Practitioner Led Engineering Experiences

Our program is fortunate to have significant support for our students and our educational mission from the local community. A number of professionals have invested their knowledge and time to lead and collaborate on advanced practically oriented experiences for our Civil Engineering students. These practitioner instructors take time from their firms and become positive models for our students. This group fills a gap by teaching material that our faculty is unable to teach or that is better suited to being taught by practitioners. Their involvement in the curriculum expands opportunities that are geared to real world applications. In particular, they have partnered with faculty to develop communication and surveying courses, and participate in our senior design sequence in a range of capacities including course leader. Finally, a group of eight practitioners organized and offered a novel bridge design course centered on newly accepted probabilistic design procedures. These successful partnerships are summarized in this submission for consideration for a NCEES Engineering Award.

These courses provide an outstanding link between students and practice in a range of curriculum components including design and developing communication and teamwork skills. Collaboration results demonstrate curriculum innovation that would not be possible without the leadership of our practitioner partners. The practical emphasis has added unique experiences such as site visits and the introduction of emerging state-of-the practice technology in the curriculum. In addition to practitioner leadership of the courses, the instructors extend our network in the community by inviting other practitioners to contribute to courses by providing lectures in their specialty areas and serving on expert panels to review student work. The later activity has led to a significant impact on professionalism and quality of presentations. Positive impacts on applicable award evaluation criteria are discussed below.

Successful collaboration of faculty, students, and professional practitioners and impact of partnering teaching and practice – Our departmental alumni and friends have recognized the opportunity to support our department and work in tandem with our faculty to develop novel educational experiences that better prepare graduates. The two most collaborative efforts are the practitioner initiated bridge design course that was collaboratively organized and taught by practitioners and faculty and our capstone design courses that are led by a practitioner with lectures taught by faculty and practitioners. Capstone design evaluation teams were comprised of a mix of the two groups.

Benefit to health, safety and welfare of the public – Practitioners are more acutely aware of the need to design for safety and students are more open to accepting this guidance from practitioners who have that perspective. Technically, the bridge design course was based on new technology that accounted for the uncertainties in the all aspects of the design. Understanding and applying, this newly instituted approach will improve the safety of transportation structures designed by these graduates.

Impact of raising social consciousness – The senior design course under practitioner leadership has added modules on social issues including requiring students to attend a public meeting to develop an understanding of the social implications of their work and the strength of public opinion. As Civil Engineers, this understanding is critical.

Knowledge and skills gained - The success of these courses and the amount of material learned is documented in student evaluations. Passing this knowledge to the students is a tribute to the instructor's quality and their communication skills. We can measure this success as our students have consistently scored average to above average scores on the FE exam in structural design and surveying.

Professional leadership – All instructors in design courses are professional engineers demonstrating the desirability of licensure. Further, the first semester of our two semester design course includes a range of professionalism topics including an ethics module that is taught by practitioners.

Practitioner Led Engineering Experiences

Introduction and Justification

Our program is fortunate to have significant support for our students and our educational mission from the local community. A number of professionals have invested their knowledge and time to lead and collaborate on advanced practically oriented experiences for our Civil Engineering students. These practitioner instructors take time from their firms and become positive models for our students. This group fills a gap by teaching material that our faculty is unable to teach or that is better suited to being taught by practitioners. Their involvement in the curriculum expands opportunities that are geared to real world applications. In particular, they have partnered with faculty to develop communication and surveying courses, and participate in our senior design sequence in a range of capacities including course leader. Finally, a group of eight practitioners organized and offered a novel bridge design course centered on newly accepted probabilistic design procedures. These efforts of blending practitioner experience and knowledge with faculty expertise have proven exceptional productive for our program. These successful partnerships are summarized in this submission for consideration for a NCEES Engineering Award.

This nomination consists of five courses that have significant practitioner contributions. In several cases, faculty and practitioners have collaborated such as conducting lectures in their areas of expertise or project review. The Integrated Bridge Design and capstone design courses fit in this category. In others, the efforts are organized and run by a practitioner with consultation with the faculty in terms of course objectives and expectations. Timber and masonry design, elementary surveying and communications are practitioner taught. The following pages provide details on each of those five practitioner led courses, their history, and benefits.

