Optimizing Safety
Engineering, Systems, Human Factors: Part 2

By Vladimir Ivensky

Part 1 of this article (*PS*, January 2017, pp. 36-45) discussed the three key elements of a modern occupational safety program: engineering and technical standards and controls, management and operation systems, and human factors. Each element plays an important role, yet many organizations continue to stress one at the expense of the others, which creates an unbalanced and ineffective OSH program. The human factor is present in most every incident, yet often the focus is too narrowly trained on blaming at-risk behaviors or unsafe acts rather than on identifying and addressing the conditions, systems and norms that enable or cause those errors.

Part 2 of this article examines how employers can better incorporate engineering and system elements into worker-oriented initiatives to create a more comprehensive approach to OSH and thereby better understand incident causes, reduce incident rates, confirm regulatory compliance, and prevent serious injuries and fatalities.

Proving Due Diligence

While some allege that companies may use behavior-based safety (BBS) as due-diligence or reasonable-care proof in potential litigation (United Steelworkers Local 343, 2000), in the author's opinion, BBS observation documentation does not appear to be strong in that regard, as it is typically based on basic observations of workers' behaviors by nonprofessionals, and often has nothing to do with recognizing and controlling occupational hazards. Traditional regulatory compliance-based safety systems should be expected to provide due diligence.

Only Applicable to "Best in Class"?

BBS programs are often recommended for best-in-class companies that already have engineering controls and systems in place and an excellent safety culture. Implementation in less-advanced safety systems may be less ideal.

For example, "Practical Guide for Behavioral Change in the Oil and Gas Industry," states:

> During the past 10 years, large improvements in safety have been achieved through improved hardware and design, and through improved safety management systems and procedures. However, the industry's safety performance has leveled out with little significant change being achieved during the past few years. A different approach is required to encourage further improvement. This next step involves taking action to ensure that the behaviors of people at all levels within the organization are consistent with an improving safety culture. (Step Change in Safety, 2001)

The potential effect of behavior modifications on safety performance (incident rates) is illustrated in Figure 1 (p. 48). The conclusion suggested by Figure 1 is that significant incident reduction can be achieved through engineering and systems controls. When those two are addressed, an organization can then work on behavioral modifications for further improvements. At that advanced stage, the unsafe behavior component may become a significant source of injuries; engineering and systems components are "completely" corrected, and any further improvement is impossible. It appears, however, that neither of these stages likely exists in a pure form, and engineering and systems controls must be continuously maintained and improved.

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It also can be suggested that the cultural and behavioral aspect is an integral part of any safety management system at any phase. Its role can vary depending on the type and maturity of a safety management system. Ultimately, as pointed out by United Steelworkers (2000), there is only one comprehensive safety program (Figure 2, p. 48): Behavioral/administrative safety should be applied together with engineering and systems safety.

Implementing Observation Programs

To make a safety observation program work for a specific company it should be properly designed, fit local culture, be understood, and be agreed upon and supported by senior management, technical professionals and employees. Management must be vigilant to prevent a situation similar to the following example:

> One of the companies I worked for used a safety observation program. This program essentially required supervisors to record observations and turn them in for review. The program almost destroyed the positive culture that had been fostered by our forward-thinking operations manager. The regional safety folks for this company established quotas for these observation cards. The supervisors would sit around a table fabricating observations to meet their quotas on the Thursday before they were due. When they did record field observations, the employees resented it because the program seemed to assign blame to the workforce (whether that was the intent or not). In many cases, the supervisors knew employees were engaged in "unsafe" behaviors because they were short on resources, equipment or some other necessary tool, system or process necessary to perform their work safely. (Smith, 2007)

To be most effective, observation sheets must include not only behaviors, but also field hazards and management controls (Mangan, 2015). This approach allows proper balance of necessary elements (i.e., behavioral, engineering, systems) into one integrated inspection and auditing tool. The resulting program is a comprehensive safety program with a behavioral safety element.

One major component of BBS costs, in addition to training observers and conducting observations, is managing the extensive data collection system. Analyzing collected data would result in finding the main causes of occupational injuries in a specific company to correct them. Typically, employees conduct safety observations and report the results to a centralized database. Professional safety staff may then be asked to analyze and interpret the data, a task that can be time consuming.

