Ergonomic interventions at Vulcan Materials Company

J. TORMA-KRAJEWSKI, C. HIPES, L. STEINER AND R. BURGESS-LIMERICK

J. Torma-Krajewski is lead research scientist with NIOSH, Pittsburgh, PA; **C. Hipes** is safety and health representative with Vulcan Materials Company, Chester, VA; **L. Steiner** is team leader, Ergonomics Section, NIOSH, Pittsburgh, PA; **R. Burgess-Limerick** is associate professor with the University of Queensland, Australia.

Abstract

Although many mining companies apply ergonomic principles, it is usually done either informally and/or reactively. An example of an informal approach is replacing worn equipment (such as seats) with models that have ergonomic features. Another example is modifying a task to eliminate safety hazards. Such approaches reduce risk-factor exposures that can lead to musculoskeletal disorders (MSDs). A reactive approach is followed when modifying a task/equipment after an MSD occurs. However, neither of these approaches involves a systematic method of proactively applying ergonomic principles to actually prevent injuries or illnesses. This paper discusses how Vulcan Materials Company applied ergonomic principles and implemented interventions to reduce risk-factor exposures.

Introduction

According to the International Ergonomics Association (2000), ergonomics is concerned with understanding interactions among people and other elements of a system to optimize their wellbeing and overall system performance. This is generally accomplished by applying ergonomic principles to the design and evaluation of tasks, jobs, products, environments and systems to match them with the needs, capabilities and limitations of people. When integrated with safety and health programs, ergonomics can be viewed as an approach to reduce injury and illness rates and to improve the overall working conditions for employees by addressing risk-factor exposures that may occur during manual tasks. These exposures are most often associated with musculoskeletal disorders, but they may also result in other disorders and illnesses, such as heat-stress disorders or vibration-related illnesses. Manual tasks include any activity requiring the worker to grasp, manipulate, strike, throw, carry, move, hold or restrain an object, load or body part.

Unlike office and manufacturing settings, mining is often characterized by physically demanding manual tasks performed under dynamic, non-routine working conditions, often in harsh environments, including restricted spaces (Steiner et al., 1999; Scharf et al., 2001). Consequently, greater challenges sometimes exist for applying ergonomic principles, particularly when typical solutions cannot be applied because of the environmental and dynamic conditions.

In 2005, the National Institue for Occupational Safety and Health (NIOSH) and Vulcan Materials Company formed a partnership to demonstrate the efficacy of applying ergonomic principles in mining environments. The purpose of this paper is to illustrate how Vulcan applied ergonomic principles and adapted the implementation process to meet its organizational and cultural needs.

Process implementation

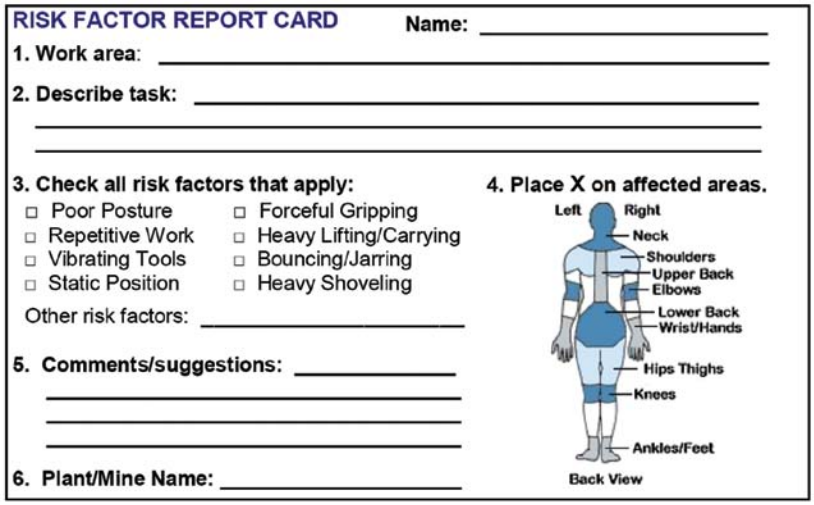
Vulcan Materials Company is the largest producer of construction aggregates (crushed stone, sand and gravel) in the United States. Vulcan has more than 356 facilities in 21 states, the District of Columbia and Mexico and has more than 6,000 employees. The facilities are diverse in function and include stone quarries, sand and gravel plants, sales yards, asphalt plants and ready-mix concrete plants. In 2004, Vulcan shipped 220 Mt (243 million st) of aggregates.

