What Works (and What Doesn't) in Mining Ergonomics

(From a paper by Sean Gallagher, NIOSH)
Edited for the Bulletin by Charlotte Richardson, Staff Writer

Ergonomics -- the study of the interactions and stresses between man and his total working environment. The term has evolved to include the mechanics of adapting and fitting the machine, the tool, and the job to the worker.

History and Background

When the Bureau of Mines started an ergonomics research program in the early 1980s, some quarters of the industry expressed a great deal of skepticism and pessimism that ergonomic approaches could be applied successfully in underground mining. A number of fundamental ergonomics techniques for reducing injuries appeared to be impractical and unusable in many mining locations.

For example, an ergonomist tries to design a job so that it eliminates, or at least reduces, unnecessary and uncomfortable body positions that contribute to the risk of injury. When dealing with a factory worker who continuously bends down to pick up items from the floor, a simple solution is to provide a lift table. The lift table raises the materials to a height that allows the worker to remain standing upright to complete the job. However, such a solution requires sufficent space to stand up in-- a luxury not afforded in many underground mines. In fact, restricted space in several types of underground mines compel employees to work in awkward postures, and there's not a lot an ergonomist can do about it.

Another technique is to provide mechanical devices to assist with lifting duties. Again, these devices often require more space than what is available, both in underground and surface operations. Designing solutions that will work well in a variety of complex dynamic mining surroundings is especialling challenging. Controlling other environmental factors -- such as uneven or slippery walking surfaces and climate or atmospheric problems -- present additional obstacles to using many of the traditional methods of reducing risks of injuries.

In spite of the difficulties mentioned above, some mining companies began to experiment with ergonomics programs in the late 1980s and early 1990s. They believed that many things could be done to reduce injuries, although their programs didn't have all the means typically available to an ergonomist. And some of these programs have been quite successful at reducing low back injuries and other musculoskeletal disorders.

What is interesting is that these separately developed efforts show a lot of similar designs and applications. This article will examine what the characteristics of successful programs are and what kinds of ergonomic interventions help reduce the risk of injuries in underground mining.

Basics

Regardless of the industry involved, there are certain fundamentals that are key to the succes of an ergonomics effort. The two most important keys are:

- Management commitment and participation
- Worker acceptance and participation

Experience has shown that without BOTH of these ingredients, chances of success are seriously diminished.

Management commitment

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Management commitment includes more than just statements of support. Instead, it requires active participation and the assurance of sufficient technical and financial involvement to sustain the effort. At a recent conference on ergonomics, Tim Martin of American Electric Power (AEP) talked about the strong safety culture and the commitment of resources his company has provided: "I can honestly say that [management] has empowered each committee. We have never been turned down for any project with merit."

Management commitment often takes the form of active participation on an ergonomics committee as stated by Mr. Martin. All too often, ergonomics committees are established without the influence of a management member who has the authority to "get things done", that is to dedicate necessary resources to the efforts. Such committees are continually frustrated by the fact that they have great ideas that can reduce injury risks but can't get management to provide the funds, the training, or technical assistance to carry them out. These committees don't usually last long and don't accomplish much of significance.

Active management participation on committees ensures attaining the resources needed for success.

Worker Acceptance

As ergonomics efforts cannot be successful without active management support, employee involvement is equally important. "[Miners] are the people that know the problems in the mining industry, and...they can be the most creative and innovative with ideas for improvements", says Mr. Martin of AEP. At the same conference, Dan Anderson of CONSOL related that employees were more than willing to provide ideas for job improvements. Mr. Anderson said: "I was surprised at just how many ideas came in, and how fast they came in. We had an excellent response." Getting workers involved practically guarantees their acceptance and participation in ergonomics programs.

Successful applications

Engineering controls put into place by effective ergonomics programs follow very similar themes, some of which are listed in this article. Although these approaches have been effective in a variety of companies and mining situations, not all these methods can be applied. But there are many mines that can use or adapt these controls and techniques to prevent or reduce injuries.

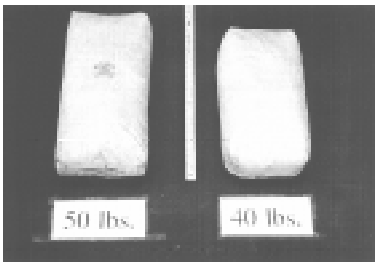
- Hoists

One device that has met with considerable success is the standard hoist mechanism (both underground and on the surface) to handle timber,

track, and other bulky materials. Several mines report that installing hoists at central destination and delivery points have eliminated a significant amount of manual handling of heavy or cumbersome objects.