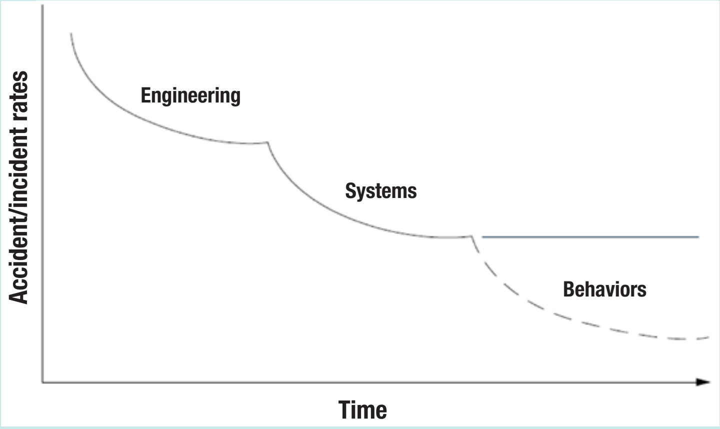
Therefore, it is critical that this effort produce valuable information that would be instrumental to identifying and correcting real safety problems. If collected data are not representative, the effort wastes significant resources and could compromise the integrity of the overall safety program.

It is easier to recognize violations or errors in simple, repetitive tasks than in complicated professional tasks that require special skills and knowledge. For example, it is reasonable to observe and recognize simple safety violations such as not wearing a hard hat or other basic PPE, not using a seat belt or talking on a cellphone while driving (e.g., using dashboard video cameras). Such behaviors can either lead to an incident or make the outcome of an incident more severe; therefore, observing, trending and communicating about those events can help alter the behavior, and reduce the probability and severity of the associated negative outcomes.

IN BRIEF

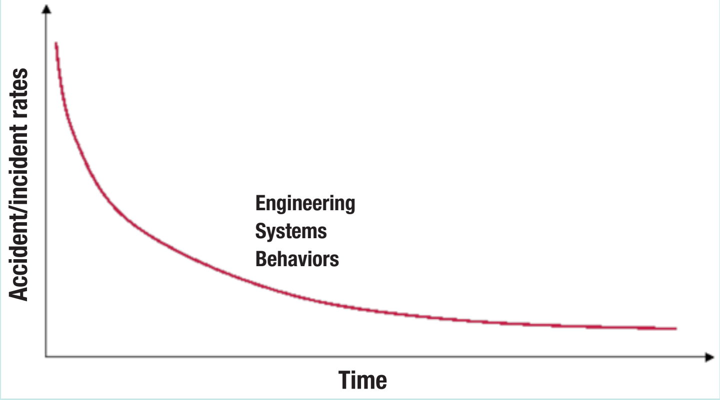
- **When planning work safety observation programs, observers should be trained to recognize and report hazards (unsafe conditions) and management system deficiencies in addition to unsafe acts.**
- **Part 2 of this article offers recommendations for securing management commitment to comprehensive safety and warns against instilling a blame culture.**

FIGURE 1
The Effect of Behavior on Safety



Note. *Adapted from* Changing Minds: A Practical Guide for Behavior Change in the Oil and Gas Industry*, by Step Change in Safety, 2001, Aberdeen, U.K.: Author.*

FIGURE 2
Comprehensive Safety Program



Errors or violations that occur while performing complicated tasks are more difficult to recognize; doing so would require professional knowledge of the task and/or safety qualification. Figure 3 illustrates this point. Some observation tools may ignore nonbehavioral elements such as unsafe conditions/hazards, regulatory compliance deficiencies or deficient safety systems.

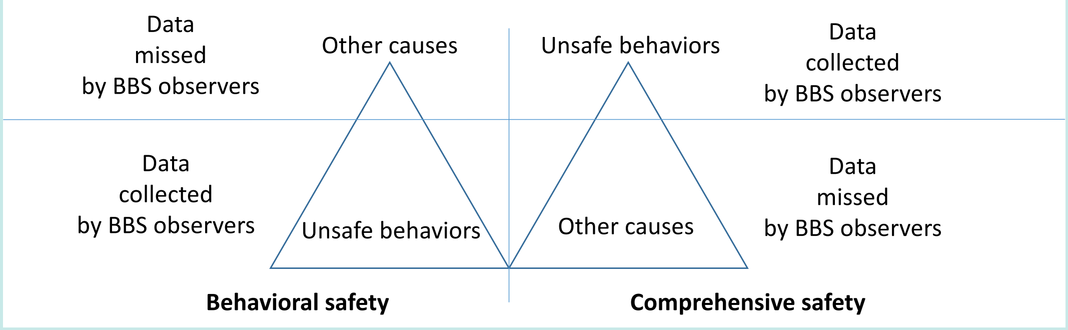
In many cases, employees are not trained to recognize these deficiencies; they are trained only to recognize simple, visible, observable behaviors such as missing basic PPE, lifting with the back rather than the legs, incorrect posture and proximity to pinch points. Despite this, some organizations may presume that they have observed most safety deficiencies (unsafe acts) (Figure 3, left side). While the actual proportion of unsafe acts to unsafe conditions may not be known, the individual looking only at behaviors is clearly missing a significant portion of a complete picture (Figure 3, right side). This bias becomes especially troubling when the observer's only safety education is a BBS course.

