A Project-Based Integrated Work/Review Cycle (PBIWR) for Design and Learning of Accelerated Construction Monitoring

A SOTL Grants Proposal submitted by:

Don Chen

Assistant Professor

Department of Engineering Technology and Construction Management

and

Shen-En Chen

Associate Professor

Department of Civil and Environmental Engineering

An industrial reviewer will be identified from the list in Appendix C, pending their availability.

Abstract

To minimize impact due to travel delay, the US Department of Transportation (USDOT) has been pushing for Accelerated Construction (AC) techniques for public transportation construction. In contrast to traditional construction techniques, the AC technology is envisioned by this federal agency to have the potential to generate great savings for the nation by eliminating unnecessary traffic jams.

This change in construction philosophy offers a great opportunity to introduce the advanced concept of full monitoring of structural construction/aging processes via embedded sensing technologies. Since this involves both inspection techniques and construction management, this proposal suggests an integrated learning approach that offers a design project-oriented course content that is offered in both Construction Management (ET) and Structural Monitoring (CEE) courses, such that students from both Departments can work separately, but produce one project outcome.

The primary objectives of this research are to:

- enhance students' skills of generating creative and realistic solutions for solving open-ended problems;
- promote an active learning environment by diffusing interdisciplinary knowledge and engaging collaborations amongst graduate/undergraduate study groups; and
- disseminate findings via international and national conferences, including the American Society for Engineering Education (ASEE) conference in 2012, Associated Schools of Construction (ASC) international conference in 2012, and a reports and presentations to the university community.

Budget Request for SOTL Grant

Year 2011

Joint Proposal? X Yes ____ No

Title of Project: A Project-Based Integrated Work/Review Cycle (PBIWR) for Design and Learning of Accelerated Construction Monitoring

Duration of Project: Jan. 10, 2011 – Dec. 16, 2011

Primary Investigator(s): Don Chen, Shen-En Chen

Email Address(es): dchen9@uncc.edu, schen12@uncc.edu

UNC Charlotte SOTL Grants Previously Received (please names of project, PIs, and dates): No

Allocate operating budget to Department of: Civil And Environmental Engineering, Engineering Technology And Constructing Management

		Year One	Year Two
Account #	**Award**	**January to June**	**July to December**
Faculty Stipend	Transferred directly from Academic Affairs to Grantee on May 15	$ -	$6,000
911250	Graduate Student Salaries		$1,280
911300	Special Pay (Faculty on UNCC payroll other than Grantee)		
915000	Student Temporary Wages		
915900	Non-student Temporary Wages		
920000	Honorarium (Individual(s) not with UNCC)		
921150	Participant Stipends		
925000	Travel - Domestic		$4,500
926000	Travel - Foreign		

928000	Communication and/or Printing		$1,000
930000	Supplies		
942000	Computing Equipment		
944000	Educational Equipment		
951000	Other Current Services		
	GRAND TOTAL	$ -	$12,780

Attachments:

1. Attach/provide a narrative that explains how the funds requested will be used.

   - A faculty stipend, $3,000 for each researcher, for Dr. Shen-En Chen and Dr. Don Chen to conduct this project during summer 2011, is requested. The total amount is $6,000.
   - A graduate student will be paid for working one month (at the rate of $16.00/hour for 20 hours per week) on collecting and analyzing data. The total amount is $1,280.
   - Travel expenses for researchers to disseminate research findings at conferences are requested in the amount of $4,500.
   - Communicating and printing cost of $1,000 is requested for phone interviews and mailing questionnaires.

2. Has funding for the project been requested from other sources? ___ Yes _X___ No. If yes, list sources.

October 27, 2010

Scholarship of Teaching and Learning Grants Committee
Center of Teaching & Learning
Atkins 149 C
UNC Charlotte
9201 University City Blvd.
Charlotte, NC 28223-0001

Dear SOTL Grants Committee Members:

I fully support the research proposed by Drs. Don Chen and Shen-En Chen entitled "A Project-Based Integrated Work/Review Cycle (PBIWR) for Design and Learning of Accelerated Construction Monitoring." This research proposes a framework that fosters successful interdisciplinary engineering education through project-based learning and extends our educational programs by incorporating the emerging field of accelerated construction monitoring technologies that have the potential to address the concern of public travel delay.

