nuclear Engineering Past, Present, Future Environmental Future; Profession 7 - How to Say It (I7b)
9	Geotechnical Future Hydrology and Hydraulics Future
10	Structures Future Student Presentations (for T5, T6, T7, T8 see team schedule)
11 -14	Student Presentations Student Presentations
15	Course Summary Final Essay (I10)

* Team and Individual Assignments are noted in parentheses. Not all components and their deadlines are shown in the schedule partly due to the asynchronous aspects of the team components in the latter portion of the term. For further details, direct inquiries to the lead author.

Appendix B

Team Project Assignments

Each team prepares both a written report and oral presentation of their historic project. Team deliverables include eight items and are described as follows:

T1 **Team Name (100 points)**. Per direction, determine an appropriate name for your team. Submit that name according to instructions provided in-class. The name should somehow reflect the collective interests or passions of the team. Names that are deemed inappropriate will be changed and replaced by a name of the instructors' choice.

T2 **Draft team charter (100 points)**. Prepare a memo with the following information regarding the organization of your team: Team Name (including logo if you desire), Team Organization (Roles of Responsibility), Schedule for Rotation of Roles, Ground Rules, and Enforcement Policy. Include the roles of responsibility that your team will use, the tasks associated with each role, the means by which performance will be measured, and how those roles will be rotated through-out the semester. Ground Rules should include specific reasons constituting firing of a member. An individual who gets fired will have to work by his/herself. Firing should be used as a last resort and can only be implemented, after consultation with the instructor. Note that formal assessments will be conducted at the mid-term and at the end-of-semester assessment using the CATME instrument. The enforcement policy must specifically address the Ground Rules and must also include an "undersigned" statement. Each team will be held accountable to their own rules, so don't create rules that you can't live with nor intend to enforce.

T3 **Project Sources (100 points)**. Develop a detailed list of sources that you plan to use for your project. Although your group will inevitably add to these sources, there should be a substantial list provided. Use a memo format to provide the information.

T4 **Project Outline (100 points).** Provide a memo that presents a detailed outline for your written report. Follow the example provided and modify as appropriate for your project. Include an updated list of sources.

T5 **Report 1.0 (100 points)** Provide a complete and thorough written report for review.

T6 **Report 2.0 (100 points)** Provide a complete and thorough written report with improvements that reflect the provided feedback.

T7 **Presentation 1.0 (100 points)** Provide a copy of the slides of your oral presentation project. The copy should be in the form of 6 slides per page and in pdf format. Animations need not be indicated nor printed.

T8 **Presentation 2.0 (100 points)** In-class delivery of the project presentation.

Appendix C

Individual Assignments

Each student is responsible for each of the following assignments. Details, submission requirements, schedules and deadlines are provided on the course web page.

I1 **ASCE Membership (100 points)**. Obtain your free ASCE student membership from the national organization. Go to www.asce.org/join and scroll to the bottom of the page. The form is the same for both professionals and students. Submit your membership number via the course web site. This item is eligible for PD points as well; see the PD schedule to determine its value.

I2 **Educational Requirements (100 points).** Research two other PAC-12 civil engineering programs and discover their requirements to earn a BSCE.

I3 **Professional Development (100 points).** Prepare a memo that proposes how you will earn 1000 professional development points during the semester.

I4 **Hydrologic Data Analysis (100 points).** Select a USGS River Gauge Station and determine the peak flow associated with 1% chance of being exceeded in a single year. (Follow the step-by-step guide and use Excel to process and analyze the data.)

I5 **<Intentionally Blank>**

I6 **Rising Tide (200 points).** Prepare and submit your reflection essay on the assigned readings of *Rising Tide* by John Barry.

I7 **CATME Peer Review (50 points).** Complete a formative assessment of yourself and each team member via the online instrument CATME (www.catme.org) (you will be sent an email with the link when the survey is active).

I8 **Bridge Design (100 points).** Design a truss bridge to meet safety and budgetary constraints using the Bridge Designer software. Value engineering will provide you an opportunity for bonus points. See the online assignment for details. The software can be obtained at www.bridgecontest.org.

I9 **CATME Peer Review (50 points).** Complete a summative assessment of yourself and each team member via the online instrument CATME (you will be sent an email with the link when the survey is active).

I10 **Final Essay (200 points).** In-class essay that summarizes your experiences and what you have learned in the course regarding the practice of civil engineering and its interactions with society. A general theme for the essay prompt will be provided in advance.

Authorized aid includes your (bound) hard copy of Rising Tide and your printed course journal. You will submit your completed essay and your journal.

Course Journal

Your course journal provides you a resource for the final essay of the course. The specific prompt will not be announced until that lesson; consider it to be similar to a typical in-class examination in an English or History course. The topic of the question will be announced in advance and will fit the general theme associated with the course: the interaction of the practice of civil engineering and society. The essay will expect you to draw reflective connections between *Rising Tide*, the historical projects presented by the teams, and the picture of civil engineering that emerges from the faculty and guest speaker presentations. There will be a number of prompts provided to you throughout the semester, e.g., the weekly "questions" for *Rising Tide* during Weeks 1 – 5. You can anticipate that having worked through these will significantly prepare you for the final essay. A printed version of your course journal will be authorized aid. Hence, although the course journal is optional, you should consider it essential to success in the course.

Appendix D

Report Template for Student Team Projects

1. Project Cover with appropriate title including project name
2. Project Team Page (with Honor Pledge written and signed by each member)
3. Executive Summary
4. Table of Contents
5. List of Figures (as appropriate)
6. List of Tables (as appropriate)
7. Introduction
8. Project Description (include as appropriate)
    a. Location
    b. Type of Facility
    c. Size, Scope, etc.
    d. Design and/or Construction Timeline
    e. Design and Development Cost (in both construction period and current dollars)
9. Project Need
    a. Function
    b. Societal Need
    c. Culture Significance
10. Engineering Challenges
    a. Needs or Issues faced in and unique to the project
11. Engineering Solutions
    a. Alternative engineering solutions considered (if applicable)
    b. Description of Selected Solution (along with criteria)
    c. CE Innovations and/or Technologies implemented
    d. Construction techniques and innovations
12. Historic Significance and Existing Relevance
    a. Long-term Impact of Project (on society, engineering community, etc.)
    b. Success of Project (give some perspective of whether the facility is still in service, whether there was/is any controversy associated the facility, etc.)
    c. Major Repairs or Renovations to the facility to keep it in service (if applicable; how has the facility "held up" over time)
13. Summary/Outcomes
14. References