www.cpwr.com • www.elcosh.org

CPWR
THE CENTER FOR CONSTRUCTION
RESEARCH AND TRAINING

**Topics in Construction Safety and Health**

# Training:

## An Interdisciplinary Annotated Bibliography

CPWR - The Center for Construction Research and Training

2023

8484 Georgia Avenue
Suite 1000
Silver Spring, MD 20910

PHONE: 301.578.8500
FAX: 301.578.8572

 Production of this document was supported by cooperative agreement OH 009762 from the National Institute for Occupational Safety and Health (NIOSH). The contents are solely the responsibility of the authors and do not necessarily represent the official views of NIOSH.

# Training: An Interdisciplinary Annotated Bibliography

Ahonen, E. Q., et al. (2013). "Evaluating goals in worker health protection using a participatory design and an evaluation checklist." New Solut 23(4): 537-560.

Spanish-speaking immigrant workers in construction are considered hard to reach and at high risk for work-related injury and fatality. This evaluation study describes the use of participatory methods and an evaluation checklist to consider a health and safety (H&S) training program for these workers. A previously developed training manual and model were disseminated to eight worker centers (WCs) through participatory research collaboration. It incorporated H&S training for workers while strengthening the role of WCs as sources for leadership development and worker empowerment. Design, delivery, reaction, application, and extension were assessed through individual interviews with participants, trained trainers, and center staff and through observation of training sessions and partner debriefs; pre- and post-training tests assessed participant learning. Results indicate moderate learning and application by participants and strong evidence for structural gains in and among WCs. We conclude that such partnerships and models are valuable tools for collaborating with hard-to-reach workers.

Albert, A., et al. (2014). "Enhancing Construction Hazard Recognition with High-Fidelity Augmented Virtuality." Journal of Construction Engineering and Management 140(7): 04014024.

Most construction safety management processes rely on the hazard recognition capability of workers. Hazards that remain unidentified can potentially result in catastrophic injuries and illnesses. As such, thorough hazard recognition is fundamentally essential to protect the health and well-being of the construction workforce. Despite its importance, recent research indicates that a large proportion of hazards remain unrecognized, exposing workers to unmitigated risks. Surprisingly, safety research has not adequately focused on developing specialized strategies to develop construction worker competency in hazard recognition. This paper reports a two-year research effort with the following objectives: (1) develop a high-fidelity augmented virtual environment [System for Augmented Virtuality Environment Safety (SAVES)] that helps develop workers' hazard recognition skill through risk-free learning and immediate feedback; (2) embed cognitive retrieval mnemonics to improve long-term retention of cues for construction hazards; (3) evaluate the effectiveness of the strategy as an intervention on active construction crew by using the multiple baseline testing approach. The first two objectives were accomplished through a combined effort from a panel of 14 subject matter experts and five academic researchers. This was followed by field experiments to test the hypothesis that the experience with SAVES improves the proportion of hazards identified by participants during subsequent field operations. The findings revealed that crews, on average, were able to only identify 46% of hazards prior to the introduction of the intervention, but were able to recognize 77% of hazards in the postintervention phase. This study represents the first endeavor to measure the effectiveness of augmented virtuality and serious gaming in developing hazard signal detection skills in construction field settings.

Albert, A., et al. (2014). "Enhancing Construction Hazard Recognition and Communication with Energy-Based Cognitive Mnemonics and Safety Meeting Maturity Model: Multiple Baseline Study." Journal of Construction Engineering and Management 140(2): 04013042.

Nearly every safety management activity is designed around the fundamental and implicit assumption that the workforce is capable of identifying hazards before exposure. Unfortunately, research shows preliminary evidence that construction crews perform relatively poorly with respect to hazard recognition. This may be attributable, in part, to the diverse and dynamic nature of construction work. Consequently, many hazards remain unidentified, uncontrolled, and unmanaged until they are encountered by workers. To advance theory and practice in the area of construction hazard recognition and communication, a large-scale, multiphase research project was conducted with the following objectives: (1) devise a new hazard recognition method based upon the principles of cognitive mnemonics and that promotes hazard recognition skill; (2) build a maturity model to improve hazard recognition performance and encourage hazard communication; and (3) experimentally measure improvement in hazard recognition and communication resulting from the new program. The first two objectives were achieved by using the nominal group technique driven by input from an expert panel of 14 industry professionals from organizations with world-class safety records and an average of 26 years of safety management experience. A new method for measuring the quality of prejob safety meetings was devised in a series of eight face-to-face meetings and teleconferences among the experts over a 1-year period. The null hypothesis that the strategy does not improve the proportion of hazards identified and communicated before the start of construction was experimentally tested with six crews using the multiple baseline testing approach. This is a series of concurrent longitudinal A-B designs that are time-lagged among independent treatment groups. The obtained observations were analyzed using interrupted time series regression models. The results showed that workers were able to identify and communicate an average of 38% of hazards before the intervention was applied and that the new strategy caused a weighted overall level-change improvement in hazard recognition skill of 31% ($p<0.01$)

Albert, A., et al. (2014). "Experimental field testing of a real-time construction hazard identification and transmission technique." Construction Management and Economics 32(10): 1000-1016.

Hazard identification and communication are integral to most construction methods, and every construction safety management activity. Unfortunately, in practice, significant hazards are often not recognized and communicated leading to sub-optimal hazard awareness at the crew level. To bridge this gap in performance, we conducted a two-year intensive research project focused on developing a strategy that increases the proportion of hazards identified, communicated, and managed. Specifically, we designed a hazard identification and transmission (HIT) board that is used in conjunction with energy-based retrieval mnemonics and facilitates identifying and communicating hazards during both the planning and the execution phases. The strength of this strategy lies in the fact that workers are able to detect and communicate hazards in real time using energy-source mnemonic cues, which significantly reduces cognitive demand. Following development, we conducted immersive field studies to evaluate the impact of the devised strategy on two projects in the United States. Data from six crews were gathered using the rigorous multiple baseline testing experimental approach and analysis was conducted using interrupted time-series regression models. The results indicate that the crews were able to recognize and communicate only an average of 54% of hazards in the baseline phase, but were able to recognize and communicate 77% during the planning phase after using the intervention. An additional 6% of hazards were identified and communicated in

the execution phase. This represents the first known formal effort to evaluate a real-time hazard identification and communication strategy for the construction industry. © 2014, Taylor & Francis.

Albert, A., et al. (2017). "Empirical measurement and improvement of hazard recognition skill." Safety science 93: 1-8.

One explanation for high injury rates and the recent plateau in construction safety performance is that workers remain unable to recognize and manage hazards in dynamic and transient construction environments. This notion is supported by recent experimental studies, which revealed that workers are typically unable to identify and manage over 55% of hazards in their immediate work environment. These alarming discoveries prompted a series of multiple baseline experiments that tested three interventions thought to improve hazard recognition. In these studies, data were gathered from over 3000 h of field observations with 103 workers and hazard recognition performance was measured before and after each intervention was introduced. All three interventions caused improvement in overall hazard recognition performance; however, each intervention's impact on the recognition of specific types of hazards was not evaluated. This paper addresses this knowledge gap by presenting and in-depth analysis of these data that: (1) elucidates micro-level hazard recognition across different hazard types and categories and (2) evaluates the hazard-specific impact of three recently developed interventions. The results reveal that gravity, motion, mechanical, and electrical hazards are associated with the highest baseline hazard recognition levels; whereas temperature, chemical, radiation, and biological hazards were the least recognized hazards in both the baseline and post-intervention phases. This suggests the need for targeted hazard recognition programs that focus on energy sources that are commonly missed. © 2016 Elsevier Ltd

Albert, A., et al. (2020). "Focus on the fatal-four: Implications for construction hazard recognition." Safety science 128: 104774.

Much effort has been devoted to improving hazard recognition in the construction industry. One such effort is the training outreach program pioneered and promoted by the Occupational Safety and Health Administration (OSHA) – commonly known as the Construction Focus Four or the Construction Fatal Four program. This program which is integrated in much of the training efforts offered in the construction industry seeks to promote hazard recognition and management by focusing on the four leading causes of fatal incidents – namely falls, caught-in/between, struck-by, and electrocution (i.e., fatal-four) hazards. Given the emphasis of these hazards in most training efforts, the objective of the current research was to explore if there are any performance disparities among workers in recognizing hazards that fall under the fatal-four and the non-fatal-four hazard categories. To accomplish this research goal, more than 280 workers were recruited from 57 construction workplaces in the United States to participate in a hazard recognition activity. The results of the study reveal that workers fail to recognize a disproportionate number of safety hazards in both the fatal-four and the non-fatal-four hazard categories. However, workers are relatively more proficient in recognizing hazards in the fatal-four hazard category than the non-fatal-four hazard category. More specifically, on average, the participating workers roughly recognized 57% of the fatal-four safety hazards while only recognizing 18% of the non-fatal-four safety hazards. Collectively, these findings suggest that apart from focusing on the fatal-four hazards, training efforts must also focus on the non-fatal-four safety hazards – given the relative poor performance.

Albert, L. and C. Routh (2021). "Designing Impactful Construction Safety Training Interventions." Safety 7(2): 42.

Construction workplaces still report an unacceptable number of safety incidents every year. To tackle these disproportionate incident rates, safety training interventions are adopted widely in construction workplaces. Despite their adoption, poor safety performance continues to be a universal and global problem in the industry. In fact, recent research has called into question the effectiveness of training programs that are commonly adopted in the industry. There is also evidence that suggests that training interventions, in many cases, do not yield tangible benefits and may sometimes simply reduce to wasted resources. Therefore, it is important for industry stakeholders to possess a good understanding of the characteristics of training interventions that translate to superior safety performance. Towards achieving this goal, the present article concisely summarizes specific safety training intervention elements, which when integrated into training programs, can translate into superior safety performance and outcomes. The objectives of the research were achieved by performing a review of the construction safety training literature from diverse sources. The findings demonstrate that training interventions that integrate visual cues to guide hazard recognition, immersive experiences in virtual environments, andragogical training principles, personalization of training experiences, testing and feedback, and other elements can improve training effectiveness and outcomes. The article will serve as a resource for industry professionals that seek to address the weaknesses of existing training interventions. Researchers may also use this as a resource to inform the development of the next generation of safety training interventions. Together, the presented research can be leveraged to reduce the number of undesirable safety incidents experienced in construction workplaces.

Anger, W. K., et al. (2018). "Total Worker Health(R) Intervention for Construction Workers Alters Safety, Health, Well-Being Measures." J Occup Environ Med 60(8): 700-709.

OBJECTIVE: The aim of this study was to evaluate the effectiveness of a 14-week Total Worker Health (TWH) intervention designed for construction crews. METHODS: Supervisors (n = 22) completed computer-based training and self-monitoring activities on team building, work-life balance, and reinforcing targeted behaviors. Supervisors and workers (n = 13) also completed scripted safety and health education in small groups with practice activities. RESULTS: The intervention led to significant ($P < 0.05$) improvements in family-supportive supervisory behaviors ($d = 0.72$). Additional significant improvements included reported frequency of exercising 30 minutes/day and muscle toning exercise ($d = 0.50$ and 0.59), family and coworker healthy diet support ($d = 0.53$ and 0.59), team cohesion ($d = 0.38$), reduced sugary snacks and drinks ($d = 0.46$ and $d = 0.46$), sleep duration ($d = 0.38$), and objectively-measured systolic blood pressure ($d = 0.27$). CONCLUSION: A TWH intervention tailored for construction crews can simultaneously improve safety, health, and well-being.

Barlet, G., et al. (2020). "Operating Engineers and the OSHA Silica Standard: A Survey of Union Trainers." New Solut 29(4): 530-535.

Enclosed cabs with filtration systems, an engineering control preferred in the hierarchy of controls, may reduce heavy equipment operators' silica exposure during demolition, grading, and excavation. We surveyed operating engineer trainers about silica training, familiarity with the Occupational Safety and Health Administration (OSHA) silica standard, and cab filtration

systems. A voluntary and anonymous online survey was e-mailed to 437 trainers in January 2018. The response rate was 22.9 percent (n = 100). Most trainers (84 percent) covered health risks and silica exposure prevention in their courses. Of these, 59 percent discussed cab filtration as an engineering control. Trainers identified possible barriers to the use of cab filtration systems and a need for education to increase use, and raised concerns about other exposures associated with heavy equipment use. Education about selection, use, and maintenance of cab filtration systems to control silica exposure is needed. Engineering improvements to heavy equipment should address cab filtration, noise, heat, and vibration.

Bhandari, S., et al. (2019). "Making construction safety training interesting: A field-based quasi-experiment to test the relationship between emotional arousal and situational interest among adult learners." Safety science 117: 58-70.

Safety training within the construction industry is often quite mundane and generic which is a problem for an industry combatting with high fatality rates on job sites for decades. Recent studies have found construction safety training programs severely lacking in developing hazard recognition and risk assessment skills among its workforce. Moreover, techniques used in these training programs are not geared to help adult learners engage or retain information provided. To address these shortcomings, this paper tests the efficacy of a multimedia simulation-based training program: Naturalistic Injury Simulations (NIS) in inducing interest among construction workers. NIS has been empirically shown to elicit targeted negative emotional experience among construction workers and the work presented here tests if NIS can also generate situational interest in construction workers regarding safety. This paper collected data from 489 construction workers on a construction job-site in an interventional experimental design. Analysis revealed that NIS were able to increase situational interest among workers and that these findings were consistent across all demographic dimensions captured in our study. Multiple linear regression analysis did not show clear evidence of a relationship between change in emotions and increase in situational interest among workers. This work shows that NIS will promote learning among workers by keeping them interested in the safety training process while also generating risk-averse behavioral patterns through emotional manipulation.

Borjan, M., et al. (2016). "Assessing barriers to the use of fall protection in small residential construction companies in New Jersey." New Solut 26(1): 40-54.

Three focus groups were conducted with residential construction workers from local New Jersey labor organizations to characterize barriers to fall protection use among residential construction contractors who work for companies with fewer than ten employees. Thirty-six residential construction workers volunteered to participate, the average age was thirty-nine years, and twenty-four (67%) were of Hispanic origin. Twelve (33%) of the participants reported having fallen from greater than 6 ft at work and twenty (56%) of the participants had known someone who has fallen from greater than 6 ft. Sixteen (44%) had not been provided with fall protection equipment by their employer and eighteen (50%) reported their current employer had not provided workplace safety training. Factors that created barriers to use of fall protection equipment such as equipment availability, employee/employer relationships, cultural differences, and company size were identified. Results from this study confirm that falls remain a concern among residential construction workers in small companies.

Brunette, M. J. (2005). "Development of educational and training materials on safety and health: targeting Hispanic workers in the construction industry." Fam Community Health 28(3): 253-266.

The number of Hispanics in the construction work force continues to grow and their fatal and nonfatal occupational injuries are higher than those in any other ethnic group in the United States. Focusing on safety and health for this group may reduce injuries and promote safe workplaces. However, involving hard-to-reach workers is a difficult process because of language and cultural differences within ethnic groups. This article presents findings on effective design, development, and dissemination of safety and health educational materials targeted to Hispanic construction workers. How to utilize a linguistically and culturally sensitive approach is described. The author stresses the need for collaboration among researchers, unions, community development organizations, and advocacy groups in this effort.

Burgel, B. J., et al. (2015). "Work-related health complaints and injuries, and health and safety perceptions of latino day laborers." Workplace Health and Safety 63(8): 350-361.

This study describes socio-demographic, health, and work factors as well as health and safety perceptions of day laborers who reported work-related health complaints and injuries. The researchers completed a secondary data analysis of 217 interviews conducted in 2009 with day laborers in a large city. The participants reported 83 health complaints or injuries (38%) that had occurred during the prior 12 months, with 57 of these complaints or injuries resulting in lost work time. Pain and soreness of the back were the most prevalent health complaints or injuries; 66% of participants did not report their injuries, 62% reported no health and safety training, 96% reported they needed personal protective equipment (PPE), and 63% were provided with PPE. Latino day laborers reported a high 12-month prevalence of work-related health complaints and injuries. Ongoing policy work is needed to encourage injury reporting by day laborers and the provision of health and safety training and PPE to this group of workers. 

