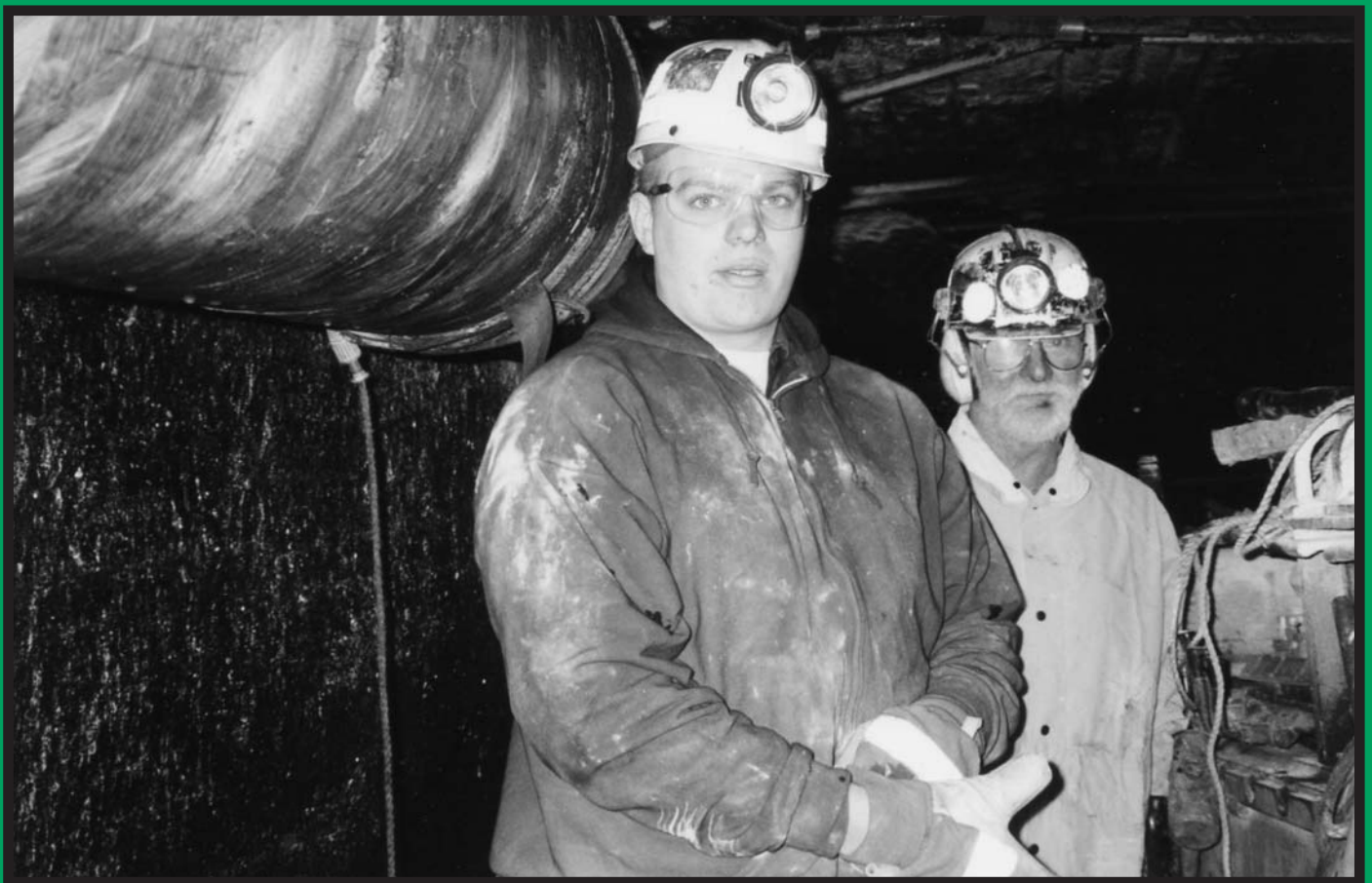


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# **Safety and Health Training for an Evolving Workforce: An Overview From the Mining Industry**



Department of Health and Human Services  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health



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An Overview From the Mining Industry**

**By Kathleen M. Kowalski-Trakofler, Ph.D., Charles Vaught, Ph.D., CMSP,  
Launa G. Mallett, Ph.D., Michael J. Brnich, Jr., CMSP, Dana C. Reinke,  
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U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES  
Centers for Disease Control and Prevention  
National Institute for Occupational Safety and Health  
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Pittsburgh, PA

July 2004

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# **SAFETY AND HEALTH TRAINING FOR AN EVOLVING WORKFORCE: AN OVERVIEW FROM THE MINING INDUSTRY**

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## **ABSTRACT**

Safety and health professionals recognize that training is a critical element of any effective safety and health program. An extensive literature survey has led the authors to conclude that we are at the beginning of a revolution in training due to changes in the demographics of the workforce, the rapid growth of technology, and the universal ascendance of the information age. Of present major concern in the mining industry is how to provide appropriate training for an aging workforce and concurrently develop training for the expected influx of new and less experienced miners as older workers retire. This report explores the key issues in the changing safety and health training area as identified by the multidisciplinary team of NIOSH researchers who conducted the literature survey. Issues include generational differences between newer mine workers and the present workforce with respect to their physical, psychological, social, and cultural characteristics; their learning styles and work expectations; and the impact of technology. Some preliminary conclusions are offered for future training needs.

