Sixth International Conference on Construction in the 21st Century (CITC-VI)
"Construction Challenges in the New Decade"
July 5-7 2011, Kuala Lumpur, Malaysia

State of the Art Integration of CII Research Products within Higher Education Curricula: A Case Study

David Grau
Assistant Professor, Department of Civil, Construction, and Environmental Engineering, The University of Alabama, Box 870205, Tuscaloosa, Alabama, USA

Salman Azhar
Assistant Professor, McWhorter School of Building Science, Auburn University, Auburn, Alabama, USA

G. Edward Gibson
Professor, School of Sustainable Engineering and the Built Environment, Arizona State University, Tempe, Arizona, USA

Richard Burt
Professor, McWhorter School of Building Science, Auburn University, Auburn, Alabama, USA

Abstract
The Construction Industry Institute (CII) has a long line of research products that have been successfully implemented by industry organizations. When properly implemented, such products have been found to lead to enhanced project delivery processes. However, there is a perception that colleges and universities have been rather slow in the utilization of those products for teaching purposes, but no data on the topic has yet been published. Thus, this study unveiled the state of the art integration of CII products within the higher education curricula of construction-related courses in North American colleges and universities. To this end, an interactive survey tool was distributed to the academic members that actively teach construction-related courses. Based on the survey responses, the integration of CII products into higher education curricula is detailed in this manuscript.

Keywords
Research products, Construction Industry Institute, Graduate education

1. Introduction and Motivation

The Construction Industry Institute (CII) is a consortium of leading owners, contractors, suppliers, and academia. It was established in 1983 and based in University of Texas at Austin, Austin, Texas, USA. The mission of CII is to improve the safety, quality, schedule, security, reliability, cost effectiveness, and operability of the capital investment process through research and implementation support for the purpose of providing a competitive advantage to its members in the global marketplace. More information about CII can be found at its website http://www.construction-institute.org.

CII has developed a long line of research products for project management in the Engineering and Construction industry since its inception in 1983. A knowledge system framework was developed to organize much of this information into CII's current knowledge structure in the late 1990s. Even though

CII products and tools have been well received by industry organizations, which can actively integrate them into their operations, there is the perception that North American colleges and universities have been slow to adopt CII products and tools. CII has been producing research to advance the knowledge in the complex process of delivering capital facility projects. CII products aim at increasing the efficiency of the organizations that deliver capital projects through improved engineering and construction practices. Indeed, when properly executed, the implementation of such products leads to enhanced project performance. Over more than 27 years, CII has produced a large number of research products and tools structured within 14 best management practices. These management practices summarize the best methods and techniques that industry organizations utilize to deliver capital facility projects in core areas such as front end planning, team building, alignment, constructability, and change management. Even though the successful adoption and dissemination of these best practices and their corresponding implementation tools across industry organizations, CII has not yet focused directly on the education outlet for the dissemination of its products.

Thus, there is a significant potential to expose undergraduate and graduate students to the best management practices of the capital facility industry, an integration that would likely improve the education of future engineers and better prepare them to face the challenges that they are to encounter in their professional careers (Robertson and Bond 2001; Turrell 2003; Amaratunga and Senaratne 2009; Jestrab et al. 2009). Indeed, the integration of industry knowledge and practices in the classroom positively increases the cognition of the students (Jestrab et al. 2009). Similarly, the integration of research and industry practices into teaching activities has demonstrated to be effective for transferring knowledge to the students (Robertson and Bond 2001; Turrell 2003). In addition, it has been noted that the integration between research and teaching requires the development of appropriate mechanisms that can only be developed through the integration of these two different, but frequently complementary, academic facets (Amaratunga and Senaratne 2009). To this date, though, no previous study has investigated the integration of the best industry practices for the delivery of capital projects within higher academic institutions. In order to promote and accelerate the integration of industry practices or their products (such as those of CII) into higher education curricula, one must know at what level such products are currently being used by colleges and universities. Thus, the study presented in this paper attempts to provide factual data to assess the level of integration of CII products, and by default their corresponding best practices, into higher education institutions.

The rest of this paper is organized as follows. This introduction is followed by the objectives of this study, which precedes the discussion of the data collection methods and tools. Based on the collected data, the current integration of CII products within engineering and construction management programs is also detailed. Finally, the conclusions summarize the findings of this paper.

2. Objectives

This study primarily focused on characterizing the state of the art integration of CII research products in higher education curricula for project management, construction management, construction engineering, and construction methods and techniques courses. The study was geographically constrained to North American colleges and universities. In addition, the study also identified and characterized the standing barriers that are opposing to the integration of CII products into higher education curricula. However, due to space limitations, the findings related to the standing barriers have not been included in the present document, even though all the findings from this study will be presented at the 2011 CSCE conference. The details of the entire study are given in Grau et al. (2011).

