Managing Ergonomics

Applying ISO 45001 as a Model

By Walter G. Rostykus, Winnie Ip and Jennifer Ann Dustin

Organizations that successfully reduce and control musculoskeletal disorders (MSDs) follow a systematic ergonomic improvement process to identify and reduce employee exposure to the risk factors known to cause MSDs. OSH management system models provide a common process for managing environmental and safety risk, particularly MSD risks. The draft ISO 45001 standard on occupational health and safety management provides another model that can be used as an effective system for managing ergonomics. This article aims to provide safety professionals, engineers, operations managers and ergonomists with an illustration and framework to systematically manage workplace ergonomics, aligned with ISO 45001.

MSD Risk Factors & Historic Approaches

For more than 300 years, history has documented injuries resulting from overuse of musculoskeletal joints from occupational risks. Ramazzini (1713/1964) first identified work-related injuries as "diseases of those who do fine work." As recently as 1917, Hamilton (1943) described a disorder called "dead fingers" affecting stone cutters using air hammers to cut and shape limestone; the disorder was a result of the effect of vibration on soft tissue. Today, numerous studies clearly define the causative risk factors and exposure thresholds of MSDs (Bernard, 1997; da Costa & Vieira, 2010; Gallagher & Heberger, 2013).

MSDs are the result of harsh wear and tear on the joint structures of the body beyond the tissues' ability to recover. Three primary risk factors cause MSDs:

- awkward posture;
- high force;
- long duration or high frequency.

The combination of two or three of these risk factors, along with an increased exposure to any or all of the factors, increases the chance of develop-

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ing discomfort, pain or an MSD. Several secondary risk factors also contribute to developing an MSD:
- soft-tissue compression;
- low temperature;
- vibration;
- impact stress;
- glove issues.

The threshold for each risk factor varies by body part. Larger joint structures, such as the shoulder and knee, typically have a higher tolerance for each risk factor than smaller joints such as the wrist. Epidemiologic studies provide quantitative MSD risk assessment methods enabling professionals to calculate risks based on the exposure to combined MSD risk factors (Bernard, 1997).

Programs and processes used to reduce MSDs are more recent and varied within the OSH profession. In the 1990s, OSHA and NIOSH promoted implementation of an ergonomics program that included key elements and activities (e.g., risk assessment, workplace changes, training, injury management) but did not include a specific sequence or prescribed process. The advent of total quality management and OSH management systems launched the approach of managing safety (and ergonomics) as an ongoing process versus an episodic program.

ISO 45001: Standard for Occupational Health and Safety Management Systems

The purpose of a safety management system is to provide a structured approach (system or process) that enables an organization to control its OSH risks and to improve performance (ANSI/ASSE, 2012; BSI Group, 2007; ILO, 2001; ISO, 2015). Historically, this process approach began with the ISO 9001 quality management system, which is based on the Shewhart (1939/1986) cycle of continuous improvement (plan-do-check-act) and supported by Deming's (2000) fundamental principle number 2: "To improve performance you need to improve the system rather than focus on the individuals."

ISO 45001 is a proposed international safety management system standard, the latest in the progression of similar standards over the past 2 decades. It is built from the environmental management systems approach (ISO 14001) to address safety, first with OHSAS 18001 (a British standard), then ANSI Z10 (an American standard). The current proposed ISO 45001 is the product of a project committee (ISO PC 283) representing more than 70 countries (AFNOR Group, 2015; BSI Group, 2014).

ISO 45001 provides a structure for building an ergonomic improvement process, whether that is a standalone improvement process or an element of an organization's safety management system. This practice of leveraging a safety management system model to manage ergonomics is illustrated by several organizations including AIHA (Rostykus, 2008), CSA (2012), NIOSH (Torma-Krajewski, Steiner & Burgess-Limerick, 2009) and ILO (1997).

In their review of published literature, Yazdani, Neumann, Imbeau, et al. (2015), developed con-

IN BRIEF
- **Current OSH management system models provide a common process for managing environmental and safety risk, including musculoskeletal disorder (MSD) risks and ergonomics improvements. The draft ISO 45001 standard provides another model.**
- **Leveraging a process such as ISO 45001 can increase engagement and effectiveness of the ergonomics improvement process.**
- **This article describes steps for managing ergonomics improvements and MSD risk reduction for each element of the ISO 45001 model.**