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## INTRODUCTION

We are at the beginning of a revolutionary change in mine safety and health training. The event leading to this revolution is the projected retirement of a large number of today's mining population within the next 5 years. Media coverage suggests that the fast-approaching departure of "baby boomers" from the workforce will have a profound impact on our Nation's economy [Zachary and Rohwedder 2001; Kentucky Post 2001; Cines 2001; GAO 2001].

The mining industry is part of this trend. In fact, changes in the workforce will have a greater impact on mining than in many other industries because of past hiring patterns. The mining boom that occurred in the late 1970s led to the employment of many new miners, most of whom were in their 20s. Downsizing and layoffs occurred as mining became more capital-intensive in the 1980s and 1990s. This led to a corresponding decline in hiring new miners. This means that mining today faces issues related not only to an aging population of experienced miners, but also to training new miners. The situation is becoming critical, and the industry will need to apply a variety of effective and efficient approaches to address emerging training problems.

Demographic changes have led us to examine training concerns, but there are other compelling reasons that support the belief that the challenges posed by safety and health training issues (and solutions) require evolving and flexible responses to meet the needs of the 21st-century miner. These issues include the changing philosophy of training and learning theory, the influences of a postindustrial economy, the information age, rapid technological changes applicable to education, and the sociotechnical nature of the mining environment itself.

A significant reason for the expectation that training will be different in the 21st century reflects changes in the way safety and health is taught. Miners who came into the industry after the Federal Coal Mine Health and Safety Act of 1969 (and until recently) were trained under a model that separated instruction and production: training was a "staff" function and production was a "line" function. Training and job performance were viewed as discrete activities, with little connection between the two. Miners were trained and then went to work. The next year, they were re-trained and returned to work. Training and work have largely resided in two separate spheres.

New miners are entering today's workforce at a time when learning is beginning to be accepted as a continual and interactive process. Current thinking recognizes the connections between learning and work and acknowledges the importance of learning

as an integral part of the work process. The learner is perceived as an active participant in his or her own instruction, bringing personal experiences and world views to the instructional setting. This "active" learning mode is based on the premise that certain cognitive models and experiences are the basis for future learning [Miller 2000].

Another key principle behind the present viewpoint on training is the recognition that only a small fraction of all learning results from formal training or teaching, and the rest takes place outside the classroom. This implies that there are many ways to promote and sustain the development of increased learning besides traditional training.

Other contributors to the 21st-century training revolution include widespread availability of information and the rapid infusion of technology into our society. Gone are the days when it was thought that power could best be exercised by restricting the flow of information. It is now believed that knowledge management (KM) affords the most effective use of an organization's intellectual assets. KM adherents tell us that information sharing and decision-making at the lowest level are keys to a successful enterprise. KM, of course, has a major impact on worker training. Changes in educational technology also affect curriculum development and delivery.

Mining (along with agriculture, construction, and transportation) is one of the most dangerous occupations in the United States (figure 1). As a critical element in an effective safety and health program, training is especially relevant in the mining industry because the mine environment is dynamic and constantly changing. This dynamic environment makes engineering controls harder to implement and frequently less effective than they might be on a shop floor [Scharf et al. 2001]. Training serves as a necessary condition for miners' well-being in their workplaces.

Even so, little attention has been given to the kinds of educational interventions that could help miners cope with their ever-changing environment. There has been almost no research dealing with dynamic and physically demanding workplaces and their effect on workers of various ages. Coal mine accident statistics from 1968 to 1978, after the last large influx of new miners, suggest that being young and inexperienced leads to higher injury rates among workers. Data also suggest that older workers, while injured less often, sustain more serious injuries with more lost time from the job [Fotta and Bockosh 2000]. Clearly, safety and health training should be a significant issue for all mine workers, regardless of age.

## MINING WORKFORCE TRANSFORMATION

The basis for the shift in training methods and styles is grounded in demographic transformations and the globalizing economy. The demographics of the workforce have changed dramatically in the past few decades. There are currently four cohorts of workers in the mining workforce. A cohort is a group of individuals born at approximately the same time with

common experiences as they pass through life. Workers today fall into the following categories defined by birth year: Veterans (1922-1943), Boomers (1943-1960), Generation Xers (1960-1980), and Nexters (1980-2000).

Because cohorts are generational, it may seem logical to assume that cohort differences are simply due to age differences.