An alternative approach is to include engineering and system elements in the safety observation programs (or behavior elements in traditional safety checklists). Comprehensive safety systems using the BBS element along with other necessary modules would improve safety culture and performance.

What Is Working in BBS

According to HSE (2005), the lack of effective management of the human element has been a contributing factor in the causes of many major incidents including the *Piper Alpha* oil rig fire, Esso Longford gas explosion, the passenger ferry capsize at Zeebrugge, the Paddington rail crash at Ladbroke Grove, the explosion and fires at Texaco's Milford Haven plant, the Chernobyl nuclear explosion, the toxic gas release at Union Carbide's Bhopal pesticide plant and the explosion at BP's Grangemouth refinery (HSE, 2005). For many of these major incidents, human error was not the sole cause but one of several causes, including technical and organizational failures, that led to the outcome (HSE,

FIGURE 3
Observers' Perceived Scope of Safety Data Collected From BBS & Comprehensive Safety Points of View



2005). Therefore, the need to effectively manage the human-related risks is critical and clear.

Implementing any corporate program requires serious senior management commitment and support. Management has interest in the success of the investment when initiating a safety program. This results in increased management attention and commitment to comprehensive safety. Management leadership, support and participation in a safety program is necessary and beneficial.

BBS is a valued addition to a comprehensive safety program when applied proportionally. It integrates important human and psychological elements with technical safety.

Safety culture development and improvement programs play a remarkably positive role. BBS programs newly integrated into existing safety management systems may revitalize them.

Integrating BBS Into a Comprehensive Safety Program

Secure Management Commitment

Provide a review of comprehensive safety programs (engineering controls, management systems, human behaviors), explaining that BBS is one component of a comprehensive safety program. As any safety tool, it should be applied correctly and proportionally, and should fit the task. Explain the hierarchy of safety controls. When appealing for management and employee commitment and buy-in, seek commitment to comprehensive safety.

When discussing safety culture and commitment, emphasize that "creating the right mind-set is not a strategy which can be effective in dealing with hazards about which workers have no knowledge and which can only be identified and controlled by management" (Hopkins, 2000). Technical safety training, qualified, competent management and personnel, effective safety management and hazard control are required.

Work toward securing management commitment to provide necessary project safety resources and budget, hazard recognition, evaluation and control, ensuring competent, qualified, trained employees and supervision, and subcontractors' safety qualification.

Avoid stating that human error risks are completely managed through commitment to safety and BBS (HSE, 2005). Explain exactly how human factor safety risks will be mitigated to achieve the selected standard of care.

Explain that frontline supervisors' behavior and actions toward safety have a direct effect on workers' perception of safe behavior and actions. Supervision must demonstrate leadership and safe behavior, and adhere to site policies.

Incident Causation

When an organization believes that most occupational injuries are caused by unsafe behaviors that can be observed, measured and corrected, it logically leads to similarly proportioned attention to employees' behaviors in the field. This may skew the safety priorities away from recognizing, evaluating and controlling occupational hazards, and identifying and correcting management system deficiencies (including nonobservable decisions) in favor of observing and correcting defined visible behaviors of line workers.

Discuss the elements of root-cause analysis in incident investigations to illustrate the diversity of potential incident causes. If managers state that unsafe acts are the cause of almost all incidents, mention that this incident causation theory is contested and debated (as are other incident causation theories) (Hopkins, 2006).

When discussing unsafe acts, differentiate between unintentional errors, habits, and negligent or willful safety violations. Explain the differences in causes and management of these categories. For example, consider mentioning that up to 70% of human errors are management-system induced (Conklin, 2016) and up to 90% of errors in aviation maintenance were judged blameless (Reason, 2000). As Reason (2000) says, "It is often the best people who make the worst mistakes—error is not the monopoly of an unfortunate few." Warn of the dangers of assigning blame for unintentional errors and of instilling a blame culture (Myketiak, 2015).

Consider replacing the term *behavioral safety* with *human factors safety*, expanding the scope to differentiate between various types of unsafe acts: intended/unintended, habits, violations, mistakes, lapses and slips (HSE, 2005). The meaning of *unsafe behavior* may imply that an employee is aware of safe behavior but intentionally chooses to act unsafely. This is not always the case, as unintentional errors make up the majority of so-called unsafe acts.

It appears that the A-B-C model, popular in BBS and safety culture improvement efforts is more ap-

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plicable to reducing intentional safety violations and simple reparative habitual acts (e.g., failure to buckle up in a car, failure to wear hard hat and safety glasses on a project site) and less effective in controlling human (employee and management) errors in more complicated tasks.