Table 1
Alignment of Draft ISO 45001 Content With Shewhart Cycle

Proposed ISO 45001		Shewhart Cycle
1. Scope		
2. Normative references		
3. Terms and definitions		
4. Context of the organization		
5. Leadership, worker participation and consultation	5.1 Leadership and commitment 5.2 Policy 5.3 Organizational roles, responsibilities, accountabilities and authorities 5.4 Participation, consultation and representation	
6. Planning	6.1 Actions to address risk opportunities 6.2 OH&S objectives and planning to achieve them	Plan
7. Support	7.1 Resources 7.2 Competence 7.3 Awareness 7.4 Information and communication 7.5 Documented information	Do
8. Operation	8.1 Operational planning and control 8.2 Management of change 8.3 Outsourcing 8.4 Procurement 8.5 Contractors 8.6 Emergency preparedness and response	Do
9. Performance evaluation	9.1 Monitoring, measurement, analysis and evaluation 9.2 Internal audit 9.3 Management review	Check
10. Improvement	10.1 Incident, nonconformity and corrective action 10.2 Continual improvement	Act

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clusions that support the management system model approach. The authors state:

> Incorporating MSD prevention into tools and techniques used by other stakeholders within an organization will likely increase awareness and improve communication with respect to MSD prevention. Bringing ergonomics as a means of preventing MSD into organizations' management systems and avoiding silos appears to be highly desirable. (Yazdani, et al., 2015)

In the authors' experience, most organizations use a common system, or model for continuous improvement, that is familiar to most in the OSH field. Plan-do-check-act (the Shewhart cycle; the continuous improvement process) continues to be the most familiar. The proposed content of ISO 45001 (ASSE 2015; ISO 2015b) aligns closely with the four steps of the Shewhart cycle (Table 1).

The approach of managing ergonomics as a process versus a program has been emphasized for more than 20 years (CSA, 2012; Kohn & Friend, 1993; Krause, 1995; Rostykus, 2008) and proven in practice by companies with leading, effective ergonomic improvement processes (Humantech, 2011).

This article has discussed the high-level concept of a management system. So, what does it look like to manage an ergonomics process as a management system?

Elements of an Ergonomics Management System

By definition, the purpose of a safety management system is to provide continuous improvement that reduces the risk of occupational injuries, illnesses and fatalities (Manuele, 2006), which aligns with the works of Deming (2000), who says, "Manage the cause, not the results." The first step in establishing an ergonomics management system is to define the hazards and subsequent risks. This is critical for establishing a common foundation for the management system.

For management of workplace ergonomics, the hazards vary. Hazards can be factors that cause MSDs, quality defects and/or lost productivity. Most employers focus on improving workplace ergonomics in order to control the first exposure to the risk factors that cause MSDs (see "Hazard & Risk" sidebar).

In 2009, NIOSH stated:

> By applying ergonomic principles to the workplace with a systematic process, risk factor exposures are reduced or eliminated. Employees can then work within their abilities and are more efficient at performing and completing tasks. The benefits of applying ergonomic principles are not only reduced MSD rates, but also improved productivity and quality of life for workers. (Torma-Krajewski, Steiner & Burgess-Limerick, 2009)

Using the proposed content of ISO 45001 (Table 1) as a systematic process, following are the key elements and activities in an ergonomics management system. The first two elements of the ISO 45001 system involve planning at a strategic (organization) level and at the tactical (workplace) level. This starts with establishing the foundation for the ergonomics process (management system), including clear definition of ownership, responsibility, involvement and accountability.

Leadership, Worker Participation & Consultation

Whether managing business performance, safety or MSD reduction, an organization's performance will not improve without leadership's commitment, support and sponsorship. These leaders must demonstrate commitment and hold individuals accountable for their role in the ergonomic improvement process. For ergonomic improvements, successful organizations typically establish a sponsor to drive the process as a best practice. This sponsor must be a CEO, operations manager, or a site, plant or office manager (Humantech, 2011).

Policy is defined as a high-level overall plan that embraces the general goals and acceptable procedures. Policy is a clear statement of the common direction and belief set by leadership. It establishes "true North," the common goal that aligns all people and activities involved in ergonomic improvement.

Start by reviewing the company's safety policy. Statements such as "We will identify and reduce risks in our workplace"; "engage our employees to continuously identify and improve workplace safety"; and "design our workplace, processes and operations to reduce impact on people and the environment" set a foundation for a successful ergonomic improvement process. Best practices in wording an ergonomics policy and goal include "identify and reduce risk to an acceptable/low level"; "control risks through design and engineering controls"; and "align with continuous improvement."

A well-crafted policy provides the foundation for a successful ergonomic improvement process because it defines the process, outlines roles and responsibilities, and provides criteria from which to measure and audit. Establishing a risk-reduction-based goal in the policy will help organizations focus on systematically identifying and reducing MSD risks proactively.