The objectives of this research are closely aligned with the ET and CEE learning outcomes and their program educational objectives, as well as criteria defined in the UNC Charlotte's strategic planning for student achievements. The benefits will accrue in terms of better prepared graduates, enhanced curricula, and expedited and safer construction processes.

This research is important, feasible, and consistent with the goals of the Lee College of Engineering. In addition, the PI's are experienced instructors and excellent researchers with considerable expertise in this field. The results from this curriculum enhancement and research program will have significant impact on undergraduate and graduate engineering education, the university community, and the profession. Therefore, I strongly endorse this proposal.

Sincerely,

Robert Johnson
Professor and Dean
Lee College of Engineering

Table of Contents

Project Narrative

1. Specific Aims

1.1. The overall purpose of the project

The overall purpose of this project is to develop a new learning method to enhance student learning and to generate synergistic knowledge through integrated project studies on the subject of SMAC (Smart Monitoring of Accelerated Construction) from undergraduate students attending the ETCE4251- Highway Construction Technology course and graduate students in the CEGR 6090 – Nondestructive Testing course. Our ultimate intent is to use and share the lessons learned from the proposed project-based teaching approach to improve engineering curricula, to enhance student learning experiences and to produce better engineers for the society.

1.2. The specific objectives of the project

The objectives of this project are to:

- enhance students' skills of generating creative and realistic solutions for solving open-ended problems;
- promote an active learning environment, by diffusing multidisciplinary knowledge and engaging collaborations amongst graduate/undergraduate study groups; and
- disseminate findings via international and national conferences, including the American Society for Engineering Education (ASEE) conference in 2012, Associated Schools of Construction (ASC) international conference in 2012, and a report and presentations to the university community.

1.3. The rational for the proposed project

Due to the social-economic impacts in delayed travels, the US Department of Transportation (USDOT) has been pushing for Accelerated Construction (AC) technologies for public transportation facilities that would minimize delay costs (FHWA, 2005). AC technologies may include optimized construction management delivery techniques, or modularized constructions where ready-made structural components can be assembled in a very short time. In contrast to

traditional construction techniques, the AC technology is envisioned by the federal government to generate great savings for the nation by eliminating unnecessary traffic jams.

This change in construction technique offers a great opportunity to introduce an advanced monitoring concept for structural construction/aging processes via embedded sensing technologies. On-site construction constantly imposes constraints to system-wide monitoring because the requirement of an embedded sensing system on site would mean a slow-down and disruption of the construction process – an unwelcomed demand on the contractors. However, with modularized construction, the building in of sensing systems can be performed at the manufacturing level without causing time constraints at the construction site. Also, since the sensor systems are embedded in the pristine structure prior to assembly into the full structure, the sensing system can be mobilized to monitor the structure as early as the construction phase.

The Self-Monitoring Accelerated Construction (SMAC) technology conception represents a true smart system, like the human body, that allows the structure to report defects that may be induced either during construction or during its service life. The development of such technology requires integrated knowledge in civil engineering electronic sensory design, as well as the specific accelerated construction involved. This proposal suggests a joint investigation effort among students between two different disciplines and supervised by faculty specialized in Civil Construction Technologies (Dr. Don Chen – Department of Engineering Technology) and Structural Health Monitoring (Dr. Shen-En Chen – Department of Civil and Environmental Engineering). The conception will be used as the subject matter for specific class projects that will be offered in ETCE4251- Highway Construction Technology and CEGR 6090 – Nondestructive Testing courses.