Reducing Weights

If a lifting task cannot be replaced with a mechanical means, one way to reduce the strain on employees' backs is to reduce the weight of objects handled. A number of mines have gone to lighter weights of bagged materials; for example, going from 50-pound bags of rock dust to 40-pound bags. One problem discovered when a mine goes from handling 50-pound bags to 40-pound bags is the increase in the amount of bags. For example, dividing 1,000 pounds of material among 40-pound bags will add five bags to the total handled. Too often, workers will attempt to reduce the amount of movement and minutes re-



50 lbs. and 40 lbs. Bags

quired to handle the additional bags by attempting to grab two of the bags at a time.

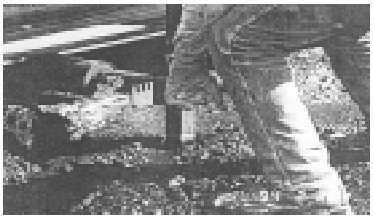
Another common material handled in underground mines is wood products. A particular problem with wood products is that they can easily absorb a great deal of water if care is not taken to prevent this from happening. The weight of timbers can actually increase on the order of 20 to 40 pounds when wet. Proper storage (both underground and on the surface) can eliminate this weight gain. Elevating the timbers and the stringent use of water-resistant coverings such as tarpaulins are both effective methods in reducing unnecessary weight gain.

Working with Suppliers

Many companies have eliminated some materials handling operations entirely simply through better coordination with their suppliers. A common problem is that supplies such as cables or concrete blocks may delivered on spools or in loads stacked too high for delivery in a mine with limited seam heights. These materials then have to be reconfigured (usually by hand) in a layout suitable for underground delivery. The experience of many mines indicates that suppliers are more than willing to work with them on these isues. In some cases, redistributed loads actually saved money for both the mine and the supplier!

Developing Specialized Mining Tools

Another problem ergonomics committees identified is the limited range of tools specifically designed for mining tasks. Several of these committees developed in-house tool designs themselves, relying on innovative ideas developed by the miners familiar with the demands of the jobs they perform routinely. The photo below shows an example of such a tool that is used to help remove conveyor belt rollers.

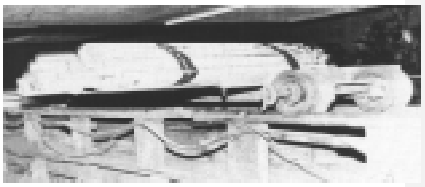


Roller Handling Tool

This tool has a two-handed handled on one end and a prong which fits into the hole on the belt roller at the other end. The tool provides the needed leverage in the removal (or installation) of belt rolls, freeing the miner from direct contact with the roller, which can be quite hot.

Another demonstrated success is the development of specialized vehicles. In many instances, these vehicles were built entirely of salvaged parts and supplies, making these solutions quite cost effective.

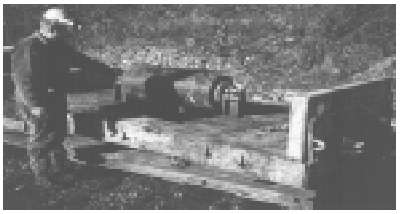
The next picture shows a materials-handling cart called the "Zipmobile" for the miner who developed it. This cart rides on the handrails of the longwall conveyor and moves supplies along the longwall face. Instead of having to



"Zipmobile"

manually carry supplies beneath the longwall shields, a miner can simply load up the car and pull the supplies down the face.

Another example of a specially developed vehicle is the belt car shown below. The belt car was made from a recovered supply car that was modified so it could carry a 500-foot roll of converyor belt. Modifications consisted of



Belt Car

cutting a hole in the car's bottom (allowing for a larger roll of belt) and installing a pair of stanchions to hold the roll. Workers could then drive the car right up to the tailpiece and splice 500 feet of belt without having to do any manual handling of the belt other than pulling it off the roll to perform the splice.

Some miners developed specialized utility vehicles used

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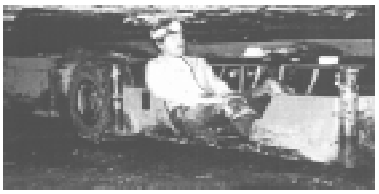
underground to benefit maintenance and repair workers. A good example is the "Ergobus" developed at AEP's Parker Run Portal. Made almost entirely of recovered parts and equipment, the "Ergobus" provides a mobile unit packed with tools and equipment for any number of maintenance tasks. Other useful features designed into this vehicle include:

- compressed air and hydraulics to run power tools
- acetylene torches and welding equipment
- winches for pulling heavy parts
- two toolboxes that hold both power and handheld tools

Maintenance and outby crews at the Parker Run facility use this popular vehicle extensively.