Next, establish organizational roles, responsibilities, accountabilities and authorities. This key element involves defining distinct roles and responsibilities within the ergonomics process and empowering individuals. Responsibilities must be established for all cross-functional roles supporting ergonomic improvements; these roles typically include a sponsor (top manager), ergonomics process lead, subject-matter experts (e.g., ergonomics team members, safety committee members, ergonomists), engineers and maintenance, managers and supervisors, employees, medical staff and safety staff.

Well-defined roles and responsibilities are the criteria for holding individuals accountable for their involvement and results in the ergonomics process; they are effective when integrated into an organization's performance evaluation process. The roles and responsibilities also become learning objectives from which to design or specify training in ergonomics.

Employee participation, consultation and representation in any process or change project are critical to ensure that change or improvement sticks. This is true for line employees (whose workstations are typically changed or modified to reduce MSD risk) and for engineers and maintenance personnel who are key in designing new and modifying existing workplaces and tools to reduce risk. As Krause (2000) notes, "How can employees be motivated for safety success? By engaging employees at the intellectual, emotional, creative and psychological levels."

Several key opportunities exist for engaging employees in the ergonomics improvement process. As members of a safety or ergonomics team, line employees can conduct MSD risk assessments, lead workplace improvements in their area, serve as the eyes and ears of local supervisors to monitor ergonomics issues and MSD risks, and be a point of communication on ergonomics for colleagues. All employees can participate in the ergonomics process by applying simple learned methods (see description on training in the Support section starting on p. 38) to identify MSD risk present in their immediate work area, then make workstation adjustments to reduce the risk or, if they cannot make the change, escalate the need to their supervisor. As noted, well-defined roles and responsibilities provide a means for individual employees to be recognized and held accountable for their participation and contribution to MSD risk reduction.

Plan

The first step in planning is to identify where to take action to address risk opportunities. This is the diagnostic practice of assessing tasks and workstations to identify and quantify exposures to MSD risk factors. For MSDs, risk assessment should be based on the same four-step safety and environmental risk assessment process used by U.S. regulatory agencies: hazard identification, dose response assessment, exposure assessment, and risk estimation and characterizations (NIOSH, 1973; NRC, 1983; Samet & Burke, 1998).

As noted, research has identified the risk factors (hazards) of MSDs. As a result, valid quantitative MSD risk assessment tools are available based on the dose response relationship of these injuries (Marras, Allread, Burr, et al., 2000; Marras, Fine, Ferguson, et al., 1999; Törnström, Amprazis, Christmansson, et al., 2008). These assessment tools enable subject-matter experts, ergonomists, industrial hygienists and other trained individuals to quickly conduct exposure assessments to de-

Hazard & Risk

There are no ergonomic risks or hazards. Basic to the management of safety is the understanding of hazard and risk.

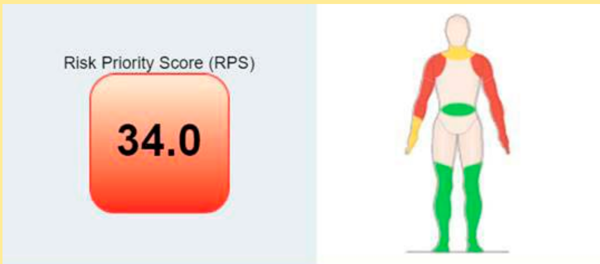
Hazard is the inherent potential to cause injury or damage to people's health. *Risk* is a combination of the likelihood of an occurrence of a hazardous event and the severity of injury or damage to the health of people caused by that event (ILO, 2001). Since poor fit of a workplace or task can encourage awkward postures and forces that wear the body's joint structures, the hazard and risk apply to developing a musculoskeletal disorder (MSD) (that is, an MSD risk, not an ergonomic risk).

Occupational ergonomics is defined as "the science of fitting workplace conditions and job demands to the capabilities of the working population. Ergonomics is an approach or solution to deal with a number of problems—among them are work-related musculoskeletal disorders" (Cohen, Gjessing, Fine, et al., 1997).

This means that ergonomics is the solution, and MSD risk factors are the hazard.

Figure 1

Example of Whole-Body MSD Risk Assessment Results



Whole-Body Assessment

Hands/Wrists		Elbows		Shoulders				
Left	Right	Left	Right	Left	Right	Neck	Back	Legs
3	2	3	3	3	3	2	1	0

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termine whether an exposure is above or below the established threshold. This allows for quick, objective and valid determination of the level of exposure to MSD risk factors by body part and job task, and makes it possible to combine results into a risk map across multiple workplaces.

