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Integration of Project Management Course to Satisfy ABET's Requirements

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Today's engineers are faced with challenges that are vastly different from the challenges faced by previous generations. These challenges include global competition, intelligent technology, and a constantly changing work environment. But the speed with which this civilization continues to advance is fundamentally challenging the way in which engineering is practiced and the way in which engineering and engineering technology students are educated. Technological breakthroughs—the Internet and apple products most prominent among them—have effected an increasingly global "workplace" in which the collaborative efforts of multinational teams are unhampered by geographical distance or time zones, and this global workplace in turn is introducing new imperatives not only to engineering practice but to engineering and engineering technology education as well.

Past reports and studies have been prepared by the American Society for Engineering Education (ASEE), the National Academy of Engineers and the American Society Civil Engineers (ASCE) discussed that the changes are needed for improvement of engineering education. Numerous studies revealed that the engineering curriculum of today still does not provide the foundation necessary to ensure the engineer's success in the 21st century. In the past, the skills workers acquired would serve them well for decades. In the 21st century, however, an engineer's success or a company's success will be measured against how well they can adapt to new conditions and technologies. Thus to remain competitive in this global and knowledge-based economy and to ensure that the quality of life improves for everyone around the world, engineers must be educated differently (Galloway, 2008).

If engineers are to compete successfully in this global workplace and establish themselves as leaders in solving many of the world's most pressing problems, engineers must embrace the need for professional innovation and they must do so quickly (Galloway, 2008). Companies and public agencies alike are crying out for engineering education reform that will allow engineers to broaden their technical skill sets with those skills required for engineering management in the 21st Century. Engineering educators need to understand that long-established methods of practicing engineering and educating engineers are in critical need of reform, and they must understand that they must act decisively within the next several years to ensure that these reforms are adequately formulated and implemented.

Practicing engineers also need to embrace the need to enhance their image on the world stage to elevate their professional standing to the higher level. Engineers by and large have come to be viewed as technicians, not as practitioners of a profession engaged in a high calling comparable to the practice of law or medicine. In order to elevate the professional standing on the global stage, engineers must understand why and how they must do so. It is Imperative that changes are needed for the survival of the engineers.

These demands require knowledge that cannot be acquired by means of a four-year curriculum; they require knowledge acquired via graduate study (ASCE, 2004). It is critical for the engineering profession to understand that the four-year curriculum is no longer adequate—that given the rate of change within the field of technology and the need to cope with the increased breadth and complexity of modern engineering practice, additional subjects of study need to be incorporated into engineering and engineering technology curricula at both the undergraduate and graduate levels. These subjects include globalization, leadership, communication,

collaboration, decision making, ethics and professionalism, public policy, diversity, project management, risk management, and dispute resolution.

Skill Sets Needed for the 21st Century Engineer

While engineers remain strong in terms of their technological skills, they are generally weak in terms of their management and communication capabilities. They do not fully understand the concept of globalization; they may not have a firm grasp of the issues confronting the 21st-century engineer; they lack the competencies that would enable them to rise to leadership positions within government and industry; and they are not developing curricula that would train engineers to anticipate and focus on the rapid changes by which the 21st century will be at least partially defined (NAE, 2004).

In its 2004 book *The Engineer of 2020: Visions of Engineering in the New Century*, the National Academy of Engineering defined the engineer of the 21st century as follows:

"Engineering is problem recognition, formulation, and solution. In the next twenty years, engineers and engineering students will be required to use new tools and apply ever-increasing knowledge in expanding engineering disciplines, all while considering societal repercussions and constraints within a complex landscape of old and new ideas. They will be working with diverse teams of engineers and non-engineers to formulate solutions to yet unknown problems….The engineers of 2020 will be actively involved in political and community arenas. They will understand workforce constraints, and they will recognize education and training requirements necessary for dealing with customers and the broader public. Engineering will need to expand its reach and thought patterns and political influence if it is to fulfill its potential to help create a better world for our children and grandchildren."

