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Development of a Theory-Based Safety Climate Instrument

Michael E. Hall, Earl H. Blair, Susan M. Smith and June D. Gorski

Abstract

This study described the development of a safety climate instrument for employees at three mini-steel mill locations in the U.S. The instrument was validated by structural equation modeling using AMOS and measured safety climate at a specific "point in time" to assess the safety culture of the industry. The Hall Safety Climate Instrument was developed using a three-construct theoretical framework of the theory of planned behavior. Reliability of the instrument was established using Chronbach's Alpha, exploratory factor analysis and confirmatory factor analysis. The instrument was designed, piloted and field tested at three mini-steel mills to assess employee perceptions of safety climate in a high-hazard industry. Managers and supervisors participating in the study self-reported a significantly higher safety climate than other participating employees. Individuals self-reporting no previous work-related injuries achieved a higher safety climate score than employees who self-reported previous work-related injuries.

Keywords
Safety climate instrument, theory of planned behavior, structural equation modeling, safety culture

Introduction

Work-related injuries can be costly to employers due to loss of life or permanent disabling injury, as well as impacting productivity. These monetary costs include insurance compensation for loss of life or injury. Injuries have been reported to reduce worker morale and to cause personal suffering (Barreto, et al., 2000; Brown, 1996; Brown, et al., 2000; Clarke, 1999; Courtney & Webster, 2001; Dedobbeleer & Beland, 1991; Mearns, et al., 2001). In the U.S. in 2010, 4,547 work-related injuries resulted in death (BLS, 2011). The cost associated with the year 2003 death statistic was $27.1 million per death (National Safety Council, 2003). Work-related injuries in the U.S. that result in death cost Americans $156.2 billion in 2003 (National Safety Council, 2003).

Historically, in the industrial sector, the accident reduction approach has focused on examining "lagging" data, such as lost-time accident rates/incident rates (Flin, 2007). The term "lagging" is typically used in economics and indicates past events. With lagging data, the injury or fatality needed to occur before the company took action to eliminate or reduce exposure to the hazard. With lagging data, the analysis occurred after the event and was documented by company records (Flin, et al., 2000). Therefore, reporting was after an incident rather than a proactive attempt to prevent injury.

Traditional methods of improving safety within industry focused primarily on accident investigations to determine specific causes and recommend changes in the future (Petersen, 1996). More recently, industries have changed the protocol and have adopted an approach to prevent injuries and fatalities by focusing on predictive measures to monitor safety culture (Flin, et al., 2000). Current safety management and injury prevention research suggests human behavior may have a greater role in preventing injuries or fatalities than was first suspected. The recognition of behavioral factors and the use of accident prevention programs to reduce injuries have been cited in research focused on organizational culture, human factors and safety culture (Brown, 1996; Brown, et al., 2000; Carder & Ragan, 2003; Cooper, 2002; DePasquale & Geller, 1999; Flin, et al., 2000; Griffin & Neal, 2000; Hayes, et al., 1998; O'Toole, 2002).

Need for Safety Climate Measurement

Safety climate incorporates the predominant attitudes and employee behaviors associated with the state of safety in an organization at a particular moment (Yule, et al., 2007). Safety climate is relatively unstable and subject to change depending on current conditions. Furthermore, safety climate is considered a temporal state or snapshot of safety culture (Dedobbeleer & Beland, 1991; Flin, et al., 2000; Mearns, et al., 2001). Safety culture can be indirectly evaluated from instruments that assess safety climate (Flin, et al., 2000). Published research supports the use of a reliable and valid safety climate instrument to measure safety climate (Bailey, 1989; Carder & Ragan, 2003; Clarke, 1999; Dedobbeleer & Beland, 1991;

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Flin, et al., 2000; Fogarty & Shaw, 2010). Published results indicate this approach can overcome many of the limitations of traditional safety measures, such as tracking lost-time accident rates and generating accident investigation reports. In contrast, safety climate instruments can be used as a predictive tool to assess hazardous exposures before they develop into injuries or fatalities (Seo, et al., 2004). A valid safety climate survey can help eliminate the deficiencies found in more traditional methods because it incorporates near-miss cases and an evaluation of risk exposure (Seo, et al., 2004).

Use of Safety Climate Assessments

Research has shown that a positive safety climate is associated with improved safety practices (Zohar, 1980), a decrease in accidents (Mearns, et al., 2001) and the practice of fewer unsafe behaviors at the workplace (Brown, et al., 2000). Professional organizations supporting best practices promote the use of measuring safety climate as one of the leading indicators of effective safety management (Flin, et al., 2000). Safety climate assessments have been used by organizations to benchmark the effectiveness of an overall safety process or to assess the progress of specific safety initiatives (Arboleda, et al., 2003; Blair, 2003; Brown, et al., 2000; Carder & Ragan, 2003; Clarke, 1999; Cooper, 2002; Diaz & Cabrera, 1997; Geller, 2000; Griffin & Neal, 2000; Mearns, et al., 2001; Petersen, 1996; Zohar, 1980).

One reported limitation associated with available safety climate instruments was that a majority of the instruments lacked a unifying theoretical model, and few attempted to address issues of validity and reliability during development (Flin, et al., 2000). Most instruments were found to be customized to fit the sponsoring organization's requirements. Many instruments used focus groups and interviews to determine specific safety issues to incorporate in an instrument for a particular workforce and then developers tailored the instrument to focus on those issues (Cox & Cox, 1991; Niskanen, 1994; Diaz & Cabrera, 1997; Lee, 1998). A few instruments have attempted to determine an underlying factor structure (Brown, 1996; Brown, et al., 2000; Brown & Holmes, 1986; Mearns, et al., 2001; Niskanen, 1994; Seo, et al., 2004). However, Flin, et al. (2000) found these methodological inconsistencies in instrument development, and cultural differences among specific industries made it difficult to bridge the factor structures into a common group.

Targeting High-Hazard Industry

Of the 4.4 million work-related injuries reported in the U.S. during 2002, the manufacturing sector, including the steel industry, accounted for 23% of all injuries (BLS, 2004). This was the third-highest sector for occupational injury in the U.S. (BLS, 2004). The injury rate for the steel industry, including jobs with high-potential risk, increased from 15.2 in 2003 to 17.0 in 2004 (BLS, 2004). High-potential risk is "any situation, practice, procedure policy, process, error or occurrence of such a nature that, if it causes an accident, the accident will almost surely and predictably result in severe loss" (Lack, 2001). The high number of injuries as reported by the Bureau of Labor Statistics (BLS), the growing workforce and the increasing demand for steel products demonstrate the importance of addressing safety climate conditions in the steel industry in an attempt to reduce future injuries/fatalities.

The steel mill industry has been recognized as a high-hazard environment and the subject of previous research studies focused on the development of mitigation strategies to lessen the number of accidents (Ong, et al., 1987; Rosa, et al., 1996; Barreto, et al., 1997; Prussia, et al., 2003; Ologe, et al., 2005). Research studies on steel mills have suggested an association between accidents and specific variables related to causation.

Ong, et al. (1987) analyzed the role of shiftwork schedule and incidence of injury among steel mill workers. Differences in occurrence were found depending whether the employee was a dayshift or nightshift worker. However, since the employees had similar training and job function, along with associated risks, other contributing factors must be considered. Rosa, et al. (1996) went on to suggest possible modification to shift schedules that proved to enhance alertness and reduce fatigue, both of which were instrumental in reducing chance of accidents. The workers, due to social concerns, displayed resistance to these modifications. Motivation for behavior adoption needs to be considered when implementing safety protocols if the overall safety program is to be successful.

The hazardous work environment of steel mills was the subject of focus for Barreto, et al. (1997). These researchers found fatal injury was positively correlated with the number of environmental risk factors. Since many steel mills share the high-hazard environment, there is a need to determine the efficacy of safety measures and the likelihood of compliance by the workforce to prevent accidents.

Ologe, et al. (2005) chose to look at the specific relationship of PPE with awareness and attitude toward the behavior. These researchers found that even though workers were aware of the need for PPE, had access to PPE and had knowledge of the methods of prevention, only 8.8% actually used PPE.

Reviewing the existing body of research on safety in steel mills found that there are many contributing factors and unanswered questions (Brown, 2000; Prussia, 2003; Watson, 2005). Of particular interest is the relationship between identification of mediating procedures to address known factors associated with injury and the willingness of the employee to make the behavior changes necessitated by the procedures (Prussia, 2003). Previous research has not adequately addressed the underlying factors that groups of individuals contemplate when deciding to make a behavior change (Yule, et al., 2007). Determining what changes employees need to make to prevent injury is not a solution if those changes are not adopted and implemented by the worker population (Yule, et al., 2007). This research focused on steel mini-mills because workers in this environment are considered a high-risk group for serious injuries and because the mill administrator afforded access.

Measuring Safety Climate

Safety climate is a collection of attitudes and behaviors as expressed at a point in time and can be measured using surveys

(Yule, et al., 2007). Safety climate measurement has been shown to illuminate the industrial accident process through the linking of safety climate scores and risky behaviors. Also, safety climate has been linked to accident-related variables (Hayes, et al., 1998). These linkages indicate accidents can be prevented if countermeasures are taken to address areas of safety climate. This process allows safety managers to expand safety program focus and to address behavioral and safety climate concerns through uncovering accident-related variables.

Measurement of safety climate requires an instrument to record employees' self-reported perceptions on safety issues. Safety climate instruments generate a score from a summation of safety attitude and behavior measurement items within the safety climate survey. Perception surveys, as designed by Rensis Likert, were used to measure organizational factors as they related to productivity (Petersen, 1996). Likert's research examined the establishment of a relationship between "high achievement" and scoring high on the perception instrument domains. These domains or themes included support, supervision, attitude toward the company and motivation. The high correlation also supports the usefulness of the surveys to indicate weak areas that can be addressed by managers. In theory, improving the deficient areas of the survey results will improve workers' productivity (Petersen, 1996).

This same approach used by Likert was adapted to safety management by Charles Bailey and Dan Petersen during the development of the "Minnesota Perception Survey." This perception survey analyzed safety perceptions within the railroad industry (Bailey & Petersen, 1989). Bailey determined that the effectiveness of safety programs could not be measured by traditional procedural-engineering criteria. Rather, Bailey found safety program effectiveness was best measured by responses from the entire organization to assess the safety system. Bailey's research found that the most successful safety programs effectively identify worker and supervisor behaviors and attitudes that affect safety performance (Bailey & Petersen, 1989). Bailey's (1989) research concluded that safety climate surveys were a better measure of safety performance and predictor of safety results than traditional audit programs.

Need for a Theory-Based Safety Climate Instrument

Most safety climate instruments documented in the literature did not report procedures to test reliability or validity, and weighting factors were not included. Only a few of the instruments reviewed by the researchers were reported to have been adopted and reused by individuals other than those who created the instrument. Existing instruments reflected a lack of consistency in the items included in the survey, and a significant variety in the number of safety climate dimensions included in reviewed instruments did not agree. One possible explanation for the divergence of factor structures within existing instruments could be that each instrument was designed to only meet the needs of a specific population within an industry (Bailey & Petersen, 1989; Brown, et al., 2000; Carder & Ragan, 2003; Clarke, 1999; Dedobbeleer & Beland, 1991; Diaz & Cabrera, 1997; Flin, et al., 2000; Griffin & Neal, 2000; Niskanen, 1994; O'Toole, 2002; Petersen, 1996; Seo, et al., 2004; Williamson, et al., 1997).

Flin, et al. (2000) described a paradigm that existed at the time where safety climate instruments were developed or had been developed using similar techniques. These techniques can be identified as using literature review to select safety themes and to determine particular issues at a specific location. Additionally, Flin and associates (1997) were able to identify a core group of themes common to the published studies.

A recent review of the literature suggests that the paradigm described by Flin, et al. (2000) may still exist today. As a follow up, Flin (2007) reiterates the 2000 position while applying high-hazard industry safety climate questionnaires to the healthcare field. Recent studies have attempted to incorporate a theory-based approach to measurement of safety climate. The intention of other researchers was to measure intervention outcomes rather than explore the behavioral decision-making process (Christian, et al., 2009; Diaz-Cabrera, et al., 2007; Hartman, et al., 2009; Mark, et al., 2008; Tharaldsen, et al., 2008; Guldenmund, 2007; Vinodkumar & Bhasi, 2009).

Traditionally, there has been a lack of consistency in the approaches to measure safety climate in worksite settings (Flin & Mearns, 2000; Guldenmund, 2000, 2007). Guldenmund (2007) surmised that instruments intending to measure safety climate were typically developed following one of two pathways. The first approach is to use a theoretical perspective to establish a description of safety climate for the organization. The second is to build an instrument based on the findings of previous safety climate measures. This research study is an exercise in applying both techniques to develop a comprehensive instrument that possesses the attributes of a theoretical and a pragmatic design to measure safety climate. The use of behavior theory in the assessment of safety climate allows the discovery and understanding of the link between safety climate and the behavior outcomes (Fogarty & Shaw, 2010; Johnson & Hall, 2005).

Instruments that do not incorporate social cognitive theory (SCT) into their design are measures of factors that contribute to safety climate. Albert Bandura postulated that the SCT explained human behavior following a reciprocal model, which included the behavior, personal factors and environmental influences (Bandura, 1986). Psychosocial researchers have long applied the SCT to create procedures to influence the underlying variables in order to affect behavioral change. The recognition that the SCT can be used to change behaviors also supports that existing behaviors can be explained following the constructs of the SCT. The SCT explains how individuals learn and maintain acquired behaviors patterns; the understanding of the interaction of constructs is crucial when planning intervention strategies to change those behaviors.

To address the need for a theory-based instrument with both validity and reliability, the authors designed a theory-based safety climate instrument and tested it for validity and reliability. The instrument discussed in this article was based on behavioral theory. Behavioral theory is a conceptual tool that can be used by researchers as a guide for measurement and assessment of the impact of interventions designed to influence behavioral choices (Glanz, et al., 1997). The use of theories during the stages of planning and evaluation of a new safety climate instrument allowed the researchers to seek answers to the critical questions of why, what and how (Glanz, et al., 1997). This new instrument was targeted for use as a tool to measure safety climate in high-risk industries. The industrial settings selected to pilot this instrument were high-hazard work environments with the potential for serious injury if appropriate safety practices were not followed.

