Grant Information
Mining Occupational Safety and Health Research (RFA Number: RFA-OH-05-005)
National Institute for Occupational Safety and Health (NIOSH)

Title of Project
Developing an Effective Data-Driven Training Strategy for Mine Supervisors

Research Plan
Project Summary and Relevance

There is an urgent need for supervisor training in the nation's coal mining industry. A large percentage of the current supervisory workforce is nearing retirement, which will leave the industry with a critical shortage of trained supervisors. Mine supervisors are the key individuals in maintaining a mine's safety and health program. Additionally, the growing need for energy and the inherent hazards in the industry make mine supervisors essential for ensuring future coal supplies. Currently mine supervisory training lacks comprehensiveness and does not adequately address the complexity of supervisory tasks. The goal of this project is to develop a systematic and effective training strategy for mine supervisors based on state-of-the-art instructional design principles, processes, and learning technologies. Specifically, the goal of this project is to examine the extensive and validated mine supervisor Job Task Analysis (JTA) developed by the Mine Safety and Heath Administration (MSHA) in cooperation with the U.S. Navy, and transition this JTA to an effective and efficient training strategy for mine supervisors. To achieve this goal, a team of faculty and graduate students from the Instructional Technology program at George Mason University will perform the following tasks: (1) conduct a comprehensive performance and needs analysis of the current state of mine supervisor training, (2) conduct a cognitive task analysis of the JTA to determine the cognitive domain type and level of the supervisory tasks, (3) develop an appropriate training strategy and delivery approach, and (4) conduct formative evaluation and usability testing on model training prototypes. While the scope of this project is to primarily address the training need for current and new coal supervisors, MSHA anticipates that this data-driven training strategy will be utilized to address the training needs of all mine supervisors. MSHA also anticipates that States, mining associations, mining schools, private contractors, and individual mine operators will also benefit from this training strategy. It is envisioned that the eventual full-scale implementation of this training strategy will result in improved mine productivity; reduction of maintenance costs; and an improved safety record of the nation's mines.

Short Description

Mine supervisors are the key individuals in maintaining a mine's safety and health program. The goal of this project is to develop a systematic and effective data-driven training strategy for coal mine supervisors in order to improve current supervisory training. This training strategy will lead to improved mine productivity; reduction of maintenance costs; and an improved safety record of the nation's mines.

A. Specific Aims (1 page)

The goal of this research project is to transition the Job Task Analysis (JTA) developed by the Mine Safety and Heath Administration (MSHA) in cooperation with the U.S. Navy, into an innovative and effective training strategy for coal mine supervisors in order to improve current mine supervisory training and subsequently achieve the following long-term or broad objectives: (1) improve mine productivity, (2) reduce maintenance costs, and (3) reduce accidents and injuries. Training plays a fundamental role in MSHA's effort to help protect the American miner from illness and injury on the job. Inspections alone cannot keep the mines accident-free. Miners and their supervisors need knowledge and motivation in order to stay safe and healthy. More specifically, supervisors in the nation's mines are subjected to many, if not more, of the hazards that non-supervisory miners face and therefore they must be aware of how to perform their jobs properly, and they must learn to recognize and control the hazards in their work places. Currently however, mine supervisory training does not address the complexity of supervisory tasks revealed by JTA. In addition, current supervisory training approaches are not compatible with new training theories, methodologies, and technologies. Supervisors need more effective tools and knowledge processes if they are to be effective team leaders. Effective leadership requires effective communication, problem solving, decision-making, and conflict resolution skills, and the ability to motivate people. This research project is aimed at developing a training strategy based on state-of-the-art instructional design principles, processes, and learning technologies, in order to help mine supervisors achieve those skills and the skills specified in the JTA. The field of Instructional Design and Technology (IDT) "encompasses the analysis of learning and performance problems, and the design, development, implementation, evaluation, and management of instructional and non-instructional processes and resources intended to improve learning and performance in a variety of settings, particularly educational institutions and the workplace" (Reiser, 2001, p. 53). Professionals in the field of IDT use systematic and data-driven instructional design procedures and employ a variety of learning technologies to accomplish their goals.

It is anticipated that a training strategy developed using the principles and processes of IDT will lead to more effective planning, work oversight, and miner performance improvement. It will also improve a mine supervisor's ability to perform more effective job observations, conduct risk assessment, implement cost reduction methodologies, and improve working group dimensional skills. Such training will also enable the mine supervisor to more effectively direct employees, anticipate risks due to changes and mistakes, and develop a working culture conducive to effective and safer operations. This in turn will lead to a reduction in operational mistakes and equipment misuse, and will help mine supervisors better recognize maintenance requirements. In order to design an effective training strategy for mine supervisors, several principles and processes need to be considered and systematically examined. Specifically, the goal of this research project is to (1) conduct a comprehensive performance and needs analysis of the current state of coal mine supervisor training, (2) examine the mine supervisor JTA to determine the cognitive domain type and level of supervisory tasks, (3) develop an appropriate training and delivery approach based on the results of the these analyses, (4) develop model training prototypes, and (5) conduct usability testing and formative evaluation on model training prototypes.

B. Background and Significance (2-3 pages)

There is an urgent and critical need for supervisor training in the nation's coal mining industry. As Kowalski et al. (2001) contend "A major concern in the mining industry today is how to train the present aging workforce plus the expected influx of new and less experienced miners and mine operators as the cohort of older workers retire" (p. 1). According to the Bureau of Labor Statistics (BLS), the median age of the mining workforce, which has been experiencing overall declines in numbers of employees, is rising more rapidly than the overall U.S. Civilian labor force. Additionally, in a study conducted by Fotta and Bockosh (2000) using injury and illness data reported to MSHA, it was revealed that from 1988 to 1998, the percentage of injured or ill older workers (45 or older) has been steadily increasing. The most notable increase occurred at coal mining operations where the proportion of injured/ill older workers increased from 24 to 44 percent. Accident statistics in coal mining (1968-1978) also indicated that being young and inexperienced leads to higher injury rates (Kowalski et al., 2001). These statistics suggest that there is a significant safety issue with both the older and younger worker in the nation's mines. This is even more significant for coalmine supervisors. Fatalities among underground coalmine supervisors confirm their exposure to hazards (DOL, 1998). From 1990 to 1997, 15% of all underground coal fatalities were underground coalmine supervisors. Supervisors direct the work force, and are responsible for assuring that work is done in a safe and healthful manner. In many instances, supervisors have to visit many work areas at a mine and as a result may encounter more hazards than miners who may be assigned to one area or one piece of equipment. Also, supervisors often personally intervene and perform non-supervisory tasks when interruptions of normal work operations occur or when hazardous situations arise (DOL, 1998). Therefore supervisors are subjected to many, if not more, of the hazards that non-supervisory miners face.

