AC 2011-617: TOMORROW'S UNIVERSITY GRADUATE: CONSTRUC-TION INDUSTRY NEEDS AND CURRICULUM ENHANCEMENT

John Walewski, Texas A&M University

John A. Walewski, Ph.D., is an assistant professor with the Zachry Department of Civil Engineering at Texas A&M University with research interests in sustainable design and construction techniques, risk management and insurance, pre-project planning, and the use of alternative project delivery and procurement methods. John is a Board member of the U.S. Green Building Council's Central Texas-Balcones Chapter. Dr. Walewski obtained a Civil Engineering Ph.D. (Construction Engineering and Project Management focus) at The University of Texas at Austin (UT) in May 2005, and became a research associate with UT's Center for Transportation Research assisting with local, regional, and national transportation issues. Before moving to Texas, John was a program officer with the Board on Infrastructure and the Constructed Environment at the National Research Council, National Academy of Sciences, in Washington, DC. He has over fifteen years of experience in industry and research associated with the planning, design, transportation, and construction professions. Dr. Walewski obtained a graduate degree in urban planning from the University of Michigan, and a BS in construction management as well as a BLA in landscape architecture from Michigan State University.

Amy Ahim Kim

TOMORROW'S UNIVERSITY GRADUATE: INVESTIGATING CONSTRUCTION INDUSTRY NEEDS AND CURRICULUM ENHANCEMENT

Introduction

The professional skill set needs of the construction industry continues to mature. Construction industry employers increasingly tend to hire university graduates for supervisory and management appointments and most entry-level professional positions are filled by employees with degrees in construction science/management, or civil engineering. A core issue for the construction industry and academic institutions that feed it is to determine out-year skill requirements and assess the process of how university graduates align with industry needs.

This paper focuses on the initial phase of a research effort to develop an understanding of how future industry and societal trends impact future university graduates, and how this is critical to the process to ensure the construction industry is prepared to meet the challenges. The authors present a review and assessment of near-future skill needs for university graduates entering the construction industry and a synthesis of previous research. The intent of this in depth review is to develop a framework for a follow-on survey instrument and methodology to evaluate whether university curricula currently succeed in training students to meet industry needs and to sustain future leadership.

Research Motivation

The skills necessary to successfully manage projects are dynamic and evolve as the industry changes over time. The September 2007 and 50th anniversary issue of the *Journal of Construction Engineering and Management*, published by the American Society of Civil Engineering focused on the past accomplishments of the construction industry as well as the future challenges. Stanford Professor Raymond Levitt discussed¹ the following three emerging trends that will have a significant impact the future of the construction industry and to how projects are managed:

- 1. Integration of the planning, design, construction, and operations of buildings and infrastructure processes across the entire facility life cycle including building information modeling, collaborative project management structures, and further advances in information technologies.
- 2. Globalization of the construction industry, as well as the outsourcing of services and global teams
- 3. Heightened global awareness of, and demands for, enhanced sustainability approaches and methods including green building and sustainable construction practices.

The authors are involved with a Construction Industry Institute research project to identify and evaluate the skill sets that future construction industry graduates will need in the 2015 timeframe—as well as the potential barriers that academic program may encounter to adequately teach the identified skill necessary for new employees in 2015 and beyond. The objectives of this effort are to:

- 1. Identify and rank the most critical skills for recent university graduates to deliver capital projects from the viewpoint of owners and contractors.
- 2. Identify the current and anticipated industry trends that have the highest probability to impact the delivery of capital projects in 2015 and beyond.
- 3. Identify and rank the most critical skills needed by recent university graduates that are anticipated for 2015 and beyond.
- 4. Identify the capacity of university degree programs, as well as the barriers, to adequately teach the identified skill necessary for new project managers in 2015 and beyond.
- 5. Provide findings and recommendations to the industry and academia on how to meet skills required for 2015 university graduates

The study was motivated by factors within and outside of the construction industry. First, the trends documented by Levitt are the subject of much discussion, and whether taken individually or collectively, are considered challenging issues facing the construction industry for the next 10-20 years. Second, industry leaders and practitioners have identified the need to develop a comprehensive and accurate description of the future skill sets engineering and construction graduates should have to excel in an evolving profession. Of further interest is that construction-related university education occurs within multiple disciplines governed by different accreditation organizations (Accreditation Board for Engineering and Technology (ABET), and American Council for Construction Education (ACCE)), and it is difficult to develop a comprehensive process to identify the skills needed by university graduates interested in a construction industry career. To date, most evaluations of the skills needed for the construction industry have been limited to a specific university department or degree major.

