AN ANALYSIS OF CONSTRUCTION GRADUATE ACADEMIC PREPAREDNESS IN THE AREAS OF SAFETY, HEALTH, AND RISK CONTROL

by

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ABSTRACT

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The construction industry relies heavily on college and university construction management graduates to fill their supervisory and managerial positions and it is essential that these college graduates have a thorough knowledge of all aspects of the construction process, including safety, health, and risk control. However, recently construction professionals have voiced concerns regarding the aptitude of construction graduates. It is likely that graduates of construction management programs are not receiving the adequate safety, health, and risk control education required to succeed in the construction industry.

The purpose of this study was to compare the level of preparedness graduates of construction management programs have in applying risk control elements to the construction

process. The study also evaluated the perceived level of understanding contractors feel their recent hires from construction management and engineering programs have of risk control functions. The results from the survey were used to interpret whether a need exists for risk control to be integrated throughout core construction curriculum.

Backgrounds of curriculum development and change, safety and health curriculum, integration of safety and health into other disciplines, and current construction accreditation curriculum requirements were researched and reviewed. This process included examining techniques and success rates of integrating safety and health into engineering, business, and even construction curriculum. The literature review was used to develop a twenty-five question survey which asked respondents to evaluate how well their undergraduate construction programs prepared them in the areas of safety, health, and risk control. Respondents were recent graduates of two accredited, baccalaureate construction programs: one emphasizing an integration of risk control into the curriculum, while the other program relies on one construction safety class to relate the applicable information. Results were evaluated using statistical analysis and an independent groups t-test. Two contractors, both of whom hire graduates of the sample colleges, were interviewed regarding their feelings on the preparedness levels of construction graduates in the areas of safety, health, and risk control.

Survey results indicate inadequate levels of preparedness on the part of graduates from both institutions. Students indicated that safety, health, and risk control were not emphasized equally with the other elements of a construction project and critical safety components were often not even included in the program curriculum. There was minimal statistical difference between the perceived preparedness of graduates from either institution, regardless of the integrated safety curriculum of one undergraduate program. Industry professionals from the two contractors interviewed indicated that while graduates have knowledge of safety regulatory compliance, there is a lack of preparedness on behalf of graduates from both institutions, particularly in the areas of public liability, construction safety pre-planning, and workers' compensation claim reporting and management.

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Statement of the Problem

Introduction

Construction is one of the most hazardous industries. It has the third highest rate of death by injury (15.2 deaths per 100,000 workers), preceded only by mining and agriculture (National Institute of Occupational Safety & Health [NIOSH], n.d.), and fifteen percent of workers' compensation costs are spent on construction injuries. Construction comprises six percent of the United States workforce, yet accounts for approximately seventeen percent of all industries' deaths (The St. Paul Construction, 2002). Assuring safety and health in construction is complex, since projects involve short-term work sites, changing hazards, multiple operations and crews working in close proximity (NIOSH, 1997). Adding to the pressures of working in a constrained environment, owners of construction projects expect the contractor to finish the work within a specific period of time, at an established price, with an agreed upon level of quality workmanship, and also perform the work safely (Tam, Fung, & Chan, 2000). However, many project management personnel focus only on immediate concerns, and view their top priorities as meeting the production schedule, quality and cost targets. Only after addressing these priorities will they give some consideration to safety (Tam, Fung, & Chan, 2000). Petersen (2001) stated that, "safety should be managed like any other company function" (p. 15), implying that in the process of running a construction project, safety should be integrated throughout the course of the schedule, receive proper allocation of resources and be audited as strictly as quality control. The significance of Petersen's statement is understood by safety professionals, but rarely by project management personnel. The preventative measures and techniques required to effectively manage risk are rarely budgeted into a project, and safety procedures are often the initial cutback if resource constraints develop (Hinze & Raboud, 1988). Additionally, the belief that the nature of construction work makes accidents inevitable is still very apparent in the minds of many project management staff (Fullman, 1984). This false belief continues to be passed down from the more experienced management personnel to the new project management hires as an excuse for neglect in effectively managing safety.

Since the construction industry relies on college and university construction management and engineering programs to provide qualified professionals to fill their supervisory and managerial positions, it is essential that these college graduates have a thorough knowledge of all aspects of the construction process, including safety, health, and risk control (Construction Risk Control Partnership [CRCP], 1999a). However, professionals in the industry have voiced concerns regarding the aptitude of construction graduates. The Construction Information Exchange, sponsored by The St. Paul Fire and Marine Insurance Company and the Construction Safety Council (CSC), provides an opportunity for the St. Paul Construction Loss Group, CSC members, and St. Paul insurance policy holders to discuss current safety, health, and risk control issues and trends affecting the construction industry (CRCP, 1999b). The policyholders, who represent a nation-wide sample of contractors engaging in high rise, commercial, heavy/highway, utility, and tunneling construction, identified a concern regarding "the inadequate training in safety, health, and risk control issues evident in many of the new construction professionals entering the employment market" (CRCP, 1999b, p. 6).

Problem Statement

It is likely that graduates of construction management and engineering programs are not receiving the adequate safety, health, and risk control education required to succeed in the construction industry.

Purpose Statement

The purpose of this study was to compare the level of preparedness graduates of construction management and engineering programs have in applying risk control elements to the construction process. The study also evaluated the perceived level of understanding contractors feel their recent hires from construction management and engineering programs have of risk control functions. The results from the surveys were used to interpret whether a need exists for risk control to be integrated throughout core construction curriculum.

Research Questions

This study will answer the following questions with information from the surveys conducted:

1. Do graduates of construction management programs have an adequate understanding of the impact risk control has on budget and schedule, the two components which drive a construction project?

2. Did graduates from a construction program where risk control is integrated throughout the curriculum feel more prepared for the workforce in the areas of safety, health, and risk control than graduates from programs that did not have risk control integrated throughout the curriculum?

3. What level of importance do graduates feel their construction programs placed on risk control/safety compared to quality, budget, and schedule?

4. Do contractors feel their new hires from construction management programs are well prepared in the areas of safety, health, and risk control as they relate to construction?

Background and Significance

In the year 2000, the construction industry led all other industries in the number of fatal work injuries with a total of 1,154 deaths (JJ Keller & Associates, n.d.). Over the past seven years, 324,700 construction injuries and illnesses have involved time away from work beyond the day of the incident (Bureau of Labor Statistics, 2002). The construction industry contributed 11.4% of the 1.7 million nonfatal, lost-time occupational injuries and illnesses reported in 2000 (Bureau of Labor Statistics, 2002). Although improvements have been made over the last twenty years, construction injury and illness statistics illustrate a lack of effectiveness of risk management in the areas of human and financial loss. College graduates who are placed in supervisory and management positions have a direct impact on the safety and health performance of a company. If these graduates have not received sufficient safety, health, and risk control education, they will be unable to properly manage risk control issues as they arise on the job.

This inadequacy of construction education is not the fault of the students, but rather a deficiency in the curricula taught to students. It is common for academic programs to choose curricula based on the requirements set forth by national accrediting agencies. Unfortunately for students, accreditation of construction management and engineering programs requires minimal safety, health, and risk control instruction, and the programs' selection of curricula is often driven by the agencies' standards and criteria. The American Council for Construction Education (ACCE) is recognized by the Council for Higher Education Accreditation (CHEA) as the accrediting agency for 4-year baccalaureate degree programs in construction, construction science, construction management, and construction technology (ACCE, 2002b). According to

ACCE Form 103: Standards and Criteria for Baccalaureate Programs (2002), accreditation requires only one-semester hour in safety per minimum 120-semester hours of total education. Compared to the required 49-semester hours of construction and construction science education, it appears that safety education is not as equally influential as the schedule, quality, and budget components of construction education. This shortcoming is likely part of what leads to construction graduates with inadequate comprehension of safety, health, and risk control.

Assumptions

This researcher assumes that questions on the survey will be answered as honestly as possible.

Limitations

The study was limited to the number of graduates that were available to answer the survey. The ability of graduates to distinguish between information learned in school versus information learned on the job or in company training sessions could affect the results.

Chapter Two

Review of Literature

Introduction

The construction industry has identified a need for graduates to be better educated in the areas of safety, health, and risk control. The deficiency of knowledge in these areas may be a result of curriculum that lacks effective safety, health, and risk control content. This chapter will present an analysis of the process of curriculum development and the stages of curriculum change; a review of the necessary components of safety and health curricula; a review of the integration of safety and health into the curricula of other disciplines; and an analysis of the present construction curriculum and accreditation requirements of construction academic programs. Finally, this section reviews the current curriculum content of the two construction management programs analyzed for this study.

Curriculum Development and Change

Finch and Crunkilton (1999) defined curriculum as "the sum of the learning activities and experiences that a student has under the auspices or direction of the school" (p. 11). By this definition, the focus of curriculum is the student and the curriculum developed should meet the relevant needs of the student pursuing a particular field of study. Curriculum development is defined as the "planning of learning opportunities intended to bring about certain changes in pupils and the assessment of the extent to which these changes have taken place" (Nicholls & Nicholls, 1978, p. 14). Nicholls and Nicholls (1978) outlined four steps in the development of curriculum:

1. Examination of the objectives of teaching,

2. Development of materials and methods needed to achieve the objectives,
3. Assessment of the development work as to how well it has achieved the objectives, and
4. Feedback of all the experience gained, to provide information for further study.

These steps describe the development of curriculum as a cyclical process, since instructors should build a curriculum that, at any given time, is the most advantageous one they can provide for their students (Nicholls & Nicholls, 1978). The curriculum remains advantageous to students through constant evaluation and modification as time goes on. Nicholls and Nicholls (1978) and Finch and Crunkilton (1999) both agree that employers and the general public are taking a greater interest in education. They also agree that since the world is ever changing, with new knowledge and technology being introduced daily, it is important that curriculum address these new developments. Since students must be able to deal with the demands of a society that is changing so quickly, academic programs need to reevaluate what education they are offering (Nicholls & Nicholls, 1978).

The process of curriculum change involves four stages: recognition of need, planning and formulation of a solution, initiation and implementation of the plan, and institutionalization of the change (Levine, 1978). The first stage, recognition of need, involves an understanding that some need is not being met, be it on an individual, group, institutional, or other level (Levine, 1978). The realization may not always come from within the college, but rather from the local community, or a particular industry (Levine, 1978). In the instance of construction curriculum, the need was established by a group of construction industry associates at the Construction Information Exchange. The second stage, planning and formulating a solution, can be an individual or group effort, and will look to develop a plan to satisfy the identified need (Levine, 1978). In the third stage, the plan developed in stage two is initiated and implemented on a trial basis (Levine, 1978). After the change is implemented, the institution either puts it into operation, or the change will be unsuccessful and terminated (Levine, 1978).

Levine (1978) also discussed the factors that affect the success or failure of a change in curriculum. The first factor is the environment targeted for change, since successful changes are more likely to occur in unstable or particularly supportive environments (Levine, 1978). Environments in which there is a crisis, power imbalance, structural change (such as requirements mandated by government), or the people have a shared self-interest in change are likely to see positive results when change is initiated (Levine, 1978). The second factor that affects success or failure of change is the characteristics of the change. When an improvement is consistent with the norms, values, and traditions of the environment in which it is being introduced it is likely to be successful (Levine, 1978). Most academic institutions seek to maintain constancy and stability within their practices, so they react well to compatibility (Levine, 1978). If the proposed curriculum change can meld into its environment, it may be more likely to be institutionalized. In the same respect, a change will also be looked upon favorably if it is viewed as profitable (Levine, 1978). People tend to agree with change when they think they are directly or indirectly benefiting from the situation (Levine, 1978). The process by which a change is implemented also influences its success or failure (Levine, 1978). That process shapes people's attitudes, acceptance, and participation in the implementation of the change (Levine, 1978). The changes should be clearly defined, well communicated and publicized with strong support from administration (Levine, 1978).