Research Purpose

The purpose of this research was to 1) develop a theory-based, reliable safety climate instrument validated by structural equation modeling to assess the safety climate of steel mini-mill employees and on-site contractors at three mill company locations within the U.S. and 2) establish an initial profile of the safety climate at three steel mini-mill company locations within the U.S. (Hall, 2006). Further investigation of the initial profile included the research question, "Does safety climate differ depending on self-reported position, department or previous work-related injury experience?"

Methods

Theoretical Framework

The theoretical framework selected for use in the development of an instrument was the Theory of Planned Behavior (TPB). This theory was selected because it explores the relationship between attitudes, beliefs and self-efficacy. This relationship may affect decisions of the individual to follow or reject prescribed safety protocols. The theory of planned behavior is an extension of the theory of reasoned action. The central factor in the theory of planned behavior is the individual's intention to perform a behavior. The constructs of the theory of planned behavior shown to affect health decisions are a) attitudes, b) subjective norms and c) perceived behavioral control. The development of a scale to measure safety climate based on human behavior theory allowed the measurement of the elements of that theory (Montano, et al., 1997) (Table 1).

The TPB has been examined as a suitable predictive model of behavioral intention in several safety and occupational settings (Arnold, et al., 2006; Elliot, et al., 2003; Evans & Norman, 2002; Petrea, 2001; Quine, et al., 2001; Sheeran & Silverman, 2002). The findings from these studies support a reasonable expectation that TPB can be used as the basis for development of a model representing safe behavior. Johnson and Hall (2005) found that many existing safe behavior studies evaluated specific intervention outcomes rather than explore the factors underpinning the decisions to follow those interventions. Johnson and Hall (2005) concluded that the TPB's constructs can be appropriately used in a worksite setting to guide interventions to encourage adherence to safe behaviors. Fogarty and Shaw (2010) furthered the Johnson and Hall (2005) study by fortifying the structural model of the TPB with the addition of "management attitude to safety." Fogarty and Shaw (2010) found that while holistically, the TPB was a suitable representation of factors that lead to behavior intention, there were disparities in influence exerted by the themes selected to represent the TPB constructs. A review of the literature led to

Categories Assigned for Analysis	Theory of Planned Behavior	Fogarty & Shaw Model	Hall Safety Theme Model
Factor Linking Determinants[a]		"Management Attitude to Safety"	**"Management/ Supervisor Attitude to Safety"**
Determinant of Intention #1	"Attitude"	"Own Attitudes to Violations"	**"Risk"**
Determinant of Intention #2	"Subjective Norms"	"Group Norms"	**"Group Norms"**[b]
Determinant of Intention #3	"Perceived Behavioral Control"	"Workplace Pressures"	**"Workplace Pressures" "Competence"**[c] **"Safety System"**[c]
Measurement Variable #1	"Intention"	"Intention to Violate"	**"Intention to Follow Safety Procedures"**
Outcome	**"Behavior"**	**"Violation"**	**See Footnote**[d]

Table 1 Theory Construct Assignment of Fogarty & Shaw Model and Hall Safety Theme Model*

Note: *[a]The use of factor analysis to develop the new instrument was guided by findings of Fogarty and Shaw (2004) as an external link affecting "Determinants of Intention." [b]Group norms, competence and safety system were added to the model as recommended by Fogarty and Shaw (2004) as a measure of "Subjective Norm." [c]The two additional determinants of intention "Competence" and "Safety System" were added by the researchers to increase strength of "Workplace Pressures," which were reported by Fogarty and Shaw (2004) to be an inadequate substitute for "Perceived Behavioral Control." [d]The researchers also elected to measure "Intention to Follow Safety Procedures" as an indirect measure of behavior as recommended by Ajzen (1991) based on findings that intention is highly correlated with actual performance of behavior.*

the development of the Hall Safety Climate instrument. The premise of this study was to build on the current understanding of application of TPB in the worker safety context by strengthening the measures of the TPB constructs by incorporating additional safety themes.

The selection of which safety themes were to be included was based on the meta-analysis by Flin, et al. (2000). Flin, et al. (2000) attempted to determine the fundamental base from which safety climate could be assessed. Flin, et al.'s (2000) findings were that a core taxonomy existed in the safety climate assessment field of research.

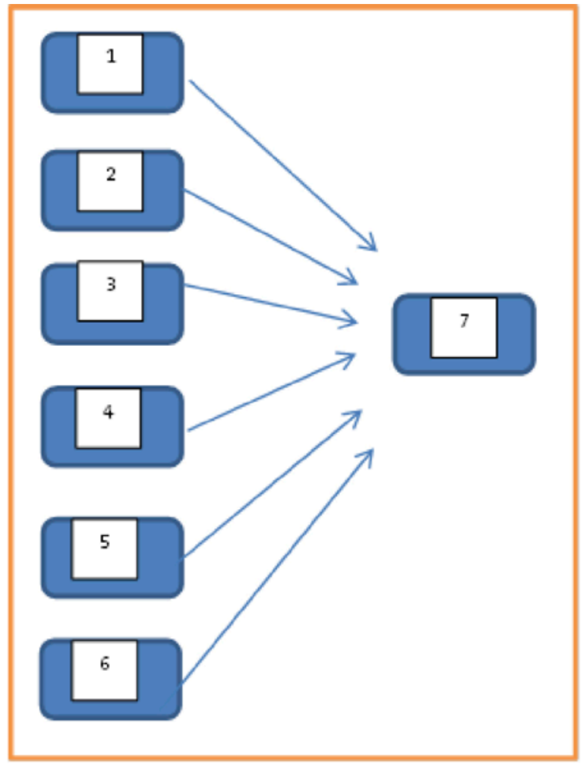
To create this new instrument, six safety themes and one intention measure were assigned. These included "Management/Supervisor Attitude to Safety," "Risk," "Group Norms," "Workplace Pressure," "Competence," "Safety System" and "Intention to Follow Safety Procedures" to one of three constructs of the theory of planned behavior: "Attitude Toward Behavior," "Subjective Norms" and "Perceived Behavioral Control." The content validity of the initial six safety themes was supported because all eighteen safety climate instruments analyzed by Flin, et al. (2000) incorporated items that measured these six themes. A seventh measure of "Intention to Follow Safety Procedures" was added as an outcome variable. This intention measure was added for the "intention" variable derived from the theory of planned behavior. The intention variable is influenced by each of the six other theme variables (Figure 1). It should be noted in the unpublished manuscript that Fogarty and Shaw (2004) were referenced during the development and application of this study. The manuscript has since been published as Fogarty and Shaw (2010) found that an intention variable was needed to fulfill the requirements of the theory of planned behavior when used to model safety climate. A panel of three experts was selected to assist the researchers to establish face validity of the safety themes. Additionally, the panel approved the theoretical basis used to establish constructs for the instrument.

The approach that this research undertook, incorporation of the safety themes into the TPB model, allowed for the evaluation of predictive capabilities. Previous research that forgoes the incorporation of a social cognitive model into safety climate study lacks the ability to explain the interaction of the underlying factors that lead to safe work behavior (Fogarty & Shaw, 2004).

Development of Item Pool & Test for Reliability

The items, adapted for use in the Hall Safety Climate Instrument, were consistent in context to those used in previous published safety climate surveys. Additional items were incorporated to characterize demographic information to characterize if the individual respondent had experienced an injury event, acknowledged hazards in the work area and the specific job position and/or department of the respondent.

Sixty-five items were initially assigned to reflect concerns related to all of the six safety themes and the one intention



1) Manager and Supervisor Attitude Toward Safety
2) Risk
3) Group Norms
4) Workplace Pressure
5) Competence
6) Safety System
7) Intention to Follow Safety Procedures

Figure 1 Safety Theme Influences on Intention to Follow Safety Procedures

variable. All 65 items were confirmed and randomly placed on the questionnaire regardless of the theme. The questionnaire used a 5-point Likert scale. The response options available to the respondent included 1-Strongly Disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly Agree. The selection of the 5-point Likert response scale was based on use in previous organization and safety climate studies (Colla, et al., 2005; Zohar, 2000; Williamson, et al., 1997). Further consideration used to select 5-point over an even number of responses (4- or 6-point), the researchers chose to avoid overscaling the responses by forcing the respondents to select answering to one extreme or the other. Going above a 7-point scale may be too cognitively challenging (Colman, et al., 1997). The 5-point scale was ultimately selected to allow easier comparisons to existing safety climate studies. In addition, Colman, et al. (1997) found that 5-point response scales were equivalent to 7-point response scales when accounting for total variance.

The safety themes initially proposed in this research were used for instrument design purposes, and the issues by individual themes were further refined to incorporate factor analysis procedures. The instrument was tested for internal consistency reliability using Cronbach's alpha (Schmitt, 1996). Published studies have used Cronbach's alpha as a method of establishing a reliability measure for instrument design (Carder & Ragan, 2003; Clarke, 1999; Hayes, et al., 1998; Williamson, et al., 1997).

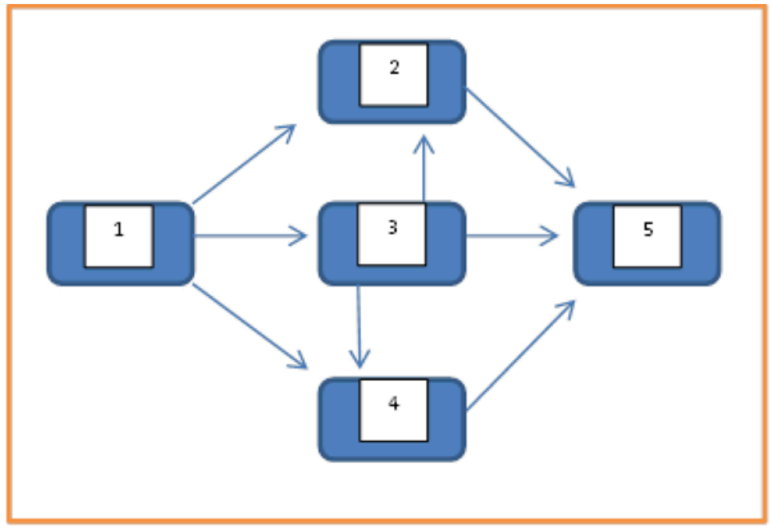
Pilot Data Collection Process

A steel mini-mill located in the southeastern U.S. was selected for pilot testing of the Hall instrument and conducted during January 2006. Three hundred sixty eligible participants attended monthly safety meetings where the pilot Hall Safety Climate Instrument was introduced, and employees were given an opportunity to complete the survey. The on-site safety manager introduced, administered and provided direction for workers to submit responses for the voluntary completion of the survey during monthly safety meetings. The process used by employees for returning a completed or blank survey was anonymous. The purpose of the initial pilot study was to verify the data collection methodology and to collect data for instrument refinement. The findings of the pilot study were used to further refine the instrument and are presented below. The data collected were entered into a database using an earlier version of Statistical Package for the Social Sciences (SPSS); however, all final analyses were conducted using SPSS v19.0.

Pilot Study 1

Determining the factors (latent variables) of the instrument helped lead to improving the understanding of the main influences contributing to the overall safety climate as measured by the instrument. The 54 items were subjected to a factor analysis with principal component extraction and Varimax rotation. The scree plot generated from SPSS yielded an interpretable solution of five factors, which accounted for 77.1% of variance. The final solution determined 34 items that loaded .4 or greater on only one factor. The criteria for response item selection were adapted from a study conducted by Williamson, et al. (1997). Twenty items failed to load under these conditions on any factor.

The remaining 34 items had a five-factor structure. The first factor extracted was interpreted as "Understanding of Safety Program" because of the nature of the items that made up the factor. The second factor was interpreted as "Influence of Management and Supervisors" because it contained items that were related to the perceptions of management and supervisors. The third factor was interpreted as "Group Beliefs" because the nature of the items dealt with the individual's perception of the belief of others around them. The fourth factor was interpreted as "Risk Acceptance" because the items focused on elements that may encourage risk-taking behavior. The final factor was interpreted as "Intention to Follow Safety Procedures," and the items contained addressed variables that contribute to an individual adhering to safety procedures. Figure 2 represents the resultant model of factor interaction. All factors contained at least three items, and the internal consistency across items in each factor was acceptable for all. Additional measures to improve the Cronbach's alpha for factors four and five were not conducted because further planned field testing of the instrument was designed to explore and confirm the factor structure. The factor Cronbach's Alpha is presented in Table 2.



1) Influence of Managers and Supervisors
2) Risk Acceptance
3) Group Norms
4) Understanding of Safety Program
5) Intention to Follow Safety Procedures

Figure 2 Five-Factor Structure of Safety Climate From Pilot Study 2

Response items from the Hall Safety Climate Instrument pilot were assigned to a factor if they loaded greater than .4 on only one factor. The final five-factor structure included 29 response items that met the criteria for factor assignment. Five items loaded above .4 but did on two or more factors and were discarded. To further investigate other possibilities for factor structure, the factor analysis was restricted to 4-, 3- and 2-factor solutions. Each of the four structures was tested during the structural equation modeling (SEM) portion of the results section.

Based on the findings from Pilot Study 1, the TPB constructs were represented by the resultant factors rather than the initial six safety themes proposed by Flin, et al. (2000). This technique of using EFA to determine the valid measure

Safety Factors	Variance	Cronbach's* Alpha	N
Understanding of Safety Program	45.664	.93	17
Influence of Management & Supervisors	15.443	.87	8
Group Beliefs	5.505	.72	3
Risk Acceptance	4.690	.60	3
Intention	5.764	.62	3

*Round to two significant figures and none below .60 criteria

Table 2 Internal Consistency Reliability Analysis of Specific Safety Factors Within the Hall Safety Climate Instrument Pilot Study 1

of safety climate was essential to preserve the theoretical base of the TPB. Further refinement of the model was achieved through SEM testing to examine which factor structure best represented the constructs of the TPB.

Field Test of Instrument

Pilot Study 2

Pilot Study 2 used the refined instrument based on the data collected during Pilot Study 1. In late 2006, an additional three steel mini-mill plants were selected to receive the 29-item Hall Safety Climate instrument.