3. Methodology

An online questionnaire survey tool was utilized to collect data for the characterization of the current integration of CII research products into North American colleges and universities. The survey was

designed in compliance with the survey research methods literature (Fowler 1995; de Vaus 1995; and Fowler 2008) in order to capture true and unbiased data. Just as an example, a special care was taken to elaborate open ended questions that could not guide the survey respondents in their answers. The survey was structured in two distinct sections: 1) collection of academic and personal information of the survey respondent, and 2) collection of information on the integration of CII products into the courses taught by the respondent. The collection of academic and personal information was used to characterize and group the answers on the integration of CII products by type of program, academic rank, or best management practice, among others. Also, it provided contact information so we could actually contact the respondent if clarifications or further explanations on the responses were sought. The collection of information on the integration of CII products in the courses taught by respondent aimed at the characterization of such integration with questions related to the identity of CII products used in the classroom, the course(s) in which they were taught, or the level of utilization of each product within the scope of each course, among several others. This section of the survey tool was interactive, so that the responses to certain questions would rout the respondent to a different set of questions or to exit the survey. For instance, those respondents who had no previous knowledge on the existence of CII or of CII products were invited to leave the survey, since they would have not been able to respond to the questions on the utilization of CII products in their courses. Once designed, the survey was pre-tested among a reduced, but diverse in terms of CII and CII products knowledge, number of academics. Once pre-tested, the survey was distributed by email to 760 faculty members that teach construction related courses in North America.

These 760 faculty members were actually divided in two distinct populations. Indeed, 350 academics taught construction courses within engineering departments (typically civil engineering departments) and 410 academics taught construction within schools of construction. For the rest of this manuscript, the population of academics within the schools of construction will be referred as ACCE —in reference to the affiliation of their programs to the American Council for Construction Education (ACCE). Similarly, the population of academics within the engineering departments that taught construction within engineering departments will be referred as ABET —in reference to the affiliation of their programs to the Accreditation Board for Engineering and Technology (ABET). The identification of these distinct populations was important in order to unveil plausible differences in the level of integration of CII products, differences that were suspected due to the different behavior of both populations in terms of academic pursuits, number of courses taught, or level of involvement with CII. The results confirmed that, for the most part, ACCE and ABET populations were distinct regarding the integration of CII products.

In order to statistically analyze the collected data, a hypothesis test for differences between population proportions was performed for the following questions:

- Academic Awareness of CII
- Academic Awareness of CII Products
- Academics Implementing CII Products for Classroom Use
- Applicability of CII Products at Undergraduate and Graduate Levels
- Perception of CII Marketing Efforts

For each of these questions, the statistical test aimed at determining whether or not the differences between the proportion of ACCE and ABET responses (p1 and p2) are statistically significant with a 95 percent level of confidence, based on their point estimates. Thus, the null and alternate hypotheses are defined by the following: H0: $p1 - p2 = 0$; H1: $p1 - p2 \neq 0$ (two-tailed test).

4. Main Findings

Out of the 760 faculty members selected for the survey, 198 responded—yielding a total response rate of 26 percent. The individual response rates for ABET and ACCE groups are 23% (80 responded from a

group of 350 ABET members) and 29% (118 responded from a group of 410 ACCE members) respectively. The main findings of this research study are briefly presented in this section while the detailed results will be available in the research report which will be released by CII in 2011.

4.1 Academic Awareness of CII

Based on the survey results, 94 percent of ABET and 44 percent of ACCE respondents were aware of CII as shown in Table 1. It is also found that there is a statistically significant difference in population proportions. Based on this finding, it can be inferred that most of the faculty members of ABET-type programs know about CII, while a minority of the faculty members of ACCE programs know about CII. We also determined that most of the academics first learned about CII through CII publications, through their colleagues, and CII events.

Table 1: Awareness of CII by Academic Populations

	ABET	ACCE
Awareness	94%	44%

4.2 Academic Awareness of CII Products

The survey results indicated that a majority ABET faculty members know the existence CII products and of their applicability for classroom use. On the contrary, only a minority of ACCE faculty members know the existence CII products and of their applicability for classroom use. The difference in the population proportions was demonstrated to be statistically significant. The main determinant of such difference seems to be related to a larger level of involvement of ABET academics. Historically, ABET academics has performed research and served through CII committees more intensively than their ACCE colleagues.

4.3 Implementation of CII Products

It was found that 53 percent members of ABET group and 38 percent members of ACCE sample that was aware of CII products before the survey used them in the classroom. Table 2 illustrates the descriptive statistics on the number of actual courses in which these products are being used. As evident from Table 2, although some participants have used CII products in up to six different courses, the majority use them in teaching one or two courses. Many respondents also mentioned that they often combine several CII products to teach a single course. It is also noticeable that ACCE academics implement, on average, a larger number of CII products than ABET academics.