Safety issues have a significant impact on mine productivity. The effectiveness of mining operations is often characterized in terms of safety and productivity and statistical evidence for a positive relationship between safety and productivity indicates that both may be related to common underlying factors. More specifically, skills training, efficient operation or job performance, and safety are not mutually exclusive (MSHA JTA Design Team). Safety and health professions from all sectors of the industry recognize that training is a critical element of an effective safety and health program (Kowalski, et al., 2001). Underground coal supervisors are of particular concern because MSHA estimates that only about 34% of underground coal supervisors receive, or are required to receive, part 48 training (DOL, 1998). Currently, however there is little research that addresses the kinds of education and training experiences that are most effective for mine supervisors and more importantly, how to transfer knowledge and experience from older to younger mine workers. The mining industry is in a transitional state and more research is needed to investigate training models and delivery approaches that can effectively and efficiently address the training needs of the industry. In addition, the comprehensive analysis of mine supervisory tasks conducted by MSHA in cooperation with the U.S. Navy, resulted in a Job Task Analysis (JTA) that revealed the complexity and extensiveness of a mine supervisor's job. Currently, this complexity is not adequately addressed in existing supervisory training.

Several researchers (e.g., Lankard, 1995; Caudron, 2000; Shockley, 2000; Holsapple, 2001; Bock, 1998; Camm & Cullen, 2002; Varley & Boldt, 2002) have suggested numerous training theories, models, and strategies for the workplace that support knowledge transfer as well as the acquisition of practical and task specific skills that relate to a worker's goals and the psychological, social, and physical characteristics of different cohort groups (e.g., baby-boomers & Generation M). These include knowledge management (KM), workflow learning, collaborative learning, adult learning theory, action learning, situated learning, incidental learning, mentoring, tailgate or toolbox training, on-the-job training (OJT), apprenticeship learning, multimedia learning, and employee wellness programs among others. Based on this research preliminary recommendations for training the mining workforce were identified such as focusing on different cohorts, formal and informal training, content, learning styles, worker involvement, delivery methods, innovative ergonomic training solutions, and evaluation (Kowalski et al., 2001). Although these training theories, models, strategies, and recommendations are viable and theoretically grounded, a systematic process is needed to determine which training models and delivery approaches most effectively address the tasks specified in the JTA. The conundrum facing the evolving mining industry requires careful, thoughtful, and methodological development of a training strategy to ensure effective results. The evolving mining workforce, the differences between older and younger miner cohorts, the evolving training technologies, and the evolving training content, are characteristics of a transitional and transformative industry. Therefore a transitional research approach is required to address these issues.

The National Institute of Environmental Health Sciences (NIEHS) defines transitional or translational research as "the conversion of environmental health research into information, resources, or tools that can be used by public health and medical professionals and by the public to improve overall health and well-being, especially in vulnerable populations" (DERT, para 2). The conversion of the JTA into an effective training strategy for mine supervisors aligns with this definition. As MSHA's JTA Design Team proposed "The JTA can be used as a basic training outline and an excellent starting point for developing a more in depth training program that addresses all three training aspects requested by the industry including production, maintenance, and safety". In addition, the aging mining workforce can be perceived as a vulnerable population (not in the clinical sense) specifically in the coal mining industry. In coal operations, the proportion of older injured/ill workers increased as the employment size of mine operations increased (Fotta & Bockosh, 2000). Fotta and Bockosh add that "although most research studies indicate that occupational injury rates appear to decline with increasing age [which is not the case for coal miners], the severity of these injuries appear to increase and injured older workers tend to require longer recovery periods" (WHO, 1993). Furthermore, Kowalski et al. (2001) suggest that it is possible that miners that were laid off ten to fifteen years ago may return to mining for the remainder of their work life. This research suggests that health and safety programs must consider the physiological changes associated with aging when evaluating job tasks, as well as the effect of the continually changing, dynamic, and physically demanding workplaces such as mines. Given the evolving nature of the mining industry and its workforce, this project is ideal for transitional research. Specifically, this research project will transition the coalmine supervisor's JTA to an effective and efficient training strategy by employing the psychological, pedagogical, technological, cultural, and pragmatic foundations of the field of instructional design and technology (IDT).

IDT supports a transitional research approach. As mentioned previously, IDT encompasses the analysis of learning and performance problems, and the design, development, implementation, evaluation, and management of instructional and non-instructional processes and resources intended to improve learning and performance in a variety of settings. Two practices have formed the core of IDT over the years: (a) the use of media for instructional purposes, and (b) the use of systematic instructional design procedures (Reiser, 2001). Systematic instructional design involves the analysis of performance problems, and the design, development, implementation, and evaluation of instructional procedures and materials intended to solve those problems. The JTA was developed in response to a performance problem in the coalmine industry. The JTA represents an extensive overview of mine supervisory tasks that include pre-shift, on-shift, and end-shift examination procedures, and other related training responsibilities including monitoring production, coordinating power center moves, ensuring personal safety, and handling emergency or unusual situations that might occur at the workplace. These activities represent different cognitive or learning tasks requiring different training strategies. The IDT process allows the deliberate examination of the cognitive type and level of JTA tasks in order to determine the appropriate training strategy for each type of task while at the same time maintaining an explicit connection amongst the different training strategies to ensure theoretical consistency. This approach is known in the IDT literature as grounded-learning systems design (Hannafin, Hannafin, Land, & Oliver, 1997).

Grounded-learning systems design supports training approaches that enable different theoretical perspectives allowing the instructional designer or training developer to consider multiple design frameworks and to establish epistemological connections amongst the learning foundations of these design frameworks. This is accomplished by linking the psychological, pedagogical, technological, cultural, and pragmatic foundations of the different theoretical perspectives that drive training methods. Grounded-learning systems design ensures that, by design, training methods are linked consistently with given foundations and assumptions. In addition, grounded designs are generalizable, that is training methods can be applied more broadly than only to a specific setting or problem. Therefore a training strategy developed using a grounded-learning systems design approach is extensible and scalable. This aligns with the broad goals of this research project. Specifically, this will allow States, mining associations, mining schools, private contractors, and individual mine operators to benefit from this training strategy. Lastly, grounded designs and their frameworks are validated iteratively through successive implementation. The systematic instructional design process continuously informs, tests, validates, or contradicts the theoretical framework and assumptions upon which grounded designs are based on providing a methodologically sound approach to conduct transitional research and ensuring that the specific and broad goals of this research project are achieved.

