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Western Mining Safety and Health Training Resource Center

University of Arizona

Final Report

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Abstract

The University of Arizona (UA) has created the Western Mining Safety and Health Training Resource Center in Tucson, AZ. The project has changed the way mine safety training is conducted with safety leadership training, active learning, and gaming strategies. We have increased the safety-focused, total-health aware, leadership competency of front-line supervisors, superintendents, and managers representing operations throughout the U.S., spanning all major commodity sectors in surface and underground mining, as well as contractors. The Center has implemented health and safety-focused leadership competencies that respond in near real-time to changing workforce needs and environments of Western U.S operations. Further, we continue increasing the capacity, tools, and methods to reduce miner exposure risks associated with heat, noise, and aerosol particulates.

The 4 aims of the project are: 1) Offer a wide range of regularly scheduled safety training courses, including mine rescue. 2) Deliver courses for trainers and supervisors for adult learners, English language learners, low literacy, and education disadvantaged learners including best practice translation of existing training materials. 3) Incorporate current knowledge of occupational health and industrial hygiene into training courses and materials for miners, trainers, and supervisors with a focus on exposures, noise, ergonomics, heat stress, wellness, and behavior risk management; provide leadership training for supervisors 4) Create flexible and realistic scenarios for serious gaming software for use in mine safety training.

Key accomplishments of the project include: a) training more than 9,000 miners and supervisors; b) Translated training materials into Spanish; c) Created teaching strategies training program for mining trainers; d) Created Mining Institute for Supervisor Leadership (MISL) training focused on safe production; e) Created the first computer simulated fatalgrams; f) Built the only mine training facility in the SW US for mine rescue teams; g) Provided constant professional evaluation and improvement of training material and related instruction approaches; h) Created the most active engagement of western mine safety professionals through the Technical Advisory Committee (meets monthly) with 35 members representing 28 mining companies and other organizations (e.g. medical and law practices); i) built a large and exceptionally strong team of researchers for mine health and safety at the University of Arizona and have improved the training of mining engineers and industrial hygienist in mine health and safety.

Section 1

Significant Key Findings

The overall objective of this agreement is to reduce the number of injuries and illnesses among workers who are involved in mining operations through a focused, relevant, and comprehensive training program that educates mine workers regarding how best to protect themselves from risks and hazards in the mining environment, and that expands the number of qualified mine safety and health trainers in the U.S.

Our key accomplishments are:

1. We have partnered with a Hispanic-owned business, Hazard Prevention Institute, to facilitate increased training capacity for mine safety. We have offered more than 150 full days of training each contract year. We have trained more than 9,000 workers and trainers since the project started. We have since trained and partnered with more professional trainers.
2. We created a very active industry Technical Advisory Committee that has monthly teleconferences and meets face to face twice each year. We have 35 members from 28 companies and organizations.
3. Conducted a needs assessment of the mining industry. Key needs: a) Biodiesel and Nanoparticle Exposures; b)Chemical/Heat Exposures; c)Industrial Hygiene Training; d)Wellness Programs
4. We offered 7 hours of training sessions to more than 100 safety professionals at the 7th Annual Joint Western Regional Mining Safety and Health Conference in 2011; 4 hours at the 8th annual conference in 2012; and had a booth with one-on-one contact at the 2013 and 2014 conferences.
5. We have created and offered a two-day Mining Language and Literacy (MLL) training course for mine safety trainers. We added an individual mentoring component in 2012. The MLL has now morphed into an active learning strategies training course based on industry needs.
6. We have completed the Spanish translation of 52 toolbox training modules for Part 46 training. We have had the materials reviewed by several Spanish-speaking mining experts. The modules were reviewed by MSHA and NIOSH.
7. We created the Mining Institute for Supervisory Leadership 2-day workshop series with the first offering in December 2011. Subsequent offerings were April 2012, December 2012, April 2013, April 2014. In 2013 we added advanced levels of training for mentors. Industry members have asked us to create company specific versions of MISL. We have also been asked to create a version for leadership training of in-country mine managers at international locations (taught in the U.S.).
8. We have equipped two mine rescue teams and have begun training at the San Xavier Mine.
9. We have a beta version of our first fatalgram simulation for a surface mine powered haulage accident. Harry's Hard Choices game for mine self-escape and that product is ready to be commercialized.

10. We have trained miners and supervisors at their mine sites for industrial hygiene and exposure monitoring. To assist with industry requests for information before, during, and after training, we have created a website for the Center at www.miningsh.arizona.edu which is undergoing a significant re-design.
11. We have built a very large, exceptionally talented research team at the University of Arizona for mine health and safety including engineers, scientists, public health specialists, medical doctors, nurses, economists, training specialists, evaluation specialists, and professional trainers.

Translation of Findings

Our translation of findings as outputs include:

- Translation of the Part 46 Toolbox Training Modules to Spanish
- Gaming software for fatalgram simulations (MineSAFE)
- Mine Institute for Supervisory Leadership (MISL), a training program for supervisors/leaders employed in mining that is based on a succession of former trainees becoming mentors for current trainees; now expanded with “Silver” level of advanced training
- Handbook for active learning in mine safety training
- Training course on active learning/teaching strategies for mine safety trainers
- Sustainable involvement of mining industry in guiding mine safety and health improvements through the Center

Outcomes

Key outcomes for the project are: 1) a full range of MSHA safety courses are available on a regular schedule using best practices for improved learning; 2) focus on needs of low-literacy and English Language Learners as well as focus on competencies and capabilities of all mine workers; 3) course modules and materials developed for industrial hygiene and occupational health disseminated via widely available communication channels; 4) rigorous evaluation and assessment and a continuous improvement process with industry input 5) a health and safety technical advisory committee that is actively engaged and implements best practices in their organizations; 6)new training materials and approaches such as serious games.

Impacts

The project has changed the way mine safety training is conducted with safety leadership training, active learning, constant industry feedback, rigorous evaluation, and improved communication of state of art and practice between academia, government, and industry. We have increased the safety-focused, total-health aware, leadership competency of front-line supervisors, superintendents, and managers representing operations throughout the U.S., spanning all major commodity sectors in surface and underground mining, as well as contractors. The Center has implemented health and safety-focused leadership competencies that respond in near real-time to changing workforce needs and environments of Western U.S operations. Further, we continue increasing the capacity, tools, and methods to reduce miner exposure risks associated with heat, noise, and aerosol particulates.

Section 2

Scientific Report

The University of Arizona (UA) created the Western Mining Safety and Health Training Resource Center in Tucson, AZ as a collaboration between the Colorado School of Mines and the UA Lowell Institute for Mineral Resources, the Teaching, Learning and SocioCultural Studies in the College of Education, and the Division of Community, Environment and Policy in the Mel and Enid Zuckerman College of Public Health. The Center utilized the new training facility at the San Xavier Mine owned by the University of Arizona.

The overall objective of this agreement is to reduce the number of injuries and illnesses among workers who are involved in mining operations through a focused, relevant, and comprehensive training program that educates mine workers regarding how best to protect themselves from risks and hazards in the mining environment, and that expands the number of qualified mine safety and health trainers in the U.S.

We increased the training capacity and efficacy for western states miners through training classes for miners, trainers, and supervisors and development of new materials and methods especially for a growing Hispanic population of miners. We created a robust evaluation mechanism that establishes a continuous improvement process for training. Our process for training and new materials development is responsive to changing workforce needs and environments, including small mines.

The 4 aims of the project are: 1) Offer a wide range of regularly scheduled safety training courses, including mine rescue. 2) Deliver courses for trainers and supervisors for adult learners, English language learners, low literacy, and education disadvantaged learners including best practice translation of existing training materials. 3) Incorporate current knowledge of occupational health and industrial hygiene into training courses and materials for miners, trainers, and supervisors with a focus on exposures, noise, ergonomics, heat stress, wellness, and behavior risk management; provide leadership training for supervisors 4) Create flexible and realistic scenarios for serious gaming software for use in mine safety training.

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Key Accomplishments

Aim 1

1. We partnered with a Hispanic-owned business, Hazard Prevention Institute, to facilitate increased training capacity for mine safety. We offer annual refresher, new/inexperienced miner, mine rescue, self-rescue training and other training activities, including task training. We have offered more than 500 full days of training during the contract. We taught a Part 46 refresher course in Spanish to 6 miners from Kalamazoo Materials. In later phases of the project we also partnered with McCraren Compliance for training. We have trained more than 9,000 workers and trainers during the contract period. We built capacity for better training methods in local companies as well as the Arizona State Mine Inspector's Office.

1. We equipped two mine rescue teams and performed training at the San Xavier Mine. We have 12 Drager BG4's breathing apparatus, fully equipped to be used in an actual mine emergency. We have state of the art communication system manufactured by Conspec. We have 2 ISC MX6 atmospheric monitors and 3 ISC ITX instruments. We have an oxygen pump to refill cylinders for the apparatus. We have worked with Oracle Ridge Mining and Resolution Copper with a total of 20 people from these 2 companies. We have trained 20 people from Maricopa County Mountain Rescue teams. We have trained Pima county bomb squad 3 different times with 10-15 people each time.

2. We offered 4 hours of training sessions to 120 safety professionals at the 7th and 8th Annual Joint Western Regional Mining Safety and Health Conferences in October 2011 and 2012. In 2013 and 2014 we had a booth and demonstrated our gaming software and active training methods to several hundred participants. We evaluated our sessions from the October 2011 conference as described in Appendix A and summarized below.

   The project team used the conference as an opportunity to broadly disseminate information about occupational health and industrial hygiene (Aim #3), fatalgram gaming scenarios (Aim #4) and adult learning teaching strategies (Aim #2). Team members presented materials and information in 75-minute "breakout sessions". At the completion of each breakout session, participants were asked to provide feedback via an 18 question, 5-point (1=Strongly Disagree, 5=Strongly The project team used the conference as an opportunity to broadly disseminate information about occupational health and industrial hygiene (Aim #3), fatalgram gaming scenarios (Aim #4) and adult learning teaching strategies (Aim #2). Team members presented materials and information in 75-minute "breakout sessions". At the completion of each breakout session, participants were asked to provide feedback via an 18 question, 5-point (1=Strongly Disagree, 5=Strongly Agree) End-of-Course Questionnaire (Appendix A). Additionally, all participants received the session materials and topic-relevant supplementary information on a jump-drive. As we noted in the Evaluation Plan for Aim #3, our evaluation focused on dimensions that the project team were able to influence; such as course objectives, materials, delivery methods, and instruction.

Other important metrics were out of the control of the project team, such as room size, length of program, scheduling, etc, as these were determined by the conference organizers.

Responses from each session's questionnaires were compiled and are presented in Tables 1 through 6 of the evaluation report in Appendix A. The data tables include the relative frequency of participant's ratings, the number of participants responding, the mean or average response, and the standard deviation. Additionally Questions #14 through #18 were open response and we have included each participant's notations without determining its value or meaning. For example, if the participant responded "none" or "???" to a question, we have included it as a response on the data tables. Agree) End-of-Course Questionnaire (Appendix A). Additionally, all participants received the session materials and topic-relevant supplementary information on a jump-drive. As we noted in the Evaluation Plan for Aim #3, our evaluation focused on dimensions that the project team were able to influence; such as course objectives, materials, delivery methods, and instruction.

3. We created a very active industry Technical Advisory Committee that has monthly teleconferences and meets face to face twice each year. The TAC consists of safety leaders at the major western mines. The TAC has 35 members from 28 companies. The TAC represents a broad cross section of the mining industry. They are actively engaged in improving safety performance at their companies. We have created one of the largest mine safety and health groups at a university in the US with more than 50 faculty, staff, students, contractors, and industry professionals involved.

