Safety Management Systems

Comparing Content & Impact

By Joel M. Haight, Patrick Yorio, Kristen A. Rost and Dana R. Willmer

IN BRIEF
- Occupational health and safety management systems (OHSMS) are receiving much attention in the safety community and among regulators and consensus industry groups.
- Few differences exist between individual systems, but significant differences exist in their implementation. Differences also exist between the OHSMS approach and the traditional safety program approach.
- If a company elects to implement an OHSMS, the challenge is not deciding which one to use; rather, it is implementing the many policies, processes, intervention initiatives and activities and protocols that make up the specific system used, then measuring its effectiveness.

Occupational health and safety management systems (OHSMS) have become popular as agencies such as OSHA expect to propose regulations and as consensus standards and industry programs such as ANSI/AIHA/ASSE Z10, OHSAS 18001 and National Mining Association's (NMA) CORESafety are implemented. Other management-system-like processes have been implemented over the years as well, including OSHA's Process Safety Management of Highly Hazardous Chemicals (PSM) standard, promulgated in 1992, and American Chemistry Council's Responsible Care program, introduced in 1988.

But what is the difference between an OHSMS and how occupational safety has traditionally been managed? Why do many practitioners and researchers perceive management systems to be a better way to manage occupational safety and health? How can one know that the content of these systems and the content mix are appropriate and that their implementation will be effective?

With so many systems being promoted, it has become confusing. This confusion is tempered in industries guided either by regulations (e.g., OSHA PSM standard in process industries) or by their professional industry organization (e.g., NMA's CORESafety). This article aims to identify differences between systems to provide readers with some basis for their selection of an OHSMS.

Although Responsible Care has existed for more than 25 years and the PSM standard for more than 20, empirical evidence of their effectiveness is lacking. Furthermore, since many management system consensus standards are relatively new, not enough time has passed to let them work and to subsequently provide evidence to demonstrate whether and to what extent they effectively accomplish safety objectives (e.g., prevent injuries).

So, why are regulators, consensus organizations and industry associations actively supporting the management system approach to safety? Why is more than one system available? How can the effectiveness of such a system be measured? The authors attempt to answer these questions by examining the similarities and potential differences in the content of various OHSMS models, and by discussing the benefits associated with their implementation and current thinking relative to measuring effectiveness. The goal is to help readers better understand

Joel M. Haight, Ph.D., P.E., is an associate professor of industrial engineering at the University of Pittsburgh, where he teaches and conducts research in the industrial engineering field, and coordinates the department's master's degree program. From 2009 to 2013, Haight was chief of NIOSH's Human Factors Branch. Prior to that, he was an associate professor of energy and mineral engineering at Pennsylvania State University and worked as a manager and engineer for Chevron Corp. He holds a Ph.D. and an M.S. in Industrial and System Engineering, both from Auburn University. Haight is a professional member of ASSE's Western Pennsylvania Chapter, a member of the Engineering Practice Specialty and an ASSE Foundation Trustee.

Patrick Yorio, CSP, SPHR, is a technical analyst in the Human Factors Branch of NIOSH's Office of Mine Safety and Health Research.

Kristen A. Rost, Ph.D., is a research scientist in the Human Factors Branch of NIOSH's Office of Mine Safety and Health Research. She holds a B.S. in Psychology from Western Michigan University, an M.S. in Applied Behavior Analysis from Florida Institute of Technology and a Ph.D. in Psychology from City University of New York.

Dana R. Willmer, Ph.D., is a lead behavioral scientist in the Human Factors Branch of NIOSH's Office of Mine Safety and Health Research. She holds a B.A. in Sociology and Organizational Communication from Alma College, and an M.A. and Ph.D. in Sociology from University of Pittsburgh. Over the past 12 years, Willmer has led several research projects designed to improve miners' safety and health. She is the principal investigator of a project assessing the effectiveness of health and safety management systems in the U.S. mining industry. Other research interests include improving miners' adoption of self-protective behaviors to prevent noise-induced hearing loss and strategies for improving the diffusion and adoption of NIOSH's mining research outputs and recommendations.