Bush, D., et al. (2019). "Essential Elements for Effective Safety and Health Education in Postsecondary Construction Career Technical Education." New Solut 29(1): 53-75.

Because Career Technical Education (CTE) programs at the community/technical college level are among the few places new construction workers receive training or preparation, they are an important vehicle for educating new and young workers about occupational health and safety (OSH). We developed recommendations for (1) OSH "core competencies" that all postsecondary construction students should achieve and (2) "essential elements" for OSH education in construction training programs. Based on a review of the literature, subject matter expert focus groups, and iterative engagement with an expert advisory group, we identified fourteen core competencies and a list of essential supporting elements at the school, program, and instructor levels. Knowledge and recognition of the importance of effective safety and health management systems served as the foundation for elements and competencies. Findings provide an important starting point for systematically improving the preparation of construction CTE students that can help keep them safe on the job.

Buzzetti, A. J., et al. (2005). "Impact of a lead-safe training program on workers conducting renovation, painting, and maintenance activities." Public Health Rep 120(1): 25-30.

OBJECTIVE: An important source of lead exposure is lead-based paint that is disturbed when unsafe work practices are used during renovation, remodeling, and maintenance activities. This study explores the success of a pilot lead-safe skills training program for home improvement contractors and their employees (including renovators, remodelers, and painters) and small property owners. METHODS: The study evaluates whether attendees at eight-hour lead-safe work practices training courses learned and retained information about lead exposure; developed and retained positive attitudes toward lead-safe work practices; and developed lasting, positive behavioral intentions to use lead-safe work practice skills and techniques. A questionnaire was administered immediately before, immediately following, and several months following the training program. Coded data from the questionnaires were analyzed using SPSS software. RESULTS: Respondents showed statistically significant changes from before to after the training program, and the changes were maintained over time. Knowledge improved, and attitudes and behavioral intentions changed in a favorable direction. CONCLUSION: These results suggest that lead-safe training can be successful and can create lasting changes in lead-safe knowledge, attitudes, and behaviors.

Caban-Martinez, A. J., et al. (2018). "Health Promotion at the Construction Work Site: The Lunch Truck Pilot Study." Workplace Health Saf 66(12): 571-576.

The transient nature of construction work makes it difficult to conduct longitudinal worksite-based health promotion activities. As part of a workplace health assessment pilot study, we worked with a commercial lunch truck company to disseminate four types of health education materials including cancer screening, workplace injury prevention, fruit and vegetable consumption, and smoking cessation to construction workers purchasing food items from the truck during their job breaks. Two weeks following the worksite assessment, we followed up with these workers to ascertain their use of the health promotion materials. Of the 54 workers surveyed, 83% reported reviewing and sharing the cancer screening materials with their families, whereas 44% discussed the cancer screening materials with coworkers. Similar proportions of workers reviewed, shared, and discussed the other health promotion materials with their family. Lunch trucks may be an effective strategy and delivery method for educating construction workers on healthy behaviors and injury prevention practices.

Caban-Martinez, A. J., et al. (2018). "Physical Exposures, Work Tasks, and OSHA-10 Training Among Temporary and Payroll Construction Workers." J Occup Environ Med 60(4): e159-e165.

OBJECTIVE: We characterize and compare the self-reported physical exposures, work tasks, and OSHA-10 training in a non-probabilistic sample of temporary and payroll construction workers. METHODS: In June 2016, a total of 250 payroll and temporary general laborers employed at Florida construction sites completed a survey at the job site as part of the falls reported among minority employees (FRAME) study. RESULTS: Workers employed through temp agencies (57.1%) were significantly more likely to report moving or lifting materials more than 100 pounds than payroll workers (38.5%; $P < 0.01$). Temporary construction workers with 10-hour OSHA training (22.2%) spent significantly less time with intense hand use/awkward hand posture than temporary workers without 10-hour OSHA training (46.9%; $P = 0.048$). CONCLUSIONS: Temp construction workers with OSHA 10-hour training reported less hazardous physical postures than workers without the same training.

Cakan, H., et al. (2014). "Investigation of Factors Contributing to Fatal and Nonfatal Roofer Fall Accidents." International Journal of Construction Education and Research 10(4): 300-317.

Roofers continue to suffer frequent fall-related injuries and fatalities. The objectives of this research were (a) identifying the factors affecting roofer fall accidents; (b) investigating the frequency distributions of these factors; (c) examining the relationships between the factors; and (d) developing a statistical model for fatal and nonfatal fall outcomes. Occupational Safety & Health Administration (OSHA) accident data was analyzed using categorical variables. After establishing data demographics, cross-tabulation analysis was performed to determine factor relationships, and logistic regression modeling was done to predict accident outcomes using degree of injury as a dependent variable and the significant factors from cross-tabulation as independent variables. It was found that roofers most frequently experienced falls while working in smaller alteration/rehabilitation projects and at heights below 20 feet. Unguarded/improperly secured platforms, walkways, openings, edges and ladders, misjudgment of hazardous situation, and improper choice of equipment/process came out to be significant contributing factors. It was observed that the odds of fatality decreased when roofers were provided OSHA-compliant fall protection systems; used these systems; and received fall protection training per OSHA requirements. The model developed and validated in this study successfully predicted the fall accident outcomes in terms of fatality and nonfatal injury. © Associated Schools of Construction.

Cunningham, T. R., et al. (2018). "Differences in safety training among smaller and larger construction firms with non-native workers: Evidence of overlapping vulnerabilities." Saf Sci 103: 62-69.

Collaborative efforts between the National Institute for Occupational Safety and Health (NIOSH) and the American Society of Safety Engineers (ASSE) led to a report focusing on overlapping occupational vulnerabilities, specifically small construction businesses employing young, non-native workers. Following the report, an online survey was conducted by ASSE with construction business representatives focusing on training experiences of non-native workers. Results were grouped by business size (50 or fewer employees or more than 50 employees). Smaller businesses were less likely to employ a supervisor who speaks the same language as immigrant workers ($p < .001$). Non-native workers in small businesses received fewer hours of both initial safety training ($p = .005$) and monthly ongoing safety training ($p = .042$). Immigrant workers in smaller businesses were less likely to receive every type of safety training identified in the survey (including pre-work safety orientation [$p < .001$], job-specific training [$p < .001$], OSHA 10-hour training [$p = .001$], and federal/state required training [$p < .001$]). The results highlight some of the challenges a vulnerable worker population faces in a small business, and can be used to better focus intervention efforts. Among businesses represented in this sample, there are deflcits in the amount, frequency, and format of workplace safety and health training provided to non-native workers in smaller construction businesses compared to those in larger businesses. The types of training conducted for non-native workers in small business were less likely to take into account the language and literacy issues faced by these workers. The findings suggest the need for a targeted approach in providing occupational safety and health training to non-native workers employed by smaller construction businesses.

Dale, A. M., et al. (2016). "Evaluation of a participatory ergonomics intervention in small commercial construction firms." Am J Ind Med 59(6): 465-475.

BACKGROUND: Work-related musculoskeletal disorders (WMSD) among construction workers remain high. Participatory ergonomics (PE) interventions that engage workers and employers in reducing work injury risks have shown mixed results. METHODS: Eight-six workers from seven contractors participated in a PE program. A logic model guided the process evaluation and summative evaluation of short-term and intermediate impacts and long-term outcomes from surveys and field records. RESULTS: Process measures showed good delivery of training, high worker engagement, and low contractor participation. Workers' knowledge improved and workers reported changes to work practices and tools used; contractor provision of appropriate equipment was low (33%). No changes were seen in symptoms or reported physical effort. CONCLUSIONS: The PE program produced many worker-identified ergonomic solutions, but lacked needed support from contractors. Future interventions should engage higher levels of the construction organizational system to improve contractor involvement for reducing WMSD. Am. J. Ind. Med. 59:465-475, 2016. (c) 2016 Wiley Periodicals, Inc.

Darragh, A. R., et al. (2004). "Effectiveness of the HomeSafe Pilot Program in reducing injury rates among residential construction workers, 1994-1998." Am J Ind Med 45(2): 210-217.

BACKGROUND: The construction industry typically has one of the highest fatal and non-fatal injury rates compared with other industries. Residential construction workers are at particular risk of injury (work is in remote sites with small crews, there are often many subcontractors, and they have limited access to safety programs). Difficulty accessing information specific to this group has made research more challenging, therefore, there are few studies. This study evaluated the effectiveness of the HomeSafe Pilot Program, a safety education and training program designed to reduce injuries among residential construction workers. METHODS: Researchers evaluated whether overall and severe injury incidence rates declined during the intervention period. Data were analyzed using incidence rates and Poisson regression to control for the effect of antecedent secular trend. RESULTS: Injury incidence rates declined significantly following HomeSafe; however, this effect was not statistically significant once temporal variation was controlled. CONCLUSIONS: The decline in injury rates following HomeSafe cannot be attributed solely to HomeSafe, however, programmatic and methodologic limitations contributed to the inconclusive results. Further research into the hazards faced by residential construction workers is needed. Am. J. Ind. Med. 45:210-217, 2004.

Dennerlein, J. T., et al. (2009). "Portable ladder assessment tool development and validation-quantifying best practices in the field." Safety science 47(5): 636-639.

Many causes for falls from ladders in construction are related to the user's activities; however, the extent to which users comply with ladder use best practices is unknown and has not been well quantified before. We developed and tested an audit tool that assesses compliance with best practices guidelines for portable ladder use designed for applications in the construction industry. Implemented on a hand-held computer, the assessment tool consisted of a series of checklists categorized in four groups; ladder condition, setup, moving on a ladder, and completing tasks from a ladder. For these four observational categories, the resulting tool contained 31 and 33 questions for step and extension ladders, respectively. Three individuals trained to use the tool scored a set of photographs and videos depicting 25 ladder conditions, 20 ladder setups, 10 users moving on ladders, and 13 users completing tasks from a ladder for a

total of 78 observations. The assessment tool had good agreement across and within raters. For the three raters, agreement ranged from 79% to 97% across the questions. Within one subject, kappa coefficients for the intrarater reliability ranged from 0.67 to 0.91. The tool offers a practical method to quantify best practices associated with ladder use that can ultimately inform targeted intervention efforts.

Dong, X., et al. (2004). "Effects of safety and health training on work-related injury among construction laborers." J Occup Environ Med 46(12): 1222-1228.

OBJECTIVES: This study was designed to evaluate the effects of safety and health training on work-related injury in the construction industry. METHODS: Union health insurance records, union training records, and workers compensation data for 1993 and 1994 were analyzed for more than 8000 construction laborers in Washington State. RESULTS: After controlling for demographic factors, laborers who received safety and health training during the study period were 12% (95% confidence interval [CI] = 0.75-1.02) less likely than nontrained laborers to file for workers compensation. Among workers 16 to 24 years old, training was associated with a 42% (95% CI = 0.35-0.95) reduction in claims. CONCLUSIONS: These findings provide evidence of the effectiveness of safety and health training in preventing occupational injuries among construction laborers, particularly among younger workers. However, the results cover only a limited time and the long-term effects remain unclear.

Dong, X. S., et al. (2017). "The construction FACE database - Codifying the NIOSH FACE reports." J Safety Res 62: 217-225.

INTRODUCTION: The National Institute for Occupational Safety and Health (NIOSH) has published reports detailing the results of investigations on selected work-related fatalities through the Fatality Assessment and Control Evaluation (FACE) program since 1982. METHOD: Information from construction-related FACE reports was coded into the Construction FACE Database (CFD). Use of the CFD was illustrated by analyzing major CFD variables. RESULTS: A total of 768 construction fatalities were included in the CFD. Information on decedents, safety training, use of PPE, and FACE recommendations were coded. Analysis shows that one in five decedents in the CFD died within the first two months on the job; 75% and 43% of reports recommended having safety training or installing protection equipment, respectively. CONCLUSION: Comprehensive research using FACE reports may improve understanding of work-related fatalities and provide much-needed information on injury prevention. PRACTICAL APPLICATION: The CFD allows researchers to analyze the FACE reports quantitatively and efficiently.

Duffy, S. A., et al. (2018). "The Sun Solutions Intervention for Operating Engineers: A Randomized Controlled Trial." Cancer Epidemiol Biomarkers Prev 27(8): 864-873.

Background: Because Operating Engineers (heavy equipment operators) are outdoor workers at risk for skin cancer, interventions are needed to promote sun safety. The objectives were to determine changes in sunscreen use and sunburning among Operating Engineers randomized to four conditions in the Sun Solutions study: (i) education only; (ii) education and text message reminders; (ii) education and mailed sunscreen; and (iv) education, text message reminders, and mailed sunscreen.Methods: In this randomized controlled trial, Operating Engineers (N = 357) were recruited at required safety training sessions throughout Michigan during winter/spring of 2012 to 2013 and provided baseline surveys. The four interventions

were delivered over the summer. Postintervention surveys were collected in the fall (82.1% follow-up).Results: Sunscreen use improved significantly from baseline to follow-up in all four conditions ($P < 0.05$), except sunscreen use among those receiving education and text message reminders was only marginally significant ($P = 0.07$). There were significantly greater increases in sunscreen use in the two conditions that were mailed sunscreen ($P < 0.001$). There was a significant decrease in the number of reported sunburns from baseline to follow-up in all four conditions ($P < 0.001$), but there were no significant differences in sunburns among the groups. Participant evaluated the interventions highly with those who received mailed sunscreen rating the intervention the highest.Conclusions: Providing proper sun-safety education and minimizing barriers to sunscreen use can increase sunscreen use and decrease reported sunburns.Impact: The implementation of the Sun Solutions intervention may be an effective method to modify skin cancer-related behaviors. Cancer Epidemiol Biomarkers Prev; 27(8); 864-73. (c)2018 AACR.

Edelson, J., et al. (2009). "Predictors of hearing protection use in construction workers." Ann Occup Hyg 53(6): 605-615.

OBJECTIVES: Although noise-induced hearing loss is completely preventable, it remains highly prevalent among construction workers. Hearing protection devices (HPDs) are commonly relied upon for exposure reduction in construction, but their use is complicated by intermittent and highly variable noise, inadequate industry support for hearing conservation, and lax regulatory enforcement. METHODS: As part of an intervention study designed to promote HPD use in the construction industry, we enrolled a cohort of 268 construction workers from a variety of trades at eight sites and evaluated their use of HPDs at baseline. We measured HPD use with two instruments, a questionnaire survey and a validated combination of activity logs with simultaneous dosimetry measurements. With these measurements, we evaluated potential predictors of HPD use based on components of Pender's revised health promotion model (HPM) and safety climate factors. RESULTS: Observed full-shift equivalent noise levels were above recommended limits, with a mean of 89.8 +/- 4.9 dBA, and workers spent an average of 32.4 +/- 18.6% of time in each shift above 85 dBA. We observed a bimodal distribution of HPD use from the activity card/dosimetry measures, with nearly 80% of workers reporting either almost never or almost always using HPDs. Fair agreement (kappa = 0.38) was found between the survey and activity card/dosimetry HPD use measures. Logistic regression models identified site, trade, education level, years in construction, percent of shift in high noise, and five HPM components as important predictors of HPD use at the individual level. Site safety climate factors were also predictors at the group level. CONCLUSIONS: Full-shift equivalent noise levels on the construction sites assessed were well above the level at which HPDs are required, but usage rates were quite low. Understanding and predicting HPD use differs by methods used to assess use (survey versus activity card/dosimetry). Site, trade, and the belief that wearing HPD is not time consuming were the only predictors of HPD use common to both measures on an individual level. At the group level, perceived support for site safety and HPD use proved to be predictive of HPD use.

