PROCEEDINGS OF THE SYMPOSIA SERIES: INTRODUCING AND EMBEDDING SAFETY CULTURE CONCEPTS IN UNDERGRADUATE EDUCATION

NATIONAL ACADEMY
OF CONSTRUCTION

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301 E. DEAN KEETON STREET, C1752

AUSTIN, TX 78712

Proceedings of the Symposia Series:

Introducing and Embedding Safety Culture Concepts in Undergraduate Education

National Academy of Construction (NAC)
301 E. Dean Keeton Street, C1752
Austin, TX 78712

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AUTHORS:

John Gambatese, PhD, PE(CA) (Primary author)
Oregon State University

Ken Arnold (Contributing author)
K. Arnold Consulting, Inc

Wayne Crew, PE (Contributing author)
National Academy of Construction, retired

G. Edward (Edd) Gibson, Jr., PhD, PE(TX) (Contributing author)
National Academy of Construction

Mike Loose (Contributing author)
Parsons Corporation, retired

EXECUTIVE SUMMARY

Graduates of undergraduate education programs represent and shape the future of the architecture, engineering, and construction (AEC) industry. Their knowledge, skills, and motivations are critical to the long-term performance and success of the industry. Recognition of their importance to the industry motivates considerable and pointed attention to their education and training from educators and industry stakeholders.

The safety, health, and welfare of the public are commonly held as the top values and goals of professions. The AEC industry continues to look for ways to improve its safety performance, which regularly lags many other work industries according to historical injury and fatality data. Safety culture within an organization and its projects has been shown to be a strong contributing factor to outstanding safety performance. Those organizations that possess excellent safety cultures also typically experience industry-leading safety performance.

Recognizing the importance of undergraduate education, and with the desire to improve safety performance in the AEC industry, the National Academy of Construction (NAC) conducted a series of five symposia in summer/fall 2022 and spring 2023 that focused on safety culture within university undergraduate education programs. The symposia series explored and promoted teaching the principles, practices, and value of safety and safety culture in undergraduate education programs in the U.S. Each of the symposia was organized and hosted by a leading university and supported financially by NAC industry partners. The symposia followed a common structure with presentations from educators and industry practitioners along with breakout group discussions among all attendees of pertinent topics related to undergraduate education, safety, safety culture, and industry practice and needs. Representatives of 45 universities and 94 construction industry companies and organizations attended one or more of the symposia.

Thematic analyses of the presentation and breakout group transcripts revealed guidance for enhancing safety culture in undergraduate education programs. The results suggest how to promote safety and safety culture in undergraduate programs, barriers to their inclusion, needed resources, expected outcomes, and strategies for embedding safety culture concepts. Programmatic drivers of undergraduate education programs include university and accreditation standards, student needs, and industry advisory board recommendations. Participants indicated that the culture within an organization comes from the actions of leaders and starts at the top, and that safety behavior and procedures are a subset of safety culture. Participants commented that safety is an operational function and mental health affects safety, both of which are necessary, but not sufficient to, establish a positive safety culture.

Recognized barriers to teaching safety and safety culture concepts in undergraduate education programs include reluctance to change curricula, apathy towards safety as a priority, lack of safety knowledge, lack of room in the curriculum, and the cost and time required for site visits. Strategies recommended for overcoming the barriers included teaching people to care, avoiding time and resource impacts to educators, focusing on faculty needs and motivations, increasing industry exposure to students, and improving attitudes toward safety in general and specifically in classes and labs. Success in creating a culture of safety will lead to students with improved "soft" skills (e.g., communication and empathy), courage to stop work that is unsafe, care for others, and an understanding that safety of the public is paramount. Greater exposure to safety and safety culture concepts will motivate students to lead, ask questions about safety, and challenge organizations to improve their safety behavior and performance. It is expected that students will also exhibit receptiveness (interest, awareness, lifelong learning), resilience, an understanding of the importance of safety, an ability to immediately contribute to safety in their organizations, and respect and genuine care for craftworkers.

NAC highly encourages all universities to take steps to introduce and embed safety and safety culture concepts in undergraduate education programs and recommends industry organizations support universities in this effort. Enhancing safety culture throughout the academic community will help elevate safety in all industry sectors and geographical locations across the U.S. The following are recommended steps for academia and industry to enhance safety culture in undergraduate education programs:

1. Integrate safety into education and training activities along with professional ethics
2. Develop and implement educational content for use in undergraduate courses
3. Create out-of-class opportunities for students to learn and experience safety culture concepts and practices
4. Demonstrate and communicate the importance of safety and being an advocate for safety culture in personal and professional lives
5. Foster academic program partnerships with industry to expose students to safety practices and concepts for promoting safety culture in organizations
6. Develop and implement motivators for faculty to integrate safety into their academic roles

Developing and changing a safety culture is a significant endeavor, requiring purposeful attention and continual reinforcement. Changing the safety culture in a program involves changing norms, assumptions, and perceptions. As a result, the process can take a long time, and the result may not be immediately evident. The desired eventual outcome is a student body possessing a safety-centric engineering identity and, as a result, improved safety performance in the construction industry.

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The National Academy of Construction (NAC) would like to acknowledge and thank the individuals and organizations who supported, organized, and conducted the symposia. Their time, effort, and financial contributions helped make the symposia series an outstanding success. Special thanks to the host universities and symposia organizers:

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1. INTRODUCTION

University undergraduate education programs are a vital partner of the construction industry. Graduates of undergraduate programs who work in the construction industry design, engineer, construct, operate, and maintain our nation's physical infrastructure. Undergraduate programs teach students the fundamental concepts and practices needed to create and operate the infrastructure and shape their personal development as professionals ready to enter, contribute to, and eventually lead the industry. The formative influence that university education has on students contributes to their identity as an architect, engineer, constructor, operator, or maintainer and ultimately to their personal success throughout their career and the success of the AEC industry. It is with this overarching and critical influence in mind that focused attention is given to the content and quality of university undergraduate education programs across the country.

It should be noted that reference to the AEC industry herein is intended to incorporate all aspects of planning, design, engineering, procurement, construction, operation, and maintenance associated with our built environment. Therefore, references to the AEC industry include architects, engineers of all disciplines, constructors, operators, maintainers, and their associated undergraduate education programs. Also, the term "construction industry" is used in these proceedings to refer to the AEC industry.

At their foundation, architecture, engineering, and construction are about human health and safety. The construction industry provides the means necessary to establish and maintain safe and healthy communities – a prerequisite for people to exist, thrive, and prosper. Moreover, the attention to safety and health is all-encompassing; it targets everyone who constructs, uses, operates, maintains, and is exposed to all the different types of physical infrastructure and in all of their forms.

Given its importance, safety, health, and welfare of the public is commonly held as the top value and goal of professions. The Code of Ethics of the National Society of Professional Engineers (NSPE), for example, states that "Engineers, in the fulfillment of their professional duties, shall: (1) Hold paramount the safety, health, and welfare of the public" (NSPE, 2019). Placing the safety, health, and welfare of the public first and foremost shapes both the standards to which design and construction adhere and the overriding culture throughout the industry. Overlapping the comprehensive and critical integration of safety and health into all aspects of the construction industry with the influence of education on architects, engineers, and constructors suggests that safety and health should be an integral part of undergraduate education programs. Additionally, as the top priority, safety and health should be the first content included, and given the greatest attention, within academic curricula.

The safety performance of the AEC industry has improved over the past 50 years (BLS 2022). Greater attention to safety in designs, safer construction practices, management and worker training, new technologies, adherence to occupational safety and health standards, and many other safety programs and practices have all played a role in eliminating hazards and preventing injuries and fatalities. Those who work in the industry know how to be safe; zero injuries and fatalities over extended periods of time have been achieved by many organizations. However, the construction industry endures as one of the work industries with the highest rates of injuries and fatalities. While safety and health are unconditionally important and maintain primary importance, consistently achieving zero injuries and fatalities throughout the industry remains painfully confounding. Human behavior, much of which is based on education, training, and the surrounding culture, is identified as the principal issue of concern. The behaviors and decisions of architects, engineers, and constructors continue to be identified as primary causes of injury and fatality incidents. It is clear that changes to current education and training, both in the classroom and on the job, and a re-commitment to professional ethics and a culture of safety, are critically needed.

With these objectives in mind, and the ultimate goal of improving safety performance in the construction industry, the National Academy of Construction (NAC) conducted a series of symposia focused on safety culture within university undergraduate education programs. The symposia series, titled "Introducing and Embedding Safety Culture Concepts in Undergraduate Education," explored and promoted teaching the principles, practices, and value of safety and safety culture in undergraduate education programs in the U.S. Many construction industry executives, managers, and supervisors currently in charge of design and construction graduated from educational programs that did not explicitly teach the principles, practices, and value of safety and safety culture.

Committed to improving safety in the construction industry, NAC partnered with leading universities and industry practitioners to determine ways to augment the educational knowledge, experiences, and professional identity of graduates to include the critical importance of safety and safety culture. Teaching safety and safety culture to students and creating a culture of safety within academic programs will improve student awareness of and interest in safety and make students more attractive/valuable as entry-level employees. It is anticipated that doing so will ultimately empower graduates to lead and immediately contribute to the industry and their employer in the area of safety. Safety-focused education programs will help graduates influence the organizations they join to create, develop, sustain, and continuously improve the organization's safety culture and safety performance.

These proceedings provide a detailed report on the NAC safety symposia series. The proceedings describe the NAC safety symposia content, provide an analysis of the symposia presentations and discussions, present findings from the analysis, and offer recommendations for a path forward to introduce and embed safety culture concepts in undergraduate education programs. The proceedings also function as a resource for university faculty to reference when determining how best to incorporate safety and safety culture into their undergraduate education programs.

Given that the symposia were sponsored and conducted by NAC, the symposia, and therefore these proceedings, naturally focus on safety in the construction industry and civil and construction engineering education programs. Nevertheless, the findings and recommended practices also apply to other academic programs in other engineering disciplines (e.g., mechanical, electrical, industrial, and chemical engineering) as well as to architecture programs. All educational settings (e.g., in-class and outside class) and topics (e.g., introductory courses, basic science classes, engineering design classes, construction engineering courses, and professional development courses) are considered. In addition, the symposia and proceedings target safety during all phases of infrastructure projects and the safety of all who interact with the projects in all of the phases.

2. SAFETY AND SAFETY CULTURE

Determining how to integrate safety and safety culture into undergraduate education programs requires an understanding of safety concepts and practices along with the nature of the current safety performance in the construction industry. This section provides background information on these topics to support understanding the symposia context, participant perspectives, and proceedings content. Only summary information on the safety-related topics is provided. An in-depth literature search will reveal many references and resources related to safety in the construction industry – too many to include in these proceedings. Readers are encouraged to explore additional literature on the topics to obtain more detailed information.

2.1 SAFETY PERFORMANCE IN THE CONSTRUCTION INDUSTRY

The concern for safety in the construction industry and motivation for improving safety in the industry stems in great part from its safety performance. According to the Bureau of Labor Statistics, the construction industry employed approximately 7.4 million full-time equivalent (FTE) workers in all industry occupations in 2021, the most recent data available (BLS, 2022). This level of employment amounted to approximately 5.2% of the entire employed workforce in the U.S. Unfortunately, the construction industry sustains a much greater percentage of workplace injuries and fatalities in the country. Metrics commonly used to assess safety performance in an industry are the numbers and rates of occupational injuries and fatalities that occur each year in the industry. For the construction industry, these values are quite high relative to other work industries.

The Bureau of Labor Statistics (BLS) reported that 169,200 injuries occurred in the construction industry in 2021, the most recent year in which data is available (BLS, 2023). When normalizing for the size of the industry using the number of full-time equivalent workers in the industry, the annual rate of injuries for 2021 amounted to 2.5 injuries per 100 full-time equivalent workers (BLS, 2023). Figure 2.1 shows how the number and rate of nonfatal injuries in the construction industry have changed from 2006 – 2021. The figure shows a decrease in both the number and rate of injuries over the 15-year time period.

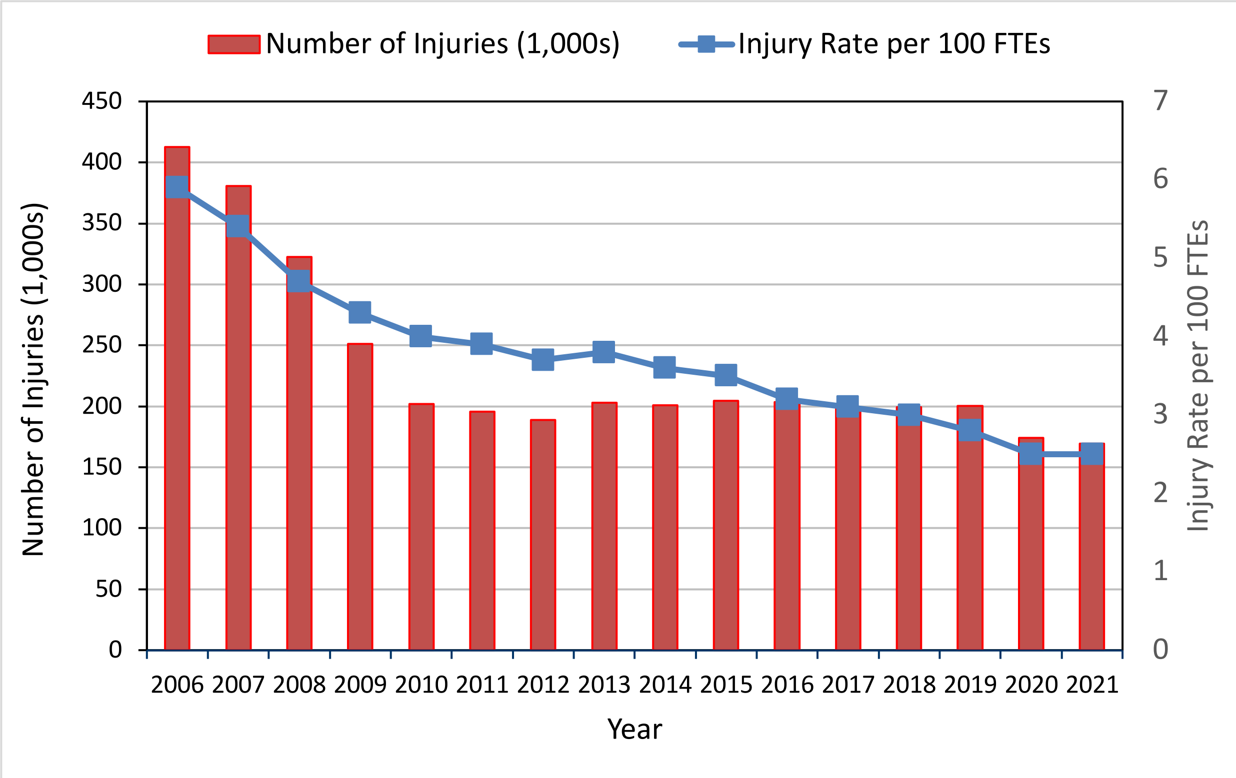

Figure 2.1. Number of Unintentional Nonfatal Recordable Injuries and Injury Rate in Construction Industry, 2006 – 2021 (BLS, 2023)

With respect to fatalities, the construction industry experienced 986 workplace fatalities in 2021, approximately 2.7 fatalities per calendar day and more than any other work industry in the U.S. (BLS, 2023). The annual rate of fatalities in the industry was 9.4 per 100,000 full-time workers in 2021 (BLS, 2023). These fatality statistics are not unique to 2021. Figure 2.2 presents the annual numbers of fatalities and fatality rates for the years from 2006 to 2021. As can be seen in the figure, the number of fatalities in construction has varied from approximately 800 to 1,300 fatalities each year. However, when normalized for the number of full-time equivalent workers in the industry, the fatality rate has remained relatively constant from year-to-year.