Skills Identification

Numerous studies have been conducted on evaluating the practitioners' expectations of recent graduates and few have extended the assessment to the relationship of what being taught at the university-level. In technical professions such as construction and engineering, researchers often conclude that recent graduates have achieved the technical skills that meet industry expectations. However, a common finding of this body of research is that recent graduates often lack the skills associated with interpersonal and written communication, and do not have a broad understanding of subjects such as sociology, business, law, and psychology. The finding and recommendations of the work tend to center around the need for a broader and balanced training in technical and social skills with recognition that achievement of such balance requires collaboration between industry and academic leaders. For construction related degree programs, the ABET and ACCE accreditation organizations have made significant improvements to ensure some minimal skill set for entry into the workforce or for future education. However, a limited body of research has been conducted that explores the skill set needs of the construction industry that align with the lifecycle of construction that evolves from a business decision, feasibility analysis, design construction, and operations. As the construction industry moves towards a model of filling management positions with university graduates that come from academic programs that are ABET or ACCE accredited (a few universities have both), an evaluation of the need skills of future university graduates should be from the much broader construction project life cycle perspective, rather than the skills associated with a particular degree program or discipline.

For business school graduates, the gap between technical and behavioral skills warranted work based placement, internships and lifelong learning necessary to acquire soft skills such as listening, questioning and communication skills.² Over time, the gaps between degree programs and industry expectation resulted in industry practitioners providing continuous feedback and developing partnerships with academia to shape future professionals.³ Research surveys and focus groups that emphasized the need for a balance between technical and business knowledge required universities to continually reassess the market for current trends and customer needs. In a study⁴ of recent business school graduates, industry leaders suggested that by strategically offering orientation/training, matching graduates with mentors, varying assignments, providing performance feedback and working in team environments the skill needs of industry could be met. In parallel, educators were called to encourage students to develop competence in organizational behavior, communication, decision analysis and business oriented skills.

The engineering disciplines have been at the forefront of the explosion of knowledge, complexity of projects, effects of globalization and the changing work environment. A growing body of knowledge has been developed to address the need to revisit the current engineering education model and to generate future engineers that reflect industry needs.^{5 6 7} To meet societal demands, engineers and engineering educators have increasingly recognized that engineering is more than technical and scientific skills.⁸ Young engineers are expected to meet increasingly higher expectations by having technical skills and understand non-technical contents such as social responsibilities, social skills and humanities. Engineers that are flexible, work well in teams, have good communication skills and knowledgeable about political, environmental, economical and ethical concerns are becoming commonplace. The effect of globalization has also put more pressure on engineers and engineering education. Martin et al.⁹ studied engineering graduates' perception on how well they were prepared to work in industry. Their findings confirmed previous research that engineering graduates often feel their greatest competency is with their technical ability, and they have little or no exposure to multidisciplinary teamwork, and management experience. The results emphasized that engineering students recognize and support that technical knowledge and skills should be the fundamental foundation for building other non-technical skills such as communication, teamwork and interpersonal skills. Developing non-technical skills may necessitate redesigning the current curriculum in some cases so they are taught not in isolation but integrated into projects of other technical courses.