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what OHSMSs are, how they are expected to work, and the complexities involved in measuring system performance and establishing the relative performance of each element and practice used within an organization. This information will help readers be better prepared to develop and implement an OHSMS should they deem it right for their workplace.

What Is a Health & Safety Management System?

A *system* is a grouping of interrelated and often interdependent components brought together in nature or in the manufactured world to achieve a common objective or perform a common function. Common attributes present in most definitions of a system are interrelatedness or interdependence of system components and the notion of a common objective.

The literature contains more formal definitions of a system (Haight, Yorio & Willmer, 2013). Elsayed and Boucher (1994) define *production system* as “a collection of material, labor, capital and knowledge that goes into the manufacture of a product. How this collection of components is put together in any specific situation defines the particular system” (p. 1). Eisner (2002) offers a more simplified definition: “A system is any process that converts inputs to outputs” (p. 3).

Many types of systems exist in both the natural and manufactured worlds. An example of a natural system is the respiratory system. It is made up of trachea, bronchioles, lungs, alveolar ducts and more. These components work together to oxygenate and remove carbon dioxide from the blood.

People rely on systems to improve the quality and efficiency of industrial processes. For example, in the manufacturing world an electric power supply system includes components such as power generation turbines, transmission lines, transformers and distribution lines. These components work together, with human contribution, to bring electricity to customers to light and heat (or cool) buildings and homes.

To move this discussion into a specific category, consider the concept of a management system. A management system may be described as a structure and set of processes, procedures, policies and/or actions that an organization implements to achieve a defined objective or perform a common function in an efficient, structured way.

For example, companies use accounting and finance management systems to manage revenue and debt by integrating people, software and processes that work interdependently to identify, record and track income, issue bills and ensure that the organization's bills are paid. This management system may include an investment component, a tax component and a debt management component, all of which work collectively to ensure that the organization's financial goals are met. It can be argued that a systems approach to management can be characterized based on a common objective and strategic interrelatedness or interdependence of the components that comprise it, along with the structure necessary to ensure their collective effectiveness.

An OHSMS is perhaps more specific and focused than the previous examples. ANSI/AIHA/ASSE Z10 (2012) defines an occupational health and safety management system as "a set of interrelated elements that establish or support occupational health and safety policy, objectives and mechanisms to achieve those objectives in order to improve occupational health and safety."

British Standard Institute's OHSAS 18001:2007 and its guidelines for implementation (OHSAS 18002:2008) define an OHSMS as "part of an organization's management system used to develop and implement its OH&S (Occupational Health and Safety) policy and manage its OH&S risks."

Notes provided as a component of the OHSAS 180001:2007 definition help to illuminate the system qualities: "A management system is a set of interrelated elements used to establish a policy and objectives and to achieve those objectives"; "A management system includes organizational structure, planning activities (including, for example, risk assessment and the setting of objectives), responsibilities, practices, procedures, processes and resources."

Much similarity can be noted between the fundamental definition of a system, the concept of a management system and cited definitions of an OHSMS. Key similarities include: 1) multiple components (or elements) with different functions but the same objective; and 2) the interrelatedness, interdependence and/or complementary way the elements interface with each other to achieve the common objective. Because occupational safety and health risks encompass complex physical, cognitive and/or behavioral phenomena that can originate in both the natural and the man-made world, effective mitigation necessarily involves a proactive management system that can address such complexities. It is surmised that this is the reason OHSMS have received so much recent attention.

One way to visualize an OHSMS is to consider all the activities that go into a traditional safety and health program, such as safety training, behavioral safety observations, safety meetings, safety inspections, audits and other safety-related nonconformance work, hazard and risk assessments, safety awareness campaigns and organizational culture activities. Each activity can fit into one or more of the defined OHSMS elements and can then be tracked for both implementation and effect under one system and one management philosophy, policy and strategy. This big-picture oversight is what brings the oneness of purpose and the interaction of OHSMS that is not necessarily found in the traditional safety program approach.

Systems vs. Programs: Important Differences

As suggested, a general systems approach brings together oneness of purpose and interdependence between system elements with a level of organization and structure necessary to support system effectiveness. Logically, the fundamental attributes that underpin a systems approach should then result in some practical, observable differences between an OHSMS and the more traditional program approach to occupational safety management.