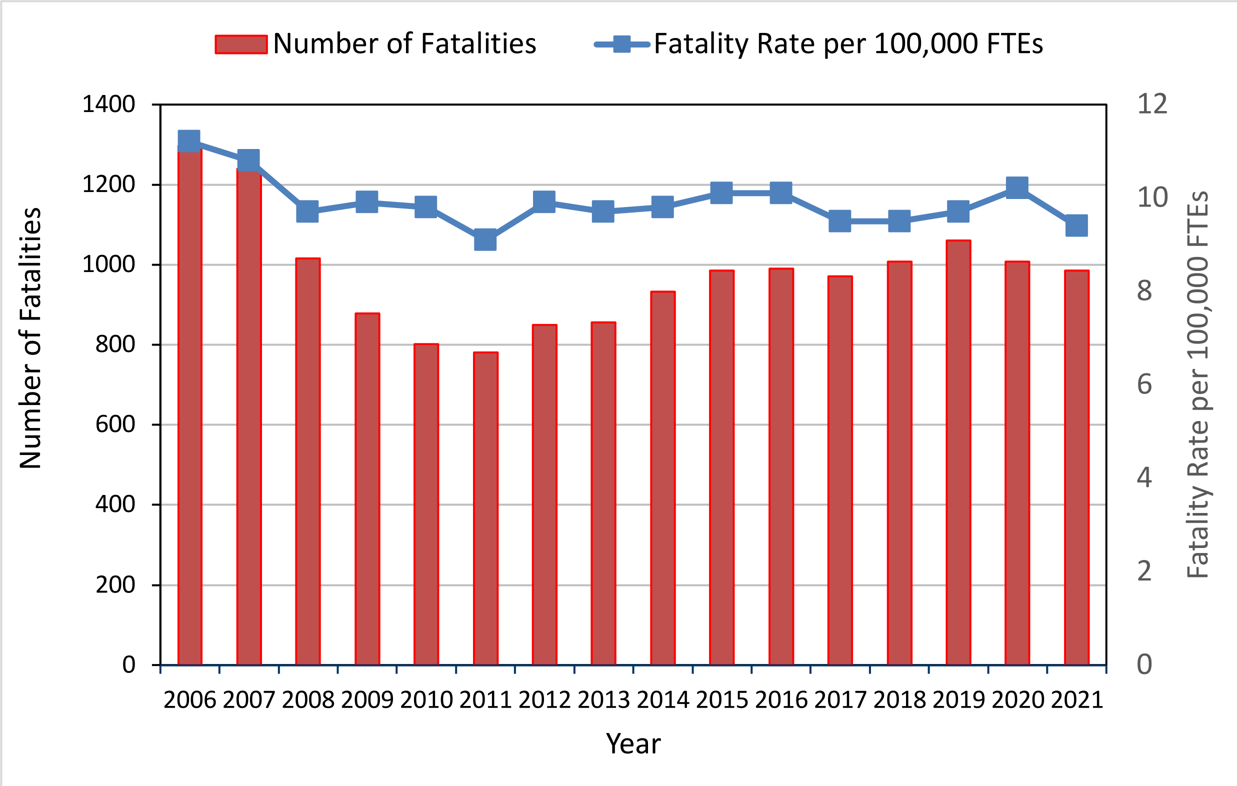

Figure 2.2. Number of Unintentional Fatalities and Fatality Rate in Construction Industry, 2006 – 2021 (BLS, 2023)

How does the safety performance in the construction industry compare to that in other industries? Construction typically experiences high rates of injuries and fatalities compared to similar production-based industries. In fact, the rate of nonfatal recordable injuries in construction is consistently among the highest of all work industries in the U.S. Figures 2.3 and 2.4 show how the construction industry performs with respect to injury rate and fatality rate, respectively, compared with other similar work industries. It is encouraging to see that, compared to fatalities, the recordable injury rate has seen recognizable decreases over the 15-year period.

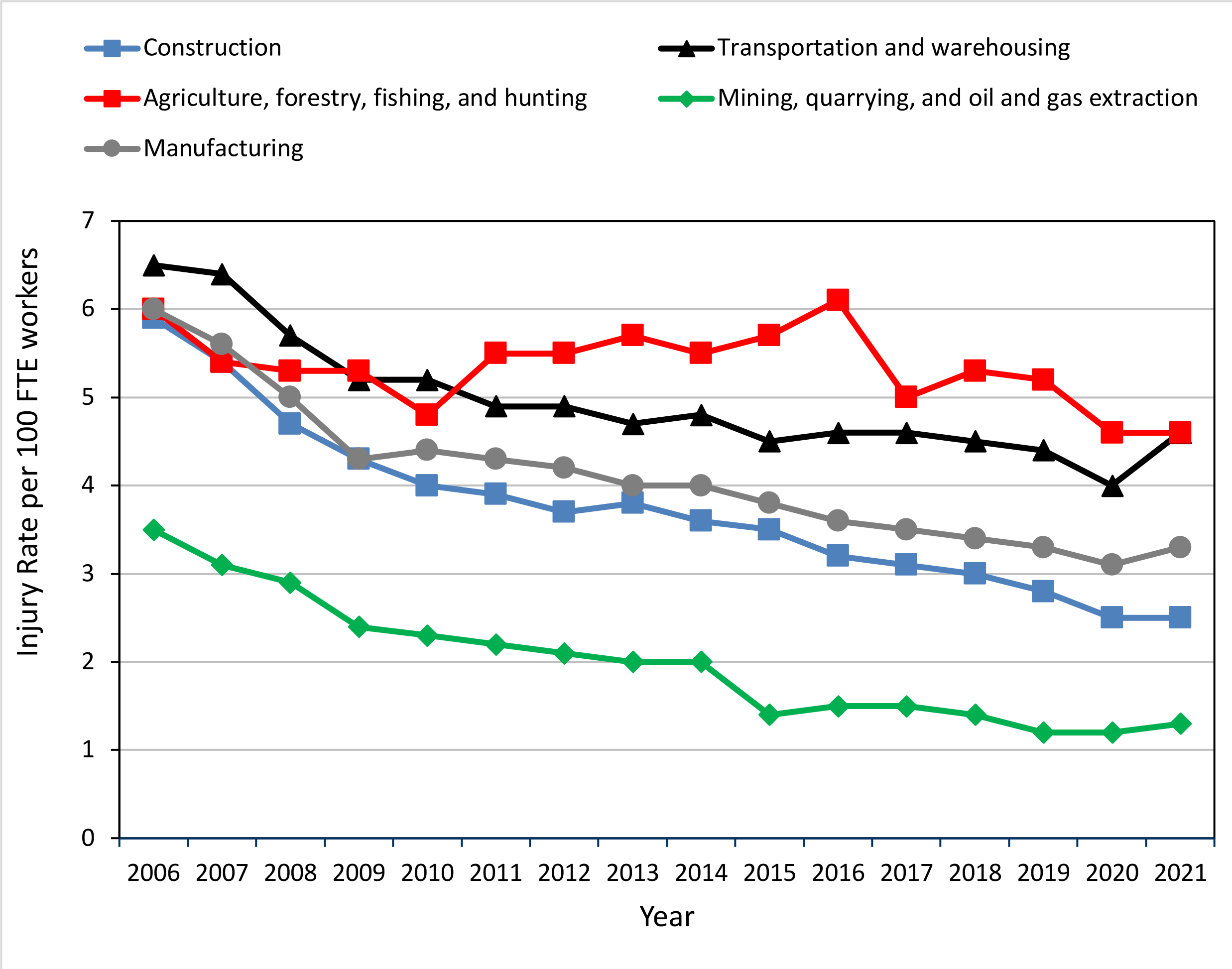

Figure 2.3. Unintentional Nonfatal Recordable Injury Rates in Selected Private Work Industries, 2006 – 2021 (BLS, 2023)

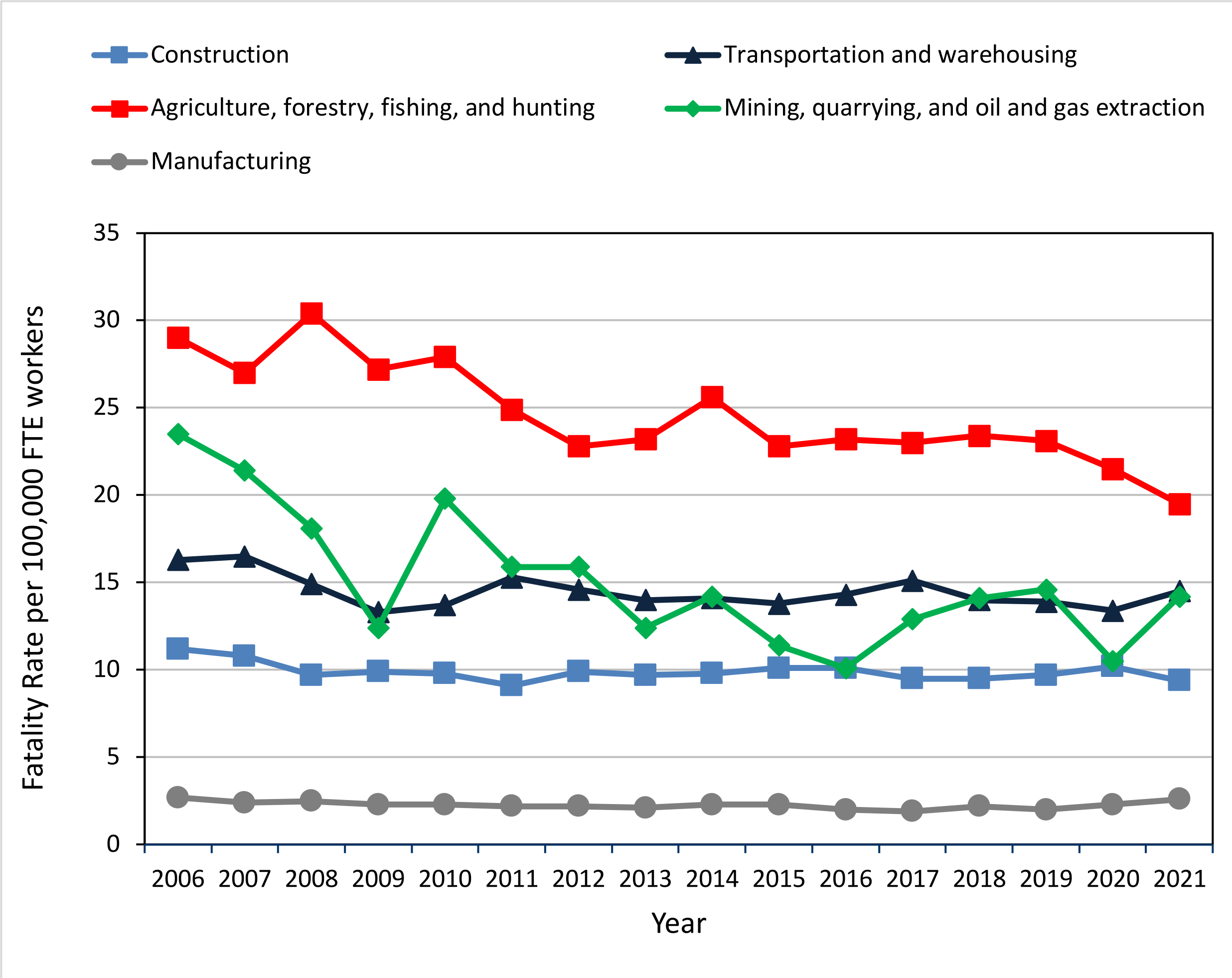

Figure 2.4. Unintentional Fatality Rates in Selected Private Work Industries, 2006 – 2021 (BLS, 2023)

The injury and fatality data presented above are of concern. The data reveal that since 2006, while injury rates have decreased, safety performance in the construction industry has relatively plateaued for fatalities, a result that is confounding and disappointing. The industry has greatly increased attention to safety. Safer work practices and technologies, increased expectations about safety behavior on the job, greater incentives to prevent injuries and fatalities, and increased safety training have occurred over the last 17 years. However, safety performance with respect to fatalities appears to remain approximately the same. Additional efforts are needed to improve safety performance.

2.2 SAFETY PRACTICES

Like many other industries, the construction industry dedicates a significant amount of resources to safety and implements a wide range of safety practices. The practices are intended to eliminate hazards, reduce worker exposure to recognized hazards, provide safety training, and prevent injuries/fatalities associated with the hazards. Adherence to the governing occupational safety and health standards is a minimum. Chapter 29 of the Code of Federal Regulations (CFR) contains the Occupational Safety and Health Administration (OSHA) standards. Part 1926 of 29 CFR, *Safety and Health Regulations for Construction*, provides the minimum requirements for employee safety on construction sites (OSHA, 2023a). Similarly, safety standards for general industry are contained within *Part 1910 – Occupational Safety and Health Standards* (OSHA, 2023b). A thorough understanding of the safety requirements associated with a particular work task and implementation of the required safety precautions while performing the task are needed to ensure a minimum level of safety on the job.

It is commonly known that additional attention to safety and the implementation of additional safety practices beyond that required by OSHA are needed to prevent injuries and fatalities. Organizations must establish and sustain an outstanding safety culture. Companies typically develop and implement safety management systems within their organization to guide employees on the safety and health expectations and requirements. Safety management systems include the selected practices (at least as stringent as that required by OSHA) to be implemented by the organization to manage and ensure safe work and working conditions. Research has identified a wide variety of beneficial safety practices and their respective impact on safety performance. Safety practices commonly implemented by construction industry organizations are described throughout safety literature (e.g., Hinze et al., 2013; Hill, 2014; Rajendran and Kime, 2013; Findley et al., 2004; and CII, 2002). Some examples of construction industry safety practices include:

- Developing a site-specific safety and health plan/manual
- Prequalification of contractors/subcontractors based on safety
- New employee safety orientation and training
- Safety leadership training for supervisors
- Addressing safety during constructability reviews
- Prevention through design
- Owner involvement in safety
- Management commitment to safety
- Staffing for safety
- Heavy equipment safety inspection and approval program
- Lock-out/tag-out policy and program
- 100% personal protective equipment (PPE) policy
- Stop work authority
- Emergency response plan
- Pre-task planning
- Job-hazard analyses
- Worker involvement in hazard assessment and mitigation
- Safe behavior recognition program
- Injury, fatality, and near miss investigation program
- Daily/weekly safety toolbox meetings
- Workplace substance abuse program

Each safety practice is intended to target a specific objective of the safety management system and the factors that have been shown to contribute to injuries and fatalities. Employee education and training are especially important elements of safety management systems. In addition to the employees who perform the work, those who plan, manage, and oversee the work need to understand the jobsite hazards and how to work safely. Possession of the needed safety knowledge and skills must be present when employees begin working. Therefore, education and training programs designed to prepare future industry employees should include content on safety practices and safety culture to make sure that program graduates are prepared from day one of their employment.