As a company, the basic organizations within Vulcan are seven autonomous divisions. The safety program is multilevel with safety, health and environmental (SHE) teams at the plant level, a safety and health department at the division level (safety manager and safety and health (S&H) representatives) and a safety and health department at the corporate level (safety director and two safety professionals). Members of the plant SHE teams include two to four hourly employees who volunteer for this assignment. The main functions of the SHE teams are to conduct periodic inspections of the site and to report the findings to the plant manager. The division safety staff provides technical support to the plant management and SHE teams, while the corporate safety staff provides technical support to the division safety department.

As a member of the National Stone, Sand and Gravel Association (NSSGA), Vulcan committed in 2002 to reduce its overall injury rate by 50 percent within five years. Vulcan immediately took steps to address safety and health hazards, which resulted in significant reductions in its injury rate; however, the injury rate was still above its goal because many of the injuries that were still occurring were a result of exposures to MSD risk factors. Vulcan decided it needed to take another approach. In August 2005, NIOSH researchers (two certified professional ergonomists) and Vulcan safety personnel (corporate and division level safety professionals) met to discuss how ergonomic principles could be applied within Vulcan Materials Company to prevent musculoskeletal disorders. The plan for implementing an ergonomics process had to address issues commonly associated with a large, multisite company with most sites having less than 50 employees and limited onsite safety and health expertise. The plan that was developed took a two-phase approach. The

FIGURE 1

Risk-factor report card used by employees to identify risk-factor exposures and body discomfort.



first phase demonstrates how ergonomics can be applied at their sites, and the second phase lays the foundation for implementing a process throughout the company. To date, the first phase involved implementing ergonomics processes at two pilot sites within the Mideast Division; the second phase began with introducing ergonomic concepts and Vulcan's ergonomics initiative to other Vulcan sites.

At the pilot sites (North and Royal Stone quarries), ergonomics was integrated with the existing safety and health programs, primarily with the Vulcan injury-reduction initiative called "Taking Work out of Work." Using the card shown in Fig. 1, employees are encouraged to report risk-factor exposures to the ergonomics review team, whose members include the plant manager, the pit and plant supervisors and the SHE team leader. The ergonomics review team, along with input from the S&H representative, addresses the concerns using the process shown in Fig. 2. When the concerns are investigated, a Manual Task Risk Assessment Form is used to evaluate risk factors to determine which risk factors should be controlled and establish a prioritization score for determining which exposures should be addressed first.