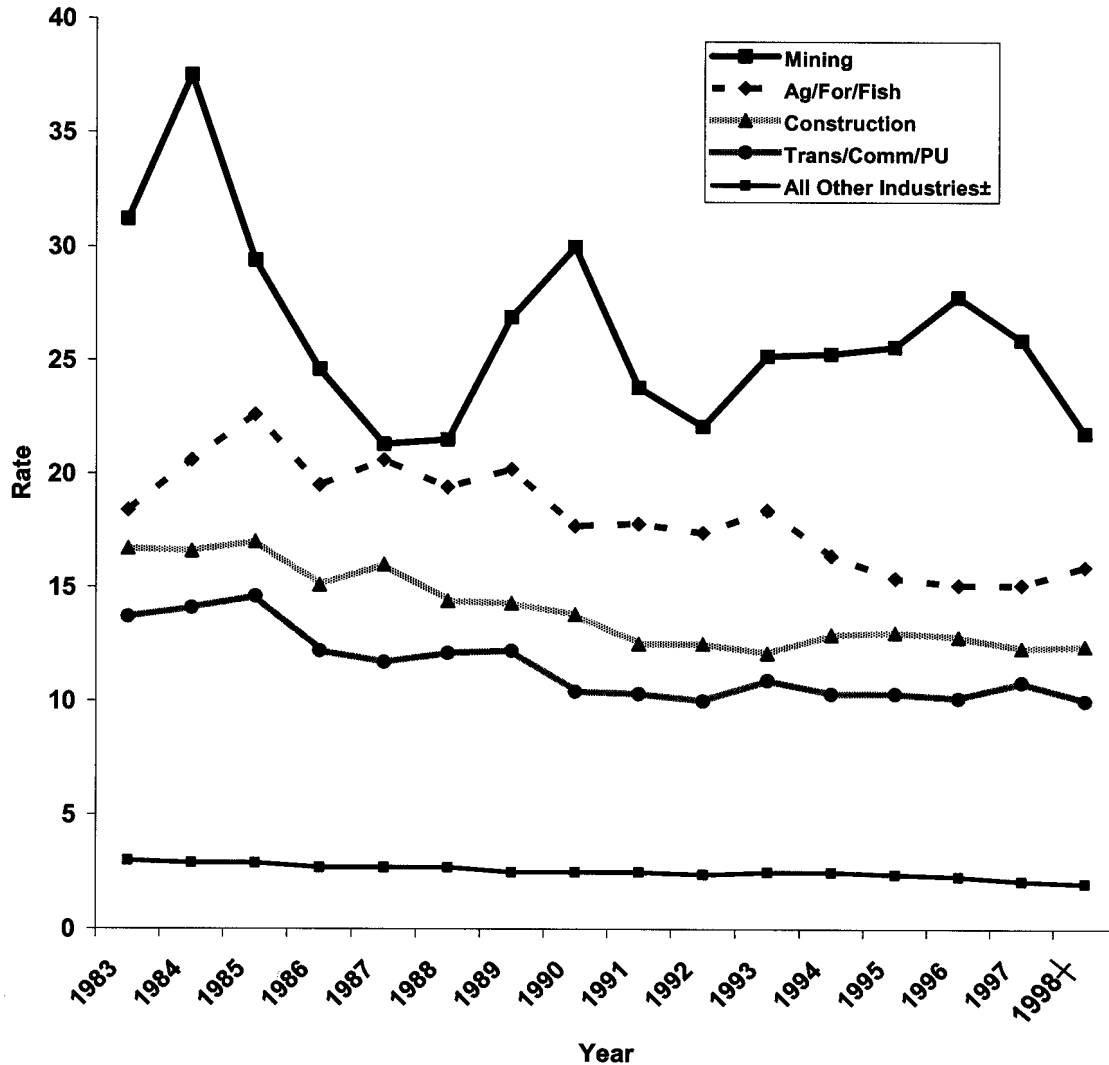


Figure 1.—Rate (per 100,000 workers) of U.S. traumatic occupational fatalities by industry division and year, 1983-1998.

(NOTE: The number of fatalities is based on data from the National Traumatic Occupational Fatalities surveillance system. Employment data are from the Bureau of Labor Statistics' Current Population Survey monthly microdata files. 1998 data exclude New York State. "All other industries" includes manufacturing, wholesale trade, retail trade, services, finance/insurance/real estate, and public administration.)

Researchers studying age-related variation, however, have found cohort membership to be a separate important factor. Problems introduced into aging studies by cohort differences can be well illustrated by the data. For example, when persons tested on the Army Alpha examination in 1919 (mean age 19) were retested in 1961, they showed substantial increases in scores. When a new group of 19-year olds were tested in 1961, they scored as high as the 1961 scores of the 1919 group. "Thus, the apparent improvement with age was more fundamentally a cultural change." [Stagner 1985].

Work-related cohort differences discussed in the literature include such issues as career expectations, changing recruitment and retainment strategies, skill obsolescence, and communication gaps. Each of these issues affects today's training practices.

Practically, training will have a positive impact only if participants see it as valuable and worthwhile. Value deter-

minations are impacted by a number of factors, one of which is generational cohort variations. This means that training content and methods have had to be reevaluated as new cohorts join the Veterans and the Boomers in the training room. Today, "the practical application of basic skills and job skills are preferred over instruction in theory; hands-on activities over lecture" [Ruch 2000]. As stated by Caudron [1997]:

Members of Generation X...are forcing companies to re-think and re-engineer their training programs drastically. Gen Xers' values, communication styles, and life experiences are so different from those of the baby boomers that traditional training doesn't stand a chance. To connect with these young employees, forget Father Knows Best: bring on MTV.