2.3 SAFETY CULTURE

An overarching goal of safety management systems is to create a positive safety culture within an organization. There are many definitions of organizational culture and safety culture (Al-Bayati et al. 2019). Organizational culture represents the patterns of interacting elements that characterize the accumulated learning of a group – the ways of thinking, feeling, and perceiving the world that have made the group successful (Schein, 1999). It represents "the way we do things around here." Safety culture is a subset of an organization's overall culture and is widely known to influence employee behavior related to safety and, ultimately, the organization's overall safety performance (Al-Bayati, 2021a; 2021b; Fernandez-Muniz et al., 2007; Morrow et al., 2014; Clarke, 2006; Alruqi et al., 2018; Molenaar et al., 2009). The NIOSH National Occupational Research Agenda (NORA, 2008) indicates that an organization's safety culture is revealed in the organizational principles, norms, commitments, and values related to the operation of safety and health in the organization. It has also been defined as the aggregate sentiment towards safety that is created by the individual and group behaviors and attitudes within an organization (Fang, 2006). Safety culture influences the commitment to, and style and proficiency of, an organization's safety system and how its personnel act and react in terms of day-to-day safety practices and behaviors (Fang, 2006).

It is important to remember that employees assess an organization's safety culture, and the safety culture on a particular project, quickly and intuitively based on their first impressions (Hartley and Cheyne, 2010). The interpreted safety culture immediately affects the new employee's behavior with respect to safety. This initial affect is critical given the high rate of injuries experienced by new employees. Employers should establish a positive safety culture at the start of employment and the start of a project, and continuously promote and reinforce the expected safety culture.

Safety climate is closely related to safety culture. According to the Center for Construction Research and Training (CPWR, 2023), safety climate refers to the shared perceptions within an organization of the adequacy of the safety and health programs and the consistency between the organization's espoused safety policies/procedures and the actual conditions at the jobsite. As opposed to the actual elements implemented, safety climate represents the workers' collective perception of those elements, and the role of safety in the workplace and their attitude toward safety (Chen and Jin 2013). Figure 2.5 provides a helpful description of the relationship between safety culture and safety climate, the involvement of different groups of employees within an organization, and how safety culture/climate interacts with the safety management system.

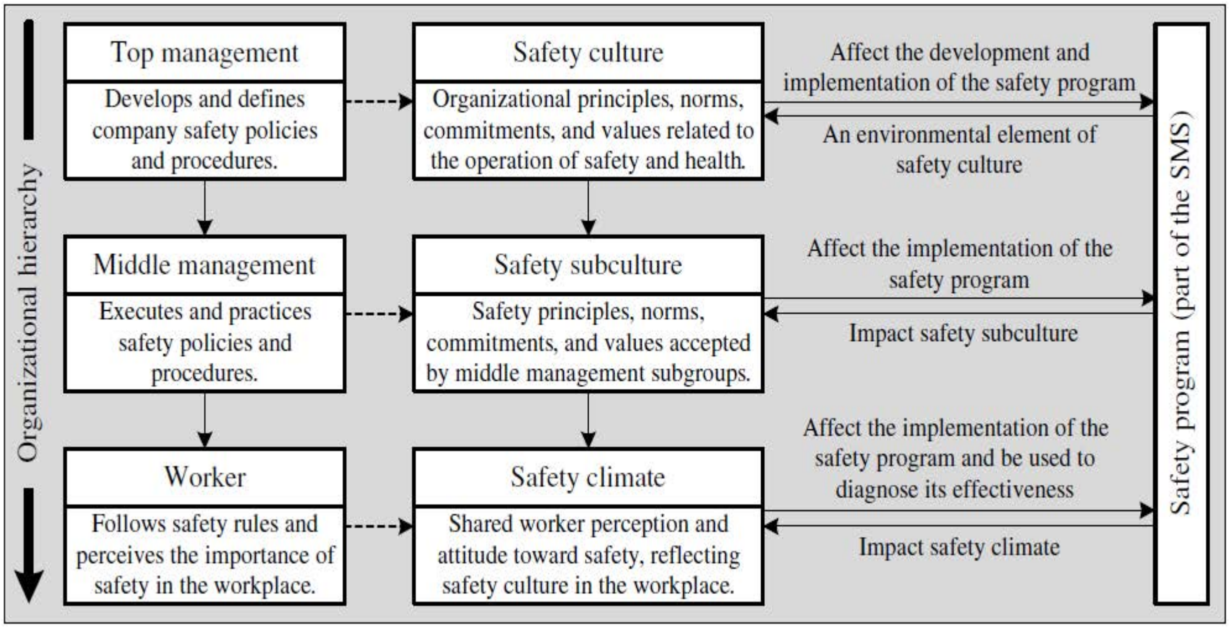

Figure 2.5. Relationship between Safety Culture and Safety Climate (Chen and Jin, 2013)

Given the difficulties in measuring culture, safety climate is commonly used as a proxy for safety culture. Safety climate is assessed through employee perception surveys to gauge safety culture in an organization. To determine the safety culture within an organization, CPWR recommends assessing the following eight indicators of safety climate (CPWR, 2023):

1. Demonstrated management commitment
2. Alignment and integration of safety as a value
3. Accountability at all levels
4. Supervisory leadership
5. Empowerment and involvement of employees
6. Communication
7. Training at all levels
8. Owner/client involvement

Actively engaging in activities that promote the safety climate indicators listed above is intended to create a culture of safety. The goal of the activities is to create mutual respect and trust among team members, remove fear and intimidation when speaking out on safety issues, and develop a collective mindfulness amongst employees to be aware of safety hazards to themselves and others. Meeting this goal will create a culture of safety by enhancing employee empowerment and engagement with respect to safety (Frankel et al., 2006; Reason, 2010). Characteristics of positive safety cultures include (Ostrom et al., 1993):

- The value of and belief in occupational safety are deeply and widely shared within the organization.
- Workers have particular patterns of attitudes and beliefs regarding safety practices.
- Workers might be alert for unexpected changes and ask for help when they encounter an unfamiliar hazard.

- Workers seek and use available information that improves safety performance.
- The organization has a safety management system in place, and this system is applied when performing all activities and reviewed regularly.
- The organization encourages and rewards individuals who call attention to safety problems and who are innovative in finding ways to locate and assess hazards.
- The organization has systematic mechanisms to gather safety-related information, measure safety performance, and bring people together to learn how to work more safely.

Different organizations can exhibit different levels of safety culture depending on the attitudes and actions of the organization's employees towards safety. Table 2.1 presents examples of levels of safety culture that an organization can exhibit. The complexity and nature of the construction industry can also cause multiple cultures to exist within different parts of an organization, on a single project, and in the industry as a whole. Each culture forms around different groups composed of individuals with commonalities (Sackman, 1997). The correlations between safety performance and the safety cultures at different levels, e.g., crew, project, and organization levels, are well-known (Schein, 2010). An employee's viewpoint about safety and ultimately their actions towards safety are influenced by the safety cultures within the organizational and industrial communities in which they exist. It is these aspects of safety culture, in conjunction with the influences that education has on new employees and the desire to improve safety performance in the construction industry, that constitute much of the motivation for the safety symposia.

Table 2.1. Levels of Culture (Adapted from Schein, 2010)

Level	Values	Appearances	Authentic?
1	Artifactual values: What people say they value or how values appear (the aspect of culture that can be seen)	Example: Company logo with a green safety cross embedded in it	Not clearly congruent with actual values, but could still be authentic
2	Stated values; espoused values (the aspect of culture that can be heard)	Example: Policy stating "no tolerance for drug use at work"	Not clearly congruent with actual values, but could still be authentic
3	Actual values (the aspect of culture that is lived)	Example: Intervention; actively stopping an unsafe act without being told to do so	Congruent and authentic leadership

3. UNDERGRADUATE EDUCATION PROGRAMS

To understand how to introduce and embed safety culture concepts in undergraduate education, knowledge of the content, drivers, and resources typically present in undergraduate education programs is required. A variety of different types of 2- and 4-year architecture, engineering, and construction programs are present within educational institutions throughout the U.S. While the programs typically strive to meet standardized accreditation requirements, each program is unique. This section provides a summary of typical undergraduate education program content and accreditation needed to identify opportunities to enhance safety culture in the programs. Given that the fields of civil engineering, construction engineering, and construction management were the common target of the symposia discussions, the section only focuses on undergraduate education programs in these disciplines, and primarily 4-year undergraduate programs.

3.1 PROGRAM CONTENT

Undergraduate programs commonly provide a wide variety of learning experiences for students, both within the classroom and outside the classroom. First and foremost, the programs are designed to educate incoming students in their chosen field of study. Program objectives commonly include other objectives as well, such as to prepare and assist students to join the workforce, assist with professional skill-building and personal development, provide a well-rounded education, and instill a desire for life-long learning. Actual formal program content and organization of the content within the program are generally similar from one university to another. However, variances exist between universities. Provided below are descriptions of typical program content present within civil engineering (CE), construction engineering (ConE), and construction management (CM) programs.

3.1.1 In-Class

Course topics covered in the classroom typically start in the first and second years with foundational courses on science, math, writing, social sciences, basic computer applications (e.g., Excel, MathCad, and programming tools), and computer drafting, plus a course(s) that supports exploring different majors and prepares students to be successful at the college level. Statics, strength of materials, and dynamics is a common course series taken in the second year. Towards the end of the second year, students typically start taking courses more specific to their chosen major, which for civil and construction majors may include courses such as surveying, engineering economy, geographic information systems (GIS), and additional computer applications (e.g., AutoCAD and Revit). Classes in the third and fourth years are very focused on a particular major and go into significant detail on the course topics. A capstone course is commonly included in the fourth year which is designed to bring all of the learned material together and connect the content learned to a real-world project. Depending on the nature of the content, courses throughout the curriculum may be offered via lectures, recitations, labs, or a combination of these. Classes may meet from 1 to 4 or more hours per week over 1 or more days in the week. The programs are typically set up for students to take 4 or 5 courses each semester in order to graduate within 4 years.

The third and fourth years of undergraduate programs are filled with in-depth, major-specific coursework. CE programs contain multiple courses on the analysis and design of the different parts of civil infrastructure. Examples of common CE course topics include engineering materials (concrete, steel, wood, masonry), fluid mechanics, hydraulics, soils/geotechnical engineering, structural analysis, concrete and steel structure design, transportation engineering, environmental engineering, and engineering planning. In ConE programs, students also typically take some version of these classes, as well as courses on construction-related topics such as temporary structures, heavy civil/equipment, estimating, scheduling, mechanical/electrical facilities, building construction, and project management. Lastly, CM programs are typically lighter on the design courses, require the same construction courses as in ConE programs, and add in business management courses such as accounting, human resources management, and business law. ConE and CM programs also typically contain a required class on safety, while a safety class may be available as an elective in CE programs.

3.1.2 Outside Class

Student engagement and involvement occurs to a great extent outside the classroom as well. Academic departments commonly host student chapters of industry associations such as the American Society of Civil Engineers (ASCE), Associated General Contractors of America (AGC), Institute of Transportation Engineers (ITE), Engineers without Borders (EWB), Design-Build Institute of America (DBIA), and many more. Students voluntarily participate in one or more of the student chapters. Internship and/or co-op programs are common also. In some programs, one or more internships are required. Whereas in other programs, participation in an internship or co-op experience may be encouraged and supported, but there is no requirement or credits given towards graduation. Many other events take place throughout the school year in which students are encouraged to participate, such as presentations from industry, field trips to project sites, inter-university competitions (e.g., the ASCE concrete canoe competition and the Associated Schools of Construction (ASC) student competition), special topic lectures, and career fairs. All of the opportunities are designed to engage and motivate students, create an inviting community, and develop professional skills and connections. Beyond the student's academic department, universities have a wide variety of opportunities for student involvement in clubs, sports, lectures, and many other group and individual activities.

3.2 PROGRAM ACCREDITATION

Accreditation is third-party certification that an academic program meets specified educational standards. Universities seek accreditation for a variety of reasons. For example, accreditation confirms that the quality of the academic program is on par with that of other peer institutions. Accreditation also helps attract students who wish to pursue a career, license, or certification that requires graduation from an accredited program. The two main types of accreditations are institutional-level accreditation (e.g., the entire university and the Graduate School within the university) and programmatic accreditation. Programmatic accreditation is typically at the major area of study level; each major typically carries its own accreditation. Undergraduate programs are accredited separately from graduate programs. University programs are accredited for a defined period of time, e.g., 6 years, after which the programs undergo an in-depth re-evaluation for renewal of the accreditation.

Engineering programs in the U.S. are predominantly accredited by the Accreditation Board for Engineering and Technology (ABET). ABET is a non-governmental organization that accredits post-secondary education programs (https://www.abet.org/). Accreditation is earned through various ABET commissions. The ABET Engineering Accreditation Commission (EAC) accredits engineering programs at the Bachelors and Masters levels. The Engineering Technology Accreditation Commission (ETAC) accredits engineering technology programs at the Associate (2-year degree) and Bachelors (4-year degree) levels.

Focusing specifically on baccalaureate level programs, ABET maintains General Criteria for Baccalaureate Level Programs along with Program Criteria that are discipline-specific (https://www.abet.org/accreditation/accreditation-criteria/criteria-for-accrediting-engineering-programs-2023-2024/). For example, CE programs must satisfy the General Criteria for all baccalaureate programs and the Program Criteria for Civil and Similarly Named Engineering Programs. The General Criteria for all disciplines contain requirements in the following eight categories: (1) Students, (2) Program Educational Objectives, (3) Student Outcomes, (4) Continuous Improvement, (5) Curriculum, (6) Faculty, (7) Facilities, and (8) Institutional Support. ABET relies on lead professional societies to establish the Program Criteria. For civil engineering, the lead society is the American Society of Civil Engineers. The present Program Criteria for CE programs are as follows (ABET, 2023):

1. Curriculum

   The curriculum must prepare graduates to apply knowledge of mathematics through differential equations, calculus-based physics, chemistry, and at least one additional area of basic science; apply probability and statistics to address uncertainty; analyze and solve problems in at least four technical areas appropriate to civil engineering; conduct experiments in at least two technical areas of civil engineering and analyze and interpret the resulting data; design a system, component, or process in at least two civil engineering contexts; include principles of sustainability in design; explain basic concepts in project management, business, public policy, and leadership; analyze issues in professional ethics; and explain the importance of professional licensure.

2. Faculty

   The program must demonstrate that faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience. The program must demonstrate that it is not critically dependent on one individual.

ABET also accredits ConE programs, for which ASCE is also the lead society. The current Program Criteria for Construction and Similarly Named Engineering Programs are as follows (ABET, 2023):

1. Curriculum

   The curriculum must include:

   a. Application of:

        i. mathematics through differential and integral calculus, probability and statistics, general chemistry, and calculus-based physics;
        ii. knowledge of construction methods, materials, equipment, planning, scheduling, safety, and cost analysis.
    b. Analysis and design of construction processes and systems in a construction engineering specialty field.
    c. Explanation of:
        i. basic legal and ethical concepts and the importance of professional engineering licensure in the construction industry;
        ii. basic concepts of management topics such as economics, business, accounting, communications, leadership, decision and optimization methods, engineering economics, engineering management, and cost control.