An OHSMS emphasizes system-wide recordkeeping, document control and integrated interelement tracking (and correction) of nonconformance. This is important because it illuminates the interdependence qualities of an OHSMS. When all procedures are written in the same format and quality, they create a familiarity that enhances their use. When nonconformance records are stored in one tracking system, whether they are the result of incident investigations, compliance audits, preventive maintenance findings or other activities, they can be addressed with the same risk-ranking process.

This consistency allows for sound, cost-effective, risk-reducing interventions that are consistent with overall system objectives. Document control across all elements also ensures consistent updating that is reflected in up-to-date equipment specifications, inspection records, operating procedures, risk assessment results and nonconformance documentation. Although these important activities may be part of traditional safety programs, they are likely not integrated within the management structure.

Another difference is the structure of an OHSMS compared to a structureless traditional program. Defining responsibilities and accountabilities, interelement interdependence, nonconformance tracking, system-wide management reviews and risk assessments, as well as resource allocation and investment decisions based on comprehensive information, produce a greater potential to guarantee successful implementation and the subsequent realization of injury prevention objectives.

To further visualize the differences between the traditional approach and the management system approach, consider the plan-do-check-act cycle (Deming, 1982, 2000). The first step of the cycle is to develop a plan, so much must be done before any intervention occurs. In the planning process, an organization must first identify and prioritize its risks, then develop plans necessary to minimize this risk, set performance objectives, and facilitate management buy in and employee ownership. Several of the current OHSMSs support elements that target this planning stage, while traditional safety programs do not necessarily have built-in planning provisions.

Intervention occurs during the do phase of the cycle. Interventions may include safety training, physical hazard inspections, preventive maintenance inspections, safety meetings, awareness campaigns, behavioral safety observations, risk analyses and work permit system implementation. How these elements are built and implemented is critical. While some of the same physical, cognitive and behavioral activities occur during implementation, the differences in the "whom" and the "how" elements of implementation may be stark.

In a traditional safety program, these activities may be implemented independently, by different people, each with their own objectives. Implementation of these same activities within the framework of an organized system ensures a unified objective and complementary (rather than competitive) functions. In an OHSMS, it is planned for each element to complement, interact with or depend on the proper implementation of each other. The intervention activities are implemented so as to optimize them in terms of quality and amount of effort. The ultimate goal is to optimize the overall objective to reduce the number and/or severity of injuries and illnesses.

While one would see similar activities in a traditional program approach, the OHSMS structure contains elements to address the check and act phases of the cycle as well. It is proposed that this structure then helps to ensure or at least improve the probability of success. The management review and proactive and reactive checking (e.g., audits, inspections, investigations) elements contribute to the check phase. The act phase would encompass elements related to corrective actions. This entire structure and the continuous improvement nature of OHSMS (or any management system) also help to increase the likelihood of success. While measuring system effectiveness is addressed in more detail starting on p. 48, it is proposed that using a system-based approach to safety management allows more opportunity to measure effectiveness, another advantage over the traditional approach.

In sum, the authors believe that the fundamental principles of a systems approach to safety management deliver three significant benefits beyond those provided by a traditional safety program approach. The systems approach creates oneness of purpose, an interdependence between system elements, and a structure and level of organization not achievable with traditional safety programs. These improvements also increase the ability to measure effectiveness and establish accountability, both of which increase the likelihood of organizational safety performance success. They also provide an opportunity to optimize the organizational quest to minimize injuries while concurrently minimizing resources and maximizing implementation quality (Haight, Thomas, Smith, et al., 2001b; Iyer, Haight, del Castillo, et al., 2004).

Management Systems Comparison

In addition to ANSI/AIHA/ASSE Z10 and OHSAS 18001, other management system standards have been adopted or proposed. For example, within the past year, NMA began implementing its CORESafety OHSMS. In addition, OSHA and MSHA are pursuing related regulations. Much overlap exists between the various systems. One might even say that because each may be considered a performance-based standard (i.e., implementation activities are context specific) any of the system standards would suffice. Although terminologies used to reflect system elements may differ slightly between the standards, striking similarities are evident regarding the spirit and intent of the operational definition of each.