Once the random order for the 29 items was determined, the final instrument was prepared for distribution. Each facility safety manger in the field study was contacted and provided a copy of the Hall Safety Climate Instrument, coversheet and instruction sheet. The industry facilities made copies and administered, collected and shipped the completed instruments to the researcher. The completed surveys were entered into an Excel database and screened for incomplete surveys.

Survey Response Rate by Location

Survey responses totaled 671 out of a possible 955, which yielded a response rate of 70.3%. The response rates for the three survey locations are as follows: location No. 1 (73.1%); location No. 2 (64.6%) and location No. 3 (72.6%).

After screening, the database was imported into SPSS for factorial analysis. Analyses included an exploratory factor analysis (EFA) to determine a 5-factor, 4-factor, 3-factor and 2-factor structure solution, and SEM procedures were used to confirm which factor structure best fit the data from response items on the instrument. Analysis of variance (ANOVA) and multivariate analysis of variance (MANOVA) procedures were used to explore group differences among the convenience sample respondents. When differences were detected, post hoc analysis was performed using Tukey's Honestly Significant Difference (HSD).

Structural Equation Modeling

A panel of experts validated the initial mapping for the six safety themes. This content validity was further tested by maximum likelihood procedures in AMOS 6.0 by test-fitting the path model to the six safety theme variables. Additional measures were taken to revise the model based on modification indices along with theoretical considerations. This step was essential to the assurance that the resulting model was a valid measure and followed the constructs of the TPB.

Survey Response at Three Field-Study Locations

Survey responses totaled 671 out of a possible 955, which yielded a response rate of 70.3%. The response rates for the three survey locations are as follows: location No. 1 (73.1%); location No. 2 (64.6%) and location No. 3 (72.6%).

Results

Confirmation of 3-Factor Model to Represent the TPB

SEM, using AMOS 6.0 was used to test the fit of the relationships among the instrument variables. The choice of fit indices in SEM was determined by literature review of similar studies (Fogarty & Shaw, 2004). The fit indices selected were (indicates acceptable value): the ratio of χ^2 to degrees freedom (<3); Good Fit Index, GFI (>.9); Comparative Fit Index, CFI (>.9); Tucker-Lewis Index, TLI (>.9); and Root Mean Square Error of Approximation, RMSEA (>.05, <.08), (Byrne, 2001).

The three-factor model exhibited the best fit; CMIN/DF = 3.197; GFI = .894; CFI = .889; TLI = .878; RMSEA = .057, see Table 3, Revised Three Factor Model for the Theory of Planned Behavior. The modification index was selected as an output option in AMOS 6.0. The large values reported by the modification index may indicate the presence of factor cross-loading and error co-variances (Fogarty & Shaw, 2004).

At this point, further modification of the model becomes exploratory in nature even though Confirmatory Factor Analysis (CFA) procedures are continued in order to test the hypothetical factor structures. Items that have large modification index values were reviewed for wording and any similarity in meaning with other items. Based on the reported value and theoretical considerations, five items were discarded from the three-factor model to yield a modified structural equation model.

Safety Climate & Safety Factor Mean Scores

Independent variables were analyzed by comparing the safety climate mean scores and individual safety factor mean scores using ANOVA and MANOVA. If a significant difference was detected during the MANOVA, further analysis using post hoc tests, specifically Tukey's HSD, were conducted to determine the specific differences.

Safety Climate & Safety Factor Mean Scores by Job Position

ANOVA analyses were conducted to determine if there was a significant difference in self-reported job position and safety climate. Self-reported job position was the independent variable and was compared to the average overall score of the instrument. Job position categories included 1) Manager; 2) Supervisor; 3) Employee; and 4) Nonexempt. Note that the categories "Em-

Safety Factor	TPB Construct
Risk-Taking Behaviors	Attitude Toward Behavior
Manager/Supervisor Support	Social Norms
Safety System Program	Perceived Behavioral Control

Table 3 Revised 3-Factor Model for the Theory of Planned Behavior Constructs

Note: *The modified model fit was achieved in 10 iterations and exhibited excellent fit statistics: CMIN/DF = 2.876; GFI = .919; CFI = .913; TLI = .903; RMSEA = .053.*

ployee" and "Nonexempt" were used because they were internal company designations to identify the type of work performed. "Employee" refers to hourly production work, and "Nonexempt" refers to hourly administrative and staff personnel.

ANOVA analysis detected significant differences at a p = .05 level in responses to job position and overall safety climate. The ANOVA F value was $F_{(3,667)} = 14.57$, p = .001, indicating significant differences between job positions and overall safety climate. Post hoc analysis was performed based on the significant differences found using Tukey's HSD. Job positions "Employee" and "Nonexempt" scored significantly lower than job positions "Manager" and "Supervisor." Safety climate mean scores for job position are presented in Table 4, Job Position Safety Climate Mean Scores from the Hall Safety Climate Instrument Field Study.

MANOVA analyses were conducted to determine if significant differences existed between self-reported job positions and individual safety factor scores. Self-reported job position was the independent variable and was compared to individual safety factor scores.

MANOVA analysis detected significant differences at a p=.05 level in job position and individual safety factor scores. The MANOVA F value was $F_{(9,1618.57)} = 5.33$, p = .001, indicating that significant differences exist between job position and individual safety scores. Post hoc analysis was performed based on significant differences found using Tukey's HSD. Job positions "Employee," "Nonexempt" and "Manager" scored significantly lower for safety factor "Risk-Taking Behaviors" than job position "Supervisor." Job positions "Employee" and "Nonexempt" scored significantly lower for safety factor "Manager/Supervisor Support" than job positions "Manager" and "Supervisor."

Safety Climate & Safety Factor Mean Scores by Department

ANOVA analyses were conducted to determine if there was a significant difference in self-reported department and overall safety climate. Self-reported department was the independent variable and was compared to the average overall score of the instrument. Department categories included the Rolling Mill, Melt Shop, Maintenance, Administration and Contractor.

ANOVA analysis detected no significant differences at a $p = .05$ level in responses to job position and overall safety climate. The ANOVA F value was $F_{(4,666)}=2.23$, $p = .064$, indicating no significant differences between department and overall safety factor score. Results indicate that safety climate was not different among employees based on department location. Safety climate score is presented in Table 5, Department Safety Climate Mean Score from the Hall Safety Climate Instrument Field Study.

MANOVA analyses were conducted to determine if significant differences existed between self-reported department and individual safety factor scores. Self-reported department was the independent variable and was compared to individual safety factor scores.

MANOVA analysis detected significant differences at a p=.05 level in department and individual safety factor scores. The MANOVA F value was $F_{(12,1757.07)} = 2.26$, $p = .008$, indicating that significant differences exist between department and individual safety factor scores. Post hoc analysis was performed based on significant differences found using Tukey's HSD. Departments "Rolling Mill," "Contractors," "Melt Shop" and "Administration" scored significantly lower for safety factor "Manager/Supervisor Support" than "Maintenance."

Safety Climate & Safety Factor Mean Scores by Previous Work-Related Injury Experience

ANOVA analyses were also conducted to determine if there was a significant difference in self-reported prior work-related injury experience and overall safety climate. Self-reported prior work-related injury experience was the independent variable and was compared to the average overall score of the instrument. Responses to the item "At this or any previous place of employment have you ever been involved in a work-related accident that resulted in an injury?" were (1) yes and (0) no.

ANOVA analysis detected a significant difference at a $p = .05$ level in responses to self-reported prior work-related injury experience and overall safety climate. The ANOVA F value was $F_{(1,669)} = 4.85$, $p = .028$, indicating a significant difference between self-reported prior work-related injury experience and overall safety climate. Respondents who reported a prior work-related injury experience scored significantly lower than those who reported no prior work-related injury.

MANOVA analyses were conducted to determine if significant differences existed between self-reported prior work-related injury experience and individual safety factor scores. Self-reported prior work-related injury experience was the independent variable and was compared to individual safety factor scores.

MANOVA analysis detected significant differences at a $p = .05$ level in self-reported prior work-related injury experience and individual safety factor scores. The MANOVA F value was $F_{(3,667)} = 5.20$, p = .001, indicating that significant differences ex-

Self-Reported Job Position	Number of Respondents	Mean	Std. Dev.	Std. Error	Min.	Max.
Manager	26	4.0	.3519	.0699	3.4	4.8
Supervisor	53	4.0	.4014	.0551	2.4	4.9
Employee	551	3.7	.4031	.0172	1.5	5.0
Nonexempt	41	3.8	.4622	.0722	2.8	4.9
Total	**671**	**3.8**	**.4171**	**.0161**	**1.5**	**5.0**

Table 4 Job Position Safety Climate Mean Scores from the Hall Safety Climate Instrument Field Study

Self-Reported Department	Number of Respondents	Mean	Std. Dev.	Std. Error	Min.	Max.
Rolling Mill	227	3.7	.3854	.0256	2.6	4.9
Melt Shop	183	3.7	.4345	.0321	2.5	5.0
Maintenance	116	3.8	.4640	.0431	1.5	5.0
Administration	90	3.8	.3887	.0410	2.6	4.9
Contractor	55	3.8	.4054	.0547	2.8	4.9
Total	**671**	**3.8**	**.4171**	**.0161**	**1.5**	**5.0**

Table 5 Department Safety Climate Score Mean From the Hall Safety Climate Instrument Field Study

ist between self-reported prior work-related injury experience and individual safety scores. Individuals who responded (1) "yes" to prior work-related injury experience scored significantly lower for safety factor "Risk-Taking Behaviors" than those who responded (2) "no."

ANOVA analyses were conducted to determine if there was a significant difference in self-reported awareness of hazard in immediate work area and overall safety climate. Self-reported awareness of hazard in immediate work area was the independent variable and was compared to the average overall score of the instrument. Responses to the item "Are there any hazards in your direct work area?" were (1) yes and (0) no.

The results of the ANOVA analysis found no significant differences at a $p = .05$ level in responses to awareness of hazard in immediate work area and overall safety climate. The ANOVA F value was $F(_{1,669}) = 3.19$, $p = .075$, indicating no significant differences between awareness of hazard in immediate work area and overall safety factor score. Results indicate that safety climate was not different among employees based on awareness of hazard in immediate work area.

Results of Pathway Model Testing

Pathway model testing resulted in an acceptable fit for the instrument. Factor analysis revealed an initial five-factor solution for the pilot data. Confirmatory factor analysis and follow-up exploratory factor analysis resulted in a three-factor solution for the field testing data. Significant differences were found during the ANOVA and MANOVA testing of the Likert-type item responses and specific differences identified with Tukey's HSD.

Group differences in safety climate and safety factor scores were determined by ANOVA and MANOVA. Significant differences ($p < .05$) among variables were identified when the F ratio indicated larger variance among variables than within variables. Post hoc comparisons were performed to determine the specific groups that yielded the significant differences. Pair wise correlations, specifically Tukey's HSD, were computed to determine which groups differed the most in self-reported perceptions of safety climate.

It should be noted that a potential source of measurement error that threatens the validity of the conclusions is common method variance (CMV) (Podsakoff, et al., 2003). CMV is when measurement method is the actual source of variance rather than the variable of interest (Podsakoff, et al., 2003). In the case of this study, the procedure of measuring the independent variables and the dependent variables in the same instance could be a source of CMV. Lance, et al. (2010) argue that while CMV may artificially increase observed relationships between variables, there is a counteracting effect from measurement error. In light of these contrasting views, the reader must decide whether the effect of CMV is large enough to discount the findings.

Discussion

The Hall Safety Climate Instrument was created and validated to assess the safety climate of workers in high-hazard occupations in heavy industry, such as workers employed at three steel mini-mill locations in the U.S. Steps involved in the development of the instrument first required the creation of the Hall model based on the theory of planned behavior. This was accomplished by linking safety themes selected from current safety management research to the theory of planned behavior constructs. Then an expert panel was assembled and requested to validate that each safety management-related theme was correctly assigned to the appropriate theory construct. Specific survey items representing each theme were determined by the research through a rigorous search of the literature and review of other psychometric instruments. The expert panel was also requested to review the assignment of each survey item previously assigned to an appropriate theme by the researchers. The researchers then established internal consistency reliability and factor analysis reliability through the pilot testing of the survey instrument with employees at a steel mini-mill location in the U.S. and the analysis of the data the pilot study provided. Further reliability was measured by conducting a pathway analysis of the Hall model using AMOS 6.0 to refine the model and achieving excellent model fit statistics.

Survey responses further revealed that although the majority of employees and on-site contractors indicated agreement with the statement, "I know other workers at the company who do not follow safety procedures," the majority also agreed that most participants have an intention to avoid taking risky behaviors that circumvent company procedures and that managers and supervisors supported safety at the organizational level. Differences were noted in perceptions from employees at various levels. Those in management and supervisory roles self-reported a higher company safety climate than hourly and nonexempt employees.

Three-Factor Model

SEM yielded a three-factor model, which best fit the path model representing the TPB constructs. Factor one was interpreted as "Risk-Taking Behaviors" because of the nature of the items that loaded on that factor were associated with individual choices related to safety behavior. Factor two was interpreted as "Manager/Supervisor Support" because each item considered management or supervisory views on the behavior. Management has long been thought of as an influence on worker attitudes, but inclusion of supervisor consideration shows a disassociation of workers from floor-level supervisors.

The second factor was mapped to the "Social Norms" construct of the TPB since managers and supervisors set the climate for how safety behavior is to be regarded in the workplace. The final factor was interpreted as "Safety System Program" because the items reflected the self-efficacy, training and opportunity to follow safety procedures. This factor was thought to be representative of the individual's ability to follow through with required safe behaviors and a good proxy for the TPB construct of "Perceived Behavioral Control."

Job Position: Safety Climate/ Safety Factor

Participants at steel mini-mills located in the U.S. in a supervisor job position reported under the safety climate factor for "Risk-Taking Behaviors" an intention to avoid risk-taking behaviors that circumvent company safety procedures higher than the safety climate factor reported by managers, employees and those respondents in nonexempt job positions. The disparity in perceived importance should be eliminated by addressing the need for all personnel to avoid poor safety decisions. This raises the question whether supervisors may perceive they are under greater pressure to produce than to work safely, even if the company jargon and management line espouse "safety first."

Maintenance departments reported a significantly (.05 level) higher safety climate factor for manager and supervisor safety support at the organizational level than other departments. Efforts to replicate the delivery of safety programming in the maintenance department to the other areas of the company may be the best way to improve the perception of manager and supervisor support for safety.