2. Faculty

    The program must demonstrate that the majority of faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience. The faculty must include at least one member who has had full-time experience and decision-making responsibilities in the construction industry.

The American Council for Construction Education (ACCE) is another organization that accredits Construction programs. Construction programs may choose to attain accreditation through ABET or ACCE, or both. ACCE provides detailed standards and criteria for accreditation that address program governance and administration, curriculum, faculty and staff, student policies, physical resources, financial resources, industry/alumni/public relations, and academic quality planning process and outcome assessment (ACCE, 2023). ACCE accreditation requirements and procedures are generally similar to those established by ABET.

To what extent is safety included in the accreditation requirements? Inclusion of safety, and the nature in which safety is included, varies depending on the accrediting organization and program being accredited. Table 3.1 provides a summary of how safety is explicitly included in the present ABET and ACCE accreditation requirements for CE, ConE, and CM baccalaureate programs. Safety is also presently included in the ABET Program Criteria for Fire Protection Engineering and Mining Engineering programs.

For a further discussion of accreditation requirements, including those in other engineering disciplines and architecture, please see Ud Din and Gibson (2019).

Table 3.1. Safety in ABET and ACCE Accreditation Requirements for CE, ConE, and CM Baccalaureate Programs (ABET, 2023; ACCE, 2023)

Accreditation Organization	Criteria / Program	Safety currently included?	Description
ABET	General Criteria	Yes	Student Outcome #2: An ability to apply engineering design to produce solutions that meet specific needs with consideration of public health, safety, and welfare…
ABET	Program Criteria / CE	No*	N/A
ABET	Program Criteria / ConE	Yes	The curriculum must include application of knowledge of safety.
ACCE	Construction Programs	Yes	Upon graduation, all graduates shall be able to create a construction project safety plan.

* The ABET CE Program Criteria are in the process of being revised by ASCE. The proposed revised criteria include the following statement: *The curriculum must include explanation of professional attitudes and responsibilities of a civil engineer, including licensure and safety*. If adopted by ABET in fall 2023, the new program criteria will be applied for accreditation reviews starting with the 2024-25 accreditation review cycle.

3.3 PROGRAM DRIVERS AND MOTIVATING FACTORS

The pace of change in undergraduate education programs may be considered slow compared to that in industry; however, the content and nature of programs are dynamic. Changes are made in response to university, accreditation, industry, faculty/staff, student, community, and other influences. University resources, strategic plans, and policies affect the hiring and development of faculty to teach courses and conduct research. While maintaining sufficient capacity across all programs, universities commonly promote specific educational programs that tie closely to strategic initiatives (e.g., healthy communities, technological innovation, and environmental justice) and university strengths. Additional funding is made available on a competitive basis to programs that closely align with university strengths and strategic topic areas. Universities also typically mandate a suite of course topic areas that all students must take to ensure a comprehensive education. These baccalaureate core courses commonly include at least introductory courses in science, math, writing, social science, health, and other general education topics.

As mentioned above, accreditation standards place requirements on education programs. In fact, accreditation is one of the primary drivers of course content and programmatic decisions. Program administrators and faculty/staff place great importance on, and take significant effort to attain, accreditation for their degree programs. Changes to accreditation requirements will result in corresponding changes to education programs.

Most CE, ConE, and CM undergraduate programs convene an industry advisory board (IAB) for the entire department and/or each individual program. IABs are typically composed of representatives from industry who work in fields related to the program topics and hire program graduates. IAB members are also usually alumni of the programs. As part of periodic meetings with the IAB, program administrators keep the IAB abreast of the program status, needs, and performance, and solicit input and suggestions from the IAB. While incorporating IAB input is not a requirement, feedback received from the IAB is used to guide programmatic decision-making and changes to support industry's needs and preferences.

Programmatic content, both in and outside the classroom, is also affected by the faculty themselves. A faculty member's educational background, work experiences, and field of research influence the classes they teach and, to a certain extent, the content which they choose to include in the classes. Required undergraduate courses typically must include specified content to meet accreditation and departmental requirements; however, there is leeway in terms of additional content that can be provided and the way in which the content is communicated. As a result, the "flavor" of a class may be different from one instructor to another.

Faculty are also greatly motivated by the demands placed on them by their faculty position description. Faculty position descriptions typically include a distribution of teaching, research, and service. Instructor/lecturer positions predominantly include teaching and perhaps some level of service to the university and to the profession (e.g., participation on university and/or professional association committees). For example, an instructor/lecturer position description may specify 90% teaching and 10% service. As a result, instructors/lecturers may teach 4 to 6 or more classes per year and not get involved in any research. Employment for instructors/lecturers is commonly based on a 9-month (academic year), non-tenure-track contract that is renewable each year. Promotion to higher positions within the university (e.g., Senior Instructor) is commonly based on performance in the classroom and contributions to the educational mission of the university.

Conversely, tenure-track faculty typically have a research component within their position. For example, a tenure-track faculty position description may specify 50% teaching, 40% research, and 10% service. As part of their research commitment, tenure-track faculty are expected to develop an externally-funded research program, oversee and advise graduate students, and publish scholarly works (e.g., journal and conference papers). Research-active faculty typically teach 3 to 4 courses per year. Most tenure-track faculty in colleges of engineering have 9-month appointments; they are paid over the academic year (9-months) and then in the summer pay themselves salary from research grants that they acquire. Promotion to a higher academic position and receipt of tenure are commonly based on the faculty member's performance, contributions, and long-term promise with respect to teaching, scholarship/research, advising, and service.

In faculty annual reviews and in promotion and tenure decisions, the relative weights placed on teaching, research, and service can vary between universities and between programs within a university. Universities that have teaching as their primary mission typically put greater emphasis on the performance in the classroom and demonstrated effectiveness in teaching. In research-intensive universities, teaching performance is considered in promotion and tenure decisions, yet research and scholarly activity performance is a primary factor. Tenure-track faculty are expected to demonstrate achievement in scholarship and creative activity that establishes the individual as a significant contributor to the field or profession and creates distinction. Both non-tenure track and tenure-track faculty are motivated to a great extent by both their position descriptions and the criteria established for promotion and tenure.

Many universities also have established additional requirements for faculty with respect to collegiality and diversity, equity, and inclusion (DEI). Faculty are evaluated with respect to the extent to which they are a collegial member of their unit and perform appropriate service that contributes to the effectiveness of their department, college, the university, and their profession. With respect to DEI, faculty are expected to promote DEI in the classroom and in their scholarly activities and service. A faculty member’s performance with respect to collegiality and DEI is typically evaluated during annual reviews and when being considered for promotion and tenure.

From the discussion above, it is clear that both tenured/tenure-track faculty members and teaching faculty members have many expectations and responsibilities competing for their time and many competing requirements, priorities, and activities, thus making safety culture one of many items that could be a focus. Putting an emphasis on safety culture as part of their responsibilities and prioritizing it as one of importance will go a long way toward its emphasis in curricula and undergraduate education programs.

4. THE SYMPOSIA SERIES

With the overall goal of improving safety in the construction industry, the NAC symposia series engaged with academic institutions and industry to promote knowledge of safety practices and safety culture concepts in undergraduate education programs and explore ways in which safety culture can be enhanced in program curricula. The anticipated outcome from programs that incorporate safety and safety culture into student experiences is graduates who are of greater value to the industry as a result of their knowledge of, and attitude toward, safety, and who are ready for the industry leadership roles they will fill in their careers. Educational programs focused on safety will help program alumni influence organizations they join to create, develop, sustain, and continuously improve the organization's safety culture. Ultimately, it is expected that inclusion of safety and safety culture concepts in undergraduate education programs will help the industry achieve fewer injuries and fatalities.

The NAC identified the following questions to guide the development, content, and delivery of the symposia series:

1. What is the current status of safety education in the universities represented at the symposium (e.g., in what classes is safety taught, what programmatic efforts related to safety are present, in what academic units is safety covered)?
2. What are examples of how safety is included in classes and in out-of-class student activities?
3. What barriers to increasing safety content in undergraduate education are present?
4. What are the expected benefits of increasing safety practices and safety culture content in undergraduate education?
5. What resources are needed to incorporate safety topics into undergraduate programs?
6. How can industry assist with enhancing safety within undergraduate programs?
7. What are industry's (constructors, engineering firms, owner organizations) expectations/requests to educators with respect to safety?
8. What was learned in the symposia about a way forward to encourage learning about safety in undergraduate education?
9. What are three (or more) recommendations for integrating safety into undergraduate education?

NAC formed an organizing committee composed of NAC members to conduct and shepherd the symposia series. The committee oversaw the selection of the symposia locations, partner universities, sponsorships, and symposia agenda. Organizing committee members also attended one or more of the safety symposia.

4.1 SYMPOSIA HOSTS AND LOCATIONS

The symposia series consisted of five symposia held at selected locations across the U.S. The symposia were hosted by NAC members in partnership with universities in each location. Table 4.1 presents the symposia locations, host universities, and dates. Host universities and locations were selected based on the affiliations of those NAC members interested in leading the symposia and the proposed geographic locations of the symposia. NAC desired to hold symposia in multiple regions around the country to engage a wide spectrum of universities and industry partners.

Table 4.1. Symposia Date, Host University, and Location

No.	Date	Host University	Location
1	08/18/2022	University of Kansas (KU)	Lawrence, KS
2	10/21/2022	Worcester Polytechnic Institute (WPI)	Worcester, MA
3	11/30/2022	New Jersey Institute of Technology (NJIT)	Newark, NJ
4	01/12/2023	The University of Texas at Austin / Texas A&M University	Houston, TX
5	02/09/2023	University of Colorado at Boulder	Boulder, CO

4.2 SYMPOSIA STRUCTURE, CONTENT, AND PARTICIPANTS

The symposium organizers were given the freedom to structure and organize their symposium as they saw fit. Each symposium organizer identified and invited presenters and panelists to participate in the symposia and established the symposium agenda. The organizers as a whole chose to maintain a common structure and content amongst the symposia to provide consistency and to facilitate follow-up evaluation of all symposia.

Each symposium included a day-long agenda filled with individual and panel presentations by academic and industry leaders in the field of construction. Table 4.2 provides an example agenda. Former NAC President and CEO Wayne Crew started each symposium by describing the need for improving safety in the industry and NAC's motivation for focusing on safety culture within undergraduate academic programs. Next, each symposium typically included presentations (individual and panel) from high-level industry practitioners regarding safety culture in their organizations and what they look for in new hires with respect to safety. After hearing from industry, the agendas included individual and panel presentations from educators about their current and planned efforts to include safety and safety culture in program curricula and how the effort can be enhanced in their programs. The symposia followed with breakout group discussions amongst all of the attendees to brainstorm additional ways to teach the concepts of safety and safety culture within academic programs and how industry can support the effort. Lastly, the symposia leaders provided summary recommendations from the breakout group discussions and proposed next steps to support greater inclusion of safety and enhanced safety culture concepts in undergraduate education programs.

Table 4.2. Example Symposium Agenda

Time	Agenda Item	Presenter / Panelists
8:30 – 9:30am	Light breakfast / Networking	
9:30 – 9:45am	Welcome to the Symposium	University Host and Symposium Moderator
9:45 – 10:00am	Introducing the Opportunity • Safety moment • Symposium structure • Construction industry safety statistics • Critical need to implement safety concepts and safety culture • Role/contribution of undergraduate education	NAC Past-President and CEO
10:00 – 10:30am	Keynote #1: A Construction Company Perspective • Benefits of a positive safety culture • Industry's expectation of recent graduates	Construction industry executive (e.g., Company president or CEO)
10:30 – 11:15am	Panel #1: Safety Culture and the New Graduate • Industry representatives describe their culture of safety and what they need in new graduates	Panel of 3-5 industry professionals involved in project delivery, employee oversight, and student recruitment
11:15 – 11:30am	Break	
11:30am – 12:00pm	Keynote #2: A Dean's Perspective • Understanding of industry needs • Curriculum and staff constraints • Ability to meet industry's requirements	Dean of the College of Engineering or similar college at the host university
12:00 – 12:45pm	Panel #2: Including Safety Culture Concepts in Existing Academic Programs • Academic representatives describe how they have incorporated and integrated safety concepts into their course material and programs, or how they might do so	Panel of 3-5 educators involved in undergraduate education programs

12:45 – 1:45pm	Lunch, with lunch speaker	Academic or Industry representative
1:45 – 3:15pm	Breakout Discussion Session • Creating culture vs. teaching procedure • Providing help to educators • Leveraging the results of the symposium	Symposium attendees separate into groups of approximately 6-8 people per group to discuss the discussion topics
3:15 – 3:30pm	Break	
3:30 – 4:30pm	Summary report of breakout group discussions to all attendees, followed by open discussion	Breakout group moderators
4:30 – 4:45pm	Next Steps	NAC Past-President and CEO
4:45 – 5:30pm	Social hour / Networking	

Each symposium included one or more breakout group sessions that allowed for in-depth discussion of the symposium topics. Attendees were typically assigned to specific breakout groups based on their title and role (e.g., educator or industry practitioner) to ensure a diverse mix of participants in each breakout group. Selected attendees were asked to volunteer as breakout group moderators to oversee the discussions and report the results to the group at large. The breakout groups were also given a list of questions to guide their discussion. A sample of the discussion questions is provided below:

1. What did you take away from the keynote addresses and panel discussions?
2. How do we create culture vs. just teaching procedures?
3. What kind of help do educators need?
4. How do we leverage the results of this workshop?
5. How can higher education help in the promotion of safety culture?
6. What are the industry's needs?
7. How big is the issue of safety culture in the construction industry?
8. How does industry value incorporating safety culture concepts in undergraduate education?

5. RESULTS

Following the completion of the symposia, the organizing committee analyzed the symposia content and discussion comments to identify overarching themes and recommendations for the path forward. The symposia presentations and panel discussions were video-recorded and transcribed for analysis. Hardcopies of breakout group comments were also collected and analyzed. This section presents the results of the symposia series including summary descriptions of the attendees, presentations, and discussion comments.

5.1 SYMPOSIA ATTENDEES

The symposia were well-attended by both education (faculty, staff, and students) and construction industry professionals. A total of 245 people attended and participated in the five symposia, representing 45 universities and 94 construction industry companies and organizations from across the country. Details of the symposia attendance are provided in Table 5.1.

Table 5.1. Symposia Attendance

No.	Symposium location	Attendees (presenters, panelists, and participants)			# of universities represented	# of industry organizations represented
		Academic	Industry	Total		
1	Lawrence, KS	41	26	67	18	21
2	Worcester, MA	16	17	33	6	17
3	Newark, NJ	25	46	71	10	32
4	Houston, TX	14	40	54	7	37
5	Boulder, CO	21	15	36	11	15
	Total*	117	144	261	52	122
	Total without overlap	111	134	245	45	94

* There is overlap between the symposia attendees. Some attendees attended more than one symposium. Also, some universities and industry organizations were represented at more than one symposium.

5.2 SUMMARY OF PRESENTATION AND DISCUSSION COMMENTS

Transcripts of the symposia presentations and breakout group discussions were aggregated for analysis. Summary statements made in the presentations and the recorded comments from the breakout discussions were individually entered into an Excel spreadsheet for coding. The review process resulted in approximately 450 unique statements and comments. The following identifiers were then applied to distinguish each statement and comment:

- *Symposia location*: One of the five symposia locations shown in Table 5.1.
- *Breakout group or speaker*: The breakout group number or the name of the presenter.
- *Question ID* (for breakout group discussion questions only): One of the eight breakout group questions listed above.