Recently, the authors developed a model to guide an exploration of issues in the literature and to determine how cohort variation might impact the problem of training an evolving mining workforce (figure 2). Initially, the model focuses on the mining population in relation to the four cohorts found in the general population: Veterans (1922-1943), Boomers (1943-1960), Generation Xers (1960-1980), and Nexters (1980-2000). Overlap exists in these group designations; in fact, some authors use different terms to refer to the same cohorts. Zemke et al. [2000] indicated that they would have overlapped the groups if they had not been concerned about confusing the reader. For convenience, the authors chose to use the Zemke et al. definitions, which would designate most miners in the current workforce as either Baby Boomers or Generation Xers. In all, more than 330 articles were reviewed by our team in the areas defined by the model.

Cohort is a key concept because it addresses the diversity of today's worker population, which is substantially different from the homogeneous worker population of the past 50 years.

Historically, the mining population may be viewed as fairly homogeneous with common values, often because of the geographic location of mines and the adjacent communities and also because families included generations of miners: a grandfather, an uncle, a father, a son, a cousin. Career choice was relatively predictable for those entering the workforce in mining communities, but this is not true today.

There is no longer an expectation of lifetime employment with one company or even within one industry [Wyld 1994]. The psychological, social, and physical similarities and differences of cohorts, therefore, are basic to a better understanding of the composition, characteristics, and needs of present and future workers in the mining industry. In addition, past and present training methods need to be reviewed and training approaches evaluated within the context of these various cohort differences. With this information, training needs may be identified and appropriate evaluation techniques incorporated into recommendations for the future.

## LEARNING CHARACTERISTICS OF COHORT DIFFERENCES

Essentially, it took but four generations, or cohorts, of workers to span the transition from a late industrial to post-industrial economy. Immediately before and somewhat after World War II, but before the rise in the late 1980s of what came

to be called the "information economy," most of the Nation's workforce was viewed as being homogeneous. Workers, in general, were expected to stay with one company throughout their careers, jobs were consistent and well-defined, and career

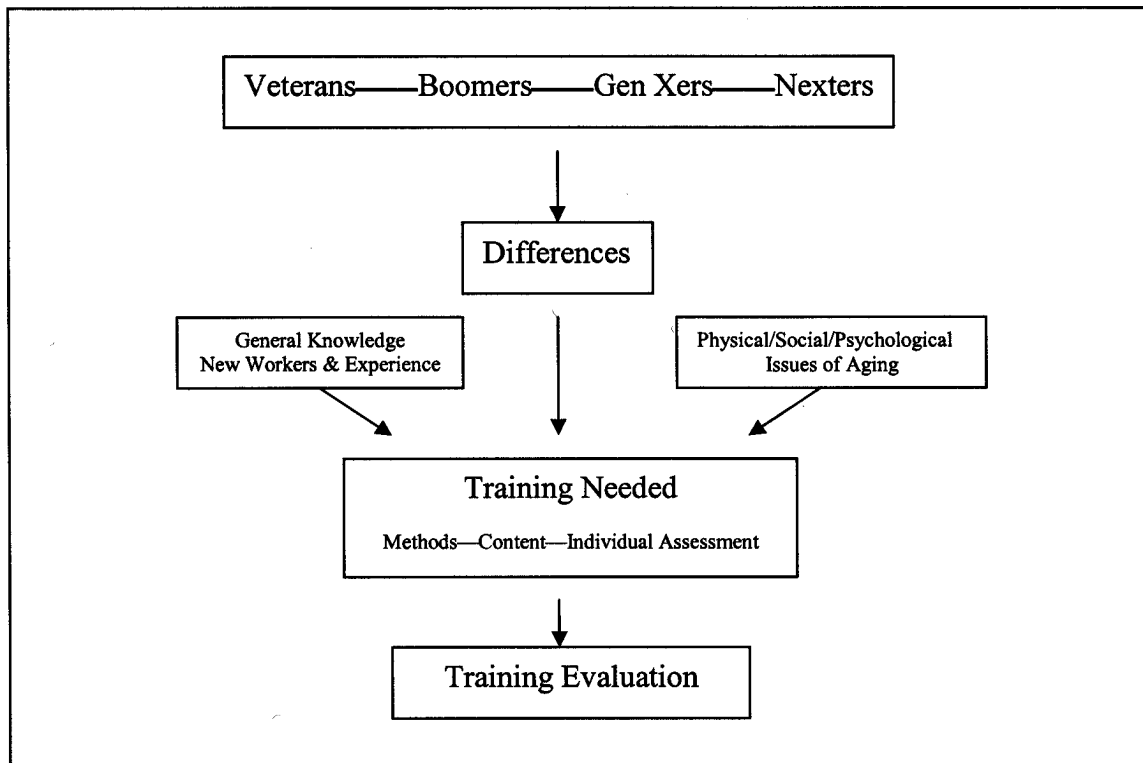


Figure 2.—Model for the evolving workforce.



directions were seen as always moving forward [Wyld 1994]. Individuals born in the 1930s through the early 1940s and entering the workforce preferred a structured and traditional learning environment. "A teacher teaches and a student listens and learns" was the motto. The preferred training style was logical, disciplined, and consistent. Trainers who followed traditional styles of training were viewed as authorities and almost automatically treated with respect by their trainees.