Work-Related Injury Experience: Safety Climate/Safety Factor

Participants at steel mini-mills located in the U.S. who had no previous work-related injury experience reported significantly higher company safety climate scores than those who had a previous work-related injury experience. Participants also reported a significantly higher safety climate factor for "Risk-Taking Behaviors," the intention to avoid risk-taking behaviors that circumvent company safety procedures than those who have had a previous work-related injury experience using a .05 level of significance. This implies there is individual variance in risk perception even when employees of an organization have experienced the same training and education and work in the same jobs. This self-reported factor also suggests that those individuals who have a lower perception of, and are less serious about avoiding risk-taking behaviors, are more likely to take risks and consequently may be more likely to be injured.

Conclusions

The Hall Safety Climate Instrument proved to be reliable, and an expert panel determined face validity of the selected factors to accurately reflect intended themes. This research revealed that a majority of employees and on-site contractors indicated that safety climate was perceived as "high" and that company safety programs were effective, confirming that high safety climate perceptions can exist in high-hazard occupational environments as found in previous studies (Brown, et al., 2000; Dedobbeleer & Beland, 1991; Fogarty & Shaw, 2010). This research further exemplified the fact that separate safety climates can exist among workers in different groups as reported in other studies (Fogarty & Shaw, 2010; Hayes, et al., 1998; Williamson, et al., 1997).

The identification of a three-factor model of safety climate can lead to a more focused approach to safety management. "Risk-Taking Behaviors" as a factor indicates a need to address consequences associated with poor safety decisions. The goal should be to convince employees that following safety protocol for each and every task performed is in their best interest. "Manager/Supervisor Support" reinforces the concept of a "top-down" approach to positively influencing safety climate. Employees need to know that upper management along with direct supervisors expect adherence to safety policies. One way to convey that message is to have involvement of key management and supervisory personnel during delivery of safety messages. "Safety System Program" addresses the need for safety to become a core value and to take priority over production if there is a conflict that could result in injury. Efforts to increase safety awareness, engage all levels in supporting, enforcing, and reinforcing safe behavior will affect the overall safety climate of the employees.

Additionally, employees who have had a previous work-related injury may need follow-up contact with safety personnel to identify possible reasons for the lower safety climate scores. There may be opportunities to affect these employees with positive reinforcement in a way that strengthens their attitudes concerning safety in the workplace. Perhaps employees with previous work-related injuries could share their experiences with others to increase awareness of the importance of adhering to safety policies. Some organizations have successfully taken a behavioral approach by pairing employees who have been injured with veteran employees who have not been injured and establishing a coaching or mentoring relationship.

Given the seriousness of work-related employee injuries and fatalities in high-hazard industry, more research that builds on the existing findings is needed. The utility of theory-based safety climate instruments resides in the potential to measure safety climates in other high-hazard industries. This research provides a foundation for the development and application of safety climate instruments based on the theory of planned behavior to specific high-hazard industries other than the steel mini-mill industry.

Further investigation is needed to explore the persistent gap in safety climate constructs between management and employees. Until the organization is able to view safety from a single perspective, it will be difficult to create the culture necessary to effectively elevate safety as a core value. Additional attention should be given to streamlining the instrument to minimally impact the time away from production being used to complete the survey. One possible approach is to focus on the three-factor structure of "risk-taking behavior," "manager/supervisor support" and "safety system program" as the basis for a leaner measure of safety climate. ✪

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Current Practices Related to the Use of Human Performance Improvement & Worker Engagement Tools

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Abstract

High-performing organizations in the field of human performance often cite that using tools that engage their workers is critical to their human performance success. Based on this understanding, the purpose of this work is to determine the current practice of the tools used by organizations in general for human performance improvement and worker engagement. Surveys were completed by as many as 325 safety managers asking them to qualitatively answer two questions: What is the most important human performance tool used for human error prevention or human performance improvement? What is the most important tool used to engage workers in the safety function? The level of worker engagement was then estimated based on the responses given to these questions.

Results indicate that the tools used across organizations today to prevent human error are not necessarily those tools used by high-performing organizations. In addition, the general worker engagement level of these human error prevention approaches reported by survey respondents is quite low and can be considered to be somewhat passive. Results also indicate that the majority of tools used by these organizations to actually engage workers in safety are not generally the same ones used to increase human performance. These engagement tools are also not exceptionally engaging to workers. Based on the results of this study, for organizations to enhance human performance and reduce human error, safety managers and their organizations need to become better educated and focused on adopting those human performance tools being used by high-performing organizations today that engage workers.

Keywords
Human error, worker engagement

Introduction

The field of human performance attempts to understand and eliminate the causes of human error—and thus accidents—in the workplace. Human errors are actions or inactions that unintentionally 1) result in undesired conditions, 2) lead to tasks being outside their limits or 3) deviate from sets of rules, standards or directives (Fisher, 2012). Examples of human errors are slips, lapses or honest mistakes. Human errors are different than conscious at-risk behaviors since the former are inadvertent actions, while at-risk behaviors typically involve intentional choices where risks are not recognized or believed justified. At-risk behaviors are actions that involve shortcuts, violations of error-prevention strategies or simple actions intended to improve efficient task performance, usually at some expense of safety (U.S. Department of Energy, 2009).

According to the U.S. Department of Energy (2009), in human performance theory, mission, goals, policies, processes and programs (i.e., the components of safety management systems) have latent organizational weaknesses that could give rise to flawed defenses and error precursors within organizations (Figure 1). These error precursors, which give rise to error-likely situations called error traps, are unfavorable conditions that increase the probability of human errors occurring while performing specific actions. Likewise, workers bring their own visions, values and beliefs to the workplace, which can initiate actions resulting in accidents.

However, even though it has been estimated that 80% or more of accidents are initiated by workers' actions or behaviors (20% are due to equipment failures) (U.S. Department of Energy, 2009; Reason, 1990; Perrow, 1984), 70% of these workers' actions are actually caused by latent organizational weaknesses and 30% by individual mistakes (U.S. Department of Energy, 2009).

But in spite of having safety management systems in place, human errors in the workplace will arise and lead to incidents, resulting in injuries, illnesses and environmental releases (U.S. Department of Energy, 2009). Worker engagement in safety functions may act to reduce the probability of human errors from occurring by making employees more involved in and aware of their tasks/surroundings and associated risks, as well as error traps that could be present (Shockey, et al., 2012; Wachter & Yorio, 2013; Parker, 2011). Thus, increased levels of worker engagement in safety activities could possibly be related to increased safety performance as measured by standard safety outcomes (e.g., recordable case rates). In fact, studies have shown a positive relationship between the measured level of employee engagement with business unit outcomes, such as higher productivity, better quality, lower employee turnover, greater customer satisfaction, increased profitability and even safety (Raines, 2011; Vance, 2006).

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Human Error, Modes of Operation & Error Traps

Based on the extensive works of Reason (1990), employees operate (and more importantly, address uncertainties and deviations in their workplaces) in skill-based, rule-based and knowledge-based modes. Given less-than-perfect planning and control activities, employees react and adapt to imperfection, variability, uncertainty and working conditions by using knowledge, rules and/or skills. Errors can occur in the workplace because workers do not perfectly operate within these modes.

According to the U.S. Department of Energy (2009, 2012), Reason (1990) and Summers (2012), skill-based behaviors are associated with highly practiced actions in familiar situations usually executed from memory without significant conscious thoughts. Skill-based errors result from these misapplied competencies, often seen as slips or lapses. Workers may be inattentive or become distracted when operating in a skill-based mode, leading to a potential injury. Rule-based performance behaviors are based on incorrect selections of written or stored rules derived from recognition of the situation. These rule-based errors are basically failures of expertise mistakes, such as not applying required rules, misapplying or misinterpreting rules or applying substandard rules. Knowledge-based behaviors are in response to totally unfamiliar situations (no skills, rules or patterns are recognizable to the individual). These are lack-of-expertise mistakes as evidenced by some workers not having the adequate knowledge to deal correctly with uncertain or changing work situations.

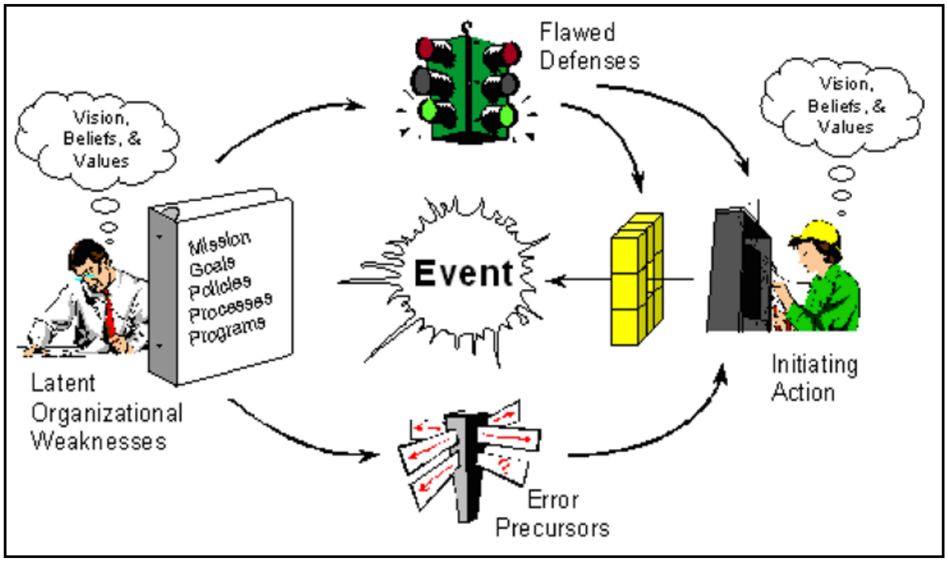

Figure 1 Anatomy of an Event (U.S. Department of Energy, 2009)

Based on data from the nuclear industry, skill-based, rule-based and knowledge-based performance mode errors account for 25%, 60% and 15% of all human errors respectively (Performance Improvement International, 2000). The error rates for skill-based, rule-based and knowledge-based performance modes are around 1:1,000, 1:100 and 1:2 to 1:10, respectively (Shockey, et al., 2012). Many precursors exist in the workplace that predict that these human errors will increase when operating within these modes. Common error precursors are listed in Table 1.

Human Performance Tools

In the field of human performance improvement, many human performance tools can be used to reduce the chance of human error, such as pre- and post-task briefings (Table 2, pp. 73-74). These tools can be viewed as vehicles for providing mental and social skills that compliment a worker's technical skills to promote safe and efficient task performance, carving out time to think about work—in particular critical steps of that work—or the error traps associated with the work to be conducted (Muschara, 2012).

These human performance tools are designed for use by individuals as well as teams. Many of the tools used by individuals are geared toward achieving situational awareness and positive control of work situations (U.S. Department of Energy, 2009a). The tools used by teams require participation and/or coordination of two or more employees, supervisory involvement and management support.

As an initial part of this study, the researchers canvassed many known high-performing organizations in a variety of sectors (e.g., nuclear operations, aviation, power generation, heavy manufacturing) regarding the human performance tools they have used with success. Some of the leading human performance improvement tools for these high-performing organizations are summarized in Table 2. These human performance tools are emphatically "worker-centric" in that they engage workers to be more aware of their safety, error traps present, tasks to be performed and conditions/surroundings. For a comprehensive list and description of human performance tools, see U.S. Department of Energy (2009a).

Employee Engagement

In terms of accident prevention, safety management systems are developed and implemented to identify, evaluate, control and ultimately reduce safety risk and to generate numerous layers of defenses that prevent accidents from occurring. But, as stated, these safety management systems are flawed both during their development and implementation, perhaps due to the fact that these systems cannot anticipate and control all possible work situations and that these systems tend to be slow to adapt to changing situations or uncertainty because of their rigid, controlled and complicated structures. In addition, where work is conducted, there are humans, who are capable of error, connecting that work with the safety management system. Active errors occur at this "sharp" edge, where the safety management system touches workers and workers touch the tasks to be performed.

What general offenses and defenses do workers have within

Characteristics of Worker (Pressures)	Timing & Characteristics of Work	Procedure-, Instruction- or Communicated-Related*
Time Pressure/Being Behind in Production or Schedule	End-of-shift work	Vague work guidance or instructions; vague, misleading or poor communications
Mental Pressure	Returning to work after being off for 4 days	Procedure users must make decisions with little or no guidance for making those decisions.
High Workload Pressure	Non-normal conditions	Procedure users have multiple options for choosing course of actions.
Fatigue	Non-routine work	Procedure users have options for choosing next course of action contingent on conditions, which requires the procedure user to determine if conditions are present.
New/Unfamiliar to a Task	Distractions present	Procedures have multiple actions included in the same step.
Multitasking	Difficult task	Procedures have embedded actions which could be easily missed.
Distracted		*Section adapted from Fisher (2012)
Overconfidence		

Table 1 Common Error Precursors

their control that will keep them safe and make them aware of their ever-changing surroundings, error traps and the fallibility of safety management systems and themselves? The answer perhaps is in workers' ability to become engaged in the safety aspects of their work.

Rich, et al. (2010) provide a detailed account of employee engagement and how it relates to overall job performance in general. Their conceptualization of employee engagement, as well as its job performance consequences, can be applied to safety management. Engagement reflects an organizational members' willingness to "harness their full selves in active, complete work role performances by driving personal energy into physical, cognitive and emotional labors" (Rich, et al., 2010). In contrast, disengaged employees, "withhold their physical, cognitive and emotional energies, and this is reflected in task activity that is, at best, robotic, passive and detached" (Rich, et al., 2010).

As stated, studies have shown a positive relationship between employee engagement levels with outcomes, such as higher productivity, better quality, lower employee turnover, greater customer satisfaction, increased profitability and better safety performance (Raines, 2011; Vance, 2006). In identifying the measures of a company's health, former General Electric CEO Jack Welch cited employee engagement as the most important measure (Raines, 2011; Vance, 2006). Gallup compared the critical business outcomes of workgroups within more than 125 organizations. This meta-analysis compared workgroups that were in the top quartile and bottom quartile in employee engagement measures (Harter, et al., 2006). According to the study, engaged business units experienced 62% fewer incidents due to the lack of safety than units with lower employee engagement.