Eggerth, D. E., et al. (2018). "Evaluation of toolbox safety training in construction: The impact of narratives." Am J Ind Med 61(12): 997-1004.

BACKGROUND: Construction is a dangerous industry with a large number of small businesses. Because they require minimal resources to deliver, toolbox talks may be an ideal

training format for small construction contractors. METHODS: Eight toolbox talks were developed, each with two versions. One version of each toolbox talk was standard and one version included a narrative and discussion questions. Participants were randomly assigned to receive the standard or the narrative version. Pre- and post-intervention surveys measured demographics, workplace safety climate, and knowledge. The post-intervention survey also measured training impact. RESULTS: Including narratives with discussion questions significantly increased knowledge gain and led to increased training impact. Less experienced workers were more likely to gain knowledge and training impact compared to more experienced workers. There were no significant changes in workplace safety climate. CONCLUSIONS: The results suggest that including a narrative and discussion questions increases toolbox talk effectiveness.

Eiris, R., et al. (2018). "PARS: Using Augmented 360-Degree Panoramas of Reality for Construction Safety Training." Int J Environ Res Public Health 15(11).

Improving the hazard-identification skills of construction workers is a vital step towards preventing accidents in the increasingly complex working conditions of construction jobsites. Training the construction workforce to recognize hazards therefore plays a central role in preparing workers to actively understand safety-related risks and make assertive safety decisions. Considering the inadequacies of traditional safety-training methods (e.g., passive lectures, videos, demonstrations), researchers have employed advanced visualization techniques such as virtual reality technologies to enable users to actively improve their hazard-identification skills in a safe and controlled environment. However, current virtual reality techniques sacrifice realism and demand high computational costs to reproduce real environments. Augmented 360-degree panoramas of reality offers an innovative alternative that creates low-cost, simple-to-capture, true-to-reality representations of the actual construction jobsite within which trainees may practice identifying hazards. This proof-of-concept study developed and evaluated a platform using augmented 360-degree panoramas of reality (PARS) for safety-training applications to enhance trainees' hazard-identification skills for four types of sample hazards. Thirty subjects participated in a usability test that evaluated the PARS training platform and its augmented 360-degree images captured from real construction jobsites. The usability reviews demonstrate that the trainees found the platform and augmentations advantageously to learning hazard identification. The results of this study will foreseeably help researchers in developing engaging training platforms to improve the hazard-identification skills of workers.

Esmaeili, B. and M. R. Hallowell (2011). "Diffusion of safety innovations in the construction industry." Journal of Construction Engineering and Management 138(8): 955-963.

Safety performance in the construction industry has improved significantly in the past four decades. This improvement has been attributed in part to the increased implementation of injury prevention strategies. Although the relative effectiveness of these strategies has been studied in previous research, there has been no attempt to evaluate their diffusion. To address this gap in knowledge, 12 highly effective administrative safety innovations were identified in literature, and 58 firms were interviewed to investigate their adoption rate. The diffusion patterns of the identified safety innovations were explored using four common innovation diffusion models: the internal, external, Bass, and Gompetz. The findings indicate that the internal and Bass models have the highest explanatory power and that internal factors are the

most influential factors in adoption of safety innovations by construction firms. It was also found that project-specific training and safety meetings (91%), frequent worksite inspections (91%), and safety and health orientation and training (90%) are the three most commonly adopted safety innovations, and employment of a site safety manager (62%), subcontractor selection and management (64%), and substance abuse programs (69%) were the three innovations most infrequently implemented. The implication of the findings is that the construction industry has now reached saturation with respect to traditional injury prevention strategies and new safety innovations are needed.

Evanoff, B., et al. (2016). "Results of a fall prevention educational intervention for residential construction." Safety science 89: 301-307.

Falls from height remain the leading cause of fatalities in residential construction. We used results from a comprehensive needs assessment to guide changes in fall prevention training in a joint union-contractor carpenter apprenticeship program; including surveys of 1018 apprentice carpenter and observational audits at 197 residential construction sites. The revised training utilized hands-on, participatory training methods preferred by the learners to address the safety gaps in the curriculum; including ladder use, leading edge work, truss setting, and use of scaffolding and personal fall arrest. We compared apprentice surveys (n = 1273) and residential worksite audits (n = 207) 1–2 years post-training with baseline measures. Apprentices working residential construction were more likely to fall from heights (OR = 2.26, 95% CI 1.59–3.21) than those working commercial construction. The revised training resulted in improved fall safety knowledge, self-reported worksite behaviors, risk perceptions, and safety climate, even after adjusting for temporal trends. We also observed significant improvements in fall safety compliance in most domains of the worksite audit, with larger changes observed in areas emphasized in the training, demonstrating specificity of the effect. Greater effects were noted in small and medium-sized contractors, who often have limited resources to devote to safety. Self-reported falls fell from 18.2 to 14.5 per 100 person-years of work. This research supports growing evidence that worksite safety can be improved by training. This curriculum could be readily adapted to other union apprenticeship programs. Fall safety of inexperienced residential construction workers' should remain a focus of future research. © 2016 Elsevier Ltd

Evanoff, B., et al. (2012). "Outcomes of a revised apprentice carpenter fall prevention training curriculum." Work 41 Suppl 1: 3806-3808.

Falls from heights are a leading cause of morbidity and mortality among construction workers, especially inexperienced workers and those performing residential construction. This research reports changes in fall prevention behaviors following revision of fall prevention training in a union-based carpenters' apprenticeship program. We used a comprehensive needs assessment to identify gaps in apprentice carpenters' preparation to work at heights, used these results to guide a school-based fall prevention curriculum to fill these gaps, and measured the effects of the revised curriculum on knowledge, beliefs, and fall prevention behaviors.

Evia, C. (2010). "Localizing and designing computer-based safety training solutions for Hispanic construction workers." Journal of Construction Engineering and Management 137(6): 452-459.

Despite the construction industry's generally positive reaction to the use of information and communication technologies (ICTs) in many of its functions, some of the profession's key players reside in a digital divide and do not benefit from advances in technology. Hispanic construction workers, an at-risk population with high rates of workplace accidents, are affected by that divide because they rarely take advantage of available ICTs at work. One application of ICTs that can help Hispanic/Latino workers is computer-based training (CBT) for occupational safety. However, the design of CBT materials for Spanish-speaking workers needs to go beyond basic localization of existing products in English. A radical localization approach that uses participatory design sessions with construction workers and their supervisors is proposed in this paper. This case study reports that Latino workers reacted positively and retained knowledge from CBT materials, including videos with elements of humor and without graphic representations of accidents, modeled after the genre of a television situation comedy.

Evia, C. and A. Patriarca (2012). "Beyond Compliance: Participatory Translation of Safety Communication for Latino Construction Workers." Journal of Business and Technical Communication 26(3): 340-367.

Developing effective workplace safety and risk communication materials for Latino construction workers poses a challenge for technical communicators. These workers are at a disadvantage because of culture and language differences on many job sites. Furthermore, low levels of literacy in any language and lack of proper training compound their job site communication problems. This article builds on cultural studies-based recommendations to develop discourse in workplace safety and risk that these workers can fully understand. The authors in this study used direct creative input from Latino construction workers in order to create safety and risk communication products that were evaluated as effective and culturally relevant for these workers and their peers. 

Flynn, M. A. and J. M. Sampson (2012). "Trench Safety-Using a Qualitative Approach to Understand Barriers and Develop Strategies to Improve Trenching Practices." International Journal of Construction Education and Research 8(1): 63-79.

Despite efforts to ensure workplace safety and health, injuries and fatalities related to trenching and excavation remain alarmingly high in the construction industry. Because properly installed trenching protective systems can potentially reduce the significant number of trenching fatalities, there is clearly a need to identify the barriers to the use of these systems and to develop strategies to ensure these systems are utilized consistently. The current study reports on the results of focus groups with construction workers and safety management personnel to better understand these barriers and to identify solutions. The results suggest several factors, from poor planning to pressures from experienced workers and supervisors, which present barriers to safe trenching practices. Based on the results, it is recommended that safety trainings incorporate unique messages for new workers, experienced workers and management in an effort to motivate each group to work safely as well as provide them with solutions to overcome the identified barriers. 

Forst, L., et al. (2013). "More than training: Community-based participatory research to reduce injuries among hispanic construction workers." Am J Ind Med 56(8): 827-837.

Background: Workplace mortality and severe injury are disproportionately distributed among foreign born and Hispanic construction workers. Worker Centers (WCs) provide

services and advocacy for low-wage workers and a way for investigators to reach them. The goal of this project is to prevent occupational injuries by increasing awareness of hazards and self-efficacy among foreign born, Hispanic construction workers and by expanding the agenda of WCs to include occupational health and safety (H&S). Methods: Investigators partnered with eight WCs in seven cities to train worker leaders to deliver a modified OSHA 10-hr curriculum to their peers. Results: Thirty-two worker leaders trained 446 workers over 3 years. There was a demonstrated improvement in knowledge, hazard identification, self-efficacy, and sustainable H&S activities. Conclusions: This study provides evidence for successful implementation of a training intervention for low wage, low literacy Hispanic construction workers using a community-based participatory research approach. © 2013 Wiley Periodicals, Inc.

Gillen, M., et al. (2004). "Construction managers' perceptions of construction safety practices in small and large firms: a qualitative investigation." Work 23(3): 233-243.

BACKGROUND AND GOALS: Despite the institution of explicit safety practices in construction, there continue to be exceedingly high rates of morbidity and mortality from work-related injury. This study's purpose was to identify, compare and contrast views of construction managers from large and small firms regarding construction safety practices. A complementary analysis was conducted with construction workers. METHODS: A semi-structured interview guide was used to elicit information from construction managers (n = 22) in a series of focus groups. Questions were designed to obtain information on direct safety practices and indirect practices such as communication style, attitude, expectations, and unspoken messages. Data were analyzed using thematic content analysis. RESULTS: Managers identified a broad commitment to safety, worker training, a changing workplace culture, and uniform enforcement as key constructs in maintaining safe worksites. Findings indicate that successful managers need to be involved, principled, flexible, and innovative. Best practices, as well as unsuccessful injury prevention programs, were discussed in detail. Obstacles to consistent safety practice include poor training, production schedules and financial constraints. CONCLUSIONS: Construction managers play a pivotal role in the definition and implementation of safety practices in the workplace. In order to succeed in this role, they require a wide variety of management skills, upper management support, and tools that will help them instill and maintain a positive safety culture. Developing and expanding management skills of construction managers may assist them in dealing with the complexity of the construction work environment, as well as providing them with the tools necessary to decrease work-related injuries.

Goldenhar, L. M., et al. (2019). "Leadership skills for strengthening jobsite safety climate." J Safety Res 70: 263-271.

INTRODUCTION: Construction foremen may lack the leadership skills needed to create a strong jobsite safety climate. Many construction companies address this by sending their lead workers to the OSHA 30-h course; however the course does not include a leadership training module. This article describes the development and pilot testing of such a module and evaluation surveys designed to address this training gap. METHODS: A 17-member curriculum development team, numerous subject matter experts, and an instructional design company helped us develop a comprehensive set of teaching resources and a set of survey instruments for evaluating the materials' effectiveness on improving safety leadership and safety climate. All materials and surveys were pilot tested with representative members of the target population.

RESULTS: Pilot surveys showed high reliability and data collected on the resulting Foundations for Safety Leadership (FSL) module indicated that the majority of foremen thought the training was helpful or valuable, particularly the discussion questions. The majority said they intended to use the skills on the jobsite. With the exception of the role-play activities, the trainers rated highly all other components, especially the videos and discussion questions. Modifications were made to the training materials and surveys based on pilot test findings. The most important result of the development and pilot testing efforts is that the OSHA Training Institute (OTI) included the FSL as an elective in the OSHA 30-h course. CONCLUSIONS: The FSL module fills a needed skills gap by providing safety leadership training to all foremen who might otherwise not have access to it through their company or union. The continued success of the FSL training will be ensured by dissemination via the OSHA 30-h course, an established nationwide safety training program. Practical applications: The FSL training module has already been widely accepted by the construction industry as a useful approach for providing construction foremen/See new abstract lead workers with the knowledge and skills they need to become more effective jobsite safety leaders.

Goldsheyder, D., et al. (2002). "Musculoskeletal symptom survey among mason tenders." Am J Ind Med 42(5): 384-396.

BACKGROUND: Low back pain (LBP) constitutes a major problem in construction. The magnitude and musculoskeletal injury characteristics in certain construction trades have been studied extensively. Musculoskeletal research targeting mason tenders is limited. High physical demands of the job primarily contribute to an increased risk of LBP experienced by these laborers. METHODS: A symptom survey was conducted to determine the magnitude and musculoskeletal injury characteristics among the mason tenders, and to identify work-related activities perceived by them as contributing to their disorders. RESULTS: The findings revealed that 82% of the mason tenders experienced at least one musculoskeletal symptom in the last year. LBP was the most frequently reported symptom (65%). Due to LBP, 12% of the laborers missed work and 18% of them visited a physician. Bending or twisting the back, working in the same position or in pain, and heavy lifting they perceived as the most problematic work-related activities. The vast majority of the laborers requested job-safety training. CONCLUSIONS: The mason tenders experienced high prevalence of LBP. To address the problem a model for primary prevention of LBP was developed and implemented in the trade. The model incorporated ergonomic principles, hazard recognition, and problem solving in the training curriculum for the union instructors teaching apprentices the trade-specific skills.

Halperin, K. M. and M. McCann (2004). "An evaluation of scaffold safety at construction sites." J Safety Res 35(2): 141-150.

PROBLEM: This study evaluated common scaffold safety practices in construction. METHOD: A 150-point checklist was used to evaluate supported scaffold safety practices at 113 scaffolds in nine areas of the eastern United States. RESULTS: Thirty-six scaffolds (31.9%) were either in danger of collapse or missing planking, guardrails, or adequate access. There was a strong statistical correlation between structural flaws and fall protection hazards, and between proper scaffold safety practice and (a) competent persons with scaffold safety training, (b) use of separate scaffold erection contractors, and (c) scaffolds that were not simple frame types. A slightly weaker correlation was found with union status of the scaffold erector, and no correlation was found with geography, site size, number of scaffold users, and trade working on

the scaffold. DISCUSSION: Recommendations are made for safer scaffold practice, including a simple four-factor scaffold inspection method. IMPACT ON INDUSTRY: Implementation of the four-factor method could result in a cost-effective way to identify unsafe scaffolds.

Hammer, L. B., et al. (2015). "Effects of a Workplace Intervention Targeting Psychosocial Risk Factors on Safety and Health Outcomes." Biomed Res Int 2015: 836967.

The goal of this study was to test the effectiveness of a workplace intervention targeting work-life stress and safety-related psychosocial risk factors on health and safety outcomes. Data were collected over time using a randomized control trial design with 264 construction workers employed in an urban municipal department. The intervention involved family- and safety-supportive supervisor behavior training (computer-based), followed by two weeks of behavior tracking and a four-hour, facilitated team effectiveness session including supervisors and employees. A significant positive intervention effect was found for an objective measure of blood pressure at the 12-month follow-up. However, no significant intervention results were found for self-reported general health, safety participation, or safety compliance. These findings suggest that an intervention focused on supervisor support training and a team effectiveness process for planning and problem solving should be further refined and utilized in order to improve employee health with additional research on the beneficial effects on worker safety.

Hardison, D., et al. (2014). "Identifying construction supervisor competencies for effective site safety." Safety science 65: 45-53.