These Veterans were followed by Baby Boomers—those born during or after World War II and raised in the postwar era of extreme optimism, opportunity, and progress. Boomers are discussed by Salopek [2000]. The traits associated with this group are idealism, competition, antiauthoritarianism, and self-interest. Boomers see training as a way to improve themselves as workers and as people, so they are very interested in learning. Those in this generation tie training to individual success. Boomers will apply their strong work ethic in the training classroom in order to improve themselves and to stand out on the job. Boomers respond to a classroom that is more interactive without a central authority figure. Because they have good interpersonal skills and like to interact with others, a trainer can create a traditional classroom but give Boomers the opportunity to talk and work with other trainees to accomplish a task.

Generation Xers are those who were born between 1960 and 1980 and came of age in the shadow of the Boomers during the rise of Asia as a supereconomy. The traits associated with this group are diversity, skepticism, technical sophistication, and an entrepreneurial orientation. Tulgan [2000] noted: "This generation gap is different from others simply due to an accident

of history: we are living through the most profound changes in the economy since the industrial revolution, and all of the forces shaping the changing economy are the same forces that shaped Generation X."

According to Tulgan [2000], Generation Xers learn well on their own. They want to get involved with what they are learning and get feedback on their use of skills. They respond to trainers who are informed and who use time effectively during training. Training materials created for Generation Xers need few words, but they require more visual stimulation, such as headlines, subheads, quotes, graphics, and lists.

Those born to the Baby Boomers and early Generation Xers have been dubbed "Generation Nexters." This group is globally concerned, health-conscious, and cyberliterate, as discussed by Zemke et al. [2000]. Nexters think globally and exhibit and expect diversity in all its forms: ethnic, religious, gender, etc. Nexters are accustomed to classroom situations that encourage interaction between students. They prefer to work in groups to complete tasks. Nexters expect technology to be used in training if possible and also expect the trainer to be comfortable and competent in its use. Training materials created for Nexters should be lively and varied, with multiple focal points similar to materials created for Generation Xers. Nexters like to read, so extra information should be included in training materials geared toward them.

As noted by Ruch [2000]: "The common experiences of a generation create a specific sensibility that connects its members in some way." These connections may also have an opposite result by creating divisions or differences that can lead to misunderstandings between individuals from different cohorts.

## TRAINING THEORIES AND METHODS

Training will only be successful if it is designed around identified adult educational needs and sound learning principles. Several authors [Caudron 2000; Lankard 1995] discuss the importance of designing training materials targeted toward the ways adults learn. Based on their research, these authors suggest that the best adult learning experiences occur through personal experience, group support, and mentoring. As opposed to following the traditional model of an instructor imparting knowledge to passive learners, training needs to allow employees to draw on experience.

Continuous on-the-job growth and skill development is strongly suggested for the diverse workforce. The context of learning is also important, since most adults want to know how their newly acquired knowledge can be applied to the job. Group activities are also important, as learners help each other understand the learning experience through sharing knowledge and questioning each other. The use of collaborative interaction and an atmosphere where learners and instructors support each other in the training process are key components in successful training.

Lankard [1995] suggests three methods for trainers: action learning, situated learning, and incidental learning. Action

learning is defined as learning that takes place in the process of finding solutions to problems.

Action learning has been adopted in the workplace as a viable approach to experiential management education and development and an important element of a training and development strategy...It involves the members of an organization in group situations with the goal of helping each group member learn through the process of finding solutions to their own problems. Through this process, learners increase their self-awareness and develop new knowledge, attitudes, behaviors, and skills for making changes and redefining their roles within new contexts.

In situated learning, knowledge is taught within the context of a real-life situation. The notion is that by presenting content in an authentic social context and culture, learning occurs that offers the benefit of increased knowledge and potential for applying the knowledge and skills in new ways in the real situation.

This strategy is based on the premise that knowledge is not independent, but fundamentally situated, being in part

a product of the activity, context, and culture in which it is developed... Thus, in situated learning, it is the authentic social context in which learning occurs that offers the benefit of increased knowledge and offers the learner the potential for applying that knowledge in new ways and in new situations.

Last, Lankard describes incidental learning—learning that is embedded in the trainee's actions.

The primary intent of the activity is to accomplish the task, not to learn. When incidental learning occurs, it is a surprise—a byproduct of other activity. The learner discovers something while in the process of doing something else. To act upon and pursue that discovery, the learner must pull away from the primary or planned task and examine the discovery clearly before he/she can learn from it. Awareness of opportunities and the value of such learning may be brought to learners' attention by emphasizing the outcomes they might anticipate through incidental learning.

Examples provided include learning from mistakes, learning by doing, and learning from personal experimentation. Lankard concludes that these types of learning need to be considered for future workplace training.

Accelerated learning has received a great deal of attention. Greenbaum [1999] defines accelerated learning as a process in

which the learner is the key component of the learning process as opposed to the content of the training. The key concept of accelerated learning is that training methods and materials are developed with an understanding of (and in support of) the unique ways learners receive, process, recall, and use knowledge and skills they are taught. Accelerated learning acknowledges that everyone has a different preference for learning. Some like to experience new content, while others prefer to read about it. Some learners organize new information following the "big picture" view, while others must follow a logical sequence of discrete events in order to learn.