Implementing changes within the construction curriculum to include safety, health, and risk control elements is a potential solution to the need identified by construction industry professionals. Assessing what is taught in safety, health, and risk control education, as well as analyzing those programs that have already attempted to implement this change into their curriculum can help identify the means and methods needed to integrate this information into the current construction curriculum.

Safety and Health Curriculum

Due to the rapid development of occupational safety and health in recent years, many universities and tertiary institutions in both the United States and around the world have started offering undergraduate and graduate programs in this field of study. The American Society of Safety Engineers (ASSE) and the Board of Certified Safety Professionals (BCSP) have developed curriculum standards for baccalaureate safety and health programs as well (ASSE, 1991). ASSE has merged with the Accreditation Board for Engineering and Technology (ABET) to establish academic accreditation for safety programs, through ABET's Related Accreditation Commission (Kohn, 1997). While ASSE and BCSP developed the curriculum requirements, they felt that being associated with ABET accreditation would give their program requirements more national recognition (Kohn, 1997). Along with university studies courses, ASSE and BCSP have identified the following professional core courses as necessary to develop a safety professional's basic knowledge and skills (ASSE, 1991):

- Introduction to Safety and Health – introduces student to the safety and health field by discussing a wide range of topics such as general safety and health concepts and terms, program concepts, hazard recognition, safety engineering, systems safety, risk assessment, risk management, accident investigation, ergonomics, and traffic safety.
- Safety and Health Program Management – addresses the application of management principals and techniques to the management of safety, health, and loss control programs.

This course should include economic analysis of employer costs from accidents, illness, fire, etc.

- Design of Engineering Hazard Control – addresses the use of scientific and engineering principals and techniques to achieve optimum safety and health through the examination and design of processes, equipment, products, facilities, operations, and environments.
- Industrial Hygiene and Toxicology – often a sequence of courses and focuses on the principals of industrial hygiene through both lecture and laboratory exercises. Topics include noise, vibration, ionizing and non-ionizing radiation, thermal conditions, chemicals, airborne contaminants, and biological substances.
- Fire Protection – typically includes behavior of fire, fire hazards of materials, fire suppression systems, alarms and detection systems, building codes and other fire codes, process fire hazards, and life safety.
- Ergonomics – coursework includes man-machine systems, human capabilities and limitations, design of displays, controls, equipment, and workstations, fundamentals of biomechanics in human activities, and cumulative trauma or repetitive motion disorders.
- Environmental Safety and Health – topics include air and water quality, sanitation, hazardous materials and their storage, handling and transportation, waste management and cleanup, environmental laws and regulations, and worker and community right-to-know.
- System Safety and Other Analytical Methods for Safety – coursework includes preliminary hazard analysis, fault tree analysis, failure mode and effects analysis, risk assessment, chemical risk assessment, risk acceptance, risk analysis, risk management, and cost-benefit analysis.

- Experimental Education – this portion of the coursework includes an internship or COOP course supervised by safety faculty which places the student in the industry where hazard control programs are planned and implemented. Student should be assigned significant hazard assessment activities involving safety, health, fire and other hazards.

ASSE and BCSP have also identified required professional subjects that do not need an entire course dedicated to them, but are important for professional development (ASSE, 1991). These topics are measurement of safety performance, accident/incident investigation and analysis, behavioral aspects of safety, product safety, construction safety, and educational and training methods for safety (ASSE, 1991). The construction safety professional subject includes safety in trenching and shoring, scaffolding, temporary electrical systems, cranes and other mobile equipment, tunneling, blasting, steel erection and bridge work, demolition and other operations (ASSE, 1991). The safety and health curriculum standards also include site safety management, traffic control, contractor and subcontractor relationships, and permit systems as being important factors in construction safety (ASSE, 1991). Since it has been identified that these are important aspects of construction for safety and health professionals to know and understand, it would seem to be just as beneficial for construction professionals to be familiar in these areas.

Safety and health curriculum has also been developed for the environmental safety and health (ESH) discipline. The National Environmental Education and Training Center (NEETC) at Indiana University Pennsylvania has developed a model curriculum in ESH in order to minimize the lack of uniformity and consistency in the material of ESH training programs, technology based ESH programs offered by two-year degree colleges, and ESH baccalaureate degree programs (NEETC, 1997). The intent of this curriculum is to prepare graduates for work at the management level in the hazardous waste remediation industry (NEETC, 1997). Graduates from programs utilizing this curriculum will possess a extensive view of the industry, as well as the technical and managerial proficiency required to respond to increasingly complicated concerns regarding environmental and public health (NEETC, 1997). The curriculum requires eight semesters of study (124 semester hours), including an internship (NEETC, 1997). Natural sciences, labor relations, management, and ESH are all included in the coursework (NEETC, 1997). Since this curriculum was designed to help close the gap that exists between vocational training and two- and four-year academic programs, there are limitations to its success. One is the difficulty and impracticality for laborers and graduates of two-year degree programs to geographically relocate to continue their education at a four-year institution (NEETC, 1997). The other limitation is that success of the model curriculum is dependent on the number of institutions throughout the nation that adopt and implement the curriculum into their degree programs (NEETC, 1997). The NEETC (1997, p. 6) state the objectives of the model curriculum to be as follows:

1. Be able to identify pollution sources, their impact on human health and the ecosystem and recommend environmental pollution prevention/control method.
2. Be able to apply environmental laws, occupational health and safety standards, and appropriate control techniques to minimize or eliminate safety and health hazards at hazardous waste sites.
3. Be able to apply their knowledge of microbial ecology, transport mechanisms and their applicability to the remediation of hazardous waste sites.
4. Be familiar with current environmental, safety and health issues, labor-management relationships and collective bargaining practices as they relate to the normal judgments and ethical decision associated with hazardous waste site management.

5. Be able to develop, evaluate, and implement safety and health plans at hazardous waste sites.
6. Meet established criteria required to obtain the 40-hour hazardous waste operations and emergency response (HAZWOPER) certificate and OSHA Voluntary Trainer Authorization.

Students are educated in the various environmental regulation requirements at the federal, state, and local levels, as well as hazardous waste remediation technology with emphasis on health and safety concerns associated with various treatment methods (NEETC, 1997). They are also provided with education in managing multi-employer worksites and environmental responsibilities of all stakeholders (NEETC, 1997). Students are informed of current issues and activities regarding environmental, safety, and health concepts through interaction with industry professionals (NEETC, 1997). Upon completion of the program, graduates will be technically competent and possess the abilities needed for constructive management/labor relations (NEETC, 1997).

Not only have United States organizations set forth guidelines for safety and health undergraduate education, but similar criteria for safety and health education have also been developed in Australia. In a study by J.T. Spickett (1999) of occupational safety and health curricula in Australia, the author outlined expected characteristics that graduates of safety and health programs should have upon completion of their studies. These characteristics include the ability to:

- assess, select, and critically analyze information;
- work collaboratively as part of a team;
- adopt a critical approach to anticipating and solving problems;

- communicate arguments and other information concisely, both orally and written.
- use numerical and basic statistical methods;
- apply a high level of professional and ethical standards to practice;
- work to time constraints; and
- appreciate cultural diversity.

These abilities are, in general, key skills needed to practice successfully as an occupational safety and health professional. In a broad sense, these are also skills expected of many college graduates, including construction graduates. Australia's National Institute for Occupational Health and Safety has also set objectives for tertiary level education, which represent the minimum expectations of skills and knowledge required by a safety and health professional (Spickett, 1999). These objectives include development, implementation and monitoring of prevention programs; identification of safety and health hazards and recommendations for controls; knowledge of relevant legislation, standards and codes of practice in day-to-day situations; and application of sound management practices to all aspects of the safety and health function (Spickett, 1999).

As important as it is to achieve the standards set forth by national institutions, academic programs must also strive to meet the needs of industry employers. Spickett (1999) explained that undergraduate education must be flexible and allow for adaptation to the changing legislation governing safety and health regulations. Employers also need people who work well in teams, communicate with a wide range of people (workers to specialists), and demonstrate management capability (Spickett, 1999). Graduates are expected to be able to generate changes, which may involve resourcefulness and optimizing end results in, sometimes rapidly, changing circumstances (Spickett, 1999). Construction graduates may also face similar circumstances upon entering the workforce, and will need comparable knowledge to be successful. It is likely that graduates of construction programs will enter the workforce as field engineers, or superintendents of projects. It is common for these positions to be responsible for enforcing safety policies and procedures on the job and it may be helpful to the construction graduates if they receive similar education as safety and health professionals as it relates to construction.

To provide students with the capabilities demanded by the workforce, universities need to make changes in the curricula that offer a more applied and practical education, encouraging independence and adaptability to change (Spickett, 1999). The occupational safety and health profession requires graduates to be able to measure or quantify a range of factors, such as industrial hygiene monitoring and measures of the cost benefit of a proposed hazard control (Spickett, 1999). Quantification is also necessary to compare various data with standards, regulations, and other criteria (Spickett, 1999). Along with these skills, the safety and health profession lends itself to increased teamwork. Since industry is becoming more complex everyday, it becomes crucial to bring together professionals from varied backgrounds to develop solutions (Spickett, 1999). When people with expertise in specific areas contribute to a team, it is important for them to be able to communicate their ideas to those from different backgrounds (Spickett, 1999). Being an effective part of a team cannot be taught, so it is essential that the experience of working in teams be part of the education process (Spickett, 1999). Currently, one of the more prominent factors that individuals face when working in teams is the internationalization of the workforce. People from a range of cultural backgrounds are required to work together on many assorted tasks, so graduates need to be aware of and considerate toward different cultures (Spickett, 1999). This issue is just as common in the construction industry, especially with the growing non-English speaking workforce. It is likely that graduates will deal with workers from other cultures and need to be sensitive to their workers' backgrounds.

Along with the typical responsibilities of an occupational safety and health professional, they are also frequently asked to deal with the environmental aspects of a company's operation, and graduates will need to be equipped with knowledge of applicable environmental regulations and testing (Spickett, 1999). Another factor which safety and health professionals must be aware of is management's increasing role in occupational safety and health, particularly where the law allows for the personal prosecution of managers for negligence in management of safety and health (Spickett, 1999). Research suggests that the role of management failure in accidents tends to be underestimated by many companies, and safety and health professionals need to be able to identify deficiencies in management systems that contribute to the cause of incidents (Spickett, 1999). Additionally, the workers' awareness of the hierarchy of controls is increasing and they are more aware that personal protective equipment should be the last resort to protect workers (Spickett, 1999). This puts more pressure on management to eliminate the hazards and implement engineering control methods, for which they look to safety and health professionals for solutions (Spickett, 1999).

Occupational safety and health, like many other disciplines, is being required to adjust to a changing work environment and to the social and economic factors that affect how people live and work (Spickett, 1999). Coursework in this area needs to adapt to the changing situations and meet the demands of the workforce, students, and legislation (Spickett, 1999). As safety and health awareness increases, its presence in other disciplines is evident. Other academic programs have attempted to integrate safety and health issues into their curriculum to increase the effectiveness of their graduates.

Safety and Health Integration with Other Disciplines

In an article regarding the integration of safety and health into business and engineering school curricula, Talty and Walters (1987) reasoned, "although a significant investment has been made to eliminate occupational safety and health problems in industry, the cost of occupational accidents continues to rise and represents a major cost in terms of human and industrial resources" (p. 26). To reduce these costs and the human affliction they reflect, the National Institute for Occupational Safety and Health (NIOSH) concluded that the skills of managers and engineers should be used as the solution to these problems through education programs concerning occupational safety and health issues, including legal, cost, ethical, and liability standpoints (Talty & Walters, 1987). NIOSH initiated two projects that addressed the need to provide business and engineering students with the appropriate occupational safety and health instruction (Talty & Walters, 1987).