The rationale for the multi-disciplinary, project-based course is to optimize the learning experience with active peer/supervisor evaluation and to stimulate student creativity. There are two key pedagogical objectives in this study: 1) To establish a potentially creative and synergistic environment for student learning through interactions between multi-discipline teams: Construction Technology and Structural Monitoring students; and 2) To enhance autonomous self-correcting and learning mechanisms by peer reviews to ensure quality outputs

by avoiding infusion. The goal is for students to meet the ET and CEE program outcomes as well as criteria defined in the UNC Charlotte strategic planning for student achievements.

However, since the two student levels are distinct, hence, to ensure we understand how each group learn and contribute to the general idea, we intentionally avoid direct interaction between the two groups. This will guarantee that proper observations about the student learning experiences can be attributed to the right process for future improvements on the course content.

1.4. The benefits to student learning and success

This project will generate better-prepared graduates in the subjects of science, mathematics and engineering designs. The CEE program will graduate engineers who are responsible for designing industrial projects; graduates from the ET program will become construction managers. An engineer who understands how the projects are constructed can generate optimized designs that are easy to be implemented on the job sites; and a constructor who has been exposed to design philosophy is able to appreciate design details, propose feasible value engineering strategies, and fully collaborate with designers. By introducing construction management knowledge to the CEE students, and advanced monitoring to the ET students, the researchers expect that a comprehensive grasp of bridge construction and monitoring can be achieved in both groups.

This project will enhance both undergraduate and graduate educations. Most of the ET students involved in this project are seniors. All the CEE students are graduate students. The breadth and sophistication of knowledge and the level of maturity are different in these two groups. Group reports from one level will be critiqued by students at a different level. i.e., the graduate students will grade group reports developed by the undergraduate students, and vice versa. This is beneficial to student learning because both groups of students can learn how others solve problems from different perspectives.

2. Literature Review

An extensive literature review has been conducted to synthesize past and ongoing research related to this study. Interdisciplinary integration in engineering education has been widely adopted by faculty because of improved “awareness of [their] collaborators’ perspectives, …, and noted increased satisfaction and quality of work” (Borrego and Newswander, 2008). This

way of teaching creates diversity among engineering students. "..., without diversity, engineering cannot take advantage of life experiences that bear directly on good engineering design" (Wulf, 1998). Optimized designs can be achieved through several inductive teaching and learning methods. Project-based learning (PBL) has proven to be one of the most effective inductive methods (Dym et al., 2005). Other promising inductive methods include problem-based learning, case-based learning, discovery learning, and just-in-time teaching. Prince and Felder (2006) indicated that these inductive methods "promote students' adoption of a deep (meaning-oriented) approach to learning, as opposed to a surface (memorization-intensive) approach." Whether or not faculty research supports engineering education remains a debate at academic institutions. Waston (2009) suggested that the integration of research and engineering education will take place only if research is "translated into changes into faculty, courses, and curriculum."

3. Methodology

This research will include the following steps:

1. Develop relevant new course materials, the project description, and the grading rubric;
2. Dr. Shen-En Chen will give a lecture on non-destructive testing and monitoring of bridges in Dr. Don Chen's undergraduate level course ETCE 4251 Highway Design and Construction section 001 (45 students). This lecture will be videotaped using Panopto and then played to ETCE4251 section 090 (32 students).
3. Dr. Don Chen will lecture on a similar topic but with an emphasis on accelerated bridge construction to Dr. Shen-En Chen's graduate level course CEGR 6090 Nondestructive Testing (10 students).
4. A group project (Appendix A) will be assigned to the ETCE4251 and CEGR 6090 students.
5. Students will be asked to grade project reports and redesign the project based on feedback obtained.
6. An industrial reviewer closely affiliated with the subject matter will be invited as an external reviewer to critique student works.

7. Faculty will compile and synthesize all assessment outcomes to determine the success level of the project.

4. Evaluation

The effectiveness of this project will be evaluated through the following measurements (Figure 1):

- group project scores;
- peer review from each team;
- the results from the learning experience survey; and
- evaluation from faculty and industrial reviewers.