Accelerated learning—

- Uses the learners' existing knowledge as a foundation for learning;
- Creates a collaborative environment by using specific types and sequencing of events;
- Features a variety of perceptual styles to engage the learner; and
- Applies real-life experiences to evaluate the learners' knowledge and skills.

In short, accelerated learning incorporates a variety of teaching methods and materials based on how people acquire knowledge and skills in the "real world." The trainer's role changes to focusing on establishing an environment and processes that are conducive to learning and facilitating training to enhance retention.

## USING GENERAL KNOWLEDGE

The growing interconnection between rapid technical change and a globalizing economy has led organizations to increasingly emphasize knowledge enhancement and knowledge application in the workplace. The organization that survives is one that is flexible and can improve its performance the best and the fastest. KM is an example of how organizations attempt to better put to use their stocks of knowledge in order to improve workplace performance.

In essence, all organizations must react to environmental changes in much the same way—through information exchange. The organization with the best, most accurate information in the appropriate quantity and at the right time is the one most likely to survive [Shockley 2000]. One outcome of this philosophy is the growth of worker proficiency at knowledge-based decision-making and the organization's willingness to foster and enhance employee skills in this area. It is generally recognized that, just as KM allows organizations to react to their environment, it is the decision-maker's facility at KM that determines whether or not the organization will survive [Holsapple 2001; Holsapple and Joshi 2001].

Bock [2004] characterizes the management of knowledge in decision-making as a process with four parts that compose a loop:

- Knowledge is *created*. This happens in the heads of people.

- Knowledge is *captured*. It is put on paper in a report, entered into a computer system of some kind, or simply remembered.
- Knowledge is *classified and modified*. The classification can be the addition of keywords, or it may be indexing. Modification can add context, background, or other things that make it easier to re-use later. The test of this step is how easily people in the organization will be able to find and use the knowledge when they need it.
- Knowledge is *shared*. When knowledge is shared and used, the persons who use it modify it. This takes the loop back to knowledge creation.

Bock suggests that we look for important knowledge by asking: "What do we lose when key people leave?" or "What do we have to teach every new person?" He further notes that to strengthen these repositories, we should change our thinking from "training" to "facilitating learning," and put job aids and learning tools in the hands of people on the job. This approach allows for greater flexibility and breadth of learning for the worker than the "old-fashioned" classroom structure. This flexibility and increased knowledge are then reflected in the organization.

The more that learning takes place, the more tacit or indirect knowledge is created in the organization. The decision process, which depends on explicit (clear-cut) and/or tacit (indirect) knowledge, begins with the perception of a problem. Given the increasing existence of unstructured conditions in modern organizations, these problems are increasingly of the type that require access to tacit knowledge. In recent years, organizations have directed a great deal of interest to tacit knowledge and to discovering ways it can be shared and used [Courtney 2001]. The decision process no longer consists principally of a technically determined analysis, but of a developing mental model that draws upon the store of tacit knowledge residing in the organization.

Shockley [2000] suggests that training should run the gamut from seminars in which senior managers explain why KM is

essential to survival and how each worker fits into the process, to a review of the advantages of each individual having information available to allow him or her to resolve problems quickly and at the lowest level. The training should also provide a general description of the organization's overall system for capturing and disseminating information, and specific instruction should be given any time a component is added to the knowledge infrastructure or any time a critical element changes. Communication skills become especially important. Clearly, KM offers a set of tools and the opportunity to support the reworking of organizational processes, but the greatest benefit is likely to be innovation and creativity. Hackett [2000] suggests that perhaps what is needed now is to apply the lessons KM has to impart in order to create new organizational capabilities for the enrichment of all.

## PERCEIVED TRENDS AND POTENTIAL APPLICATIONS

A review of the literature with respect to overall evaluation of trends in training indicates that organizations are indeed conducting training using various sources [Cohen and Colligan 1998]. Both formal and informal training, incentives, worker involvement, on-the-job training (OJT), and mentoring or "coaching" are used. Today's employees also demand and expect more training and expect this training to provide them with a growing "personal toolbox" of skills.

Lynch and Black [1998] used the Educational Quality of the Workforce National Employer Survey to determine how employers' training investments are appropriated. They found that 81% of the companies sampled provided some type of formal training. Fifty percent used equipment suppliers and buyers for training their employees. Thirty-six percent used private consultants, 34% used industry councils or associations, 33% used technical or vocational institutes, 30% used community or junior colleges, 20% used 4-year colleges, 12% used Government-funded training programs, and 5% used unions.

The researchers concluded that the types of training programs offered by businesses varied considerably by employer. Most employers offered some sort of informal training, and smaller employers were less likely to provide formal training. In the mining industry, training is mandated, and thus the principal type of mine training would be considered formal.

Most U.S. organizations use a formal/informal approach to provide training for their employees (although it must be noted that it is easier to measure the effect of formal training as opposed to informal training). Bartel [1989] reported that U.S. organizations employing 50 or more workers spent \$32 billion on formal training programs. There are no such figures for informal workplace training. A survey comparing both formal and informal training in relation to individual job wage growth concluded that, when combined, formal and informal training measures jointly accounted for the majority of improvement in individual job wage growth [Loewenstein and Spletzer 1998].