Construction supervisors are crucial to eventual site safety performance. In the United States, the OSHA 30-hour training is becoming the de facto standard for supervisor safety competence. A literature review of recommended supervisor safety competencies reveals gaps when compared to the OSHA 30-hour training contents. We address this gap by identifying the necessary knowledge-based safety competencies that are most important for the front-line construction supervisor and prioritizing them for the first time. A Delphi process confirmed that knowledge of pre job planning, organizing work flow, establishing effective communication, and of routine and non-routine work tasks are highly important competencies for the construction supervisor to possess. Construction organizations who utilize the 30-hour training for supervisor safety competence must recognize its limitations and ensure supervisors are equipped with these additional competencies to effectively manage site safety. Government agencies should also recognize the policy limitations of requiring the 30-hour training for supervisors. © 2013 Elsevier Ltd.

Harrington, D., et al. (2009). "Conducting effective tailgate trainings." Health Promot Pract 10(3): 359-369.

The California Department of Health Services' Occupational Health Branch and others have identified the construction industry as being at high risk for injuries, illnesses, and fatalities. Effective tailgate trainings (brief job site safety meetings) can be a powerful tool to promote hazard awareness and safe work practices. The authors found that many contractors and supervisors conducted ineffective tailgate trainings. They developed the BuildSafe California Project to assist contractors to have more effective programs by holding 25 training-of-trainers sessions reaching 1,525 participants. The needs assessment, intervention, and evaluation results from the first 18 trainings are presented. Eighty-six percent of the participants found the program "very helpful." Participants used the materials and made improvements in

the quality and frequency of trainings. Supervisors must be skilled at conducting tailgate trainings as part of their responsibilities. There is a serious need to provide more culturally appropriate safety training in a workforce increasingly made up of Latino workers.

Hasanzadeh, S., et al. (2017). "Measuring the Impacts of Safety Knowledge on Construction Workers' Attentional Allocation and Hazard Detection Using Remote Eye-Tracking Technology." Journal of Management in Engineering 33(5).

Although several studies have highlighted the importance of attention in reducing the number of injuries in the construction industry, few have attempted to empirically measure the attention of construction workers. One technique that can be used to measure worker attention is eye tracking, which is widely accepted as the most direct and continuous measure of attention because where one looks is highly correlated with where one is focusing his or her attention. Thus, with the fundamental objective of measuring the impacts of safety knowledge (specifically, training, work experience, and injury exposure) on construction workers' attentional allocation, this study demonstrates the application of eye tracking to the realm of construction safety practices. To achieve this objective, a laboratory experiment was designed in which participants identified safety hazards presented in 35 construction site images ordered randomly, each of which showed multiple hazards varying in safety risk. During the experiment, the eye movements of 27 construction workers were recorded using a head-mounted EyeLink II system. The impact of worker safety knowledge in terms of training, work experience, and injury exposure (independent variables) on eye-tracking metrics (dependent variables) was then assessed by implementing numerous permutation simulations. The results show that tacit safety knowledge acquired from work experience and injury exposure can significantly improve construction workers' hazard detection and visual search strategies. The results also demonstrate that (1) there is minimal difference, with or without the Occupational Safety and Health Administration 10-h certificate, in workers' search strategies and attentional patterns while exposed to or seeing hazardous situations; (2) relative to less experienced workers (<5 years), more experienced workers (>10 years) need less processing time and deploy more frequent short fixations on hazardous areas to maintain situational awareness of the environment; and (3) injury exposure significantly impacts a worker's visual search strategy and attentional allocation. In sum, practical safety knowledge and judgment on a jobsite requires the interaction of both tacit and explicit knowledge gained through work experience, injury exposure, and interactive safety training. This study significantly contributes to the literature by demonstrating the potential application of eye-tracking technology in studying the attentional allocation of construction workers. Regarding practice, the results of the study show that eye tracking can be used to improve worker training and preparedness, which will yield safer working conditions, detect at-risk workers, and improve the effectiveness of safety-training programs. 

Hess, J. A., et al. (2020). "Safety Voice for Ergonomics (SAVE): Evaluation of a masonry apprenticeship training program." Appl Ergon 86: 103083.

BACKGROUND: Masons have a high rate of musculoskeletal disorders among construction workers and greater than all other industries. Viable solutions to musculoskeletal hazards have been identified by industry stakeholders, yet masons receive minimal ergonomics training. Apprentices, as the next generation of masons, need training and strategies to identify and speak up about ergonomic and safety issues on job sites. To fill this gap, our team

developed the Safety Voice for Ergonomics (SAVE) training program. METHODS: The interactive, 7-unit SAVE program was developed specifically for masonry brick and block apprentices. This innovative training contains detailed ergonomics lessons focusing on risk factors and solutions specific to this masonry craft. It also contains lessons that provide communication and problem solving strategies. Evaluation of SAVE employed a randomized control trial designed to assess the effectiveness of SAVE for apprentices over a six-month period. RESULTS: Our findings demonstrated that compared to controls, SAVE trained apprentices used their safety voice more (P = .049) and had greater safety participation (P = .028). They adopted more ergonomic practices such as adjusting scaffolding (P = .016) and using better body postures (P = 042). Apprentices liked SAVE and indicated that it prompted them to change workplace safety behaviors. CONCLUSIONS: SAVE is an effective program, providing needed ergonomic and safety communication training for workers as they begin their trade. The broad adoption of SAVE training by the masonry industry has the potential to empower apprentices, elevate the trade's safety culture, and ultimately reduce musculoskeletal disorders.

Hinze, J. (2005). "Use of trench boxes for worker protection." Journal of Construction Engineering and Management 131(4): 494-500.

Safe work practices for the use of trench boxes identified by a survey of utility contractors are presented. Trench boxes are designed to protect workers from cave-ins, but human error and judgment can lead to unnecessary risks. The practices include the prevention of workers leaving the trench by the backfill and the provision of frequent training courses

Hsiao, H., et al. (2005). "Human responses to augmented virtual scaffolding models." Ergonomics 48(10): 1223-1242.

This study investigated the effect of adding real planks, in virtual scaffolding models of elevation, on human performance in a surround-screen virtual reality (SSVR) system. Twenty-four construction workers and 24 inexperienced controls performed walking tasks on real and virtual planks at three virtual heights (0, 6 m, 12 m) and two scaffolding-platform-width conditions (30, 60 cm). Gait patterns, walking instability measurements and cardiovascular reactivity were assessed. The results showed differences in human responses to real vs. virtual planks in walking patterns, instability score and heart-rate inter-beat intervals; it appeared that adding real planks in the SSVR virtual scaffolding model enhanced the quality of SSVR as a human - environment interface research tool. In addition, there were significant differences in performance between construction workers and the control group. The inexperienced participants were more unstable as compared to construction workers. Both groups increased their stride length with repetitions of the task, indicating a possibly confidence- or habit-related learning effect. The practical implications of this study are in the adoption of augmented virtual models of elevated construction environments for injury prevention research, and the development of programme for balance-control training to reduce the risk of falls at elevation before workers enter a construction job.

Huang, Y. H., et al. (2006). "Safety climate and self-reported injury: assessing the mediating role of employee safety control." Accid Anal Prev 38(3): 425-433.

To further reduce injuries in the workplace, companies have begun focusing on organizational factors which may contribute to workplace safety. Safety climate is an

organizational factor commonly cited as a predictor of injury occurrence. Characterized by the shared perceptions of employees, safety climate can be viewed as a snapshot of the prevailing state of safety in the organization at a discrete point in time. However, few studies have elaborated plausible mechanisms through which safety climate likely influences injury occurrence. A mediating model is proposed to link safety climate (i.e., management commitment to safety, return-to-work policies, post-injury administration, and safety training) with self-reported injury through employees' perceived control on safety. Factorial evidence substantiated that management commitment to safety, return-to-work policies, post-injury administration, and safety training are important dimensions of safety climate. In addition, the data support that safety climate is a critical factor predicting the history of a self-reported occupational injury, and that employee safety control mediates the relationship between safety climate and occupational injury. These findings highlight the importance of incorporating organizational factors and workers' characteristics in efforts to improve organizational safety performance.

Hung, Y.-H., et al. (2013). "Identifying fall-protection training needs for residential roofing subcontractors." Appl Ergon 44(3): 372-380.

Falls remain the leading cause of injuries and fatalities in the small residential roofing industry and analogous investigations are underrepresented in the literature. To address this issue, fall-protection training needs were explored through 29 semi-structured interviews among residential roofing subcontractors with respect to recommendations for the design of fall-protection training. Content analysis using grounded theory was conducted to analyze participants' responses. Results of the analysis revealed six themes related to the design of current fall-protection training: (1) barriers to safety training; (2) problems of formal safety-training programs; (3) recommendations for training implementation; (4) important areas for fall-protection training; (5) training delivery means; and (6) design features of training materials. Results of the study suggest the need for informal jobsite safety training to complement what had been covered in formalized safety training. This work also provides recommendations for the design of a more likely adopted fall-protection training program.

Jaegers, L., et al. (2014). "Development of a program logic model and evaluation plan for a participatory ergonomics intervention in construction." Am J Ind Med 57(3): 351-361.

Background: Intervention studies in participatory ergonomics (PE) are often difficult to interpret due to limited descriptions of program planning and evaluation. Methods: In an ongoing PE program with floor layers, we developed a logic model to describe our program plan, and process and summative evaluations designed to describe the efficacy of the program. Results: The logic model was a useful tool for describing the program elements and subsequent modifications. The process evaluation measured how well the program was delivered as intended, and revealed the need for program modifications. The summative evaluation provided early measures of the efficacy of the program as delivered. Conclusions: Inadequate information on program delivery may lead to erroneous conclusions about intervention efficacy due to Type III error. A logic model guided the delivery and evaluation of our intervention and provides useful information to aid interpretation of results. 

Jeelani, I., et al. (2017). "Development and Testing of a Personalized Hazard-Recognition Training Intervention." Journal of Construction Engineering and Management 143(5).

Unrecognized or unmanaged hazards can expose workers to unanticipated safety risk and can potentially result in catastrophic safety incidents. Unfortunately, recent research has demonstrated that a large proportion of safety hazards remain unrecognized in construction workplaces. To improve hazard-recognition levels, employers adopt a variety of safety and hazard-recognition training programs. However, desirable levels of hazard recognition have not been achieved, and the expected benefits from training have not been attained. Such failure in training efforts have generally been attributed to the adoption of poor and ineffective training practices. While efforts are being undertaken to address these issues, construction research has not focused on developing or evaluating personalized training solutions that are customized to the learning needs of individual workers. To advance theory and practice, the objective of this study was to develop the first personalized training strategy targeted at improving hazard-recognition levels. The objective was accomplished by a collaborative effort involving two industry experts and three academic researchers, along with guidance from training literature. The training strategy incorporates important elements known to improve stimuli or threat detection in domains including medicine, the military, and aviation. The elements include (1) visual cues to aid systematic hazard search, (2) personalized hazard-recognition performance feedback, (3) personalized eye-tracking visual attention feedback, and (4) metacognitive prompts that trigger the adoption of remedial measures. After development, the effectiveness of the training strategy in improving hazard recognition was empirically evaluated using the nonconcurrent multiple-baseline testing approach. The findings of the study showed that the participating workers on average were able to identify only 42% of hazards prior to the introduction of the intervention; but were able to recognize 77% of hazards in the intervention phase. The findings of this study will be of interest to practicing professionals seeking to improve hazard-recognition levels within construction. 

Jeelani, I., et al. (2020). "Development of virtual reality and stereo-panoramic environments for construction safety training." Engineering, Construction and Architectural Management 27(8): 1853-1876.

Purpose Workers and construction professionals are generally not proficient in recognizing and managing safety hazards. Although valuable, traditional training experiences have not sufficiently addressed the issue of poor hazard recognition and management in construction. Since hazard recognition and management are cognitive skills that depend on attention, visual examination and decision-making, performance assessment and feedback in an environment that is realistic and representative of actual working conditions are important. The purpose of this paper is to propose a personalized safety training protocol that is delivered using robust, realistic and immersive environments. Design/methodology/approach Two types of virtual environments were developed: (1) Stereo-panoramic environments using real construction scenes that were used to evaluate the performance of trainees accurately and (2) A virtual construction site, which was used to deliver various elements of instructional training. A training protocol was then designed that was aimed at improving the hazard recognition and management performance of trainees. It was delivered using the developed virtual environments. The effectiveness of the training protocol was experimentally tested with 53 participants using a before–after study. Findings The results present a 39% improvement in hazard recognition and a 44% improvement in hazard management performance. Originality/value This study combines the benefits of using a virtual environment for providing

instructional training along with realistic environments (stereo-panoramic scenes) for performance assessment and feedback. The training protocol includes several new and innovative training elements that are designed to improve the hazard recognition and hazard management abilities of the trainees. Moreover, the effectiveness of training in improving hazard recognition and hazard management is measured using specific outcome variables.

Jorgensen, E., et al. (2007). "An English/Spanish safety climate scale for construction workers." Am J Ind Med 50(6): 438-442.

BACKGROUND: Workers in the construction trades experience high rates of traumatic injury. An increasing number of workers in this industry speak only Spanish, including members of construction trade unions. This brief communication reports a dual language safety climate scale developed during a larger training intervention study. METHODS: Construction workers in two unions self-completed a previously validated 6-item safety climate scale modified for the construction trades. A seventh item was developed midway through the study and incorporated into the version completed by half of the respondents. For one union with a sizeable number of Spanish-speaking members, a dual-language (Spanish/English) version was administered. Follow-up telephone interviews conducted 3 months after the self-completed survey also included the safety climate scale. RESULTS: Cronbach's coefficient alpha was 0.85 for the 6-item scale and 0.85 for the 7-item scale. Similar coefficient alpha scores were found for the subgroup of Spanish-speakers on the 6- and 7-item scales. Spanish speakers with low education were less likely to respond to the scale when self-completing but not when it was administered by telephone in Spanish. CONCLUSION: This safety climate scale elicits consistent and reliable response from unionized construction workers when administered in English or in Spanish. Spanish literacy may be a consideration for the use of this scale among foreign-born Hispanic workers.

Kaskutas, V., et al. (2016). "Foremen's intervention to prevent falls and increase safety communication at residential construction sites." Am J Ind Med 59(10): 823-831.

Background: This research aimed to improve residential construction foremen's communication skills and safety behaviors of their crewmembers when working at heights. Methods: Eighty-four residential construction foremen participated in the 8-hr fall prevention and safety communication training. We compared pre- and post-intervention surveys from foremen and their crewmembers to measure the effect of training. Results: Foremen and crewmembers' ratings showed improvements in fall prevention knowledge, behaviors, and safety communication and were sustained 6-months post-training, with emphasized areas demonstrating larger increases. Ratings were similar between foremen and crewmembers, suggesting that the foremen effectively taught their crew and assigned accurate ratings. Based upon associations between safety behaviors and reported falls observed in prior research, we would expect a 16.6% decrease in the one year cumulative incidence of self-reported falls post-intervention. Conclusions: This intervention improved safety knowledge and behaviors of a large number of workers by training construction foremen in fall prevention and safety communication skills. Am. J. Ind. Med. 59:823–831, 2016.  © 2016 Wiley Periodicals, Inc.

Kaskutas, V., et al. (2013). "Fall prevention and safety communication training for foremen: Report of a pilot project designed to improve residential construction safety." J Safety Res 44: 111-118.

PROBLEM: Falls from heights account for 64% of residential construction worker fatalities and 20% of missed work days. We hypothesized that worker safety would improve with foremen training in fall prevention and safety communication. METHOD: Training priorities identified through foreman and apprentice focus groups and surveys were integrated into an 8-hour training. We piloted the training with ten foremen employed by a residential builder. Carpenter trainers contrasted proper methods to protect workers from falls with methods observed at the foremen's worksites. Trainers presented methods to deliver toolbox talks and safety messages. Results from worksite observational audits (n=29) and foremen/crewmember surveys (n=97) administered before and after training were compared. RESULTS: We found that inexperienced workers are exposed to many fall hazards that they are often not prepared to negotiate. Fall protection is used inconsistently and worksite mentorship is often inadequate. Foremen feel pressured to meet productivity demands and some are unsure of the fall protection requirements. After the training, the frequency of daily mentoring and toolbox talks increased, and these talks became more interactive and focused on hazardous daily work tasks. Foremen observed their worksites for fall hazards more often. We observed increased compliance with fall protection and decreased unsafe behaviors during worksite audits. DISCUSSION: Designing the training to meet both foremen's and crewmembers' needs ensured the training was learner-centered and contextually-relevant. This pilot suggests that training residential foremen can increase use of fall protection, improve safety behaviors, and enhance on-the-job training and safety communication at their worksites. IMPACT ON INDUSTRY: Construction workers' training should target safety communication and mentoring skills with workers who will lead work crews. Interventions at multiple levels are necessary to increase safety compliance in residential construction and decrease falls from heights.