4. We have created a robust evaluation plan that we are applying to all of our activities. We have tested the protocol at the regional conference and at the MISL workshop as well as during the Mining Language and Literacy courses.

Aim 2

5. We created and offered a two-day Mining Language and Literacy training course for mine safety trainers. The course proved successful and companies requested on-site offerings for their companies. We ultimately morphed this course into a train the trainer course on using active learning strategies for mine safety trainers and produced a handbook of active learning techniques (jointly funded with a grant from the Alpha Foundation). We have appended a pdf of the handbook in Appendix B.

   We have delivered the Teaching Strategies for the Mine Safety Trainer course 3 times in year 2. Based on feedback the course was reduced in length from 2 days to 1 day. The course was offered October 14, 2011, February 17, 2012, and May 18, 2012. A total of 18 trainers have attended the first two courses in Year 2 (10 in year 1). The course was requested by companies. In year 2 we have offered a one-day coaching session every month at company sites. Five people have received coaching. We have completed extensive evaluations of each class and used the feedback to improve each offering. We began preparing an on-line version of the class in 2013 but based on industry input changed the approach to focus on active learning strategies.

a) Mining Language and Literacy (MLL) Training Courses

In year 2, the MLL project completed evaluation and improvements of the course 'Teaching Strategies for the Mine Safety Trainer'. Course development represents collaboration between the MLL team and local mine safety trainers. Following are the steps taken to prepare for the course and develop curriculum, and an overview of the course.

Development of the course was driven by two questions: 1) How do current Mine Safety and Health Administration (MSHA) safety courses reflect adult learning and literacy theories? and 2) What understandings about language, literacy and learning do safety trainers need for mandatory safety training? Observations, surveys and focus groups were used to plan the course. Each is described below.

Observations were collected by researchers attending MSHA new miner courses as participant-observers. Researchers documented class atmosphere and student response to teaching strategies, to ascertain theories implied by the instructors' methods. Additionally, researchers attended and collected field notes at the following sites: the State Mine Safety Conference, meetings with safety professionals, and the San Xavier Mine training facility.

An email survey was sent to safety professionals in order to illicit attitudes and beliefs about teaching and learning. Additional informal interviews with safety professionals informed our understanding of current teaching and learning beliefs and practices in the industry.

The focus group was held three times: the first meeting to discuss teaching methods with a focus on 'what works'; the second meeting focused on 'challenges,' including language and literacy; the third meeting was a brainstorm session, to explore the instructional needs of trainers.

Findings. Observational field notes, interview transcriptions, survey results and focus group transcriptions were collected and coded. Below are several themes we found which informed the design of the curriculum for the Teaching Strategies for the Mine Safety Trainer Course.

Literacy. We refer to literacy as the ability and inclination to use symbol systems (print, pictures, formulas) to function safely and productively on the job and in society, to achieve goals, and to develop one's knowledge and potential (Kirsch et al., 1993, p. 2). Miners are skilled in a profession which is physically rigorous and requires a high degree of mechanical and technical literacy. Miners in the Western U.S. are likely to be English Language Learners. Most often Spanish is the dominate language. Trainers say they would like to be able to recognize the signs of an individual with low English literacy, and need strategies for teaching concepts using sign and symbol systems.

Current industry training practice. The mandatory safety training is reputed to be very boring; the typical miner or contractor "dreads" attending, reports not learning much, "endures" it and looks forward to getting back to work. While mentoring and social interaction happens naturally on the mine site, collaborative learning situations do not

tend to happen in the classroom. Although trainers express much appreciation for the background knowledge and experience of their trainee colleagues, they do not have strategies for accessing this background knowledge and experience to create collaborative learning in the classroom.

Course design. 'Teaching Strategies for the Mine Safety Trainer' is divided into five modules: 1) Orientations to Adult Learning, 2) The Language of Mining, 3) Second Language Acquisition, 4) Sharing Expertise, and 5) Worker-driven Teaching. The course uses collaborative teaching techniques while introducing theories and best practices for workplace literacy, adult education and language learning. Through active shared learning experiences, trainers develop a working knowledge of adult learning principles. The mining industry is explored from a teaching and learning standpoint. Trainers learn how to best communicate with miners who have low literacy and/or comprehension in English. Trainers will also learn strategies for accessing and building upon the prior knowledge and expertise of their students.

Courses offered. During 2011, Teaching Strategies for the Mine Safety Instructor was offered twice as a pilot course. The first course was offered on June 30 and July 1, and was a 16 hour course that met at the University of Arizona campus. Ten safety trainers were in attendance and the course was very well received. The course was offered again as a one day, 8 hour course on October 14 to nine attendees. The course was offered free of charge to these trainers, with lunch and snacks provided; was well received and modifications were made to the curriculum based on feedback from the first course.

6. We completed the Spanish translation of 52 toolbox training modules for Part 46 training. We have had the materials reviewed by several Spanish-speaking mining experts. The modules were reviewed by MSHA and are available on the MSHA website.

   All 52 modules of the NIOSH Toolbox Training have been translated into Spanish. The Language Consultant has met with four reviewers and revised accordingly, specifically paying attention to structural features of the language, regional variations, and authenticity and cultural appropriateness of the translated information. The finished modules were delivered to NIOSH for review in fall 2011 and were reviewed by MSHA.

   The primary goal of the project is to achieve the most accurate translation of the document so that the miners reading it would understand it linguistically and culturally. The consultant (Susan Rice) ensured that the translation stayed true to the meaning of the original text with appropriate adaptations, and was free of grammar, spelling and punctuation errors. Awkward sentence structure and unnatural sounding grammatical forms were adapted in accordance with Spanish grammar. The consultant was alert to figures of speech, colloquialisms and other expressions that need special care in translation (e.g. hair standing on end), and she was also aware of carefully translating words and concepts which may be unfamiliar to readers of the target language or individuals with low literacy. Ms. Rice adapted the text to make sense to the intended readers by paying attention to English words, phrases and concepts that have no direct equivalent in the target language (e.g. lockout/tagout). Ms. Rice helped readers learn a particular word or acronym in English that they will hear repeatedly in that language on the mine-site (e.g. PPE – Personal Protective Equipment); to reinforce comprehension, she also defined the term using well-understood vocabulary words and reused the term

in English, including the translated definition in parentheses when appropriate. For ease of reading by all and to accommodate miners with low literacy skills, the translation uses the simplest word when there was more than one appropriate choice in the target language.

Translation Vetting Process

The translation was vetted by four reviewers for accuracy, cultural suitability and ease of use. The four reviewers were chosen because of their linguistic expertise, experience in the mining industry, writing abilities and service as cultural informants/advisors. Vetting the translation using multiple reviewers enabled me to confirm the accuracy and comprehensibility of the translation from the perspective of readers with diverse backgrounds and specializations. Ms. Rice met with reviewers to discuss translation issues that arose. The comments of reviewer #4 are especially important as they provide feedback from the intended reader. Ms. Rice engaged the following four individuals in the vetting process of the translation:

Table 1. Translation Vetting for Part 46 Toolbox.

Reviewer	Background Information	Focus
1	• monolingual Spanish speaker • familiarity with the mining industry	• checked for overall quality – accuracy, fluidity, clarity, free of grammatical and syntax errors • checked for appropriateness of the technical vocabulary according to his experience with mining in the border/Northern Mexico region
2	• bilingual/biliterate • no mining background • translator for a national non-profit organization	• compared the English and Spanish versions • checked for overall quality – accuracy, fluidity, clarity, free of grammatical and syntax errors
3	• bilingual/biliterate • President of the Hazard Prevention Institute • extensive experience in the mining industry • experience translating similar mining documents • teaches the NIOSH Annual Refresher courses	• reviewed and edited specific portions of the modules that contained specialized vocabulary with which I was unfamiliar
4	• bilingual/biliterate • trainer who participated in the mining trainers' focus groups	• checked for overall quality and ease of reading from an intended reader's perspective (review is currently underway)

Results

There were three categories of changes to the translation that were made as a result of the vetting process. Each category of change is described below.

Structural Features

The first category of changes was related to the structural features of the language in the translation. The first two individuals reviewed the translation for grammatical errors (i.e. misuse of pronouns, incorrect verb conjugations) and commonly occurring syntactic errors (i.e. reorganization of sentence word order so as to sound more natural versus translated).

Regional Variations

The second category of changes was related to regional variations of the Spanish language. The target audience of this document is miners in the Western U.S.; because Spanish speakers in the West are principally from Mexico, it was important to be aware of regional colloquialisms across different dialects of Spanish. Thus, the translation favors Mexican terminology (the third reviewer gave particular attention to the regional and cultural appropriateness of the Mexican Spanish mining terminology). One example is the word for drum (i.e. container): it is translated by Spanish speaking miners from Northern Mexico as “tambor” rather than the Castilian Spanish word “bidón.”

It is important to use the vocabulary which most precisely captures the meaning of the term being translated. In choosing the most appropriate term, Ms. Rice also took into account the extent to which the intended readers have adapted to the culture and language patterns in the U.S. Several of the English terms had a Spanish equivalent; however, per the third reviewer, use of the English term was more prominent (albeit with a varied pronunciation) (e.g. near-hit). Other words had no direct equivalent in Spanish or could be translated in multiple ways, each of which carries a different meaning. In this last case, Ms. Rice identified the implicit meaning and decided how to best convey the term to Spanish speakers with cultural and linguistic complexities.

Authenticity and Cultural Appropriateness

The third category of change was related to authenticity and cultural appropriateness. Ms. Rice did not translate the document literally but instead interpreted the essence of the message being communicated in order to avoid vestiges of English grammar and syntax (interpretation as opposed to word-for-word translation also prevents confusion and misleading messages). The reviewers had knowledge of the intended readers’ culture and local language patterns as well as their variations of language use. They were also aware of the style appropriate for the document (i.e. the translation is written as a formal, published document to be used by tradesmen of a technical and hazardous profession) and of the objective that the text read naturally by the target audience (i.e. to native speakers of the Northern Mexican dialect of Spanish).

7. Our highly engaged Health and Safety Technical Advisory Committee (H&S TAC) was established in the fall of 2011. The H&S TAC consists of more than 30 members representing large, medium, and small companies, including: BHPBilliton, Rio Tinto, Resolution Copper, Freeport McMoRan, Newmont, Barrick, Hecla, Coeur Mining, Salt River Material Group, Vulcan Materials, Anglo American, Asarco, Peabody, Luminant Mining, Intrepid Potash, 3M Mining Group, Modular Mining Systems, Cementation, H.L. Boling, Mark Savitt (Jackson Lewis LLP), and the Arizona State Mine Inspectors Office.

   Table 2. Health and Safety Technical Advisory Committee Membership as of Spring 2015.

Bill Beaver	Coeur Mining
Belle Bharath	Anglo-American
Robert Blaylock	Peabody Energy
HL Boling	Consultant
Jefferey Burgess	University of Arizona
Tim Caylor	Mineral Park Inc.
Ken Chavez	Peabody Energy
DeVar Cluff	Asarco Silver Bell Mine
Joe Fletcher	Vulcan Materials
Fred Fox	Gila Health Resources
Tim Fox	Rio Tinto
Annette Gelfi	Freeport McMoRan
Steve Gravley	University of Arizona
David Hales	BHP Billiton
Joe Hart	Arizona State Mine Inspector
Ross Hill	University of Arizona/Retired
Deb Hutchison	Vulcan Materials
Donald Johnson	Luminant Mining
Tim Kilbreath	Intrepid Potash
Chris Knudsen	3M Mining and Minerals Extraction
Scott Krasner	Krasner Medical Consultants
Vivien Lee	University of Arizona
Michael Lewis	Modular Mining Systems
Roberto Lopez	Freeport McMoRan
Eric Lutz	University of Arizona
Michelle Lutz	Freeport McMoRan
Colin Nexhip	Rio Tinto
Mary Poulton	University of Arizona
Rustin Reed	University of Arizona
Bill Rice	Campbell County Memorial Hospital

Fred Samson	BHP Billiton
Mark Savit	Jackson Lewis
Jill Schultz	Freeport McMoRan
Renato Souza	Modular Mining Systems
Lance Steilman	Barrick Gold of North America
Brian Still	Cementation
Laurie Swartzbaugh	Arizona State Mine Inspector
Tom Vanderwalker	Salt River Materials Group
Aly Waibel	University of Arizona
Mike Wegleitner	Hecla Limited

Since inception, the H&S TAC formally meets via two primary venues: 1) monthly teleconference calls with an average per meeting attendance of 13 members, and 2) twice per year on campus Board Meetings, which have occurred in Dec 2011, and every subsequent April and December since.