Engineering curriculum integration

One of these projects, known as Project SHAPE (Safety and Health Awareness for Preventative Engineering), was initiated in 1980 to encourage engineering programs to focus on Occupational Safety and Health (OS&H) technical issues in engineering coursework (Talty, 1986). In the early 1980's, representatives from academic, private, and government sectors made recommendations for engineering curricula to include a required course that incorporates engineer responsibilities and OS&H engineering problems and solutions (Talty, 1986). However, response from universities to that recommendation was negative, claiming overcrowded curricula, and lack of textbooks and trained faculty (Talty, 1986). Talty (1986) pointed out that a single course in OS&H issues is only one option to educating engineering students in this field. Alternatively, OS&H information could be spread throughout the existing courses to accommodate overcrowded curricula (Talty, 1986). An example of this approach was implemented at Tufts University, during the 1985-1986 academic year, in which OS&H course materials were developed and introduced into existing engineering courses at the undergraduate level (Talty, 1986). Chemical engineering courses, for instance, identified the health effects of chemicals, the fate of chemicals within the plant, and also included case studies concerning transportation problems associated with chemicals and the risk of releases (Talty, 1986).

However, almost ten years later, studies suggested that few undergraduate engineering programs include any structured course material relevant to health and safety (Farwell, Rossignol, & Talty, 1995). In 1995, Farwell, Rossignol, and Talty set out to determine if engineering faculty were including occupational and public health and safety material in their undergraduate engineering courses. Results from a survey of 157 faculty showed that the majority believed it is necessary to address OS&H (78.8%) in undergraduate coursework (Farwell, Rossignol, & Talty, 1995). Of those surveyed, over half address OS&H in their courses, while 41.8% address public health and safety and most instructors include these topics because of personal interest, ethical considerations and departmental encouragement (Farwell, Rossignol, & Talty, 1995). Those engineering faculty who are not including safety and health topics in their coursework cited lack of room in the curriculum, lack of relevance to the course content, and lack of materials readily available as the most common reasons for not doing so (Farwell, Rossignol, & Talty, 1995). It is important to note that one-third of this study's participants had attended a NIOSH-sponsored workshop for engineering faculty, which demonstrates some bias toward safety and health on the part of those participants, and the results concerning the importance of safety and health in engineering curriculum may have been overstated (Farwell, Rossignol, & Talty, 1995).

Regardless of any bias, the results also showed that the ABET requirements of engineering programs to address safety and health was not a convincing factor for faculty to include those topics in their classes, which suggests that ABET should consider making their requirements for safety and health instruction more specific and refuse accreditation to those schools not meeting the requirements (Farwell, Rossignol, & Talty, 1995). The 1985 annual report of ABET stressed the need for engineering education to increase the extent to which occupational and public safety and health were included in the curriculum (Talty, 1986). The report also pointed out that the increasing complexity of engineering systems draws students' attention away from potentially hazardous conditions and the evaluation of safety concerns should be considered a vital part of the design process (Talty, 1986). However, if these requirements and recommendations made by ABET are not enough to influence faculty to include safety and health in their coursework, then perhaps the safety and health accreditation criteria is not being enforced as stringently as other areas of engineering curriculum. The importance of occupational and public safety and health is certainly not unknown to ABET, since, as mentioned earlier, it accredits safety and health programs under its Related Accreditation Commission (Kohn, 1997).

In response to the findings from the curriculum development projects at various universities, such as the one at Tufts University, NIOSH has developed a list of instructional topics (Figure 1) that reflect the major technical elements of OS&H (Talty & Walters, 1987). The topics are listed alphabetically and should be assembled in an appropriate sequence within the curriculum (Talty & Walters, 1987). Many of these topics are similar to those that construction personnel address on a daily basis. It is likely that construction graduates would also benefit from the inclusion of these topics into their studies.

Suggested OS&H Engineering Instructional Topics		
1. Air Contaminants	12. Industrial Toxicology	23. Personal Protective Equipment
2. Control Technology	13. Industrial Ventilation	24. Product Liability
3. Electrical Safety	14. Loss Control	25. Radiation Control
4. Emission Control	15. Materials Handling	26. Respiratory Protective Equipment
5. Engineering Control Systems	16. Mechanical Guarding	27. Risk Assessment
6. Epidemiology	17. Monitoring	28. System Safety
7. Ergonomics/Human Factors	18. Noise Control	29. Vibration Control
8. Facility Layout	19. Occupational Diseases	30. Waste Disposal
9. Fire Protection	20. Occupational Injuries	31. Work Practices
10. Heat Stress Control	21. OS&H codes and standards	
11. Illumination/Lighting	22. OS&H Literature	

Figure 1 - Developed by NIOSH (Talty & Walters, 1987)

Project SHAPE is designed to allow the engineering community to contribute to the prevention of occupational injuries, diseases, and deaths (Talty & Walter, 1987). However, education in this field must be improved before Project SHAPE realizes its objectives (Talty & Walters, 1987). Talty and Walters (1987) also stressed that engineering graduates must learn of the importance of OS&H technical issues and information, and in addition, accreditation criteria should be strengthened to "clarify the fact that safety and health in the workplace is an engineering issue that requires the attention of the engineering community, both in the classroom and on the job" (p. 31).

Business curriculum integration

The other project initiated by NIOSH is known as Project Minerva, after the Roman goddess of wisdom (Talty & Walters, 1987). The long-range goal of the project is that all graduates with bachelor and master degrees in business will understand that safety and health must be managed like any other business function for a company to prosper (Talty & Walters, 1987). The project is a four-phase effort that first makes business schools aware of the need for safety and health education in business, then encourages schools to include increments of OS&H

in curriculum through NIOSH efforts (Talty & Walters, 1987). The third phase is to provide schools with safety and health educational materials for incorporation into coursework, or if the school wishes, development of new courses, and the fourth phase involves feedback from students and faculty as to the usefulness of the material (Talty & Walters, 1987). As Talty and Walters (1987) explained, it is the belief of safety and health professionals that managers must be prepared to consider the following in their management roles:

1. Changing Perceptions of Who is Responsible for Workplace Injuries and Illnesses

   Managers can no longer attribute accidents and injuries to being unavoidable consequences of production, nor can they assume that safe work performance can be a reality without the knowledge of hazards, skills training, and competent supervision. It is becoming more common for courts to find managers negligent in safety-related issues.

2. Workers are More Concerned About Their Safety and Health

   A study of labor turnover, by Colorado State University, indicated that 33% of participants changed jobs because of a concern for their safety and health. "Workers are better educated, receive better pay, and have higher expectations relative to safety and health than ever before" (p. 27).

3. Product Liability

   Liability is the obligation to pay or make good on a loss. Many product liability cases are filed each year to recover losses of various types. Costs to business include payments awarded by courts, as well as settlements out of court, and liability insurance to handle other legal fees.

4. Increased Cost of Workers' Compensation

   Recent decisions from the courts and administrative agencies have broadened coverage to include causes such as job stress. The increase in workers' compensations costs are a major concern to industry, since dollars that go to these types of losses could otherwise be used to develop the organization.

5. Financial Incentives

   The injury/illness record of a company can have an enormous impact on its profits. Large dollars paid out in losses results in the necessity to increase sales to make up for the money lost to a poor safety record.

6. The Occupational Safety and Health Act of 1970

   The intent of this act is to prevent occupational injuries and illnesses by the control of recognized workplace hazards. Facility safety and health is the responsibility of the employer, who has the obligation to provide a safe and healthy work environment. "The question is no longer whether something should be done to improve the working conditions, but what should be done and how quickly" (Talty & Walters, 1987, p. 28).

These are all vital aspects of safety and health that business graduates should be fully aware of upon entering the job market.

Stewart, Ledgerwood, and May (1996) presented additional arguments for the integration of safety into business school curricula, including the ethics, economics, and legalities of employee safety and health, as well as industry and academic perspectives on the issue. Employee safety and health have ethical aspects since many managerial decisions affect workers' lives and welfare (Stewart, Ledgerwood, & May, 1996). Economically, managerial decisions relating to safety and health also impact an organization's operations and profitability in that managerial inattentiveness to safety and health issues costs millions of dollars each year in the form of employee injuries, illnesses, and deaths (Stewart, Ledgerwood, & May, 1996). These costs used to be passed down to the consumer through the price of goods and services, but through the increase of fines and penalties issued by the Occupational Safety and Health Administration (OSHA), workers' compensation premiums, and litigation suits by injured workers and their families, businesses can no longer afford to be negligent to affairs concerning to safety and health (Stewart, Ledgerwood, & May, 1996). The legal aspect of safety and health continues to become more prominent through the actions of OSHA (Stewart, Ledgerwood, & May, 1996). If employees believe their employers are in violation of maintaining a safe and healthy workplace, the employees may take actions, which could culminate not only civil fines, but also criminal prosecution for the employer (Stewart, Ledgerwood, & May, 1996).

As a matter of course, managers have taken the position that employee safety and health consumes valuable resources that minimize profitability, but this attitude is yielding to a stronger recognition that sound safety management has its benefits (Stewart, Ledgerwood, & May, 1996). A former corporate safety manager for IBM once stated that "There should be no argument that the same management principals and concepts that are applied to quality, cost, and production, must also be applied to safety" (Stewart, Ledgerwood, & May, 1996, n.p.). Comments like this from industry leaders present a challenge to academic institutions to increase awareness of safety and health among students and faculty (Stewart, Ledgerwood, & May, 1996).

Business schools are accredited through the American Assembly of Collegiate Schools of Business (AACSB), and while AACSB does not dictate a prescribed curriculum, it emphasizes that programs educate for not only the present, but also for the future (Stewart, Ledgerwood, & May, 1996). Also included in the AACSB standards are influence of ethics, legal, regulatory, environmental and technological issues on business (Stewart, Ledgerwood, & May, 1996). As stated earlier, safety and health is inherent to all these issues as they relate to an organization, but the AACSB has not supported safety and health as being worthy of inclusion in business curriculum (Stewart, Ledgerwood, & May, 1996).

Since safety and health elements are not required by the AACSB, the subject is often excluded from business textbooks (Stewart, et al., 1996). A survey of textbook editors reveals the perception that safety and health should be part of human resource management education, but surprisingly, a large portion of human resource management textbooks do not include safety management coverage (Stewart, Ledgerwood, & May, 1996). Those schools that do not include human resource management as part of their coursework rely on the principals of management course to introduce safety management, but only 25% of those textbooks have some coverage of safety and health issues (Stewart, Ledgerwood, & May, 1996). Even finance and insurance textbooks are clearly deficient in the areas of safety and health, with only two percent having some coverage of the topic (Stewart, et al., 1996). Although these results are disappointing, 55% of the editors surveyed thought that text coverage of safety and health would increase in the future (Stewart, Ledgerwood, & May, 1996).

The most effective method of including safety and health in business education is to include the issues within the framework of each existing practical course (Stewart, Ledgerwood, & May, 1996). The following list of courses was identified by Stewart, Ledgerwood, and May (1996) as being relevant for safety and health to be included:

- Business ethics
- Labor relations
- Business policy
- Business law
- Marketing management
- Finance/insurance
- Risk management
- Principals of management
- Human resources management
- Organizational behavior

Assistance in providing materials and current information is available through organizations like NIOSH, who, since 1982, has been working with OSHA and industry leaders to include safety and health in business curricula through efforts like Project Minerva (Stewart, Ledgerwood, & May, 1996). The Minerva Education Institute (TMEI), a nonprofit organization, is a continuation of Project Minerva's philosophy to assist in business education efforts by providing instructional materials, lecture modules, and various case studies (Stewart, Ledgerwood, & May, 1996). TMEI has been enlisting knowledgeable business administration faculty and their respective deans to play an increasing role in Minerva, in hopes of eventually combining the efforts of several schools to promote awareness, academic and professional training, research, and community involvement with safety and health issues (Stewart, Ledgerwood, & May, 1996).