C. Preliminary Studies/Progress Report (6-8 pages)

The Instructional Technology (IT) program at George Mason University (GMU) has had an extended and profitable association with the Mine Safety and Health Administration (MSHA). The IT program at GMU has a partnership framework in place designed to encourage joint enterprises between area businesses and government agencies, and IT faculty and students. This partnership framework ranges from individual student internships, class projects, and small group design teams, to full time immersion teams in which 8-10 graduate students work full time on an authentic project for one year. The IT partnership framework provides students with the opportunity to work on real world projects, extending their knowledge and experience beyond the classroom. Our clients benefit from faculty expertise and the application of state-of-the-art training theories, models, strategies, and technologies. Under this partnership framework, the IT program faculty and students have worked on three projects that enabled MSHA to make significant advances to training the nation's miners. The first project involved a student intern, the second project involved a class project, and the third project involved a small student design team. These past projects relate directly to the development of the training strategy that is the core of this research project. In fact, this mine supervisory training project can be perceived as an extension of these three previous projects. A description of each of these projects follows.

The student intern served on the JTA development committee. She participated as a working member on the mine site pilot programs. She developed the instruction manual for the MindManager software used for the development of the JTA (this manual enabled MSHA users to exceed the software manufacturer's specifications) and the Word based worksheet matrix associated with the JTA (see Appendix). The student intern also developed survey forms to elicit feedback on the instruction manual and conducted a field test at a mine in New York State using this survey instrument. Feedback results were analyzed and recommendations for future work surrounding the use of the JTA were provided. The class project (second project) was a 12-week exercise in which teams of graduate students enrolled in EDIT 730 (our analysis and design course) developed two models or prototypes for Web-based interactive training appropriate for mine safety workshop facilitators training. These two models included a Community of Practice approach and a Case-Based Learning approach. The JTA was used to develop these training models. Students in this class worked directly with mine operators and MSHA technicians to develop the model workshop training prototypes. At the conclusion of this class project, five members of the class were funded to continue working on the Web-based interactive training models. Their mission was to select the most effective components of the training models designed in the class project and to integrate these components into a Web-based training module to help mine supervisors develop their own JTA Workshop. This student team designed the Web-based training module that is currently being used on the MSHA Website (see http://www.msha.gov/interactivetraining/tasktraining/index.html).

These projects were very successful in addressing training challenges for mine supervisors. MSHA's Jim Baugher described the effectiveness of these projects as follows: "The students exceeded our expectations in designing and developing new training methodologies that have been very effective in meeting MSHA and mine training needs. The skills and abilities that the

students brought to our joint projects have enabled our federal agency to make significant advances to training the nation's miners that we could not have done otherwise. Based on our past experience, we anxiously anticipate what can be done in the more extensive immersion program."

The IT Immersion program is based on the need to provide better congruency in the content and methods involved in teaching instructional design and actual practice in the field. Researchers have noted that students upon leaving traditional courses have difficulty with their first real projects, noting the wide gap between the complexity of the instructional design cases they encounter on the job, and the simple processes they learned in their program of study. Instructional design is a complex and challenging field of study. Practitioners in this field are called upon to create effective instructional solutions for all types of education and training contexts and content. Theorists and practitioners involved in teaching instructional design have begun to find fault with traditional teaching methods, which convey a formal, abstract process often far removed from the exigencies and specificities of real world practice (Dabbagh, 2000). These leaders are calling instead for more authentically based experiences that allow students to function successfully within the challenging context of real-world instructional design situations (Bannan-Ritland, 2001).

To avoid the problems of teaching instructional design as a simple procedure that focuses primarily on the media production process, the IT Immersion program involves student participation in complex, real world design projects and focuses heavily on the integration of processes and theory related to these projects and the field of instructional design. The IT Immersion program is a one-year intensive masters program (see http://immersion.gmu.edu) based on action learning and high-performance team concepts. Action Learning is both a process and a powerful program that involves a small group of people solving real problems while at the same time focusing on what they are learning and how their learning can benefit each group member and the organization as a whole. Focusing on a clear project purpose as well as strong commitment to learning and working toward the achievement of successful application of instructional design processes are the major areas of emphasis in this program. The IT Immersion program integrates action-learning processes with authentic project-based instructional design experiences enabling a grounded-learning systems design approach to the development of training models and strategies. The philosophy of the IT Immersion program is based on a compilation of several theoretical constructs including: problem-based learning, authentic macro-contexts, constructivist teaching, and cognitive apprenticeship.

The IT Immersion program is designed to allow students the opportunity to participate in an authentic project-based and guided instructional design experience. Given that knowledge and application are different levels of learning, the program allows students to assimilate, utilize and practice their instructional design knowledge in an applied context. Additionally, in this type of experience, other required skills become apparent such as a team-based orientation, and clear communication and negotiation skills. The Immersion program allows students to practice and explore necessary skills of practitioners as well as the ability to integrate and internalize instructional design processes. The nature of the Immersion program required a new and distinct model of teaching involving the investigation and exploration of content, theory, and process related to the project at hand. Teaching in this just-in-time fashion can involve various methods of instruction including lecture, discussion, collaborative group activities, guest experts as well as

student-initiated presentations and contributions. This instructional approach is supported by an electronic infrastructure that provides Web-based resources often created by students as well as instructors in order to complement and reinforce teaching or project management activities.

The IT Immersion program modifies the traditional instructional design process of analysis, design, development, implementation, and evaluation to reflect an applied theory-to-practice approach. The program incorporates constructs and processes from instructional design, usage-centered design, usability testing, performance-centered design and other fields. Specifically, the program experience includes the following stages: performance analysis, usage-centered design (which includes the development of role models, use cases, and interface content models), wire frame modeling, and rapid prototyping. If we characterize the Immersion method in terms of the traditional instructional design model, the analysis is accomplished in the performance analysis stage, design is accomplished in the usage-centered design stage, development is accomplished in the creation of the wire frame model and the prototype, and the evaluation process is similar to traditional instructional design models.

Examples of the IT Immersion program projects since its inception in 1999, include: (1) The development of online course templates for the Lands and Realty Management (LRM) training for supervisors, facilitators, and administrators (sponsored by the U.S. Forest Service and the Bureau of Land Management); (2) The design and development of an online Community of Practice (CoP) prototype for an underserved community (sponsored by the National Science Foundation); (3) The design and development of an online training and technical assistance delivery system for service providers to children with disabilities in the state of Virginia (sponsored by the Virginia Department of Education); and (4) The design and development of an interactive multimedia CD-based overview of the structure and operation of the Department of Defense (DOD) newly appointed executives in DOD's senior executive service (sponsored by the DOD's Washington Headquarters Service).

