

DEVELOPMENT OF NIOSH HARD-ROCK SAFETY TRAINING MATERIALS

Elaine T. Cullen

Spokane Research Laboratory, National Institute for Occupational Safety and Health,
Spokane, WA

ABSTRACT

Safety training materials appropriate for specific underground noncoal operations in the United States are often outdated or nonexistent. The Spokane Research Laboratory (SRL) of the National Institute for Occupational Safety and Health has developed several new training tools, including three videos on common underground activities, software that will allow trainers to create a virtual training mine using their own mine map, and toolbox training materials. SRL is working closely with industry in the development of these tools. Teams of safety professionals are involved in the early stages, and actual mines and miners are involved throughout the production phase. This presentation describes the development process and results of SRL's safety training projects.

INTRODUCTION

Shortly after the move from the U.S. Bureau of Mines to the National Institute for Occupational Safety and Health (NIOSH), the Spokane Research Laboratory (SRL) held a series of stakeholder meetings in various mining districts in the western United States (the Pittsburgh Research Laboratory was holding a similar set of meetings in the eastern United States). The objectives of these meetings were simple: To gather information from customers to help guide a research program that was diminished both in size and in scope from that conducted by the Bureau, and to open communication lines between the new Office for Mine Safety and Health Research (OMSHR) and its customers. Meetings were planned to allow input from different segments of the industry, including vein mines, surface and underground coal mines, industrial minerals mines, surface and underground metal/nonmetal mines, stone, etc. Participation was generally by invitation and included safety professionals, engineering staff, miners' representatives, and any others who could provide information on the mission that the laboratories had under NIOSH—namely, worker safety and health issues. Participation at each meeting was kept to between 8 and 22 people, and a trained facilitator moderated the meetings.

As expected, most meetings brought out the more common safety and health concerns of the mining industry, such as the effects on workers of exposure to diesel fumes, ground control in deeper mines, or man-machine interface problems. One of the unanticipated concerns voiced at every meeting was the huge gap perceived between existing safety training materials and what was needed, particularly as the mining population aged and new workers began entering the field. A pattern began to emerge, and in mid-1998, SRL staff put together a mini-proposal to begin filling that gap for the hard-rock mining industry.

APPROACH

The mining industry is hardly homogeneous and neither is the safety training problem. To gather additional information on what the most serious issues were, a team made up primarily of safety training specialists—regional safety directors, members of the Central Mine Rescue organization, and a mine safety and rescue training group that included people from several Western states—was put together. Mine managers were also asked to provide input, and a prioritized list was developed that identified gap areas.

Because the problem of safety training was considered multifaceted, it was decided to attempt to cover the most serious gaps fairly quickly and address more complex issues on a longer-term basis. Examples of topics that were considered to be critical were handling explosives, working around mobile equipment and powered haulage, eye injuries, and new miner orientation in general.

Discussions at the stakeholder meetings revealed some interesting demographic issues. According to participants, the average age of miners in the country is around 50. This means that a large percentage of the mining workforce is nearing retirement. The big concern was over who would train new miners if the experienced miners all left over a relatively short time. More importantly, how could the wisdom and knowledge of these “expert miners” be captured before they left so that new miners could benefit long after the experts were gone.

Another concern of both stakeholders and the investigative team was addressing the significant differences in learning styles of new trainees. Contrary to a fairly passive “seat-work” approach to learning common in the past 30 years, new trainees had a strong preference for interactive, hands-on-type learning. They generally have a strong affinity for high tech as well, contrary to older miners, who often can be described as “computer-phobic.”

Armed with this customer input, SRL researchers set out to find some solutions. The projects initially funded fell into two main categories: development of safety training videos with accompanying “tips for trainers” and use of computer-generated “virtual mines” to create any training scenario. Projects were added later, such as “tailgate training” for use in sand and gravel operations and computerized accident reconstruction in which a trainee could analyze an accident from a variety of visual perspectives to determine possible causes more accurately.

Safety Training Videos

Videos generally fall into the category of passive training materials. Unless pauses for discussion are built into the video, trainees merely sit and watch. In spite of this drawback, safety trainers consider videos to be very useful tools. It was believed, however, that very few were current enough to be relevant or specific to underground noncoal mining. (The Mine Safety and Health Administration has produced some very good videos for the coal industry, but these were not considered to be of much use to noncoal miners.) According to the members of the team, if videos were going to be truly effective, they needed to be focused, realistic, include some device to stimulate interest such as humor or fear, and easy to use.

To actually produce effective training videos, it was critical that SRL have the cooperation of the mining industry in the form of access to mining locations, equipment, and employees. Several mines agreed to collaborate on this project. Because SRL does not employ professional videographers, a commercial studio was contracted to gather the footage and edit the results into concise videos under the direction of the SRL project leader. Currently, SRL has over 50 hours of raw footage shot in underground hard-rock mines. This material has been recognized as a valuable resource in its own right. This footage has been used in numerous other projects, from explaining research to

describing details of mining operations.

SRL has completed three training videos. These follow the mining cycle, beginning with breaking rock, checking the back for loose rock and barring down any found, and installing ground supports before workers begin loading out the rock. The three videos are—

- Explosives Underground – Handling Explosives in Modern Mines* (15 minutes) (figure 1)
- Rock Falls – Preventing Rock Falls in Underground Mines* (20 minutes)
- Miner Mike saves the Day – or- Ground Support...It's Important* (33 minutes) (figure 2)



Figure 1.—Loading explosives at the mine face

A fourth video entitled *Hazards in Motion – Working Around Mobile Equipment* is in the development stage and will be released in 2001.