Despite the significance of safety and health in industry, the majority of colleges and universities with business programs have not included such topics in the curriculum (Stewart, Ledgerwood, & May, 1996). Pressure from outside industry is being placed on universities to educate their students in safety and health issues, since the need for knowledgeable graduates is becoming more prevalent. This situation is similar to the pressures facing the construction management programs in that a need for graduates educated in safety and health issues has been identified, and the resulting solution may be to integrate the issues into the curriculum. However, like business curriculum, the present construction curriculum does not adequately cover the areas of safety and health identified as important by industry.

Industrial Technology curriculum integration

As with Engineering and Business curriculum, attempts have been made to integrate safety, health, and risk control education with industrial technology undergraduate programs. One instance of this integration occurs at Iowa State University where the disciplines of manufacturing technology, and safety have been merged into a cross-functional curriculum (Freeman & Fields, 1999). Since the workforce is a mass of numerous disciplines and concentrations, according to Freeman and Fields, curricular activities that require the cooperation of several groups within an educational setting to accomplish various outcomes will more adequately prepare graduates for the cross-functional working environment (1999). In the Iowa State cross-functional program, interaction occurs between students in the institution's safety program and manufacturing program through several classes designed to give safety students the technical knowledge behind manufacturing, while also granting manufacturing students the safety and health related knowledge that is critical to manufacturing processes. Course components that include safety information include "the safe utilization of manufacturing materials and equipment, understanding of how safety policies and procedures impact the manufacturing environment, and an appreciation for the expertise and responsibilities of skilled workers and the role they play in ensuring a safe manufacturing environment" (Freeman & Fields, 1999). These safety elements are all discussed in the same course that involves learning the chemical, electrical, mechanical, and thermal properties of metallic materials, as well as an introduction to select industrial manufacturing processes (Freeman & Fields, 1999). In combining the technical aspects of manufacturing with the importance of safety policies and procedures, the students are getting a complete understanding of how both aspects work together in the workplace.

Construction curriculum integration

In at least one of the many construction programs around the country, an attempt has been made to integrate safety, health, and risk control into construction curriculum. Through collaboration between The St. Paul Companies, the Construction Safety Council (CSC), the

University of Wisconsin – Stout, and the Construction Industry, the Construction Risk Control Partnership (CRCP) was initiated to "provide educational opportunities for new and existing construction professionals that will lead to the prevention and elimination of human, material, and financial loss" (CRCP, 1999a, p. 1). Two of the goals established by the CRCP are to integrate safety, health, and environmental risk control topics into college and university Construction Management programs and to connect with industry partners to provide internships, mentors, and resource speakers to develop the integrated curriculum and provide students with real life experiences (CRCP, 1999a). Through a construction curriculum integrated with risk control competencies, the partnership aims to achieve its vision for all new professionals to possess a safety and health risk control consciousness (CRCP, 1999a). This integrated curriculum, which was incorporated into existing coursework, is divided into content packages that identify hazards, controls and suggested references in eight different areas construction (CRCP, 1999b):

- Residential and Light Building Construction Methods
- Commercial, Industrial and Highway Construction Methods
- Concrete and Masonry Technology
- Soils, Excavations and Mining
- Environmental Systems – HVAC
- Environmental Systems – Electrical and Plumbing
- Structural Systems – Wood and Steel
- Structural Systems – Concrete and Masonry

Each of the content packages outlines several units of instruction (e.g. mobilization and site preparation, foundations, or masonry), for which risk control content is incorporated into the unit instructional objectives. Each unit includes an overview of the work associated with the identified phase of construction, risks commonly associated with the type of work, suggested risk controls and resources available to help integrate risk control competencies into construction practices (CRCP, 1999a). For example, under the unit of mobilization and site preparation, the construction phase of site preparation is identified (CRCP, 1999a). One of the risks associated with site preparation is underground and overhead utility location removal and/or protection (CRCP, 1999a). A risk control identified for this risk is "contact one-call system and local utilities for location of underground and overhead systems" (CRCP, 1999a, p. 14). Suggested resources available to help educate students about this risk include various videos and St. Paul Technical Guides, which are brief summaries used for instruction on a wide variety of topics. Through the implementation of this curriculum, UW-Stout was able to maintain its existing coursework. New classes were not developed or added to the construction curriculum.

Construction Curriculum and Accreditation Requirements

Like many other disciplines, construction academic programs often strive to be accredited by a recognized accrediting agency. Since being a nationally accredited academic program gives the construction program recognition among industry and students, the curriculum criteria set out by such agencies tends be the guide used when establishing coursework. The American Council for Construction Education (ACCE) is a private, non-profit corporation, whose mission is "to be a leading global advocate of quality construction education programs; and to promote, support, and accredit quality construction education programs" (ACCE, 2002a, n.p.). Organized in 1974, ACCE is recognized by the Council for Higher Education Accreditation (CHEA) as the accrediting agency for 4-year baccalaureate degree programs in construction, including the areas of construction science, construction management, and construction technology (ACCE, 2002a).

ACCE supports both students' and industry's needs by helping students to find construction programs that offer quality education in the field, and allowing employers to identify those graduates who have the potential for making long-term contributions to the business, having met the standards of an accredited construction program (ACCE, 2002a).

ACCE has set forth specific curriculum criteria that must be met in order for a construction program to be accredited. ACCE Form 103 – Standards and Criteria for Baccalaureate Programs outlines organization and administration requirements, including the institution, construction unit, and budget requirements, curriculum requirements, faculty and staff qualifications, student admissions, facilities and services, and relations with industry and the general public (ACCE, 2002b). The curriculum should be attentive to social, economic, and technical developments, and suggest the use of growing knowledge in construction, and behavioral and quantitative sciences (ACCE, 2002b). Curriculum should "provide an education that will lead to a leadership role in construction and prepare the student to become a responsible member of society" (ACCE, 2002b, p. 3). It is recommended by the ACCE that curriculum be relevant to the needs of the construction profession and society, and therefore, be reevaluated on a regular basis and modified to reflect changes in construction technologies and management trends (ACCE, 2002b). ACCE requires a minimum of 120 semester (180 quarter) credit hours for accreditation of United States construction education baccalaureate programs, in which one semester credit hour equals 15 instructional hours, and one quarter credit hour equals 10 instructional hours (ACCE, 2002b).

The curriculum requirements are divided into five categories: general education, mathematics and science, business and management, construction science, and construction. The following information from ACCE Form 103 (2002) detailed the requirements of each category:

General Education – 15 semester (22 quarter) credit hours

Core Subject Matter	Minimum Academic Credit
*Oral and written communication**	8 semester (12 quarter) hour(s)
Ethics*	1 semester (1.5 quarter) hour(s)

**In addition, oral presentation, business writing and ethics must be integrated throughout the construction-specific curriculum.*

– Includes appropriate courses in communications, social sciences, and the humanities.

– Content should indicate the needs of the construction industry, as well as the philosophy of the educational institution.

– Graduates should have the ability to communicate, both orally and in writing, and have an understanding of human behavior.

– Example courses in this division include: human relations, psychology, sociology, social science, literature, history, philosophy, art, language, political science, other appropriate courses.

Mathematics and Science – 15 semester (22 quarter) credit hours

Core Subject Matter	Minimum Academic Credit
Analytical: physical or environmental	8 semester (12 quarter) hours
Statistics and/or Mathematics	3 semester (4.0 quarter) hours

– The laws of physics, chemistry, geology, and environmental sciences are essential to understanding the behavior of the materials, equipment, and methods used in construction.

– Basic scientific, quantitative, and qualitative topics, which provide groundwork for subsequent technical subjects, are to be included in this category.

– Example courses in this division include mathematics (analytic geometry, pre-calculus, calculus, linear algebra, statistics), physical sciences (physics, chemistry, geology, environmental science), and other sciences, such as computer science.

Business and Management - 18 semester (27 quarter) credit hours

– Fundamental courses to provide a foundation for contemporary business practices appropriate to applications in construction.

– The graduate should have a broad understanding of the fundamentals of the free enterprise system, accounting, finance, business regulations, contract law, labor law, and marketing.

– While no minimum credit hours are specified, core subject matter includes economics, principals of management, accounting, and business law.

– Example courses in this division include macro- and microeconomics, financial accounting, finance, cost accounting, personnel management, labor relations, supervision, productivity, principals of management, business management, organizational behavior, and business law.

Construction Science – 20 semester (30 quarter) credit hours

Core Subject Matter	Minimum Academic Credit
Design Theory	3 semester (4 quarter) hours
Analysis and Design of Const. Systems	6 semester (9 quarter) hours
Construction Methods and Materials	6 semester (9 quarter) hours
Construction Graphics	1 semester (1.5 quarter) hour(s)
Construction Surveying	1 semester (1.5 quarter) hour(s)

– This category will include construction sciences and architectural or engineering design topics chosen to aid communications with the design disciplines and to solve practical construction problems.

– Examples of courses in this division include statics, strength of materials, dynamics, thermodynamics, soil mechanics, HVAC, plumbing, mechanical, electrical, temporary facilities, rigging, formwork, construction materials, project development, and feasibility studies.

Construction – 20 semester (30 quarter) credit hours

Core Subject Matter	Minimum Academic Credit
Estimating	3 semester (4 quarter) hours
Planning and Scheduling	3 semester (4 quarter) hours
Construction Accounting and Finance	1 semester (1.5 quarter) hour(s)
Construction Law	1 semester (1.5 quarter) hour(s)
Safety	1 semester (1.5 quarter) hour(s)
Project Management	3 semester (4 quarter) hours

– Course material shall cover both office and field activities required by a project safety program and shall include a cost benefit analysis.

– Content addresses the constructor's role as a member of a multi-disciplinary team, the assessment of project risk, and the alternate methods that can be used to configure the owner-designer-constructor team.

– Courses should encourage problem definition and solution, creativity, communication, evaluation, and continuous learning. The knowledge, understanding, and skills gained from prerequisite courses should be integrated and used in subsequent courses.

– Examples of courses in this category include drawings and specifications, contract documents, quantity surveying, bid compilation, bidding strategy, safety, field records, quality control, scheduling, mechanical, electrical, and work experience

Along with requiring construction programs to provide curriculum within specific categories, ACCE also requires fundamental topical content within those categories to be covered (ACCE 2002b). The extent to which these topics are covered within a program's curriculum is left to the discretion of that program as it fulfills its mission (ACCE, 2002b). Table 1 is found in ACCE Form 103 and is intended to provide guidance to construction programs preparing for accreditation visits.