The IT Immersion program is an ideal context for conducting this research project. Under the guidance of expert IT faculty, teams of graduate students over a period of three years will perform the following tasks: (1) conduct a comprehensive performance and needs analysis of the current state of mine supervisor training, (2) conduct a cognitive task analysis on the JTA to determine the cognitive domain type and level of the supervisory tasks, (3) develop an appropriate training strategy and delivery approach, (4) develop model training prototypes for selected JTA tasks, and (5) conduct usability testing and formative evaluation on model training prototypes. Students will perform these tasks using constructs and processes from instructional design, usage-centered design, performance-centered design, and usability testing among others, enabling the transitioning of the JTA to an effective training strategy. The IT faculty who will guide these student teams are experts in facilitating the learning of instructional design in an authentic project-based context. They are also experts in the field of instructional design and technology, have managed several research projects and grants, and are highly published.

The principal investigator for this research project, Dr. Nada Dabbagh, is associate professor in the College of Education and Human Development (CEHD) at George Mason University. Dr. Dabbagh received her doctorate in Instructional Systems from the Pennsylvania

State University in 1996. Currently, she teaches courses in Learning Theory, Applied Psychology, Instructional Development, E-Learning Design, and Technology Integration in the Instructional Design and Development (IDD) track of the Instructional Technology (IT) program in CEHD. She is the primary student advisor for this track and is responsible for fostering collaborative partnership with the corporate and government sector in Northern Virginia including the MSHA partnerships referred to earlier in this narrative. Prior to joining the faculty at George Mason University Dr. Dabbagh was awarded a technology fellowship in the Center of Instructional Advancement and Technology (CIAT) at Towson University. As a result of this fellowship she designed and developed a problem-based learning environment that exposes students to the contextual and problem-solving nature of the process of instructional design. This research effort is ongoing with the goal of building a Web-enabled database of problem-based case scenarios to support the teaching and learning of instructional design through authentic contexts.

In 2003, Dr. Dabbagh received the George Mason University Teaching Excellence award. This is a rigorous yearly competition involving several processes and layers of selection. Semi-finalists are required to submit a teaching portfolio that (a) captures the scope and complexity of their teaching, documenting the various approaches, successes, ongoing refinement, and excellence of educational work, and (b) demonstrates the uniqueness of their teaching in relation to their discipline and the learning of their students. Dr. Dabbagh demonstrated teaching excellence through her roles as a leader in the use of emerging technologies and as a student mentor. Through innovative course designs, adoption of new technologies, and continuous evaluation and refinement of her teaching practice, Dr. Dabbagh developed several pedagogical models and instructional strategies and examined the effectiveness of such models on student learning resulting in the publication of over 40 scholarly manuscripts and close to 70 presentations including invited talks at international conferences (see biographical sketch). Her role as a student mentor was demonstrated through exemplary student projects and class products. Dr. Dabbagh's students have won several project awards including the First Place Award in the 2000 IT Innovations Showcase at GMU, the Exemplary Project status at the EdMedia conference in Denver, Colorado in June 2002, and first prize out of 600 entries in a contest by Architectural Record for Interactive Media in 2000.

Dr. Dabbagh's main research interests include: (1) task structuring in online learning environments, (2) problem generation and representation in hypermedia learning environments, and (3) supporting student self-regulation in distributed learning environments. Dr. Dabbagh has published many scholarly articles in each of these research areas and most recently a book entitled *Online Learning: Concepts, Strategies, and Application*. This practical volume details the journey of online instruction from theory to practice. Using an integrative instructional design framework that enables even novice instructors to design, plan, and implement customized instructional environments, this text thoroughly addresses how course management systems (CMS) and other online learning technologies can be used to design learner-centered environments that actively engage students.

Dr. Kevin Clark, co-PI for this research project, is assistant professor in the College of Education and Human Development (CEHD) at George Mason University. Dr. Clark holds Bachelor's and Master's degrees in computer science from North Carolina State University, and a

doctoral degree in Instructional Systems from The Pennsylvania State University. He has taught courses in instructional design, leadership in instructional technology, project management, analysis and design of multimedia learning environments, design and production of multimedia learning environments, and the instructional technology practicum (Immersion). Prior to coming to George Mason University, Dr. Clark was a faculty member at San Jose State University, and worked for an educational software company that produced computer and web-based educational materials. Dr. Clark's corporate experience included positions as a software tester, consultant, content designer, program manager, and founder/director of a non-profit youth program.

Dr. Clark has supervised several client-supported Immersion projects including Training and Technical Assistance Center (TTAC) for coordinators and service providers; Lands Management and Realty (LRM) training for U.S. Forest Service and Bureau of Land Management supervisors, facilitators, and administrators; a National Science Foundation (NSF) sponsored research and development of an online community of practice for an underserved community; and the design and development of a national community of practice for educators, researchers, administrators, teachers, and policy makers. Dr. Clark's research interests include the application of instructional design principles and learning theories to the design and development of online learning environments, the integration of technology into non-formal learning environments, and digital equity. Dr. Clark and his work have been honored by the Education Technology Think Tank and the Congressional Black Caucus Education Braintrust for his outstanding technology leadership in the community.

<u>D. Research Design and Methods (no specific page requirement)</u>

The design of learning and training systems is rooted in several foundations, including psychological, pedagogical, technological, cultural and pragmatic (Hannafin et al., 1997). Instructional design is a systematic and iterative process by which such systems are designed. Generally, instructional design models consist of five major components: analysis, design, development, implementation, and evaluation, often referred to in the literature as the ADDIE model. Briefly, in the analysis phase, the instructional problem is clarified, the goals and objectives of training are established, and the learning environment and learner characteristics are identified. The design phase is where the instructional or training models and strategies are conceptualized and media choices are made. In the development phase, training materials are produced according to decisions made during the design phase. The implementation phase includes the testing of prototypes (with the targeted audience), putting the product in full production, and training learners and instructors on how to use the training product. The evaluation phase generally consists of two parts: formative and summative. Formative evaluation is present in each stage of instructional design. Summative evaluation consists of tests for criterion-related referenced items and providing opportunities for feedback from the users. Serving as an explanatory framework (Kemp, et al., 2004), learning theory informs each phase of the instructional design process, and helps to ensure that target learning outcomes or training system goals are accomplished.

This research project will use the phases of instructional design as its research design framework. As mentioned earlier, instructional design is an appropriate methodology to conduct transitional research. Given that formative evaluation is present in each phase and that learning theory informs each phase, adopting this process will ensure a grounded-learning systems design approach and hence the transitioning or conversion of the JTA to an effective training strategy. Specifically, the following instructional design processes will be utilized in this project:

(1) A comprehensive performance and needs analysis of the current state of mine supervisor training (analysis phase).
(2) A cognitive task analysis of the JTA to determine the cognitive domain type and level of the supervisory tasks (analysis phase).
(3) Developing an appropriate training strategy and delivery approach (design phase).
(4) Developing model training prototypes for selected JTA tasks (development phase).
(5) Conducting usability testing and formative evaluation on model training prototypes (implementation and evaluation phases).