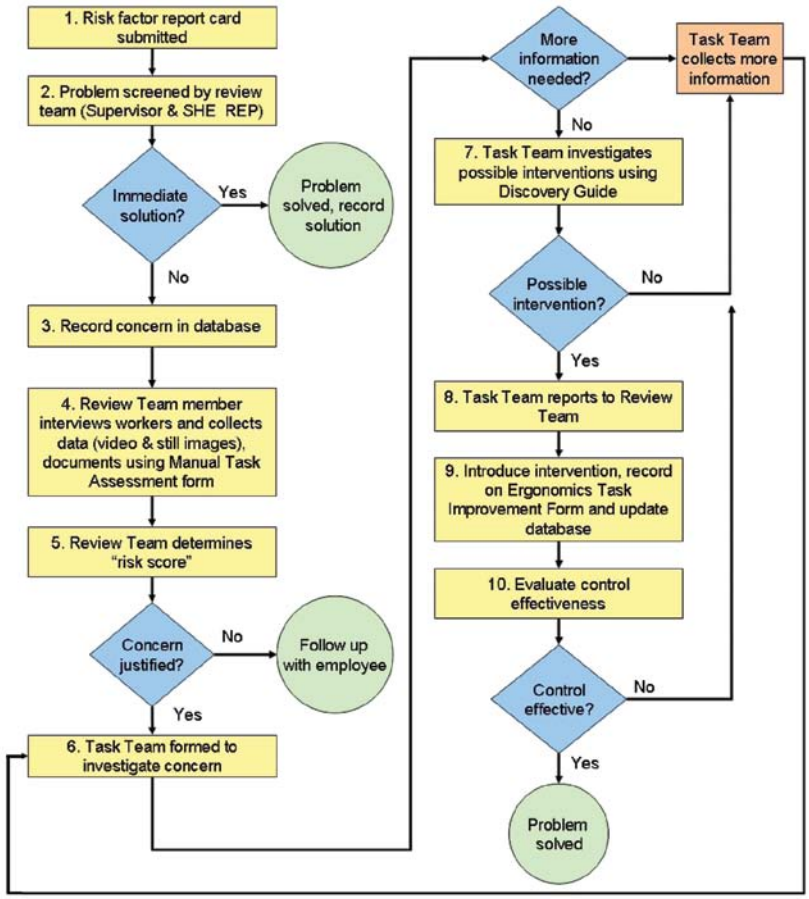
The Vulcan process includes documenting the concern and the action taken to address the concern in a pilot Access database. As Vulcan expands its application of ergonomics throughout the Mideast Division and the other six divisions, information from the submitted cards and controls implemented will be captured in a division or corporate-wide database and will be used as a resource for finding solutions to specific exposures, as well as to identify trends.

In April 2006, Vulcan employees at the two pilot sites received ergonomics and risk-factor awareness training. The objectives of the employee training were twofold: to provide employees with skills for identifying risk factors in their work areas similar to their skills for identifying safety or health hazards and to encourage employee participation in the ergonomics process. Prior studies have shown that an important element of successful ergonomics processes is employee involvement (Cohen et al., 1997). The employee training was given in two 90-minute sessions held one week apart. The training was modified to include a homework assignment that encouraged employees to complete report cards identifying risk-factor exposures for two tasks they do as part of their jobs. The first session of this training at both pilot sites was given by the division safety manager, and the second session was given by the S&H representatives assigned to each of the pilot sites. To become familiar with the training, these instructors attended a train-the-trainer session offered by NIOSH in February 2006.

Because the Vulcan personnel responsible for implementing the ergonomics process had limited backgrounds in ergonomics, NIOSH provided the S&H representa-

FIGURE 2

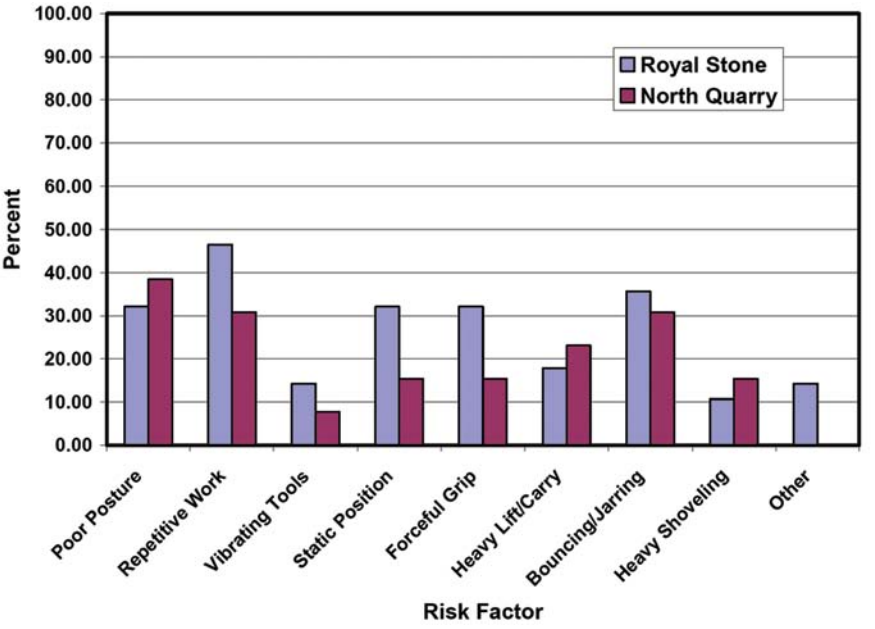
Vulcan ergonomics process flow diagram.