In the report issued by Society for Human Resource Management Foundation, the Molson Coors beverage company saved $1.7 million in safety costs by enhancing employee engagement. It was found that engaged employees were five times less likely than non-engaged employees to have an incident and seven times less likely to have a lost-time incident. In addition, the average cost of a lack of safety incident was $392 for non-engaged employees but only $63 for engaged employees (Raines, 2011; Vance, 2006).

Nahrgang, et al. (2010), using a meta-analysis of 203 studies covering more than 185,000 people, investigated the relationship between various job demands and resources with burnout, engagement and safety outcomes in the workplace. They found support for health impairment and motivational processes as mechanisms through which job demands and resources relate to safety outcomes. They also found that burnout was negatively related to working safely but that engagement motivated employees and was positively related to working safety. Across industries, risks and hazards were the most consistent specific job demand that explained the variances in burnout engagement and safety outcomes.

As stated, engagement involves an organization's members complete work roles by driving personal energy into physical, cognitive and emotional labors and by so doing achieves active, full work performance (Rich, et al., 2010). Engagement occurs when individuals are emotionally connected to others and cognitively vigilant (Harter, et al., 2002; Kahn, 1990). Connection and vigilance can be described as being psychologically present, fully there, attentive, feeling, integrated and focused in their role performance. Therefore, we believe that worker engagement may be viewed as important defenses against the presence of error traps and latent organizational errors in an organization.

Purpose of Study

Based on the information presented here, it is clear that engaging workers can improve human performance in the area of

1. Conducting Pre-Task & Post-Task Briefings

Pre-Task Briefings: Topics to be covered during pre-task briefings can include discussion of tasks, critical steps, hazards, related safety precautions, potential error traps, performance modes of operation that apply to the task (skill-based, rule-based, knowledge-based), determining the high risk for the day and the HP tools that can be used to recognize, avoid or resolve these error traps. During these briefings, roles and responsibilities, conditions, resource needs, PPE requirements and emergency procedures can also be discussed. Some important questions to ask include: What is the worst credible thing that could happen? What are the conditions that could stop this job? What do we want to achieve and what do we want to avoid in this task?

Post-Task Briefings: At these briefings, job conditions can be reviewed, program gaps can be identified and corrective actions discussed. Other topics addressed include unexpected outcomes, usability and quality of work documents, knowledge and skill shortcomings, and adequacy of tools and resources. These briefings are important “learning” opportunities that can be used to identify latent organizational weaknesses and reduce human error.

Note: Pre- and post-task briefings and pre- and post-task reviews are similar. However, briefings connote more communication and engagement with workers, while reviews can be conducted independent of task employees (e.g., by supervisors and safety managers).

2. Take-A-Minute

This tool improves an employee’s situational awareness, especially when first arriving at a jobsite. By “taking-a-minute,” the worker explores the jobsite and compares current jobsite conditions with prejob briefing information. Using this tool, unexpected hazards and complicating factors, conditions and precautions can be discussed, especially if these involve safety-critical steps. Based on this revised risk status at the jobsite, hazards can be eliminated, appropriate defenses can be installed or contingencies developed.

3. Self-Checking Tools

These tools involve developing and implementing approaches, such as Stop-Think-Act-Review (STAR), and are most applicable when operating in skill-based and rule-based modes of operation. They are particularly effective for repetitive tasks. Self-checking helps employees focus attention on the appropriate action, think about the appropriate action, understand the expected outcomes before actions commence and verify the results after the actions are completed. A description of each step follows:

- Stop (or slow down): Pause to focus attention on the immediate task.
- Think: Think methodically and identify correct action to perform and understand what will happen when correct/incorrect action is performed.
- Act: Perform the action.
- Review: Confirm anticipated result has occurred or apply contingency.

4. STOP & Seek/Pause When Unsure

Developing and implementing STOP and seek-out-help approaches are important when employees operate in knowledge-based modes. Basically, employees are aware of their knowledge limitations as applied to dealing with specific work situations/variations and will seek out help (typically from supervisor and possibly fellow employee) to continue work and to deal with uncertainty and/or lack of knowledge. The Pause When Unsure tool supports the idea that workers should approach their work deliberately and mindfully.

5.Three-Way (Repeat Back) Communications

In this tool, the sender states the message, the receiver acknowledges the sender and repeats the message back in a paraphrased form and the sender acknowledges the receiver’s reply. This method is typically used to communicate changes to physical facility equipment during work activities via face-to-face, telephone or radio modes of communication.

Table 2: Part 1 Common Human Performance Tools

Note: *Information in table obtained from Cornell, et al. (2012); Ferguson, et al. (2012); U.S. Department of Energy (2009a); Muschara (2012); Shockey, et al. (2012); Summers (2012); Wachter & Yorio (2013).*

safety and that certain human performance tools used by high-performing organizations tend to work by engaging their workers in the safety function. But how common are these approaches used across all organizations? This study’s major objective is to determine the general current practice for organizations with respect to those tools used for increasing human performance and for engaging workers. Another objective is to determine if there is an overall difference in what organizations are using as human performance and worker engagement tools and their levels of worker engagement versus what research suggests and what high-performing organizations validate should be used for enhancing human performance and reducing human error.

6. Concurrent Verification
This tool involves a series of actions by two individuals working together at the same time and place to separately confirm the condition of a component before, during and after an action, especially when the consequences of an incorrect condition would lead to harm. Using this tool, the performer and verifier agree on the action to be taken; performer and verifier separately self-check the action to be performed; performer and verifier agree once again; verifier observes performer during execution; and verifier stops performer if action is incorrect. Concurrent verification is typically applied to verifying conditions, while peer-checking is more oriented toward verifying actions.
7. Peer-Checking
This tool involves a series of actions by two individuals working together at the same time and place, before and during a specific action. Its purpose is to prevent an error by the performer and augments self-checking by the performer. This technique takes advantage of a "fresh set of eyes." In this tool, the performer self-checks the correct component or hazard present; the peer self-checks the correct component or hazard present; the performer and peer agree on the action; the peer observes the performer before and during execution; the performer executes the intended action; the peer stops the performer if the performer's action is incorrect; and if the performer's action is correct, the peer informs the performer of such.
8.Questioning Attitude
A questioning attitude promotes a preference for facts over opinion and assumptions, fosters thought about safety before action is taken and helps individuals maintain an accurate understanding of work conditions at any given time. This tool is predicated on a "stop, look and listen" mentality. One process that reflects a questioning attitude is described as follows: workers proactively search for work situations that forecast uncertainty; they ask questions; they gather relevant information; they stop when unsure; they do not proceed in the face of uncertainty and ask for expert help; and they proceed if sure and continue the activity if the uncertainty has been removed with facts.
9. Identifying Critical Steps
These steps are actions that will that will trigger immediate, intolerable and irreversible harm (if that action or preceding action is performed improperly). So in terms of reducing human error, if steps are identified for employees, then employees will be more cautious when involved in these steps and less apt to operate erroneously using skill-, rule- and knowledge-based behaviors.
10. Coaching & Observation
Integration of human performance principles can be promoted by coaching employees on potential hazards, performance modes, traps, triggers and tools. Through coaching, employees are able to identify the little things before they become big things. One way is to identify error precursors prior to having a potential accident. Injuries can be reduced by providing employees with the knowledge and recognition skills to know when they are in a specific error trap and how to use the human performance tools to pull them out of the trap. The purpose of in-the-field observations is to review the quality and effectiveness of work preparations, work practices and work performance. Observation scope should include the whole job, not just performer behavior. In-the-field observation (e.g., by managers or employees) looks at what error traps the employees may be experiencing based on triggers they are providing (e.g., scratching their heads). Tools are then provided to reduce the error rate. Based on the observation, the critical learning that needs to be institutionalized to reduce or eliminate potential error in the future may be discerned.

Table 2: Part 2 Common Human Performance Tools

Note: *Information in table obtained from Cornell, et al. (2012); Ferguson, et al. (2012); U.S. Department of Energy (2009a); Muschara (2012); Shockey, et al. (2012); Summers (2012); Wachter & Yorio (2013).*

Methods

In 2011 and 2012, the authors collected data using a survey distributed to safety managers designed to assess safety management system practices implemented by organizations. This survey was approved by the Indiana University of Pennsylvania Institutional Review Board (IRB Log No. 11-218) on September 28, 2011. Through ASSE, the survey was distributed to 2,456 members primarily across North America. There were 342 responses to this survey, although not all of the participants responded to all of the questions, in particular the qualitative questions, which required written responses. To determine who would receive a survey, ASSE filtered its membership database based on members' job title (e.g., safety director or safety manager) as well as those sectors that included manufacturing establishments. The number of members who were ultimately selected to receive the survey was based on historical response rates (~15%) in order to obtain around 300 responses.

Multiple sectors were represented in the sample, including

Engagement Level	Description
1 Very Passive; Very Low Level	• Survey response is "manager-centric" and/or the response does not mention the worker at all. • It is improbable that the response would engage the worker cognitively, emotionally and/or physically.
2 Passive; Low Level	• Survey response is "manager-centric" and/or the response does not mention the worker at all. • It is unlikely that the response would engage the worker cognitively, emotionally and/or physically.
3 Neutral	• The survey response is neutral. • It does not specifically mention the worker and/or it is unclear or uncertain if the response could engage the worker cognitively, emotionally and/or physically.
4 Active; High Level	• Survey response mentions (or strongly alludes to) the worker. • The response probably engages the worker cognitively, emotionally and/or physically.
5 Very Active; Very High Level	• Survey response is clearly "worker-centric." • The response specifically states an employee action or activity that should engage the worker cognitively, emotionally and/or physically.

Table 3 Description of Engagement Levels for Survey Responses

agriculture (n = 4), construction (n = 55), transportation and distribution (n = 20), education (n = 5), government (n = 13), healthcare (n = 8), light manufacturing (n = 98), heavy manufacturing (n = 97), mining (n = 20), research and development (n = 7) and service (n = 15). The total number of participating manufacturing and nonmanufacturing establishments was 195 and 147, respectively. The average number of employees per establishment was 632. Approximately 50% of the companies employed more than 500 employees. There were some limitations with the sample collected in that the same organization could be represented many times in the data collected. However, multiple surveys collected from the same organization probably represented different sites or divisions within the organization.

A 69-item survey was developed to assess and correlate the characteristics of safety management system practices in organizations, the level of worker engagement and the total recordable case and days away, restricted or transferred rates for each organization. There were some qualitative questions in which safety managers would write their answers in the appropriate fields. This survey was based in part on the work of Zacharatos, et al. (2005) and Vredenburgh (2002). However, the safety management system practices and the items chosen to reflect their properties were chosen through a team-based approach. The team was made up of safety managers and practitioners, senior-level safety executives, corporate strategic advisors, academicians and human factors and human performance consultants. A limitation to this survey design was the realization that not all of the desired questions could be included in the survey due to respondent time considerations since the researchers wanted all respondents to complete the entire survey. Another pragmatic limitation was that all respondents did not entirely complete the survey, and a decision was made that if at least 90% of the survey was completed, it was considered a valid survey.

This research highlights the analysis of answers provided to two of the qualitative questions (within the set of 69 questions) contained in the survey. The specific questions being addressed in this research article are:

•What is the most important human performance tool used (by your organization) for human error prevention or human performance improvement? (qualitative question in survey)

•What is the degree of worker

Response Category	Number of Responses	Percent Response
Communications	49	15.3
Training	46	14.3
Risk Assessments	46	14.3
Behavior- or Observation-Based Programs	39	12.1
Integration	37	11.5
Other	26	8.1
Leadership	16	5.0
Directives	11	3.4
Human Performance Tools	11	3.4
Auditing/Inspections	9	2.8
Controls	8	2.5
Incident Investigation	7	2.2
Authorization	6	1.9
Goals & Incentives	5	1.6
Reporting	5	1.6
Total	**321**	**100**

Table 4 What Is the Most Important Tool Used for Human Error Prevention/Human Performance Improvement?

engagement associated with these human error prevention/human performance improvement tools? (transformed data from qualitative answers provided)

•What is the most important tool used (by your organization) to engage workers in the safety function? (qualitative question in survey)

•What is the degree of worker engagement associated with these worker engagement tools? (transformed data from qualitative answers provided).

Safety managers' survey responses were placed into various categories and more specific subcategories as appropriate post hoc. Each response was classified under a category, but not all of the responses were classified under a subcategory. The degree of worker engagement (1 = very passive/very low to 5 = very active/very high) associated with each response was estimated based on the classification scheme outlined in Table 3.

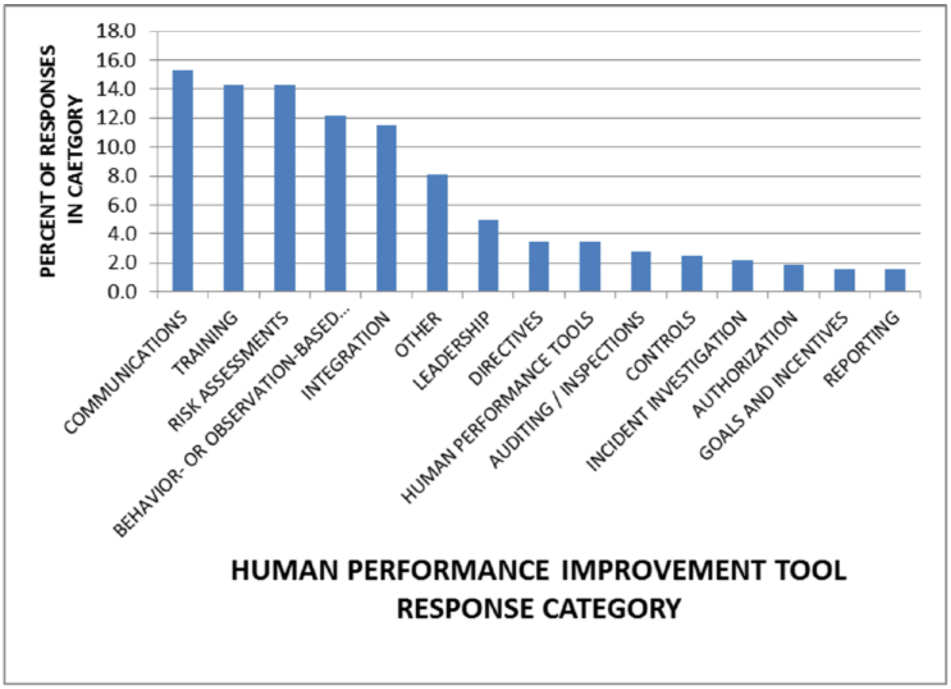

Figure 2 Percent of Responses in Human Performance Tool Categories

Results

In terms of the most important human performance tools used by organizations of the 321 safety managers who completed the first qualitative survey question, the results listed in Table 4 and displayed in Figure 2 indicate that no single response category accounted for a significant portion of the primary tools used. Thus, the human performance tools used by organizations are spread across many categories, such as communications (15.3%), training (14.3%), risk assessments (14.3%), behavior-based programs (12.1%) and integration (11.5%).