Curriculum Topical Content
General Education
Communications
Ethics
Humanities
Social Sciences
Mathematics and Science
Analytical Physical Science
Mathematics and/or Statistics
Business & Management
Economics
Principles of Management
Accounting
Business Law
Construction Science
Design Theory (Select one or more from the following options.)
Structural Mechanics
Electricity
Thermodynamics
Soil Mechanics
Analysis and Design of Construction Systems (It is the intent of this requirement to ensure that construction program graduates have, at minimum, some exposure to all basic systems that may be incorporated into a building project.)
Civil
Electrical
Mechanical
Structural
Building Codes and Standards
Construction Graphics
Basic Sketching and Drawing Techniques
Graphic Vocabulary
Detail Hierarchies, Scale, Content
Notes and Specifications, Reference Conventions
Computer Applications
Construction Surveying
Survey, Layout, and Alignment Control
Site Organization, Development
Construction Methods and Materials (including: concrete, steel, wood, and soils)
Composition and Properties
Terminology & Units of Measure
Standard Designations, Sizes, and Graduations
Conformance References and Testing Techniques
Products, Systems and Interface Issues
Construction
Estimating
Types of Estimates and Uses
Quantity Takeoff
Labor and Equipment Productivity Factors
Pricing and Price Databases

Job Direct and Indirect Costs
Bid Preparations and Bid Submission
Computer Applications
Planning and Scheduling
Parameters Affecting Project Planning, to include site, area, owner and environmental issues
Schedule Information Presentation
Network Diagramming and Calculations with CPM
Resourcc Allocation and Management
Computer Applications
Construction Accounting and Finance
Cost Accounting and Industry Formats
Fixed and Variable Costs: insurance, bonding, marketing, general and administrative expenses
Bidding and Procurement Practices
Record and Report Practices
Capital Equipment, Depreciation, and Expensing
Forecasting Costs, Cash Flow Requirements
Payment Processes and Time Valuc of Money
Construction Law
Construction Contracts, Roles & Responsibilities of Parties
The Regulatory Environment and Licensing
Lien Laws and the Contractor's Rights
National and Local Labor Law
Administrative Procedures to Avoid Disputes
Safety
Safe Practices
Mandatory Procedures, Training, Records, and Maintenance
Compliance, inspection and penalties
Project Management
Concepts, Roles, and Responsibilities
Project Life Cycle
Alternate Delivery Methods
Project Control and Quality Control
Project Documentation
Managing Project Change
Labor Relations

Table 1 – Curriculum Topical Content Requirements (ACCE, 2002b)

ACCE also states that curricula offered by the construction programs must be consistent with the philosophy and the objectives of both the institution and construction program (ACCE, 2002b). The construction programs' curricular intent must also be related to the needs of society and the construction profession (ACCE, 2002b).

This study compares the academic preparedness in the areas of safety, health, and risk control of graduates from two construction management programs. A brief review of the existing curriculum offered in each program is discussed below. The curriculum information originated from the construction programs' websites, however, due to the confidential nature of this study the website locations are withheld to prevent identification.

College A curriculum

This construction management baccalaureate degree program trains graduates to manage, coordinate, and supervise the construction process from project conception through final construction on a timely and economical basis. Students are educated in coordinating and managing people, equipment, materials, budgets, contracts, and schedules, as well as employee and public safety. The College A construction management program is accredited by the ACCE and students are evaluated on the outcomes set forth by the accrediting agency. Specified areas in which outcomes are evaluated include estimating, plan reading and bid process, budgeting/cost accounting, cost control and closeout, scheduling and project control, construction materials and methods, construction surveying and layout, safety, and project administration. The safety outcome evaluation requires that the student be able to identify and implement safety standards including the ability to interpret the OSHA construction standards, establish safety and health procedures on the job site, perform hazardous material and process analysis, and enforce safety procedures. This program requires a total of 128 semester hours for completion. Students must complete either an industry internship or a class in computer-integrated construction.

Coursework requires general education/liberal arts studies, including speech communications, physics, economics, chemistry and geology. Construction related coursework includes sequential classes in the following areas:

- Commercial building methods and materials
- Construction graphics
- Heavy/highway construction - materials, lab, estimating
- Estimating – quantity survey, pricing and productivity
- Construction cost analysis
- Planning and scheduling
- Structural design and analysis
- Mechanical/electrical systems
- Construction documents and specifications
- Equipment productivity and analysis
- Project control and administration
- Surveying
- Construction safety
- Construction law

These core course requirements culminate in a capstone course, which is an individualized project that integrates the concepts learned in the core program into an application activity. This course allows for application of all construction software used throughout the program.

Students have the opportunity to complete their degree with certifications already in hand. Students receive the OSHA 30-hour certification in the construction safety course, and seniors are required to complete the Certified Professional Contractor exam, although graduation is not dependent on passing the exam.

College B curriculum

The College B construction management program aims to provide students with a quality career oriented education, which allows them to understand and participate in the construction process. The goals of this program include preparing students for careers in the construction industry, delivering a cost effective program that meets the needs of the students, and becoming knowledgeable concerning construction safety/risk control. College B hopes to produce leaders with the analytical, technical, organizational, and communication skills to manage the most complicated construction procedures. College B construction management focuses more on the business and management end of construction as well as the construction process. They do not stress the engineering or technology components, as some construction programs do. This program is accredited by the ACCE. The curriculum is divided into the areas of business and management, architecture, engineering, and construction, and general/other requirements.

Business and management coursework includes engineering economy, organizational leadership, principals of management, principals of marketing, and human resources management. All business and management classes are offered through either the industrial management department or the business department. Architecture, engineering, and construction coursework includes architectural graphics and technology, contract regulations and specifications, environmental systems (HVAC, plumbing, and electrical), structural systems (wood, steel, concrete, and masonry), construction materials, construction estimating, project scheduling and cost control, construction safety, legal aspects of construction, and statics/strengths of materials. The general and other requirements section of the curriculum includes liberal arts classes such as English, speech, economics, psychology, physics, geology, calculus, statistics, and government. The student is required to complete an internship/co-op education experience in the construction industry. A total of 129 semester hours is required to complete the construction program.

College B offers the integration of safety, health, and risk control throughout its construction curriculum. Students can also increase their safety, health, and risk control knowledge by taking risk control classes offered by the College B risk control department, which allows the student to graduate with a minor in construction risk control. Students are also required to sit for the Certified Professional Contractor exam, and as with College A, graduation is not dependent on passing the exam.

Summary

As stated earlier, industry leaders have indicated that the same management techniques that pertain to quality, production, and budget, should also pertain to safety, and safety should be treated like any other management function. The current construction curriculum requirements do not reflect this belief. Only one semester credit hour out of 180 semester credit hours are dedicated to safety and health education (ACCE, 2002b). Not only is safety misrepresented in the curriculum, but also the required safety content is not representative of the principals of safety and health. ACCE curriculum topical content in the area of safety deals only with safe practices, complying with mandatory procedures, training, records, and maintenance, and governmental agency inspections and penalties, which are only the bare minimum activities used to control risk (ACCE, 2002b). Construction curriculum safety, health, and risk control shortcomings are similar to those of business and engineering curriculum. In order for these disciplines to accurately represent the safety and health needs of industry, changes need to be made in the content of their curriculum. The curriculum needs to reflect the needs of the changing world. With limited space available in already crowded curriculum, it is not necessary to introduce more coursework into the schedule to implement change. As demonstrated by both Tufts University and University of Wisconsin-Stout, safety, health, and risk control content can be introduced into the applicable, existing classes. The two construction management programs analyzed for this study offer similar core curriculum requirements and are both accredited by ACCE. Both programs also provide the students with a construction safety course, although College B offers safety, health, and risk control content throughout the core construction classes as well.

Chapter Three

Methodology

Introduction

This study compared the perceived level of preparedness graduates from two different construction programs have in the areas of safety, health, and risk control. This chapter will detail the methods of study; how the sample was selected and a description of the sample; and explain the instrumentation used to collect the data. An explanation will follow of the data analysis procedures, and finally, the research methodological limitations of this study.

Method of Study

The construction management program directors of College A and College B provided contact information of graduates. The surveys were sent out to the list of contacts via e-mail during the week of December 2, 2002. The participant first completed a consent form and then continued on to complete the survey. The consent form explained that by returning the completed survey, the graduate was giving their informed consent to participate in the study. This was considered a confidential survey because the respondents were aware that they would not be identified in any way through the results of the study, and all identifying information would be destroyed upon completion of the study. The consent form also included the survey author's name and phone number, as well as the name and phone number of the research advisor for the study.

Subject Selection and Description

Study participants responded to the survey questions as graduates from construction programs of either College A or College B regarding their perceived level of preparedness in the areas of safety, health, and risk control upon entering the construction industry after graduation. Graduates from two construction undergraduate programs were contacted to respond to the survey from a list of names provided by program directors. From a list of 39 College A graduates, 30 responded to the survey (77%), while 30 of 41 College B graduates (73%) participated in the study.

College A participants

Of the 30 College A participants, 5 were female and 25 were male. Graduation dates of participants ranged from 1993-2001. Graduates from College A are all employed in management positions (Figure 2) with either commercial, highway, industrial, or residential construction companies. These companies are located and complete projects across the United States.

Field Engineer	Senior Project Manager
Piping Field Engineer	Vice President
Project Manager	Engineered Wood Specialist
Estimator	Construction Representative
Construction Manager/Owner Representative	Combustion Turbine Field Engineer
Project Engineer	Site Supervisor
Project Manager/Estimator/Safety Coordinator	Project Engineering

Figure 2 - Job titles of study participants from College A

College B participants

College B participants (n = 30) consisted of 28 males and 2 females. Graduation dates of this group ranged from 1999 – 2001. Figure 3 shows the job titles of participants from College B, who all have obtained management positions in commercial, highway, or residential construction. These companies, some of which are the same companies employing College A graduates, are also located and complete projects across the United States.

Project Engineer	Senior Project Manager
Graduate Student	Estimator
Project Manager	Field Engineer

Figure 3 - Job titles of study participants from College B

Instrumentation

This author designed a 25-question survey, using a Likert scale, specifically for this study. The survey questions were derived from the information obtained in the literature review and the CRCP's Risk Control Curriculum Integration Guide (1999b). In developing the survey, the questions were directed specifically to gather information on the graduates' opinions of the safety, health, and risk control content of their undergraduate degrees. The survey addresses the effect of safety, health, and risk control on budget, schedule, the public, and employees. Participants were given the option of selecting one of five levels of preparedness in response to the survey statements: extremely well, moderately well, average, poorly, and topic not mentioned. Since this instrument was developed specifically for this study, no measures of validity or reliability were documented (survey instrument, Appendix 1).

Data Analysis

In order to address the research goals of this study, relevant descriptive and analytical statistics were used as the appropriate forms of measurement. Frequencies, percents, mode, mean, standard deviation and independent groups T-test were calculated to identify trends in the safety, health, and risk control content of construction program curriculum. Since some of the survey questions were posed using a Likert scale, numerical scores were applied to the scale in order to run analytical statistics on the data. The numerical scores assigned were 4 – Extremely Well; 3 – Moderately Well; 2 – Average; 1 – Poorly; and 0 – Topic Not Mentioned. The score of zero had a value of "user missing" so that frequencies of this response could be used without affecting the mean.

Limitations

The limitations associated with this instrument may include the absence of validity or reliability measures. In addition, the comparison of only two construction programs may not accurately depict the preparedness of graduates across the country. The survey tool was designed to gauge the knowledge, skills, and abilities obtained through completion of core construction courses, however, for individuals who have not completed the construction program within the past three years, it may have been difficult to distinguish where they received certain information. Based on the objective nature of the survey, some of the respondents' answers may have reflected the graduates' desire to preserve their program's reputation.

Chapter Four

Results and Discussion

The surveys were sent out to the list of contacts via e-mail and the participants completed a consent form and then continued on to complete the 25-question survey. The questions were specifically directed to gather information on the graduates' opinions of the safety, health, and risk control content of their undergraduate degrees. The survey addresses the effect of safety, health, and risk control on the public, employees, schedule, and budget. This chapter will discuss the results of the survey as they relate to the research questions indicated in Chapter One.

Research Question 1

Do graduates of construction management programs feel they have an adequate understanding of the impact risk control has on budget and schedule, the two components which drive a construction project?

The impact safety, health, and risk control have on schedule was addressed in section three of the survey. These questions were directed toward construction program content regarding the use of pre-planning and estimating the safety, health, and risk control elements of a project in order to remain on schedule. College A and College B results were combined to answer this research question. Means and standard deviation were calculated to represent the graduates' level of understanding. Respondents indicated a level of preparedness that ranged from 1.78 (SD=.70) to 2.54 (SD=.87). Results of respondents to section three are presented in Table 2.