In the past 20 years, studies have shown that incentives and feedback programs have not only led to improved safety and accident reduction [McAfee and Winn 1989], but have also

increased the skills knowledge of involved workers [Miles 1992]. Involvement of workers complements a movement back to—

...training via apprenticeship and on-the-job training experience that targets skills and knowledge and places the burden of responsibility on the learner. Even though the "renewed OJT" incorporates much of the new technology...the knowledge and skills of the individual trainer will always be the most critical component of OJT. These include both knowledge of the job and the ability to communicate that job effectively to the on-the-job trainees [Semb et al. 2000].

Semb and his colleagues suggest that the body of literature relating to tutoring (mentoring, coaching) might be extended to the OJT environment with the ultimate goal of enhancing the efficiency and effectiveness of the OJT. Although the number of OJT studies is small (Semb et al. quote three references), they suggest that there is rich material on tutoring, tutor training, and supervisory training in the literature.

Today's employees demand training. Some suggest that it is a key benefit, especially for younger workers. When it comes to staying on the job, a study by Bridgegate LLC found that workers under the age of 24 were twice as likely to be influenced by the amount of training provided as by money [Kleiman 2000]. These young people have concluded that employment does not mean job security. Their only sense of security is what they know and how to do it. That is why they value training so highly.

Experts agree that this emphasis on training benefits young workers, while older workers are often neglected in the training process [Hallett 1997]. Yet, training can mitigate declines in performance as a worker ages. Age only accounts for a small portion of the variance in worker performance. In one study, older workers who received recent task training actually performed better than those who had not received recent training [Czaja 1995].

There are several types of training that should be considered for the aging workforce. These include task-specific training, general ergonomics, age awareness, and employee wellness. Specific training for older workers as well as their managers and coworkers is needed *now* to educate them about the process of aging and how it relates to job design. As physical and physiological declines due to aging are discussed, the worker should be given an opportunity to derive solutions for his or her work environment.

Exercise and wellness programs, often promoted by companies for increased productivity, are critical for substantial gains in muscle strength, aerobic capacity, thermoregulation, mood state, and healthy lifestyle. Strength and flexibility training can slow down the aging process and increase workers' abilities. Physical function is strengthened through conditioning, reducing risk of injury and related costs while enhancing productivity and worker capacity [Shephard 2000].

Czaja and Sharit [2001] report:

[When] considering skill acquisition, training and older adults there are three important conclusions. One, older people are quite capable of learning new skills, tasks, and procedures. Two, training strategies may need to be modified for older people and these modifications may significantly improve the learning efficiency of older adults. Finally, it is important to recognize that costs associated with additional training or extended practice may be offset by lower turnover and absenteeism among older people.

The merits of providing transferable training (of use in other jobs/industries) versus more job-specific training are currently under consideration by companies. The current tendency is to provide very specific, focused training for workers. Companies are concerned that providing more transferable training may develop skills that apply to competitive firms. In other words, the global market for employee skills increases as the number of skilled workers decreases, and organizations tend to underinvest in training for fear of external "poaching" of "trained" employees. It is important to note that this trend in training is opposed to the stated needs of certain workers, which are to focus on their individual career development and to seek positions that will allow them to improve their knowledge and skills. Thus, to engage these goal-oriented employees, training needs to focus on practical and universal skills and knowledge that satisfy the workers' expectations.

Training must also recognize worker diversity. With the "salad bowl" of employees needing safety and health training, a comprehensive training program must include the following assessment: (1) literacy among workers must be evaluated in English or a native language; (2) if communicated in English, workers must be taught to read and write English, with special emphasis on workplace terms and language; (3) translators/interpreters familiar with technical jargon should be used whenever possible; (4) signs and training materials must be easily understood; and (5) cultural differences and their effects on the workplace must be addressed.

One of the current trends in training is that of companies in the same industry working together to develop "collaborative materials." Dugas et al. [1999] identified a 1996 study that looked at the success of delivering interactive instruction in the workplace through industry organizations and associations. Case studies were conducted looking at four human resources council modules and four industry association modules. In all cases, the councils or associations were contemplating development and distribution of courseware to associated employers. The authors point out that these associations not only served as developers and providers of courseware, but served as a conduit to help small and midsize companies gain access to materials. Six factors were identified as leading to the success of such a program: development of partnerships, adequate needs assessments, authentication of materials, content that meets industry needs, sufficient market for products, and appropriate delivery media.

The final trend in training is that multimedia learning materials are receiving the greatest attention. Dr. Brandon Hall, a technology-based training expert has suggested that "this is a major trend that's occurring and it's going to dramatically change the face of training over the next several years [Grensing-Pophal 1998]." Several authors [Dugas et al. 1999; Grensing-Pophal 1998] point out a number of advantages to using multimedia. They believe that multimedia instruction can deliver training just-in-time, is self-paced, and, above all, is interactive. Multimedia can also be cost-effective for employers whose employees need constant upgrading of skills, but cannot be released from work. The content of a training module can be easily upgraded, especially if delivered on Intranet systems and networks. Multimedia learning materials are particularly advantageous for smaller and/or remotely located workplaces where traditional training methods can be time-consuming and expensive. Multimedia can offer reduced training time, consistency in content delivery, and embedded evaluation.