8. In the early stages of the H&S TAC, a formal needs assessment was performed identifying supervisor leadership training as a high priority. From that direct feedback, the UA/IMR developed the Mining Institute for Supervisor Leadership (MISL).The most recent MISL flier is provided below, and MISL participant registration is found through the Western Mining Safety and Health Training Resource Center (WMSHTR Center) website at http://miningsh.arizona.edu/, under the "training" tab.

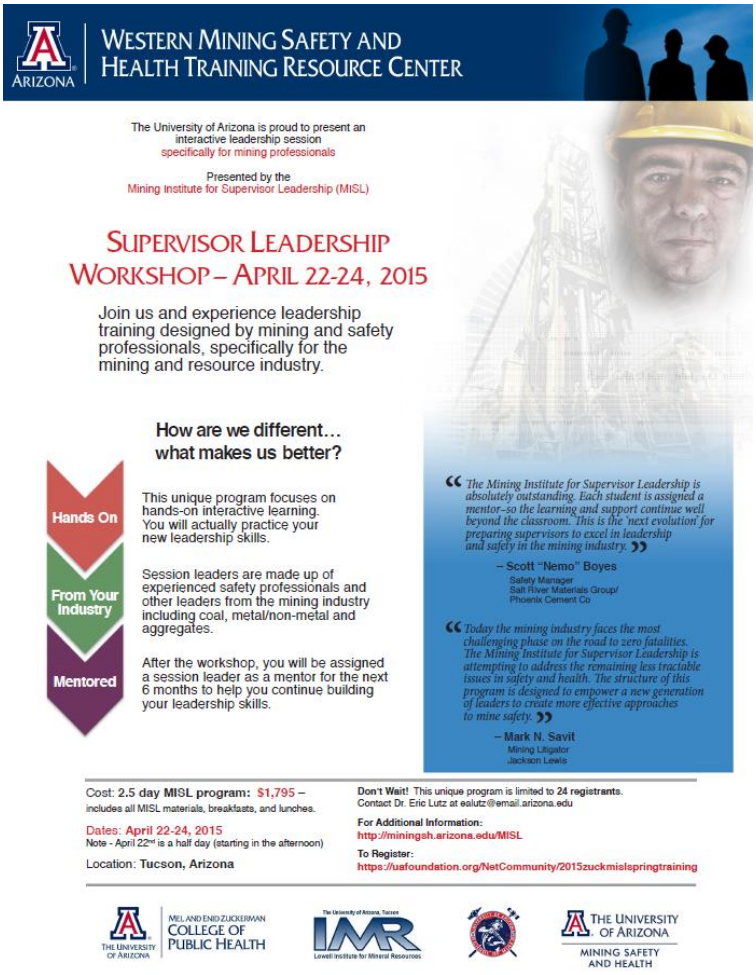
   At the completion of the intensive two and a half day course, participants in the MISL were partnered with a Mentor (from the TAC and UA faculty) that provides guidance and coaching while the participant undertakes a Leadership Project, allowing them to apply their new knowledge and skills in their respective workplaces. The participants (Mentees) return at the 6 month mark during the next MISL to present their projects and transition to becoming Mentors to the next cohort of participants. The first MISL workshop was held December 1-2, 2011 and has been repeated 5 times. Typical cohorts are 20-25 supervisors. The cohorts asked for more advanced training after they finished their first round of mentoring so in 2013, we created the Silver-Advanced Leadership Training (SALT). Extensive evaluations have been conducted and the overall result was that 95% "agreed" or "strongly agreed" that they would recommend the course to others; 90-95% felt the course met their goals and that they would be able to apply what they learned in their workplace.

   More than 100 MISL projects have been completed at mine sites to improve safety ranging from creating new software for safety observations to changing company procedures for electrical safety. Examples of a few MISL projects in recent years that have had positive impact in mining companies, include: creating an executive decision leadership team, new operation-wide fall protection program, improved pre-shift safety meetings, standardizing execution of improved safety management, hazard recognition, and fatality prevention training with a focus on contractors. The projects have resulted in permanent change in companies. In addition, we changed the way safety training is

done, with use of active learning techniques based on andragogical principles (adult learning techniques) at several mining companies.

The MISL has been attended by 81 miners from 23 companies across the U.S. The list of participants is in Appendix C.

Figure 1. Mining Institute for Supervisor Leadership to be held in April 2015. We have had participation from NIOSH in teaching this workshop.



A list of the specific MISL courses, instructors, and topic covered is provided in the following table.

Table 1. List of MISL instructors and topics.

Instructor	Company	Topics Taught
Thomas Bassier	Barrick/Retired	Leadership, MSHA Inspection Decorum, Achieving Safe and Compliant Production
Bill Beaver	Coeur Mining	Culture Specific Communications, Training Methods
HL Boling	Consultant	Leadership, Keynote
Scott Boyes	Salt River Materials Group	MSHA Inspection Decorum, Crisis Management and Self Rescue
Jefferey Burgess	University of Arizona	Risk Management
Carin Kosmoski	NIOSH	Culture Specific Communications, Training Methods
Tim Fox	Rio Tinto	Hazard Recognition
Steve Gravley	University of Arizona	Hazard Recognition
Annette Gelfi	Freeport McMoRan	Safe Behavior Recognition
Dave Hales	BHP Billiton	Planning/Time Management
Joe Hart	Arizona State Mine Inspector	Communication
Ross Hill	University of Arizona/Retired	History and Mine Tour, Communication
Deb Hutchison	Vulcan Materials	Communication
Donald Johnson	Luminant Mining	Human Performance Improvement
Tim Kilbreath	Intrepid Potash	Planning/Time Management
Chris Knudsen	3M Mining and Minerals Extraction	Getting the Most from your Suppliers
Eric Lutz	University of Arizona	Leadership, Planning/Time Management
Michelle Lutz	Freeport McMoRan	Effective Training, Advanced Leadership Training, Communication, Team Strategic Planning
Mary Poulton	University of Arizona	Business Management, Professional Miner/Fit for Duty
Rustin Reed	University of Arizona	Time Management
Mark Savit	Jackson Lewis	Legal
Jill Schultz	Freeport McMoRan	Conflict Resolution, Driving Culture Change, Motivating Your Team, Communication
Brian Still	Cementation	Conflict Resolution
Tom Vanderwalker	Salt River Materials Group	Conflict Resolution, Risk Management
Aly Waibel	University of Arizona	Compassionate Leadership

Evaluation of the MISL courses has occurred using pre-course questionnaires, in-course 'temperature gauge' questionnaires (e.g., "what in the prior session did you find most confusing", what in the prior session did you find most engaging, etc.,), two post-course questionnaires (i.e., logistics and training environment, program objectives and content), and a 6-month leadership project presentation evaluation built on a predetermined rubric. While the formal analysis of the questionnaires is ongoing, the H&S TAC has met following each MISL course to conduct a review of participants comments, quality of presentations, and 'hot wash' the event. From these reviews, significant course modifications have occurred throughout the

MISL's life span, including: length of course, agenda items covered, course venue, mentorship and project structure, evaluation of student 6-month project presentations, adding highest performing MISL student to one-year term on H&S TAC (Annette Gelfi – Freeport McMoRan, Joe Fisher – Vulcan Materials), etc. The pre-course and post-course questionnaires, and presentation evaluation and rubric, are provided below. We provided results of the evaluations in previous reports. Extensive evaluations were conducted and the overall result was that 95% agreed or strongly agreed (60%) that they would recommend the course to others. 90-95% felt the course met their goals and that they would be able to apply what they learned in their workplace.

Pre-course Questionnaire

1	When learning new knowledge and skills, do you prefer to:		Goal priority
	a)	do well in a course even though you don't have to work very hard; or	
	b)	work hard in a course even though you don't do very well.	
2	When in a course to learn new knowledge and skills, rank order which is most important to your success (1=most important and 5=least important). Use each number only once.		Perceptions of succe
	_____	Getting a good grade/evaluation	
	_____	Showing improvement	
	_____	Working hard	
	_____	Getting along with others in the course	
	_____	Doing as well or better than others in the course	
3	In a course to learn new knowledge and skills, rank order what feedback is most important to you (1=most important and 5=least important). Use each number only once.		Preferred feedback
	_____	Your grade/evaluation on assignments	
	_____	Performance relative to other learners in the course	
	_____	Progress or improvement	
	_____	Effort	
	_____	Performance relative to grade level norms	
4	Choose the better project for you.		Preferred task/chall
	a)	A project where I'll learn a lot of new things but also make a lot of mistakes: or	
	b)	A project that would involve a minimum of struggle and likely result in success.	
5	When having difficulty with a project do you		Preferred task/chall
	a)	continue working at it; or	
	b)	find another project where success is more likely.	
6	How would you identify your current level of performance training/teaching?		Attributions
	a)	Doing your best; or	
	b)	Could a little (or a lot) better.	
7	What factor best explains your level of performance on your job:		Attributions
	a)	Ability	
	b)	Effort	
	c)	Quality of past training and experience	
	d)	Requirements of the job/role	
8	How would you rate your ability to perform your job - compared to others at your work or in your field?		Perceived ability
	One of the lowest	One of the highest	
	1 2 3 4 5		
9	Of the leadership strategies about to be presented in this course, I will be capable of implementing…		self-efficacy
		Yes/No / If yes, confidence in doing so (1-100)	
	…at least 1 in my job.	_____ _____	
	…at least 2 in my job.	_____ _____	
	…at least 3 in my job.	_____ _____	
	…at least 4 in my job.	_____ _____	
	…at least 5 in my job.	_____ _____	
	…at least 6 in my job.	_____ _____	
	…at least 7 in my job.	_____ _____	
	…at least 8 in my job.	_____ _____	
	…at least 9 in my job.	_____ _____	
	…at least 10 in my job.	_____ _____	

Post-course Questionnaires (2)

		Strongly Disagree		Neutral		Strongly Agree	
1	Did the content meet the stated objectives?	1	2	3	4	5	Program objectives or content
	Comments/Suggestions:						
2	Were the jump-drive materials provided, consistent with the training objectives?	1	2	3	4	5	Program materials
	Comments/Suggestions:						
3	Was the content of the material easy to understand?	1	2	3	4	5	Program materials
	Comments/Suggestions:						
4	Were the presentation technologies used in the course effective?	1	2	3	4	5	Delivery methods or technologies
	Comments/Suggestions:						
5	Did the instructors present content clearly?	1	2	3	4	5	Instructor or facilitator
	Comments/Suggestions:						
6	Were the instructors well-prepared?	1	2	3	4	5	Instructor or facilitator
	Comments/Suggestions:						
7	Was the length of the program appropriate for stated objectives?	1	2	3	4	5	Program time or length
	Comments/Suggestions:						
8	Was the training content relevant to your job?	1	2	3	4	5	Planned action or transfer expectation
	Comments/Suggestions:						
9	Do you expect your organization to support your use of skills learned in this course?	1	2	3	4	5	Planned action or transfer expectation
	Comments/Suggestions:						
10	Was the overall instructional environment conducive to learning?	1	2	3	4	5	Overall
	Comments/Suggestions:						
11	Was there enough time to cover the course content?	1	2	3	4	5	Overall
	Comments/Suggestions:						
12	Did the training program meet your intended needs?	1	2	3	4	5	Overall
	Comments/Suggestions:						
13	Would you recommend this training program to others?	1	2	3	4	5	Overall
	Comments/Suggestions:						
14	What part of today's course surprised you the most? Maybe you would consider it a "lightbulb" moment.						
15	What was the most confusing idea we addressed in the presentatic						
16	What will encourage you to apply what you learned to your job?						Planned action or transfer expectations
17	What factors will inhibit you from applying what you learned?						Planned action or transfer expectations
18	What would you suggest to improve this course?						Recommendations