Construction program content regarding the monetary impact safety, health, and risk control have on the bottom line was addressed in section four of the survey. The majority of graduates from both College A and College B indicated a level of preparedness that ranged from

2.25 (SD=.97) to 2.69 (SD=.75) in these areas. Results of respondents to section four are shown in Table 3.

		Mean	Std. Deviation	Topic Not Mentioned (n=60)
17.	Job Hazard Analysis: Hazards are identified in each of the activities present for a specific task, and methods for controlling those hazards are planned and implemented	2.30	.81	4
18.	Including the safety component in the quantity take-off, such as calculating board feet of lumber required for guardrails	1.96	.89	11
19.	Using contractor pre-qualification surveys to address the safety competency of sub-contractors	1.78	.80	15
20.	Performing tool-box talks, related to the scope of work, to instruct workers on the hazards they will be facing in the field	2.54	.87	4

Table 2 – Combined Survey Results from Section III - Schedule

		Mean	Std. Deviation	Topic Not Mentioned (n=60)
21.	Fines and penalties resulting from citations by the Occupational Safety and Health Administration (OSHA)	2.48	.79	4
22.	Calculation and function of the Experience Modification Rate (EMR) used by insurance companies to determine Workers' Compensation insurance premiums – the lower the rate, the lower the premium a company pays for insurance	2.63	.96	4
23.	Criminal and civil lawsuits brought against managers and supervisors of construction projects, who can be held liable for safety negligence, resulting in fines or prison time	2.25	.97	3
24.	The direct costs of accidents such as medical expenses, wages for the injured employee, who can't work, and the wages for the injured employee's replacement.	2.57	.75	2
25.	The indirect costs of accidents including work delays, lost crew efficiency, and higher cost of insurance.	2.69	.75	1

Table 3 – Combined Survey Results from Section IV - Budget

Research Question 2

Did graduates from a construction program where risk control is integrated throughout the curriculum feel more prepared for the workforce in the areas of safety, health, and risk control than graduates from programs that did not have risk control integrated throughout the curriculum?

In addition to the responses given for sections three and four of the survey, which addressed the schedule and budget aspects of safety, health, and risk control, graduates' perceived levels of preparedness were also indicated by responses to sections one and two. Section one addressed topics related to public safety and liability, while section two topics pertained to employee safety and regulation compliance. The following tables show the mean, standard deviation and the result of the independent groups t-test that was run for each question. Only five questions showed statistical significance that graduates from a college with risk control integrated in the curriculum felt more prepared in areas of safety, health, and risk control than graduates whose program did not contain a risk control integrated curriculum. College B's Construction Management program has risk control integrated throughout their curriculum, whereas College A does not. Results from each college to the questions in survey sections one through four are displayed in Tables 4,5, 6, and 7 respectively.

		College A			College B			
		Mean	Std. Dev.	Topic Not Mentioned (n=30)	Mean	Std. Dev.	Topic Not Mentioned (n=30)	t-test for Equality of Means t(df)=t-value, p=significance
2.	Securing the site and limiting public access	2.31	.81	1	2.47	.73	0	t(57)=-.781, p=.438
3.	Traffic control on and around the job site	2.32	.90	5	2.14	.79	1	t(52)=.792, p=.432
4.	Traffic control work zones for street and road construction	2.12	.83	5	2.00	.65	1	t(52)=.592, p=.556

5.	Locating underground utilities and protecting overhead hazards	2.28	.96	1	2.41	.78	1	t(56)=-.601, p=.551
6.	Risks to the public during demolition operations	2.05	.84	8	2.24	.83	1	t(49)=-.829, p=.411

Table 4 – Survey Results from Section I - Public Safety

		College A			College B			
		Mean	Std. Dev.	Topic Not Mentioned (n=30)	Mean	Std. Dev.	Topic Not Mentioned (n=30)	t-test for Equality of Means t(df)=t-value, p=significance
7.	Hazard recognition relating to OSHA regulations	2.83	.75	0	2.80	.85	0	t(58)=.162, p=.872
8.	Mandatory procedures including training, recordkeeping, and maintenance	2.34	.81	1	2.40	.97	0	t(57)=-.236, p=.814
9.	Hazard communication requirements including storage, use, and disposal of hazardous substances	2.35	.98	4	2.21	.88	2	t(52)=.523, p=.603
10.	Risks related to electrical work including assured grounding, damaged cords, and improper wiring	2.11	.92	2	2.83	.83	0	t(56)=-3.160, p=.003* *(Sig. Level of .01)
11.	Excavation and trenching safety including cave-in prevention, soil classification, access/egress requirements, and atmospheric testing	3.00	.79	0	3.40	.67	0	t(58)=-2.112, p=.039
12.	Risks related to placing and consolidating concrete including face and eye protection, protection from and treatment of concrete burns, and carbon monoxide problems during interior pours and finishing	2.36	.87	2	2.70	.92	0	t(56)=-1.460, p=.150
13.	Choosing the right equipment for the task, including cranes, pump trucks, loaders, forklifts, aerial lifts and power buggies	2.38	.98	1	2.83	.95	0	t(57)=-1.808, p=.076
14.	Avoiding falls from work environments including elevations, ground level, scaffolding, and leading edges	2.67	.84	0	3.00	.79	0	t(58)=-1.581, p=.119
15.	Risks associated with cranes and rigging such as crane failure, electrocution, improper rigging and loading, use of cranes during high winds	2.12	.88	5	2.83	.79	0	t(53)=-3.161, p=.003* *(Sig. Level of .01)

		Mean	Std. Dev.	Topic Not Mentioned (n=30)	Mean	Std. Dev.	Topic Not Mentioned (n=30)	t-test
16.	Identification and elimination of hazards associated with asphalt/concrete operations during road work such as heat stress and sunburn, burns, public traffic, inhalation of asphalt fumes and silica dust	1.64	.70	5	**2.11**	**.80**	**3**	t(50)=-2.251, p=.029

Table 5 - Survey Results from Section II - Employee Safety

		College A			College B			
		Mean	Std. Dev.	Topic Not Mentioned (n=30)	Mean	Std. Dev.	Topic Not Mentioned (n=30)	t-test for Equality of Means t(df)=t-value, p=significance
17.	Job Hazard Analysis: Hazards are identified in each of the activities present for a specific task, and methods for controlling those hazards are planned and implemented	2.15	.97	4	**2.43**	**.63**	**0**	t(54)=-1.262, p=.214 *Unequal Var. assumed
18.	Including the safety component in the quantity take-off, such as calculating board feet of lumber required for guardrails	**1.81**	.81	9	**2.07**	**.94**	**2**	t(47)=-1.021, p=.312
19.	Using contractor pre-qualification surveys to address the safety competency of sub-contractors	1.58	.61	11	1.92	.74	**4**	t(43)=-1.652, p=.106
20.	Performing tool-box talks, related to the scope of work, to instruct workers on the hazards they will be facing in the field	**2.65**	.80	4	2.43	.94	**0**	t(54)=.942, p=.351

Table 6 - Survey Results from Section III – Schedule

		College A			College B			
		Mean	Std. Dev.	Topic Not Mentioned (n=30)	Mean	Std. Dev.	Topic Not Mentioned (n=30)	t-test for Equality of Means t(df)=t-value, p=significance
21.	Fines and penalties resulting from citations by the Occupational Safety and Health Administration (OSHA)	2.59	.69	3	2.38	.86	**1**	t(54)=1.015, p=.315

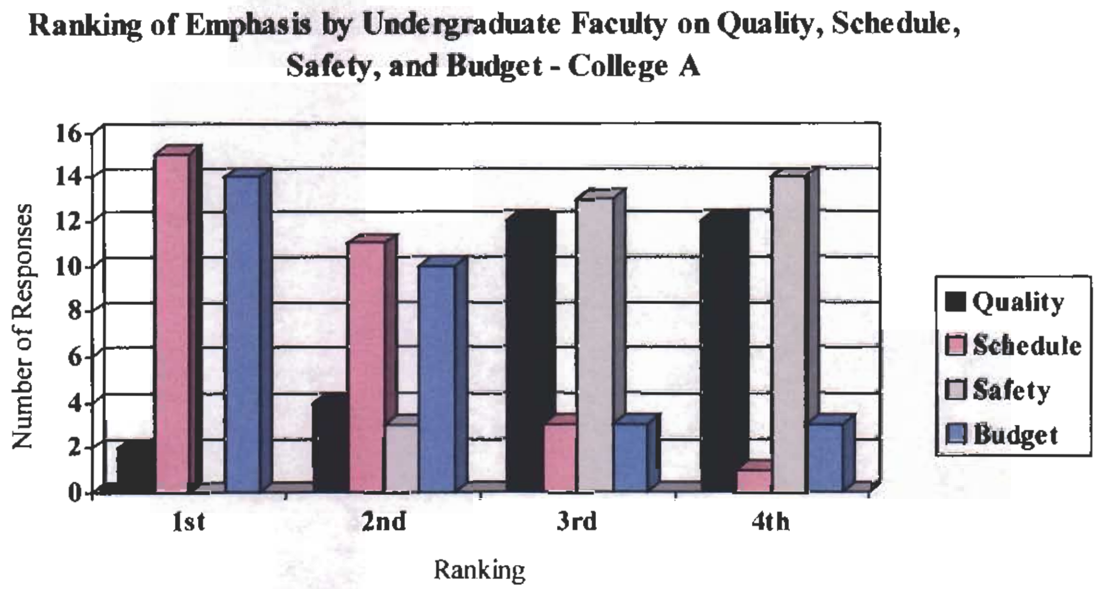
22.	Calculation and function of the Experience Modification Rate (EMR) used by insurance companies to determine Workers' Compensation insurance premiums – the lower the rate, the lower the premium a company pays for insurance	2.19	.98	4	3.00	.79	0	t(47)=-3.363, p=.002* *(Sig. Level of .01)
23.	Criminal and civil lawsuits brought against managers and supervisors of construction projects, who can be held liable for safety negligence, resulting in fines or prison time	2.32	1.02	2	2.17	.93	1	t(55)=.577, p=.566
24.	The direct costs of accidents such as medical expenses, wages for the injured employee, who can't work, and the wages for the injured employee's replacement.	2.50	.75	2	2.63	.76	0	t(56)=-.672, p=.505
25.	The indirect costs of accidents including work delays, lost crew efficiency, and higher cost of insurance.	2.62	.62	1	2.77	.86	0	t(57)=-.746, p=.459

Table 7 - Survey Results from Section IV - Budget

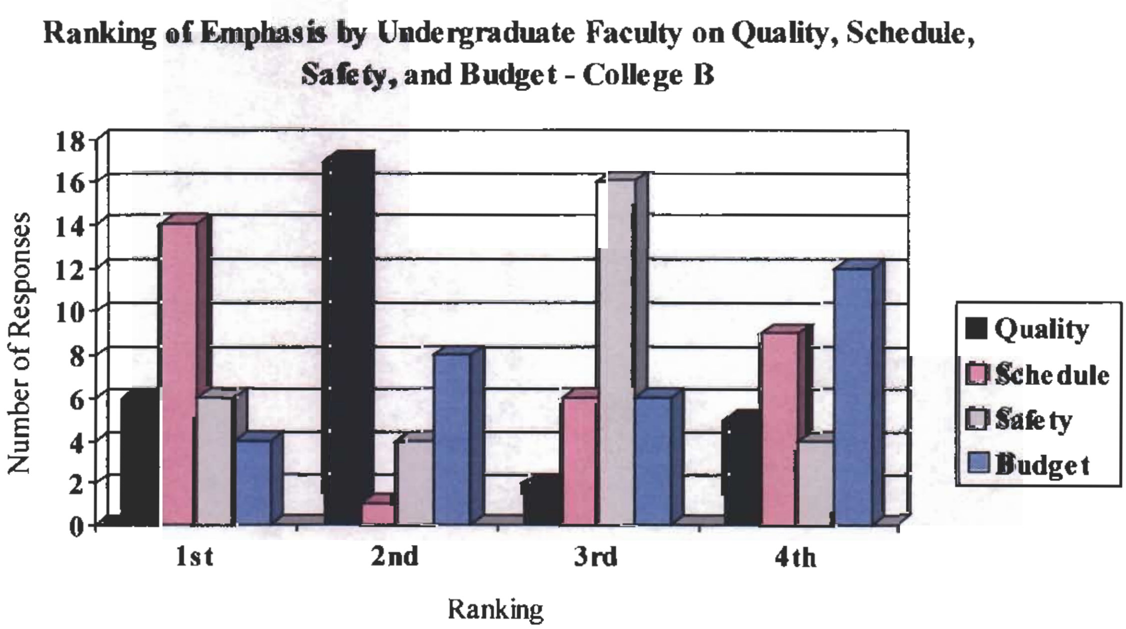
Research Question 3

What level of importance do graduates feel their construction programs placed on risk control/safety compared to quality, budget, and schedule?