Kaskutas, V., et al. (2010). "Fall prevention among apprentice carpenters." Scand J Work Environ Health 36(3): 258-265.

OBJECTIVES: Falls from heights are a leading cause of mortality and morbidity in the construction industry, especially among inexperienced workers. We surveyed apprentice carpenters to identify individual and organizational factors associated with falls from heights. METHODS: We developed a 72-item survey on fall prevention with multiple domains including fall experience, fall-prevention knowledge, risk perceptions, confidence in ability to prevent falls, training experience, and perceptions of the safety climate and crew safety behaviors. We administered the questionnaire to apprentice carpenters in this cross-sectional study. RESULTS: Of the 1025 respondents, 51% knew someone who had fallen from a height at work and 16% had personally fallen in the past year, with ladders accounting for most of the falls. Despite participation in school-based and on-the-job training, fall-prevention knowledge was poor. Ladders were perceived as low risk and ladder training was rare. Apprentices reported high levels of unsafe, fall-related behaviors on their work crews. Apprentices in residential construction were more likely to fall than those in commercial construction, as were apprentices working on crews with fewer senior carpenters to provide mentorship, and those reporting more unsafe behaviors among fellow workers. CONCLUSIONS: Despite participation in a formal apprenticeship program, many apprentices work at heights without adequate preparation and subsequently experience falls. Apprenticeship programs can improve the timing and content of

fall-prevention training. This study suggests that organizational changes in building practices, mentorship, and safety practices are also necessary to decrease worker falls from heights.

Kaskutas, V., et al. (2010). "Changes in fall prevention training for apprentice carpenters based on a comprehensive needs assessment." J Safety Res 41(3): 221-227.

PROBLEM: Falls from heights in residential construction are common, especially among inexperienced workers. METHODS: We conducted a comprehensive needs assessment to determine gaps in the school-based apprentice carpenters' fall prevention training. A team of carpenter instructors and researchers revised the fall prevention training to fill these gaps. Apprentice evaluation and feedback guided ongoing curricular improvements. RESULTS: Most apprentice carpenters performed work tasks at heights prior to training and fall protection techniques were not commonly used at residential construction sites. Priorities of the revised school-based training included safe ladder habits, truss setting, scaffold use, guarding floor openings, and using personal fall arrest systems. New apprentices were targeted to ensure training prior to exposure at the workplace. We used adult learning principles to emphasize hands-on experiences. A framed portion of a residential construction site was fabricated to practice fall protection behaviors in a realistic setting. The revised curriculum has been delivered consistently and apprentice feedback has been very favorable. CONCLUSIONS: Integration of needs assessment results was invaluable in revising the school-based carpenters apprentice fall prevention curriculum. Working closely with the instructors to tailor learning experiences has provided preliminary positive results. IMPACT ON INDUSTRY: The fall safety of the residential construction industry continues to lag behind commercial construction and industrial settings. The National Occupational Research Agenda includes a Strategic Goal to strengthen and extend the reach of quality training and education in the construction industry via mechanisms such as construction safety and health training needs assessments. This study demonstrates how a structured process can be used to identify and remedy gaps and improve training effectiveness. We encourage others to take steps to assess and increase the impact of training efforts directed at all residential construction professionals; including both union and non-union workers. The implications are even greater in the non-union sector where most U.S. residential work is done.

Kazan, E. and M. A. Usmen (2018). "Worker safety and injury severity analysis of earthmoving equipment accidents." J Safety Res 65: 73-81.

INTRODUCTION: Research on construction worker safety associated with construction equipment has mostly focused on accident type rather than injury severity and the embedded factor relationships. Significant variables and their effects on the degree of injury are examined for earthmoving equipment using data from OSHA. Four types of equipment, backhoe, bulldozer, excavator, and scraper are included in the study. Accidents involving on-foot workers and equipment operators are investigated collectively, as well as separately. METHODS: Cross tabulation analysis was conducted to establish the associations between selected categorical variables, using degree of injury as a dichotomous dependent variable (fatal vs. nonfatal) and a number of independent variables having different values. Odds ratios were calculated to determine how much a certain variable/factor increases the odds of fatality in an accident, and the odds ratios were ranked to determine the relative impact of a given factor. RESULTS: It was found that twelve variables were significantly associated with injury severity. Rankings based on odds ratios showed that inadequate safety training (2.54), missing

equipment protective system (2.38), being a non-union worker (2.26), being an equipment operator (1.93), and being on or around inadequately maintained equipment (1.58) produced higher odds for fatality. CONCLUSION: A majority of the earthmoving equipment accidents resulted in fatality. Backhoes were the most common equipment involved in accidents and fatalities. Struck-by accidents were the most prevalent and most fatal. Non-OSHA compliant safety training, missing seatbelt, operator not using seatbelt, malfunctioning back-up alarms, and poorly maintained equipment were factors contributing to accidents and fatalities. On-foot workers experienced a higher number of accidents than operators, while fatality odds were higher for the operators. Practical applications: Safety professionals should benefit from our findings in planning and delivering training and providing oversight to workers in earthmoving equipment operations.

Kincl, L. D., et al. (2016). "Safety voice for ergonomics (SAVE) project: Protocol for a workplace cluster-randomized controlled trial to reduce musculoskeletal disorders in masonry apprentices." BMC Public Health 16: 362.

Background: Masons have the highest rate of overexertion injuries among all construction trades and rank second for occupational back injuries in the United States. Identified ergonomic solutions are the primary method of reducing exposure to risk factors associated with musculoskeletal disorders. However, many construction workers lack knowledge about these solutions, as well as basic ergonomic principles. Construction apprentices, as they embark on their careers, are greatly in need of ergonomics training to minimize the cumulative exposure that leads to musculoskeletal disorders. Apprentices receive safety training; however, ergonomics training is often limited or non-existent. In addition, apprenticeship programs often lack "soft skills" training on how to appropriately respond to work environments and practices that are unsafe. The SAVE program - SAfety Voice for Ergonomics - strives to integrate evidence-based health and safety training strategies into masonry apprenticeship skills training to teach ergonomics, problem solving, and speaking up to communicate solutions that reduce musculoskeletal injury risk. The central hypothesis is that the combination of ergonomics training and safety voice promotion will be more effective than no training or either ergonomics training alone or safety voice training alone. Methods/design: Following the development and pilot testing of the SAVE intervention, SAVE will be evaluated in a cluster-randomized controlled trial at 12 masonry training centers across the U.S. Clusters of apprentices within centers will be assigned at random to one of four intervention groups (n = 24 per group): (1) ergonomics training only, (2) safety voice training only, (3) combined ergonomics and safety voice training, or (4) control group with no additional training intervention. Outcomes assessed at baseline, at the conclusion of training, and then at six and 12 months post training will include: musculoskeletal symptoms, general health perceptions, knowledge of ergonomic and safety voice principles, and perception and attitudes about ergonomic and safety voice issues. Discussion: Masons continue to have a high rate of musculoskeletal disorders. The trade has an expected increase of 40 % in the number of workers by 2020. Therefore, a vetted intervention for apprentices entering the trade, such as SAVE, could reduce the burden of musculoskeletal disorders currently plaguing the trade. © 2016 Kincl et al.

Kincl, L. D., et al. (2020). "Efficacy of text messaging apprentices to reinforce ergonomics and safety voice training." J Safety Res 74: 35-43.

INTRODUCTION: Injuries and work-related musculoskeletal disorders (MSDs) are common among masons. SAfety Voice for Ergonomics (SAVE) integrates training in ergonomic and safety problem-solving skills into masonry apprenticeship training. The purpose of this study was to assess the efficacy of text messaging to reinforce SAVE program content. METHOD: SAVE effectiveness was evaluated at masonry apprenticeship training centers across the United States by comparing three experimental groups: (1) Ergonomics training, (2) Ergonomics and Safety Voice training, and a (3) Control. Apprentices received SAVE training with their standard instruction. To reinforce classroom training, refresher training was implemented by sending weekly text messages for six months. Half of the text messages required a response, which tested knowledge or assessed behavior, while the remaining reiterated knowledge. Apprentices (n = 119) received SAVE text messages. Response rates and percentage of correct responses were compared with chi-square tests and independent group t-tests. Multivariable logistic regression analysis predicted apprentice response with selected demographic and work experience variables. Finally, feedback on of the use of text messaging was obtained. RESULT: Of 119 participants, 61% (n = 72) responded to at least one text message. Logistic regression revealed that being a high school graduate and a brick and block mason significantly affected the odds of responding. Sixty-nine percent of apprentices agreed that text messages reinforced SAVE content. CONCLUSION: Even though there was no training center requirement to respond, the high response rate suggests that text messaging can effectively be used to reinforce ergonomics and safety voice training for both knowledge and behavior. Practical Application: The prevalent use of text messaging creates opportunities to reinforce health and safety training and engage workers, especially for populations that may be at various locations over time such as construction sites. Instructors and practitioners should consider the utility of text messaging for supporting their training and safety programs.

Lara, M., et al. (2021). "Pilot of a Community Health Worker Video Intervention for Immigrant Day Laborers at Occupational Health Risk." Front Public Health 9: 662439.

Significance: Immigrant day laborers suffer from disproportionate occupational health risks from hazardous reconstruction jobs after natural disasters. Methods: We conducted a randomized controlled trial of a short-video educational intervention to improve safety knowledge and intent to engage in safety preventive behaviors among 98 Hispanic day laborers (49 randomized to video and 49 control). The short video featured a male promotor and a female promotora who narrated 3 stories of day laborers who were injured while doing construction work in post-Katrina New Orleans. The main outcome measures were changes in scores for day laborer-reported safety knowledge and safety behaviors derived from interviewer-delivered baseline and post-intervention surveys. Results: Video participants reported improvement in overall average safety knowledge score (mean score of 11.3 out of a max score of 12 or 94% when standardized to 0-100% scale), as compared to the control group (mean score of 8.6 or 72%) who were not offered the video ($p < 0.00001$). The intervention was highly successful in workers stating that they learned and were willing to change their safety preventive behaviors to reduce their occupational risk. The average safety behavior score was higher among those watching the video (17.2 out of a max of 22 or 78.1% when standardized on a scale 0-100%) as compared to control (14.5 or 65.9%) ($p = 0.0024$). Conclusion: A short video intervention can improve knowledge and intent to engage in preventive behaviors among Hispanic workers for which there is a dearth of construction safety preventive research.

Lin, K.-Y., et al. (2018). "Training of Low-Literacy and Low-English-Proficiency Hispanic Workers on Construction Fall Fatality." Journal of Management in Engineering 34(2): 05017009.

The construction industry has made extensive efforts to improve the safety of its labor force through various approaches, including training. However, many construction workers in the United States are recent immigrants who lack English proficiency and do not possess sufficient literacy levels in their own language for training comprehension. This reduces the effectiveness of traditional text-dominated translated training materials, which depend on both literacy and proficiency in a language. Thus, in this study, the authors used three-dimensional (3D) visualization to overcome the communication barriers that hinder effective safety training for low-literacy (LL) and low-English-proficiency (LEP) construction workers. This article summarizes the contributions of a study sponsored by the Occupational Safety and Health Administration (OSHA) Susan Harwood Training Grant Program; it describes the methodology to develop scenario-based 3D training materials on fall safety for LL and LEP workers and to validate the effectiveness of the materials. The results show that 3D training materials improve interaction between trainer and trainee during safety training, facilitate learning processes, and can overcome some of the communication barriers that hinder effective safety training.

Lipscomb, H. J., et al. (2008). "Challenges in residential fall prevention: insight from apprentice carpenters." Am J Ind Med 51(1): 60-68.

BACKGROUND: Falls remain a serious source of morbidity and mortality in residential construction despite considerable knowledge of risk factors and prevention strategies. While training is universally viewed as positive, we know little about its effectiveness in preventing residential falls. METHODS: A series of focus groups were conducted with union apprentice carpenters (n = 36) at varied levels of training to elicit input on factors that might influence the effectiveness of residential fall prevention training, including hazard awareness, timing of elements of formal instruction, jobsite mentoring, and workplace norms. RESULTS: While apprentices identified many residential fall hazards, they voiced little concern about work near unprotected vertical or horizontal openings such as stairwells, window openings or leading edges. On residential jobs, apprentices worked at heights immediately and were often exposed to hazards they had not yet been trained to handle. The quality of mentoring varied tremendously, and things they had been taught in school were often not the norm on these small worksites. Use of fall arrest equipment was uncommon. Job insecurity in this fast-paced work environment influenced behaviors even when apprentices reported knowledge of safe procedures; this was more of a problem for less experienced apprentices. CONCLUSIONS: These data provide compelling evidence that apprentices often do not apply safety principles they have been taught in school in the actual work environment, illuminating how attempts to empower workers through training alone can fall short. The findings have policy implications and demonstrate the importance of measuring more than knowledge when evaluating effectiveness of training.

Lipscomb, H. J., et al. (2006). "Nail gun injuries in apprentice carpenters: risk factors and control measures." Am J Ind Med 49(7): 505-513.

BACKGROUND: Nail guns increase residential construction productivity but their use is associated with risk of injury. METHODS: Active surveillance data from 772 apprentice carpenters were used to document the injury risk associated with the use of nail guns and the

potential impact of modifiable risk factors. Using reported work hours and nail gun injuries injury rates per 200,000 hr worked in the past year were calculated. Using estimates of hours of tool use, Poisson regression was used to calculate adjusted rate ratios for injury associated with time in the trade, trigger mechanism on the tools and training prior to injury. RESULTS: Forty-five percent of these apprentices had sustained a nail gun injury; injury rates in the past year based on hours of work were considerably higher than previously recognized. Those with less than 1 year in the trade compared to those with more than 5 years experience (RR = 2.7; 95% CI 1.2, 5.9) and those with no training in tool use (RR = 2.9; 95% CI 1.9, 4.4) were at greatest risk. After adjusting for experience and training, the rate of injury was twice as high with tools with a contact trip trigger compared to those with a sequential trigger (RR = 2.0; 95% CI 1.2, 3.3). CONCLUSIONS: Preventive measures should include change to the safer sequential trigger that prevents unintentional firing and early training in safe tool use. Because of the high prevalence of use of tools with contact trip triggers the greatest number of injuries among these apprentices could be prevented with an engineering solution.

Lipscomb, H. J., et al. (2008). "Prevention of traumatic nail gun injuries in apprentice carpenters: use of population-based measures to monitor intervention effectiveness." Am J Ind Med 51(10): 719-727.

INTRODUCTION: Nail guns are responsible for a significant injury burden in residential construction. Risk, based on hours of work, is particularly high among apprentice carpenters due in part to more frequent exposure to tool use. METHODS: Nail gun injuries were evaluated over 3 years among carpenters enrolled in two apprenticeship programs in the Midwest (2.3 million residential work hours observed) following initiation of training and a voluntary ANSI standard change calling for safer sequential triggers on framing nailers. Injury rates, based on hours of tool use, were calculated yearly. Rates and adjusted rate ratios were calculated with Poisson regression. Attributable risk percent (AR%) and population attributable risk (PAR%) were calculated yearly for modifiable independent risk factors for injury including lack of training in tool use and type of trigger mechanism on tools being used. RESULTS: As apprentices received training and safer trigger mechanisms became more widespread, injury rates decreased significantly (31%). While school training and hands-on mentoring were both important, injury rates were lowest among apprentices who received both. Although injury rates changed over the observation period, the relative risk comparing trigger mechanisms did not; contact trip triggers consistently carried a twofold risk. CONCLUSIONS: Although training and safer trigger use both increased, because of the relative prevalence of training and trigger exposures in this population, the engineering solution consistently had the potential to make more difference in population risk. Our findings demonstrate the utility of observational methods including measures of population-based risk in monitoring intervention effectiveness and making recommendations that lead to injury reduction.