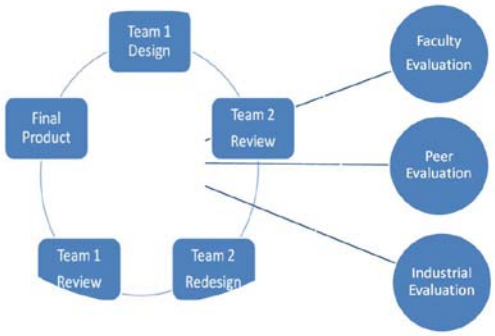

Figure 1. Integrated Work/Review Cycle Project Approach

The outcomes of the evaluation will be used to improve on the contents of the course and as material for developing a NSF proposal.

5. Knowledge Dissemination

The results from this research will be presented to the UNC-Charlotte community and at various international and national conferences. The researchers also plan to develop a NSF proposal that focuses on the integration of the accelerated bridge construction technology and state-of-the-art bridge monitoring strategies. Our intent is to apply for a NSF CCLI grant to develop a series of integrated courses focusing on SMAC technologies.

6. Human Subjects

An IRB approval has been requested for collecting human subject related data for this project (Appendix B).

7. Extramural Funding

Faculty stipend, $3,000 for each researcher, for Dr. Shen-En Chen and Dr. Don Chen to conduct this project during summer 2011, is requested. The total amount is $6,000.

A graduate student will be paid for working one month (at the rate of $16.00/hour for 20 hours per week) on collecting and analyzing data. The total amount is $1,280.

Travel expenses for researchers to disseminate research findings at conferences are requested in the amount of $4,500.

Communicating and printing cost of $1,000 is requested for phone interviews and mailing questionnaires.

8. Timeline

Spring 2011:

- Delivering of the lectures
- Assigning the group project
- Conducting the learning experience survey
- Collecting assessment data

Summer 2011:

- Surveying recent graduates and their employers

Fall 2011:

- Analyzing data
- Disseminating research findings

9. References

Borrego, M., and Newswander, K.L., (2008). "Characteristics of Successful Cross-Disciplinary Engineering Education Collaborations," Journal of Engineering Education, Apr2008, Vol. 97 Issue 2, p123-134, 12p.

FHWA, ACTT: A “How To” Guide for State Highway Agencies, US Department of Transportation, 2005.

Dym, C.L., Agogino, A.M., Eris, O., Frey, D.D., and Leifer, L.J., (2005). "Engineering Design Thinking, Teaching, and Learning," Journal of Engineering Education, January 2005.

Prince, M.J., and Felder, R.M., (2006). "Inductive Teaching and Learning Methods: Definitions, Comparisons, and Research Bases," Journal of Engineering Education, April 2006.

Waston, K., (2009). "Change in Engineering Education: Where Does Research Fit?" Journal of Engineering Education, January 2009.

Waston, K., and Froye, J., (2007). "Diversifying the U.S. Engineering Workforce: A New Model," Journal of Engineering Education, January 2007.

Wulf, W.A., (1998). "The Urgency of Engineering Education Reform," The Bridge Vol. 28, No 1,1998, pp. 4-8.

Appendix A. Sample Student Group Project

1) Identify an Accelerated Construction Approach as outlined in the class notes.

2) Conduct literature review on the State-of-the-Art of the Approach.

3) Design a monitoring system/approach for an imaginary system (for example, a 2 mile highway pavement or a bridge).

4) Write a summary report not more than ten pages that includes:

1. Description of the system design
2. Description of the system application
3. Description of what it would take for you to actually put such a system together
4. Description of what obstacles you might face in the design/use of the system
5. Description of the benefits your system can contribute to the US infrastructure issues

5) Draw a Schematic Picture of how your team envisions how the system would work.

Appendix B. IRB Human Subject Approval Application

From: Runden, Cat
Sent: Thursday, October 28, 2010 12:14 PM
To: Chen, Shen-En
Subject: RE:

Shenen,

As you may recall from your previous IRB application submittals, the first step in the review process is a preliminary review by the Compliance Office. I have completed this review and have the following feedback, questions, and suggestions. I made some direct changes to the protocol application. Please review these changes and let me know if you approve them.