Question one from the survey asked the respondents to rank the construction elements of safety, budget, quality, and schedule with respect to how much their undergraduate faculty emphasized them. The elements were ranked 1-4, with "1" being the most emphasized. As Graph 1 indicates, the majority of College A respondents ranked schedule and budget as first and second in emphasis by construction undergraduate faculty. Safety was never ranked as "most emphasized" and the majority of respondents placed it as fourth in line after the other three construction elements. Graph 2 denotes the majority of respondents from College B ranked schedule as first, quality as second, safety as third, and budget as fourth.



Graph 1 - College A responses to survey question 1



Graph 2 - College B responses to survey question 1

Research Question 4

Do contractors feel their new hires from construction management programs are well prepared in the areas of safety, health, and risk control as they relate to construction?

After interviewing representatives from two construction companies (both of which require their identity to remain confidential) with hires from both College A and College B, no difference was indicated in the level of preparedness between hires from either college. One company stated that it would be hard to indicate how prepared the graduates were after graduation, since this company places new hires through two days of safety training sessions, including the OSHA 10-hour certification class. The other company stated that graduates of both schools have the competency to perform their duties, but do lack slightly in the areas of risk control. The company representative indicated that while graduates are aware of safety issues regarding regulation compliance, they lack knowledge in the areas of public liability, construction safety pre-planning activities (e.g. Job Hazard Analyses, pre-qualification of subcontractors), and workers' compensation claim reporting and management.

Summary

The results obtained from construction graduates regarding their preparedness level in safety, health, and risk control indicated that there is no significant difference between a construction program with risk control integrated in their curriculum and a program that does not integrate risk control. When looking at graduates' responses regarding the impact safety and health have on budget and schedule, the mean values ranged from 1.78 to 2.69. When asked to rank the emphasis placed on each element of the construction process (quality, schedule, safety, and budget), the majority of graduates from each school never ranked safety as most emphasized by their faculty. It ranked third with College B and fourth with College A. Construction companies with new hires from each program indicated no difference between the two programs' graduates, but did point out some areas in which the graduates are lacking sufficient knowledge.

Both college A and B displayed similarities and differences in their ranking and preparedness. However, based on the data collected, neither of the undergraduate programs appears to sufficiently address safety or risk control to prepare graduates completely for a career in construction project management.

Chapter Five

Summary, Conclusions, and Recommendations

This chapter will discuss the following three sections: a summary of the study, conclusions based on the results of the study, and recommendations related to the study.

Summary

The following summary includes a restatement of the problem, a description of the sample population and instrumentation used in the study, methodological procedures, and the study results.

Restatement of the problem

The St. Paul Insurance policy holders who participated in the Construction Information Exchange, identified a concern regarding the insufficient training in safety, health, and risk control issues found in many of the new construction professionals entering the job market. It is likely that graduates of academic construction programs are not receiving the adequate safety, health, and risk control education required to succeed in the construction industry.

The purpose of this study was to compare the level of preparedness graduates of construction management and engineering programs have in applying risk control elements to the construction process. The study also evaluated the perceived level of understanding contractors feel their recent hires from construction management and engineering programs have of risk control functions. The results from the surveys were used to interpret whether a need exists for risk control to be integrated throughout core construction curriculum.

Answers to the following research questions were sought through the use of a survey of graduates from two university four-year construction programs and interviews of contractors who have hired graduates from these institutions.

1. Do graduates of construction management programs have an adequate understanding of the impact risk control has on budget and schedule, the two components which drive a construction project?

2. Did graduates from a construction program where risk control is integrated throughout the curriculum feel more prepared for the workforce in the areas of safety, health, and risk control than graduates from programs that did not have risk control integrated throughout the curriculum?

3. What level of importance do graduates feel their construction programs placed on risk control/safety compared to quality, budget, and schedule?

4. Do contractors feel their new hires from construction management programs are well prepared in the areas of safety, health, and risk control as they relate to construction?

Methods and procedures

To assess the perceived levels of preparedness construction graduates had upon entering the workforce, surveys were sent out to the list of contacts via e-mail. This author designed a 25-question, confidential survey, using a Likert scale, specifically for this study. The survey questions were derived from the information obtained in the literature review and the CRCP's Risk Control Curriculum Integration Guide (1999b), and were directed specifically to gather information on the graduates' opinions of the safety, health, and risk control content of their undergraduate degrees. The survey addressed the effect of safety, health, and risk control on budget, schedule, the public, and employees. Participants were given the option of selecting one of five levels of preparedness in response to the survey statements: extremely well, moderately well, average, poorly, and topic not mentioned. These levels were then each given a score (0-4) and mean, standard deviation, and an independent groups t-test were calculated for each survey question.

Graduates from two construction undergraduate programs were contacted to answer the survey from a list of names provided by program directors. From a list of 39 College A graduates, 30 responded to the survey (77%), while 30 of 41 College B graduates (73%) participated in the study.

Major findings

The results obtained from construction graduates regarding their preparedness level in safety, health, and risk control upon graduation indicated that while College B curriculum includes a risk control integrated component and College A does not, there was no statistically significant difference between graduates' perceived level of preparedness upon entering the workforce. Only five questions on the survey showed significant differences between the schools. Based on the mean values of the questions, College B never scored higher than 3.4 out of 4 on any of the questions, while College A had a "high score" of 3.00. When asked to rank the construction elements of safety, budget, quality, and schedule with respect to how much their undergraduate faculty emphasized them, College A respondents ranked schedule and budget as first and second, respectively. Safety was never ranked as "most emphasized" and the majority of respondents placed it fourth in line after the other three construction elements. The majority of respondents from College B stated that their faculty placed the most emphasis on schedule, followed by quality, safety, and budget, respectively. Construction companies with new hires from each program indicated no difference between the two programs' graduates, but did suggest the graduates were lacking sufficient knowledge in the areas of public liability, construction safety pre-planning activities, and workers' compensation claim reporting and management.

Conclusions

This section will discuss the conclusions inferred from the results of the survey in response to the research questions posed in chapter one.

Question 1: Do graduates of construction management programs feel they have an adequate understanding of the impact risk control has on budget and schedule, the two components which drive a construction project?

Based on the results given in Tables 2 and 3 in the previous chapter, the low preparedness levels indicated by the graduates regarding the impact of risk control on budget and schedule appear to show that current construction curriculum does not emphasize additional factors relating to the budget and schedule of a project. For example, including safety in the quantity take-off resulted in a mean value of 1.96, and 11 respondents indicated the topic was not mentioned at all. Similarly, other topics with direct impact to the schedule of a project, like pre-qualifying subcontractors based on their previous performance and loss history, also seem to be rarely mentioned at all. Factors such as these are not only vital to the safety performance of a contractor, but can have a critical impact on the financial and timely outcome of construction project. Those questions relating risk control and budget had better mean values than the schedule component questions, but still only scored as high as 2.69 (SD=.75) out of 4.00. This score shows that graduates do not feel their programs prepared them even moderately well in these areas. While the topics may have been covered during the course of their education, the information is not being conveyed to the graduates adequately, or at least not well enough to give them a high level of confidence in these areas. Section four of the survey includes some of the areas included in ACCE curriculum requirements, such as OSHA fines and penalties. Both Colleges A and B are accredited by ACCE, but the responses to this survey question resulted in a mean score of 2.48 (SD=.79). According to the scale represented by the survey, this places the graduates preparedness between "average" (2.00) and "moderately well" (3.00). This competency should be receiving much higher scores if it is required for construction programs to maintain accreditation by ACCE

Question 2: Did graduates from a construction program where risk control is integrated throughout the curriculum feel more prepared for the workforce in the areas of safety, health, and risk control than graduates from programs that did not have risk control integrated throughout the curriculum?

In order to answer this question, each graduate's answers to the survey were evaluated and compared using an independent groups t-test. Test results showed significant differences between the two colleges on only five of twenty-four questions (the t-test was not used to evaluate question 1). These questions dealt with risks related to electrical work including assured grounding, damaged cords, and improper wiring (question 10), excavation and trenching safety including cave-in prevention, soil classification, access/egress requirements, and atmospheric testing (question 11); risks associated with cranes and rigging including crane failure, electrocution, improper rigging and loading, and use of cranes in high winds (question 15); risks associated with asphalt and concrete operations (question 16); and the calculation and function of the Experience Modification Rate (EMR) used by insurance companies to determine Workers' Compensation insurance premiums (question 22). In all of these areas, College B scored a higher mean value than College A.

The remaining nineteen questions did not show statistically significant differences in the graduates' perception of how well their construction management programs prepared them in the areas of safety, health and risk control. Based on these results, it can be inferred that College B, where risk control is integrated throughout the curriculum, does not cover the necessary safety, health, and risk control content any better than College A, which offers one safety class as a requirement of their curriculum. Thus, it does not appear that graduates of College B are any more prepared in safety, health, and risk control upon entering the workforce than graduates of College A.

Question 3: What level of importance do graduates feel their construction programs placed on risk control/safety as compared to quality, budget, and schedule?

It is apparent from the responses to this question that neither program places much emphasis on the safety component of a construction project. Even though College B integrates risk control into many of their core classes, it is still ranked as third in faculty emphasis by graduates. Not one respondent from College A even placed safety as number one, and instead the majority placed it as fourth. This provides an insight into the minds of the faculty and what they consider to be the most important aspects of the construction project. The students only receive the education their faculty provide them and often interpret what is important based on the faculty's viewpoint. It is apparent from the graduates' ranking of construction project components that the faculties, at both institutions, may feel safety is not a critical part of the success of a construction project and may not communicate to the students how the safety, health, and risk control directly impact not only the individual project, but the construction company as a whole.

Question 4: Do contractors feel their new hires from construction management programs are well prepared in the areas of safety, health, and risk control as they relate to construction?

The Construction Information Exchange, sponsored by The St. Paul Fire and Marine Insurance Company and the CSC, allowed contractors to voice their views on the safety and risk control aptitude of construction graduates. These contractors felt there was a concern with inadequate training of new construction professionals. Two contractors were interviewed for this study, both of which hire graduates from College A and College B. It is apparent that one company has little faith in the safety and risk control aptitude of their new hires since they immediately put them through rigorous safety training upon employment. There is also a lack of risk financing education, specifically in the areas of Workers' Compensation and General Liability. One contractor indicated graduates were aware of safety issues regarding regulation compliance, yet while this contractor may feel graduates are prepared in this area, results of the survey show students themselves are not as confident in their knowledge of regulation compliance. These results show a distinct disconnect between what employers need and what the undergraduate construction programs provide in the form of a construction graduate. The industry is specific in describing the areas they need new hires to be proficient in, but these construction undergraduate programs are not providing the industry with candidates competent in these areas.