Lipscomb, H. J., et al. (2010). "Continued progress in the prevention of nail gun injuries among apprentice carpenters: what will it take to see wider spread injury reductions?" J Safety Res 41(3): 241-245.

PROBLEM: Nail guns are a common source of acute, and potentially serious, injury in residential construction. METHOD: Data on nail gun injuries, hours worked and hours of tool use were collected in 2008 from union apprentice carpenters (n=464) through classroom surveys; this completed four years of serial cross-sectional data collection from apprentices. A

predictive model of injury risk was constructed using Poisson regression. RESULTS: Injury rates declined 55% from baseline measures in 2005 with early training and increased use of tools with sequential actuation. Injury rates declined among users of tools with both actuation systems, but the rates of injury were consistently twice as high among those using tools with contact trip triggers. DISCUSSION AND IMPACT: Nail gun injuries can be reduced markedly through early training and use of tools with sequential actuation. These successful efforts need to be diffused broadly, including to the non-union sector.

Liu, K. H., et al. (2019). "The Gap Between Tools and Best Practice: An Analysis of Safety Prequalification Surveys in the Construction Industry." New Solut 28(4): 683-703.

This study characterizes safety prequalification surveys currently in use in the construction industry to identify approaches that include leading indicators of worker safety performance. We collected prequalification surveys available in the public domain from internet searches, construction company websites, published literature, and construction industry partners. We utilized a conceptual framework, based on safety theory and best practices, to categorize survey questions. Fifty-two prequalification surveys were identified containing 112 unique questions. Most included questions related to lagging indicators (83 percent), safety management leadership (75 percent), and worker training (60 percent). Safety management system elements such as hazard prevention and control, program evaluation and improvement, and coordination and communication were notably absent in 90 percent of the surveys. There was little consistency in the surveys available concerning leading indicators of safety. Only a small number of surveys currently in use incorporate all the elements of best practices associated with robust safety management systems.

Manjourides, J., et al. (2018). "The Effect of Workforce Mobility on Intervention Effectiveness Estimates." Ann Work Expo Health 62(3): 259-268.

BACKGROUND: Little is known about how mobile populations of workers may influence the ability to implement, measure, and evaluate health and safety interventions delivered at worksites. METHODS: A simulation study is used to objectively measure both precision and relative bias of six different analytic methods as a function of the amount of mobility observed in the workforce. Those six methods are then used to reanalyze a previously conducted cluster-randomized control trial involving a highly mobile workforce in the construction industry. RESULTS: As workforce mobility increases, relative bias in treatment effects derived from standard models to analyze cluster-randomized trials also increases. Controlling for amount of time exposed to the intervention can greatly reduce this bias. Analyzing only subsets of workers who exhibit the least amount of mobility can result in decreased precision of treatment effect estimates. We demonstrate a 59% increase in the treatment effect size from the reanalysis of the previously conducted trial. CONCLUSIONS: When evaluating organizational interventions implemented at specific worksites by measuring perceptions and outcomes of workers present at those sites, researchers should consider the effects that the mobility of the workforce may have on the estimated treatment effects. The choice of analytic method can greatly affect both precision and accuracy of estimates.

Marin, L. S. and C. Roelofs (2018). "Engaging Small Residential Construction Contractors in Community-Based Participatory Research to Promote Safety." Ann Work Expo Health 62(suppl_1): S72-S80.

Construction is a large employment sector with a high prevalence of small businesses. Despite the high injury rates reported for employees of small construction firms, these firms are under-represented in occupational safety research studies. Such studies are needed to understand barriers experienced by these firms and to examine ways to overcome them. However, challenges accessing and recruiting this hard-to-reach population are frequently reported. Traditional approaches of recruiting through unions or workers' compensation insurers may not be appropriate or effective for small construction businesses. Previous studies have demonstrated the value of academic collaborations with community-based organizations for recruiting participants from hard-to-reach populations for research studies. In accordance with the principles of Community-Based Participatory Research (CBPR), we formed a recruitment team comprised of staff from a local union, a community organization, and a community outreach team to recruit small construction contractors in Lawrence, MA. Media marketing strategies, participation in community events, exploring neighborhoods in search of ongoing residential projects, and partnership with vocational training institutions and building trade associations were some of the strategies implemented during this project. We recruited 118 contractors, supervisors, and foremen from more than 50 construction firms across the Greater Lawrence area to participate in an intervention project to reduce falls and silica exposure. The CBPR approach facilitated the development and implementation of recruitment strategies that resulted in the participation of a significant number of hard-to-reach small construction contractors.

McGlothlin, J., et al. (2009). "Ergonomics. Case study: safety training issues for Hispanic construction workers." J Occup Environ Hyg 6(9): D45-50.

Case study found that few of the Hispanic construction workers in the sample had formal safety training and many did not understand safety and health terms used in training.

Namian, M., et al. (2016). "Role of safety training: Impact on hazard recognition and safety risk perception." Journal of Construction Engineering and Management 142(12).

Hazard recognition and the accurate perception of safety risk are fundamental to the success of any safety program. When hazards remain unrecognized, or the associated safety risk is underestimated, the likelihood of catastrophic and unexpected injuries dramatically increase. Unfortunately, recent research has found that a large number of hazards in construction remain unrecognized. Likewise, past studies have demonstrated that safety risk is widely underestimated within construction. To improve hazard recognition and the accurate perception of safety risk, employers adopt a wide variety of training programs. However, the prevalent use of ineffective and unengaging training methods have significantly impeded training efforts in construction. The purpose of this research was to assess the impact of safety training on two objective training outcomes: hazard recognition performance and safety risk perception. The research objectives were accomplished by gathering empirical data from 51 active projects in the United States. Specifically, data pertaining to the training method (i.e., high-engagement versus low-engagement training) adopted at the project level were gathered, following which the hazard recognition ability of representative workers and their safety risk perception levels were measured. The results of the study revealed that (1) compared to low-engagement training, high-engagement training is associated with higher levels of hazard recognition and safety risk perception; and (2) the effect of training on safety risk perception is mediated by hazard recognition performance. Therefore, workers representing projects that offered high-

engagement training were able to identify a larger proportion of hazards, and consequently perceived that safety risk was relatively higher. The findings of this study will be useful to practicing professionals seeking to improve training delivery, hazard recognition performance, and the perception of safety risk within construction. This study represents the first formal attempt to empirically evaluate the holistic relationship between training, hazard recognition, and safety risk perception in the construction context. © 2016 American Society of Civil Engineers.

Namian, M., et al. (2016). "Improving Hazard-Recognition Performance and Safety Training Outcomes: Integrating Strategies for Training Transfer." Journal of Construction Engineering and Management 142(10).

Most construction safety activities focus on managing identified hazards. Hazards that remain unrecognized, and as a result unmanaged, can potentially result in catastrophic and unexpected injuries. Therefore, proper hazard recognition is foundational to the success of any safety program. However, recent research has revealed that a large proportion of construction hazards remain unrecognized in construction projects. To improve hazard recognition performance, employers provide their workers with safety and hazard recognition training. Despite these efforts, desirable levels of hazard recognition have not been achieved, and the anticipated return on investment (ROI) from training has not been attained. Such failures in training efforts are partly because knowledge acquired through training programs is often not transferred or applied in the workplace. Subsequently, training efforts do not alter work practices or behavior once workers return to the field. Other reasons for training failure include improper training delivery and the adoption of low-engagement training methods. To advance theory and practice in hazard recognition, training transfer, and training delivery, the objectives of this study were to (1) identify training transfer elements that maximize the transfer of safety training, (2) evaluate the relative effectiveness of the identified training transfer elements in transferring safety knowledge gained through training programs, and (3) assess the interaction effect between training method (i.e., high-engagement versus low-engagement training) and training transfer levels on hazard recognition performance. The objectives of the study were accomplished by gathering input from construction industry experts through interviews, questionnaire surveys, and the analysis of empirical data gathered from 51 case projects in the United States. The results of the study revealed that training efforts may be undermined if training transfer elements are not synergistically adopted. Specifically, the findings suggest that safety training is necessary, but is not sufficient to maximize training outcomes such as hazard recognition. To maximize safety training outcomes, employers must adopt training transfer elements along with high-engagement training methods. This study represents the first formal attempt to evaluate the role of training transfer elements in the construction context. © 2016 American Society of Civil Engineers.

Neitzel, R., et al. (2008). "Development and pilot test of hearing conservation training for construction workers." Am J Ind Med 51(2): 120-129.

BACKGROUND: Hearing conservation efforts in construction frequently rely on use of hearing protection devices (HPDs): however, training on HPDs is often not provided, and usage rates remain low. In this study, a hearing conservation training program was developed and pilot tested. METHODS: A theoretical model was selected as the basis for the program, and program contents and delivery methods were selected to optimize the effectiveness and flexibility of the

training. Two evaluation measures were selected to assess training-related changes in self-reported HPD use. The first was a validated method using concurrent work-shift noise dosimetry, and the second was a survey concerning workers beliefs and attitudes towards HPDs and HPD use. RESULTS: The training program was pilot tested on a single construction site. Complete assessment data were available for 23 workers. The percent of time when hearing protection was used during noise levels above 85 dBA nearly doubled post-training, and the change was statistically significant. CONCLUSIONS: Pre- and post-training data from participating workers demonstrated that HPD use can be increased significantly with basic model-based training, even in industries with complex noise exposures such as construction.

Ochsner, M., et al. (2008). "Immigrant Latino day laborers in New Jersey: baseline data from a participatory research project." New Solut 18(1): 57-76.

This study reflects the collaborative efforts of university-based researchers, New Labor, a non-profit, membership-based worker center, the Laborers' International Union of North America New Jersey Chapter (LIUNA), and the N.J. Laborers Health and Safety Fund to develop a greater understanding of the needs, experiences, attitudes, and practices of the Latino day-labor workforce in New Jersey. Survey and qualitative data presented in this study address several questions about which there is currently very little information. These results strongly suggest that a significant subgroup of day laborers are both aware of and concerned about the dangers they face, open to opportunities for Spanish language training, and despite challenges, ready to use what they learn about health and safety. As a reflection of the perceptions and reports of roughly 150 day laborers, this project provides further validation of the importance of stakeholder involvement in research and training among hard-to-reach worker populations.

Ochsner, M., et al. (2012). "Beyond the classroom: a case study of immigrant safety liaisons in residential construction." New Solut 22(3): 365-386.

Latino day laborers often work at dangerous construction sites with little power to change conditions. We describe the development, implementation, and early-stage results of a program to train immigrant day laborers as safety liaisons. These are construction workers prepared to recognize and respond to health and safety hazards. Based in Newark, NJ, the project involves collaboration between New Labor, a membership-based worker center, and university researchers and labor educators. Safety liaisons undergo training and receive ongoing support for their roles. Both qualitative and quantitative data are collected to monitor progress. Although lacking in formal authority, safety liaisons have prompted improvements at specific sites, filed OSHA complaints, and developed a local worker council. Participatory training methods, opportunities for leadership outside the classroom, and participation in project planning have strengthened liaisons' effectiveness, leadership skills, and commitment. The safety liaison approach could be adapted by worker centers and their partner organizations.

O'Connor, T., et al. (2005). "Adequacy of health and safety training among young Latino construction workers." J Occup Environ Med 47(3): 272-277.

OBJECTIVES: This study aimed to assess the adequacy of safety training provided to young Latino immigrant construction workers. The study posited that, because of their youth and immigrant status, these workers would be less likely to receive adequate training. METHODS: We interviewed 50 youths aged < or =21 who had worked at least 10 days in construction in the previous year. The in-person interview included 140 questions covering a

range of construction work and health and safety experiences. RESULTS: Participants reported performing a range of hazardous tasks, some while under the age of 18. Of these, 68% to 72% reported receiving some training, but median training time was only 1 hour. Only 24% reported receiving written training material. Those with less English ability received less training. CONCLUSIONS: Young Latino immigrants in this study received inadequate training given the hazardous work they performed. CLINICAL SIGNIFICANCE: Results of this research, especially the relatively low level of English communication skills among young Latino workers, point to the need for increased bilingual services not just in worker safety training programs, but also in medical clinics and emergency rooms that treat Latino workers.

Olson, R., et al. (2016). "Toolbox talks to prevent construction fatalities: Empirical development and evaluation." Safety science 86: 122-131.

Three studies were conducted to develop and evaluate safety toolbox talks about fatal construction incidents. Study 1 surveyed workers (n = 28) about existing pre-shift meetings. An evidence-based structure for toolbox talks was developed, and study 2 evaluated our selected line drawing illustration format with workers (n = 30). Study 3 evaluated supervisors' talks using: (1) new toolbox guides and (2) long-form investigation reports with workers from eight construction crews.In study 1, 25% of the sample reported never conducted safety meetings. In study 2, compared to photos, line drawings increased the distance workers' could correctly identify hazards by over 1.5 m. In study 3, the new format was preferred by 82% of supervisors, saved them 15 min preparation/presentation time, and produced favorable impacts with workers.Brief scripted toolbox talks made it easier for supervisors to share fatal stories and prevention recommendations with their crews. When the format includes scripted text for the supervisors, prompts for discussion and action items, and line drawings worker understanding can be enhanced. © 2016 Elsevier Ltd.

Panikkar, B., et al. (2014). "Characterizing the low wage immigrant workforce: a comparative analysis of the health disparities among selected occupations in Somerville, Massachusetts." Am J Ind Med 57(5): 516-526.

BACKGROUND: This study estimates job-related risks among common low wage occupations (cleaning, construction, food service, cashier/baggers, and factory workers) held by predominantly Haitian, El Salvadorian, and Brazilian immigrants living or working in Somerville, Massachusetts. METHODS: A community-based cross-sectional survey on immigrant occupational health was conducted between 2006 and 2009 and logistic regression was used to assess the job-related risks among the most common low wage occupations. RESULTS: Construction workers reported significantly higher health risks, and lower access to occupational health services than the other occupations. Compared to cashier/baggers, the reference population in this study, cleaners reported significantly lower access to health and safety and work training and no knowledge of workers' compensation. Factory workers reported significantly lower work training compared to cashier/baggers. Food service workers reported the least access to doctors compared to the other occupations. CONCLUSION: We found significant variability in risks among different low wage immigrant occupations. The type of occupation independently contributed to varying levels of risks among these jobs. We believe our findings to be conservative and recommend additional inquiry aimed at assuring the representativeness of our findings.

Peters, S. E., et al. (2020). "Designing a Participatory Total Worker Health((R)) Organizational Intervention for Commercial Construction Subcontractors to Improve Worker Safety, Health, and Well-Being: The "ARM for Subs" Trial." Int J Environ Res Public Health 17(14).