Mega and complex projects, sustainability, infrastructure security, resilience, and multi-cultural teams-all that will pose engineering management challenges and for which engineers of today are largely unprepared. The practice of engineering continues to become increasingly more complex. As a result of the rapid rise of information technology, the explosion of knowledge in engineering and construction, the enhanced public awareness of and involvement in engineered projects, and the growing complexity of civil infrastructure systems around the world, the job performed by the engineer continues to become more demanding.

Is Engineering Accreditation the Answer?:

In 1995, *Accreditation Board for Engineering Education and Technology* (ABET) set out the draft of "Engineering Criteria 2000" as a mandate to educators to design curriculums that could produce engineers with the right skill sets to enter the job market. In 1996, ABET approved a set of eleven outcomes that all engineering baccalaureate graduates should possess under new Engineering Criteria. The criteria writers concentrated on what it was that all engineers should be able to do which resulted in eleven desirable outcomes, no matter what the discipline. The criteria can be divided into two categories: "hard skills" and "soft skills" or what is becoming

increasingly better known as “people skills”. Six of the eleven outcomes address the people skills including (Shuman et al., 2005):

• an ability to function on multi-disciplinary teams

• an understanding of professional and ethical responsibility

• an ability to communicate effectively

• the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental and societal context

• a recognition of the need for, and an ability to engage in lifelong learning

• a knowledge of contemporary issues

While curriculums at many colleges and universities have been tweaked and even overhauled in some cases in response to ABET’s criteria, the changes are in mostly into the coursework? In general, there appears to be a mismatch on both sides that it is not happening quickly enough (Hannon, 2003).

ABET continues to work though these issues in order to better the curriculum, however, many universities are still struggling of how best to meet industry’s needs while meeting the criteria of ABET. According to ASEE, employers like to have an engineer who will be able to do the following in his/her career (ASEE, 2003):

• An ability to apply their knowledge of mathematics, science and engineering to design, conduct experiments, and analyze data

• An ability to perform on multidisciplinary teams and communicate effective solutions in a global and societal context. That means a smattering of everything from history to sociology to psychology

• A desire for lifelong learning and continuous improvement

• A bona fide knowledge of contemporary issues

New Draft Criteria:

According to the commentary document prepared in December 2014 by the ad hoc Civil Engineering Program Criteria Task Committee as authorized by the ASCE Committee on Accreditation, civil engineering program evaluators and civil engineering program faculty can utilize the guidance document in association with the ABET/EAC Criteria for Accrediting Engineering Programs. The guidance effective from 2016-17 included the following as new criteria or modification of existing criteria:

- The curriculum must prepare graduates to apply probability and statistics to address uncertainty
- The curriculum must prepare graduates to include principles of sustainability in design
- The curriculum must prepare graduates to explain basic concepts in project management, business, public policy, and leadership.

This article focuses on the criteria of project management instead of other new criteria.

Understanding the criteria

This provision of the Civil Engineering Criteria includes four components: basic concepts in project management, business, public policy, and leadership. Previously, this provision did not specifically state project management and implied a broader exposure to management, including project management, construction management, and asset management.

Basic concepts in project management should include project manager responsibilities, defining and meeting client requirements, risk assessment and management, stakeholder identification and involvement, contract negotiation, project work plans, scope and deliverables, budget and schedule preparation and monitoring, interaction among engineering and other disciplines, quality assurance and quality control, and dispute resolution processes.

The guideline mentioned that it is not necessary for the program to offer one or more courses explicitly devoted to project management, business, public policy, or leadership. They suggested that these topics might be integrated into other courses or curricular experiences. Additionally, graduates' ability to explain generic, business---oriented project management, business, public policy, or leadership concepts such as those acquired from a course or courses offered outside engineering could also represent full compliance with this criterion.

Rationale for the new criteria:

Narrowing the focus on management in the previous program criteria to project management in the current program criteria recognizes civil engineering work is largely project based. Additionally, to be effectively productive on a project, civil engineers need to know how their work fits into the overall team effort to produce the project. This focus is not intended to diminish any involvement of civil engineers construction engineers and/or other engineers.