The issue with current engineering curriculum is often the absence of connectivity and integration of courses and the emphasis on course content rather than providing a broader educational experience. By surveying over 40 percent of the national civil engineering undergraduate curriculum, Russell & Stouffer¹⁰ found that the curriculums were developed with high number of technical specialization, liberal arts classes were out of focus and not in context with each other, elective courses were haphazard with no integration to the program and had no requirements on advanced courses in sustainability, vulnerability or systems engineering. Professional societies and educators should be leaders in reforming the current educational system and train engineers to thrive through change.^{11 12 13}

Souder and Gier¹⁴ concluded that students graduating from accredited construction programs require more emphasis in particular areas. The survey revealed that the industry's primary

expectations of graduates were having fundamental technical skills like estimation, scheduling, reading drawings and specifications, and safety with emphasis on other project management skills like handing change orders and requests for information. The industry also expected soft skills like communication and business writing. In surveying contractors, Love et al.¹⁵ found that graduates failed to meet their expectations with respect to the practical knowledge, interpersonal skills, time management, and ability to exercise professional judgment. An issue raised with this work is whether these skills can be only acquired through experience and experimental learning.

Chang¹⁶ found that new entrants, who enter the construction industry, particularly those entering the construction management phase, are expected to have a strong academic background in multiple disciplines. Knowledge of basic subjects included construction materials and methods, design, engineering principles, safety, environmental concerns, computer skills, personnel management, construction law, business management, codes, labor relations, finance, and oral and written communication skills. Nevertheless, fragmentation of the construction industry, changes in the technology, and faculty isolated from industry are factors that can hinder designing a comprehensive program that addresses industry expectation. Love et al.¹⁷ recommends that managers need to be tolerant and considerate with the inexperience recently hired graduates. One way to resolve this is to encourage mentoring the graduates to convey the skills necessary to succeed in the profession. New graduates and entry level professionals should bring new skills, concepts, and ideas to the organization that employ them, and they should be considered more as a source of corporate revitalization and new energy. A continuous feedback from industry to educational institutions about revised expectations and tweaks to improve the effectiveness of the curriculum are recommended. Industry should evaluate candidates coming out of university programs and providing constructive feedback to academia on modifying and updating the coursework depending on developments taking place in the industry. Because construction engineering and management is an applied discipline, an internship complements the classroom educational experience. The benefits of an internship included the awareness of various career option, increased engineering and technical knowledge and improved communication skills, and the universities should develop students with practical experience and leadership skills. To achieve this goal the faculties should develop practical skills by either working in the industry or interacting with practicing engineers.¹

Chinowsky¹⁹ rightfully encourages universities to train students as assets in the changing technical and business world by incorporating management related courses. The construction industry is expecting recent graduates to contribute from the beginning of their careers and increasingly so as they progress into upper management. These recommendations should all be developed in a global context. Future construction industry employees should be exposed to more training in interpersonal skills, management, leadership, and the ability to handle multidisciplinary problems. The undergraduate curriculum should be broad and comprehensive with more specialized subjects redistributed to postgraduate programs.²⁰

Researchers continue to recommend involvement from the industry, a balance of technical and non-technical courses, and professional and leadership experience to enhance construction education. The inputs from industry to the academia could be in the form of sharing problems, and provide support and assistance based on experience and specialized knowledge in finding

solutions to those problems. A great amount of trust on the part of industry and academic participants will boost the abilities of those who are searching for common solutions.

The above literature review combined with the experience and expertise of the industry members of the research team has been used to develop a comprehensive list of skill sets desired by the construction industry for graduates in 2015. The research team consisted of executives, managing principles from the industry, as well as faculty members at Texas A&M University from both the Civil Engineering and Construction Science Departments. The skills list and associated definitions were further clarified and the research team found that construction industry skills are relative and that every person entering the construction industry does not need expertise with all skills. In response to this aspect of skill-level attainment, the research team developed a proposed evaluation criteria for each skill set that is based upon Blooms Taxonomy.²¹ Final evaluation criteria for this study, shown in Figure 1 include four progressive levels ranging from awareness to analysis. The survey model will be built upon skill sets developed by previous studies and critically reviewed for comprehensiveness and appropriateness by the research team.



Figure 1 – Proposed Tiered Evaluation Criteria Regarding Skill-Level Attainment

References

¹ Levitt, R. (2007). "Construction Engineering and Management for the next 50 Years: Maximizing Economic, Environmental, and Societal Value of the Built Environment." *Journal of Construction Engineering and Management*, *133*(9), 610-619.