tives assigned to the pilot sites and the ergonomics review teams at both pilot sites additional training on implementing the ergonomics process, primarily how to process report cards, evaluate risk factor exposures and determine appropriate controls. Although the training emphasized engineering controls because of the reduction or elimination of the risk-factor exposures, personal protective equipment and administrative controls, such as job enlargement/rotation, work-rest schedules and work pace, were also discussed. This training, given in April 2006, was a combination of classroom training and a field exercise. In the classroom, participants discussed how to implement the process, evaluated various implementation tools and viewed several short videos to gain practice at identifying risk-factor exposures. The field exercise provided practice with observing actual tasks being performed by employees and with completing the Manual Task Risk Assessment Form. The field exercise was followed by a brainstorming session to determine solutions for the observed risk-factor exposures. The training methods and risk-assessment tools were based on previous experiences in implementing participative ergonomics in surface and underground coal mines (Unger et al., 2002; Steiner et al., 2004; Torma-Krajewski et al., 2006; Burgess-Limerick et al., 2007; Torma-Krajewski et al., 2007).

FIGURE 3

Percentage of report cards identifying exposures to specific risk factors (more than one response permitted).



In July 2006, NIOSH offered the S&H representatives and ergonomics review team members another training session focusing on job improvements, primarily selecting hand tools and modifying manual tasks. Additional information was provided on the stress experienced by the back muscles and spinal discs during various lifting tasks. Participants were given practice at determining options for reducing exposures to risk factors by analyzing several tasks performed at their sites and then brainstorming job improvements.

Vulcan initiated the second phase of its application of ergonomic principles in November 2005 by offering all of the safety and health representatives training that helped them to identify risk-factor exposures and to determine simple task improvements for reducing or eliminating risk-factor exposures. During this training, the representatives were asked to submit examples of job improvements implemented at sites within their divisions. Approximately 10 improvements were submitted and posted on the Vulcan intranet. In February 2006, ergonomic concepts were introduced to the Mideast Division plant managers by a joint presentation given by Vulcan and NIOSH. This presentation focused on Vulcan injury statistics with risk-factor exposures and how ergonomics helped other companies with reducing their injury rates. The Mideast Division Engineering Department also received training in July 2006. This training emphasized the need to apply ergonomic principles during the planning and design stages to prevent exposures to risk factors. Specific components of this training included anthropometry and workstation and conveyor design principles. Anthropometry is the study of the shape, size and strength capabilities of the human body. It is used to design workstations, tools and equipment to ensure an adequate interface and a compatibility with the user.

For a homework assignment, participants were asked to design a sales-yard clerk workstation that could be used as a prototype for other Vulcan sites. The training/presentation offered during this phase was conducted primarily by NIOSH researchers, with support from Vulcan safety and health staff that provided information specific to Vulcan injury rates.

Because Vulcan is applying ergonomic principles at several levels within its company, there are several champions. The need for a champion is discussed in Torma-Krajewski et al. (2006). At the pilot sites, the plant manager and the S&H representatives are the champions. At the division level the division safety manager is the champion and at the corporate level the champion is the corporate safety manager.