Based on a review of the corresponding content of the prominent OHSMSs and consistent with the plan-do-check-act cycle, these elements are evident in each: management commitment, employee involvement, planning, implementation and operation, proactive checking and corrective action, reactive checking and corrective action, and management review. Therefore, it can be generally said that all OHSMSs have a similar purpose, they are all performance based, and they all set standards and guidelines to help organizations achieve their safety objectives.

Most of the differences between the various systems will likely not become apparent until individual organizations begin to implement each particular element through intervention actions. For example, while most systems have an employee participation element (or something similar), how each individual organization engages employees may be completely different. One organization may give employees an advisory role (e.g., only to suggest revisions to safety and health policy), while another may give employees a more hands-on role that involves, for example, making decisions on intervention priorities, conducting risk analyses and/or developing safe operating procedures. These implementation differences may result from differences in leadership and its level of commitment, and from the type of organizational culture present.

Given content consistency of elements across available systems, it is difficult to go wrong in selecting one over another. The final selection may also depend on an organization's particular industry. For example, NMA CORESafety targets the mining industry, Responsible Care targets the chemical manufacturing industry and OSHA's PSM covers the process industries. Implementation of ANSI Z10 or OHSAS 18001 is less restricted when considering specific industries.

Thus, the real challenge is to develop and implement specific interventions or program activities. Thankfully, many traditional safety program practices and intervention activities fit management system element expectations and their implementation. Furthermore, it seems plausible that an organization may sufficiently cover a given management system element with continued use of practices developed for use in its traditional safety program.

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Assuming that the injury prevention goal remains consistent between traditional occupational safety practices and existing OHSMS elements, one may find comfort in knowing that OHSMS implementation may begin with the addition of structure, an assessment of the complementary and interconnected nature of existing practices, and the development of ways to measure and track the effectiveness of existing processes. It is also important to note that each element and activity is likely to interact with other elements and/or activities to enhance both (or more) of the interacting elements (Haight, Thomas, Smith, et al., 2001a).

Care should be taken, however, as much foundation building may be needed up front if leadership support, ownership and commitment are lacking; if finding creative and impactful ways to facilitate employee ownership is difficult; or if the organizational culture does not yet support such a change. A supportive organizational culture is essential because of the accompanying generalized trust and value congruence between organizations and their employees (Burns, Mearns & McGeorge, 2006; Choudhry, Fang & Mohamed, 2007).

Organizational culture attributes, such as supportive management and supportive employees who are interested in taking ownership of the new OHSMS, are critical to initial as well as long-term, sustainable performance success. This premise is formally recognized and integrated into the NMA CORESafety system through an explicit cultural enhancement element.

Measuring Intervention Effectiveness

Quantitative measurement of safety program effectiveness has historically been difficult. Injury and illness prevention is a stated goal of most programs, but if an injury or illness has been prevented by some action taken as a result of the safety program, how would one know? One cannot count things that do not happen. Even if one fewer injury was recorded this year than last year, how does one know whether that reduction was due to chance or resulted from the safety initiative?

Safety professionals have historically measured program effectiveness by comparing the year-end incident rate to the previous year's rate or to an average rate over some period. Some in the safety community recognize that this approach only produces a yo-yo effect on the injury rates as more resources are allocated to injury prevention when the rate is high and fewer resources are allocated when the rate is low. Therefore, it may not be enough to measure what are often referred to as lagging indicators.

Recognized limitations of lagging indicators have led to an emphasis on leading indicators. Leading indicators reference the quality of an intervention's implementation (Haight & Thomas, 2003; Manuele, 2009; Wachter, 2012). Such indicators are advocated as an improved measure within the safety community because they are proactive and allow program adjustments before an injury happens.

However, it is difficult to argue that either lagging or leading indicators have been proven to be true measures of OHSMS effectiveness. More realistically, they provide by-chance, intermittent feel-good-sense-of-reason-based measures of variation (Shakioye & Haight, 2010). Much of the published literature does not adequately address the interactive effects between performance variables and the cause-and-effect relationships between leading and lagging indicators.