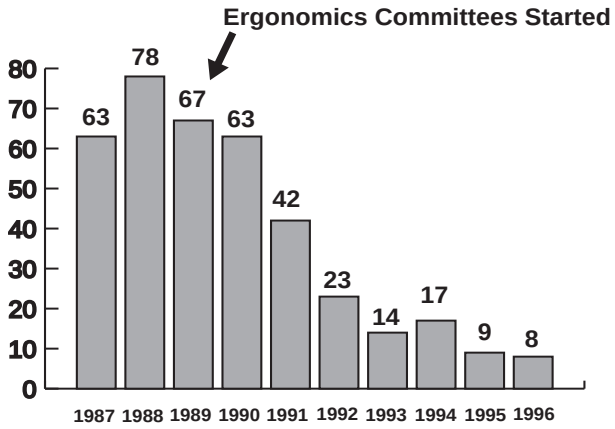
Improved Seating

Nearly all mining ergonomics effects have focused on improving seat designs, primarily on shuttle cars, scoops, and mantrips. Traditional seating in or on underground equipment is poorly designed. Committees identified inadequate seats -- either ones that were torn up or had unsatisfactory vibration transmission characteristics -- and systematically replaced them throughout the mine. Shuttle cars at some AEP coal mines are now equipped with air-ride suspensions that reduce workers' exposure to the damage of wohole-body vibrations.

Results

While there is not yet a tremendous amount of data proving the effectiveness of ergonomics programs in mining, the existing data suggests that these approaches are working. In the mid-to-late 1980s, Island Creek instituted an ergonomics program and saw a 13-to-15 percent injury reduction over a two-year period. AEP's Fuel Supply Division experienced a dramatic decrease in lost-time back injuries since they initiated their program, as shown in the chart below. This chart shows that this division had about 70 lost-time back injuries per year before the program was started in 1989. By 1995-96, they had less than 10 of these injuries per year. Along with this dramatic drop in injuries came a drastic reduction in compensation costs, increased productivity, reduced downtime, and improved employee relations