		Strongly Disagree		Neutral		Strongly Agree	
14	Were the presentation technologies used in the course effective?	1	2	3	4	5	Delivery methods or technologies
	Comments/Suggestions:						
15	Did the instructors present content clearly?	1	2	3	4	5	Instructor or facilitator
	Comments/Suggestions:						
16	Were the instructors well-prepared?	1	2	3	4	5	Instructor or facilitator
	Comments/Suggestions:						
17	Was the length of the program appropriate for stated objectives?	1	2	3	4	5	Program time or length
	Comments/Suggestions:						
18	Was there enough time to practice course objectives?	1	2	3	4	5	Program time or length
	Comments/Suggestions:						
19	Was the training content relevant to your job?	1	2	3	4	5	Planned action or transfer expectation
	Comments/Suggestions:						
20	Do you expect your organization to support your use of skills learned in this course?	1	2	3	4	5	Planned action or transfer expectation
	Comments/Suggestions:						
21	Was the overall instructional environment conducive to learning?	1	2	3	4	5	Overall
	Comments/Suggestions:						
22	Was there enough time to cover the course content?	1	2	3	4	5	Overall
	Comments/Suggestions:						
23	Did the training program meet your intended needs?	1	2	3	4	5	Overall
	Comments/Suggestions:						
24	How committed are you to attaining the goals you developed for applying your new knowledge and skills to your job?	1	2	3	4	5	Goal commitment
	Comments/Suggestions:						
25	How confident are you in the strategies you outlined to achieve your goal(s)?	1	2	3	4	5	Goal commitment
	Comments/Suggestions:						
26	Would you recommend this training program to others?	1	2	3	4	5	Overall
	Comments/Suggestions:						
27	What will encourage you to apply what you learned to your job?						Planned action or transfer expectations
28	What factors will inhibit you from transfering what you learned?						Planned action or transfer expectations
29	Of the leadership strategies presented in this course, I will be capable of implementing…						Self-efficacy
		Yes/No	If yes, confidence in doing so (1-100)				
	…at least 1 in my training/teaching program.	_____			_____		
	…at least 2 in my training/teaching program.	_____			_____		
	…at least 3 in my training/teaching program.	_____			_____		
	…at least 4 in my training/teaching program.	_____			_____		
	…at least 5 in my training/teaching program.	_____			_____		
	…at least 6 in my training/teaching program.	_____			_____		
	…at least 7 in my training/teaching program.	_____			_____		
	…at least 8 in my training/teaching program.	_____			_____		
	…at least 9 in my training/teaching program.	_____			_____		
	…at least 10 in my training/teaching program.	_____			_____		
30	What would you suggest to improve the training program?						Recommendations

6-month Project Presentation Rubric

Components	Description	Novice		Intermediate		Advanced
Situational Analysis	Identifies and describes a problem present in the leadership situation. Analyzes the problem in-depth (articulates the complexity) and presents it in a clear, concise fashion.	1	2	3	4	5
	Comment:					
Goals and Objectives	Overall goal of the Leadership Project is explicitly stated. Specific and measurable objectives were defined.	1	2	3	4	5
	Comment:					
Action Plan and Strategy	Clearly defines steps to achieve each objective.	1	2	3	4	5
	Comment:					
Outcomes/Impact	Clearly documents accomplishments - outcomes realized and/or ultimate impact of the Leadership Project.	1	2	3	4	5
	Comment:					
Communication of Results	Presentation clearly documents results of Leadership project. Slides are clear and well-organized. Voice is adequately audible.	1	2	3	4	5
	Comment:					
1) What do you believe is the greatest leadership strength of this presentor?						
2) What do you believe is the greatest leadership weakness of this presentor?						
3) Do you believe the presentor embodied the leadership traits and principles presented in the Fall 2011 MISL? Please explain your answer.						
4) If you were able to give this presentor "one piece" of advice as a future leader, what would it be?						
5) Based on this presentation, what do you believe should be added/stressed/deleted from the future MISL programs?						

Rubric for Leadership Project 1 of 2

Components	3-Sophisticated	2-Competent	1-Not yet Competent
Organization	Presentation is clear, logical, and organized. Listener can follow line of reasoning.	Presentation is generally clear and well organized. A few minor points may be confusing.	Organization is haphazard; listener can follow presentation only with effort. Arguments are not clear.
Style	Level of presentation is appropriate for the audience. Presentation is a planned conversation, paced for audience understanding. It is not a reading of a paper. Speaker is comfortable in front of the group and can be heard by all.	Level of presentation is generally appropriate. Pacing is sometimes too fast or too slow. Presenter seems slightly uncomfortable at times, and audience occasionally has trouble hearing him/her.	Aspects of presentation are too elementary or too sophisticated for audience. Presenter seems uncomfortable and can be heard only if listener is very attentive. Much of the information is read.
Use of Communication Aids	Communication aids enhance presentation. • The font on the visuals is readable. • Information is represented and organized to maximize audience comprehension. • Details are minimized so that main points stand out.	Communication aids contribute to the quality of the presentation. • Font size is mostly readable. • Appropriate information is included. • Some material is not supported by visual aids.	Communication aids are poorly prepared or used inappropriately. • Font size is too small to read. • Too much information is included. • Details or some unimportant information is highlighted, and may confuse the audience.
Project Description and Goals	Speaker provides complete explanation of project including issue addressed, steps and individuals/departments involved.	For the most part, explanations of project including issue addressed, steps and individuals/departments involved.	Explanations of project including issue addressed, steps and individuals/departments involved are incomplete.
Benefit	Identified barriers or challenges. Long term benefit to company is clearly presented.	Mentioned barriers or challenges. Some reference to long term benefit for the company is presented.	No mention of barriers or challenges. No long term benefit to company is presented and/or was not considered in the project.

Mining Institute for Supervisor Leadership (MISL), University of Arizona, April 2014

Rubric for Leadership Project 2 of 2

Impact and Assessment			
Plans to expand participants and/or dissemination	Plan to expand/integrate project to impact more participants and/or disseminate the project to other sites or companies (or clear reasons for not doing so).	Limited plan to expand/integrate project to impact more participants and/or disseminate the project to other sites or companies (or clear reasons for not doing so).	No plan to expand/integrate project to impact more participants and/or disseminate the project to other sites or companies (or clear reasons for not doing so).
Assessment	Presented pilot-level data for impacts of project OR presents plan to assess outcomes of project.	Presented extremely limited pilot-data for impacts of project or limited plan to assess outcomes of project.	Makes no reference to assessing impacts of project or has no plan for assessing impacts of project.

The Lowell Institute for Mineral Resources (IMR) and the Western Mine Safety and Health Training Resource Center provides mine operators with customized leadership training. To date, three custom leadership programs have been implemented, including: Papuan Supervisor Leadership Programs (3 cohorts), Executive Leadership Coaching, and a leadership program for South American miners in Chile (2 cohorts in 2015 and projected to continue).

Aim 3

9. We have trained miners and supervisors at their mine sites for industrial hygiene and exposure monitoring. The training courses are proving popular and have had positive feedback for effectiveness. In addition to significant industrial hygiene web content available on the Center website, the IMR provides industrial hygiene, health, and safety training to mine operators. This training has, to date, been provided to four mine operators (3 aggregate operators and 1 underground metal/non-metal mine). The content of this training has ranged from radon sampling, noise exposure monitoring, compliance respirable dust monitoring, and silica compliance evaluations.

10. We conducted industrial hygiene training at the September 2011 meeting of the Arizona Chapter of the International Society of Mine Safety Professionals. We have established a partnership with the UCLA So. California NIOSH ERC partnership for offering Mining Industrial Hygiene Training classes starting January, 2012.

11. Since our contract is a cooperative research agreement we have built strong relationships across NIOSH and OMSHR. For example we have hosted several research visits from NIOSH personnel to conduct research at the San Xavier Mine. One of the key program faculty member of the Center (Co-PI on funded competitive renewal), and UA Director of the Mine Safety and Health Programs, Dr. Eric A. Lutz, PhD CMSP, is currently providing senior scientific contract services via IPA on two NIOSH mining-related studies, including: the DRDS Metal/Non-metal Worker Health Surveillance project (10% FTE, renewed for second year) and the OMSHR IR Silica Dust Real-time Monitor project (15% FTE, in year 1). We hosted a researcher to collaborate on real time silica monitoring. We hosted a full day meeting with the NIOSH DRDS group on a roadmap for metal/non metal total worker health. We also are working with OMSHR personnel and a technology company called DAQRI (augmented reality products) on efficacy of advanced visualization for training.

Aim 4

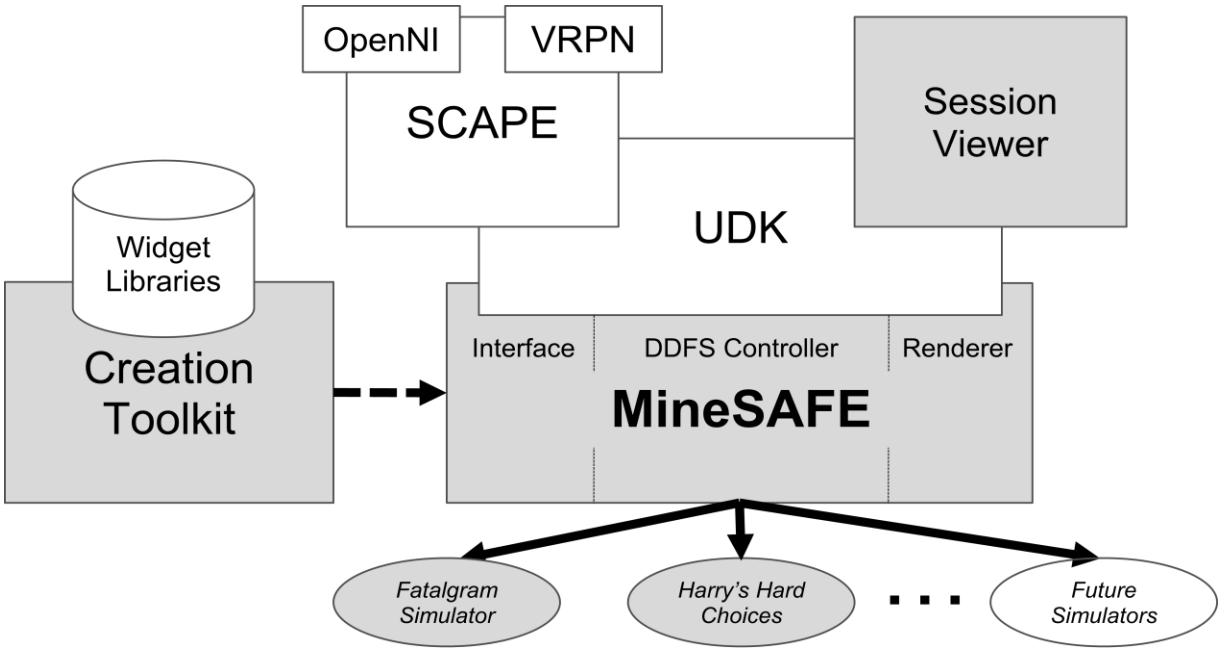
Appendix D provides detailed information on MineSAFE software which has been submitted as an invention disclosure. Below is a brief synapsis of the platform and product.