The above processes will be performed using the Immersion program methodology over a period of three years beginning in August of 2005 and ending in August of 2008.

More specifically, year 1 objectives include:

- Conducting a performance and needs analyses, learner analysis, and cognitive task analysis to map the JTA tasks to a learning taxonomy.

- Identifying an overall design strategy and implementation approach (and possibly develop a prototype example on a specific cluster of the JTA tasks, i.e., one high level task)

Deliverables for year 1 include:

(1) Performance analysis report
(2) Needs analysis report
(3) Learner analysis report
(4) Cognitive task analysis
(5) First level design document (includes a prototype)

Year 2 objectives include:

- Dividing the JTA into sections by cognitive level and type and developing detailed design documents for each section
- Developing model training prototypes for selected JTA tasks

Deliverables for year 2 include:

(1) Detailed design documents for different JTA tasks
(2) Model training prototypes for selected JTA tasks

Year 3 objectives include:

- Conducting formative evaluation on model training prototypes
- Conducting usability testing on model training prototypes
- Conducting level 1, 2, and 3 evaluations on model training prototypes

Deliverables for year 3 include:

(1) Formative evaluation report
(2) Usability testing report
(3) Level evaluations report
(4) Revised prototypes for selected JTA tasks

The Analysis Phase

The analysis phase is the foundation for all other phases of the instructional design process (Braxton, et al., 1995). In the analysis phase, the instructional designer identifies the problem, sources of the problem, and possible solutions (Seels & Glasgow, 1998). For this project, the analysis phase will include specific research techniques such as a performance analysis, learner analysis, and prioritization of the JTA tasks. An essential component of the analysis phase is Performance Analysis (PA). PA involves partnering with clients and the target audience in order to define and achieve the intended training goals. The process of PA involves:

- Figuring out what needs to be done to serve the client and the organization
- Establishing relationships to serve the client and the organization for subsequent interventions
- Describing and sketching, providing fresh views, asking questions that push the project in practical and systemic, not habitual directions
- Seeking to understand what is really going on in order to add value to the effort
- Getting out of your shoes and into the theirs
- Providing a more vivid view of the situation to the client
- Considering a solution system, rather than just one intervention
- Considering what is and isn't working within current system and what needs to be included in the future
- Providing documentation to sell and justify the time and expense of meetings with the SMEs and lengthier examination of the literature and work products (needs assessment)

PA makes use of various forms of data. Data, broadly defined, (formal or informal) is critical to figuring out what to do. This process will utilize human data sources, which may include but is not limited to: experts, colleagues, managers, customers, and supervisors. The use of inanimate or non-human data sources may include: policies, records, interviews, reports, grants, course materials, performance appraisals, facts, letters, and surveys.

In addition to the performance analysis, a three-phase prioritization process will be performed using the JTA. In Phase I, the elements of the JTA will be categorized and organized based on complexity, importance, and cognitive load. Tasks will be examined to determine if they are intellectual, affective, or psychomotor skills, and subsequently classified according to the levels within each of these learning domains (e.g., procedural, application, or problem solving). For example, figure 1 below depicts an intellectual JTA task that is procedural and its subtasks include psychomotor skills.

Figure 1 – Load Operator Pre-operational check
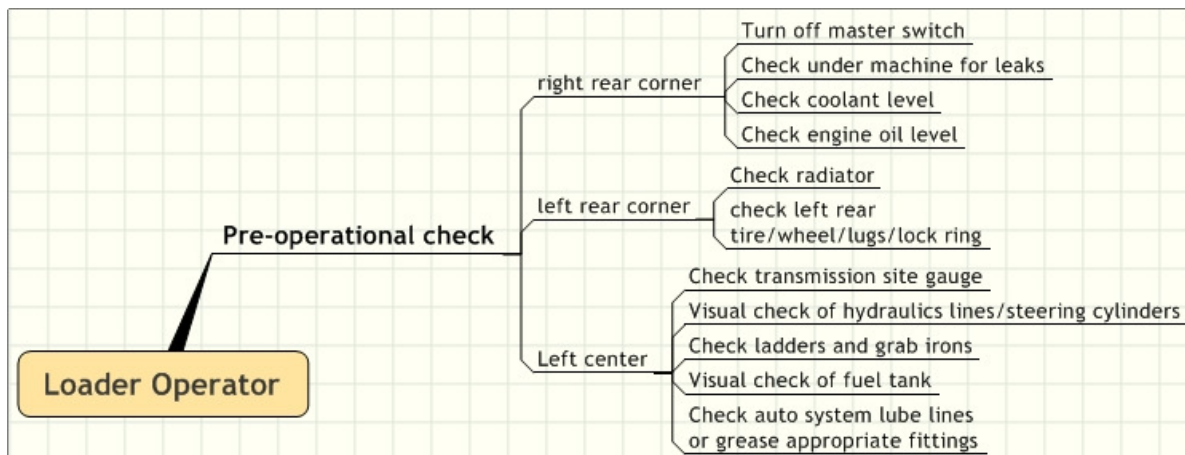
There are several learning taxonomies that instructional designers use to classify learning tasks or outcomes. These include Bloom's taxonomy of the cognitive domain, Gagne's five learned capabilities, Krathwohl's taxonomy of the affective domain, and Harrow's taxonomy of the psychomotor domain (see the Instructional Design Knowledge Base developed by Dr. Dabbagh at http://classweb.gmu.edu/ndabbagh/Resources/IDKB/task_analysis.htm). The purpose of classifying learning tasks using these taxonomies is because different learning tasks require different training approaches or strategies.

In Phase II of the PA process, the JTA will be evaluated based on importance and feasibility criteria. The importance criteria consist of the following five components:

- Number of individuals affected
- The extent to which the need contributes to the organizational goals
- The extent to which the task requires immediate attention
- Magnitude of discrepancy, and
- Instrumental value.

The feasibility criteria consist of the following three components:

- Educational efficacy
- Resource availability, and
- Commitment or willingness of the organization to change.

Finally, in Phase III of performance analysis, based on the prioritization of the job tasks and the evaluation of their importance and feasibility, specific JTA tasks or groups of tasks will be selected for further design and development. The JTA remaining tasks will be addressed in subsequent phases of the project.