Several MSD risk assessment tools can measure exposure to a single joint of the body (e.g., rapid upper limb assessment, rapid entire body assessment, postural loading on the upper body assessment, baseline risk identification of ergonomic factors). In addition, a few whole-body assessment tools can combine exposure of all individual joints into a risk score that reflects whole-body exposure. An example is the risk priority score in Figure 1, which combines exposures from nine different body parts with the total time spent performing a task. The resulting value reflects the cumulative exposure, which is used to prioritize and select tasks to address, and to balance exposures from multiple tasks when scheduling work performed during a shift.

An effective method for visualizing and communicating MSD risk assessment results is to use colors (red, yellow, green) to illustrate when exposure to MSD risk factors are within or exceed an established threshold. This method (Figure 1) is a common way to display business and quality measures (Tjan, 2013).

Based on where to take action, establish objectives and plans to reduce risk. Based on the findings of the MSD risk assessment step, identify those tasks and workstations with exposure that exceed the threshold for MSD risk (moderate or high risk). The resulting risk map provides one place from which to prioritize, select and plan workplace changes to reduce the level of risk (Table 2). Plans should not be based solely on risk level but balanced with other factors such as ease of change, number of people benefiting from the improvement, productivity and quality improvements, and leveraging scheduled maintenance time and equipment changes. Effective plans include a defined action and end result (what), the person responsible (who) and the completion date (when).

The responsibility and accountability for completing workplace changes should be assigned to the equipment owner, for example: facilities/space planning personnel for office and computer workstations; fleet for vehicle design and enhancements; process and production engineering for production workstations and tools; and line managers and supervisors for individual workstations. Defined improvement plans provide a mechanism for holding individuals accountable for improving ergonomics and reducing MSD risk in the jobs, tasks and equipment for which they are responsible.

Do

Within the Do step of an ergonomics improvement process, improvements and changes are made to the workplace to reduce or eliminate exposure to the MSD risk factors identified in the Plan step.

Support

Well-defined resources including people, their time and funding are necessary for successful ergonomics, safety, improvement and control. In addition to understanding their responsibilities, individuals involved in ergonomics must know the amount of time expected or allotted for them to support the ergonomics process. The authors identified through benchmarking that most participants allot 1 to 8 hours per month for each team member to conduct risk assessments and lead improvement projects (Humantech, 2014). Funding of ergonomics programs and improvements is a challenge for many companies (Humantech, 2011).

To ensure that people are able to fulfill their roles and responsibilities in supporting the ergonomic improvement process, they must be prepared with the required skills, knowledge, abilities and competence. Competence is achieved through training. The learning objectives of any training should be based on the defined responsibilities (OSHA, 2015). Training can be categorized into two general types: skills training and awareness training (Roughton & Whiting, 2000).

- Skills training develops the expertise of subject-matter experts (e.g., ergonomics/safety team members, people in engineering roles) to use quantitative risk assessment tools and design guidelines to assess and control MSD risks. Skills training also prepares key individuals to manage the ergonomic improvement process.
- Awareness training provides knowledge and awareness of workplace and job-specific information about risk identification and workplace adjustments that an individual employee can make within his/her workplace. This type of training is typically provided for all employees and may be job-specific (e.g., computer work, manual materials handling, manufacturing, laboratory).

Table 2
Example of an MSD Risk Map

Job Name	Risk Priority Score (RPS) 1	LH	RH	LE	RE	LS	RS	N	B	L
Journal Bearing - Greasing	40.0	3	3	3	3	3	3	2	3	0
Warehouse	38.0	1	0	1	1	0	0	0	0	1
Raw Material Transfer	36.0	3	3	3	3	3	3	0	4	2
Journal Bearing - Cups	36.0	2	2	3	3	3	3	2	3	0
Valve Turning	36.0	2	2	1	1	0	1	0	0	0
Liner Roll Handling	34.0	3	3	1	1	2	2	1	0	0
Hand Welding	33.0	2	2	3	3	3	3	0	3	0
UPS Packer	32.0	2	2	3	3	3	3	1	2	0
Rivet Tumble Unload	30.4	3	3	2	2	2	2	3	4	1
Sorting	30.0	1	1	1	1	0	0	2	0	0
Cleaning 2000 Blender	28.8	2	2	2	0	2	0	1	1	0
Cartridge Installation	28.0	3	3	2	2	2	2	2	1	0
Dual Driver	26.0	2	2	2	2	2	2	2	2	0
Sub Assmbly Satge 1	25.0	2	2	2	2	0	2	2	3	0
Bull Gear Deburring	23.0	1	1	2	2	2	2	1	2	1
Assembly - Plastic Rolls	19.0	1	1	2	2	2	2	0	3	0
Battery Tray Assembly	13.6	2	2	3	3	3	3	2	2	0
Cylinder Shimming Process	10.0	1	1	1	1	1	1	0	0	0
Fabrication	8.8	0	0	2	2	2	2	0	2	2
Sub Assembly 1	6.0	0	0	0	0	2	2	0	0	0