New Approaches in Computer-based Training Software. We realized early in our planning stages that existing training software and simulations would be insufficient to meet our training objectives. In year one, we assessed the body of existing software products targeted to the mining industry to identify limitations and areas for improvement. Along these lines, we conducted a triangulated needs assessment with three data sources: 1) product surveys conducted by a group of experts within our team, 2) informal user studies of existing training software, and 3) feedback from industry stakeholders. Our needs assessment identified five vital characteristics to drive the design of computer simulations for mine safety training:

1. Accessible: Software should be accessible to a broad range of user demographics, engaging a new generation of miners in addition to experienced miners. Reasonable accommodations should be made to address computer and workplace literacy issues, as well as second language learners.
2. Team-Oriented: Training simulations should attempt to capture the social interactions and team dynamics present in the mining workplace. An emphasis should be placed on promoting good communication and cooperative thinking.
3. Contextualized: The virtual training environment should provide a believable and immersive context that allows for situated learning. The environment should be immersive and multi-modal, replicating the sights, sounds, and dynamic interactions of the mining workplace. The software should support a mentoring style of learning.
4. Consequent. Choices should have tangible consequences that impact both the individual player and his or her team. Consequences should be persistent and cumulative, resulting in realistic changes to simulation state and user options. Both positive and negative outcomes should be memorably reinforced.
5. Competitive. The training session should foster a competitive spirit and a desire to replay through metrics such as high scores and time limits, as well as rewards that are based on the quality of outcome. Training software should incorporate varying degrees of difficulty and randomize events to promote competitive replay.

Supporting these findings, Peters *et al* (2010) point to the research by Burke *et al* (2006) and Robson *et al* (2010) that suggest realistic and engaging training is more effective and may result in greater transfer to the job. The researchers also identified the potential of "serious games" using virtual reality to create more realistic and engaging training, noting "the more experience people gain through participating in such role playing simulations, the better prepared they will be to handle real-world events." This view is strongly supported by the findings of Alexander *et al* (2010), who calls for the development of "virtual reality theatres" (p. 41) for mine emergency rescue training. Toward this end, we have developed a scalable platform called MineSAFE to enable serious games for mine safety.

MineSAFE: The Software Architecture For Education in Mine SAFEty. MineSAFE was built atop the Unreal Engine (<http://www.unrealengine.com/udk/>), a commercially available game engine with advanced graphics and interaction capabilities. Our platform uses well-established workflows and software practices employed by the gaming industry to expedite development and reduce costs. As opposed to linear stories, game scenarios can be programmed as decision trees that fork to different sequences of events. For example, users can be assigned task objectives with competing choices that lead to different outcomes and impact all future choices available to the user. A corresponding physics engine enforces interactions with the virtual world. The physics engine provides believable interactions with objects in the environment, as well as ambient conditions such as propagating fires and smoke and destructible objects. Finally, the platform allows for sophisticated rendering through programmable shaders to realistically portray skin, duress to actors, and various particle-based mine disaster events. MineSAFE games can run on computer hardware ranging from mid-range laptops to higher-end workstations and virtual reality theatres, with support for interface devices that include keyboards, mice, gamepads, as well as emerging gesture-enabled interfaces such as Leap and Kinect.



Structure of the MineSAFE gaming platform. Its dependencies include UDK and our proprietary Creation Toolkit; supplementary external APIs (SCAPE, OpenNI, and VRPN) provide optional functionality for experimentation in user interaction, virtual reality, and gaming strategies. MineSAFE's derivatives include the serious games "*Harry's Hard Choices*" and "*Interactive Fatalgram Simulator*." The shaded components were built in whole or in part under this contract.

In addition to the core simulation engine, MineSAFE also incorporates a suite of tools to speed scenario development and assist in evaluation. The data-driven capacity of the platform makes games modular and easier to modify. A specialized scripting language, called Data-Driven Function Script (DDFS), was developed in-house to support the creation of new training scenarios. We have also developed the Creation Toolkit, which provides generic mine safety assets suitable for future games and expansion modules, and the Session Viewer, which provides logging and playback capabilities.

Center Management

The Western Mine Safety and Health Training Center (Center) was jointly administered under separate contracts by the University of Arizona (UA) and the Colorado School of Mines (CSM) during this contract period.

Ros Hill served as liaison between the UA Industry Mine Health and Safety Technical Advisory Committee (TAC) and CSM's advisory committee. Mary Poulton shares results of the UA project with the CSM team after UA team meetings and we met at SME annual meetings and the western mine safety conference to coordinate activities. Ros Hill coordinated with CSM on mine rescue training. Our evaluation consultant assisted CSM in developing their evaluation strategies. We created a joint brochure for CSM and UA's components of the Center. We created a unified exhibit booth that we used at the 7th and 8th Annual Joint Western Regional Mining Safety and Health Conferences in October 2011 and 2012 in Henderson and Reno, NV.

Ros Hill and Eric Lutz were instrumental in moving the the SME Health and Safety Committee to division status in SME. Hill and Lutz have/are chairing the committee. This service provides the opportunity to interface the Center with the SME membership. Further, Lutz, is bringing mine safety to the attention of other professional societies such as the International Society of Exposure Science.

Publications

Peer Reviewed Journal Papers

1. Waibel, A., Anders, P. L., Kelley, J. (2012). Digging deeper: Language, literacy and learning in the mine safety industry. Literacy Research Association Yearbook. Oak Creek, WI: The Literacy Research Association.
2. M. Lutz, E. Lutz, 2013, "Training Future Leaders in Mining: Conducting and Evaluating an Action Learning Program", submitted to *Action Learning: Research and Practice*
3. M. Lutz, E. Lutz, 2013, "Teaching and Learning in the Mining Community: A Matter of Life and Death", American Educational Research Association proceedings
4. Poplin GS, Miller HB, Sotille J, Hu C, Hill JRM, Burgess JL. 2013, Enhancing severe injury surveillance: The association between severe injury events and fatalities in US coal mines. *Journal of Safety Research*; 44:31-35.
5. Gerald S. Poplin, Jefferey L. Burgess, John RM Hill, Chengcheng Hu, Hugh Miller and Joseph Sotille. Development of a Severe Injury Surveillance System for Hazard Identification and Guiding Technological Interventions submitted to NIOSH Mining.

Conferences

1. E. Lutz, R. Reed. 2014. "Pilot-Scale Application of Using Traditional and Novel In-Ear Noise Exposure Monitoring in Active Shaft Mining to Evaluate Noise Controls," SME Annual Meeting and Exhibit. Salt Lake City, UT.
2. E. Lutz, R. Reed. 2014. "Occupational Heat Strain in Deep Shaft Metal Mining," SME Annual Meeting and Exhibit. Salt Lake City, UT.
3. M. Lutz, J. VanLandingham. 2014. " Leadership Mentoring in the Mining Community: A Case Study," SME Annual Meeting and Exhibit. Salt Lake City, UT.
4. E. Lutz, T. Regan, X. Liu, J. Burgess. 2014. "Age, Injuries, and Costs in the Mining Industry: A Case Study for U.S. Gold and Coal Mines," SME Annual Meeting and Exhibit. Salt Lake City, UT.
5. L. Brown. 2014. "MineSAFE: Application and Extension of Serious Games for Mine Safety Education."SME Annual Meeting and Exhibit. Salt Lake UT.
6. E. Lutz, C. He, G. Gowrisankaran, J. Burgess. 2014. "Fatalities and Disasters in Coal Mining," SME Annual Meeting and Exhibit. Salt Lake City, UT.
7. Waibel, A., Anders, P., Zabari, D. (2013, April). Literacy and Pedagogy in Mine Safety Training: The Intersection of Academic and Workplace Domains. Roundtable presentation at the American Educational Research Association Meeting, Adult Literacy and Education SIG, San Francisco, California.

8. Waibel, A., Anders, P., Zabari, D. (2013, April). Digging Deeper: Language, Literacy, and Learning in the Mine Safety Industry. Roundtable presentation at the American Educational Research Association Meeting, Adult Literacy and Education SIG, San Francisco, California.
9. Burgess, J., 2013, XVII International Seminar on Safety in Mining Operations, Lima, Peru. Burgess JL.Instituto de SeguridadMinera “International Evaluation of injury rates in metal and coal mining: A comparison of risk and compliance-based regulatory approaches”
10. Lutz, EA, 2013. Society of Mining, Metallurgy, and Exploration (SME), Denver, CO. Extract your Full Leadership Potential.
11. L. Brown, R. Hill, M. Poulton. 2013, MineSAFE: A New Software Architecture for Mine Safety Education, SME Annual Meeting, Denver, CO
12. Lutz, E, 2012. Invited Presentation - Mining Leadership – ISMSP Critical Issues Conference, Reno, Nevada, May, 2012.
13. Lutz, EA, 2012. 8th Annual Join Western Regional Mining Safety and Health Conference, Reno, NV. Safety-focused Leadership – Mining Institute for Supervisor Leadership (MISL).
14. Lutz, EA, 2012. Critical Issues Conference, International Society of Mine Safety Professionals, Reno, Nevada. Building Leaders - Mining Institute for Supervisor Leadership (MISL) Program.
15. E. Lutz and M. Lutz, 2012, Language and Literacy in the Mining Community – Western Mining Safety and Health Conference, Reno, Nevada, October, 2012.
16. Brown L, 2012, 3-D Gaming Simulation for Mining Training – Western Mining Safety and Health Conference, Reno, Nevada, October, 2012.
17. Stobbe T, 2012, Ergonomics – Western Mining Safety and Health Conference, Reno, Nevada, October, 2012.
18. Waibel, A., Anders, P., Zabari, D. (2012, October). Teaching Strategies for the Mine Safety Instructor. Presentation at the 8th Annual Joint Western Regional Mine Safety and Health Conference, Reno, Nevada.
19. Lutz, EA, 2011. 7th Annual Joint Western Regional Mining Safety and Health Conference, Henderson, NV. Institute for Mineral Resources (IMR) Industrial Hygiene Resources Program.
20. Lutz EA. 2011. 7th Annual Joint Western Mining Safety and Health Conference Ergonomics (2), Fatalgram Simulations (2), Train-the-Trainer Methodologies, Industrial Hygiene, IMR and UA Mining Research.
21. Anders, P., Waibel, A., Kelley, J., Rice, S. (2011, October). Teaching Strategies for the Mine Safety Instructor. Presentation at the 7th Annual Joint Western Regional Mine Safety and Health Conference, Henderson, Nevada.
22. Waibel, A., Anders, P., Kelley, J. (2011, December) Digging Deeper: Language, Literacy and Learning in the Mine Safety Industry. Paper presented at the Literacy Research Association Annual Conference, Jacksonville, Florida.