To complicate the measurement puzzle, the systems-based approach suggests that some driving forces necessary for OHSMS success (e.g., leadership or management commitment, employee ownership, organizational culture), which now need to be measured and tracked, have arcane or esoteric characteristics. In other words, they are difficult to measure. It has been written that a sign on Albert Einstein's office door at Princeton read, "Not everything that counts can be counted, and not everything that can be counted counts" (Cameron, 1963). This philosophy illustrates the difficulty of measuring OHSMS effectiveness.

Given these factors, one can use many non-quantitative techniques to assess the effectiveness or the contribution of the more arcane elements of an OHSMS. Surveys can measure the presence of these drivers, and experienced professionals can assess whether these elements are present in high levels. For example, OSHA's (1989) Voluntary Safety and Health Program Management Guidelines offer numerous programmatic, procedural and behavioral examples of observable ways that organizations can demonstrate management commitment and employee participation.

However, it is not easy or even possible sometimes to define or present a number that represents a conducive organizational culture, a committed leader or an employee who feels ownership over aspects of an OHSMS. Instead, the focus should be on qualitatively measuring existing levels of the defining characteristics of elements such as leadership, ownership and organizational culture—that is, to show some measure or index of their levels that will allow comparison of those levels to system outputs over time and/or to compare those levels to the experience of other organizations (similar and nonsimilar) to establish baseline measures. At that point, continuous measurement of those values over time can indicate some sense of improvement or lack of improvement.

In addition, an OHSMS enables a risk-based approach to implementation. By defining a baseline level of operating risk, then establishing a level of acceptable risk, an organization has a basis to compare implementation quantity and quality across the whole system on an instantaneous and a longitudinal basis.

While risk itself cannot be measured by mathematical or quantitative means, it can be indexed, which provides a means to perform relative ranking of intervention options or levels or quality of intervention implementation with consistency. Risk is semiquantitative at best, but because of its consistent quality, this approach provides a means and a measure to make decisions regarding the level of investment, amount and quality of effort, and adequacy of performance, as well as the overall direction the system should take.

Looking optimistically toward the future, the OHSMS paradigm provides an opportunity for measuring an intervention's true effectiveness. Research has been scratching at the surface of statistically significant measures of performance for the past 12 years. Several researchers (Haight, et al., 2001a, b; Haight & Thomas, 2003; Iyer, Haight, del Castillo, 2004; and Iyer, et al., 2005) determined that to measure safety intervention effectiveness, one must establish a mathematical relationship between the leading and lagging indicators.

If well designed and conducted with sufficient attention to intervention detail, these research-based, empirical approaches are an opportunity to understand and explain variation in injury rates. This also provides an opportunity to measure the interactive effects between performance variables.

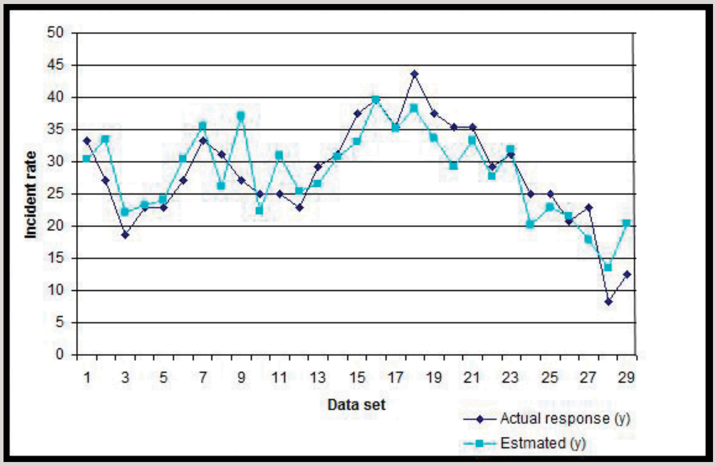
Haight, et al. (2001a), were the first to establish this mathematical relationship and much work has been conducted since then to understand and use this mathematical relationship. As with any input/output model, the resulting mathematical function provides an opportunity to explain, in model form, a real system as it operates. Care should be taken here as mathematical models are only representations of real processes and, as such, present some margin of error. However, some can still be useful as decision-making tools, provided uncertainty in the results can be minimized and the residual uncertainty can be accepted or at least considered.