In addition to the performance analysis, needs analysis, and cognitive task analysis, a learner analysis will be performed on the target audience. The purpose of a learner analysis is to identify learner/trainee/employee characteristics and individual differences that may have an impact on learning and performance, such as prior knowledge, personality variables, aptitude variables, and cognitive styles. This is critical in this research project given the different cohorts of the target population (older and younger miners, new and current miners) and the physiological, psychological, social, technological, and cultural characteristics of these cohorts. A learner analysis enables the instructional designer to create instruction with a particular audience in mind, rather than centering the design solely around content (Smith & Ragan, 1999). In addition, a learner analysis could lead to the identification of a primary and secondary audience, which makes a training strategy or application extensible and scalable. Target audience characteristics that will be examined in this research project include cognitive, physiological, affective, and social characteristics. Interviews, on site observations, surveys that provide information about backgrounds and interests, and assessment instruments that provide information about cognitive strategies, processing styles, and preferred instructional delivery modes will be used to conduct learner analyses. Examination of job descriptions and research about the miner cohorts' age groups, interests, ethnic backgrounds, and motivations will also be performed.

The specific deliverables for this research project associated with the analysis phase include: a performance analysis report, a needs analysis report, a learner analysis report, and a cognitive task analysis of the JTA.

The Design Phase

The result of the analysis phase informs what will happen in the design phase. Using the results from the analysis phase, an overall design or training strategy will be formulated. A design document that maps the JTA tasks to pedagogical models, instructional strategies, and learning technologies will be developed (Dabbagh & Bannan-Ritland, 2005). For example, if a cluster of JTA tasks is classified as problem solving skills based on the results of the cognitive task analysis conducted in the analysis phase, then pedagogical models such as problem-based learning or case-based learning would be considered appropriate training models, and instructional strategies such as hypothesis generation, exploration, role playing, and problem solving would be considered appropriate training strategies. In addition, learning technologies such as Microworlds or interactive video-based scenarios would be considered appropriate delivery approaches that support the development of problem solving skills.

Next, a usage-centered design approach will be used. Usage-centered design is a streamlined but systematic approach for developing training closely fitted to the genuine needs of the target audience (the users of the training). Usage-centered design will be implemented through the development of user role models and interface content models. These models will be determined based on the results of the learner analysis conducted in the analysis phase and the pedagogical models and instructional strategies identified in the design phase. User role models are abstract representations of a user with particular relationship to some system, in this case, the mine supervisory training system. Role models are determined based on the relationship of the user to the system, how they will interact with the system, and what expectations they have of the system. Role models are created to show representations of what user roles would be supported by the training system. Each role model is described in terms of the needs, interests, expectations, behaviors, and responsibilities that characterize and distinguish that role. In constructing these models, we will collect information that improves our understanding of (1) How the users are going to interact with the training system; and (2) What do the users expect from the training system. For example, more experienced mine supervisors will have different expectations from the training system than new or novice mine supervisors. Or, younger cohorts of mine supervisors might be more technologically inclined than older cohorts of mine supervisors and could benefit from interacting with Web-based rather than print-based materials Usage-centered design will help us identify the most effective training delivery approach by taking into consideration pragmatic, contextual, environmental, physiological, and technological constraints of the target population and the workplace.

The specific deliverables for this research project associated with the design phase include: a first level design document for the JTA and detailed design documents for different JTA task groups.

The Development Phase

The development phase in instructional design addresses the tools and processes used to create instructional or training materials. This stage includes: story boards, coding, developing a Graphic User Interface (GUI), and creating all multimedia elements (if applicable). The development phase is a combination of results and efforts from the design and analysis phases. During the development phase, the instructional designer first develops instructional or training prototypes to conduct formative evaluations and revise the prototypes based on user and expert feedback, and then produces all the training materials needed to meet the learning objectives of the training model or strategy. However in this research project, only the development of model training prototypes will apply. For example, if a Web-based delivery approach is deemed appropriate for a cluster of JTA tasks, then a Web-based prototype will be developed through the use of storyboards and wireframes. A wireframe is a visualization tool for presenting the elements of a Web page layout, including: the content, navigation, branding, and functionality. The wireframe allows for quick, iterative designing of the prototype to focus on how the site works as opposed to the "look and feel" of the pages. These wireframe "mock-ups" allow for discussion with the client and users regarding the functionality of the instruction or training without the distraction of visual design elements such as font, color, buttons, metaphor, etc. Hence, they are free of color, graphics, and other visual design elements, which might take the focus off the training task and tools. A wireframe is a rapid prototyping tool. Rapid prototyping involves the early development of a small-scale prototype used to test out certain key features of a training design. Different types of rapid prototyping techniques will be used in this project depending on the training strategies and delivery approaches identified for the selected JTA tasks.

The specific deliverables for this research project associated with the development phase include model training prototypes for selected JTA tasks.

The Implementation Phase

In the implementation phase of instructional design, a plan is developed to establish the implementation timeline and procedures for training the facilitators and the learner, and delivering the final product. The final training product is developed based on needs and errors discovered while utilizing a prototype product with members of the target audience. As mentioned previously, this research project will not undertake the development and implementation of the full training product. The extent of the implementation phase in this research project will be to enable formative evaluation and usability testing of the model training prototypes created in the development phase.

The Evaluation Phase

The last and final stage of instructional design is evaluation. Evaluation is a crucial part of every design and development effort as it can determine the worth or value of the instruction or training as well as its strengths and weaknesses (Tessmer, 1993). A common assumption is that evaluation processes can only be applied in a formal manner using experimental research methods. These methods traditionally involve participants randomly assigned into groups that interact with treatment or learning materials that vary on a specific element, and the use of

statistical methods to determine if that element demonstrates differences in learning beyond the level of chance. While experimental research methods are one way of examining the impact of learning, these formal evaluation methods are not always the best way to determine worth or value of instruction or training (Bernard, de Rubalcava, & St. Pierre, 2000). In addition, these formal evaluation methods depend on the extent to which training products have been developed and implemented. There are many other ways to evaluate learning materials and the commonality among different approaches and methods is the overall goal to contribute to or improve learning effectiveness. As Reeves (1997) states:

> The purpose of evaluation within instructional design is not crunching numbers, telling stories or deconstructing meaning, but supporting the overall goals of the ID effort, improving human learning and ultimately the human condition (p. 176).

Through evaluation, we may begin to better understand the impact of instructional strategies on learning and the nature of instruction and training delivered through learning technologies. To accomplish this however, we need to first adopt a systematic process of evaluation that includes (Dabbagh & Bannan-Ritland, 2005):

(1) Clearly determining the purpose, desired results and methods of evaluation.
(2) Formatively evaluating the design and development of the training.
(3) Revising the training strategy and materials based on results of the formative   evaluation.
(4) Implementing the training and evaluating results according to identified goals.