Presentations

1. Jim Joy, Mike Byrne and Jeff Burgess. Interim Report to ICMM: Material Health and Safety Critical Control Risk Management in ICMM Member Companies. March 24, 2014 London, England
2. J. Burgess and E. Lutz, 2012, Invited participation in Alpha Foundation Mining Safety and Health Research Grants Planning Meeting in Charleston, WV – October, 2012.
3. Lutz, EA, 2012. Arizona Mining Association Safety Committee, Phoenix, Arizona. NIOSH Western Mining Safety and Health Training Resource Center and the Mining Institute for Supervisor Leadership.
4. Lutz, EA. 2011. International Society of Mine Safety Professionals – Arizona State Chapter Meeting, Tucson, Arizona. University of Arizona Mining Safety and Health Programs.
5. Hill, J., 2011, Advances in Mine Safety and Health Training and Research at the University of Arizona, Arizona State Mine Inspectors fall conference on Oct. 7, Phoenix, AZ.
6. Mary Poulton and Eric Lutz, 2011, IMR Mine Safety Research, Joint Meeting of Arizona Rock Products Association and Arizona Mining Association Meeting, January 13, 2011, Phoenix
7. Lutz EA, 2011, International Society of Mine Safety Professionals, IH Training and Service Presentation – September 2011
8. Lutz, EA, Mining Institute for Supervisor Leadership (MISL) – December 1-2, 2011
9. Lutz, EA, Arizona Mining Association – February 15th – UA and IMR Mining Safety and Health Program

Additional Presentations in which mine health and safety projects were presented:

1. Mary Poulton, Overview of the Institute for Mineral Resources, Chemical and Environmental Engineering graduate seminar, September 22, 2009.
2. Mary Poulton, Mark Barton, Tim Snider, Lowell Institute for Mineral Resources, Presentation to SFAz and Representative Judy Burges, February 12, 2010
3. Mary Poulton, Overview of the Institute for Mineral Resources, Chemical and Environmental Engineering faculty presentation, March 10, 2010.
4. Mary Poulton, Overview of the Lowell Institute for Mineral Resources, March 19, 2010, Presentation to SFAz Board of Directors
5. Mary Poulton, Overview of the Lowell IMR, Colorado School of Mines, April 15, 2010 Golden, CO (2 presentations plus meeting with vice president for research)
6. Mary Poulton, Mineral Resources Education and Research in the 21st Century: Arizona Leads the Way, April 20, 2010 Pinal Mountain Section of SME, Globe, AZ
7. Mary Poulton, Arizona's Resourceful Future, Briefing to Terry Goddard, Arizona Attorney General, May 6, 2010, Phoenix (with Gary Jones, Tim Snider, Scott Urquardt).
8. Mary Poulton, Overview of the Lowell IMR, Newmont Process Technology Center, May 18, 2010 Denver
9. Mary Poulton, October 8, 2010 presented the IMR and San Xavier Mine to the UA Foundation Board

10. Mary Poulton, October 14, 2010 presented the IMR to the UA EPA Superfund Project colloquium
11. Mary Poulton, Overview of the Lowell IMR, Newmont Process Technology Center, May 18, 2011 Denver
12. Mary Poulton, Mining in Arizona: A New Century, A New Story: presented to Arizona Mining Caucus, June 9, 2011, Tucson, AZ.
13. Mary Poulton, "Mining in Arizona: A new century and a new story", Arizona Mining Alliance Phoenix kick off meeting, August 9,2011 Phoenix, AZ
14. Mary Poulton, "The Demographic Earthquake: How to address workforce capacity in the mineral resources professions", Society of Mining Professors Annual Meeting, Arequipa, Peru, September 12, 2011
15. Mary Poulton, "Creating an Interdisciplinary Research Organization for Sustainable Development of Critical Earth Materials", Society of Mining Professors Annual Meeting, Arequipa, Peru, September 13, 2011
16. Poulton, M., "Technology Advances to Overcome Regulatory Hurdles" IQPC Mine Automation Summit, Feb 1, 2012, Tucson, AZ
17. Mary Poulton, Overview of the Lowell IMR, Colorado School of Mines, April 15, 2012 Golden, CO (2 presentations plus meeting with vice president for research)

Additional:

50 presentations to mining companies and legislators between fall 2009 and August 2014
12 talks to community groups in 2012, 2013, 2014
1 UA Presidential Distinguished Lecture, June 7, 2012, Washington, DC
10 seminars at UA to various departments

- 1 presentation to Arizona Board of Regents, December 2012, Tucson, AZ
- 1 presentation to Arizona-based staff of all Arizona federal representatives and senators, March 25, 2014

Materials Available for Other Investigators

Key products and services from this project include the following:

1. MISL training available to supervisors across the US
2. Part 46 Toolbox in Spanish – will be available on Center website
3. Handbook for active learning for required MSHA courses – we have appended a pdf of the handbook in Appendix B. Handbook will be available on Center website.
4. MineSAFE software platform for serious games in mine safety training; training products developed via the platform include *Interactive Fatalgram Simulator* and *Harry's Hard Choices.* Harry's Hard Choices is being commercialized.
5. Mine rescue training capacity for the Southwestern US
6. Train the trainer courses for improved MSHA training being offered at mine sites.
7. Industrial hygiene support services for small and medium companies

8. Health surveillance support services for mines including noise, heat stress, particulate matter
9. Easy to navigate website for access to health and safety resources and a blog on mine health and safety http://miningsh.arizona.edu/ which is currently undergoing a major revision.

APPENDIX A

Evaluation of Activities

THE UNIVERSITY OF ARIZONA

EVALUATION REPORT

AIM 2
TEACHING STRATEGIES FOR THE MINE SAFETY TRAINER

WESTERN MINING SAFETY AND
HEALTH RESOURCE CENTER
1235 E. JAMES WAY
TUCSON, AZ 85721

MAY 30, 2012

EVALUATION REPORT

AIM #2 – TEACHING STRATEGIES FOR THE MINE SAFETY TRAINER

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EVALUATION REPORT

AIM #2 – TEACHING STRATEGIES FOR THE MINE SAFETY TRAINER

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) has funded The University of Arizona (Grant #5U60OH010014) to develop training and educational programs for those working in the mining industry in the Western U.S. The overarching goal of this grant is to not only reduce the number of illnesses and injuries in the mining industry, through targeted training and educational programs, but also to increase the capacity of high quality mine safety and mine safety trainer programs. The University of Arizona team is comprised of experts from the Colleges of Public Health, Education, and Department of Mining and Geological Engineering. The project team developed four specific Aims to reach the project goal. The specific aims of this project are:

1. Training Capacity,
2. Adult Learner/ELL/Low Literacy Training (Teaching Strategies for the Mine Safety Trainer),
3. Advanced Courses in Occupational Health and Industrial Hygiene; and
4. Fatalgram Gaming Scenarios.

Because each Aim targets very specific aspects of the project goal, stand-alone Evaluation Plans and Evaluation Reports were developed for each Aim. This Evaluation Report is for Aim #2 – Teaching Strategies for the Mine Safety Trainer.

As discussed above, the overarching goal of this project is to not only reduce the number of illnesses and injuries in the mining industry, through targeted training and educational programs, but also to increase the capacity of high quality mine safety and mine safety trainer programs. The purpose of Aim #2 is to develop and deliver courses for trainers and supervisors on best practices for teaching adult learners, English language learners, low literacy and education disadvantaged learners.

EVALUATION FINDINGS

OCTOBER 2011

In October 2011, the Aim #2 project team conducted the first Teaching Strategies for the Mine Safety Trainer program. It was held at the University of Arizona facilities in Tucson, Arizona. The findings from this portion of the evaluation are to be used as feedback to the project team, for possible revisions to the

Teaching Strategies program. Furthermore, it will allow NIOSH to make decisions about the overall effectiveness of the program.

As noted in the Evaluation Plan for Aim #2, our evaluation targeted both the Content and Design and Changes in the Learner for the Teaching Strategies program. Each of these target areas is discussed below.

CONTENT AND DESIGN

Participants provided their feedback on the content and design of the October 2011 program via a 26 question, 5-point (1=Strongly Disagree, 5=Strongly Agree) End-of-Course Questionnaire (Appendix B). As we noted in the Evaluation Plan for Aim #2, the relevant dimensions of the evaluation for the Teaching Strategies program included logistics/administration, training environment, program materials, instructional activities, delivery methods/technologies, instructor/facilitator, program time/length, and planned action/transfer. The responses are compiled in Table 1, which provides the relative frequency of participants' ratings, the number of participants responding, the mean or average response, and the standard deviation. Additionally, Questions #27-31, and 33, were open response and we have included each participant's notations without determining its value or meaning. For example, if the participant responded "none" or "???" to a question, we have included it as a response on the data tables.

Expert Judgment and Advisory Panel

The Teaching Strategies program was designed by Dr. Patricia Anders and her team. Dr. Anders is the Jewell M. Lewis Distinguished Professor of Education at the University of Arizona and considered internationally as an expert in the fields of language, reading, culture, adult learning and literacy. Therefore, we believe that Dr. Anders personal involvement in the design and implementation of the program is representative of expert judgment not only in the design and delivery, but also the validity of the content.

Course Ratings

While some researchers express concern over "novices" providing feedback on content and design of a program, we believe this concern is not applicable here because Teaching Strategies participants were identified as knowledgeable and highly skilled in their respective fields. They are participating in the Teaching Strategies to increase their knowledge and skills in the area of adult learning. Therefore, we deem their feedback to be both relevant and appropriate. The results of the participants' course ratings are presented below.

Logistics and Administration

Three questions (#1, #2, #3), inquired about the scheduling and registration for the program. Most participants Agreed or Strongly Agreed that registering for the course was easy and straightforward

(M=4.43, SD=0.79) and that communication regarding the course was also clear and straightforward (M=4.00, SD=1.00). Question #3 asked participants if the "course schedule was well planned (restroom breaks, lunch, etc)" and the majority Agreed with a mean response of 4.25 (SD=0.71).

Participants were able to write-in comments for each question on the survey and on Question #2, two participants noted that the classroom number was not provided in the registration email. One participant commented on Question #3, noting that the sessions could be 45 minutes and then have a break. This participant also noted the need for a "better map".

These results suggest that overall; participants were satisfied with the logistics and administration of the Teaching Strategies program, although the project team may consider providing an additional map or clarification of the classroom number. Additionally, when preparing the schedule for the next program, the project team may want to modify the schedule to allow for additional restroom breaks.

Training Environment

Questions #4 through #8, asked participants about the training environment of the Teaching Strategies program. Participants Strongly Agreed (M=4.63, SD=0.52) that the "training environment was appropriate for learning" (Question #4) and they Agreed (M=4.25, SD=0.71) that "there was enough workspace for class activities" (Question #6). Notably, the mean response to Question #4 was tied as the second highest response.

Question #5 asked if "environmental conditions – comfort, heating, noise, visibility – conducive to learning?" While most Agreed with Question #5, it had the lowest mean response, 3.57 (SD=0.98), of any question on the End-of-Course Questionnaire. Four participants commented about the noisy projector.

Participants were asked in Question #7 if the food provided was "appropriate (variety, type, etc)", most participants Strongly Agreed (M=4.25, SD=0.89). However, two participants commented on Question #7, one noting "could have had options" while the other participant noted "no veggie".

Question #8 asked participants if they would "recommend the facilities be used again". The mean response was 4.63 (SD=0.52) and was tied with Question #4 as the second highest mean response.

These results suggest that while most participants were satisfied with the training environment, they were distracted or irritated by the noisy projector. Additionally, the project team may consider providing additional sandwiches options for participants.

Program Objectives

The majority of participants Agreed (M=4.38, SD=0.52) that the content presented in the program met the stated objectives (Question #9).

Program Materials, Instructional Activities and Delivery Technologies

Questions #10 and #13 asked participants if training materials were "consistent with the training objective" (#10) and if the "content of the material" was easy to understand. The majority Agreed with both questions each having a mean response of 4.25 (SD=0.71).

In Questions #11 and #12, participants were asked about the course exercises (#11) and group discussions (#12). The mean response for Question #11 was 4.50 (SD=0.53), suggesting the majority of participants Strongly Agreed that the "course exercises were relevant to the program objectives". The mean response for Question #12 was 4.38 (SD=0.74), suggesting the majority of participants Strongly Agreed that the group discussions were "helpful to participants in exchanging ideas with each other". One participant commented in Question #12 - "Very. We never have enough chances to do that. Very helpful".