Background: Evidence supports organizational interventions as being effective for improving worker safety, health and well-being; however, there is a paucity of evidence-based interventions for subcontracting companies in commercial construction. Methods: A theory-driven approach supplemented by formative research through key stakeholder interviews and focus groups and an iterative vetting process with stakeholders, resulted in the development of an intervention for subcontractors in the commercial construction industry. We piloted the intervention in one subcontracting commercial construction company. We used these findings to adapt and finalize the intervention design to be tested in a future large-scale trial. Results: There were several key findings from the formative research, including challenges faced by companies and assets that should be considered in the intervention design. This resulted in a communication infrastructure company-based, continual improvement, participatory intervention design, consisting of a needs assessment and report, committee-led prioritization, action planning and implementation, and worker communication/feedback cycle. The pilot contributed to the final intervention design with modifications made with respect to timing, implementation support, capacity building, adaptability and sustainability. Conclusions: The use of a theory-driven participatory approach to developing an integrated organizational intervention for commercial construction subcontracting companies was important and necessary. It allowed us to consider the empirical evidence and relevant theories and tailor these to meet the needs of our target population. This study gives pragmatic insight into the early development of a complex intervention, with practical experience of how we adapted our intervention at each stage. This intervention will be tested in a future randomized trial.

R. Kaufman and, B., et al. (2014). "Interactive effects of leader justice and support for safety on safety performance." Journal of Organizational Effectiveness: People and Performance 1(3): 296-315.

Rauscher, K. J., et al. (2010). "Construction firm practices and manager beliefs regarding the employment and safety of teenaged employees: a North Carolina based study." Work 37(2): 145-154.

OBJECTIVE: The objective of this study was to examine the reported practices of construction firms and the beliefs of firm managers/supervisors with respect to employing youth under age 18 and ensuring their safety. PARTICIPANTS: The participants in this study were firm representatives from 54, mostly small to medium sized, construction firms in North Carolina. METHODS: Survey responses were analyzed for the entire sample and within strata of firm size (1-10, 11+ employees) using descriptive statistics. Percentages and 95% confidence intervals were calculated. Chi-square tests were used to test for statistical significance in differences between firm sizes. RESULTS: The findings suggest limits in the adequacy of safety training given to youth in construction, particularly in light of the minimal experience firms require of young hires, that managers' beliefs about the causes of young worker injury are largely focused on worker behaviors rather than on the presence of hazards, and that managers' compliance with child labor laws may be hampered by their lack of knowledge of these laws and an ambivalence toward their usefulness and enforcement. CONCLUSIONS: While larger studies are needed to confirm and advance these findings, when considered along with prior

studies, they demonstrate the need to improve the safety of the construction environment for youth. The development of new educational interventions by health and safety professionals targeted at construction firms are supported, as are efforts by government regulators to increase enforcement and employer knowledge of the child labor laws.

Ray, S. J. and J. Teizer (2012). "Real-time construction worker posture analysis for ergonomics training." Advanced Engineering Informatics 26(2): 439-455.

Construction activities performed by workers are usually repetitive and physically demanding. Execution of such tasks in awkward postures can strain their body parts and can result in fatigue, injuries or in severe cases permanent disabilities. In view of this, it is essential to train workers, before the commencement of any construction activity. Furthermore, traditional worker monitoring methods are tedious, inefficient and are carried out manually whereas, an automated approach, apart from monitoring, can yield valuable information concerning work-related behavior of worker that can be beneficial for worker training in a virtual reality world. Our research work focuses on developing an automated approach for posture estimation and classification using a range camera for posture analysis and categorizing it as ergonomic or non-ergonomic. Using a range camera, first we classify worker's pose to determine whether a worker is 'standing', 'bending', 'sitting', or 'crawling' and then estimate the posture of the worker using OpenNI middleware to get the body joint angles and spatial locations. A predefined set of rules is then formulated to use this body posture information to categorize tasks as ergonomic or non-ergonomic. 

Rice, S. P. M., et al. (2022). "Does sending Safety Toolbox Talks by text message to Residential Construction Supervisors increase Safety Meeting Compliance?" Occupational Health Science 6(3): 313-332.

Construction is one of the most dangerous occupations in the U.S. Within the industry, residential construction workers are at elevated risk for worksite injury and death, yet are rarely the focus of safety research and intervention. Conducting regular safety meetings has been identified as a key practice of construction companies with lower injury rates, and thus, there is a need for evidence-based tactics that increase compliance with this preventive practice. The current project was designed to evaluate whether distributing construction safety toolbox talks about workplace fatalities to supervisors by mobile phone would increase their compliance with the Oregon Occupational Safety and Health Administration’s (OR-OSHA) standard for conducting at least one safety meeting each month. A sample of residential construction supervisors in Oregon (N = 56) were recruited and received a link to a toolbox talk by text message every two weeks for three months. Evaluation surveys were completed by supervisors before and after participating. Supervisors’ adherence to the OR-OSHA safety meeting standard improved by 19.39% during the text message period. However, self-reported safety communication quality and supervisor-rated employee safety performance did not significantly change. Supervisors indicated that they generally appreciated the mobile toolbox talk format, would like to receive them in the future, and would recommend them to other supervisors. Mobile delivery of toolbox talks may increase construction supervisors’ compliance with safety meeting standards. However, studies that replicate or extend this research are needed to confirm the safety meeting effect observed, and further advance efforts to reduce injury rates in the residential construction industry.

Roelofs, C., et al. (2021). "Preventing Opioid-Related Harms in the Construction Industry." New Solut 31(3): 367-372.

The construction sector has been hit hard by the opioid crisis. We describe CPWR-The Center for Construction Research and Training's recent efforts to address the challenges of opioid use in the construction industry. With support and guidance from the North America's Building Trades Unions Opioid Task Force, CPWR undertook three projects to promote prevention and best practices for struggling construction workers. The first project focused on recommendations for communications that reframe stigmatizing narratives into effective messages about prevention solutions. The second project refined and distributed a one-hour construction worker opioid hazard awareness training module. The third project assessed opportunities and barriers for the expansion and improvement of existing union peer support programs to support workers through treatment and recovery. Additional resources, such as opioid hazard tool box talks, to help reverse the impact on the sector are also described.

Rohlman, D. S., et al. (2018). "Building a Healthier Workforce: An Evaluation of an Online Nutrition Training for Apprentices." J Nutr Educ Behav 50(9): 913-917 e911.

OBJECTIVE: Construction workers face barriers to healthy eating, including work organization and environmental factors, that can affect productivity and lead to chronic conditions. The objective was to evaluate the effectiveness of an online nutrition training to improve knowledge and behaviors and evaluate the feasibility of conducting this training among apprentices in the highway construction trades. METHODS: A pretest-posttest control group design was used. The intervention was conducted using a Web-based electronic learning platform. RESULTS: A total of 36 highway construction apprentices (78% male) completed the study. Intervention participants demonstrated improvements in knowledge immediately after the training, reported modest weight loss, decreased body mass index, and decreased fast food consumption compared with control participants. However, increases in knowledge were not seen at follow-up. The training content and format were well-received, indicating that electronic learning approaches were acceptable for this population. CONCLUSIONS AND IMPLICATIONS: This project established the acceptability of using an online nutrition training to promote health among apprentices.

Rosen, J., et al. (2015). "National institute of environmental health sciences worker training program: Perspectives on the health and safety of workers, volunteers, and residents involved in the cleanup and rebuilding of New York City housing damaged by hurricane sandy." Environmental Justice 8(3): 105-109.

Hurricane Sandy damaged or destroyed 76,000 buildings with over 300,000 housing units; nine percent of the total housing in New York City. Sandy also damaged 405 New York City Housing Authority (NYCHA) buildings, affecting 35,000 units. Affected residents were forced to move in with family, temporary housing, or endured long periods without heat or electricity, as most building systems were located in flooded basements. Additionally, workers, volunteers, and residents who engaged in cleanup were potentially exposed to raw sewage, mold, asbestos, lead, dust, carbon monoxide, as well as electrocution; slips, trips, and falls; and construction-related safety hazards. Stress and trauma were also significant. These exposures may cause death, disease, and injury. The need to provide protection programs and effective training crosses a number of populations including day laborers, volunteer groups, and residents who are involved in cleanup and rebuilding. The National Institute of Environmental Health

Sciences (NIEHS) Worker Education and Training Program (WETP) has provided funding to more than 20 grantees including universities, labor unions, and other organizations to provide effective worker health and safety and disaster preparedness and response training for more than 20 years. This has built a critical infrastructure in the targeted industrial sectors and unions. WETP has also been active in disasters including September 11, Katrina, the Gulf oil spill, and Sandy. Preventing injury and disease in all the groups that are involved in disaster response, cleanup, and rebuilding warrants extending the NIEHS health and safety programs to volunteers, residents, and worker populations who previously have not had access to hazardous materials and related training programs. This can be accomplished by adapting health and safety programs and just-in-time training to the needs and cultures of these groups. These efforts should also further ongoing approaches to empower grantees and end-users so that they can independently build dynamic health and safety and training programs into their disaster preparedness and response work. 

Sarel, L., et al. (2010). "Fatalities of hispanic workers: Safety initiatives taken by U.S. Construction companies to address linguistic and cultural issues." International Journal of Construction Education and Research 6(4): 271-284.

The U.S. Census Bureau's projection states that Hispanics form the largest minority group in the U.S. construction industry. A major challenge faced by American construction companies is the continually increasing number of fatalities among its Hispanic workers. According to the literature, illiteracy, the language barrier, and cultural differences are major causes of Hispanic worker fatalities. This study focuses on two out of these three aspects, i.e., language barriers and cultural differences. The study was undertaken to explore the reasons behind the lack of safety awareness of Hispanic workers, and to investigate the measures that construction companies take to deal with this problem. The literature review identified the main issues that need to be addressed by construction companies to ensure the safety of Hispanic workers. A survey was created, asking supervisors/directors of the top U.S. construction companies about their safety initiatives. As a result, it was found that construction companies address the problems of language and cultural barriers by implementing initiatives such as hands-on training, English as a Second Language courses, bilingual trainers, vocabulary cards, social gatherings, and common workshops. This study may help the construction industry identify areas requiring attention in order to improve the safety of its Hispanic employees. 

Schoenfisch, A. L., et al. (2017). "Effectiveness of OSHA Outreach Training on carpenters' work-related injury rates, Washington State 2000–2008." Am J Ind Med 60(1): 45-57.

Introduction: Despite the size and breadth of OSHA's Outreach Training program for construction, information on its impact on work-related injury rates is limited. Methods: In a 9-year dynamic cohort of 17,106 union carpenters in Washington State, the effectiveness of OSHA Outreach Training on workers' compensation claims rate was explored. Injury rates were calculated by training status overall and by carpenters' demographic and work characteristics using Poisson regression. Results: OSHA Outreach Training resulted in a 13% non-significant reduction in injury claims rates overall. The protective effect was more pronounced for carpenters in their apprenticeship years, drywall installers, and with increasing time since training. Conclusions: In line with these observed effects and prior research, it is unrealistic to expect OSHA Outreach Training alone to have large effects on union construction workers'

injury rates. Standard construction industry practice should include hazard awareness and protection training, coupled with more efficient approaches to injury control. Am. J. Ind. Med. 60:45–57, 2017. © 2016 Wiley Periodicals, Inc. © 2016 Wiley Periodicals, Inc.

Schwatka, N. V., et al. (2019). "A training intervention to improve frontline construction leaders' safety leadership practices and overall jobsite safety climate." J Safety Res 70: 253-262.

INTRODUCTION: The 2.5 h Foundations for Safety Leadership (FSL) training program teaches construction supervisors the leadership skills they need to strengthen jobsite safety climate and reduce adverse safety-related outcomes. METHODS: Using a quasi-experimental prospective switching replications study design, we examined (1) if FSL-trained jobsite safety leaders would report improved understanding and practice of the FSL leadership skills, safety practices and crew reporting of safety related conditions, and (2) if their crew perceived a change in (a) their supervisors' practices, (b) their own safety practices and reporting of safety-related conditions, and (c) overall jobsite safety climate. Twenty construction sub-contracting companies were recruited and randomly assigned to either an early or lagged-control training group. Participating supervisors and workers completed surveys at multiple time points before and after the FSL training. We used linear mixed modeling to test changes over time. RESULTS: Only supervisors in the early group reported a statistically significant improvement in their understanding and practice of the leadership skills as well as safety practices from before to 2- and 4-weeks post-training. Overall, no significant change was detected in crew-reported outcomes from before to after their supervisors' participated in the FSL training. CONCLUSIONS: These results provide evidence that the FSL training can, at least in the short-term, improve construction frontline leaders' jobsite leadership skills. Future research could include an evaluation of FSL refresher activities and a longer-term follow-up. Practical applications: The Foundations for Safety Leadership (FSL) program fills an identified need for construction frontline supervisors to learn and practice critical safety leadership skills on the jobsite. It has already reached over 60,000 leaders and has the potential to reach over 100,000 each year during either an OSHA 30-h or a stand-alone course.

Seixas, N. S., et al. (2011). "A multi-component intervention to promote hearing protector use among construction workers." Int J Audiol 50 Suppl 1: S46-56.

Hearing protection devices (HPD) remain a primary method of prevention of noise-induced hearing loss despite their well-known limitations. A three-pronged intervention to increase HPD use was conducted among construction workers and included a baseline hearing loss prevention training, follow-up 'toolbox' (TB) reinforcement trainings, and use of a personal noise level indicator (NLI). A total of 176 subjects on eight sites completed three assessments. Prior to intervention, HPDs were used an average of 34.5% of the time and increased significantly, up about 12.1% after intervention and 7.5% two months after interventions were completed. The increase in HPD use was greatest among the group receiving both TB and NLI interventions; up about 25% from baseline, and this group was about two times more likely to use HPDs than the BL (baseline) training only group. This study demonstrates the mild impact of a well-constructed HPD use training and provides support for the additional use of a personal NLI to increase use of HPDs among construction workers. The most effective procedures for using such instruments require further exploration.

Shrestha, P. P. and N. N. Menzel (2014). "Hispanic construction workers and assertiveness training." Work 49(3): 517-522.

BACKGROUND: Hispanic (Latino) construction workers experience disparities in occupational death and injury rates in the United States. The cultural value of respect for those in authority may hinder these workers from requesting safe working conditions from supervisors. OBJECTIVE: To evaluate whether Hispanic construction workers in Las Vegas, Nevada found assertiveness training more useful than non-Hispanic trainees and whether or not they practiced this behavior at work after the training. METHODS: An assertiveness training simulation was part of fall prevention classes offered to area construction workers. Eight weeks after the training, participants were interviewed by telephone about class topics they found most useful and whether or not they had made any subsequent behavior changes at work. RESULTS: More than half of the 760 fall prevention trainees completed telephone interviews. A smaller proportion of Hispanic trainees found assertiveness training to be useful (11%) than non-Hispanics (28%) ($p \leqslant 0.001$). Only 2% of both groups identified practicing assertiveness at work. CONCLUSIONS: A large proportion of Hispanic trainees valued other knowledge more highly. They may weigh job security as more important than speaking up about safety issues, which might threaten their employment. Interventions to improve safety should focus instead on improving work safety climate and engineering controls.

Simeonov, P., et al. (2012). "Factors affecting extension ladder angular positioning." Hum Factors 54(3): 334-345.

OBJECTIVE: The study objectives were to identify factors affecting extension ladders' angular positioning and evaluate the effectiveness of two anthropometric positioning methods. BACKGROUND: A leading cause for extension ladder fall incidents is a slide-out event, usually related to suboptimal ladder inclination. An improved ladder positioning method or procedure could reduce the risk of ladder stability failure and the related fall injury. METHOD: Participants in the study were 20 experienced and 20 inexperienced ladder users. A series of ladder positioning tests was performed in a laboratory environment with 4.88-m (16-ft) and 7.32-m (24-ft) ladders in extended and retracted positions. The setup methods included a no-instruction condition and two anthropometric approaches: the American National Standards Institute A14 and "fireman" methods. Performance measures included positioning angle and time. RESULTS: The results indicated that ladder setup method and ladder effective length, defined by size and extended state, affected ladder positioning angle. On average, both anthropometric methods were effective in improving extension ladder positioning; however, they required 50% more time than did the no-instruction condition and had a 9.5% probability of setting the ladder at a less-than-70 degrees angle. Shorter ladders were consistently positioned at shallower angles. CONCLUSION: Anthropometric methods may lead to safer ladder positioning than does no instruction when accurately and correctly performed. Workers tended to underperform as compared with their theoretical anthropometric estimates. Specific training or use of an assistive device may be needed to improve ladder users' performance. APPLICATION: The results provide practical insights for employers and workers to correctly set up extension ladders.