## THE BOTTOM LINE FOR MINING

In relation to training, investment in a human infrastructure seems not to be understood by all accounting systems, some of which are still firmly rooted in the 1900s. Some companies view the capital outlay for training to build expertise within the workforce as a cost, while these same companies might regard the capital outlay to install a new state-of-the-art mine

monitoring system as an investment. If two companies have similar resources to purchase similar equipment, what can distinguish them in the competitive marketplace? The authors argue that treating training as an investment can provide an edge in safety, in performance, and in the "bottom line."

There are two key issues involving training as an investment: cost-effectiveness and the measurement of training impact. Donald Kirkpatrick [1976, 1977, 1998] is referenced widely for his four-step process of training program evaluation, which was first published in 1959. In 1976, Kirkpatrick defined evaluation as "the determination of the effectiveness of a training program." His steps include:

- *Reaction* – How well did the conferees like the program?
- *Learning* – What principle, facts, and techniques were learned?
- *Behavior* – What changes in job behavior resulted from the program?
- *Results* – What were the tangible results from the program in terms of reduced cost, improved quality, improved quantity, etc.?

Kirkpatrick's model of training evaluation has stood the test of time and is still widely referenced [Mangum et al. 1990; Allen and Nawrocki 2000; Fletcher and Chatelier 2000]. It allows for the blending of motivation, learning, training transfer, and economic benefit. There have been many issues raised, however, that speak to the ongoing difficulty in assessing bottom-line results of training. For example, as Rouse and Boff [1999] note: "Investments to enhance human effectiveness in complex systems are rife with several types of uncertainties, intangible benefits, multiple stakeholders, and inherent unpredictability. These characteristics make cost/benefit analysis for such systems a considerable challenge." Additionally: "Psychologists and economists have both claimed the evaluation turf and the measurement tools are so radically different that it seems to confuse the decision maker" [Mangum et al. 1990].

## CONCLUSION AND RECOMMENDATIONS

Based on this initial review of the psychological, sociological, ergonomic, training, education, and mining literature relevant to the focus of who, what, where, how, and why we train the future mining workforce, we recommend eight factors on which training should focus:

- *Demographic considerations.*—Training should target the different values, age-related work beliefs, and career expectations of the four generational groups discussed, plus address other diversity issues such as cultural and language differences.
- *Formal and informal training.*—Formal and informal training both benefit the workforce, and together they offer the best results in enhancing skill performance and, by inference, greater safety on the job. In mining, where formal safety and health training is mandated, attention should turn toward the informal, mentoring, specific OJT.

One reason why there has been a "push" to determine "results" is mentioned by Oxenburgh [1994]: "Remember that no matter what, or how good, your personal motivation is to reduce injuries, you have to compete against other demands for financial and personal resources within your company." The idea to which Oxenburgh refers is one of competition between divisions for scarce resources. Such competition within an organization puts everyone in the position of needing to produce favorable numbers on the benefit/cost question. Without common agreement as to the factors to be considered on the cost end and how to quantify intangible benefits, it becomes very difficult to compare alternatives.

Treating training as an investment puts the mining industry in a position to turn a crisis into an opportunity to develop its human capital. In the future, organizations' viability may be influenced in large part by their willingness to train workers in more transferable skills. In training workers in more transferable skills, they are likely to follow the trends identified by Bassi and Van Buren [1999]:

- Shifting from training to performance
- Training in computer skills
- Shifting from training to learning
- Creating virtual organizations
- Demonstrating training outcomes
- Measuring performance outcomes
- Delivering training to meet specific needs
- Fostering emphasis on KM
- Providing rapid development and deployment of training
- Providing teamwork training

Organizations incorporating these concepts into their employee development plans will be at the forefront of preparing for the needs and desires of the new cohorts of workers.

- *Content.*—The content of the training must match the needs of the worker being trained. The more mobile younger workers tend to be more concerned about learning broader (transferable) skills, which gives them the opportunity to change careers if need be. For example, the specific skills for underground mining might also provide more general skills related to those used by an electrician, mason, or equipment operator in other settings.

- *Learning styles.*—Teaching methods must address different learning styles and be based on principles of adult learning.

- *Worker involvement.*—Support and training are needed for workers to learn *how* to be involved in the organization, including training on management philosophy and practices, communication, and policies. Management belief in worker input is crucial to worker involvement.

- *Delivery methods.*—Determining the best training method is important. Multimedia should not be the only method used

just because it is the latest method of instruction. Although computer training may offer many advantages to mining, the delivery method needs to be carefully evaluated. For example, teaching methods drawing on the knowledge of older workers in class to create a dialogue with younger workers may be the most successful method to transfer certain types of knowledge.

- *Innovative ergonomic training solutions.*—Ergonomic solutions for worker safety and health should be viewed as a preventive measure to build into training and into the workplace.

Integrating strength and flexibility training, wellness programs, and healthy lifestyle training can become an accepted part of future mine training.

- *Evaluation.*—Evaluation is an integral and key necessity and should not be designed and added on as an afterthought. All training programs used or developed for the evolving mining workforce should contain an evaluation component such as field testing, focus group input, judgment of performance, and/or knowledge.

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