Integrated Highway Bridge Design Using LRFD Methodology

Practitioner Led Course Development

In 2006, bridge design changed. Rather than apply design safety factors to loads, AASHTO issued specifications for applying the load resistance factor design (LRFD) methodology. This methodology has been used in structural analysis for some time. The complexities and multitude of factors affecting a bridge, however, make it application much more complex in that environment. Training of practicing engineers has been completed through short courses and specialized seminars. A number of our alum have been active in that regard.

Recognizing that students should be prepared for this new methodology, a group of local practitioners approached our department with a proposal to teach a course on the topic. They volunteered their services without charge. This motivated group was joined by several others and the course, originally titled, Transportation Structures was approved in October, 2007 by our Undergraduate Studies Committee to be taught in fall 2008. As the course evolved, the titled was modified to Integrated Bridge Design Using LRFD Methodology. Eight practicing professional engineers covering four areas of expertise began to meet in earnest through the spring semester. Monthly meetings were typically one to two hours until the agenda was completed. Often a faculty would attend to support the process. In addition, one of the practitioners was a formerly faculty and head of this department. He has remained an active supporter after retirement. Also, as noted, another of the group taught LRFD Bridge design to practitioners. Their experience made the transition for material to the classroom much easier.

This process continued and several generations of notes and syllabi were produced. The theme of the course remained a constant: introduce students to probabilistic design of a complex structure that requires integration of four areas of civil engineering. Due to personal issues, a key player in the course was required to withdrawal from the course in late April. Her role as lead of the structural component was integral to the project. Given the short notice, a faculty in the area accepted responsibility for this

role. He also took leadership of organizing the group. The course syllabus, lectures and organization were completed with similar monthly group meetings during the past summer. Subgroup meetings were also necessary in some cases to insure consistency within the area. The goal of emphasizing uncertainties in all aspect of bridge design in addition to LRFD also required coordination between areas and a common set of introductory materials. The course was successfully offered during the Fall 2008 semester to 25 students. Additional instructor coordination meetings were held in the fall. All instructors often attended the other 3 hour classes that were held on Saturday mornings.

The previous paragraphs are intended to provide a glimpse of the effort; all unpaid with the exception of a late entering faculty member. This volunteer effort was a phenomenal contribution to our students and program. The students were made aware of this task and teamwork required to pull the course together. As the course progressed, the emphasis for communication and need for good teamwork for a bridge design was demonstrated in the course itself.

Course Content

An abbreviated course is syllabus is shown in the inset block below. Table 1 lists the course topics by week. Several points should be noted. First, the level of this course required a solid background in fundamental civil engineering topics. All junior level design courses were pre-requisite to taking this course. These courses with the probability course gave a common language for instructors and students.

CE 464-564A: Integrated Highway Bridge Design Using LRFD Methodology

Course Objective (as listed in the University Catalog)
Methods for the integrated design of components typically found in transportation structures including bridge super- and sub-structures, retaining walls , pavements, highway geometrics, traffic, drainage, etc. Offered in Fall semester beginning in 2008 and taught by practicing engineers.

Prerequisites: CE 310 – Probability in Civil Engineering, CE 323 – Hydraulic Engineering and Design, CE 343 – Geotechnical Engineering and Design, CE 363 – Transportation Eng. and Pavement Design
Co-requisite: CE 335 - Structural Design in Concrete

Text Books
1. AASHTO (2007 or latest). ***AASHTO LRFD Bridge Design Specifications***.
2. FHWA NHI-06-088 (2006) ***Soils and Foundations*** Volumes I and II
3. FHWA NHI-01-001 (2001). ***Evaluating Scour at Bridges – 4th Edition***, Hydraulic Engineering Circular (HEC) 18

Course Objectives:
1. Introduce students to concepts underlying the design of various components typically found in highway structures by using the Load and Resistance Factor Design (LRFD) methodology.
2. Emphasize quantification of uncertainties in design processes and importance of deformation-based design procedures.
3. Emphasize the importance of inter-disciplinary interaction for design of transportation structures.
4. Emphasize importance of considering construction procedures in design and vice versa
5. Introduce national standards produced by the Federal Highway Administration (FHWA) and American Association of State Highway and Transportation Officials (AASHTO).
6. Discuss brief case-histories using local projects with the objective of emphasizing concepts.