In the response database, responses were placed under major categories and, when appropriate, subcategories (within each major category). Some of the subcategories within these major categories that were used to classify these human performance tool responses (as well as the number of responses in the subcategories) are shown in Table 5. The information is provided to give the reader more detail with respect to the more specific characteristics of the responses.

Category	Subcategory
Authorization	Work Permits (4); Stop Work Authority (2)
Behavior- or Observation-Based Programs	General (11): Safety Observations (18); Behavior-Based Programs (12); Peer Pressure (4)
Communications	Toolbox Meetings / Prejob Briefings (18); Other Meetings (7); Written Communications (4); Oral Communications (4)
Controls	Engineering Controls (4); Design (3)
Directives	Work Instructions (6); Procedures (5)
Human Performance Tools	STOP program (e.g., stop-think-act-review) (5)
Integration	Employee Engagement/Involvement (12); Employee Ownership (4); Workers Caring for Workers (3)
Leadership	Supervisors (8); Managers (4); EHS Manager (3)
Reporting	Near Miss (4)
Risk Assessments	Job Safety Analysis/ Job Hazard Analysis (21); Prejob Planning (13)

Table 5 Some Human Prevention Tools Categories & Subcategories

Engagement Level	Number of Responses	Percent Responses
Engagement Level 1	75	23.4
Engagement Level 2	50	15.6
Engagement Level 3	116	36.1
Engagement Level 4	72	22.4
Engagement Level 5	8	2.5
Total	**321**	**100**
Average Worker Engagement Level Response	**2.7**	
Standard Deviation Worker Engagement Level Response	**1.1**	

Table 6 Estimated Worker Engagement Level for Human Performance Improvement Tools Described in Qualitative Survey Responses (1 = Passive; 5 = Active)

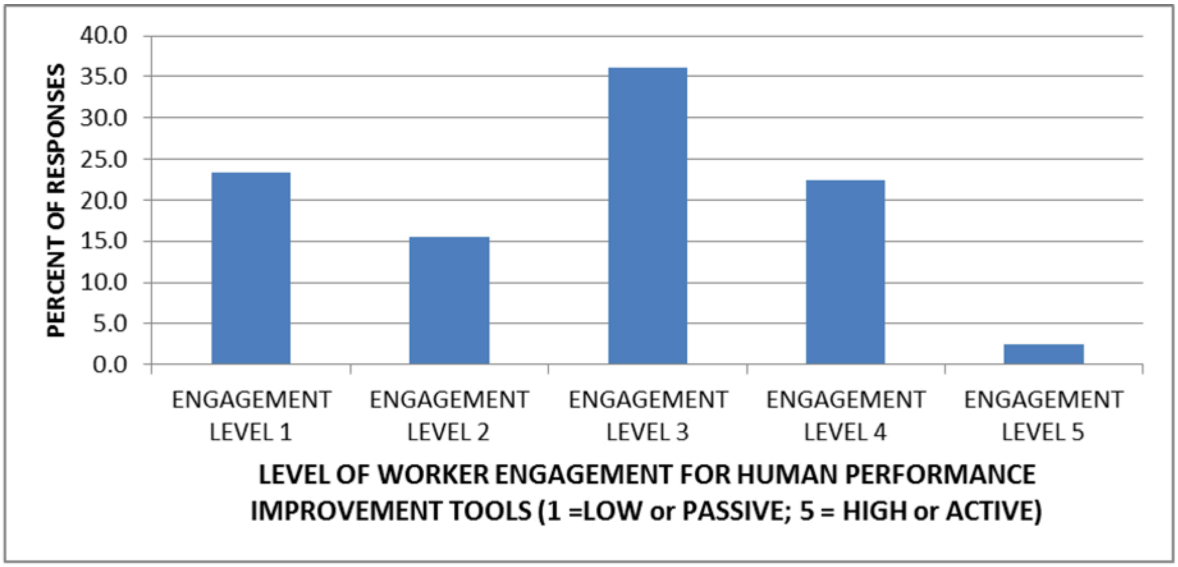

Figure 3 Percent of Human Performance Tool Responses by Worker Engagement Level

Based on the information obtained, only a small percentage of respondents are specifically utilizing "human prevention tools" that are currently used/endorsed by high-performing organizations (Table 2). A few respondents (6) mentioned adopting a STOP work approach to preventing human error (e.g., when workers are unsure as to how to proceed with a task, they are encouraged to stop work and think about the situation or solicit help). In addition, classified under the communications category, nearly 20 respondents mentioned conducting toolbox meetings or prejob briefings, probably one of the more commonly used human performance tools. Under the category of risk assessment, it is apparent that prejob planning (13 responses) and writing job safety analyses and job hazard analyses (21 responses), which are somewhat related to the human performance tool of prejob briefings since these topics are often covered during briefings, were important subcategories.

Some results in the data obtained were consistently observed among data subsets. Conducting behavior-based observation programs and/or safety observations were prominent in the responses across all sectors and sizes of organizations. The researchers inferred from this result that many managers may generally believe that to control human error, human behavior must be observed (and corrected). In addition, very few specifics were provided by the respondents as to the type of training used to prevent human error (e.g., performance-based training). Lastly, under the category "Integration," 16 responses specifically referenced employee engagement, involvement or ownership as the most important human performance improvement tool used by their organization (5% of responses).

Given the premise proposed in this article that worker engagement is an important characteristic of tools that high-performing organizations use for improving human performance, the level of worker engagement for each response to the human performance tool question was estimated according to the criteria shown in Table 3. Results of this analysis are shown in Table 6 (p. 76) and Figure 3. As shown in Table 6 and Figure 3, the level of worker engagement associated with human performance tools used by organizations is somewhat "neutral," estimated to be 2.7 on a scale of 1 to 5. This suggests that the tools currently used by organizations for human performance improvement tend to be passive or have lower levels of worker engagement.

Response Categories	Number of Responses	Percent Response
Communications	83	25.5
Leadership	38	11.7
Teams	38	11.7
Behavior- or Observation-Based Programs	32	9.8
Other	32	9.8
Training	28	8.6
Risk Assessments	18	5.5
Reporting	16	4.9
Human Performance Tools	9	2.8
Goals & Incentives	8	2.5
Regulatory/Consensus-Based Standards	8	2.5
Integration	7	2.2
Accountability	4	1.2
Quality-Based Processes	4	1.2
Total	**325**	**99.9**

Table 7 What Is the Most Important Tool Used to Engage Workers in the Safety Function?

The other qualitative question safety managers answered was what was the most important tool used to engage workers in the safety function to see if many of the tools used to engage workers would be similar to human performance tools used to reduce human error. Table 7 and Figure 4 present the information. Of the 325 responses received for this particular survey question, approximately

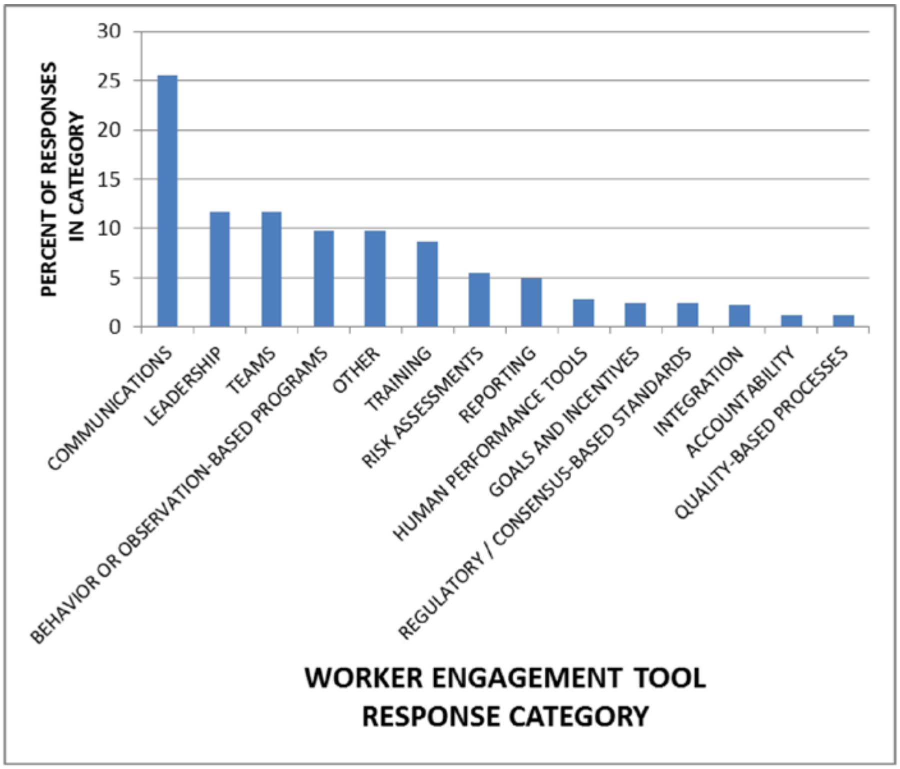

Figure 4 Percent of Responses in Worker Engagement Tool Categories

50% of the responses were concentrated in the following three response categories: communications (25.5%), leadership (11.7%) and working in teams (11.7%). Compared to the previous human performance tool results, the tools used most often for worker engagement were aligned with fewer categories, and two of the three leading categories (leadership and working in teams) were not contained in the top-five list of categories for human performance tools used. In fact the "working in teams" category did not make it as a human performance tool response category at all due to lack of response. However, the use of behavior-based tools was similar for engaging workers (9.8%) and for improving human performance (12.1%).

Communication tools for engaging workers included conducting meetings (17 responses), having toolbox talks/prejob briefings (22), oral communications (7) and written communications (4). Providing leadership for worker engagement involved managers (10 responses), supervisors (9) and environmental health and safety (EHS) managers (4). Working in teams as an engagement tool included safety committees (20 responses) and working in teams designed to tackle specific EHS issues (9).

The level of worker engagement in the responses provided as worker engagement tools was estimated using protocols described previously. The estimated level of worker engagement assigned to these worker engagement tools is presented in Table 8 (p. 78) and visually displayed in Figure 5 (p. 79). As shown in this information, the average level of engagement is approximately 3.2 (neutral). Even though the estimated level of worker engagement was higher for worker engagement tool responses than that for human performance ool responses (2.7), the level of worker engagement in the worker engagement tools utilized was not that engaging. According to the results of this survey, the tools used to engage workers in safety do not necessarily require active employee engagement or involvement.

Engagement Level	Number of Responses	Percent Response
Engagement Level 1	46	14.2
Engagement Level 2	49	15.1
Engagement Level 3	69	21.2
Engagement Level 4	116	35.7
Engagement Level 5	45	13.8
Total	**325**	**100**
Average Worker Engagement Level Response	**3.2**	
Standard Deviation Worker Engagement Level Response	**1.2**	

Table 8 Estimated Worker Engagement Level for Worker Engagement Tools Described in Qualitative Survey Responses (1 = Passive; 5 = Active)

Discussion

It has been shown that the human performance tools used successfully by high-performing organizations are worker-centric, often requiring worker engagement to "make them work" (Shockey, et al., 2012; Wachter & Yorio, 2013). However, according to the results of our survey completed by approximately 320 safety managers primarily in North America (for the specific questions addressed in this research article), the tools used across organizations today to prevent human error or to improve human performance are not necessarily those tools used by high-performing organizations. In addition, the general worker engagement level of the approaches used is quite low and can be considered to be somewhat passive. Our research results further demonstrate that the majority of tools used to engage workers are generally not the same ones used to improve work performance. In addition, these engagement tools are also not exceptionally engaging to workers.

But why is engagement so important to the field of human performance? Various general reasons have been presented previously, but Parker (2011), based on the work of Griffin, et al. (2007), explains specifically why engagement matters, primarily from a behavioral perspective. Parker contends that feelings of engagement nurture self-starting proactivity, mindful adaptivity and proficient compliance through engagement. Proficient compliance results in fewer but higher-quality and meaningful safe work procedures; employee involvement in the

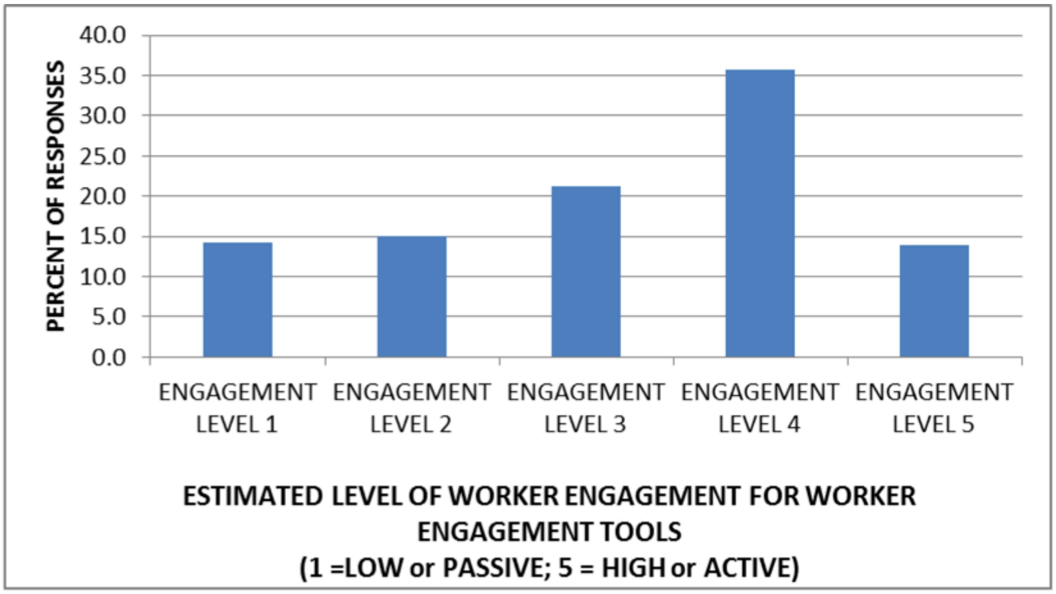

Figure 5 Percent of Worker Engagement Tool Responses by Worker Engagement Level

design, communication and updating of procedures; and better understanding of procedures. Self-starting proactivity relies on using employee initiative to suggest and bring about improvements and by anticipating and taking charge of potential problems, which can be critical in preventing the likelihood of latent failure occurrence and unanticipated hazards. Motivating proactivity is difficult to achieve without worker engagement.