Do not assume that highly safety-motivated employees are exempt from unintentional errors or deliberate violations (HSE, 2005).

Observation Programs

Concentrating on high-frequency, simple and easily observable behaviors could obscure addressing more sophisticated safety problems that may be the real priority. Manuele (2003) disproved the premise that the predominant causes of minor incidents are identical to the predominant causes of serious incidents and catastrophes. The types of elementary unsafe behaviors, visible to unprofessional observers, are not correlated to the causes of catastrophic incidents (especially in high-hazard industries). Continuous emphasis on search and control of unique or rare critical hazards, stringent control of known critical hazards and compliance with safety management system requirements (e.g., regulatory audits, maintenance audits, ensuring employee and management qualification, safety inspections and corrective actions) are necessary.

Not all unsafe acts that lead to an incident can be observed and recognized, even by trained observers. Critical errors can be made in the board room, or by designers or project managers. Recognizing other errors made within a technological process requires special professional knowledge, and effective peer-review and quality-assurance systems.

A typical BBS observation does not probe deep enough to discover and document serious injury or fatality (SIF) exposures, so the observation process must be modified (Mangan, 2015). Observation sheets must include not only behaviors, but also conditions and management controls (Mangan, 2015).

Quotas on mandatory periodic observation reporting may lead to generation of "junk" reports, leading to wasted efforts to produce, analyze and explain those data (Smith, 2007).

Regulatory Compliance

Potential BBS program users should be aware that these programs may not improve regulatory compliance and do not relieve them from legal obligations to manage hazards and provide a workplace free from recognized hazards to employees. To best demonstrate due diligence, users should rely on traditional means of achieving regulatory compliance and safety care to workers.

Reduced Incident Rates

The rate at which SIFs are decreasing is lower than that of minor incidents (Mangan, 2015). Best-in-safety companies demonstrate serious attention to safety before and in parallel with an implemented BBS system, which makes it difficult to determine the effect of the system. In addition, with injury rates (including minor cases) a key performance indicator, more attention is applied to postincident case management (Ivensky, 2015). Incident underreporting (Brown & Barab, 2007; U.S. House of Representatives Committee on Education and Labor, 2008) caused by fears of being blamed for an incident (Myketiak, 2015) or for becoming a part of a long and difficult investigation is widely documented.

Preventing a Serious Incident

Manuele (2003) states that Heinrich's premise that the predominant causes of no-injury incidents are identical to the predominant causes of incidents resulting in major injuries is invalid. Mangan (2015) similarly suggests that the discrepancy between minor incident rates and serious incident rates exists in part because practitioners treat all incidents the same, while roughly only 20% of incidents have the potential to become an SIF (Mangan, 2015). Manuele (2003) concludes:

> Unfortunately, many safety practitioners continue to act on the premise that if efforts are concentrated on the types of accidents that occur frequently, the potential for severe injury will also be addressed. That results in the severe injury potential being overlooked, since the types of accidents resulting in severe injury or fatality are rarely represented in the data pertaining to the types of accidents that occur frequently. A sound case can be made that many accidents resulting in severe injury or fatality are unique and singular events.

The noted references suggest that BBS observation techniques that concentrate on frequent, repetitive and easily observable events may miss rare, high-potential hazards. Therefore, safety inspection and observation techniques must be designed to emphasize a search for critical, high-severity potential hazards, including those with lower probability.

Application in High-Hazard Industries

According to Anderson (2006):

> The majority of major hazard sites [in high-hazard industries] still tend to focus on occupational safety rather than on process safety and those sites that do consider human factors issues rarely focus on those aspects that are relevant to the control of major hazards. For example, sites consider the personal safety of those carrying out maintenance, rather than how human errors in maintenance operations could be an initiator of major accidents. This imbalance runs throughout the safety management system, as displayed in priorities, goals, the allocation of resources and safety indicators.

The same point is included in the conclusion of the Baker Panel report (BP U.S. Refineries Independent Safety Review Panel, 2007) of the investigation of the 2005 Texas City, TX, refinery disaster. As Hopkins (2000) states, "Reliance on lost-time injury data in major hazard industries is itself a major hazard."

Finally, while "the safety professional has to learn more about the psychology of injury prevention" (Geller, 2016), behavioral psychologists involved in OSH may benefit from learning more about the technical, engineering and operational aspects of safety to ensure the proper balance and maximum effectiveness of the resulting product: a comprehensive safety program.

Conclusion

This two-part article reviews ongoing discussions on preventing misbalances among the major elements of a comprehensive safety program (engineering controls, management systems, humans) potentially impacting those programs' effectiveness in preventing serious incidents. **PS**

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PS EXTRA

Part 1 of this article can be found at **http://bit.ly/2jcziTc**.