Participants also Agreed that the "presentation technologies used in the course" were effective (Question #14), giving a mean response of 4.25 (SD=0.71). One participant noted that it was "ironic" that PowerPoint was used in the program.

These results suggest that participants were satisfied with the program materials, activities and delivery technologies.

Instructors

Questions #15 and #16 asked participants if instructors presented "content clearly" (#15) and if they were "well-prepared" (#16). Participants Agreed with both questions giving mean responses of 4.38 (SD=0.52).

These results suggest overall participants believed the instructors were well prepared and presented the content clearly.

Program Length

Participants were asked if the "length of the program was appropriate for the stated objectives" (Question #17) and if "there was enough time to practice course objectives" (Question #18). The majority Agreed with mean responses of 4.25 (SD=0.71). One participant noted, in response to Question #17 – "short of time".

The results suggest that the participants believed the length of the program was appropriate and there was enough time to practice the course objectives. However, based on participant feedback, the project team may want to consider the length of the program.

Transfer Expectation

Participants Agreed that the training content was relevant to their jobs (Question #19) and Strongly Agreed in their expectations that their organizations would support their use of skills learned (Question #20), with mean responses of 4.13 (SD=0.64) and 4.50 (SD=0.76), respectively. One participant noted in response to Question #20 – "Yes I expect so".

Question #28 asked participants "What will encourage you to apply what you learned to your job?" Eight participants responded to the question and no dominant theme was apparent. While Question #28 focused on what would encourage participants to apply what they learned, Question #29 asked participants what would inhibit them from applying what they learned. Seven participants responded and the dominant theme appears to be lack of time and/or management. All responses to Questions #28 and #29 can be found on Table 1.

These results suggest that participants found the training content to be relevant to their respective jobs, but they were unsure if they would have the time and support of management in applying their new skills. The project team may want to consider how participants can conquer these issues in future programs.

Overall Rating and Recommendations

Questions #21, #22, and #23, asked participants about the overall program with mean responses of 4.50 (SD=0.53), 3.88 (SD=1.13), and 4.50 (SD=0.76), respectively, suggesting overall Agreement. In response to Question #21 (Was the overall instructional environment conducive to learning?); one participant noted "yes". However, it should be noted that the mean response to Question #22 (Was there enough time to cover the course content?) was the second lowest of all responses in the October 2011 Teaching Strategies program.

The majority of participants Strongly Agreed, with a mean response of 4.75 (SD=0.46), that they would "recommend this training program to others" (Question #26). In fact, Question #26 was tied with Question #24 as the highest mean response for the October 2011 program. When asked "What would you suggest to improve this training program?" (Question #33), two participants noted additional time, while one noted "more visuals". Additionally, two participants noted the program was "great" and "on the right track". All the comments are provided in Table 1.

These results suggest that participants were satisfied with the overall Teaching Strategies program. However, the project team may consider possible participant concerns about "enough time" to cover the course content. Clarification may be necessary because only one participant noted on Question #18 – "short of time". The project team should review all participant comments provided in Table 1.

Table 1 – End-of-Course Questionnaire, Fall 2011 Program

	Questions	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	n	Mean	Std Dev
1	Was registering for the course easy and straightforward?	0%	0%	14%	29%	**57%**	7	4.43	0.79
2	Were communications (phone calls, emails, etc.) regarding the course clear and straightforward?	0%	14%	0%	**57%**	29%	7	4.00	1.00
3	Was the course schedule well planned (restroom breaks, lunch, etc.)?	0%	0%	13%	**50%**	38%	8	4.25	0.71
4	Was the training environment appropriate for learning?	0%	0%	0%	38%	**63%**	8	4.63	0.52
5	Were the environmental conditions - comfort, heating, noise, visibility - conducive to learning?	0%	14%	29%	**43%**	14%	7	3.57	0.98
6	Was there enough workspace for class activities?	0%	0%	13%	**50%**	38%	8	4.25	0.71
7	Was the food provided appropriate (variety, type, etc.)?	0%	0%	25%	25%	**50%**	8	4.25	0.89
8	Would you recommend the facilities be used again?	0%	0%	0%	38%	**63%**	8	4.63	0.52
9	Did the content meet the stated objectives?	0%	0%	0%	**63%**	38%	8	4.38	0.52
10	Were the materials consistent with the training objectives?	0%	0%	13%	**50%**	38%	8	4.25	0.71
11	Were the course exercises relevant to the program objectives?	0%	0%	0%	**50%**	**50%**	8	4.50	0.53
12	Were the group discussions helpful to participants in exchanging ideas with each other?	0%	0%	13%	38%	**50%**	8	4.38	0.74
13	Was the content of the material easy to understand?	0%	0%	13%	**50%**	38%	8	4.25	0.71
14	Were the presentation technologies used in the course effective?	0%	0%	13%	**50%**	38%	8	4.25	0.71
15	Did the instructors present content clearly?	0%	0%	0%	**63%**	38%	8	4.38	0.52
16	Were the instructors well-prepared?	0%	0%	0%	**63%**	38%	8	4.38	0.52
17	Was the length of the program appropriate for stated objectives?	0%	0%	13%	**50%**	38%	8	4.25	0.71
18	Was there enough time to practice course objectives?	0%	0%	13%	**50%**	38%	8	4.25	0.71
19	Was the training content relevant to your job?	0%	0%	13%	**63%**	25%	8	4.13	0.64
20	Do you expect your organization to support your use of skills learned in this course?	0%	0%	13%	25%	**63%**	8	4.50	0.76
21	Was the overall instructional environment conducive to learning?	0%	0%	0%	**50%**	**50%**	8	4.50	0.53
22	Was there enough time to cover the course content?	0%	13%	25%	25%	**38%**	8	3.88	1.13

Table 1 – End-of-Course Questionnaire, Fall 2011 Program (Cont'd)

	Questions	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	n	Mean	Std Dev
23	Did the training program meet your intended needs?	0%	0%	13%	25%	**63%**	8	4.50	0.76
24	How committed are you to attaining the goals you developed for applying your new knowledge and skills to your job?	0%	0%	0%	25%	**75%**	8	4.75	0.46
25	How confident are you in the strategies you outlined to achieve your goal(s)?	0%	0%	13%	**50%**	38%	8	4.25	0.71
26	Would you recommend this training program to others?	0%	0%	0%	25%	**75%**	8	4.75	0.46

27	What part of today's course surprised you the most? Maybe you would consider it a "lightbulb" moment.	
	- Comfort of presenters material. I learned stuff that's a good thing. Time well spent	*- N/A*
	- The number of new "tools" the strategies provide	*- The language barriers*
	- Large words "vocabulary"	*- Jigsaw activity*
	- Vast knowledge base of instructors	*- Hearing stories/experiences from others in the class*
28	What will encourage you to apply what you learned to your job?	
	- I am an achiever and I intend to achieve my goals	*- Culture*
	- Making me a better instructor (i.e. more effective)	*- Motivate the learner to learn*
	- Increased participation	*- Reflection on personal exp*
	- Give employees more benefit from meeting	*- The strategies*
29	What factors will inhibit you from transferring what you learned?	
	- Size of class	*- None*
	- Rigidity in MSH training requirement. Have to get creative	*- Time*
	- Management if anything	*- Time restraint & exec mgmt if time is an issue*
	- I currently don't create presentation	
30	What do you think is your greatest strength as a trainer/teacher?	
	- Able to speak freely	*- Open minded learn easy*
	- Passionate about content/experience	*- Understanding of my audience*
	- Experience and empathy with people	*- Move em from I gotto go to I wanna*
	- Job exp	*- Personality/buy-in*
31	What do you think is your greatest weakness as a trainer/teacher?	
	- Grammer	*- Talk too much*
	- Organization/engagement - I will be better now.	*- Too fast*
	- Talking to large groups - will need to adapt	*- Occassionally, get behind and have to play "catchup" not to often anymore but still a concern for me*
	- Knowledge of the mining industry	
33	What would you suggest to improve the training program?	
	- More visual	*- More time maybe 16 hours*
	- It was great. Food could have been better	*- I think you are on the right track*
	- I think 2 days would help me.	

CHANGES IN THE LEARNER

The Decision-Based Evaluation model includes changes in the learner as one of the three target areas for evaluation and focuses upon affective, cognitive and behavioral outcomes. Kraiger et al (1993), using the work of Gagne (1984), suggests that affective learning outcomes may impact learner behavior and/or performance. For this evaluation we focused specifically on motivational outcomes (motivational disposition, self-efficacy, and goal setting/commitment) because research suggests that these outcomes may impact participants transfer of their new knowledge and skills.

Prior to the start of the Teaching Strategies program, participants were given a Pre-Course Questionnaire (Appendix B) containing eight questions for motivational disposition – five forced choice, two ranking, and one rating question; and one question regarding self-efficacy. Additionally, three questions on the End-of-Course Questionnaire were also used to assess the participants' goal setting/commitment and their self-efficacy AFTER the training.

Affective Outcomes

Based on the work of Kraiger et al. (1993), we assessed the motivational dispositions of the participants prior to the Teaching Strategies training program. Additionally, we asked about their self-efficacy both prior to having the training and after having the training, to assess for change. Participants were asked about their level of commitment to implementing their new knowledge and skills at the end of the training.

Motivational Outcomes

The motivational outcomes were divided into three parts – motivational disposition, self-efficacy, and goal setting/commitment. These results are presented on Tables 2 and 3, and are discussed below.

Motivational disposition

Question #1 of the Pre-Course Questionnaire asked participants if when learning new knowledge and skills if they preferred "doing well" or "working hard". The majority of participants (78%) indicated they preferred to work hard even if they did not do well, while 22% preferred to do well even if they did not have to work hard. Similarly, in Question #2 of the Pre-Course Questionnaire, participants were asked to rank, in order of importance, five behaviors for being successful in a course, "showing improvement" was ranked first and "working hard" was ranked second. Question #3 inquired about participants preferred "feedback" when learning new knowledge and skills. "Progress or improvement" ranked first and "effort" was ranked second. In Questions #4 and #5, learners were asked to identify their preferred tasks. Overwhelmingly, participants identified "a project where I'll learn a lot of new

things but also make a lot of mistakes" (Question #4 – 89%) and when having difficulty with a project they prefer to "continue working at it" (Question #5 – 100%).

Participants were asked in Question #6 to rate their "current level of performance training/teaching". Seventy-eight percent rated themselves as "could do a little (or a lot) better", while just 22% rated themselves as "doing your best". Additionally, when asked in Question #7 "what factor best explains your level of performance at training/teaching", 33% identified both "ability" and "quality of past training and experience". When comparing their ability to others in their field, the majority of participants ranked their ability from moderate to high (Question #8).

The results suggest that the majority of participants held a mastery orientation to learning prior to beginning the Teaching Strategies program.

Self-Efficacy

Question #11 of the Pre-Course Questionnaire and Question #32 of the End-of-Course Questionnaire asked participants to estimate, between 1 and 10, how many of the teaching strategies they would be able to implement in their jobs (Table 3). In addition, the question asked what level of confidence they had in their ability to implement the strategies. Prior to receiving the training, 56% of participants believed they could implement 10 or more strategies; however, by completion of the course, no participants believed they could implement 10 or more strategies. However, 50% of participants believed they could implement nine of the strategies by the end of the program and 13% believed they could implement at least eight.

These results suggest that the self-efficacy of participants was slightly reduced for some participants, but increased for others.

Goal Setting

At the completion of the Teaching Strategies program, participants were asked to write down one or more goals for applying their new knowledge and skills to their jobs. They were also asked to outline a few strategies for achieving these goals.

