Results: Most of the respondents (86.3%) were male. The mean age of respondents (36.29±10.68years).Majority of the respondents (52.6%) had a poor knowledge of occupational hazards and safety measures. The mean knowledge score was 43.2 ± 12.4. The knowledge source highest among the respondents was personal experience (82%).

Conclusions: This study shows that the knowledge level among the building construction worker is poor.

E3.4
Title: **Factors causing construction accidents**
Author: Majed Moosa

Research indicates that construction site accidents are a global concern, and rates are increasing. In rapidly developing countries like Saudi Arabia, safety issues are largely ignored and little is known about the causes.

Objective: To shed light on factors causing Saudi Arabian construction accidents.

Methods: A detailed survey of accident features, safety practices, and perception of factors casing accidents was sent to thirty-five construction companies, with a response rate of 68%.

Results: The largest contributing factor in construction site accidents was found to be attitudes toward safety practices. This finding is similar to published findings on construction accident causes.

Conclusion: Survey results confirmed the findings from the literature in that management attitudes and human factors were ranked as the most important safety issues. Changes in attitudes towards safety management practices are the key to changing the practices themselves. Only by changing attitudes, can the construction industry change its accident record.

Session E4.0
Title: **Technology Transforming Safety**
Moderator: Jim Green

E4.1
Title: **The technological transformation of driving: Lessons learned in the transition from horse and buggy to internal combustion engine**
Author: Marvin Dainoff

Significant safety issues are raised by rapid technological changes in the world of surface transportation. These technologies comprise a two-dimensional space characterized by levels of Automation and Connectivity. Automation levels can be described using the NHTSA classification which ranges from no automation (human driver in control) to full automation (human driver not required). Connectivity (embedded within the vehicle infrastructure) can be unidirectional (radio, GPS), bi-directional (Bluetooth-linked mobile device, telematic devices), Vehicle-to-Vehicle (vehicle spacing information), and Vehicle-to-Infrastructure (traffic flow information). Within this space are many alternative versions of these technologies, some of which have the potential for increasing safety (Advanced Driver Assistance Systems, telematics coaching) or decreasing safety (distracting infotainment systems). A sociotechnical analysis (Geels, 2005) of the transition from horse and buggy to internal combustion engine reveals a similar period of rapid technological change. In this analysis, the automobile did not simply replace the horse-drawn carriage but a number of intermediate steps intervened and alternative trajectories might have been possible. These alternatives reflected interactions among different kinds of technology (steam, electric, internal combustion), supporting governmental policies (safety regulations, infrastructure, licensure), and public opinion, all of which relate directly to the current situation.
Geels, G.A. (2005). Technology Analysis and Strategic Management. 17(4), 445-476.

E4.2
Title: **Truck drivers' pedal-use behavior during lane changes: Examination with naturalistic driving data**
Authors: Christopher Pan, Shan Bao, Stephanie Pratt, Ted Hitchcock, Paul Keane, David LeBlanc, Huei Peng

This study is designed to evaluate heavy-truck drivers' pedal-use behavior during lane changes, which are a major source of two-vehicle crashes that involve one large truck and one light vehicle, and are very likely to produce both fatal and non-fatal injuries. Previous studies have reported that driver-related errors are the leading factors contributing to truck-related lane change crashes. There are limited studies that have been conducted to evaluate drivers' pedal use during lane changes. The data used in this study were collected through the naturalistic-driving study of the Integrated Vehicle-Based Safety System (IVBSS) program. Ten tractors were used as instrumented research vehicles, while they additionally performed normal operational activities. These vehicles were built to specification for Con-way Freight. Each truck was equipped with instrumentation to capture information regarding the driving environment, driver activity, system behavior, and vehicle kinematics. Driving data from eighteen professional heavy-truck drivers, who operated the instrumented trucks over a 10-month period, were collected, as the drivers were conducting Con-way's normal business activities. A total of 198,132 lane change events were identified from the IVBSS database. Among them, there were 111,850 left-lane changes and 86,282 right-lane changes. About 33% of all the lane changes occurred during night time, and 67% occurred during the daytime. 35% of the left-lane