In addition to the above, often, there are multiple participants in an evaluation effort with different needs resulting in a multi-level evaluation. Evaluation efforts may involve stakeholders such as learners, trainees, teachers, trainers, colleagues, experts, clients, etc. Considering who might be impacted by the evaluation provides guidance for selection of appropriate methods. Addressing multiple levels and phases of evaluation such as formative and summative provides the training developer with comprehensive knowledge of the impact of the instruction or training. Barksdale and Lund (2001) refer to this process as "balancing" the evaluation to include the customer view, the organization view, and evidence of learning and performance improvement to provide a comprehensive evaluation strategy.

Kirkpatrick's (1998) levels of evaluation permit the distinction and incorporation of many of these views in an overall evaluation effort. A process that originated in 1959 and written about extensively in corporate human resources literature, Kirkpatrick's levels of evaluation are appropriate for all evaluation methods, including formative and summative evaluation (which are integral processes of instructional design), and all evaluation efforts whether conducted in education, business, or industry settings (Kirkpatrick, 1998). The four levels of Kirkpatrick's evaluation model include:

- Level 1 – Reaction or how learners perceive the instruction or training;
- Level 2 – Learning or the extent that learners change attitudes, gain knowledge or increase skill as a result of instruction or training;

- Level 3 – Behavior or how learners have changed their behavior based on instruction or training; and
- Level 4 – Results or the final results that have occurred at the organizational level based on the delivery of instruction or training.

Kirkpatrick (1998) notes that evaluation efforts become more complex and time consuming as you advance through the levels. The Kirkpatrick evaluation model provides guidance in promoting a balanced evaluation strategy and can assist the training developer in targeting appropriate evaluation methods for his or her needs. For the purposes of this research project, the first three levels of Kirkpatrick's model will apply. A description of each of these levels and their application relative to the research design of this project follows.

Level 1 - Reaction

Level 1 of Kirkpatrick's model evaluates the reaction or satisfaction of those who are involved in the instruction or training. This is consistent with the purposes of the formative evaluation process used in instructional design. Evaluating learner reactions provides feedback that can assist in evaluating the effectiveness of the individual training program as well as providing information for the improvement of design and development efforts in general. Evaluating learner reactions to instruction or training can be accomplished in a variety of ways including the use of forms, surveys, interviews or group discussions. Regardless of the method of gathering information, ensuring a positive reaction to the training experience is important for supporting learning. Kirkpatrick (1998) indicates that a positive reaction to learning or training materials may not guarantee learning but a negative reaction can reduce learning.

For this research project, level 1 evaluation will be conducted through (a) a questionnaire using open-ended items soliciting learners attitudes about the model training prototypes, (b) a survey using scaled rating that will assess learners perceived value of the model training prototypes, and (c) one-on-one and small groups interviews with learners from the different cohorts of mine supervisors soliciting their attitudes and perceptions of the overall usefulness and effectiveness of the model training prototypes. The questions/items in the questionnaire, survey, and interview will be similar to ensure consistency and completeness and provide triangulation of data sources. Usability testing will also be used to conduct level 1 evaluation. Usability testing is a measure of a person(s) interaction with technology, specifically multimedia and Web-based training. Depending on the results of the analysis and design phases, model prototypes that are developed using multimedia and Web-based delivery approaches will undergo usability testing. The goal of usability testing is to discover those design features that facilitate and or inhibit the user(s)'s ability to easily use and find what they need from the training system or software. Moreover, usability testing process will enable us to uncover any design problems that need to be addressed. In the context of this research project usability testing will be conduced through observations of mine supervisors' interaction with the model training prototypes. These observations will be performed by the expert IT faculty leading the development effort as well as personnel from the MSHA JTA Design team.

Level 2 – Learning

The second level of Kirkpatrick's model involves the more complex effort of evaluating learning. Knowledge learned, skills developed or attitudes changed constitute learning in Kirkpatrick's (1998) view. Determining the intended learning outcomes of training is crucial at this level. Huba and Freed (2000) suggest asking the question: "If I provide the best possible [training] what will the target audience be able to do with their knowledge at the end of the [training]?" (p. 93). Determining the desired learning results or what students or trainees should know and do at the end of a course or training experience can explicitly structure the evaluation method, particularly for level 2 evaluation.

In this research project, the desired learning results of the training strategy is improved mine supervisors on-the-job performance. Typically, the most formal level 2 evaluation efforts involve experimental studies with random assignment of participants and tight control of factors that might influence learning. However as mentioned earlier, this will not be possible in this case because implementation of the full training product is not within the scope of this project. Therefore, it is important to draft the specific purpose and desired results of the evaluation effort early in the process to help formulate appropriate evaluation methods for this level. During the analysis and design phases of this project, selected JTA tasks will be identified for model training prototype development. The intended learning outcomes of these model training prototypes will be subject to level 2 evaluation. One method of conducting level 2 evaluation in this context would be to analyze mine supervisors' *perceptions* of how these intended learning outcomes will lead to improved performance. Pre- and post-assessment measures of mine supervisors' perceptions of the impact of training on performance can be achieved using survey instruments that measure job performance perceptions of intended learning outcomes. This will allow us to evaluate whether performance perceptions of the JTA tasks changed as a result of the new training strategy.

Case studies will also be used to assess mine supervisors' performance perceptions of the model training prototypes. Case studies are task simulations that involve a participant's performance in a simulation as part of an evaluation. In this context, case studies depicting specific mine supervisory operations' "what if" scenarios will be used before and after implementation of the model training prototypes to measure whether a change or gain in performance perception has occurred. Another level 2 evaluation method is to assess content accuracy of the model training prototypes. This is known as expert evaluation and is consistent with formative evaluation techniques. Expert evaluation will be conducted by asking expert mine supervisors to review the content of the model training prototypes to ensure that the content accurately depicts the mine supervisory tasks as specified in the JTA.

Level 3 - Behavior

Kirkpatrick's (1998) third level of evaluation addresses the transfer of knowledge or skills to another context as evidence of a change in performance or behavior. This level of evaluation is much more difficult to determine and attribute directly to instruction or training. However, evaluating the behavior related to the identified knowledge, skills and attitudes prior to instruction or training and after, can help to identify any change that may have occurred (Kirkpatrick, 1998). The

application of knowledge or skill can be evaluated in multiple ways through observations, surveys, or interviews that might involve teachers or trainers, their students or subordinates, and the administrators or supervisors. Using multiple sources of information and multiple perspectives can assist in detecting behavior change and consider how it might be related to the training experience. Incorporating formal qualitative and quantitative research designs in evaluation can provide very useful information about learning, however, less formal methods of evaluation are also possible to use to determine the worthwhileness of the training. The evaluation process may also include the practical objectives of delivering a product or accomplishing specific goals, the application of skills, and creating feedback mechanisms to determine progress toward those goals (Isaac & Michael, 1990).

