

Design Students Awareness and Perceptions about Occupational Safety

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The construction industry in the United States has historically been one of the most demanding and dangerous industries due to its complex and dynamic nature, resulting in research proposals to determine necessary interventions under the commonly known as Design for Safety. Interventions challenge designers to address workers' occupational safety and health needs during design phases to minimize subsequent hazards facing construction workers. To qualify and be applicable, the designers should be versed in the occupational safety of workers. The authors reviewed current United States Architecture and Interior Design Program course requirements as proposed by their respective accreditation agencies. It appears occupational safety education is not specifically required within their guidelines. However, the authors believe it is important to educate design students about occupational safety, beginning with a simple survey conducted among students enrolled in design programs at a major U.S. University. Results indicate lack of student awareness about designers' involvement in current construction project safety procedure development, but ultimately believe designers should be key project participants equally responsible for developing safety procedures for all occupants throughout construction and occupancy.

Keywords: Occupational safety, Design for Safety, Architectural Education, Interior Design Education, Occupational Safety Education.

Introduction

The construction industry, one of largest industries in United States, has been historically one of the most physical labor intensive and dangerous industries (CPWR 2013). This fact is reflected in data published by United States Bureau of Labor Statistics, defining the construction industry sector to total more fatal work injuries than any other industry in the United States at 781 in 2011 (BLS 2013). Occupational injuries or fatalities affect emotions, productivity, and morale of fellow coworkers, rippling through entire schedules, budgets, and common empathy for the precious nature of human life.

Korman (2001) suggested an intervention named Designing for Safety (DfS), which involves designers to address occupational safety and health needs of workers during design phases to minimize hazards of the construction workers downstream. The concept of DfS can be traced back to 1990s when a survey of design firms and contractors were conducted to identify their extent of involvement in jobsite safety (Hinze and Wiegand 1992). Hinze and Wiegand research concluded: more than two thirds of participating design firms admitted to have never addressed construction workers' health, safety, and welfare in their design. Literature shows several scholars believe construction industry safety hazards are "designed into" construction projects (Behm 2005; Gambatese et al. 2005). This fact is further supported through studies performed by Whittington et al. (1992), Suraji, Duff & Peckitt (2001), and Bhattacharjee & Ghosh (2014) where they documented a significant amount of construction accidents resulting from decisions taken during planning and design phases.

The previous discussion raises the question: Should occupational safety awareness be included in formal design education? The authors reviewed current United States Architecture and Interior Design Program course

requirements as proposed by their respective accreditation agencies. It appears occupational safety education is not specifically required within their guidelines. However, the authors believe it is important to educate design students about occupational safety, beginning with a simple survey conducted among students enrolled in Design Programs at a major U.S. University. This paper presents both the method and results of this student survey.

Concept of Design for Safety (DfS)

Design determines configuration, constructability, and resultant performance of final constructs. Configurations yield both positive and negative influence on jobsite safety by providing or neglecting certain features which can either make jobsites safe or unsafe. A typical example of this is when a permanent guardrail surrounding an opening in a floor plate for vertical shaft is included as part of the design element, it improves the level of safety of a jobsite. To be an effective DfS feature it is critical for the designer to clarify the sequence and time of installation of the above mentioned guardrail as a note with the relevant construction document(s). Building upon this example, several other such design features or situations can develop to reduce and potentially eliminate hazardous situations during construction.

The need for designers to consider workers safety on jobsites during design phases was addressed by the International Labor Office (ILO) as early as 1985. In the decade to follow, several other organizations, such as European Foundation for the Improvement of Living and Working Conditions (EUROFOUND) and National Institute for Occupational Safety and Health (NIOSH), took initiative to highlight the role of the designers in construction jobsite safety. American Society of Safety Engineers (ASSE) defined the concept of DfS as "addressing occupational safety and health needs in the design process to prevent or minimize hazards and risks associated with the construction, manufacture, use, maintenance, and demolition of a facility". A growing number of industry leaders in several countries, such as the United Kingdom, Australia, France, and South Africa, have included DfS as an effective means to enhance construction worker safety (Behm 2005; Bluff 2003; SAFLII 1993).

Current Design Education System

Both the Architectural and Interior Design education systems in the United States are governed by accreditation organizations which define basic requirements for a successful and effective design curriculum. The National Architectural Accrediting Board (NAAB), non-profit organization is the sole agency in United States which accredits professional degree programs in Architecture. A majority of state registration boards requires a NAAB accredited degree for licensure, preparing professionals to practice in the field of Architecture. NAAB provides guidance for general studies, professional studies and electives which together comprises the whole education requirement for architects. Review of current NAAB requirements reveal no specific Student Performance Criteria (SPC) relating to occupational safety education, but is implicit within Realms B & D based on individual program curriculum (NAAB 2014).