changes and 45% of the right-lane changes occurred during highway driving; the remainder occurred on non-highway roads (i.e., main surface and local roads). Analysis of variance results showed that road type, lane change direction and time of day all have significant impact ($p<0.05$ in each case) on drivers' maximum acceleration rate during lane changes. A significant lower maximum acceleration rate was observed when drivers were driving on highways when compared to driving on non-highways. This difference was more obvious during day time driving. Drivers had a higher value of maximum acceleration rate when making right lane changes than making left lane changes. The results of this study suggest that lane change maneuver is a multifactorial process, with implications for motor vehicle crash contributors. The study team is currently reviewing the findings, and will make recommendations for safer truck driving.

E4.3
Title: **Partnering with industry to build safe EMS work environments**
Author: Jim Green

This presentation will summarize the results from the NIOSH developed collaborative research program to improve ambulance crash safety. NIOSH worked hand-in-hand with the ambulance industry to create a family of component specific test standards or test methods aimed at improving the safety of workers and occupants while riding in the patient compartment of an ambulance. The component specific test standards cover; (1) ambulance crash response in frontal impact; (2) ambulance crash response in side impact; (3) ambulance crash response in rear impact; (4) seating and occupant restraints; (5) gurney and patient restraint; (6) equipment mounting, (7) patient compartment structural integrity, (8) gurney-to-floor structural integrity, (9) cabinet and drawer content retention, and (10) seated occupant excursion at impact.

Each test standard or test method is based on quantitative, science based research. Each meets or exceeds existing international standards. All have been validated using full scale test articles redesign and provided by the ambulance industry and its suppliers as a part of the collaborative research process. Each of these component specific test standards or methods has or will be published by the Society of Automotive Engineers (SAE). To date, the first six (6) have been published, while the remaining four (4) are in the SAE review process.

NIOSH is now utilizing these research results and published SAE documents to directly influence changes to four bumper-to-bumper standards now used, or intended for use, in the design of an ambulance. The targeted standard setting bodies and documents are: the General Services Administration's Federal Specification for the Star-of-Life Ambulance; the Ambulance Manufacturer's Division of the National Truck Equipment Association's Ambulance Standards, the National Fire Protection Association's 1917 Automotive Ambulance Standard and the Commission on Accreditation of Ambulance Services Ground Vehicle Standard for Ambulances (GVS 2015). The research team has secured the agreement and cooperation of each of these entities to work toward this common goal and has, as of 2014, provided input to, or directly published standards language with, each.

E4.4
Title: **Tracking the transfer of recommended technologies in high risk tasks of sheet metal workers**
Authors: Ann Marie Dale, Kim Miller, Ching-Ting Hwang, Bethany Gardner, Laura Welch, Bradley Evanoff

Objectives: Sheet metal workers are at high risk for developing musculoskeletal disorders, with one of the highest rates of overexertion injuries among all construction trades. The National Institute for Occupational Safety and Health held a stakeholder meeting to gather information about perceived risk of work tasks, availability of ergonomic controls, and perceived barriers to controlling hazards in sheet metal activities. Stakeholders created prioritized lists of problematic work tasks and recommended interventions for each task and published results in 2005. The objective of this study was to determine whether previously recommended voluntary control measures for high risk activities were being utilized during a sample of commercial heating, ventilating, and air conditioning installation projects.

Methods: Stakeholder groups identified six sheet metal work activities and associated tasks and assigned a risk level (high, moderate, low) and body region potentially affected, and suggested solutions to address the risk in each task. This framework was used to evaluate a series of case studies. Sixteen commercial sheet metal worksite assessments collected between 2007 and 2009 were reviewed. The reviewer determined whether the work methods used to perform each activity incorporated stakeholder-suggested solutions or novel solutions not previously described. The review included video analysis using the Multimedia-Video Task Analysis (MVTA) software, which assists with automating time studies of observable activities, to evaluate postures and time spent carrying loads.

Results: Videos were available for four primary sheet metal activities with high/moderate risk tasks including pack (move material), support system (install hangers), prep (assemble duct), and install ductwork/ equipment. Some stakeholder-suggested solutions were observed in each activity; workers commonly employed mechanical handling equipment to pack heavy objects.

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