To the extent construction engineer/management involves managing a project and not, as examples, managing a construction firm or managing construction financing, it could meet the intent of the focus on project management. Similarly, to the extent asset management involves managing a project and not, as examples, managing inventory or managing facilities, it could meet the intent of the focus on project management.

Theories of management reiterate that the discipline of project management has been traditionally served by principles of management bureaucracy, control, and hierarchy (Kolltveit, Terje Karlsen, & Gronhaug, 2007). In fact, Pollack (2007) mentioned that this rationalist and instrumentalist ideology had developed into an obsession with planning. According to the Project Management Institute (PMI; 2000), planning appears extensively linked to the failure of projects. The implication of these developments was that there had become an urgent need to conceptualize project management in a way that ensured that modern contextual and subjective ideology was built into its developing theories. As expected, this shifting management paradigm had implications for project management education. Of primary importance is that long-held assumptions of the need to "train" project managers to effectively use various and emerging

"methodologies" began to give way to a realization that the education of project managers could not be effective if primarily grounded in technical instrumentality. Studies appear to affirm that an emphasis on learning and teaching within the project management discipline is unlikely to deliver tangible benefits to major stakeholders without a clear articulation of the perceptions of the key stakeholders: the students (Wearne, 2008) and the industry. However, substantial difficulties exist when attempting to articulate students' expectations in terms of learning and teaching project management. Such difficulties include the emerging differences in student cohort composition and the significant increase in diversity (Felder & Brent, 2005).

Curriculum of Project Management Course

Depending on the new ABET requirements, guidance by ASCE commentary document and recent realignment of the curriculum of the Department of Civil and Architectural engineering at Tennessee State University, Project Management course is redesigned to educate civil engineers, architectural engineers and construction engineers.

This course is designed to give an understanding of the underlying principles that govern this process, as well as an acquaintance with some of the key tools used by civil/construction professionals in carrying out their responsibilities in the management process.

- To gain a general understanding of the AEC industry, business, processes, and organizational structures
- To develop the basic skills necessary to manage the construction process from owner/designer/contractor perspectives (a,c)
- To understand job functions and roles of the various players in the design and construction industry (d, j)
- To equip designers/contractors with knowledge of construction practices to better enable them to produce safe and practical designs and construction (c, f, e)
- To acquire basic estimating and cost control skills (a, c, j)
- To acquire fundamental scheduling skills (a, c, d, j, k)
- Use software to manage construction operations (k)
- To develop an appreciation and dedication to safety (f, n)
- To cultivate teamwork, communication and leadership skills (d, k)
- To kindle a sense of professionalism and encourage ethical practice (f, n)

Based on the above principles, the content of the new syllabus is as follows:

week 1	1	Introduction to AEC Industry/ Organization Structures
week 2	2	Project Delivery Methods/Business Development

week 3 .	3	Project Participants/Organizing and Leading the Project
week 4 .	4	Leadership, Estimating and Budget
week 5	5	Estimating and Cost Control, WBS
week 6	6	Project Management/ Planning & scheduling
week 7	7	Project Planning and Scheduling
week 8	**8**	Job-Site Administration, Payment Applications
week 9	9	Construction and Closeout
week 10	10	Project Buyout – Profit -Fieldtrip/Guest Speaker
week 11	11	Construction Safety/Professional Ethics
week 12	12	Risk Management/Legal Issues/Decision Analysis
week 13	13	project presentation
week 14	14	Project presentation

A closer look helps us understand the reasoning behind this contradiction. Simplified, project management is the defining, structuring and development of information, followed by the subsequent processing of the information and by timely decisions based on that same information. These simple but extremely powerful concepts are generally covered as academic theory in colleges and universities on an individual subject-by-subject basis, and not always by the same names in the project management field have used. Frequently, however, the academic institution misses the critical step of integration. Once integrated, understood, and "put to paper," these theoretical concepts suddenly become the lifeline of the project management professional — the tools PM will use to create his/her masterpiece.