The level of certainty is the amount of variation one can explain through the experimentation and subsequent modeling. For example, if the incident rate does not respond to a change in the amount or quality of implementation of one or more interventions, the variation or lack thereof in the output may not be explained with acceptable certainty.

With any human-based system, uncertainty in the results will be higher than when analyzing a system driven by the more predictable natural and physical laws. However, without data collection, experimentation, analysis and modeling, the uncertainly level around any decision made about the system's performance is high. More recent research in this area has shown that the level of uncertainty has been reduced to roughly 30% (Al-Mutairi & Haight, 2009; Oyewole, Haight, Freivalds, et al., 2010; Shakioye & Haight, 2010).

Figure 1

Actual Incident Rates vs. Model-Generated Estimation



Note. *Adapted from "Modeling Using Dynamic Variables: An Approach for the Design of Loss Prevention Programs," by S.O. Shakioye and J.M. Haight, 2010,* Safety Sciences, 48*(1), pp. 46-53.*

The research of Shakioye and Haight (2010) and Oyewole, et al. (2010), has yielded some interesting results. Through extensive operations research methodology, Shakioye and Haight (2010) show that the incident rates predicted by the mathematical model representing the effectiveness of the safety system is predictable and the model is valid (Figure 1).

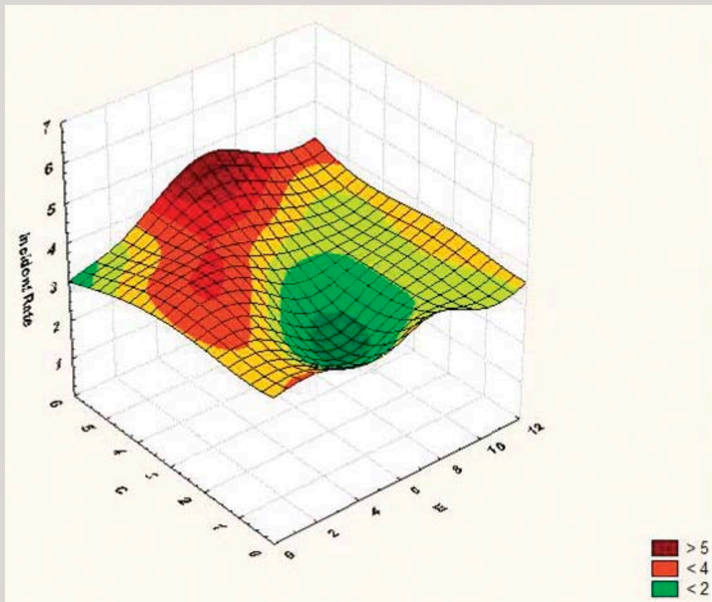
Oyewole, et al. (2010), took the work a step further by using surface response methodologies. These researchers also treat the interactive effects between intervention activities more thoroughly than the previous researchers. As shown in both Figures 2 (p. 50) and 3 (p. 51), the 3-D surface shows that the incident rate responds to the interactive effect of two variables from the OHSMS being studied. One can then adjust implementation of variables C and E of this particular OHSMS so one can attempt to more efficiently minimize the incident rate. The same model information is presented in two ways to allow better visualization. From Figure 3, one can discern that the minimized incident rate is achieved at the indexed value of the implementation quality or quantity of the two subject variables to just under level 2 for variable C and approximately level 6 for variable E.

This information should not be construed as the answer to the safety problem, but as an answer that suggests certain adjustments that can be made to improve OHSMS implementation. It is encouraging work and, as is, can inform those charged with OHSMS implementation; however, much more work needs to be done. The key takeaway is that it appears to be possible to measure OHSMS implementation effectiveness, at least with the current proven levels of certainty around 68% to 70%.

The OHSMS paradigm provides an opportunity for measuring an intervention's true effectiveness.