LH through L: Whole-Body Assessment

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Awareness, information and communication of the company or site ergonomic improvement process should occur at two levels, during two time periods. The first level is up the organization to key leaders, sponsors and management. The second level is down and across the organization to middle management, line supervision, employees and support organizations (e.g., engineering, continuous improvement, procurement).

Information communicated should vary depending on the time period or phase of the process. When preparing to launch a site ergonomics improvement process, communicate the goal (e.g., risk-based), metrics to track, those responsible for certain elements of the process, and the planned implementation timeline. After the ergonomics process has been launched and established, employees should receive regular communication of progress to the risk-reduction goals, and be made aware of specific case studies that illustrate risk reduction. An effective method for illustrating ergonomics case studies is using simple side-by-side photos of a person working at a workstation before and after the ergonomic improvement.

Documented information about an ergonomics improvement process should include, at a minimum, documented records of the following:

•common goal, measures and improvement plans;

•results of MSD risk assessment (individual workstation risk assessments and all assessments collated into a site risk map);

•controls implemented;

•verification of risk reduction achieved by the controls;

•engineering review of ergonomics designs in new and modified equipment, tools and layout;

•records of skills and awareness training in ergonomics;

•results of an ergonomic improvement process audit.

Best practices for maintaining ergonomics-specific documentation include leveraging existing documentation systems where possible (e.g., learning management system, engineering phase-gate process, key performance indicator tracking). However, for MSD-specific risk assessments, design criteria, controls and follow-up assessments, current practices include hard-copy and electronic recordkeeping. Leading organizations use specialized, integrated software applications to deliver and manage online training, record and collate risk assessment results, plan and track improvements, and collate metrics for reporting (Humantech, 2011).

Operation

Operational planning and control involve taking action and making changes to the existing workplace to reduce the level of exposure to MSD risk factors. The ergonomics of a workplace cannot be improved without changing the workplace and design of the work performed. As defined by NIOSH, occupational ergonomics is "the science of fitting workplace conditions and job demands to the capabilities of the working population. Ergonomics is an approach or solution to deal with a number of problems—among them are work-related musculoskeletal disorders" (Cohen, Gjessing, Fine, et al., 1997). This definition clearly defines ergonomics (the design or engineering of the workplace) as a solution for reducing MSD injuries.

Within the hierarchy of controls, most ergonomics improvements fall under the first and most effective type: engineering controls. The effectiveness of engineering controls was illustrated by Goggins, Spielholz and Nothstein (2008) in a review of 250 published case studies on the reported benefits of ergonomics programs and control measures. Their findings validated the hierarchy of controls, as applied to improving ergonomic conditions in the workplace. They found that the cost effectiveness of several MSD control methods were as follows:

•Eliminate exposures to MSD risk factors (engineering controls): 60% to 100%.

•Reduce exposure levels (engineering controls): 40% to 60%.

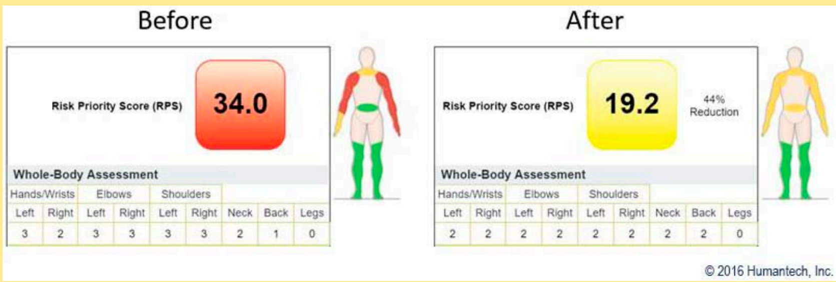
•Reduce time of exposure (administrative controls, or breaks and rotation): 20% to 40%.

•Rely on behavior: 10% to 20%.

Improving the ergonomics (fit) of an existing or future workstation involves planning and action. Successful organizations use their existing planning-and-tracking system (e.g., work orders, maintenance, process improvements) to include, schedule, assign ownership and track these improvements to completion (Humantech, 2011).