Table 2: Implementation of CII Products in the Classroom

	Average	Minimum	Maximum
ABET	1.65	1	4
ACCE	2.192	1	6

Also, the survey indicated that products within different CII knowledge areas were mostly used by ABET and ACCE faculty members –see Table 3. ABET faculty members make a more intensive use of products within the front end planning knowledge area, while ACCE faculty members make a more intensive use of products within the project controls knowledge area. Overall, Front End Planning, Project Controls, Project Organization and Management were the knowledge areas with a maximum utilization of products by the totality of the academics (both ABET and ACCE groups).

Table 3: Ranking of Most Utilized CII Products by Knowledge Area

	ABET	ACCE
1st	Front End Planning	Project Controls
2nd	Project Controls	Design Optimization
3rd	Project Organization and Management	Project Organization and Management

4.4 Academic Applicability for Undergraduate and Graduate Students

The survey participants were also asked about the applicability of CII products at undergraduate and graduate levels. The results indicated that the majority of respondents within both ABET and ACCE groups considered CII products as being *slightly-to-moderately* applicable for undergraduate education. On the contrary, these respondents felt that these products are *moderately-to-extremely* useful for graduate education. The related data is illustrated in Table 4. No statistical difference between the perceptions of ABET and ACCE respondents was recorded.

Table 4: Perception of Academic Applicability of CII Products

	Undergraduate Students		Graduate Students	
	ABET	ACCE	ABET	ACCE
Slightly Applicable	19%	19%	0%	3%
Moderately Applicable	41%	46%	25%	23%
Very Applicable	9%	16%	41%	35%

4.5 Perception of CII Marketing Efforts

Both academic communities consider that the marketing efforts by CII in order to enhance the utilization of its products for academic use should be improved. Actually, the results show that a majority of respondents from both the ABET and the ACCE communities consider that, to this date, such marketing efforts have been mostly poor –see Table 5. There are no statistical differences between population proportions regarding the perception of CII marketing efforts. The findings seem to indicate that, with improved marketing efforts, there exist a potential for a more intensive integration of CII products in higher education curricula.

Table 5: Perception of CII Marketing Efforts in Percentage of Academic Population

Perception	%
Very Good	0%
Good	24%
Fair	51%
Poor	24%
Very Poor	2%

Based on the results of this study, it is suggested that CII should focus on the effective marketing of its products within the academic community to reach out maximum faculty members. It can be done through the following ways (1) Conducting CII information sessions and CII product implementation sessions at academic and professional conferences such as CRC, AGC, ABC, CIB congress, etc.; (2) Regularly mailing CII brochures, catalogues, or sample publications to ABET/ACCE schools heads; (3) providing discounted registration for faculty and students for CII workshops and annual conference; (4) promoting

CII annual conference throughout the academic community; and (5) developing educational support material for instructors.

5. Conclusions

The following conclusions can be drawn from this study: (1) Most faculty members of ABET programs and nearly half of the members of ACCE programs are aware of CII and its products; (2) At present, most respondents use CII products for teaching courses related with Front End Planning, Project Controls, Project Organization and Management, and Design Optimization; (3) Although some respondents have used CII products for teaching up to 6 different courses, the majority use them in 1 or 2 courses; (4) CII products are found to be more useful at the graduate level as compared to the undergraduate level; and (5) CII's marketing effort is rated as poor-to-very poor by most respondents and suggested a more focused approach to reach out the maximum academic community. In summary, there is a significant opportunity to enhance higher education in ABET and ACCE programs through the specific use of CII products and research results.

6. Acknowledgments

The authors want to thank and recognize CII for sponsoring this study. Also, thanks to the ACCE and ABET academic communities for their active participation in the survey and interviews that shaped the results and insights presented in this paper.

References

Amaratunga, D., and Senaratne, S. (2009). "Principles of integrating research into teaching in higher education: built environment perspective." *International Journal of Construction Education and Research*, 5(3), 220-232.

Fowler, F.J. (1995). *Improving Survey Questions*. Sage Publications, Thousand Oaks, CA.

Fowler, F.J. (2008). *Survey Research Methods*. Sage Publications, Thousand Oaks, CA.

Grau, D., Azhar, S., Gibson, G.E., and Burt, R. (2011). "CII Products and Academic Applicability." *Construction Industry Institute*, Research Summary AC2.

Jestrab, E.M.; Jahren, C.T.; and Walters, R.C. (2009). "Integrating industry experts into engineering education: case study." *Journal of Professional Issues in Engineering Education and Practice*, 135(1), 4-10.

Robertson, J. and Bond, C. (2001). "Experiences of the relation between teaching and research: What do academics value?" *Higher Education Research and Development*, 20(10), 5-19.

Turrell, P. (2003). "Teaching and research – strengthening the relationship." *CIB W89 Building Education and Research Conference, Salford*.

Vaus, D.A. de (1995). "Surveys in Social Research." *Allen and Unwin*, St Leonards, Australia.