Next, the strength of this course is bringing practical engineering to our students. This aspect of this course is seen immediately in the course textbooks that are all practice manuals. Further, as seen in the course topics, case studies are a significant portion of the course. Finally, the last class meeting was a field trip to a local construction project that contained several bridges at various stages of construction. The state department of transport-ation regional engineer led the tour and was accompanied by other DOT personnel as well as the project contractors. The ability to see the result of the design process, in particular, aspects of constructability and ask questions was a strong positive for the students.

Table 1: Bridge design course schedule

Week	Topic
1	Introduction; Course Overview; Uncertainty and the Design Process
	Roadway and Geometrics
2	Roadway and Geometrics + Bridge Hydraulics
3	Bridge Hydraulics + Comparison of ASD, LFD and LRFD
4	Bridges - Overview; Bridge Selection Process; AASHTO LRFD Manual
5	Loads; Load Groups; Structural Analysis; Modeling (RISA)
	Introduction to Case Study
6	Methods for Superstructure Design; Case Study
7	Methods for Superstructure Design; Case Study (continued)
8	Methods for Substructure Design Overview; Case Study
9	Methods for Substructure Design Overview; Case Study (continued)
10	Basic Geo-mechanics; Uncertainty in Soil/Rock Characterization
11	LRFD Methodology in Shallow/Deep Foundations; Case Study
12	Appurtenant Structures
13	Plans and Specifications; Bridge Construction Methods
14	Field Trip – Interstate Widening Project
15	Final Exam

Although practical issues are important, the introduction of a novel design concept from practitioner experienced with the methodology in design and instruction is of enormous educational value. The demonstration of integrating design components under a common design approach is normally extremely difficult to accomplish in the usual silo atmosphere of academics. Practitioners bring unique qualities and focused on getting the best product to our students. This group of practitioners demonstrated the ability of working as a team, providing exceptional value, contributing to society and delivering and educating a group of students.

Senior Capstone Design Sequence

Capstone design requires a broad view of Civil Engineering to lead a multidisciplinary team of students through a preliminary site design project. In the past year, our students have examined the development of a commercial building site in teams of six students in a two semester course sequence. This course is difficult for faculty to bring together as a number of applied issues must be addressed. A practicing consulting engineer familiar with these attributes has led these courses for four years.

The first course in the sequence examines preliminary design and team building. The result is a written statement of qualifications that is a “bid” for the project. In addition to student tasks, lectures are provided on a range of professional issues that the students will face upon graduation. These lectures are primarily provided by P.E.’s with expertise in the area. Some technical talks are also included to support the project design (see Table 2). In the past semester 11 different practitioners provided one or more lectures in this course. As described in the course objective, this Issues course is intended to prepare students for engineering practice and, we believe, that this is best achieved by the support of practicing engineers. As seen in the inset, students appear to agree as the teaching effectiveness has improved over time as the instructor has continued teaching the course (scores out of 5).

Year	Overall Teaching Effectiveness
2008	3.8
2007	3.3
2006	3.8
2005	2.7

Table 2: Course topics in Issues in Professional Engineering

Topic	Lecturer
Class Introduction and Project Introduction - a broad overview of the project including final deliverable report- Design Summary Report. Team Questionnaire, Team organization and leadership	P.E.
Review Table of Contents of the Design Summary Report and due date. Site requirements.	P.E.
Introduction to Project Management, Introduction to Project Management specific to Land Development Projects	P.E
Transportation Engineering	P.E.
Project Site, Site Layout, Planning/Zoning, County Website	P.E.
Types of companies, characteristics of engineering consulting firms	P.E
What to expect as a newly graduated CE in the private sector.	E.I.T.
Structural Engineering - Project Site	
Geotechnical Engineering - Project Site	P.E.
Professional Registration	P.E.
Leadership in Energy & Environmental Design (LEED)	P.E.
Hydrology - Project site	P.E.
Graduate Programs in Civil Engineering, continuing education and the road to a career in CE education	PhD.
Making Effective Presentations to Interview Panel	SAAEMA Presenter
Final Opportunity for Project Input and Clarification	P.E.
Ethics	P.E.
Design Summary Reports and Final Presentations	