Managing change involves leveraging opportunities during equipment change and service, and

Figure 2
Example of Verification of MSD Risk Reduction



when introducing new equipment and processes to improve ergonomics and fit to employees. In other words, include ergonomics in prevention through design (NIOSH, 2014). Including ergonomic design criteria when specifying, selecting and designing new equipment, tools, furniture and layout is significantly more cost effective than retrofitting equipment in place (Lamba, 2013). It requires involvement and compliance of engineers (e.g., process, production, new product, space planners) and maintenance personnel to apply ergonomic design guidelines for humans when specifying and designing equipment before introducing it in the workplace.

Similar to managing the new chemicals in a globally harmonized system for a HazCom program, a review and approval process must be in place to control the quality of equipment and tools to prevent the introduction of MSD risks. The procurement (purchasing) process should be leveraged as a gatekeeper to ensure that only properly designed, low-MSD-risk equipment is introduced.

Since MSDs result from chronic exposures, the emergency preparedness and response section of ISO 45001 seems out of place. However, this portion of the ergonomic improvement process ensures that a system is in place to manage MSD injuries when they occur. Diagnosis and treatment of MSD injuries and the return to work of injured employees are not key elements of an ergonomic improvement process ("fitting workplace conditions and job demands to the capabilities of the working population"). Management of these injuries is best accomplished by qualified healthcare professionals, occupational health nurses and workers' compensation managers. However, the people managing the injuries must work closely with those managing workplace MSD risks and ergonomics to identify exposures, determine whether workplace conditions caused the injury, and reduce identified causes to protect the injured and other employees. Following up after work-related MSD injuries is a reactive process, but necessary within a proactive ergonomic improvement process.

Check

The Check step involves verifying that the ergonomic workplace improvements (Do) reduced exposures to MSD risk factors (Plan) to an acceptable level.

Performance Evaluation

Performance evaluation occurs at three levels: individual workstations, across the organization (the ergonomic improvement process/system) and in response to MSD injuries.

To monitor, measure, analyze and evaluate ergonomic improvements at individual workstations to determine their effectiveness, conduct a follow-up MSD risk assessment using the same quantitative risk assessment method as in the Plan step. Compare the risk scores before and after intervention to verify that the exposure to MSD risk was reduced to an acceptable level (Figure 2).

In addition to verifying the effectiveness of ergonomic improvements, follow-up assessments enable quantification of the amount of risk reduction achieved from a specific control (e.g., installing a lift assist device, changing the height of a work surface, moving a keyboard closer to the operator), which is a measurement of the proposed risk-based goal (see the Leadership, Worker Participation & Consultation section starting on p. 36). Measuring MSD risk reduction produces a metric for assessing progress to the goal, and drives ergonomics teams, engineers and managers to implement changes.

The second level of performance evaluation is an internal audit of the site's or company's ergonomics process. A systematic review of the policy, goal, responsibilities and plans established in the Plan step identifies how well plans and goals are being met. The review results typically include recognizing what is being done well, identifying areas for improvement, and identifying changes to the goal and future plans to strengthen the ergonomic improvement process. The results of the internal audit should be communicated through a management review. Leaders should establish plans and resources to support and continue (or improve) sustaining the ergonomic improvement process.

Act

Improvement

Checking for risk reduction achieved by workstation improvements and audits will generate a list of incidents, nonconformity and corrective action. Incidents refer to the investigation of suspected MSD injuries. A best practice for injury root-cause analysis, identified through benchmarking, is to supplement the investigation of MSD injuries with quantitative risk assessment (Humantech, 2011). This injury investigation/assessment should use the same valid MSD risk assessment tools used during planning. The results should be used to make changes to the injured employee's workstation and similar ones to prevent recurrence.

Every management system includes an element to ensure that nonconformity is addressed and that corrective actions are taken and completed. Nonconformance may indicate equipment and tools not designed within the thresholds specified in ergonomic design criteria, MSD risk exposure of a task exceeding an acceptable level, not meeting ergonomic improvement goals and metrics, or a site ergonomics process falling short of company standards. In each case, tracking nonconformance, ensuring action and holding individuals accountable for corrective action are essential for a successful ergonomics process. Benchmarking studies indicate that successful organizations include tracking ergonomic corrective action in their existing systems to ensure corrective action of all programs and processes (e.g., quality, productivity, performance) (Humantech, 2011).

The final step of the Shewhart cycle is to sustain the ergonomic improvement process and management system over time through staffing and management changes, expense controls and market fluctuations, and to learn from and adjust the process to fit future needs, resources and priorities. This step is critical for continuous improvement.

Successful practices for sustaining the ergonomic improvement process include:

•Management ensures that adequate controls and actions are in place to reduce MSD risk factors to the lowest level achievable. If further risk reduction is not financially or technically feasible, managers must understand the potential consequences of the remaining risk factors.