These tools, including WBS, work statements, trend analysis, corrective action planning, performance measurement, etc. were, until recent years, used primarily through a manual process and only by an individual with a good deal of hands-on experience. Today, however, pressures of time and budget along with a great expansion of the number of projects being implemented, have created a demand for an "instant" project manager, ready to go "online" as he completes his training. We are often told that three major factors make this possible: (1) the expanded emphasis on application of project management tools; (2) the massive explosion in the availability of micro-processors and personal computers; and (3) the proliferation of powerful, sophisticated software systems designed to automate the tools and make the project management professional's decision-making data base as complete, comprehensive, and timely as possible.

Project management educators must take the lead in effectively communicating the theory first and the methods for meaningful application second — before even considering or introducing the methods involved in automation. To deviate from this step-by-step sequence can severely dilute the ultimate value and cost effectiveness of the various project management concepts and tools. We, as project management professionals, must constantly remind ourselves that the mere existence of the tools does not result in more efficiency. The project management professional should allow the tools to do the manipulative and repetitive work, but only after obtaining a thorough understanding of the particular tool's purpose and limitations in its non-automated state. The burden of assuring that this condition exists rests squarely on the educator's shoulders. This is a significant challenge, but one that can be accomplished with the right approach.

The redesigned course probably will take care of the expectation of abet criteria. It is offered in the last spring, and received positive feedback from the students and the industry advisory board. The outcome of the course will be discussed elsewhere.

Outcome from the Course:

Civil and Architectural Engineering Department

CVEN 4520/AREN 4470 CONSTRUCTION PROJECT MANAGEMENT Spring 2014

STUDENT COURSE ASSESSMENT SURVEY

As an Engineering student in this class, we are requesting your evaluation of how this course has helped to prepare you to meet course educational objectives. The data is needed as part of our plan to continuously improve the quality of engineering education at Tennessee State University. Please rate how this contributed to preparing you with each of the outcomes using the following scale:

4. Strongly Agree 3. Agree 2. Disagree 1. Strongly Disagree

Part A. Questions regarding your preparation

		Rating					A	Avg
		4	3	2	1		B	
1	I feel that I had the prerequisite skills in CE 4520/AE 4470 to be successful in the course.	4	1				E T	3.8
2	List any prerequisite skills that you may not have had, if any.	1	1					3.5

Part B. Having taken this course, I can demonstrate the following:								
1	I can approach, analyze and solve simple problems in an orderly, systematic, and scientific way using knowledge of mathematics, science and engineering	6	10	1			*a*	3.29
2	Gain a general understanding of the construction industry, processes, and organizational structures	5	10	1	1		*b*	3.12
3	Ability to manage the construction process from owner/designer/contractor perspectives	5	8	3	1		*d, h*	3.00
4	Understand job functions and roles of the various players in the construction industry	5	9	2	1		*d h j*	3.06
5	Ability to understand safe and practical designs and construction	6	8	2	1		*c*	3.12
6	Ability to produce basic estimating and cost control skills	6	8	2	1		*k*	3.12
7	Ability to schedule a simple project	5	10	1	1		*k*	3.12
8	I can evaluate my project problems	5	10	1	1		*c k*	3.12
9	I can effectively communicate project problems to all project partners	5	10	2			*g*	3.18
10	I understand that when I become practicing engineer, it will be my professional responsibility for continuous learning	9	6	2			*g, e*	3.41
11	I understand that in the practice of engineering, I have the professional responsibility for ethical and the civic responsibility, to be knowledgeable of the impact of engineering on society	9	6	2			*f*	3.41
12	Please provide recommendations for improving the course							

According to the redesign course, this class was taught in the last spring. The outcome of the class is very impressive which can be improved over the time. In addition to conventional teaching, students usually like the industry speakers and field trips. They like to have little bit more on field responsibilities.

Conclusion:

Since the expectation from the industry for the civil engineers and construction managers is very high, and ABET is trying to address the concerns, it is the author's views that faculty needs to look out curriculum regularly and modify it as needed. It is also to consult with the industry advisory board, alumni and regional and national relevant industry.

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