Similar to NAAB, Interior Design education in the United States is governed by the Council of Interior Design Accreditation (CIDA). CIDA is a non-profit accrediting organization for Interior Design Programs at colleges and universities in the United States. More than 150 Interior Design Programs are currently accredited by CIDA serving approximately 20,000 students. CIDA has developed a professional standard, used to evaluate Interior Design Programs which prepare entry level designers. Similar to NAAB, the current CIDA standards do not require any occupational safety education for Interior Design students.

Several researchers found safety programs and educational intervention methods are proactive approaches in improving jobsite safety performance (Hislop 1991; Tam et al. 2004). Effective safety programs and educational intervention methods substantially reduce the rate of accidents by creating safer means of operation and safe work environments (Abdelhamid and Everett 2000; Anton 1989; Rowlinson 2003). Not only does effective safety education help in creating a safer environment, it can also minimize damage to equipment and tools, loss of market competition, and project delays (Findley et al. 2004; Michaud 1995).

Objectives and Method

This study attempts to understand the current level of knowledge among design students about jobsite safety of construction workers and identify the perceptions of the students about designers' contribution towards a safer work environment.

The objectives were achieved by conducting a survey among students enrolled in Architecture and Interior Design Programs at a major US university. The survey questionnaire was divided into four sub-sections including: (1) understanding the demographics of the students; (2) examining the level of knowledge of the students about current occupational safety standards in the building trade; (3) examining student perspectives on the role of the designers and other key participants such as safety director, project manager, superintendent, and workers in maintaining a safe and hazard free construction jobsite; and (4) examining student perceptions about whether considering safety of workers during the design phase can improve the occupational safety.

Samples Selection

The population of the study was undergraduate students of Architecture and Interior Design Programs of a major US university. The study included students from all the four and five year degree programs, which provided perspective on whether the students' knowledge or perceptions change with more education or industry experience through internship or fulltime jobs. Graduate students were not included as part of the study as most of the graduate students have design or construction industry experience for several years which will change their perspective about role of designers in jobsite safety.

Survey Instrument

The survey instrument was developed by the authors based on the four main focus areas of OSHA (Occupational Safety and Health Administration) inspection and previous studies on DfS by Behm (2005) and Gambatese, Behm & Hinze(2005). The individual survey questionnaires were composed of two types of questions: (1) close-ended questions with ordered choices; and (2) five point Likert-type scale questions. The survey questionnaire was divided into four sub-sections. The first section was meant to understand the background of individual student. The second section contained 5 items to determine the level of understanding of the students about the current state of occupational safety in the construction industry. The third section contained 4 items to determine the students' perspectives on the role of the designers and other key participants such as safety director, project manager, superintendent, and workers in maintaining a safe and hazard free construction jobsite. And the fourth section contained 3 items to determine the design students' perceptions about considering safety of workers during the design phase can improve the occupational safety and health of the construction trade.

The authors identified the survey items based on the study's key constructs of interest. Once the first draft of the survey instrument was developed, a research measurement expert and two subject matter experts reviewed those in order to ascertain the content validity of the items in terms of relevance, representativeness, and technical quality. Feedbacks from the subject matter experts were incorporated into the second draft, the pretest version of the survey instrument. The pretest versions of the instrument were next evaluated for substantive and structural validity through cognitive interview procedures.

Two experts from the construction industry and two senior level undergraduate students were included for the cognitive interviews. Information obtained from the cognitive interview sessions were incorporated into final

version of the survey instruments. Several typographical errors were corrected and language was revised to increase clarity of the questionnaire.

Distribution of Questionnaires and Analysis of Data

The developed and validated survey instrument was made into printed copies and distributed among the design students during their design studio classes. The participants were given a week time to complete the survey and the questionnaires were collected a week later during their respective design studio class. The response rate was 85% (n=268).

The questions in the survey instrument were Likert-type items and the authors did not intend to combine them into a single composite score during analysis. Each of the questions was used as individual items to understand the perceptions of the respondents on different aspects. While analyzing Likert-type, it is suggested to categorize them into the ordinal measurement scale (Boone and Boone 2012). As a result, the authors have computed the mode of the responses in addition to mean to identify the central tendency. Standard deviations of the responses were computed to identify the variations of the responses on the individual items.

Findings

66% of the responding students were female and 72% of the students were in the age group of 21-30 years old. Out of all the respondents, 35% were at the junior level followed by 28% who were at the senior level. The students responding "Fifth year" in their class standing were enrolled in the five years Architecture Program. Overall, 65% of the responding students were majoring in Architecture. Only 17% of the students had more than twelve months of design/construction related experience. The vast majority (69%) had less than six months of work experience. Based on their responses, it was found they have worked for a variety of companies in the Architecture, Interior Design, Construction, and Engineering fields.