The names of the contributors of the breakout discussion comments were not recorded during the symposia. A breakout group moderator recorded the comments anonymously and provided the list of comments to the symposia organizers for review and analysis.

Next, the symposia organizers combined all of the statements and comments into one spreadsheet and conducted a detailed analysis using qualitative coding. Qualitative coding involves systematically categorizing qualitative data according to established codes and then utilizing analyses based on the codes to identify themes and patterns in the data. The process began by establishing coding categories representing the desired focus areas for the analysis. The team created the following coding categories:

- *Breakout group topic*: The breakout group topic which the statement/comment relates to
- *Nature of statement/comment*: The academic program and educational process elements addressed by the statement/comment
- *Knowledge area*: The knowledge area or academic discipline targeted by the statement/comment
- *Target safety culture element*: Whether the statement/comment addresses conditions or behaviors
- *Stakeholder*: The people who are affected by the statement/comment
- *Setting*: The location in which the recommended activity is intended to take place
- *Means of instruction*: The means by which the educational content is communicated

The team also established codes within each coding category. Codes were assigned to each statement/comment based on the statement/comment content. Descriptions of the codes in each category and the results relative to each of the coding categories are provided below. The complete list of the statements/comments without overlap is provided in the Appendix.

5.2.1 Breakout Group Topic

The attendees in each symposium were asked to participate in breakout groups to discuss specific topics related to safety culture. As indicated above, the three breakout group topics were: (1) Creating culture vs. teaching procedure; (2) Providing help to educators; and (3) Leveraging the results of the symposium. Each statement/comment was coded with the breakout group topic which it addressed. In some cases, presentation statements were made and breakout group comments recorded that did not fit within any of the three breakout group topics.

Input related to creating culture vs. teaching procedure represented the greatest percentage of comments (35.4% of 454 comments). However, very few comments specifically addressed whether it was better to focus on creating culture or teaching procedure. One participant indicated that it is difficult to “teach” experiences, but students can be exposed to positive experiences. Another participant commented that safety culture should be embedded in a course(s) and not necessarily treated as a separate educational topic. These comments are in line with common viewpoints about how people learn and confirm what the safety culture is in an organization, as indicated in Section 2 above. Participants provided many suggestions regarding how to create safety culture within academic programs. Examples included starting every class with a safety moment, encouraging HSE certifications, promoting co-ops and internships that focus on safety, faculty/staff modeling safe behaviors, and integrating safety into course content on ethics. All of these suggestions help to create a culture of safety without specifically teaching safety culture. Participants also recommended teaching safety concepts in classes. Examples of the recommended safety topics to teach include: the OSHA regulations (e.g., OSHA 10- and 30-hour courses), incident investigation, root cause analysis, and prevention through design, along with many others.

A good portion of the comments (18.5% of 454 comments) described how to provide help to educators. Assistance to educators can be provided in the form of educational resources, such as safety case studies, guest speakers from industry, examples of PPE, and funding to support field trips to construction sites. The participants also recommended enhancing the safety knowledge of instructors. Internships for faculty, safety training, and teaming with industry practitioners on curricula development were some of the examples provided.

Lastly, a small percentage (8.2% of 454 comments) of the comments related to how to leverage the results of the symposia. One idea was to create safety "ambassadors" of symposia participants who can share what they learned at the symposia with other universities. Other examples included creating a safety in education group on social media (e.g., LinkedIn), sharing the results with academic program Industry Advisory Boards, conducting additional symposia at other universities, and encouraging the Board on Infrastructure and the Constructed Environment (BICE) within the National Academies of Sciences, Engineering, and Medicine to conduct a formal study on the topic.

5.2.2 Nature of Comments

The nature of the comment indicates the type of information being transferred by the comment. For example, a comment may be intended to convey a strategy for enhancing safety culture or the comment may identify a resource that would be needed or desired. The codes established within this category were: barrier, character, information, outcome, recommendation, and strategy. A description of each code along with representative examples contained within the comments is provided below:

- *Barrier*: A condition or practice that inhibits incorporating safety into educational programs (16.2% of 454 comments)
    - Examples: Reluctance to change curriculum, lack of interest, lack of safety knowledge, lack of room in the curriculum, and cost and time required for site visits.
- *Character*: The character trait desired in students entering the work force that is related to safety culture (3.7% of 454 comments)
    - Examples: "Soft" skills (e.g., communication), courage to stop work, caring for others, safety of the public is paramount, trust, and not being afraid to ask questions and act.
- *Information*: Supporting information related to safety culture, academia, or related topic (16.8% of 454 comments)
    - Examples: Culture comes from the actions of leaders and starts at the top, procedures are a subset of culture, safety is an operational function, and mental health leads to safety.

- *Outcome*: A desired outcome of enhancing safety culture in educational programs or from the symposia series (4.4% of 454 comments)
    - Examples: Receptiveness (interest, awareness, lifelong learning), resilience, an understanding of the importance of safety, can immediately contribute to safety on jobsites, and respect for craftworkers.
- *Recommendation*: Suggested means for enhancing safety culture in educational programs (41.4% of 454 comments)
    - Examples: Safety in lab assignments, student safety competitions, safety moments at beginning of classes, safety throughout the curriculum, and participation in internships where they learn about safety on jobsites.
- *Strategy*: An overarching approach or tactic for enhancing safety culture in educational programs (17.5% of 454 comments)
    - Examples: Teach people to care, avoid impact to educators, focus on faculty, increase industry exposure to students, and improve attitude towards safety in general and in classes/labs.

The list of the presenter statements and breakout group comments provided in the Appendix is organized according to the nature of the comment.

5.2.3 Knowledge Area

Understanding safety culture in the construction industry requires knowledge of safety, safety culture, and construction. The comments were coded to assess the extent to which the participants focused their input on these knowledge areas. Most of the comments (45.6% of the 454 comments) addressed student learning related to the topic of safety in general. Approximately 21% of the comments provided input related to safety culture, and 5% of the comments related to knowledge of the construction field. In some cases, the comments provided input on more than one of these knowledge areas.

5.2.4 Target Safety Culture Element

Participants provided input with respect to both student knowledge and student behavior. There was agreement that students need to understand safety practices and safety culture. Knowledge about the construction process and environment was also considered important. As indicated above, 71.6% of the 454 comments addressed one or more content areas which students should be knowledgeable about (safety, safety culture, and construction). Many comments (16.8%) focused on behaviors or traits that students need to learn and possess. Examples of desirable student behaviors and traits mentioned by the participants include awareness, respect for field craft, how to connect with their employer and fellow employees, and ethical decision-making.

5.2.5 Stakeholder

The participants recognized that enhancing an understanding of safety culture in educational programs involves both industry and academia. Actions are needed by each group and each group is impacted in some way. Many comments (35.3% of the 454 comments) related to how industry can participate and is affected. For example, industry can provide opportunities for internships that focus, at least in part, on safety. Construction organizations can also help by providing access to projects and project data, develop case studies, and participate in classes. Comments addressed faculty needs and actions as well (58.6% of the comments). As described above, faculty-related comments commonly focused on ways in which faculty can be supported, e.g., guest speakers from industry, examples of PPE, funding to support field trips to construction sites, safety training and internships for faculty, and co-teaching classes with industry.

5.2.6 Setting

Safety culture can be enhanced through activities and actions both inside the classroom and outside of class. Both settings have value and contribute to student learning. Most of the comments (46.1% of the 454 comments) related to safety culture within the classroom setting. Recommendations for outside of class activities were mentioned in 33.8% of the comments. In some cases, the comments related to both in-class and outside class settings, while other comments (e.g., information only and industry-related) did not relate to either setting.

5.2.7 Means of Instruction

Various pedagogical methods are used in academia. Using real-world scenarios, problem-based learning, group discussions, and reflective exercises are examples of different types of pedagogical approaches. Information related to safety culture, whether in or outside the classroom, can be communicated by telling the students and by showing the students. For example, providing a definition of safety culture would be telling, while behaving is a way that demonstrates safety culture would be showing. Describing an example of how safety culture is expressed on the jobsite is another way of showing what safety culture is. Both showing and telling have value and can be used in conjunction to effectively communicate important, complex, and subjective topics. Most of the comments (30.1% of the 454 comments) provided by the participants related to telling the students about safety culture. The participants suggested, for example, to teach HSE management, safety in design, the OSHA regulations, and laboratory safety. Showing is an effective way of teaching topics like safety culture since it relates to how people think, act, and make decisions. Comments provided by the participants that related to showing (13.1% of the comments) suggested activities such as jobsite visits, internships, and safety case studies.

6. ANALYSIS AND DISCUSSION

The transcripts of the presentations and recorded breakout group comments provided an opportunity to answer the questions posed by the NAC regarding safety culture in undergraduate education programs. Thematic analysis of the presentation and breakout group data was used to ascertain answers to the questions posed based on the presenter and participant input. Thematic analysis is an analysis method for analyzing qualitative data. It involves closely reading a set of qualitative data to identify patterns in the meaning of the data and to find themes. As an active process of reflexivity, investigators rely on their subjective knowledge and experience to make sense of the data and draw conclusions. The results of the thematic analysis with respect to each question about safety culture in education programs are provided below.

1. *What is the current status of safety education in the universities represented at the symposium (e.g., in what classes is safety taught, what programmatic efforts related to safety are present, in what academic units is safety covered)?*

Safety is currently present in undergraduate education programs in different forms and amounts. The nature of, and extent to which, safety is incorporated into undergraduate education programs typically varies based on program accreditation (as described in Section 3.2) and whether Construction is a formal degree program offered to the students. In engineering design-focused programs, e.g., civil engineering, safety with respect to the performance of the design is included in design-related courses. On the other hand, most undergraduate Construction programs contain an entire course, or substantial part of a course, dedicated to safety. Laboratory classes for all programs often have some element of safety to ensure student safety in the labs. As a result, safety is already commonly a significant aspect of education programs for Construction students. Additional efforts to expose students to safety practices, especially construction jobsite safety, and to safety culture concepts are needed to a greater extent for civil and other engineering disciplines.

2. *What are examples of how safety is included in classes and in out-of-class student activities?*

In design-related courses, safety is typically included in the form of safety factors to ensure design performance. Students learn about safety factors through design codes and standards and apply safety factors when solving design problems on assignments and exams. Discussions about the purpose of safety factors are often incorporated into design-related courses also. Undergraduate courses specifically on the topic of safety commonly cover the OSHA regulations and safety management practices that are typically included in site-specific safety plans. In the stand-alone safety courses, in-class and out-of-class activities, lectures, assignments, and exams are devoted entirely to educating the students about safety on jobsites. Lab classes that include a safety component typically provide students with training on how to use laboratory equipment and perform lab activities in a safe manner. However, few examples were uncovered that demonstrate concepts for establishing and maintaining a safety culture and exposing students to the idea and importance of safety culture.

Outside of class, interactions with industry, e.g., during interviews and career fairs, also typically include a focus, in part, on safety. These interactions include field trips to project sites in which visiting students and faculty are required to wear PPE when onsite and learn about the safety programs being implemented during construction.

3. What barriers to increasing safety content in undergraduate education are present?

Multiple barriers exist that inhibit introducing and embedding safety and safety culture concepts in undergraduate education programs. The barriers present are primarily related to resource availability, program demands and educational focus, and instructor knowledge, experience, and motivation. Those barriers commonly cited by the symposia participants in each of these categories were as follows:

- Resource availability:
  - Schools may be located in smaller cities without easy access to project sites
  - Lack of available facilities and equipment to teach safety concepts
  - Lack of available faculty to teach a safety class, especially those faculty knowledgeable about safety
  - Lack of funding for field trips to construction sites
  - Lack of funding to provide PPE for lab classes and field trips
- Program demands and educational focus:
  - Difficulty adding more content in an already crowded curriculum
  - Difficulty in maintaining consistency of message across the curriculum
  - Program focus on learning technical knowledge as opposed to more human-centered topics
  - Knowledge "silos" within and between academic disciplines
  - Traditional design focus on safety of end-user with little emphasis and instruction on construction and construction safety
- Instructor knowledge, experience, and motivation:
  - Lack of knowledge and experience related to safety and safety practices
  - Lack of motivation to change curriculum; resistance to change
  - Promotion and tenure emphasis on research (research-intensive universities only)
  - Lack of available funding for safety research
  - Lack of interest
  - Greater interest in and, as a result, higher priority given to other academic topics

It should be noted that the barriers inhibit incorporating safety in education programs but do not prevent its inclusion. Examples of programs that successfully include safety into their undergraduate offerings, both within and outside of class, exist in universities across the country. Overcoming the barriers requires desire and motivation within the program administrators and faculty, along with supporting resources.

4. *What are the expected benefits of increasing safety practices and safety culture content in undergraduate education?*

The overarching goal of the symposia is to help prevent future worker injuries and fatalities in the construction industry. It is anticipated that increasing safety content in undergraduate education programs will improve student awareness of and interest in safety and make students more valuable and attractive as entry-level employees. This outcome will empower graduates to lead and immediately contribute to the industry and their employer in the area of safety. In some cases, graduates may be able to help the employer improve its safety culture and better understand the benefits of doing so. The ultimate result is improved safety culture in the industry and, as a result, improved jobsite safety. In addition to the long-term benefits, the symposia participants described the following immediate benefits of increasing safety content in undergraduate education programs:

- Better job opportunities for students and employers;
- Students work-ready on day one;
- Students who possess safety program literacy, including risk evaluation and tolerance across disciplinary functions; and
- Graduates who understand that safety is a competitive advantage.

5. *What resources are needed to incorporate safety topics into undergraduate programs?*

As described in Section 5.2.1, the participants mentioned a variety of ways to help educators enhance safety culture in undergraduate education programs, many of which are needed resources. To incorporate safety topics into undergraduate programs, educators need to be knowledgeable about safety practices and safety culture concepts. Therefore, safety training for faculty may be needed if the faculty do not possess the required knowledge. Faculty also need time to develop and organize the safety content. With full-time teaching and research commitments, making time to develop safety content may require financial support to enable faculty to buy-out of an existing class. The presence of instructional resources, such as software applications and PPE to show in class, are needed as well. For lab classes, students need the appropriate PPE to mitigate the hazards to which they are exposed while working in the lab. Industry partners who the faculty can call on regularly for assistance in developing course content (e.g., lecture notes, assignments, and case studies), site visits, and in-class presentations on safety are another important resource.

6. *How can industry assist with enhancing safety within undergraduate programs?*

Industry is an important partner in introducing and embedding safety culture concepts in undergraduate education programs, as well as a key stakeholder. A significant and impactful contribution from industry is its ability to provide information about safety on jobsites and access to active jobsites. This assistance can jumpstart the development of safety course content and enable exposure to, and an understanding of, safety in the real world. The symposia participants also expressed how industry can offer internships to students that incorporate, at least in part, safety. Similar internships can be made available to faculty to learn about safety from a practical perspective. Students are greatly motivated by industry, who will ultimately be their future employers. Therefore, when interacting with students, industry can help by regularly reinforcing to the students the importance of safety and safety culture and the need to learn these topics while in school. Lastly, industry can positively affect overall interest in integrating safety in education programs through participation on the programs' Industry Advisory Boards and when in direct contact with faculty and university administrators.