Issues in Professional Engineering Practice and Senior Design

Learning Objectives:

It is the objective of this course to provide to the student experience with:

- Meeting deadlines
- Understanding professional ethnics
- Understanding what it means to be a Professional Civil Engineer
- Providing designs and design concepts that have good practical, aesthetic, and fiscal value;
- Working within a group
- Professional writing and presentations

The second course in this sequence, Senior Design, moves the students from conceptual to detailed project design. A similar course structure with a mix of student work periods and guest lectures make up the course material. Significant emphasis is placed on the statement and understanding of assumptions. Teams formed in the previous semester continue to function in this course. As in an office, student project managers play a key role in maintaining schedules and allocating work. The final design presentations are judged by sets of volunteer practitioners. In the past we have had up to 15 engineers in three presentation sessions.

The benefit of a practicing engineer in the lead role of this course is clear in bridging the gap to practice. He provides a link to practitioners and brings the theory taught in other classes to reality. This class has been undergoing major and minor changes since its inception more than 15 years ago. Factors such as optimal team sizes and configurations, depth of detail in projects, and the amount of guidance provided have been stabilized under a practitioner's guidance and stability.

Timber and Masonry Design

Although our department offers graduate degrees in structural engineering, our faculty are not well-versed in timber and masonry codes and design. However, this ability is sought after in our undergraduate students. We have struggled to consistently offer a course in this area. Three years ago, we were connected with an expert in this field with ties to our university and community. He volunteered his time to teach this course in a 2.5 hour block once per week. This commitment meant that he would fly to our city each week as he lived and operated a consulting firm in a city located 500 miles away.

This instructor brings a significant practical element to the course with over 30 years of experience. He provides a strong combination of practice and theory including real-world applications and examples. As seen in the syllabus on the right, the course provides full coverage of this topic. Our students recognize the value of this course and with the department commit resources from an upper division fee to cover the instructor salary. This course is taught each spring semester.

Course content - CE434/534 Timber and Masonry Design

Codes and Standards
Evolution of Codes in the United States
Legacy Codes – UBC, BOCA, SBC
Current Code – IBC
Standards – ANSI, ASTM, Industry
Standards and Code Activities
Industry's Role
Understanding of components of structures
Horizontal Elements - Roof Framing Systems – Beams and Girders, Trusses, Purlins, Rafters, Sheathing
Vertical Element - Wall Systems – Studs, Masonry (CMU, brick, adobe), Stud, Concrete, Post and Beam, Braced Frames
Loads on structures
Vertical – Gravity (Dead Load), Live Load, Snow, Rain
Lateral – Wind, Seismic, Flood
Wood Design
Lumber Species and Grades
Allowable stresses and adjustments
Lumber Types –
Sawn Lumber - Light Framing, Posts and Beams, Timbers and Columns
Manufactured Lumber - Glue Laminated Beams/Columns, Paralams (PSL, LVL), Truss Joists
Light Frame Trusses
Masonry
Materials - Concrete Masonry Units (CMU), Brick, Adobe
Uses – Walls, Lintels, Shear Resisting Elements

Surveying

Our faculty has evolved to emphasize research and practical surveying skills in our faculty have diminished. How-ever, our constituents strongly desire this skill in all of our graduates. Further, both faculty and engineering firms recognize that surveying is only part of a skill set that now encompasses the broader field of measurement and spatial data accessibility. One of our communities leading registered surveyors volunteered to fill this gap in our expertise and has extended the surveying course to incorporate measure-ment and design elements.

Table 3: Elementary Surveying Syllabus

Lecture	Topic
1	Introduction
2	History of Surveying and method of measurements
3	Measurement of Horizontal Distances
4	Introduction to Leveling
5	Leveling and Field Notes
6	Profile, Cross-sections, and Field Notes
7	Direction of Lines
8	Navigation Principles
9-11	Sewer Design Principles and Mapquide Demonstration
12	Measurement of Angles
13-15	Traverse Computations - Coordinate Geometry Principles
16	U.S.G.S Quad Maps
17-19	Topographic Surveys
20	Horizontal and Vertical Curves
21-24	Survey of the Public Lands
25-28	Land Ownership, Deeds, Easement, Recorded Plats, Etc.