² Jackling, B. and C. Sullivan (2007). "Financial Planners in Australia: an Evaluation of Gaps in Technical and Behavioral Skills." *Financial Services Review*(16), 211-228.

³ Trauth, E. M., D. W. Farwell, and D. Lee. (1993). "The IS Expectation Gap: Industry Expectations Versus Academic Preparation." *MIS Quarterly* (Vol. September, pp. 293-307).

⁴ Fernandes, J. (1994). "Preparing Tomorrow's Internal Auditor." *Managerial Auditing Journal*, 9(2), 20-23.

⁵ Bordogna, J. (1997). "Making Connections: The Role of Engineers and Engineering Education." *The Bridge*, 27(1), 1-5.

⁶ Graaff, E., and W. Ravesteijn. (2001). "Training Complete Engineers: Global Enterprise and Engineering Education." *European Journal of Engineering Education*, *26*(4), 419-427.

⁷ Pascail, L. (2005). "The Emergence of the Skills Approach in Industry and its Consequences for the Training of Engineers." *European Journal of Engineering Education*, *31*(1), 55-61.

⁸ Scott, G. and. K.W. Yates. (2002). "Using Successful Graduates to Improve the Quality of Undergraduate Engineering Programmes." *European Journal of Engineering Education*, *27*(4), 363-378.

⁹ Martin, R., B. Maytham, J. Case and D. Fraser. (2005). "Engineering Graduates' Perceptions of How Well They Were Prepared for Work in Industry." *European Journal of Engineering Education*, *30*(2), 167-180.

¹⁰ Russell, J. S. a. Stouffer., W.B. (2005). Survey of the National Civil Engineering Curriculum. *Journal of Professional Issues in Engineering Education and Practice*, *131*(2), 118-128.

¹¹ Russell, J. S., and W.B. Stouffer. (2005). "Survey of the National Civil Engineering Curriculum." *Journal of Professional Issues in Engineering Education and Practice*, *131*(2), 118-128.

¹² Bashford, H. (1992). "Partnership with industry at Arizona State University." Paper presented at the Associated Schools of Construction 28th Annual Conference, Auburn, Alabama, April 8-10.

¹³ Chinowsky, P. S. (2002). Integrating Management Breadth in Civil Engineering Education. *Journal of Professional Issues in Engineering Education and Practice*, *128*(3), 138-143.

¹⁴ Souder, C. a. G., D. (2006). *What does the Construction Industry expect from recent Construction Management Graduates?* Paper presented at the ASC 42nd Annual Conference Fort Collins, Colorado, April 20-22.

¹⁵ Love, P. E. D., Haynes, N.S. and Irani, Z. (2001). Construction managers' expectations and observations of graduates. *Journal of Managerial Psychology*, *16*(8), 579-593.

¹⁶ Chang, W. (2003). Hiring and Trainng in Korean Establishments: do Employers Substitute Making for Buying? *Research in the Sociology of Work, 12*, 31-48.

¹⁷ Love, P. E. D., Haynes, N.S. and Irani, Z. (2001). Construction managers' expectations and observations of graduates. *Journal of Managerial Psychology*, *16*(8), 579-593.

¹⁸ Koehn, E. (2004). Enhancing Civil Engineering Education and ABET Criteria through Practical Experience. *Journal of Professional Issues in Engineering Education and Practice*, *130*(2), 77-83.

¹⁹ Chinowsky, P. S. (2002). Integrating Management Breadth in Civil Engineering Education. *Journal of Professional Issues in Engineering Education and Practice*, *128*(3), 138-143.

²⁰ Cheah, C. Y. J., Chen, P. and Ting, S.K. (2005). Globalization Challenges, Legacies, and Civil Engineering Curriculum Reform. *Journal of Professional Issues in Engineering Education and Practice*, *131*(2), 105-110.

²¹ Bloom B. S. (1956). *Taxonomy of Educational Objectives, Handbook I: The Cognitive Domain*. New York: David McKay Co Inc.