7. *What are industry's (constructors, engineering firms, owner organizations) expectations/requests to educators with respect to safety?*

The participants did not describe any specific expectations or make specific requests to educators with respect to safety. Input from industry was in the form of suggestions and recommendations. However, based on the tone and nature of the presentations and discussions during the symposia, there appeared to be an expectation that educators would at least be open to hearing about the need to introduce safety and safety culture concepts and consider taking action to include them in undergraduate education programs. The underlying request is that education programs prepare students who are knowledgeable about safety and safety culture and ready and motivated to apply their knowledge when they enter the workforce.

8. *What was learned in the symposia about a way forward to encourage learning about safety in undergraduate education?*

Encouraging learning about safety begins by showing students the industry's critical need that they learn about safety. This need can be communicated by telling students about the dangers on construction sites, the high rates of injuries and fatalities in the construction industry, and their critical future role to reduce them. Educators can also show the students the types of hazards present on construction sites, how to design out the hazards, and the benefits of superior safety performance. Requiring students to take a class on safety, or a class that includes safety at least in part, will also encourage student learning of the topic. Incorporating safety as a learning outcome in program accreditation requirements will mandate its inclusion in education programs that desire the accreditation. Significant motivation comes from industry as well. Industry communicating to faculty and students about the paramount need for safety knowledge to work in construction is an effective motivator.

9. *What are three (or more) recommendations for integrating safety into undergraduate education?*

Section 5.2.2 provides a summary list of recommendations for integrating safety into undergraduate education programs. A longer list is provided in the Appendix. As mentioned above, example recommendations include: adding safety topics and training in lab assignments, student safety competitions, safety moments at the beginning of classes, incorporating safety throughout the curriculum, and student participation in internships where they learn about safety on the jobsite.

7. CONCLUSIONS AND RECOMMENDATIONS

With the overarching aim to improve safety performance in the construction industry, the NAC organized and conducted a series of symposia to promote and encourage a national conversation about safety culture in university undergraduate education programs and to explore ways to embed safety and safety culture concepts within the programs. The symposia series is a commendable undertaking given the large number and diversity of undergraduate programs, as well as the many drivers, complex issues, and stakeholders involved in higher education. It is an undertaking of utmost importance. The education that students receive strongly influences and helps shape the future of the construction industry. The health and well-being of those in the industry depend on the safety culture that we uphold and the actions we take, on and off the jobsite, and before, during, and after careers take shape. Success in maintaining safe workplaces leads to success in attracting new students to the industry and, ultimately, long-term success of the industry.

7.1 SUMMARY

The five symposia at universities across the country attracted a wide variety of attendees from academia and industry. Representatives of 45 universities and 94 construction industry companies and organizations attended one or more of the symposia. A comprehensive and detailed thematic analysis of the presentations and breakout group discussions held at the symposia revealed various needs and recommendations related to safety and safety culture in undergraduate programs, including how to promote safety culture in undergraduate programs, barriers, needed resources, expected outcomes, and strategies for embedding safety culture concepts. Participants recommended actions for both in-class and outside of class and identified ways to show and to tell students about safety culture. Barriers to integration of safety into undergraduate education programs exist that are related to resource availability, program demands and educational focus, and instructor knowledge, experience, and motivation. However, the barriers are not insurmountable. With motivation and additional resources (e.g., time, money, and access to safety and construction knowledge, practices, and resources), faculty are able to integrate safety into courses and create a culture of safety within undergraduate education programs.

Exposure to a positive safety culture, especially in students' formative education before starting their careers, is critical to enabling students to be safety leaders when they join the workforce. The learning is best accomplished through personal experience and supported by formal instruction. The value of real-life experiences to a student's education was expressed by Brown with regard to steel construction: "The best lessons in good steel construction practices don't come from formal instruction, but rather from real-life experience" (Brown, 2023). This value applies to safety and safety culture as well.

7.2 LIMITATIONS

As with all academically-based explorations of subjective topics such as safety culture, limitations exist in the interpretation and application of the findings to a wider population. The symposia presentations and breakout group discussions, by their nature, are based on the personal perspectives of the participants. Cognitive biases due to the participants' experiences related to, and viewpoints on, safety, safety culture, undergraduate education, and construction as a whole, affect their contributions to the symposia. The biases may sway their opinions and affect the results. The impact of this limitation on the overall study results can be magnified with a small sample of participants, or participants who come from only one industry sector. The large number of symposia participants and their diversity with regards to work location, experience, position, employer, and industry sector helped to limit the effect of any cognitive biases that may be present in individual participants. Therefore, the impact of cognitive biases on the findings is believed to be minimal to none.

As described above, thematic analyses of the presentation statements and break-out group discussion comments were used to identify themes within, and draw conclusions from, the data collected. Thematic analysis is based on the perspectives and abilities of those performing the analysis. Limited perspectives and abilities may narrow the scope of the findings or lead to incomplete results. For the present analysis, the statements and comments were reviewed by, and input received from, a team of people who participated in the symposia. Utilizing multiple perspectives to discuss and confirm the themes and conclusions minimizes the chance of bias in the analysis. As a result, the limitation present in thematic analysis is expected to be minimal, if any, for the present analysis.

7.3 CONCLUSIONS

The construction industry continues to experience high rates of injuries and fatalities on jobsites. Safety culture within an organization and on project sites is recognized as a key factor that affects human behavior and decision-making when exposed to safety hazards and vulnerabilities. Those organizations and projects that exhibit excellent safety cultures demonstrate significantly better safety performance. Educating university students about safety and safety culture concepts before they enter the workforce will have a significant positive impact on the students and the industry. The NAC safety symposia series is one step in introducing and embedding safety and safety culture in undergraduate education programs with the goal of leading the industry to better safety performance through new employees who understand and value safety culture.

Getting to the overall goal of universal teaching of safety and safety culture in undergraduate education programs requires first knowing their current status in undergraduate programs. Programs with Construction as a formal degree program typically have a stand-alone safety course, and students in these programs are regularly exposed to safety practices and concepts in other classes and extracurricular activities. In some instances, the safety exposure includes instruction in the concepts of establishing a safety culture to assure these practices are followed. However, coverage of this content is not universal. Engineering design-related programs such as civil engineering maintain a focus on design safety (e.g., end-user safety and safety factors), but typically include less content on construction site safety practices, safe work behaviors, and construction hazard prevention through design. Laboratory classes for all programs may have some element of safety to ensure student safety in the labs; however, training on and enforcement of the safety measures and the establishment of a safety culture for lab activities can be sporadic. Therefore, to enhance safety culture within undergraduate education programs across the U.S., focused efforts are needed that target in-class and outside of class learning experiences in engineering degree programs and activities and labs in all programs in which students are exposed to safety hazards.

Incorporating greater exposure to safety and safety culture concepts in undergraduate education programs is inhibited, in part, due to perceived barriers. One barrier cited is a lack of resources. Funding and facilities to support in-class and extracurricular activities that showcase safety, the amount of time needed to develop course content on safety practices and safety culture, and incorporate it into classes, and the location of the university relative to an active construction industry are all identified as types of resource barriers. Demands on the program curriculum resulting from accreditation and university requirements, historical program themes, priorities, and focus areas, and local industry recommendations can inhibit its inclusion. The levels of knowledge, experience, and motivation within the faculty may also hinder greater student exposure to safety and safety culture concepts. For some faculty, especially those in research-intensive universities, promotion and tenure may weigh other scholarly activities (e.g., research and scholarship) to a greater extent and as a result, diminish motivation to augment safety in the students' educational experience.

Although for some universities, barriers to inclusion of safety and safety culture concepts in undergraduate education programs may be present, they are not insurmountable. There are examples of undergraduate programs across the country that currently dedicate time and effort to safety both within and outside of class. Given the nature of the comments received regarding barriers, perhaps the greatest barrier is related to ethics. Over the past couple of decades, undergraduate education programs have successfully incorporated sustainability, technologies, professional development, and other additional topics into curricula. Adding content to, and changing content in, program curricula is feasible and regularly accomplished. And, importantly, if as mentioned above, safety is truly paramount, safety should be the first topic and the most prevalent topic included in curricula. In addition, those involved in educational programs should actively pursue inclusion of safety in the programs first and devote resources to safety before devoting resources to other topics. Therefore, the greatest barrier appears to be an educational system that is structured and acts in a way that is, in part, inconsistent with the ethical obligations of the profession it represents and the industry it prepares its students for a successful career in. This barrier must be eliminated as soon as possible.

The status of safety and safety culture concepts in undergraduate education programs, especially engineering design-focused programs, along with the perceived barriers, demands a need for greater attention to safety and supporting resources. "Engineering identity" reflects the attributes that students ascribe to their role and involvement in the field of engineering (Godwin, 2016). A person's engineering identity is typically established during their engineering education. It reflects what they believe is involved in and important to their role in engineering and, ultimately, influences their behaviors and decision-making when in engineering-related environments and contexts. The findings from the symposia reveal that there is a need to formally establish, reinforce, and promote safety as a part of students' engineering identity. Doing so requires creating a culture of safety in how they critically think about and approach engineering problems and how they act in their personal and professional lives. Knowledge about safety topics such as safety culture, safe work practices, safety management systems, safety regulations, prevention through design, the hierarchy of controls, workforce sustainability, and other related topics is needed to support developing a safety-centric engineering identity. Safety training is also needed to ensure students accompany their knowledge with the skills required to work safely and prevent injury incidents from occurring. Possessing both the requisite knowledge and skills will enable students to immediately contribute to safe jobsites and become the future safety leaders the industry needs.

Opportunities that support introducing and embedding safety and safety culture concepts in undergraduate education programs are present within industry and academia. The architecture, engineering, and construction industry is quite willing to help and contains a wealth of knowledge related to safety. Industry support through speakers for safety presentations in classes, access to jobsites, information for case studies and course assignments, student internships, faculty training, and financial support is often readily offered and given. Presentations by industry can discuss the "why" and "how" of safety culture and complement presentations on the more technical aspects of safety practices and procedures. Partnering with industry enables access to the significant benefits available for academia, including with respect to safety.

Within academia itself, many universities provide internal support for curriculum development (e.g., course relief and/or funding). Faculty support should include training on the characteristics of a robust safety culture, how to create and maintain it, and how to assure it exists in a workplace and an ongoing activity. Promotion and tenure commonly include assessment of unique contributions to the university and profession. Efforts to integrate safety and safety culture concepts within program curricula, and develop partnerships with industry related to safety, can augment faculty dossiers as they apply for promotion and tenure. These efforts also support enhancing the safety, health, and welfare of society, which is commonly stated as a university's strategic goal and/or part of its educational mission.

The symposia participants provided a wide variety of suggestions for action. Greater industry involvement as mentioned above was a common recommendation. Exposing students to the needs and realities of industry in terms of safety and safety culture will contribute to a culture of safety on campus and help develop the students for entry into the profession. The participants also suggested both in-class and out-of-class activities, with particular focus on design-related courses, labs, and capstone design projects. Supporting and motivating faculty is suggested as they engage in safety topics and incorporate content into coursework.

With respect to student professional development, participants advocated for developing students who have the requisite technical skills, but more importantly understand and exhibit acumen, active caring, and accountability. These emotional traits provide a life-long foundation for safe behavior and safety leadership. Motivation can be supported by awards such as a Dean's certificate recognizing students who learn about and demonstrate safe practices and safety culture. Partnering with industry to promote including safety in the Fundamentals of Engineering (FE) Exam will also motivate students to understand safety and safety culture concepts and help convey their importance.

Importantly, students should possess a baseline understanding of safety culture, an understanding that can be reinforced through their educational experiences and interactions with industry. Graduates should understand the importance of safety and be able to confidently express safety's importance when interviewing for jobs. Depth of understanding of safety and safety culture can be used by industry as a discriminator when making hiring decisions. Students who understand safety and safety culture will ultimately be more competitive when looking for a job. As a result, when graduates report to their first jobsite after being hired, they will have an appreciation for safety and can immediately begin contributing to a culture that believes all injuries and fatalities can be prevented.

Lastly, it should be noted that developing and changing a safety culture is a significant endeavor and should not be taken lightly. It requires purposeful attention and continual reinforcement and leadership. In his publication about transforming safety culture, Steven Simon states (Simon, 2018):

> "Transforming a safety culture is a process, not a program. When the process is undertaken systematically and with authentic commitment – in organizations large or small, enterprise-wide or in individual locations – qualitative change produces dramatic measurable improvements.
>
> Transforming a safety culture is not like designing and then implementing a safety program.
>
> Changing the culture means changing norms, assumptions, and perceptions, not just behavior, and not just policies, procedures, training, and equipment. And the process takes years, not months. With the right tools and some patience, the culture change process is a manageable sequence of concrete activities."

7.4 RECOMMENDATIONS

The National Academy of Construction highly encourages all universities to take steps to introduce and embed knowledge of safety practices and safety culture concepts in undergraduate education programs and urges industry to support universities in this effort. Enhancing safety culture throughout the academic community will help elevate safety in all industry sectors and locations across the U.S. The following are recommended steps based on the findings from the safety symposia series that academia and industry can take to improve safety culture in undergraduate education programs:

- *Develop and implement educational content for undergraduate courses*. Create case studies, lecture materials, presentations, assignments, and other instructional resources related to safety and safety culture that can be integrated into existing classes and/or combined for use in a class dedicated to safety. The content could include topic-specific education modules, e.g., a prevention through design education module, which incorporate various learning tools and have faculty input and buy-in. Content that applies to engineering design-focused courses and lab safety is especially beneficial. The content and activities implemented should reflect the levels within Bloom's taxonomy of cognitive learning that produce comprehensive understanding of safety and safety culture concepts.

- *Create out-of-class opportunities for students to learn about and experience safety concepts and practices*. This recommendation may best be accomplished through educators working in partnership with industry. Examples of such activities include: field trips to construction sites that focus on jobsite safety, a safety innovation student competition, a national safety challenge for student groups, and a mentoring program for first year students to learn "what the architecture, engineering, and construction is all about" and how to design for safety and be safe while on jobsites.

- *Demonstrate and communicate the importance of safety in personal and professional lives*. Examples that directly involve students include: creating a safety pledge that describes the expectations of students, faculty, and staff with respect to safety and asking incoming students to sign the pledge; promoting attendance at meetings of safety associations (e.g., local American Society of Safety Professionals chapter); and providing PPE (e.g., safety vest, glasses, helmet, and gloves) to students as they enter the program. Faculty and staff demonstrating a positive safety culture is extremely important as well. Whether in class or outside of class, faculty and staff should always wear PPE when required, perform activities in a safe manner, require all students to adhere to safety protocols, and participate in the required safety training for work activities and equipment operation.

- *Foster academic program partnerships with industry to expose students to safety practices and concepts*. Presentations in the classroom by industry are a way to integrate safety with respect to specific course topics. Field trips to jobsites that show how safety is being addressed in practice are also helpful. Industry partners can assist by providing resources, information, and data for developing educational content.