Protocol Application

Q.1 – Human Subjects Tutorial

Dr. Don Chen will need to complete human subjects research training. The online tutorial is available through CITI. I've attached registration instructions which may be helpful.

Q.4 – Student Investigators

Provide some explanation. Will you have student investigators or research assistant who will be part of your research team and use the data you collect? If so, please explain. If not, then you may uncheck all the boxes in this question.

Q.5 – Study Design

I recommend providing some additional information about the project. See the attached revised protocol application. I added some information from your grant proposal into the protocol application.

Q.8 – Characteristics of Study Population

Inclusion Criteria: Be more specific. Name the classes and specify that students are UNC Charlotte students. Also indicate that students must be age 18+ to participate.

Q.11 – Study Design

- Clarify the data collection methods. Will you use a survey or a focus group? Surveys may be completed individually and focus groups are group discussions.
- Based on the grant proposal it looks like you will use other data sources as well. Please include in the protocol application all appropriate "Evaluation" information from the grant proposal. For example, if the data you will use will include group project scores, written and verbal peer reviews, written and verbal faculty & industrial reviews, explain that this is the case.
- Also, it would probably be helpful to explain that the classroom activities and associated data that you will collect will result from routine classroom activities. Participants will not be asked to do anything more then what is required of the course.
- The grant proposal mentions a "learning experience survey". Please provide this survey for review.

Q.21 – Recruitment

Provide more information about the recruitment process. Will you make class announcements in addition to the letter of consent? I've attached an example recruitment script that may be useful.

Q.22 – Consent

Discuss the consent process in more detail. Who will distribute the consent? Perhaps you and Dr. Chen can alternate classes so that you distribute the consent for Dr. Chen's class and Dr. Chen distributes the consent for your class. This would help avoid feelings of coercion. Or maybe a graduate assistant will distribute the consents and collect them. Is it possible to have students sign (or not sign) the consents and then have a graduate student seal the consents in an envelope which you and Dr. Chen would not open until final grades are posted. Then after grades are posted you can review the consents and only use the data (surveys, focus group, grades, class assignments, etc.) for students who consented/signed the consent? Or do you plan to analyze data as you go through the semester and will need to know at the front end who has consented?

Q.23 – Waivers

Be sure all of these boxes are checked as no.

<u>Consent</u>

The consent document is slightly confusing. Will you have a focus group or a survey? Or both? Also you need to mention that part of your evaluation will include using students' class assignments (including peer review and faculty/industry review comments), grades, etc.

I've attached an example consent that may be useful.

Let me know if you have any questions.

Thanks.

Cat

Cat Runden | Office of Research Compliance

UNC Charlotte | Cameron 321F

9201 University City Blvd. | Charlotte, NC 28223

Phone: 704-687-3309 | Fax: 704-687-2292

crunden@uncc.edu | http://research.uncc.edu/comp/human.cfm

Watch your thoughts; they become words. Watch your words; they become actions. Watch your actions; they become habits. Watch your habits; they become character. Watch your character; for it becomes your destiny.

Patrick Overton

From: Chen, Shen-En
Sent: Wednesday, October 27, 2010 5:59 PM
To: Runden, Cat
Cc: Chen, Don
Subject:

Dear Cat,

Attached please find application from Don Chen and Shen-En Chen for a possible project seeking approval for research involving human subjects. Attached also include a draft of the proposal and consent forms.

Please let me know if additional information is needed.

Thank you so much for your help!!

Sincerely,

Shenen

Appendix C. Industrial Review Committee

An industrial reviewer will be identified from the following list, pending their availability:

1) Dr. Philip Yen, Federal Highway Administration

2) Dr. Maria Guimaras, EPRI

3) Dr. James Wall, EPRI

4) Dr. Paul Yue, USDOE

5) Dr. Tess Ahlborn, Michigan Tech University

6) Mr. Steve Vernado, Michigan State University