All of these videos share certain characteristics. All are specific to underground hard-rock mining, all are shot totally in operating underground mines, and all use real miners to tell the story. Interest in these training tools by the mining industry has been very strong, and over 600 copies of each video are currently in circulation. (SRL provides copies free of charge to safety training professionals.) As a result of numerous requests from industry representatives, plans are also under way to translate the videos into Spanish.

SRL has developed an accompanying “Tips For The Trainer” guide for both the explosives and the rock falls videos. These are laminated cards designed to fit into the jacket of the video. These cards provide an outline of important points in the video, as well as suggestions for activities or questions for discussion.



Figure 2.—Filming the ground support video

Virtual Reality

Virtual reality (VR) is an excellent tool for teaching hazard recognition and mine evacuation. It is usually difficult to re-create actual mine hazards, and placing inexperienced miners into these conditions is not wise. By using a virtual mine, however, trainees can be placed into extremely hazardous, even death-threatening, situations without harm.

When first investigating the applicability of VR to mine safety training, SRL realized some important factors that would play into the eventual acceptance of this medium. Few mines had training rooms equipped with high-end computers, and fewer still had the resources to either purchase these machines or upgrade existing computers to run high-end graphics. It was decided, therefore, to look at the feasibility of using low-cost gaming software as the training platform upon which to build the mine scenarios. The program that was eventually selected costs \$15 (US), which places it well within the cost range for most companies. Another factor was that, while creating a mine with a variety of hazards that might be encountered was useful, it would be much more effective if each miner could be trained in a virtual mine that was similar, or even identical, to the one where he/she worked. This meant the software needed to be compatible with common mapping software, such as AutoCAD, so that an existing mine map could be overlain upon the software and the virtual mine created would look like the existing mine. After developing the more common tools or equipment encountered underground, a virtual mine could be constructed that was a replica of the real one (figure 3).



Figure 3.—A “virtual miner”

The prototype software developed at SRL allows the trainee to begin the exercise in the training or safety room where safety equipment is picked up. This equipment is, of

course, dependent on the training scenario and could include mine rescue gear if that is what the virtual mine requires. Problems presented to the trainees can be simple or quite complex, requiring the interaction of team members who can't see each other, but who are linked by a computer network. This medium can be adapted for new-miner training, 8-hour refresher training, or specific training classes such as mine rescue. Beta tests of this training tool have shown that VR is extremely popular with younger miners, but that older miners are sometimes reluctant to try it. This merely reinforces what mine operators have said: That the mining population is increasingly bimodal in its demographics, and that younger and more mature miners show very different preferences in how they learn or how they address tasks. VR is well suited to younger miners, but training videos have been more popular with the more experienced miners.

Computerized Accident Reconstruction

Serious injuries and deaths in the mining industry are usually heavily documented. Investigations and analyses seek to identify the causes of the incident, but the text-based reports that result are often long and difficult to digest. The causes, therefore, may not be clearly understood, and one of the goals of safety training—hazard recognition—goes unmet. The goal of SRL's Computerized Accident Reconstruction project is to give an investigator the opportunity to re-create serious incidents using computer modeling and visualization (figure 4). The entire incident can then be played back, with investigators having the option of placing themselves in different locations in the scene, so the accident can be more clearly understood. Once this is done, the situation can be used as a training tool, with trainees viewing the computer-generated animation to identify the causes and effects of the incident and to discuss or determine the proper way to avoid such occurrences in the future.



Figure 4.—A reconstructed haulage truck

Toolbox Training for Sand and Gravel Mines

Problems encountered by small sand and gravel operations are often vastly different from those common to larger mines. Smaller operations can be seasonal in nature and generally do not have access to formal training rooms with computers or other training media (figure 5). Staff may be limited, and a dedicated safety trainer on that staff is uncommon. With MSHA's re-emphasis of CFR Part 46 in relation to sand and gravel operators, it was obvious that this segment of the industry needed some tools that met its unique needs. SRL researchers have been working collabor-

atively with other NIOSH researchers to develop "toolbox" or "tailgate" training to close that gap. These short, practical modules can be presented by the owner or supervisor in sessions as short as 10 to 15 minutes and do not require a computer, VCR, or training room to be effective. This project is focusing on identifying those areas of particular concern to small operators, developing short modules to meet those concerns, and evaluating the effectiveness of toolbox training. The resulting toolbox will enable these operators to comply with CFR Part 46 and to train their employees in work practices that will keep them safe.



Figure 5.—Small sand and gravel operation

CONCLUSION

There is no doubt that safety training will continue to play a significant role in the mining industry as the needs of miners and the industry change over time. SRL is relatively new to this arena, having only begun its work in training development in mid-1998, but the products that have been developed to date have been enthusiastically welcomed by the industry. The three videos released so far, for example, are being shown in over a dozen countries, with new requests coming in regularly. In addition, the industry has been very open to collaborating with researchers in the development of new tools. Stakeholders who initially brought the issue of training to the attention of NIOSH researchers have been actively involved in the process of finding a solution. It is this collaborative effort that both strengthens and validates SRL's role in the development of safety training tools and techniques. Through this spirit of cooperation, industry and government together can move toward the goal stated by the NIOSH/OSHA mission... Safety and health at work for all the nation's miners.