Figure 2

Response Surface Plot of Incident Rate vs. HSMS Variables C & E



Note. *Adapted from "The Implementation of Statistical and Forecasting Techniques in the Assessment of Safety Intervention Effectiveness and Optimization" (Unpublished doctoral dissertation), by S.A. Oyewole, 2009, Pennsylvania State University, University Park, PA.*

Research-based empirical approaches are an opportunity to understand and explain variation in injury rates. This also provides an opportunity to measure the interactive effects between performance variables.

Conclusion

OHSMSs are becoming more popular, with significant regulatory, consensus organization and industry group activity surrounding this movement. An OHSMS provides structure, integration and oneness of purpose that are not provided by a traditional approach. However, the success of an OHSMS depends on strong leadership/management support, active employee participation and a conducive, organizational culture. None of these are easy to create, and all are difficult to measure and maintain.

Through comparative analysis, an organization can rely on many of the intervention activities that make up existing safety programs to form the foundation for OHSMS implementation. The state of the available research is such that anyone can determine what variables indicate OHSMS performance; they can determine how best to quantify and measure those variables.

Haight, et al. (2001a, b), have shown that the amount of effort (in terms of percentage of available work-hours allocated to implement OHSMS elements) can effectively measure the effort level that goes into OHSMS implementation. It has been shown that incident rates vary from week to week as a function of variations in this level of effort. Examples of these resource allocation variables include safety training hours, safety meeting preparation and attendance hours, inspection and auditing hours, and hazard and risk assessment hours. Any intervention activity that is part of an OHSMS and aims to contribute to injury prevention is measurable.

More recent research has identified quality measures of OHSMS activities as being important performance variables. Quality measures to consider include safety training test scores, correction rates of inspection nonconformance findings, and perception survey results on the state of the organizational culture and its conduciveness to safe operations. Whatever an organization selects to measure OHSMS performance, it should assess those factors over time (years are suggested) so it can identify trends and document the lasting effects of each OHSMS element and intervention.

Validation would have to involve statistical analysis of these measures and their resulting effect on incident rates. Once the measures have been validated, one should be able to predict, at least with the current proven levels of certainty of 68% to 70%, injury prevention performance based on OHSMS changes to the allocations made or discontinued. For more in-depth how-to information, see Haight, et al. (2001a, b); Haight & Thomas, 2003; Iyer, et al. (2004, 2005); Shakioye & Haight (2010) and Oyewole, et al. (2010).

It may be some time before we can truly determine the effectiveness of OHSMS or even know that OHSMS is truly better than the traditional approach. However, a high level of energy currently surrounds OHSMS and sometimes that energy alone can contribute to overall improvement. One thing remains clear, the main objective of any safety and health strategy is to prevent occupational injuries. Therefore, any effort to prevent people from being injured is worth it even if SH&E professionals are still working on a way to demonstrate that what practitioners are doing is truly working. **PS**

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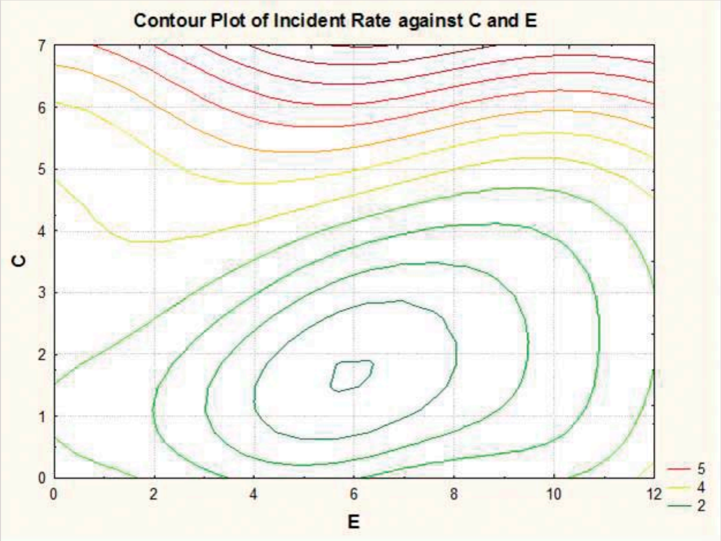
Figure 3

Contour Plot of Incident Rate vs. HSMS Variables C & E



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