Interventions or job improvements

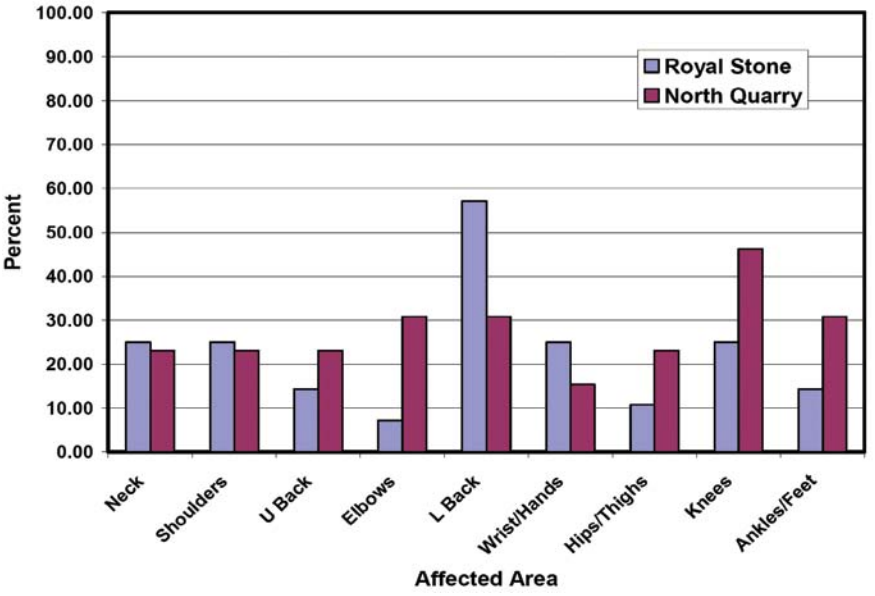
To demonstrate the ability to apply ergonomic principles at mines, interventions or job improvements implemented as a result of a report card being submitted were identified and documented. Employees submitted 42 report cards, 14 from the North Quarry and 28 from the Royal Stone Quarry. From the initial submittal of cards, risk factors and body discomfort were evaluated (Figs. 3 and 4). At the North Quarry, poor posture, repetitive motion and bouncing/jarring were the most frequently reported risk factors. Knees were the most frequently reported body part experiencing discomfort. In contrast, at Royal Stone, repetitive work and bouncing/jarring were the most frequently reported risk factors, and the lower back was the most frequently reported body part

experiencing discomfort. Royal Stone employees reported more exposures to risk factors than North Quarry employees. Many of the reported exposures were associated with seating issues in heavy equipment. The greater reporting rate by Royal Stone employees could be a result of several factors, such as cultural differences, older equipment or simply a better response to the homework assignment. At Royal Stone, the plant manager attended the training and strongly encouraged completion of the homework assignment.

Immediately following the employee training, both pilot sites implemented job improvements in response to the risk-factor report cards submitted by the employees. Within three months, several interventions were completed at both sites. In many cases the labor was done internally, and the cost of the intervention was less than $500. Examples of these interventions include:

FIGURE 4

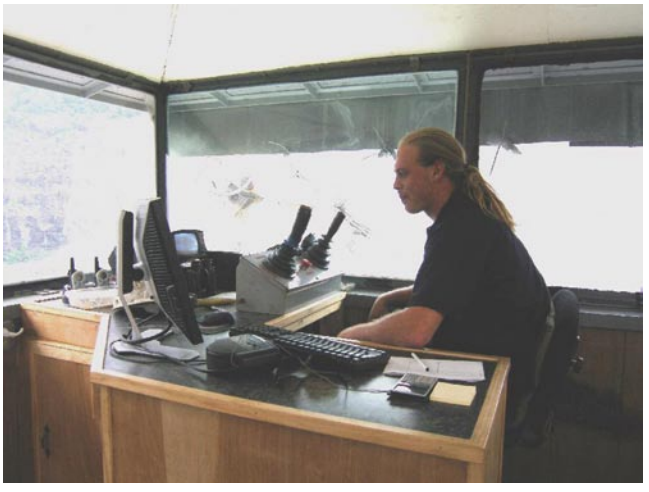
Percentage of submitted reports cards identifying specific body parts with discomfort (more than one response permitted).