- *Develop and implement motivators for faculty to integrate safety into their academic roles*. Instructional faculty must meet many demands placed on classes by the university, departments, accreditation, and students. Those faculty members who have research, scholarly, and service components in their position descriptions are subject to multiple additional pressures. Faculty performance is measured, in large part, by how they meet the demands of their position. Given the many competing priorities, success in enhancing safety and safety culture in curricula can be stimulated by motivating faculty to put time and effort toward the cause. Examples of faculty motivators include funding to support safety training, course relief to focus on developing course content related to safety, recognition and awards for inspirational teaching of safety, and preferential course assignments for those who incorporate safety into their courses. Faculty are motivated in large part by the requirements of their position descriptions. Position descriptions can also be developed that require involvement in safety. The following is an example of how safety can be incorporated into faculty position descriptions:

  > "Safety is an integral part of research and teaching. Faculty are expected to prioritize health and safety in the execution of their professional activities. This prioritization includes, but is not limited to, ensuring that their students, research and teaching assistants, and others under their supervision are briefed on and complying with [*University*] environmental, health, and safety protocols pertaining to the execution of their research and learning activities."

- *Integrate safety into education and training activities on professional ethics*. Most universities maintain and publish ethical standards of conduct for faculty, staff, and students, and require students to participate in coursework that focuses on ethics. Given the strong connection between ethics and safety, education programs should incorporate safety into course content and discussions of professional ethics.

As a leader in this area, the National Academy of Construction should consider, prioritize, and take action as resources become available on the following steps:

1. Take a leading role in producing and disseminating instructional materials and education modules on safety and safety culture
2. Establish a clearinghouse of companies and NAC members willing to provide assistance and partner with universities to embed safety and safety culture in their undergraduate education programs
3. Organize a working group of academics who participated in the symposia and invite other interested academics
4. Develop case studies related to safety culture for use in undergraduate courses
5. Post informational materials and videos from the symposia on NAC social media outlets
6. Collaborate with the National Academies of Sciences, Engineering, and Medicine (NASEM), National Institute for Occupational Safety and Health (NIOSH), American Society of Civil Engineers (ASCE), Associated General Contractors (AGC), American Society of Safety Professionals (ASSP), and other organizations to continue to create opportunities to enhance safety culture in undergraduate education programs
7. Communicate with university industry advisory boards to promote and encourage safety and safety culture in the undergraduate education programs
8. Collaborate with the National Council of Examiners for Engineering and Surveying (NCEES) and recommend the inclusion of safety and safety culture topics in the Fundamentals of Engineering (FE) exam

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APPENDIX

Provided below is a summary list of presentation statements and breakout group discussion comments recorded during the safety symposia and analyzed for these proceedings. The list is organized according to the nature of the comment: Information, Barriers, Character Traits, Strategies, Recommendations, and Outcomes. In some cases the statement/comment may apply to more than one category. Similar statements/comments have been omitted for brevity.

No.	Statement/Comment
Information about Safety and Safety Culture	
1	Safety culture is the "tone at the top"
2	Culture comes from the action of leaders
3	Culture starts at the top (C-suite)
4	Requires top engagement
5	Culture is as strong as your weakest link
6	Safety culture goes beyond the construction site
7	Safety culture holistically includes: design, construct, safety throughout the lifecycle, and environment
8	Culture is embedded in coursework all the way through the program
9	Think whole process; solar panel assembly example; quality, lean, safe
10	Safety culture, zero environmental accidents, safe and healthy conditions on the jobsite, zero fatalities and injuries
11	Safety training > safety inspection > safe behavior > site planning and management > new technologies > make safety an everyday topic > safety evaluation > safety committee and safety managers part of the job > prequalify subcontractors for safety
12	Indirect benefits: company image; establish safety culture among employees
13	Not all companies understand safety culture
14	As an industry, not very well understood (ignorance of the concept)
15	Very well understood for some individual companies
16	Safety is an operational function
17	Example: Dupont off the job safety program
18	Example: OSHA examples, promotional films, materials
19	Helmets! Don't assume it works!
20	$1 investment >> $4-$6 in return (OSHA)
21	Direct benefits: cost savings resulting from accidents; having safe work environments
22	Cost of preventing accidents during the work is far less than covering these accidents
23	There is a need to include concepts of ethics, sustainability and diversity in the educational process. There is a commonality between these topics and teaching the concepts of a good safety culture. In thinking of how to meet the needs of one of these topics there is an opportunity of combining with some or all of the others.
24	Legal and ethical aspects of engineering: liability, patent law, good stories and examples
25	Eliminate risk - leads to automation; prefabrication - leads to reduced cost
26	Legal and ethical aspects of engineering

27	Culture vs. achieving
28	Culture of architecture "rite of passage"
29	Zero harm vs. risk tolerance
30	Engineers of all disciplines who work in the chemical process industries also have to be knowledgeable of chemical process safety (outlined in OSHA 1920.119 and the new version of Risk Based Process safety as defined by CCPS
31	Include actual construction of project in their coursework through Habitat for Humanity, which includes safety aspects of the projects
32	Touring construction of new campus building as work progressed
33	Personal safety incidents outside classroom have had impact on safety in the lab/classroom
34	National "vibe" at moment: how affects ethics/safety, and university/business
35	The diploma is a "ticket to the dance," when hiring
36	Commercial versus construction related safety. What needs to be in the education is the general approach.
37	Department's focus on safety is principally on safety in design, rather than safety culture
38	OSHA 30 class they conduct as well as including safety in their classroom work
39	Construction Specialization…recommend OSHA 30 (includes maturity level, knowledge about hazards, recognize)...foreman, project manager needs, etc.
40	Co-workers have a voice!
41	Workers are humans, not machines
42	The suicide rate in the construction industry is a consideration
43	Real experience is lasting
44	Respect craft labor; craft workers are great teachers and it is they who get the work done
45	Difference between public and private funds
46	Apathy; what are we willing to tolerate
47	Positive intervention
48	See where it does exist; influence where it doesn't
49	Mental health leads to safety (impacts behavior/decisions)
50	Planning is key (safety and quality); systems approach
51	The contractual nature (namely Design-Bid-Build) de-prioritizes safety below cost, quality, and schedule
52	Safety climate vs. safety culture
53	Culture is no substitute for established procedures, both are required
54	"Procedures" subset of "culture"
55	RBPS includes 20 elements, one of which is safety culture
56	Culture is learned and shared
57	Culture = an organization's values in action
58	Equity and access issues with PPE ($)
59	There is a nexus between safety and ethics
60	Engineering design process involves creating a solution to meet a human need, subject to constraints. Creating a solution involves risk-taking. Meeting a human need and addressing constraints involves risk aversion. Safety is a human need and a constraint.
61	Safety classes: Current safety courses are mainly provided in construction programs, not so much in engineering classes. Classes that safety is taught include (but not limited to):

	Construction safety, construction management, safety management, process safety, risk analysis, risk management, risk assessment, environmental safety, occupational safety and health, industrial hygiene, scheduling (safety activity), cost estimating (budget for safety consideration), statistics (injury analysis), incident analysis, and human factors.
62	Programmatic efforts: Efforts toward building a safety culture include (but not limited to): Developing safety certificates, developing construction programs, developing safety programs based on the requirements of safety professional qualifications, developing curriculum embedding safety elements, recruiting safety instructors, embedding safety culture in the curriculum, shifting safety courses in the junior year before students start their core courses, developing a safety lab, developing criteria for evaluating process safety according to ABET's safety requirements (chemical engineering), and developing course maps based on safety professional exams.
63	Academic units: Construction departments and programs (such as construction engineering, construction management, and construction sciences) frequently involve courses with construction safety subjects. For other safety fields not explicitly focusing on construction safety, academic units may include (but not limited to): Occupational Risk and Safety Sciences Department (BS, MS, University of Central Missouri), Aerospace and Occupational Safety (BS, Embry-Riddle Aeronautical University), Occupational Safety and Health (BS, Murray State University), Occupational Safety and Health (BS, Illinois State University), Safety Management (BS, Indiana State University), Safety Technology (BS, Marshall University), Occupational Safety (MS, East Carolina University), Safety Management (MS, Oakland University), Safety Management (MS, West Virginia University), Safety Engineering (Graduate Certificate, Texas A&M), and Safety Engineering (Graduate Certificate, University of Pittsburgh).
64	In class student activities: Traditional lecture, case study, incident analysis, sharing experience, sharing personal reasons, assignments, test, role plays, and quiz.
65	Out-of-class student activities: Lab work, field trips, capstone projects, course projects, and field demonstrations.

Barriers	
66	Difficult to "teach" experiences, but can expose students to positive experiences (mindset of the worker)
67	Consistency of message
68	Visualizing PtD in a classroom
69	Defining safety culture for each discipline
70	Teaching safety culture vs. procedures: does not make sense
71	Safety appears to focus on engineering aspects of a program rather than construction operations
72	Concept to reality
73	Depends on location of schools, goals; Many schools in small towns - Zoom
74	Noted that current program culture could be a potential barrier, and emphasized that culture is learned
75	Challenge: students are at different levels
76	Challenge with consistency from school to school
77	Facilities available, and equipment available
78	Finding the "right" faculty - people with experience, not only academia
79	Constraints with time and curriculum
80	Time management
81	Site visits/experiences; $$$, time, can't always do or get opportunities
82	Peer pressure on construction sites to which students may be exposed
83	Funding the student trips! $1,200 for a bus; departments don't have the funds
84	Faculty interested in construction but not highly funded research area. How to create the research funds. Difficult for faculty to be research active in research
85	Exposure, internships, research
86	Promotion and tenure incentive; union negotiations
87	Funding availability/incentives
88	How to incentivize faculty
89	Faculty background/experience - connection to real world applications
90	Accreditation: ability to meet accreditation requirements
91	Podcast released today, change curriculum? How to work with ABET
92	Impact of ABET on academics; ABET needs to include safety (culture) as a priority
93	Resistance to change
94	Real-world scenarios are usually very complex to capture and present in a standardized basis
95	Core courses and goals: safety is still not mainstream; core courses and goals lack safety concepts
96	Instructor budget: safety typically not a core course, therefore no dedicated instructor budget
97	Instructor budget: safety programs not common: lack of programming budget
98	Incorporation into curriculum
99	Space in curriculum
100	Silos between and within departments
101	Challenge: Curriculum is so tight with required content for courses but could take advantage of push for more electives

102	Reluctance to change curriculum
103	Accreditation is a hurdle for academia. # of credits.
104	Faculty expectations…research, grants, pay for more students… not enough carrots and sticks for making education better.
105	Institutional inertia with regard to emphasis on ABET and what is included in coursework, and what is not included
106	How to incentivize students
107	Lack of ownership of your employees' problems
108	Construction industry: cost vs. time
109	As engineers, when we start to discuss "Safety Culture" we tend to quickly deviate to talking about safety processes and procedures. We like technology and shy away from thinking about and talking about soft skills. Yet the latter is the essence of concepts necessary to create a good culture of safety.
110	This predisposition was even evident in many of the panelist's answers to the moderator's questions in the symposium
111	Companies that do not possess a system of values that not only don't include safety as a primary value, but do not emphasize respect, diversity, equity, and inclusion
112	Apathy
113	Especially in engineering, some faculty members lack field operation experience
114	They may not be aware of the concepts necessary to create and maintain a culture of safety
115	Lack of appreciation for importance of safety in construction operations
116	Little to no discussion regarding safety culture other than the Department Head claiming to have a heavy emphasis on safety
117	Safety culture issue in academia
118	Faculty not being familiar with construction operations and how safety fits into those operations
119	Important things: Challenge what is important to educators
120	Academics have limited capacity of time
121	Where do educators get their curriculum, course content, resources?
122	Complacency/stress
123	Risk tolerance of younger populations ("invincible")
124	Need to overcome "that would never happen to me" mindset
125	Culture: People/graduates do not know behavior side
126	Stigma stereotypes, archetypes
127	Ignorance of safety standards
128	It is difficult to add a specific safety and safety culture course to existing engineering curricula since the credit hours are already full.
129	Some faculty members may not be aware of the concepts necessary to create and maintain a safety culture.
130	Safety is not regarded as mainstream in academics since research dollar is not largely available for construction safety.
131	Recruiting instructors for safety courses and programs may need additional budgets.
132	Safety is not the core course in architecture, civil, and construction engineering.

Character Traits	
133	More awareness via conversations, metrics for safety, safety walks
134	Safety of public paramount
135	Express/model culture
136	Space for voice on safety leads to culture
137	"No blame" problem solving and negotiation skill
138	Courage to stop work: measure
139	Labor: Greatest current resource; Acts of caring; Empathy
140	Caring credibility
141	There is a social side, a behavioral side to safety and the safety culture issue which cannot be ignored
142	They include behavioral issues in their coursework
143	Different risk tolerance for myself
144	Develop soft skills
145	Ask questions and don't be afraid to admit what you don't know
146	"Do unto other…" - Empathy, common good, make personal connection to help students understand/accept risk (ethical decision; what risk level; policy tolerance). Example: Golden Gate Bridge risk management
147	Culture is caring; it is about trust and creating bonds
148	Students who understand the value of safety can protect themselves and their workers from getting an injury.

Strategies	
149	Leverage industry; non-traditional approaches; engage subject matter experts
150	Must convey that we believe in the safety culture
151	Active learning
152	Engage with industry via internships, guest speakers, case studies, metrics, incident investigations, advisory board members
153	Culture of zero harm: Convince everyone it is possible; do what it takes (leadership); visits; engaged partners; university-industry partnerships
154	Academia should partner with industry (who do they use for safety training) to help support the learning objectives. Could be in classroom or on a subject relevant to the class. A balanced expectation incl. life lessons.
155	Teach people to care
156	Improve attitude and safety awareness in all laboratory (mindset)
157	Teach: lifelong learning/knowledge building
158	Teach: awareness, observe, ask questions
159	Encourage a holistic approach (HSE, quality, total worker health)
160	It is very difficult to add a specific course on safety and safety culture in existing engineering curricula
161	It may be easier to incorporate the teaching of safety culture concepts in construction related curricula. Perhaps we need to think of these as two separate needs and opportunities rather than thinking the challenges of educating students on safety culture concepts are identical for both engineering and construction courses of study.
162	From contractor's perspectives… we need to share general concepts… differences in civil engineering, construction, arch….basic knowledge about codes etc.
163	Expect graduates to possess a basic understanding of concepts and theory behind engineering related subjects
164	All parts of safety - emotional safety, psychological - teaching in the real world
165	Zero techniques engagement
166	ASCE and other student chapters: educate them on safety/ethics; Tau Beta Pi
167	Be able to speak about minimum general, how to approach a job from a safety point of view
168	Need to start speaking the safety language early in the curriculum
169	From a student perspective… safety in construction… research based pre- and post-assessment.
170	Why is safety important? Starts with "why" (humanity, empathy, good business)
171	Teach: How to more easily execute
172	"How safe is safe?" Zero risk
173	"Fast, cheap, safe, good": Quality and safety are non-negotiable; unethical to waste sponsor's $; leaner is cheaper, efficient, safer; safety and ethics talks by students in class
174	Safety system innovations
175	The emphasis is on safety considerations associated with design, be they structural or process related
176	How to help students to see relationship between ethics and safety
177	Safety has many faces; across project lifecycle
178	Assessing task; risk management

179	Motivating students: Prioritize safety culture in university
180	Role model the culture
181	Reward positive safety behavior
182	Empower students to identify safety problems; give them gift cards; university must carry out repairs.
183	Proactive interventions - discipline and rewards
184	Hire our students in internships, then: (1) demonstrate the importance of a safety culture as a value when they are with you; and (2) they will absorb your culture and come back to tell us about it.
185	Get students engaged - NJIT campus CSO's
186	Focus on faculty: say, act, decisions; train in safety culture
187	Include/engage Advisory Committee members
188	Industry needs more exposure to undergrads (early)
189	Industry needs to help make an impression to make a change to faculty expectations…impact chancellor… 25% of graduates goes into construction
190	Industry becomes a stakeholder, on-site at Universities
191	Things they can do to show they value: (1) faculty summer internships, e.g., 1/3 AGC, 1/3 employer, 1/3 university; (2) sabbatical in industry; (3) Research funding agencies need to value faculty with industry experience; (4) Scholarships, direct access, pipeline
192	Creating relationships with industry: case studies, mentoring, internships, site visits
193	Communication with craft labor
194	Advisory Board could be partnership board (opportunity)
195	Industry organizations can help Tech colleges by placing pressure to IAB, curriculum committee, state requirements
196	Communication between faculty, contractor, administration … to make safety a common goal.
197	Should program curriculum budgets make safety content a requirement? Mandate for funding?
198	Seamlessly integrate into curricula
199	They focus on "continuous improvement process" allowed in ABET accreditation so that rather than creating new ABET criteria associated with construction safety culture, they will look for ways to incorporate safety culture in all their courses in the spirit of continuous improvement.
200	Changes to curricula
201	Help faculty say and act ethically and with focus on safety; train them
202	Do students realize they will have safety responsibilities and accountabilities in their jobs?
203	Bring the supply side of future leaders (EDUCATION) and the demand side for future leaders (INDUSTRY) together to bring about a step change in design and construction safety performance
204	Accreditation - Industry talking to academia fulfills multiple accreditation criteria. Keep talking to us.
205	Talk to us - Tell us what's important in the world students are going into
206	Value of trade schools and community colleges (integrated) opportunity. "It's not just about 4-year engineering students." Outreach opportunity.