In this research project, a method known as action planning or improvement plans will be used for level 3 evaluation (Phillips & Snow, 2002). Given that development of the full training product is beyond the scope of this research project, it will not be possible to perform other methods of level 3 evaluation such as follow-up surveys, questionnaires, focus groups and assignments, on-the-job observations and performance monitoring, in order to determine whether a change in behavior or performance has occurred as a result of training. An action plan however can be implemented to measure the perceived change in behavior or performance as well as any perceived intangible benefits of training which in this case are improved mine productivity, reduction of maintenance costs, and reduction of injuries. An action plan is the most common type of follow-up assignment for a level 3 evaluation. Participants are typically required to develop action plans (what will they do as a result of training) as part of the training program. In this context, mine supervisors participating in the evaluation of the model training prototypes will be asked to develop action plans based on their current supervisory training experience and then revise these action plans after they have interacted with the model training prototypes. More specifically, at the end of year 2, when selections of JTA tasks for the development of the model training prototypes have been determined, a group of coalmine supervisors representing different miner cohorts will be identified, with the help of MSHA, to participate in the evaluation phase of this project. This group will be asked to complete all pre-assessment evaluation measures discussed previously, and in addition, this group will be asked to develop action plans related to the selected JTA tasks. At the midpoint of year 3, this group will be asked to revise these action plans after interacting with the model training prototypes. Action plan worksheets for the selected JTA tasks will be developed to enable this process. Figures 2 and 3 provide examples of action plan worksheets (Phillips & Snow, 2002).

Figure 2 – Action Plan Worksheet Part I

***Worksheet** Part I - Action Plan For The ---------------------------------- Training Program*

Name: _____ **Instructor Signature:** _____ **Follow-up Date:** _____

Objective: _____ **Evaluation Period:** _____ **to** _____

Improvement Measure: _____ **Current Performance:** _____ **Target Performance:** _____

SPECIFIC STEPS: *I will do this* ↵	END RESULT: *So that* ↵
1. _____	1. _____
2. _____	2. _____
3. _____	3. _____
4. _____	4. _____
5. _____	5. _____
6. _____	6. _____
7.	7.

EXPECTED INTANGIBLE BENEFITS ↵
_____
_____

Figure 3 – Example Action Plan

Part I - Action Plan For The *Leadership* Training Program

Name: Medicine Gelatin Manager   **Instructor Signature:**   Stacy Locke   **Follow-up Date:**

Objective: Elimination of Gel Waste   **Evaluation Period:**   January   **to**   May

Improvement Measure: Quality   **Current Performance:**   8,000 kg's waste monthly   **Target Performance:**   Reduce waste by 80%

SPECIFIC STEPS: *I will do this* ➴	END RESULT: *So that* ➴
1. Take a more active role in daily gelatin schedule to ensure the manufacture and processing control of gelatin quantities.	1. Better control of gelatin production on a daily basis. This will eliminate the making of excess gelatin which could be waste.
2. Inform supervisors and technicians on the value of gelatin and make them aware of waste.	2. Charts and graphs with dollar values of waste will be provided to give awareness and a better understanding of the true value of waste.
3. Be proactive to gelatin issues before they become a problem.	3. Able to make gelatin for encapsulation lines and making better decisions on the amounts.
4. Constantly monitor hours of encapsulation lines on all shifts to reduce downtime and eliminate the possibility of leftover batches.	4. Eliminate the excess manufacturing of gelatin mass and the probability of leftover medicine batches.
5 Provide constant feedback to all in the department including encaps machine operators.	5. Elimination of unnecessary gelatin mass waste.
EXPECTED INTANGIBLE BENEFITS ➴	
Gel mass will decrease to a minimum over time which will contribute to great financial gains for our company (material variance) which will put dollars into the bottom line.	

Additional questions will be used for level 3 evaluation to collect information about how participants (mine supervisors) plan to apply what they will learn in the form of *estimated or projected* impact of training. These questions will require participants to think *beyond* the mere application of training and to consider organizational impact (Phillips & Stone, 2002). These questions will also help us gauge perceived changes in behavior or performance as a result of the training strategy as well as the projected or estimated impact of this training strategy on mine productivity, reduction of maintenance costs, and reduction of injuries, which are the long-term or

broad goals of this training strategy. Examples of such questions include:

- As a result of this training program what do you estimate to be the increase in your personal effectiveness, expressed as a percentage?
- Please indicate what you will do differently on the job as a result of this training program?
- As a result of any changes in your thinking, new knowledge, or planned actions, please estimate, (in monetary values) the benefits to your organization (e.g., reduced maintenance costs, reduced injuries, improved mine productivity) over a period of one year.

Lastly, we will work with MSHA to integrate evaluation procedures that align with federal regulations of mine safety and health. It is anticipated that the evaluation procedures presented in this section will enable the researchers to effectively evaluate the specific aims of this research project and that the results of this formative evaluation will provide the potential for future funding in order to fully implement the training strategy in the nation's mines and conduct more formal evaluation methods to assess the impact of this training on mine productivity, reduction of maintenance costs, and the safety and health record of the mining industry.

E. Human Subjects Research

This Human Subjects Research falls under Exemption 1:

Exemption 1: Research conducted in established or commonly accepted educational settings, involving normal educational practices, such as (i) research on regular and special education instructional strategies, or (ii) research on the effectiveness of or the comparison among instructional techniques, curricula, or classroom management methods.

Human subjects research in this project will be conducted using established and commonly accepted educational research methodologies, specifically as this relates to item ii in exemption 1. The goal of this research project is to develop an effective training strategy for coal mine supervisors based on the JTA, and measure the effectiveness of this training strategy using the evaluation methods and techniques described in the evaluation phase of the research design section of this proposal. These methods and techniques align with common educational research practice and will include the use of surveys, questionnaires, and interviews, and the completion of learning activities embedded in the model training prototypes that will be developed.

The human subjects population involved in this research will include a group of coal mine supervisors representative of the different cohort groups discussed in this research project. This group will be selected by MSHA. Participation will be voluntary and some participants will be identified by name for the purpose of matching pre and post data. However, these data will be kept secure (under lock and key) and names will be substituted by unique codes for the purposes of analyses. Any published reports will use pseudonyms (if needed) or only general findings will be reported. Data will be collected at the following primary sites: George Mason University, MSHA's office in Washington DC, and the Mine Training Academy in Beckley, WV. Some data for the analysis phase of this project will be collected at designated mine sites in West Virginia and New York. All data collection procedures will be cleared via the Human Subjects Review Board at George Mason University, if this proposal is funded.