Table 1 – Background information of the respondents

Categories		**N (%)**
Gender	Male	31 (34%)
	Female	61 (66%)
Age	18-20 years	21 (23%)
(years)	21-30 years	67 (72%)
	31-40 years	4 (5%)
School Year	Freshman	5 (6%)
	Sophomore	16 (17%)
	Junior	33 (36%)
	Senior	26 (28%)
	Fifth Year	12 (13%)
Major	Interior Design	60 (65%)
	Architecture	32 (35%)

Work Experience	< 6 months	64 (70%)
(Months)	6-12 months	12 (13%)
	>12 months	16 (17%)

The authors have assigned number 1 for 'Strongly Agree' and 5 for 'Strongly Disagree' (2 = Agree; 3 = Neutral; 4 = Disagree). While the numbers only indicate the order, those numbers have been used to compute the descriptive statistics. In response to the questions enquiring about the students' perceptions about the current state of safety in the construction industry, mode of the response was 2 (mean = 1.85; SD = 0.76), which signifies student agreement to the construction industry being extremely dangerous in terms of workers' occupational safety. When asked about specific risks of the construction workers from fall, cave-in, struck by, and electrocution, the students perceived cave-ins to be less threatening in comparison to the other factors.

Table 2 –Responses related to specific risks in the construction industry

Questions Related to Specific Risks in Construction	**Mode**	**Mean**	**SD**
Construction industry is extremely dangerous	2	1.85	0.76
There is high likelihood that workers can be injured due to fall from height, slip, or trip	1	0.70	1.53
There is high likelihood that workers can be injured due to cave-ins	2	1.80	0.87
There is high likelihood that workers can be injured due to struck by vehicles	1	1.58	0.82
There is high likelihood that workers can be injured due to electrocution	1	1.68	0.80

The next section of the survey tried to identify the perceptions of the students about the key participants' roles and responsibilities in preparing the safety procedures and safety manual. While safety manual refers to the formal document containing all the rules and regulations related to safety, safety procedures to be followed by the workers are prepared based on the safety manual and are project specific. When asked how much input the different participants usually have in developing the safety procedures of typical construction projects, the students identified the safety director, project manager, superintendent, and worker having the most input (see Table 3). The respondents did not identify the designers as a main contributor towards preparing the safety procedures. Similarly, the respondents did not rank the designers as the likely contributor towards preparing the safety manual for typical construction projects. However, when asked how much input each of the participants should have in preparing the safety manual and developing the safety procedures, the respondents identified all the participants as equally responsible. The respondents were also asked whether they think the designers should be actively involved in the DfS process to minimize safety hazards for workers downstream. Except one, all the respondents agreed with the involvement of the designers in considering safety of the workers during the design phase. The one respondent who did not think safety of the workers should be considered by the designers cited additional liability for the designers as the reason.

Table 3 – Perceptions of the respondents regarding roles of key participants in construction safety

Questions	Descriptive Stat.	Designer/ Engineer	Safety Director	Project Manager	Superintendent	Workers
How much input does the following person/group have on safety procedures for the projects?	Mode	3	1	1	1	1
	Mean	2.59	1.18	1.90	1.93	2.16
	SD	1.16	0.53	0.99	1.08	1.19
How much input does the following person/group have in preparing the safety manual for the projects?	Mode	3	1	1	1	4
	Mean	2.95	1.19	2.04	2.1	3.33
	SD	1.23	0.47	1.04	1.10	1.20
How much input ***should*** the following person/group have on safety procedures for the projects?	Mode	1	1	1	1	1
	Mean	1.88	1.09	1.35	1.26	1.29
	SD	0.96	0.35	0.72	0.66	0.56
1How much input ***should*** the following person/group have in preparing the safety manual for the projects?	Mode	1	1	1	1	1
	Mean	1.91	1.05	1.35	1.54	1.69
	SD	0.88	0.23	0.70	0.93	0.99

Future Study

The authors have plans to expand the current study to a larger scope by including students from design programs of other universities across the US to capture their knowledge on occupational safety. Further, future study will also include knowledge of occupancy safety among design students within the scope of the study. The authors believe the perspectives of the educators and the industry practitioners are equally pertinent for the holistic adoption and implementation of the concept of DfS. In addition to surveying the educators, existing design programs across the nation will be reviewed to see if safety education can be included within NAAB guidelines under Realms B and D. Another interesting future study can be to compare and contrast the perspectives of the design programs on the importance of safety education among designers within the US to other countries.

Conclusion

The concept of DfS claims designers and engineers should be addressing occupational safety and health needs of the construction workers during the design phase to minimize hazards of the workers downstream. To better implement the process of DfS, the authors believe design students who will be future leaders of the profession should be introduced to the concept of occupation safety at the university level. A thorough review of both Architecture and Interior Design curricula accreditation standards lacked evidence of an occupational safety education requirement. To understand the awareness of occupational safety among the design students the authors conducted a survey among the students enrolled in design programs at a major US University. Responses showed student awareness about the current state of construction industry safety. The majority of respondents believed designers were not currently involved in developing safety procedures for construction projects, but should take an active role. The outcomes of the survey were as expected since the current curricula of the Architecture and Interior Design Programs do not directly educate students about construction occupational safety.

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