Sinyai, C. and G. Barlet (2020). "Designing Occupational Safety and Health Training Materials for Clear Communication." J Occup Environ Med 62(6): 431-438.

INTRODUCTION: Printed materials are an essential part of occupational safety and health programs. Public health professionals at the Centers for Disease Control and Prevention (CDC) have created a Clear Communication Index (CCI) to guide design of health education materials for the general public. METHODS: We revised an existing handout on heat exposure hazards in construction using the CCI and tested the old and new versions of the handout with an audience of 425 construction apprentices and journey-level workers. RESULTS: Some features recommended by the CCI-such as the use of subheadings, numbering, and other visual cues-strongly conditioned the readers' understanding of the main message. CONCLUSIONS: Design and layout have a significant impact on the delivery of messages in written materials. A communications-based rubric such as the CCI can help writers preparing written occupational safety and health materials for workers and general audiences.

Sinyai, C., et al. (2018). "Evaluating the readability and suitability of construction occupational safety and health materials designed for workers." Am J Ind Med 61(10): 842-848.

INTRODUCTION: Printed materials for training and hazard communication are an essential part of occupational safety and health programs, but must be understood by their intended audience. METHODS: Researchers collected 103 safety training handouts, brochures, and Safety Data Sheets and scored them for readability and suitability using four standard health communication instruments: the SMOG test, the Flesch-Kincaid Reading Ease Assessment, the SAM (Suitability Assessment of Materials), and CCI (the CDC Clear Communication Index). RESULTS: Some of the materials used unfamiliar and technical terms. The SAM and CCI checklists revealed several elements of design and layout known to facilitate communication and comprehension, but missing from most of the materials scored. CONCLUSION: Occupational safety and health professionals preparing curricula and handouts for distribution to workers should incorporate some form of readability and suitability assessment to help ensure their written materials are clear and comprehensible to all segments of their audience.

Sinyai, C., et al. (2013). "Doing it Old School: Peer-led occupational safety training in the US construction Industry." McGill Journal of Education/Revue des sciences de l'éducation de McGill 48(3): 605-611.

Sokas, R. K., et al. (2009). "An intervention effectiveness study of hazard awareness training in the construction building trades." Public Health Rep 124 Suppl 1: 160-168.

OBJECTIVE: We evaluated knowledge, attitudes, and self-reported work practices among apprentice and journeyman trainees in two construction trades at baseline and three months after participation in two training sessions as part of a 10-hour Occupational Safety and Health Administration hazard awareness training program. We developed preliminary assessment of prior and current training impact, accounting for demographics, trade, and construction site safety climate. METHODS: Participants were recruited prior to union-delivered safety training, self-completed a baseline survey prior to class, and completed a follow-up interviewer-administered telephone survey three months later. Discrimination (D) testing evaluated knowledge questions, paired t-tests examined differences in pre- and post-intervention knowledge, and attitude responses were tested with the Wilcoxon signed rank test. Linear regression analysis and logistic regression were used to assess the contribution of different categorical responses to specific sub-questions. RESULTS: Of 175 workers

completing the baseline survey, 127 were born in the U.S. and 41 were born in Mexico; 40% of those who reported ethnicity were Hispanic. Follow-up surveys were completed by 92 (53%) respondents and documented significant increases in both fall safety and electrical safety knowledge. The most recent safety climate was associated with improvement in fall safety attitudes (slope = 0.49, $p < 0.005$) when adjusted by country of birth (slope = 0.51, $p < 0.001$). Workers born in Mexico had less formal education than U.S.-born workers and lower baseline knowledge scores, but more positive attitude scores at baseline and greater improvements in attitude at follow-up. CONCLUSION: Knowledge and attitude improvement following a one-hour safety class was measurable at three months in both U.S.-born and Mexican-born construction workers.

Sokas, R. K., et al. (2007). "Trainer evaluation of a union-based ten-hour safety and health hazard-awareness program for U.S. construction workers." Int J Occup Environ Health 13(1): 56-63.

A web-based survey of union-based outreach instructors evaluated training materials developed to teach OSHA ten-hour hazard-awareness courses to members of the construction trades. Respondents taught an average of five ten-hour hazard-awareness courses per year. When asked about hazards commonly encountered by their trainees, 83% identified falls from ladders, with a range of 1-22 hazards identified. Over one third of the trainers taught individuals whose primary languages were not English. Increased interaction with trainees through subsequent phone calls may be a marker of differential training impact.

Stephenson, C. M. and M. R. Stephenson (2011). "Hearing loss prevention for carpenters: part 1 - using health communication and health promotion models to develop training that works." Noise Health 13(51): 113-121.

In phase 1 of a large multiyear effort, health communication and health promotion models were used to develop a comprehensive hearing loss prevention training program for carpenters. Additionally, a survey was designed to be used as an evaluation instrument. The models informed an iterative research process in which the authors used key informant interviews, focus groups, and early versions of the survey tool to identify critical issues expected to be relevant to the success of the hearing loss prevention training. Commonly held attitudes and beliefs associated with occupational noise exposure and hearing losses, as well as issues associated with the use or non-use of hearing protectors, were identified. The training program was then specifically constructed to positively shape attitudes, beliefs, and behavioral intentions associated with healthy hearing behaviors - especially those associated with appropriate hearing protector use. The goal was to directly address the key issues and overcome the barriers identified during the formative research phase. The survey was finalized using factor analysis methods and repeated pilot testing. It was designed to be used with the training as an evaluation tool and thus could indicate changes over time in attitudes, beliefs, and behavioral intentions regarding hearing loss prevention. Finally, the training program was fine tuned with industry participation so that its delivery would integrate seamlessly into the existing health and safety training provided to apprentice carpenters. In phase 2, reported elsewhere in this volume, the training program and the survey were tested through a demonstration project at two sites.

Stephenson, M. R., et al. (2011). "Hearing loss prevention for carpenters: part 2 - demonstration projects using individualized and group training." Noise Health 13(51): 122-131.

Two demonstration projects were conducted to evaluate the effectiveness of a comprehensive training program for carpenters. This training was paired with audiometry and counseling and a survey of attitudes and beliefs in hearing loss prevention. All participants received hearing tests, multimedia instruction on occupational noise exposure/hearing loss, and instruction and practice in using a diverse selection of hearing protection devices (HPDs). A total of 103 apprentice carpenters participated in the Year 1 training, were given a large supply of these HPDs, and instructions on how to get additional free supplies if they ran out during the 1-year interval between initial and follow-up training. Forty-two participants responded to the survey a second time a year later and completed the Year 2 training. Significant test-retest differences were found between the pre-training and the post-training survey scores. Both forms of instruction (individual versus group) produced equivalent outcomes. The results indicated that training was able to bring all apprentice participants up to the same desired level with regard to attitudes, beliefs, and behavioral intentions to use hearing protection properly. It was concluded that the health communication models used to develop the educational and training materials for this effort were extremely effective.

Taylor, E. L. (2015). "Safety benefits of mandatory OSHA 10 h training." Safety science 77: 66-71.

The 2008 recession saw a significant decrease in reported injury rates. Construction is an inherently dangerous industry. Its injury rates for the industry annually rank near the top of all U.S. industries. The Occupational Safety and Health Administration (OSHA) is charged with regulating U.S. workplace safety. Towards this end, they provide enforcement and promote training. A standardized 10. h training course sanctioned by OSHA is available for construction workers in all states. In 2004, Massachusetts became the first of seven states to legislate mandated OSHA 10. h training for construction workers on most public projects. Previous studies have shown that occupational safety training has beneficial effects on knowledge gain and improved behavior but there is weak evidence for improved safety outcomes. The natural experiment created by mandated training provided the opportunity to study the effects of mandated training on these outcomes. This study uses the Bureau of Labor Statistics (BLS) 2004-2012 State Occupational Injury and Illness data in a random effects multiple regression analysis and BLS 2008-2011 fatality data from the Census of Fatal Occupational Injuries to examine fatality trends across different strata. The results are highly encouraging but fall short of definitive evidence. The post-mandate fatality trend results compare favorably against other state groupings and the non-fatal injury regression indicated a nearly statistically significant marginal effect for mandated training. However these results are clouded by the short duration of trend data and injury data known to be underreported. Recommendations include more extensive recordkeeping for OSHA 10. h training and improved injury surveillance. 

Teizer, J., et al. (2013). "Location tracking and data visualization technology to advance construction ironworkers' education and training in safety and productivity." Automation in Construction 35: 53-68.

Most construction worker education and training environments apply traditional teaching methods to educate workers about hazards and productivity in the workplace. Many

rely on using conventional teacher-student classroom settings, but there are few effective interactive methods applied which can objectively engage trainer and trainees and assess their performance during and after training sessions. Presented is a novel approach towards integrating real-time location tracking and three-dimensional immersive data visualization technologies in existing construction worker education and training environments. The scope is limited to steel-erection tasks performed by union ironworkers in an indoor training center. Results to analysis and visualization of the gathered data from training session are shown. The potential for assessing and improving the trainers' and apprentices' safety and productivity performance is explained. Since such technologies have hardly been used as part of existing construction education and training techniques, the opportunities including return on investment and user feedback were studied. The results show that unsafe practices in worker training environments can be detected and visualized and furthermore their training effectiveness can be indirectly measured.

Trabeau, M., et al. (2008). "A comparison of "Train-the-Trainer" and expert training modalities for hearing protection use in construction." Am J Ind Med 51(2): 130-137.

BACKGROUND: Few assessments have been conducted on the impact of a "Train-the-Trainer" (T3) approach for training delivery. The present study compared the effectiveness of a noise induced hearing loss (NIHL) prevention training delivered using "Train-the-Trainer" and expert trainer modalities. METHODS: Participating construction companies were assigned to the Train-the-Trainer or expert trainer modalities. Workers were recruited from each company and then trained. The effectiveness of the modalities was assessed through the use of surveys. The accuracy of self-reported hearing protection device (HPD) use was also evaluated through on-site observation. RESULTS: Post-training scores for hearing conservation knowledge, perceived barriers, and current and intended future use of HPDs improved significantly for both training modalities. Subjects trained by T3 trainers significantly increased their beliefs regarding general susceptibility to NIHL, desire to prevent NIHL, and ability to recognize, and control hazardous noise exposures. The expert-trained groups significantly increased their beliefs regarding the benefits of HPD use and ability to ask for help with HPDs. The only changes that were significantly different between modalities were in general susceptibility to NIHL and effective use of HPDs. However, these beliefs differed significantly between subjects in the two-modality groups prior to training. Self-reported HPD use was poorly correlated with observed use, calling into question the validity of survey-based HPD use measures in this context. CONCLUSIONS: The training improved beliefs regarding HPD use, increased workers' hearing conservation knowledge, and increased self-reported HPD use. The effectiveness of the training was not found to be dependent on training modality.

Weidman, J., et al. (2016). "Effective Intervention Strategy to Improve Worker Readiness to Adopt Ventilated Tools." Journal of Construction Engineering and Management 142(8).

An effective theory-based intervention strategy is developed to improve worker adoption of a ventilated dust-control tool that reduces dust exposure by 95%. The Prevention through Design Adoption Readiness Model (PtD ARM) was employed to develop educational materials, hands-on training, and worksite cues-to-action. Educational materials were targeted to improve worker knowledge of the health risks associated with construction dusts. Hands-on training was developed with the objective of improving worker self-efficacy regarding the new equipment. Additionally cues-to-action were given to the workers. These cues were hard-hat

stickers and t-shirts with reminder slogans. In a pretest/posttest experimental design with control group (n=40), questionnaire data were analyzed using independent t-tests of the gain-scores, and significant changes ($p<0.05$) were seen in worker self-efficacy, trust-in-technology, and overall readiness to adopt the tool. Theory-based intervention strategies were found to be effective in improving worker willingness to use ventilated tools. The most impactful intervention methods include training regarding risks to worker health, hands-on training with ventilated tools, and cues-to-action reminders to use the tools. © 2016 American Society of Civil Engineers.

Williams, Q., Jr., et al. (2010). "The impact of a peer-led participatory health and safety training program for Latino day laborers in construction." J Safety Res 41(3): 253-261.

BACKGROUND: Immigrant Latino day laborers working in residential construction are at particularly high risk of fatal and non-fatal traumatic injury and benefit from targeted training. OBJECTIVE: To understand the impact of a participatory, peer-facilitated health and safety awareness training customized to the needs of Latino day laborers. METHODS: Baseline surveys exploring exposures, PPE use, attitudes, work practices and work-related injuries were collected from more than 300 New Jersey Latino day laborers in construction prior to their participation in a one day (minimum of six hour) Spanish language health and safety training class. The classes, led by trained worker trainers, engaged participants in a series of tasks requiring teamwork and active problem solving focused on applying safe practices to situations they encounter at their worksites. Follow-up surveys were difficult to obtain among mobile day laborers, and were collected from 70 men (22% response rate) 2-6 months following training. Chi-square analysis was used to compare pre- and post-intervention PPE use, self protective actions, and self-reported injury rates. Focus groups and in-depth interviews addressing similar issues provided a context for discussing the survey findings. RESULTS: At baseline, the majority of day laborers who participated in this study reported great concern about the hazards of their work and were receptive to learning about health and safety despite limited influence over employers. Changes from baseline to follow-up revealed statistically significant differences in the use of certain types of PPE (hard hats, work boots with steel toes, safety harnesses, and visible safety vests), and in the frequency of self-protective work practices (e.g., trying to find out more about job hazards on your own). There was also a suggestive decrease in self-reported injuries (receiving an injury at work serious enough that you had to stop working for the rest of the day) post-training based on small numbers. Sixty-six percent of workers surveyed post-training reported sharing information from their safety workbook with friends and co-workers. Focus groups and interview results generally confirmed the quantitative findings. CONCLUSIONS: Participatory, peer led training tailored to the needs of construction day laborers may have a positive effect on Latino immigrant workers' attitudes, work practices, and self reported injury rates, but major changes would require employer engagement. IMPACT ON INDUSTRY: Health and safety researchers have identified reducing the number of traumatic injuries among the immigrant construction workforce as an increasingly important priority. This project provides one model for collaboration between university-based researchers, a union, and a community-based organization. The specific elements of this project-participatory curriculum customized to the needs of day laborers in residential construction, training day laborers to facilitate training classes, and involving peer leaders in outreach and research-could be adapted by other organizations. The findings of this study suggest that the Latino day laborers have a strong interest in and some ability to act on health

and safety information. Widespread implementation of this type of training, especially if supported with cooperation from residential contractors, could lead to reduced rates of traumatic injury in the residential construction industry.

Zhao, D., et al. (2014). "Electrical deaths in the US construction: An analysis of fatality investigations." Int J Inj Contr Saf Promot 21(3): 278-288.

Electrocution is among the 'fatal four' in US construction according to the Occupational Safety and Health Administration. Learning from failures is believed to be an effective path to success, with deaths being the most serious system failures. This paper examined the failures in electrical safety by analysing all electrical fatality investigations (N = 132) occurring between 1989 and 2010 from the Fatality Assessment and Control Evaluation programme that is completed by the National Institute of Occupational Safety and Health. Results reveal the features of the electrical fatalities in construction and disclose the most common electrical safety challenges on construction sites. This research also suggests the sociotechnical system breakdowns and the less effectiveness of current safety training programmes may significantly contribute to worker's unsafe behaviours and electrical fatality occurrences. © 2013 © 2013 Taylor & Francis.

CPWR THE CENTER FOR CONSTRUCTION RESEARCH AND TRAINING

www.cpwr.com • www.elcosh.org