LOST TIME BACK INJURIES AT AEP FUEL SUPPLY

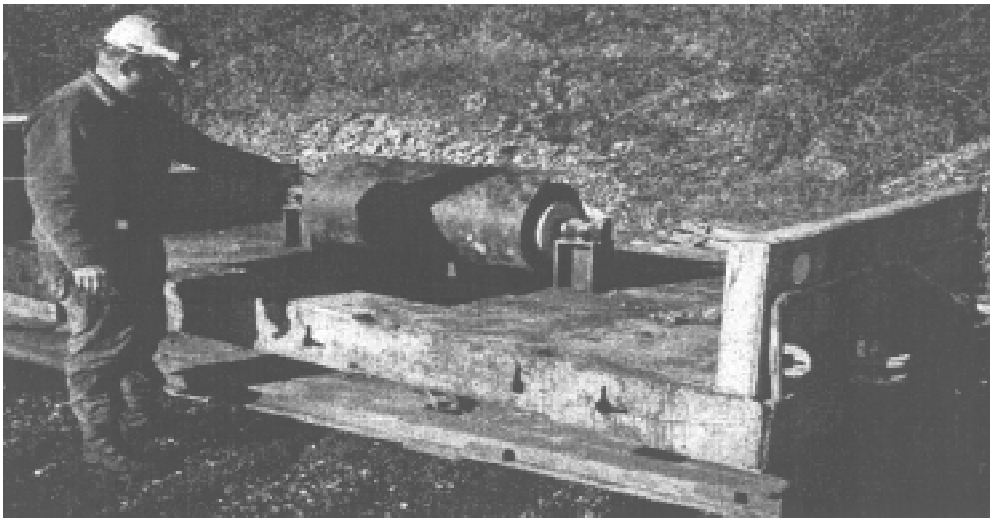


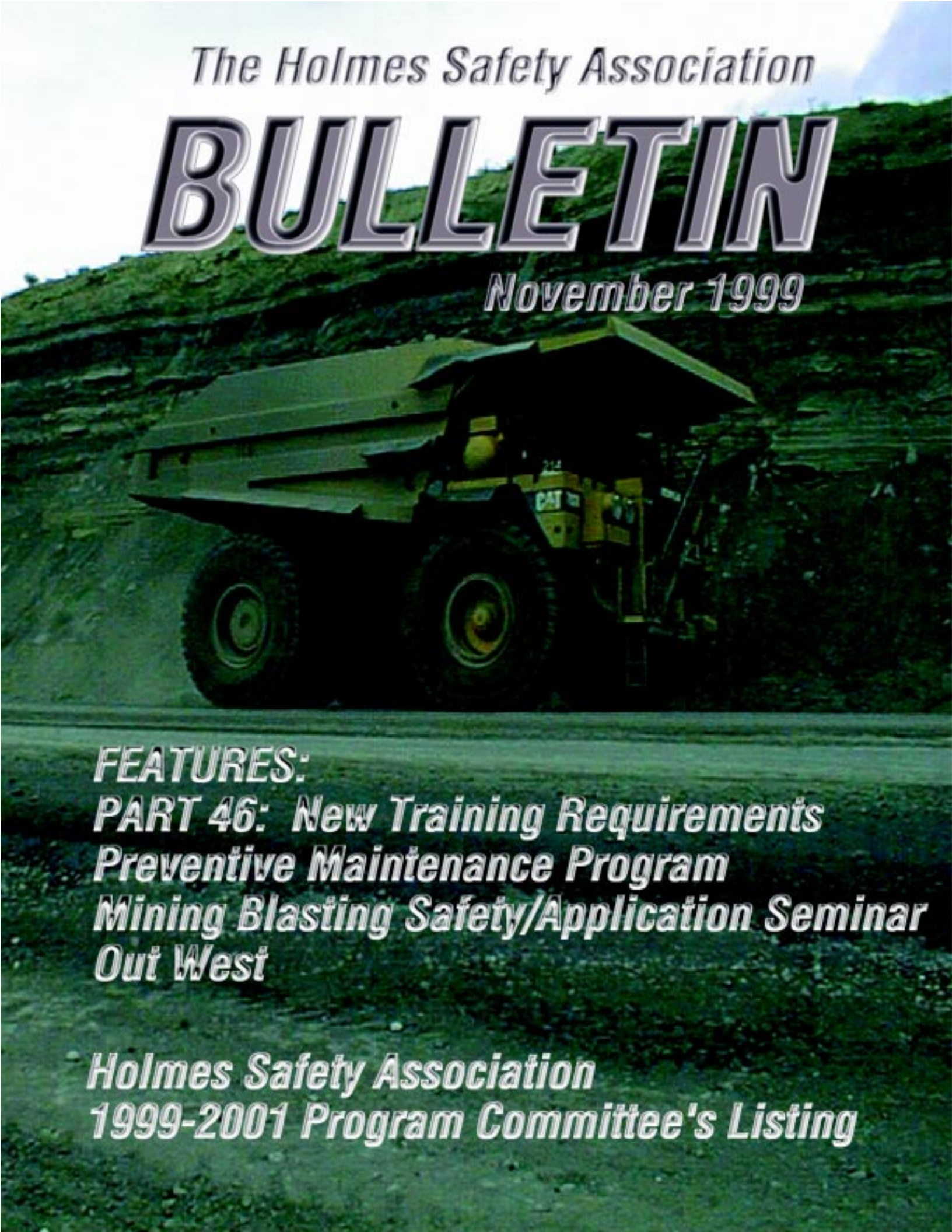
Conclusions

Many dificulties of the mining environment cannot be overcome by ergonomics. Miners forced to work in restricted spaces will continue to be put in awkward positions that increase the risk and likeihood of injuries. Ergonomics can do little, if anything, to improve floor conditions, and workers will continue to slip and fall.

However, this is not to say that nothing can be done or that ergonomic techniques can't be applied in mining. The techniques, methods, and designs passed along here can and have substantially reduced worker injuries. This suggests that there are many other mines that could adapt some of these same solutions and benefit from them.

Despite the successes described in this article, ergonomics in the mining industry has yet to be fully realized. Perhaps the information here will stimulate ideas for further changes and developments that the mining industry can implement.





The Holmes Safety Association

BULLETIN

November 1999

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Preventive Maintenance Program

Mining Blasting Safety/Application Seminar

Out West

Holmes Safety Association

1999-2001 Program Committee's Listing

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