Parker believes an organization can cultivate self-starting proactivity by increasing employees' self-confidence for going beyond the technical core, by increasing autonomy and participation in decision-making to build ownership and by creating a psychologically safe environment. Mindful adaptivity means being alert and adapting to unanticipated hazards and changes. It leads to adapting in flexible and appropriate ways in real time to changing situations. This mindful adaptivity is a desirable employee characteristic to have given that accidents often arise from latent failures, especially in complex, interdependent systems. This mindful adaptivity, involving monitoring and reporting small signals that suggest system breakdown in real time, cannot be easily coerced without having worker engagement and trust. A part of mindful adaptivity is pardoning employees who disclose unintentional mistakes, thus reinforcing a worker engagement culture.

Over the decades, there have been many approaches to managing the safety function, such as regulatory-based, loss prevention and control, risk-based and safety management system approaches. Regardless of the traditional approach used, lagging metrics still seem to indicate that the majority of accidents are caused by unsafe acts (human behavior) (U.S. Department of Energy, 2009; Hopkins, 2006). The human performance approach to safety management marries both management system and behavior-based approaches. To reduce human error under a human performance approach, cognitive and emotional engagement of the worker with and within the safety management system is needed. Cognitive safety engagement reflects active focus on, attention to and concentration on the safe execution of work tasks. Emotional safety engagement is designed to reflect both enthusiasm for and interest in the safety program in each establishment.

The human performance approach to safety recognizes the importance of safety management systems (e.g., policies, processes, programs) being in place (U.S. Department of Energy, 2009). But this approach also recognizes that these systems can be imperfect, leading to error precursors and flawed defenses, and that workers interacting with that system can work in various modes (skill-based, knowledge-based and rule-based) that can lead to error. Cognitive and emotional engagement by employees on safety can be used as a defense against the flaws in the safety management system as well as an offense against their own limitations. Thus, it is important to promote to organizations the active engagement of their workers in the safety function, such as by using human performance improvement tools that are "worker-centric."

Conclusions

In general, the human performance tools used across organizations today to prevent human error or to improve human performance are not necessarily those tools used by high-performing organizations that are leaders in the field of human performance. The worker engagement level of these human error prevention approaches used by most organizations is low and can be considered to be somewhat passive. It can be concluded that the majority of tools used by these organizations to actually engage workers in safety are not generally the same ones used to increase human performance. In addition, these engagement tools are also not exceptionally engaging to workers.

Based on the results of this study, for organizations to enhance human performance, safety managers and their organizations need to become better educated and focused on adopting human performance tools that engage workers in safety as a key way of reducing human error and therefore incidents in the workplace. Future research should examine how specific human performance tools for engaging workers in safety could theoretically reduce accident rates by reducing human error—both as defenses against flaws in safety management systems and as offenses against human limitations. This research could then be supported by empirical investigations related to the actual use of these specific practices and assessing their impact on accident reduction in the workplace. ✪

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Stretching & Flex Programs: Perceptions of Construction Specialty Firms

Sathyanarayanan Rajendran

Abstract

There is a growing interest in the use of stretch and flex (SF) exercises to reduce the risk of work-related musculoskeletal disorders (WMSDs) in construction. The study's major objective was to identify construction specialty firms' perception of SF programs' effectiveness in preventing WMSDs. Research methodology involved the distribution of a short questionnaire to 25 construction specialty firms in the northwestern (NW) U.S. Fifteen firms responded to the survey. It was evident that stretching programs are becoming common among the participant construction specialty firms in the NW mainly due to the owner's or general contractor's contract requirement. Despite lack of scientific evidence, the study participants perceive that stretching programs help prevent or reduce the severity of WMSDs. In addition, the study participants report that there are other benefits to stretching sessions, such as team-building, communication, increased worker morale and safety planning. However, the construction specialty firms should not use stretching programs as the only way to prevent WMSDs to avoid a false sense of safety among construction workers. Workers should be educated that stretching is just a part of the comprehensive ergonomic program, which should include administrative and engineering controls.

Keywords
Construction safety, musculoskeletal disorders, worker training, stretching programs

Introduction

WMSDs are a tremendous concern to the U.S. construction industry. In the U.S., sprains and strains accounted for the highest frequency of all occupational injuries in 2007 (Bureau of Labor Statistics [BLS], 2011). One major cause of WMSDs is overexertion (Center for Construction Research and Training [CPWR], 2008). Ergonomic solutions may help reduce overexertion and therefore the risk of WMSDs (CPWR, 2008). Ergonomic solutions aim to reduce or eliminate ergonomic risk factors with the help of engineering or administrative controls (Choi & Woletz, 2010). An SF program is one example of several ergonomic administrative controls (Boatman, et al., 2012; Roehrig, 2011).

The construction industry refers to stretching programs as "Stretch and Flex." SF programs are "intended" to reduce the incidence and/or severity of injuries by increasing flexibility (Hess & Hecker, 2003). It is a common belief that workers who are less flexible are more likely to have musculoskeletal pain and resultant injury (Hess & Hecker, 2003). The presumption is that, for individuals with short or "tight" muscles, stretching exercises increase flexibility by elongating tissues to a more physiologically normal range, promoting optimal function and reducing the risk of musculoskeletal injury (Hess & Hecker, 2003).

Growth of Stretch & Flex Programs

There is a growing interest in, and use of, SF programs to reduce the risk of WMSDs by construction specialty contractors (Boatman, et al., 2012). The author has worked with several construction specialty firms in the NW U.S. that only use SF programs to prevent WMSDs. Specialty firms using SF programs as the only intervention to control WMSDs might give workers a false sense of safety, that SF exercises alone will help them prevent WMSDs. For example, one study reported that stretches in isolation may be a problem if the causes of discomfort and potential injury to the musculoskeletal issues, such as workstation design, are not modified (Costa & Vieira, 2008).

This trend can be attributed to several leading occupational safety trade journals, reports and articles reporting that SF programs will prevent WMSDs (Roehrig, 2011; *Occupational Health,* 2010; *Professional Safety,* 2002). Results frequently published in these trade journals are not scientific in nature (Hess & Hecker, 2003; Choi & Woletz, 2010). Knowledge of the effectiveness of stretching programs in preventing WMSDs is minimal (Costa & Vieira, 2008). Nevertheless, why do specialty contractors implement the SF program and invest thousands of dollars without sufficient evidence? For example, it can cost a specialty firm employing 100 workers ($55/hour billing rate) more than $30,000 a month by requiring them to participate in a stretching session every day for 15 minutes. The safety literature does not reveal the cause for the growth and interest in SF programs. The author argues that until scientifically proven, construction companies should not use SF programs as the only intervention for WMSDs but should implement SF programs as part of a comprehensive ergonomic program.

Effectiveness of Stretch & Flex Programs

Can SF programs prevent WMSDs? There seems to be no definitive answer to this question in the safety literature

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(Costa & Vieira, 2008; Choi & Woletz, 2010). No study in the literature has reported the effectiveness of SF programs in preventing WMSDs in construction. However, Hess and Hecker (2003) reported that several studies in the sports literature have demonstrated that stretching before or during an athletic activity helps reduce the incidence of strains and sprains. On the other hand, several studies have also shown that stretching has no effect on injuries (Hess & Hecker, 2003).

There is no conclusive evidence within the literature that SF programs help prevent WMSDs, not only in construction, but in other industries (Choi & Woletz, 2010). In addition to the lack of scientific evidence, the literature also lacks studies on the construction industry's perception of this subject. However, studies in other industries investigated computer operators' and data entry workers' perceptions of stretching and WMSDs prevention. One study reported that stretching or strengthening exercise programs were effective in reducing perceived discomfort among computer operators (Kietrys, et al., 2007). Another computer user perception study found that stop-and-stretch software, which reminds computer users to stop and stretch at varying time intervals, could be a valuable tool in reducing WMSDs (Trujillo & Zeng, 2006).

Pharmaceutical manufacturing employees' perceptions were identified in another study. It reported that after the implementation of a workplace stretching program, employees' perception of physical conditioning, self-worth, attractiveness and strength increased significantly (Hess & Hecker, 2003). Similarly, given the high rate of WMSDs in construction, it is critical to determine construction specialty firms' perceptions of SF program effectiveness in preventing WMSDs (BLS, 2011). This study will fill this gap by identifying construction specialty contractors' perception of SF programs and their effectiveness in preventing WMSDs.

Despite the mixed evidence on SF programs' effectiveness in preventing WMSDs, construction companies implement SF programs as part of their workplace safety program (Rajendran, 2006). When construction firms include SF programs in their overall safety program, literature suggests they should be included in a comprehensive ergonomic program (Choi & Woletz, 2010). While the safety research community is working to find an answer as to whether SF programs prevent WMSDs, improper stretching can injure workers or aggravate existing injuries and should be a significant cause for concern for specialty firms. The good news is the literature includes guidelines for an effective SF program (Hess & Hecker, 2003). How do the specialty firms' SF programs compare to the guidelines reported in the literature? No research and knowledge exist on the current trends of SF programs among specialty firms. This study fills this gap by reporting the current SF program trends in the industry and compares them to SF program guidelines provided in the literature.

Study Objective

The study's major goal is to gain a better understanding of SF programs implemented by construction specialty firms in the NW U.S. by studying their current SF program trends and their perception of SF programs and their ability to prevent WMSDs. To meet this goal, the study had the following objectives:

1) understand the history of SF programs among construction specialty firms in the NW;

2) determine NW construction specialty firms' perception of SF programs' effectiveness in preventing WMSDs; and

3) investigate the current trends of SF programs among construction specialty firms in the NW.

Method

The study primarily adopted a qualitative research approach to seek NW construction specialty firms' perceptions of the effects of stretching programs on WMSDs. Qualitative research techniques are particularly useful for gathering and analyzing exploratory data (Max & Lynn, 2003). Literature recommends qualitative methods for studies that are complex, emergent in nature or revisit and reexamine previously untested assumptions (Hurley, 1999). Qualitative methods are also used to gain an initial understanding of an issue or problem and provide information needed to design a quantitative study (Mora, 2010). Studying construction firms' perceptions of the impacts of SF programs is an emerging area, and there is no clear understanding of this issue at this point.

The research method involved the development and delivery of a survey questionnaire. The author developed the perception survey based on his 6 years' professional construction safety experience. The author did not pilot-test the survey, which is a significant limitation to the study. The participants targeted for the research were safety professionals of specialty firms in the NW U.S. Construction specialty firms with an SF program were the selection criteria. No database is available on the market that lists specialty firms with mandatory SF programs. Hence, firms selected for the study were primarily those with which the author has personal contact and were willing to participate in the research. In addition, use of "purposeful sample" is considered ideal for enhancing validity when large sample size is unrealistic (Patton, 1990 as cited in Hallowell, 2010).

The author selected 25 specialty contracting firms for the study, with a history of SF programs as part of their safety program. These specialty firms together employed crafts from 22 different specialties (e.g., a mechanical firm employed pipe fitters, plumbers and sheet-metal workers). Annual revenues of the selected firms ranged from $20 million to $700 million.

The author sent the online questionnaires via e-mail to safety professionals working at the selected specialty firms. The author requested them to respond to the questions based on their firms' experience with the SF program. The duration of the data collection was from December 2011 to May 2012. The Human Subjects Review Committee affiliated with the author's institution reviewed and approved the study. Appendix A presents the survey questions used to collect data for this study. The majority of the data collected included "yes/no" and open-ended responses. Hence, the author analyzed the data using qualitative methods.

Results

Demographics

Fifteen specialty firms responded to the survey with a response rate of 60% (15 out of 25). The 15 responding specialty firms' annual volume of work ranged approximately from $20 million to $700 million. All responding firms typically performed work in the NW U.S., while many had office locations outside of NW U.S. Several firms employed more than one construction trade. For example, one firm employed five different trades, namely sheet-metal workers, plumbers, pipe fitters, sprinkler fitters and laborers. Table 1 shows the breakdown of trade specialties among the participant firms. The study sample consisted of 19 different specialty trades, the most represented by the sheet-metal workers (13.5%) and laborers (13.5%) followed by plumbers (10.8%). The participant firm's primary specialty included mechanical (n = 5), electrical (n = 2), structural concrete (n = 2), walls and ceiling (n = 2), site work (n = 2), structural steel (n = 1) and reinforcing steel (n = 1).

Origin of SF Program Implementation

Seven firms (46.7%) started the SF program due to project owner contract requirement, and three (structural concrete, reinforcing steel and walls and ceiling) started due to the general contractor (20%) contract requirement on certain projects. The reinforcing steel firm reported that workers who participated in these programs on these projects gave positive feedback; hence, they made it a requirement company-wide.

It was fascinating to find that 26.6% of the participant firms [electrical (n = 2), site work and mechanical firm] implemented the SF program as a control measure due to a spike in WMSDs. Comments from these four firms as the reason to start the SF program include:

•The company started the SF program since there was an increase in WMSDs, a contract requirement of the general contractor and SF exercises helped the muscles warm up.

•The company felt it would have an impact on WMSDs and would be beneficial for worker morale to start each day with exercises and a few comments about the day's objectives.

•The company experienced many WMSDs and hence implemented the SF program.

Participant firms also reported other reasons to implement SF programs, such as team-building, improved worker morale, communication, increased alertness in the morning and safety planning (e.g., pretask planning). Even though study participants stated the previous reasons prompted them to initiate SF programs, it should be noted that a "theoretical saturation" was not achieved during data collection; hence, responses obtained may not be comprehensive.