207	Different levels of project/organization about safety
208	Need to address with transformational vs. transactional approaches
209	Avoiding impact to educators
210	Engineers are here, but let's reach other disciplines
211	Apply across disciplines/functions
212	Ethics and safety nexus (link?)
213	Make ethics personal
214	Need to differentiate between blame and understanding
215	Obtain info from industry experts: Princeton study; Boston resources; Mind wise; Columbia 911 study; military
216	Safety progress to date at universities
217	Students might be more interested in taking safety courses if the courses are bundled with a certificate.
218	Proper pedagogy, such as active learning, case study, experiments, hands-on approach, capstone projects, course projects, and role plays.
219	Instructors who are enthusiastic about safety subjects.
220	Department Chair’s and Dean’s support.
221	Budgets for hiring instructors for safety courses.

Recommendations	
222	Include root cause analyses in their coursework
223	Use construction building projects as labs
224	Bring in safety resources from industry (variety, stories, case studies, industry experts, etc.)
225	Teach and exhibit safety culture concepts in university activities such as lab work, field trips, student competitions, etc. Discuss and practice the elements of a good safety culture as leading or monitoring these activities.
226	Instructors who understand construction operations and have a passion for safety
227	Become an ambassador
228	Make Jobsite Visits as standard as possible; enhance with reality capture data, virtual walkthroughs with project team
229	Use imagery of impacts (videos of accidents); explains the "why"
230	Root cause examples; 5 Whys
231	Incorporate OSHA 10 or OSHA 30 in curriculum or degree requirements (mindset)
232	Support local student chapters in how safety is key to project success
233	Specialty training opportunities
234	Train faculty on the characteristics of a robust safety culture: how to create it, how to maintain it and how to assure it actually exists in an ongoing activity. They need this if we expect them to incorporate safety culture understanding in the opportunities described above.
235	Emphasize HSE certifications
236	Ensuring that students get the opportunity to visit a construction site
237	Schedule specific industry lectures or presentations in courses where the industry representative can discuss the why and how of safety culture. This could complement other presentations which focus on the why and how of safety practices and procedures in construction or plant operations. It would be better NOT to combine presentations on both the technical concepts of processes and procedures with the soft concepts of culture.
238	Industry could collect curriculum content… it can be shared with faculty. How did an incident affect culture and procedures as corrective actions?
239	Get guest speakers/motivational speakers who have sustained injury
240	Lesson-Specific-Safety-Plans: Creation of industry library, populated by multiple companies with real world examples. These would be easy for educators to access and plug into lessons based on topic
241	Include industry in classroom instruction as guest lecturers, or conduct brown bag lunches for talks by guest speakers
242	From academia, we have sponsorships and board members… reach out to them…have them come in
243	Prioritizing resources, engage industry for case studies, guest speakers
244	Speakers in classroom
245	Retired industry leaders can teach classes…bringing real applications including safety issues
246	Create an infographic for professors to show in the classroom. Infographic: Acumen, Active caring, Accountability
247	Teach ethical/safety techniques/behavior

248	Teach behavioral HSE, Total Worker Health
249	A graduate's ability to communicate effectively with others both orally and in writing is important. In course work stress the need to speak up clearly and concisely, to solicit advice and respectively listen to the concerns of others.
250	Electives on behavioral psychology or organizational psychology
251	Teach leadership, leadership engagement
252	Teach inclusion, diversity, and positive mental health
253	Lean construction: teach continuous learning
254	Understand: Create an infographic
255	"Put a cost on it" (in Engineering Economics class)
256	Senior design projects and labs
257	Teach them as being interrelated
258	Explain what safety culture is in Engineering 101
259	Introduce them to the idea of safety culture
260	Explicitly include discussing elements of a good safety culture where it fits in existing course topics. Examples of topics where this could naturally fit are: engineering economics, estimating, scheduling, project management, construction management, ethics, leadership, etc. It is valuable if these elements are discussed in context many times in multiple courses during a student's education. This will help imbed the characteristics of a robust safety culture in the student's mind and make him/her a more effective employee and eventually an effective leader and evangelist for safety within industry.
261	Develop/ improve lab activities to incorporate the concepts of safety culture
262	Require that professors for capstone and labs be trained/educated in safety culture
263	Collaboration; operations input; PtD - safety reviews of designs
264	Start every class with a safety moment
265	Safety Moments – in class (strategies… awareness – 1 minute, why do you want to work safe)
266	This is a dangerous job. Give examples related to the career expectation and culture. Students will pay attention to that.
267	Capstone projects to mandate safety/risk management on a project
268	Require creativity in incorporating safety so every course models safety in some way
269	Capstone projects should include consideration of safety/risk management
270	Use engineering labs to discuss safety and risk
271	Including a safety moment at the start of a class or lab.
272	Address attire in lab sessions and requiring appropriate clothing, footwear, etc.
273	Homework regarding safety
274	Teach human respect
275	Integrate safety in course
276	Teach HSE management systems
277	Teach safety in design
278	Teach incident investigation
279	Orientation class for all new engineering students/faculty focused on HSE
280	Adding a required safety component to Capstone projects
281	Conduct an OSHA 10 class

282	Hierarchy of controls: spend research on eliminating
283	Lab safety criteria
284	Codes behind technology
285	Safety - taught as an operable function, not to industry
286	Safety moments in class: consciousness
287	Capstone projects present an opportunity
288	On-boarding program for labs: students given online modules
289	Teaching safety culture?? Key principles. Treat students with respect; ethics; diversity; right environment
290	New technologies: inputs, using VR, safety issues
291	Industry internships: field visits, safety visits, identify opportunities
292	Create good environment
293	Continued communication
294	Make construction site visits a priority in curriculum
295	Invite industry safety professionals to campus, ASCE meetings, and/or bring students into industry
296	Pick a day of safety week to offer tours to students or faculty or host events at university campuses
297	Engage with industry via internships (mandatory, with supervision)
298	Engage with industry via guest speakers with case studies, metrics, etc.
299	Field trips for faculty
300	Provide students with jobsite visits and internships with organizations that exhibit exemplary safety behaviors.
301	Job site walks, recent graduates, use adjunct or Professor of Practice faculty members – practical examples
302	Focus on safety during job tours/site visits
303	Provide real time experience on the project site
304	ASCE arrange for site visits through these organizations etc.
305	More internships
306	Provide more meaningful internships
307	Jobsite visits
308	Students - everything; ASCE competitions (e.g., concrete canoe); parties!!
309	Case studies
310	Database of case studies, safety moments
311	Companies with good safety records: go to universities to teach
312	Labs and student competition teams are often led by students who may have never been exposed to the concepts of developing and maintaining a good safety culture in a team effort. At the same time, an undergraduate will experience labs and team learning activities many times in the course of the curriculum. These activities could provide multiple powerful opportunities to teach by example.
313	Stretch and flex before and during class, even lectures
314	Review case studies and industry incidents
315	Safety related materials and statistics.
316	Incorporate real projects into academic projects
317	Industry leaders engaging with students and faculty on safety

318	OSHA 30-hour certification at a minimum
319	Safety pledge
320	Ethics recommit each year
321	Work with ABET and ACCE to emphasize importance of safety
322	Create post-co-op surveys that ask about safety
323	Familiarize educators with OSHA 10 and OSHA 30 certifications; HAZWOPER
324	Industry professional/IAB advocating to university leadership – incentivize
325	Opportunity: Engage alumni or learn from company-offered courses like Turner University
326	Industry internships for professors and adjuncts
327	Businesses need more formalization; host educators on site
328	1-day seminar for faculty
329	Input for educators via advisory boards, as parents who happen to be executives and donors
330	Mentor educators
331	Safety related certificate achievement possibilities
332	Licensing - FE exam
333	Continuing education should include safety points
334	Add safety to FE exam
335	Develop student internship program for EIT/students
336	Promote co-ops and internships
337	LinkedIn group (opportunity): post positions and questions
338	More symposia; write a report
339	BICE Board deeper study possible
340	Meet the professional - meet over drinks with construction professionals
341	Institute co-op programs/internships where they do not exist; blend of programs
342	Reporting to/from industry advisory boards
343	Improve communication and collaboration between industry, faculty, and students to show importance of PtD
344	Negotiation training around confrontation for students
345	Prepare engineering professors to teach or incorporate safety culture
346	Safety conversations in Department
347	Professors' exposure to OSHA internship - Be a leader (expertise)
348	Faculty training - labs and certifications
349	Professional development in construction safety (industry sponsors, workshop leaders) – Educating educators. (Most faculty do not know safety as we don't have to do the training ourselves. What if safety professional leaves? Who takes over?)
350	Dean's certificate
351	Motivate via research labs and research $
352	Reasonable lockdown; use swipe cards
353	Leverage student associations
354	Co-teach with safety professionals
355	Work with industry, find case studies, use/find other syllabus
356	Develop new courses with input from industry
357	Guest expert speakers

358	How to prepare a curriculum; teaming up an industry person with an academic
359	Teaming up industry leader with academia to develop curriculum
360	Accreditation agencies emphasizing safety
361	Safety culture should be embedded in a course and not necessarily treated as a separate course for it to be in culture
362	Spread safety in every class
363	Master class approach
364	Certificate program?
365	Certificate training
366	Determine the level of understanding (Bloom's taxonomy)
367	Students give safety and ethics talks
368	Understand that Safety Professionals are a resource
369	Earn respect of the field craft
370	Endowments for PPE for students
371	Be a safety advocate; spread awareness; ask questions
372	Speak up if you feel unsafe, or see an unsafe situation or action
373	Ethics/safety/sustainability/lean
374	Education standard defining zero harm and zero acceptance
375	Establish criteria; ideal vs. realistic (reporting, degrees of risk, degree of potential)
376	Indicators/metrics - how best to define
377	Considering human element
378	Engage with the safety onboarding program and take it seriously
379	Catalog of models being used and options available
380	Instructors need to spend more time and effort revising the curricula.
381	Students need to spend more time learning additional course content.
382	Provide opportunities for students to participate in their "safety week" activities.
383	Industry offers internship opportunities both for students and faculty
384	Industry provides cases for discussion and analysis
385	Industry helps with site visits
386	Industry introduces the company’s safety value and measures
387	Industry co-mentors students, e.g., provide suggestions for student course projects
388	Demonstrate hazardous situations, e.g., high voltage and cutting torch
389	Give a lecture introducing practical safety issues
390	Industry co-teaches safety subjects with the instructor
391	Replicate the job site in a lab setting, such as falls and electrocution
392	Analyze injury and fatal cases in the class
393	Hire instructors with practical experience
394	Faculty team up with industry leaders to develop curricula
395	Add safety components to capstone projects
396	Schedule specific industry lectures or presentations in courses where the industry representative can discuss safety culture
397	Incorporate OSHA 10 or OSHA 30 in the curriculum or degree requirements
398	Introduce confined spaces, fall protection, and hazard recognition
399	Improve students’ communication skills, integrity, confidence, empathy, human psychology, ethics, and passion

400	Introduce safety culture in all engineering classes
401	Promote advantages of understating safety values, e.g., it can protect ourselves and our workers so that we can return home safely. Also, understanding safety values may be easier for students to have an internship in a company that focuses on safety
402	Promote advantages of earning a construction safety certificate, e.g., it can increase employment opportunities
403	Organize a safety summer camp that simulates how incidents could occur to increase students' learning incentives
404	Establish a construction safety program that incorporates industry partners to increase employment opportunities
405	Engage with industry via Internships to learn management and supervision (rather than just filing paperwork), so students will get to know what management and supervision look like
406	Acquire support from Department Chair and Dean
407	Include discussing elements of a good safety culture where it fits in the existing course
408	Engage the advisory board to push bringing a safety culture into undergraduate education
409	Include information on workplace safety in the engineering curriculum on: People, Process, Product
410	Collaborate with industry: co-teach with safety professionals
411	Collaborate with industry: develop new courses with input from industry
412	Collaborate with industry: accreditation agencies emphasizing safety
413	Collaborate with industry: changes to curricula
414	Relocate safety courses in the first years before students take core courses
415	Treat safety courses as important as physics

Outcomes	
416	Baseline understanding of culture: taught in undergrad and experience; reinforced by companies; expanded by companies
417	Having an understanding regarding safety culture and its importance in construction would be a discriminator in hiring by construction firms
418	Respect between management and trades
419	Students need to learn to connect with employer
420	Better job opportunities for students and employers
421	Work ready on day one
422	Graduates who, when they report to their first jobsite after being hired, have an appreciation for safety and can immediately begin contributing to a culture that believes "all accidents can be prevented"
423	Graduates who understand the importance of safety and can address that when interviewing for jobs with construction companies
424	Students better prepared, and current employees as well, in safety. Safety management program literacy, including risk evaluation and tolerance; across disciplinary functions
425	Industry needs graduates reflecting the makeup of the population
426	Humbled students/grads
427	Receptiveness: Interest, awareness, lifelong learning
428	Safety is a value - how do we bring this to others?
429	Graduates who understand "safety is a competitive advantage"
430	Resilience - Prepared, mitigate, response, recover
431	Better prepared graduates for jobs in the construction industry who possess a discriminator when interviewing for jobs
432	Construction safety programs at universities focus on creating graduates who have a rich understanding of the value of safety.
433	Students will be more competitive when looking for a job, especially for those companies that focus on safety.

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Recap Paper Authors:
Ken Arnold
Wayne Crew
John Gambatese, primary
Edd Gibson
Mike Loose