•Apply effective risk-reduction controls to other similar tasks and workstations.

•Provide necessary resources (i.e., people, time, funding) to continually find and reduce MSD risks.

•Regularly review and track the status of the ergonomics process and plans within the normal business tracking process.

•Involve all levels of the organization (e.g., managers, supervisors, individual employees, engineers) in identifying and addressing MSD risks in daily operations.

Effective Implementation

In the authors' experience, whether starting an ergonomics management system from scratch or building from an existing program, five steps are essential for success:

1) Assess the current ergonomics program/process based on a management system model; the current company safety, engineering, quality, training and/or recordkeeping standards; the business and safety goals and standards; and industry best practices.

2) Define the common goal, measures, requirements, roles and responsibilities, and common tools in a foundation document on which all department and site ergonomic improvement processes are based.

3) Get buy-in, sponsorship and engagement from top leaders. Their visible interest and involvement will drive the ergonomic improvement process downward through the organization.

4) Implement the ergonomic improvement process at each location or department through the sponsor, subject matter experts and engineers. Ensure that they use common assessment tools for consistent reporting and tracking, and share effective improvements and best practices. Track progress and metrics regularly.

5) Audit each site/department ergonomics management system to ensure conformance to the company requirements, identify good practices and opportunities to improve, and engage leadership to refine their plans and focus to sustain the process.

Conclusion

The structure of the proposed ISO 45001 standard refines the structure of existing safety management systems. All of these systems provide a familiar common framework and terminology for managing workplace hazards. This same framework can be applied to systematically identify, control and verify reduction of the risk factors that cause MSDs in the workplace.

Aligning how the organization addresses ergonomics using a management system enables OSH professionals to communicate and engage business leaders in a manner with which they are already familiar. In turn, this approach has been proven to improve the effectiveness and efficiency of managing and controlling MSD risk factors in today's workplace. **PS**

References

AFNOR Group. (2015, May 19). From OHSAS 18001 to ISO 45001: The latest progress on the ISO draft standard on occupational health and safety. Retrieved from www.afnor.org/en/news/news/2015/mai-2015/from-ohsas-18001-to-iso-45001-the-latest-progress-on-the-iso-draft-standard-on-occupational-health-and-safety

ANSI/ASSE. (2012). Occupational health and safety management systems (ANSI/ASSE Z10-2012). Des Plaines, IL: ASSE.

ASSE. (2015, July). ASSE tech brief: The rise of ISO 45001: A new global occupational health and safety management system standard. Retrieved from www.asse.org/assets/1/7/45001_Tech_Brief__3.pdf

Bernard, B.P. (Ed.). (1997, July). Musculoskeletal disorders and workplace factors: A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremity and low back. Cincinnati, OH: NIOSH.

BSI Group. (2007). Occupational health and safety management system: Requirements (BS OHSAS 18001:2007).

BSI Group. (2014). ISO 45001 White paper: An update on the latest developments of the new International Standard for Occupational Health and Safety Management Systems. Retrieved from www.bsigroup.com/LocalFiles/en-GB/iso-45001/Resources/Whitepaper-Update-on-the-latest-developments-of-ISO-45001-FINAL-Dec-2014.pdf

Canadian Standards Association (CSA). (2012). Workplace ergonomics—A management and implementation standard (CSA Z1004-12). Mississauga, Ontario: Author.

Leveraging a process such as ISO 45001 can increase engagement and effectiveness of the ergonomics improvement process.

Cohen, A.L., Gjessing, C.C., Fine, L.J., et al. (1997, March). Elements of ergonomics programs: A primer based on workplace evaluations of musculoskeletal disorders (NIOSH Publication No. 97-117). Cincinnati, OH: NIOSH.

da Costa, B.R. & Vieira, E.R. (2010). Risk factors for work-related musculoskeletal disorders: A systematic review of recent longitudinal studies. *American Journal of Industrial Medicine*, *53*(3), 285-323.

Deming, W.E. (2000). *Out of the crisis*. Cambridge, MA: MIT Press.

Gallagher, S. & Heberger, J.R. (2013). Examining the interaction of force and repetition on musculoskeletal disorder risk: A systematic literature review. *Human Factors: The Journal of the Human Factors and Ergonomics Society*, *55*(1), 108-124.

Goggins, R.W., Spielholz, P. & Nothstein, G.L. (2008). Estimating the effectiveness of ergonomics interventions through case studies: Implications for predictive cost-benefit analysis. *Journal of Safety Research*, *39*(3), 339-344. doi:10.1016/j.jsr.2007.12.006

Hamilton, A. (1943). *Exploring the dangerous trades: The autobiography of Alice Hamilton, M.D.* Boston, MA: Little, Brown and Co.