Recommendations

Recommendations related to this study

1. It appears from the results of this study that construction graduates are not receiving adequate safety, health, and risk control education. This deficiency is partly a result of the limited amount of time devoted to safety, health, and risk control topics in the curriculum. ACCE accreditation only requires one-semester hour out of four years of education to fulfill the safety requirement. Aside from the insufficient amount of time, the curriculum safety content is not representative of what a construction professional should know upon entering the industry as indicated by industry professionals. Since safety should be managed like any other construction

function, accreditation requirements should also reflect this belief. Enough time should be allocated to safety education to provide the graduate with practical, applicable knowledge of construction safety. It is recommended that content be added to the safety requirements of ACCE accreditation, including workers' compensation and insurance education, construction safety pre-planning, safety documentation, and accident investigation.

2. One approach used to increase the time allotted to safety education is integrating safety and risk control into the existing curriculum. This is a preferred method since it emphasizes the importance of treating safety like any other management function. Curriculum integration places in students' minds the idea that safety and risk control are equally important to the success of a construction project. Faculty are not required to add any additional classes to accommodate the additional safety content since they can place it throughout the existing coursework. For example, workers' compensation, insurance, and public liability education can be integrated into Construction Law classes and pre-planning activities can be added to estimating and scheduling classes. This allows the students to receive safety education on a regular basis throughout their four-year degree. This also prevents them from having to depend on one semester class to provide all of their risk control instruction.

3. As Talty and Walters (1987) explained, "managers can no longer assume that safe work performance can be a reality without the knowledge of hazards, skills training, and competent supervision." Some schools, such as College B, have attempted to implement the technique of safety and health curriculum integration to increase the knowledge of hazards and skills training for their students. However, it is evident that what is intended by the curriculum of College B is not being passed on in the classroom. Students are coming away with only a partial understanding of the safety, health, and risk control content involved in construction

activities. The lack of curriculum content effectiveness could be a result of faculty that are very capable of teaching their courses well, but are not familiar with teaching safety and risk control in their courses.

This shortcoming could also be a factor in many schools attempting to keep current with the ever-changing safety and risk control regulations and fundamentals. Most faculty members have come to teach construction after working in the field or office of a contractor. Those that have been teaching for many years may not be receiving the updated safety information and training that many construction professionals obtain on a regular basis. This makes it harder for them to communicate current safety trends in the classroom and the relation of these trends to other construction elements. It is highly recommended the faculty members of construction undergraduate programs receive updated safety and risk control materials on a regular basis, as well as attend regular training sessions to be able to provide the education their students need and deserve. Lack of knowledge on the part of the teacher should not mean the students are deprived the required information.

4. The construction programs need to have a resource they can tap into for this updated information, and if they already have access to such a resource, they should take advantage of all that resource can provide. There are numerous education resources available on the Internet and in periodical publications. However, showing an occasional safety video, or giving students an article to read once in a while is not enough to fill the void in safety education. It is also recommended that safety and health industry experts be brought in to help convey the importance their field has to construction can help fill the void left by the faculty's lack of pertinent knowledge. Hands-on experiences like field trips and internships are also beneficial as they allow students to see all aspects of the project working together. According to the 1991

Secretary's Commission on Achieving Necessary Skills, "the most effective way of learning skills is placing learning objectives within a real environment rather than insisting that students first learn in the abstract what they will be expected to apply" (Freeman & Fields, 1999).

This study has identified a definite need for revision in construction management curriculum at the undergraduate level. The construction industry has identified the lack of knowledge in new hires, and construction undergraduate programs need to address the deficiencies in their graduates and fill the void left by inadequate education.

Recommendation for further study

This study was limited to the number of participants from the two colleges compared. For a better representation of construction graduates' preparation, the study should be expanded to other baccalaureate programs, as well as associate construction degree programs. It was also difficult for participants to distinguish between what material they had learned in their undergraduate program and what they had learned in training sessions and on-the-job. Therefore, it would increase accuracy of responses to survey graduates within one year of completing their degree.

Additionally, this study should focus further on what is keeping both College A and College B from producing graduates that are more prepared in safety, health and risk control. Identifying each school's shortcomings will only help to make their construction program stronger. College A's current curriculum should be examined for areas where safety and health integration is possible. Further research into the specific areas where College A's graduates feel they received inadequate education would allow for prioritization of future curriculum modification. Similarly, College B has implemented an integrated curriculum that is not effective in producing graduates with adequate safety knowledge. A closer examination of what is indicated in the curriculum guide versus what is actually being taught in the classrooms of College B would provide valuable insight into the downfalls of this program.

College B also gives construction students the option of obtaining a Minor in Risk Control through a partnership with the Risk Control Department of this university. It would be beneficial to learn whether there is a difference in safety, health, and risk control preparedness between those graduates of College B that completed the Minor in Risk Control versus those that chose not to.

To better understand the knowledge that current construction faculty have of safety, health, and risk control, it would be advantageous to survey faculty of undergraduate construction programs. Faculty should be assessed on their knowledge of safety standards, implementation of safety programs, and the effect other related risk control elements have on the construction process. This type of study would reveal whether faculty has the foundation of safety, health, and risk control education required to pass on to their students. Additionally, faculty should be questioned regarding the current curriculum of their institution, as well as institutional accreditation requirements. This would give a good indication of the faculty's awareness of curriculum requirements, as well as giving them a forum to voice concerns regarding current curriculum standards.

It would also be beneficial to expand on a survey of contractors and what areas they feel graduates of construction programs should be competent in. The construction industry should be an active participant in curriculum development so as to maintain the relevance of the material being learned. This will only help to create a more effective construction graduate.

It is important to advise accreditation curriculum committees, such as ACCE, of the inadequate training and education of construction graduates entering the industry. It is likely that the ACCE has not yet embraced the impact safety and risk control have on the construction process. A study showing the financial impact of safety on construction companies could demonstrate the need for increased safety education in today's construction management programs. It is important to be able to quantify the benefits a company receives when an effective safety program is implemented.

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Appendix A

Consent Form and Survey

Consent Form

This research examines the perceived level of preparedness in the areas of safety, health, and risk control felt by recent graduates of construction management programs upon entering the construction industry. The study consists of a survey that will be analyzed as to whether there is a need for safety, health, and risk control to be integrated throughout core construction coursework.

Before completing the survey, we would like you to give your consent after considering the potential risks and benefits of participation. Your consent to participate indicates that you understand your rights as a participant.

There is no risk to you for participating in this study. We are requesting your honest opinions regarding your construction education. Your responses are completely confidential and will only be viewed by the researcher. After the study is complete, all resources will be destroyed.

While there is no direct benefit to you by participating in the study, the results of this study have the potential to benefit others in the future by providing the construction industry with more competent and prepared graduates.

Your participation in this study is entirely voluntary. You may choose not to participate without any adverse consequences to you.

Questions or concerns about the research should be addressed to Jill Nelson, the researcher, at (715) 231-2239, or to the research advisor, Dr. Elbert Sorrell, at (715) 232-2630. Questions regarding the rights of research subjects can be addressed to Sue Foxwell, Human Protections Administrator, UW-Stout Institutional Review Board for the Protection of Human Subjects in Research, (715) 232-1126.

Having been informed of the potential risks and benefits of this study, do you understand your rights as a participant and give your informed consent to participate in this research study?

Yes ____ No ____

To be completed for researcher's records:

Name:
Date:
Job Title:
Graduation Date:

The following survey asks for your honest opinion on the following 25 items related to your undergraduate education. Please place an "X" in the column that most accurately represents your response to the item.

1. Rank the following construction elements (1-4, with "1" being the most emphasized) with respect to how much your undergraduate faculty emphasized them:

Quality _____ ***Schedule***_____ ***Safety*** _____ ***Budget*** _____

Section I – Public Safety

	Once the contractors take possession of the site, they assume responsibility for public safety. To what extent do you feel your undergraduate education prepared you in the following areas?	Extremely Well	Moderately Well	Average	Poorly	Topic not mentioned
2.	Securing the site and limiting public access					
3.	Traffic control on and around the job site					
4.	Traffic control work zones for street and road construction					
5.	Locating underground utilities and protecting overhead hazards					
6.	Risks to the public during demolition operations					

Section II – Employee Safety

	Safety of employees should be paramount on any construction jobsite. To what extent do you feel your undergraduate education prepared you in the following areas?	Extremely Well	Moderately Well	Average	Poorly	Topic not mentioned
7.	Hazard recognition relating to OSHA regulations					
8.	Mandatory procedures including training, recordkeeping, and maintenance					
9.	Hazard communication requirements including storage, use, and disposal of hazardous substances					
10.	Risks related to electrical work including assured grounding, damaged cords, and improper wiring					
11.	Excavation and trenching safety including cave-in prevention, soil classification, access/egress requirements, and atmospheric testing					
12.	Risks related to placing and consolidating concrete					

	including face and eye protection, protection from and treatment of concrete burns, and carbon monoxide problems during interior pours and finishing					
13.	Choosing the right equipment for the task, including cranes, pump trucks, loaders, forklifts, aerial lifts and power buggies					
14.	Avoiding falls from work environments including elevations, ground level, scaffolding, and leading edges					
15.	Risks associated with cranes and rigging such as crane failure, electrocution, improper rigging and loading, use of cranes during high winds					
16.	Identification and elimination of hazards associated with asphalt/concrete operations during road work such as heat stress and sunburn, burns, public traffic, inhalation of asphalt fumes and silica dust					

Section III - Schedule

	Pre-planning and estimating the safety, health, and risk control component of a project is a more efficient method of protecting the worker from jobsite hazards without affecting the schedule. To what extent do you feel your undergraduate education prepared you in the following pre-planning methods?	Extremely Well	Moderately Well	Average	Poorly	Topic not mentioned
17.	Job Hazard Analysis: Hazards are identified in each of the activities present for a specific task, and methods for controlling those hazards are planned and implemented					
18.	Including the safety component in the quantity take-off, such as calculating board feet of lumber required for guardrails					
19.	Using contractor pre-qualification surveys to address the safety competency of sub-contractors					
20.	Performing tool-box talks, related to the scope of work, to instruct workers on the hazards they will be facing in the field					

Section IV - Budget

	Safety, health, and risk control directly affect the bottom line and these components of a project are an economic necessity for an organization's success. To what extent do you feel your undergraduate education prepared you in the following areas?	Extremely Well	Moderately Well	Average	Poorly	Topic not mentioned
21.	Fines and penalties resulting from citations by the Occupational Safety and Health Administration (OSHA)					
22.	Calculation and function of the Experience Modification Rate (EMR) used by insurance companies to determine Workers' Compensation insurance premiums – the lower the rate, the lower the premium a company pays for insurance					
23.	Criminal and civil lawsuits brought against managers and supervisors of construction projects, who can be held liable for safety negligence, resulting in fines or prison time					
24.	The direct costs of accidents such as medical expenses, wages for the injured employee, who can't work, and the wages for the injured employee's replacement.					
25.	The indirect costs of accidents including work delays, lost crew efficiency, and higher cost of insurance.					

Appendix B

Employer Interview Guide

1. Do you feel that your recent hires from construction management programs are competent in the areas of safety, health, and risk control as they relate to construction?
2. Have you noticed a difference in graduates that you hire from college A and college B?
3. Do you have safety personnel that are independent of other company departments or functions?
4. Do you rely on your superintendents/project managers/foremen to evaluate and enforce your safety/risk control policies on the jobsite?
5. How is safety budgeted on a project-to-project basis? (How do you bid safety on projects?)