Responses to the question regarding the time since initiation of the SF program within their organization ranged from 1 to 14 years (mean = 5.6 years). It is reasonable to conclude that SF programs have gained traction only in the last decade. One site work contractor implemented an SF program 14 years ago. The five mechanical firms have had SF programs the longest, on average 5 years.

SF Program & WMSDs Prevention

Twelve (80%) firms stated that SF programs helped prevent and reduce the severity of injuries. The three firms that did not believe in an SF program's effectiveness in preventing WMSDs included a mechanical, site work and walls and ceiling specialty firm. One mechanical firm's safety professional stated that his firm believed the SF program helps reduce the severity of WMSDs. However, he cautioned that his firm has had so many other interventions that it would be hard to use their data to distinguish between prevention and reduction of severity. The participant further added that their crews would have an increased awareness of their bodies from their routine stretching that would support early intervention on their own part when they notice soreness or stiffness, thereby supporting reduction of severity but maybe not from the stretches themselves. This is further evidence where firms are not confident

Trade Specialty	Frequency	% of All Participants
Structural Ironworkers	1	2.7
Reinforcing Ironworkers	1	2.7
Electricians	3	8.1
Drywall Carpenters	2	5.4
Metal Stud Workers	2	5.4
Concrete Masons	2	5.4
Laborers	5	13.5
Concrete Carpenters	2	5.4
Curtain Wall Workers	1	2.7
Sheet Metal Workers	5	13.5
Plumbers	4	10.8
Pipe Fitters	3	8.1
Sprinkler Fitters	1	2.7
Equipment Operators	2	5.4
Pipe Layers	1	2.7
Demolition	1	2.7
Fireproofing Workers	2	5.4
Insulators	1	2.7
Excavation	1	2.7
Total	**40**	**100.0**

Table 1 Distribution of Trade Specialties Among Participants Firms

in the effectiveness of an SF program in preventing WMSDs but continue the program for other benefits.

The number of WMSDs declined after the inception of an SF program in the reinforcing steel firm. It should be noted that reinforcing steelworkers perform one of the hardest manual labors in the industry with many awkward postures and heavy lifting. One walls and ceiling firm's safety professional stated that he thought an SF program has injury prevention benefits but not because of the stretching. He felt that the stretching is too short to be highly effective. However, he noted the benefit of "having all hands present at one place each morning in order to get a close look at everyone, evaluate their job readiness (e.g., pretask planning) and make sure that everyone hears (communication) the same information each day."

SF Program Development & Implementation

The next question solicited information on the development and implementation of the SF program. It was interesting to note that most of the firms adopted a generic SF program borrowed from other firms. Following are select responses from the firms:

•Several firms borrowed and adopted another company's, owner's or general contractor's stretching program (80%).

•One firm (structural steel) implemented the stretching program with the help of its union (6.7%).

•Two firms (mechanical and walls and ceiling) hired an ergonomist to create an SF program unique to different trades (13.3%).

SF Program Training

There is a consensus in some studies that SF programs have some injury prevention benefits if done right and also should be included as part of a comprehensive ergonomic program (Hess & Hecker, 2003; Choi & Woletz, 2010). Inadequate performance of SF exercises may cause or aggravate existing injuries. Hence, SF training is critical to the program's success, and literature recommends performing stretches correctly for maximum benefits (Hess & Hecker, 2003). Stretching cannot be done properly without adequate training.

It was shocking to find that only 20% (one each mechanical, structural concrete and structural steel firms) of the respondents had a formal SF training program in place. The training strategy varied across participants. One mechanical firm representative noted that "at the beginning of every shift, someone who knows the stretches leads the crew and directs them what to do." One electrical firm reported that workers received stretching posters as part of their new-hire orientation packet, which gave those instructions on how to perform the stretches. A qualified foreman trained by an occupational therapist trained the workers at one structural concrete firm. Excerpts from a walls and ceiling contractor's comments in regards to training include:

"There are loose instruction guidelines (pictures) that are not well distributed but primarily by those who are leading it (stretching). (Stretching) routine can change from site to site. Admittedly, the training for this is somewhat undeveloped in comparison to other safety training we have."

Program Guidelines

Despite inconclusive evidence on their effectiveness in preventing WMSDs, there seems to be some benefit from SF programs if performed "correctly" and implemented as part of a comprehensive ergonomic program (Choi & Woletz, 2010). Hess and Hecker (2003), based on review of literature and recommendations from American College of Sports Medicine, provided some guidelines for an effective workplace stretching program:

•warm up for 5 minutes prior to stretching;

•exercises should be tailored to commonly performed job duties;

•stretch regularly: 2 to 3 days per week, minimum;

•perform stretches correctly:

1) use static or proprioceptive neuromuscular facilitation stretches;

2) hold stretch for 15 to 30 seconds;

3) 3 to 4 repetitions per muscle group;

4) stretch bilaterally and emphasize tight muscles.

•intensity should be to a position of mild discomfort;

•trained instructors should lead and monitor classes;

•compliance should be monitored;

•stretch at appropriate work times throughout the day;

•company commitment to work time and program overhead costs.

The next several survey questions solicited information on SF program specifics. The intent was to compare the study participants' program specifics to the SF program recommendations made in the literature (Hess & Hecker, 2003).

Hess and Hecker (2003) recommend, at a minimum, a 5-minute warm-up prior to stretching. Warm-up exercises are performed before stretching exercises and are designed to increase blood flow and literally warm up the body. This eliminates the chances of injury by stretching cold muscles. Examples of warm-up exercises from one study participant is a series of six exercises, which are all to be done for 30 seconds, totaling a warm-up time of 3 minutes before starting stretching exercises.

1) side steps side to side with shoulder shrugs;

2) side steps side to side with shot put (across chest at 45° angle);

3) side steps side to side with bench press;

4) side steps side to side with bench press 45° angle;

5) side steps side to side with bench press overhead; and

6) side steps side to side with backstroke.

Nine firms (60%) had a "warm-up" routine at the start of the SF exercises. Warm-up routine durations ranged from 1 to 5 minutes (mean = 2.8 minutes), well short of the 5-minute recommendation made by the literature. Only two participant firms (a structural concrete and structural steel) required a 5-minute warm-up before the beginning of stretching. One electrical company had six warm-up exercises (30 seconds each) as part of its SF program.

Regular stretching (2 to 3 days per week, minimum) was another key recommendation for an effective workplace stretching program (Hess & Hecker, 2003). Stretching at the start of the work shift was part of all participant firms' SF program. Stretching at the start of shift and after lunch was part of one structural concrete firm's SF program. Eight companies (53.3%) required stretching once every day, three companies (two structural concrete and one structural steel firm) required stretching twice a day and the others required it in the morning and as needed. This is consistent with the recommendation by Hess and Hecker (2003) to stretch at appropriate work times throughout the day.

The reinforcing steel specialty firm required stretching throughout the workday. For example, a typical task of reinforcing steelworkers includes tying rebar for a slab. A steelworker will bend over and make a few ties, then stretch his or her back out before bending over and continuing the activity. Stretching is most valuable in those situations. One participant mechanical firm required stretching before all demanding activities.

Every construction trade is different. It is not feasible to have a one-size-fits-all SF program. Exercises should be tailored to commonly performed job duties (Hess & Hecker, 2003). Only five companies administered SF programs specific to each construction trade. These five firms included two structural concrete and one each of structural steel, reinforcing steel and mechanical.

One survey question solicited information on the total duration of the SF program. The responses ranged from 5 to 15 minutes (mean = 9.7 minutes). A mechanical and an electrical firm were only two that required 15 minutes of SF per session. The next question elicited opinion on whether this duration is sufficient for getting the maximum benefits out of the program. If performed correctly, 93.3% of participants agreed that their current SF duration is sufficient.

One participant noted that this timeframe was adequate because when workers are stretching first thing in the morning, they are stretching cold muscles and will not see a significant increase in flexibility. He stated that workers were thinking about safety by stretching first thing in the morning. The respondent also noted that the real benefit came from workers performing the stretches in the field throughout the day. Encouragement to stretch in the field needs to come from management or else workers will not do it because some contractors value production above all else, and it is difficult to change that mindset.

One walls and ceiling firm's safety professional who did not agree with this timeframe performed SF for 10 minutes. He noted, "I do not feel that the time (10 minutes) is adequate for effective stretching and mobility improvement. I know a little about proper stretching and mobility. I train 4 to 5 days per week high-intensity (cross-fit) with professional trainers in the evening, and we hold all of the stretches for 2 minutes. I realize this is unlikely to happen in the industry, so I guess some may be better than none."

A site work firm called for a need for scientific data on an appropriate timeframe to perform stretching. It was found that crew foremen led the stretching session in 93.3% of the companies. Workers rotated every day to lead the stretching in another company.

Training & Compliance

Only six (40%) companies had a formal training program for the stretching leaders, of which only one company used a certified occupational therapist to train the leaders. Training also included paper instructions from safety professionals with premade stretching posters.

The last survey question asked, "How does your company monitor compliance with the SF program?" This is another critical aspect of the program's success—compliance should be monitored. The author has led hundreds of stretching sessions where workers just stand around and do not perform the stretches properly. Site audits by safety professionals were the primary method to check for compliance used by the firms. However, the companies only checked if workers performed the stretching but never checked the quality of the stretching. Improper stretching can lead to injuries.

Study Limitations

Future studies should be performed to eliminate the following limitations of this research.

1) Study participants included only construction specialty firms from the NW U.S.; therefore, results cannot be generalized to the entire U.S. construction industry. No database was available on the market that lists specialty firms with mandatory SF programs. Hence, firms selected for the study were primarily those with which the author has personal contact and were willing to participate in the research.

2) Furthermore, the small sample size may limit the extension of the results to the NW construction industry as a whole. The author recommends further study with a larger number of projects and firms to address this limitation.

3) The data collection method used for the research data is a limitation. The research did not use a random collection process to select the participants in the study sample. Since the data was not randomly sampled, inferences could not be made about the study population. The study selected the specialty firms based on the researchers' knowledge of safety professionals working at these firms. Hence, generalization about the population would be speculative.

4) The survey questionnaire was not pilot-tested before the actual survey was performed. Hence, the quality of the questionnaire is a significant limitation of the study. The author recommends future study with a properly piloted survey to improve a quality of the questionnaire.

Summary, Conclusions & Recommendations

This study's results make several contributions to the existing body of knowledge. The NW construction specialty firms' perception of SF programs' effectiveness in preventing WMSDs was a key addition to current literature. The study also reported the current trends and history of the SF program among these construction specialty firms.

It is evident that stretching programs are becoming popular among NW specialty firms mainly due to the owner's or general contractor's contract requirement. However, a small group of firms stated they implemented SF programs as an intervention to WMSDs. Despite lack of scientific evidence, 80% of the study participants perceive that an SF program helps prevent or reduce the severity of WMSDs. In addition to this perception, firms report that other benefits to stretching include team-building, communication and safety planning at the start of shift. Even though the study participants state these reasons prompted them to initiate the SF programs, it should be noted that a "theoretical saturation" was not achieved during data collection; hence, responses obtained may not be comprehensive.

The author recommends that SF programs may be implemented on construction projects due to the additional benefits reported in this study. However, the specialty firms should not rely on SF programs as the only way to prevent WMSDs to avoid a false sense of safety among construction workers. SF programs, if implemented, should be part of a comprehensive ergonomic program that includes other ergonomic administrative and engineering controls. Workers should be educated that stretching is just a piece of the comprehensive ergonomic program and not a standalone option. Furthermore, SF programs should follow guidelines provided in the literature (Hess & Hecker, 2003).

The author found that participants do not comply with many recommendations reported in the literature for proper stretching. For example, Hess and Hecker (2003) recommend a minimum 5-minute warm-up prior to stretching. However, the study found that most participant companies did not have a warm-up routine as part of their SF program. Stretching cold muscles can lead to injuries. Moreover, the majority of firms have adopted the SF programs from another entity. Firms should implement an SF program tailored to the construction trades employed by their firm under the guidance of an expert in this field, such as an occupational therapist. For example, an electrician performs tasks that are different from those of a construction scheduler (office worker) in terms of postures and muscle use. Hence, an electrician and an office worker may not have the same exercises.

Another cause of concern is the lack of training. The majority of participant firms (80%) did not have formal SF worker training. While the safety research community is working to find an answer as to whether SF programs prevent WMSDs, improper stretching can injure workers or aggravate existing injuries and should be a significant cause for concern for specialty firms. Workers and supervisors alike should be trained in SF exercise by experts, such as occupational therapists. In addition, stretching must be monitored for compliance and proper quality of stretching.

Overall, the study found some benefits of SF programs based on participant firms' input. However, the study recommends scientific studies to investigate the effectiveness of SF programs in preventing WMSDs. It is the author's opinion, with or without this evidence, that the growth of stretching programs in specialty firms will continue in the coming years. Empirical research to study the pattern of WMSDs incidents before and after the inception of SF programs within these companies will give further insight to the effectiveness of SF programs in reducing WMSDs. The author also recommends future research to examine the differences in perception of SF programs in preventing WMSDs between project owners, general contractors and specialty firms. ✪

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Appendix A
Stretch & Flex Program Perception

1) What are the different kinds of construction crafts employed by the company?

2) What is the approximate revenue of your company?

3) What is the geographical area of your company's projects?

4) How long have you worked for this company?

5) What prompted your company to start a stretch and flex (SF) program?

6) When (how long) did your company start the SF program?

7) Based on your company's experience, does SF prevent soft-tissue injuries?

8) Based on your company's experience with an SF program, do you think SF reduces the severity of soft-tissue injuries?

9) How did your company create or develop the SF program?

10) How are workers trained on the SF program?

11) Are all of your workers are trained in the SF program?

12) Does your program have a "warm-up" requirement before starting to perform SF exercises? If yes, how long is the warm-up session?

13) When do the workers do SF exercises in a typical day and how many times a day?

14) Are SF exercises tailored to the job duties/trades?

15) How long does a worker perform SF exercises per session? How did your firm decide this timeframe was adequate? In your opinion, is this timeframe adequate?

16) Who leads the SF program? Is the leader trained in SF? Who did the training?

17) How does your company monitor compliance with the SF program? Do the workers comply with the program?