Humantech Inc. (2011). Benchmarking study: Elements of effective ergonomics program management. Retrieved from www.humantech.com/resource/humantech-benchmarking-study

Humantech Inc. (2014). Benchmarking study: Cost and return on investment of ergonomics programs. Retrieved from www.humantech.com/resource/white-paper-humantech-benchmarking-study

International Labor Organization (ILO). (1997). Preventing workplace injuries and illnesses through ergonomics. *World of Work*, *21*, 5-8.

ILO. (2001). Guidelines on occupational safety and health management systems (ILO-OSH 2001). Geneva, Switzerland: Author. Retrieved from www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_publ_9221116344_en.pdf

International Organization for Standardization (ISO). (2015a). Draft international standard: Occupational health and safety management systems—Requirements with guidance for use (ISO/DIS 45001).

ISO. (2015b). ISO 45001 briefing notes. Retrieved from www.iso.org/iso/iso_45001_briefing_note.pdf

Kohn, J.P. & Friend, M.A. (1993, May). Quality and ergonomics: The team approach to the occupational people factor. *Professional Safety*, *38*(5), 39-42.

Krause, T.R. (1995). *Employee-driven system for safe behavior*. New York, NY: Van Nostrand Reinhold.

Krause, T.R. (2000, Oct.). Motivating employees for safety success. *Professional Safety*, *45*(10), 39-42.

Lamba, A. (2013, Jan.). Practice: Designing out hazards in the real world. *Professional Safety*, *58*(1), 34-40.

Manuele, F.A. (2006, Feb.). ANSI/AIHA Z10-2005: The new benchmark for safety management systems. *Professional Safety*, *51*(2), 25-33.

Marras, W., Allread, W., Burr, D., et al. (2000). Prospective validation of a low-back disorder risk model and assessment of ergonomic interventions associated with manual materials handling tasks. *Ergonomics*, *43*(11), 1866-1886.

Marras, W., Fine, L., Ferguson, S., et al. (1999). The effectiveness of commonly used lifting assessment methods to identify industrial jobs associated with elevated risk of low-back disorders. *Ergonomics*, *42*(1), 229-245.

NIOSH. (1973). The industrial environment—Its evaluation and control. Cincinnati, OH: Author.

NIOSH. (2014) The state of the national initiative on prevention through design (NIOSH Publication No. 2014-123). Retrieved from www.cdc.gov/niosh/docs/2014-123

National Research Council (NRC). (1983). Risk assessment in the federal government: Managing the process. Washington, DC: National Academies Press.

OSHA. (2015). Training requirements in OSHA standards (OSHA 2254-09R 2015). Washington, DC: Author.

OSHA. (1991). Ergonomics program management guidelines for meatpacking plants (OSHA Report No. 2023). Washington, DC: Author.

Ramazzini, B. (1964). *Diseases of workers* (W.C. Wright, Trans.). New York, NY: Hafner (Original work published 1713).

Rostykus, W. (Ed.) (2008). *Ergonomics program guidance document aligned with ANSI/AIHA Z10-2005*. Fairfax, VA: AIHA.

Roughton, J.E. & Whiting, N.E. (2000). *Safety training basics: A handbook for safety training program development*. Rockville, MD: Government Institutes.

Samet, J.M. & Burke, T.A. (1998). Epidemiology and risk assessment. In R.C. Brownson and D.B. Petitti (Eds.), *Applied epidemiology: Theory to practice*. New York, NY: Oxford University Press.

Shewhart, W.A. (1986). *Statistical method from the viewpoint of quality control*. New York, NY: Dover (Original work published 1939).

Tjan, A.K. (2013, April 12). Making priorities clear with green, yellow and red. *Harvard Business Review*. Retrieved from https://hbr.org/2013/04/winning-with-green-yellow-and.html

Torma-Krajewski, J., Steiner, L.J. & Burgess-Limerick, R. (2009). Ergonomics processes: Implementation guide and tools for the mining industry (IC 9509). Pittsburgh, PA: NIOSH.

Törnström, L., Amprazis, J., Christmansson, M., et al. (2008). A corporate workplace model for ergonomic assessments and improvements. *Applied Ergonomics*, *39*(2), 219-228.

Yazdani. A., Neumann, P., Imbeau, D., et al. (2015). Prevention of musculoskeletal disorders within management systems: A scoping review of practices, approaches and techniques. *Applied Ergonomics*, *51*, 255-262.

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