The three credit course that is offered every semester maintains a practice laboratory that includes surveying exercises using traditional and advanced equipment (e.g., taping, leveling, measuring angles, completing a traverse, conducting a topographic survey and laying out a building site). These labs complement in-class material that introduce these labs with lectures on data collection and needs as listed in Table 3. Concepts related to vertical and horizontal curves that are used in later transportation engineering courses, understanding deeds and easements, and acquiring data are critical to our student's abilities to be productive in the workplace. In addition, during our curriculum reform our program made a significant effort to move design from primarily the senior level courses to throughout the curriculum. In consultation with faculty, the instructor has added a sewer design component to this course that is at an appropriate level for the sophomore students in the course.

Students recognize the value of this course and the instructor in their course reviews. Out of a score of 5, the average instructor teaching effectiveness is 4.65 and the amount learned in the course is over 4.3 over the last 8 years. These scores are quite strong for our department. In addition to the impact in the classroom, this instructor provides a valuable link with our engineering community. He is a well respected surveyor and has been able to secure equipment donations to expand the laboratory. He has also been actively involved in our student organizations.

Engineering Communications

Employers have come to expect our graduates to have a strong technical background. When ranking desirable attributes in our graduates, communication skills rank at the top. Our program has had significant difficulty providing our students these abilities. In 2000, we introduced a communications course to our curriculum. However, it generally has been very unsuccessful. With the exception of one talented faculty who has since left our unit, faculty are not generally capable in this regard. The course ratings and learning in the course were poor as instructors taught the course with a strong writing emphasis. As seen in Table 4, the teaching effectiveness and learning were quite low in 2005 and 2003 (and in prior years). The noted faculty taught the course in 2004 and demonstrated to us that the course could be effective if taught properly.

Table 4 : Engineering Communication Evaluations

YEAR	Overall Teaching Effectiveness	Overall course rating	Amount learned in course
2008	4.6	3.9	4.0
2007	4.5	4.1	3.8
2006	4.5	4.0	3.7
2005	2.9	2.6	2.2
2004	4.5	4.2	3.6
2003	2.6	2.2	2.4

In a continuing search, a retired communications faculty with a broad range of practical experience was recommended to us as a possible instructor. He brought a number of new ideas to the 2 unit fall semester course. The material was extended from writing to a full range of communication skills including listening and group dynamics (see inset). The response to the instructor and material has been very positive as seen in the course ratings. We anticipate a change in employer perceptions as these students enter the work force. Although this instructor is not an engineer, his practical experience and knowledge have made a significant improvement to our program.

Summary

These practitioner led courses provide an outstanding link between students and practice in a range of curriculum components including design and developing communication and teamwork skills. Collaboration results demonstrate curriculum innovation that would not be possible without the leadership of our practitioner partners. The practical emphasis has added unique experiences such as site visits and the introduction of emerging state-of-the practice technology in the curriculum. In addition to practitioner leadership of the courses, the instructors extend our network in the community

by inviting other practitioners to contribute to courses by providing lectures in their specialty areas and serving on expert panels to review student work. The latter activity has led to a significant impact on professionalism and quality of presentations. Positive impacts on applicable award evaluation criteria are discussed below.

ENGINEERING COMMUNICATIONS COURSE SUMMARY

COURSE OBJECTIVES This course is designed to help you develop communication skills that are essential to functioning effectively as a professional engineer. Specifically, after successfully completing this course, you will be able to:

- Prepare and deliver effective oral presentations to groups including audience analysis.
- Write clear, concise professional reports and other documents.
- Work effectively as a team member in making group decisions, working on projects and developing proposals (including planning, accountability, and meeting facilitation).
- Understand group dynamics including conflict resolution and accountability.
- Develop interpersonal skills such as listening, persuasion, and argumentation.

MAJOR INDIVIDUAL ASSIGNMENTS

Oral Presentation #1: Develop and deliver to the class an effective informative presentation

Writing Assignment: A written report informing the reader on a particular subject.

Peer review - You will be required to review a written report written by one of your group mates

MAJOR TEAM ASSIGNMENT:

Conduct an Ngt (Nominal Group Technique) Style Meeting; Develop an Action Plan, Gannt Chart and Contract For Your Project; Develop a Proposal for Team Project; Oral Presentation of Team Project; Final Written Report

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