- Problem: Loader operator repeatedly twisted his neck and back when looking to the rear of the loader. Solution: Side mirrors were installed on the loader.
- Problem: Crusher operator twisted his neck and back when using a computer to set the speed on the feeder as he monitored the feeder and he had to stand to see the feeder. Solution: A seated workstation was installed on an elevated platform, and the feeder controls were moved to reduce the amount of twisting. (Fig.5)
- Problem: When metal was removed from large conveyor magnets, it was placed in large cans until the cans were full. To empty the cans they were manually handled. Solution: The metal is now placed in a basket designed to be moved using a forklift, which eliminates all manual handling of the cans. (Fig. 6)

FIGURE 5

Seated workstation installed for crusher operator.



- Problem: Employees driving stock trucks under supply bins had to use a pull cord to open and close the bins. The employees also had to twist and turn their neck and back to see as the truck was loaded. To perform this task, the truck window had to be open, which increased exposures to dust and noise. Solution: Mirrors were installed for viewing the back of the truck as it is filling, and a remote-control system is now used to open the bin.
- Problem: Employees had to pull large wash hoses up and down several levels of the screen towers. Solution: Valves and hoses were installed on all levels of the towers.
- Problem: When replacing a power converter on a haul truck, the power converter had to be lifted up onto the frame of the truck. The employee then had to climb onto the frame of the truck and carry the power converter down the frame of the truck. Solution: A working platform was built at the height of the power converter on the truck. Once the platform is placed with the hoist, the employee then uses the overhead hoist to lift the power converter in place, eliminating all manual handling.
- Problem: When operating the rubber-tire dozer in the stockpile area, which is a high-traffic area, the driver had to turn his head and neck repeatedly to check blind spots before reversing direction. Solution: A blind-spot camera was installed.
- Problem: A lab technician had to carry a 19-L (5-gal) bucket of stone weighing approximately 36 kg (80 lbs) down the conveyor and load it on a pickup truck to take it to the lab. Solution: An automatic belt sampler was installed that discharges the sample directly into a bucket located on a stand that is the same height as the

pickup truck's bed.

- Problem: The shop mechanic stood on concrete floors all day. Solution: Anti-fatigue floor mats are now used at various locations in the shop, and several different types of shoe insoles are being tested.

Summary and conclusions

Applying ergonomic principles within the mining industry has been shown to be a viable approach for addressing exposures to risk factors by implementing task improvements. Vulcan was able to integrate ergonomics with its existing safety and health program and to establish a systematic process to resolve risk-factor exposures and to implement task improvements. As the implementation process continues at the pilot sites, it is anticipated that the process will move from addressing risk-factor exposures and musculoskeletal disorders to incorporating ergonomic principles in the design of future workstations and equipment specifications. Risk-factor exposures will be proactively addressed in the design and planning stage.

As additional sites within Vulcan Materials Company apply ergonomic principles, it is expected that the process will be modified to meet specific needs of each site, such as cultural and organizational issues; however, all sites will be following the basic framework established by the pilot sites. Each site will:

- assign a champion to promote and serve as an advocate and leader in applying ergonomic principles;
- provide training to employees and organizational entities responsible for implementing the ergonomics process (the training should be customized to meet the roles each group plays in the implementation process);
- develop a systematic process to identify and control risk factors that considers the method, tools, equipment, workstation and environment;
- track and document progress to demonstrate the benefits of the process, share interventions and communicate lessons-learned across all Vulcan sites; and
- integrate ergonomics with other processes that affect worker safety and health, such as purchasing decisions, work schedules, modifications to existing facilities/equipment and procedures (by doing this, costly reengineering efforts to correct problems with risk-factor exposures can be avoided).

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Disclaimer

The findings and conclusions in this paper are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health.

FIGURE 6

Basket for storing metal scrap that can be moved with a forklift.

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