Questions #24 and #25 of the End-of-Course Questionnaire (Table 1) asked participants how committed they were to attaining their goals (#24) and how confident they were in the strategies they outlined (#25). The majority of participants Strongly Agreed that they were committed to attaining their goals. It is important to note that the mean response to Question #24, (M=4.75, SD=0.46), was tied with Question#26 as the highest mean response on the End-of-Course Questionnaire. In addition, in response to Question #25, the majority of participants Agreed that they were confident in the strategies they outlined for attaining their goals (M=4.25, SD=0.71).

These results suggest that participants were committed to attaining their goals and confident in their ability to do so.

SUMMARY

The Aim #2 Evaluation Plan presented the model (Decision-Based Evaluation model) used to guide our evaluation efforts. As we discussed in the plan, the design, delivery and content validity of the program are the three foci in the content and design evaluation target. Specifically, the evaluation under this target area seeks to assess many aspects of the program – were the objectives appropriate, was it structured properly, how were the materials, etc. Furthermore, to evaluate potential changes in the learners, we focused on affective outcomes, specifically motivational outcomes - motivational dispositions, self-efficacy, and goal setting, seeking to assess if the training should incorporate aspects that would change participants' motivations.

The evaluation findings from Aim#2 – Teaching Strategies for the Mine Safety Trainer suggest that the majority of participants were satisfied with the design and implementation of the program. Furthermore, participants arrived at the program with a mastery orientation to learning. This is important because some research suggests that learners having a mastery orientation may have greater transfer of training (Kraiger et al, 1993; Stevens & Gist, 1997). Additionally, participants arrived with high levels of self-efficacy. Researchers consider high self-efficacy as important as it "may provide a resiliency to any difficulties faced in trying to apply what was learned back to the work setting" (Ford et al, 1998, p. 230). However, in the Teaching Strategies program, the participants' level of self-efficacy was slightly reduced after the program and may require further consideration by the project team.

In addition to the mastery orientation and high initial levels of self-efficacy, participants in the Teaching Strategies program were highly committed to their goals of applying their new knowledge and skills at their respective workplaces. Kraiger et al (1993) suggest this is important because "Research indicates that individuals who set specific, difficult goals and who are committed to those goals are more likely to exert effort and perform at a high level (Locke, Latham & Erez, 1988; Mento, Steele & Karren, 1987; Tubbs, 1986)".

In summary, the findings from this evaluation suggest that the October 2011 program was appropriately designed and implemented. Additionally, it appears that participants were oriented on mastering the content, not just doing well, and were committed to applying it at their workplaces. Based on the both the quantitative and qualitative data we collected, we make the following recommendations for consideration by the project team.

Recommendations

- Ensure the room number and maps are provided in all correspondence for the program.
- Consider modifying the schedule to allow additional restroom breaks.
- Consider providing vegetarian or other lunch options.
- The project team may wish to provide additional training time for participants.
- Perhaps provide guidance and direction that helps participants to better understand how to find the "time" to transfer their learning and/or how to overcome possible management objections/complaints to the new knowledge and skills.

Table 2 – Pre-Course Questionnaire (Motivational Dispositions), October 2011

	Questions	
1	When learning new knowledge and skills, do you prefer to:	
	a) do well in a course even though you don't have to work very hard; or	22%
	b) work hard in a course even though you don't do very well.	78%
2	When in a course to learn new knowledge and skills, rank order which is most important to your success (1=most important and 5=least important).	**Rank**
	Getting a good grade/evaluation	3
	Showing improvement	1
	Working hard	2
	Getting along with others in the course	4
	Doing as well or better than others in the course	5
3	In a course to learn new knowledge and skills, rank order what feedback is most important to you (1=most important and 5=least important)	**Rank**
	Your grade on assignments/evaluations	4
	Performance relative to other learners in the course	3 and 5
	Progress or improvement	1
	Effort	2
	Performance relative to grade level norms	3
4	Choose the better project for you.	
	a) A project where I'll learn a lot of new things but also make a lot of mistakes; or	89%
	b) A project that would involve a minimum of struggle and likely result in success	11%
5	When having difficulty with a project do you	
	a) continue working at it; or	100%
	b) find another project where success is more likely.	0%
6	How would you identify your current level of performance training/teaching?	
	a) Doing your best; or	22%
	b) Could do a little (or a lot) better.	78%
7	What factor best explains your level of performance at training/teaching?	
	a) Ability	33%
	b) Effort	11%
	c) Quality of past training and experience	33%
	d) Requirements of the job/role	22%
8	How would you rate your ability to perform your job - compared to others at your work or in your field?	
	1 - One of the lowest	0%
	2	0%
	3	33%
	4	56%
	5 - One of the highest	11%

Table 3 – Pre-Course and End-of-Course Questionnaire (Self-Efficacy), October 2011

Of the adult learning teaching strategies presented in this course, I will be capable of implementing….		
	Pre-Course	**End-of-Course**
1	11%	0%
2	0%	13%
3	10%	13%
4	0%	0%
5	22%	0%
6	11%	13%
7	0%	0%
8	0%	13%
9	0%	50%
10	56%	0%

FEBRUARY 2012

The second Teaching Strategies for the Mine Safety Trainer program was held in February 2012 at the University of Arizona facilities in Tucson, Arizona. The findings from this portion of the evaluation are to be used as feedback to the project team, for possible revisions to the Teaching Strategies program. Furthermore, it will allow NIOSH to make decisions about the overall effectiveness of the program.

As noted in the Evaluation Plan for Aim #2, our evaluation targeted both the Content and Design and Changes in the Learner for the Teaching Strategies program. Each of these target areas is discussed below.

CONTENT AND DESIGN

Participants provided their feedback on the content and design of the February 2012 program via a 26 question, 5-point (1=Strongly Disagree, 5=Strongly Agree) End-of-Course Questionnaire (Appendix B). As we noted in the Evaluation Plan for Aim #2, the relevant dimensions of the evaluation for the Teaching Strategies program included logistics/administration, training environment, program materials, instructional activities, delivery methods/technologies, instructor/facilitator, program time/length, and planned action/transfer. The responses are compiled in Table 4, which provides the relative frequency of participant ratings, the number of participants responding, the mean or average response, and the standard deviation. Additionally, Questions #27-31, and 33, were open response and we have included each participant's notations without determining its value or meaning. For example, if the participant responded "none" or "???" to a question, we have included it as a response on the data tables.

Expert Judgment and Advisory Panel

The Teaching Strategies program was designed by Dr. Patricia Anders and her team. Dr. Anders is the Jewell M. Lewis Distinguished Professor of Education at the University of Arizona and considered internationally as an expert in the fields of language, reading, culture, adult learning and literacy. Therefore, we believe that Dr. Anders personal involvement in the design and implementation of the program is representative of expert judgment not only in the design and delivery, but also the validity of the content.

Course Ratings

While some researchers express concern over "novices" providing feedback on content and design of a program, we believe this concern is not applicable here because Teaching Strategies participants were identified as knowledgeable and highly skilled in their respective fields. They are participating in the Teaching Strategies to increase their knowledge and skills in the area of adult learning. Therefore, we deem their feedback to be both relevant and appropriate. The results of the participants' course ratings are presented below.

Logistics and Administration

Three questions (#1, #2, #3), inquired about the scheduling and registration for the program. Most participants Agreed or Strongly Agreed that registering for the course was easy and straightforward (M=4.25, SD=0.46) and that communication regarding the course was also clear and straightforward (M=4.33, SD=0.71). Question #3 asked participants if the "course schedule was well planned (restroom breaks, lunch, etc.)" and the majority Strongly Agreed with a mean response of 4.22 (SD=1.09).

Participants were able to write-in comments for each question on the survey and on Question #1, three participants commented. One noted that they were registered for the course by someone else and the other noted that the need to be able to take American Express as a form of payment. Another participant commented on Question #3, requesting additional restrooms breaks.

These results suggest that overall; participants were satisfied with the logistics and administration of the Teaching Strategies program, although the project team may consider adding American Express as a method of payment and scheduling additional restroom breaks.

Training Environment

Questions #4 through #8, asked participants about the training environment of the Teaching Strategies program. Participants Strongly Agreed (M=4.22, SD=0.83) that the "training environment was appropriate for learning" (Question #4) and they Agreed (M=4.11, SD=0.78) that "there was enough workspace for class activities" (Question #6).

Question #5 asked if "environmental conditions – comfort, heating, noise, visibility – conducive to learning?" Most Strongly Agreed with Question #5 (M=4.67, SD=0.50) and it was tied with Questions #12 and #26 for the highest mean response of the End-of-Course Questionnaire. However, one participant did note that the lights made it hard to see the screen.

Participants were asked in Question #7 if the food provided was "appropriate (variety, type, etc.)", most participants Strongly Agreed (M=4.44, SD=0.73). Question #8 asked participants if they would "recommend the facilities be used again". Participants Strongly Agreed with a mean response of 4.44 (SD=0.73).

These results suggest that most participants were very satisfied with the training environment. Although, the project team may want to verify that classroom lighting does not interfere with participants' view of the screen.

Program Objectives

The majority of participants Agreed (M=4.22, SD=0.67) that the content presented in the program met the stated objectives.

Program Materials, Instructional Activities and Delivery Technologies

Questions #10 and #13 asked participants if training materials were "consistent with the training objective" (#10) and if the "content of the material" was easy to understand. The majority Agreed with a mean response of 4.38 (SD=0.74) and 4.00(SD=0.71), respectively. One participant noted in response to Question #10 – really good material. Another participant noted in response to Question #13 – "Module #1?" This response may suggest some confusion over the material presented in Module 1 of the program. In addition, it should be noted that the mean response to Question #13 (Was the content of the material easy to understand?), was tied with Question #22 as the second lowest response.

In Questions #11 and #12, participants were asked about the course exercises (#11) and group discussions (#12). The mean response for Question #11 was 4.56 (SD=0.53), suggesting the majority of participants Strongly Agreed that the "course exercises were relevant to the program objectives". The mean response for Question #12 was 4.67 (SD=0.50), suggesting the majority of participants Strongly Agreed that the group discussions were "helpful to participants in exchanging ideas with each other". The mean response to Question #12 was tied with Questions #5 and #26, with the highest mean responses. Additionally, two participants commented on Question #12, one noting "gave me a better understanding" and the other noting "great group".

Participants also Agreed that the "presentation technologies used in the course" were effective (Question #14), giving a mean response of 4.22 (SD=0.83).

These results suggest that participants were very satisfied with the program materials, activities and delivery technologies. However, there may have been some confusion over the material presented in Module 1. The project team may wish to review this module.

Instructors

Questions #15 and #16 asked participants if instructors presented "content clearly" (#15) and if they were "well-prepared" (#16). Participants Strongly Agreed with both questions giving mean responses of 4.56 (SD=0.53) and 4.56 (SD=0.73), respectively. On participant noted in response to Question #15 – "Helped me out ☺".

These results suggest overall participants believed the instructors were well prepared and presented the content clearly.

Program Length

Participants were asked if the "length of the program was appropriate for the stated objectives" (Question #17) and the majority Strongly Agreed with a mean response of 4.33 (SD=0.87). Question #18 asked participants if "there was enough time to practice course objectives" and the mean response

was 3.89 (SD=1.17). The response to Question #18 was the lowest mean response on the End-of-Course Questionnaire. One participant noted that participants could have used more "prep time".

The results suggest that the participants believed the length of the program was appropriate for the stated objectives, but that additional time to practice their new skills may be necessary.

Transfer Expectation

Participants Strongly Agreed that the training content was relevant to their jobs (Question #19) and also Strongly Agreed in their expectations that their organizations would support their use of skills learned (Question #20), with mean responses of 4.44 (SD=0.88) and 4.56 (SD=0.73), respectively.

Question #28 asked participants "What will encourage you to apply what you learned to your job?" Nine participants responded to the question and no dominant theme was apparent. While Question #28 focused on what would encourage participants to apply what they learned, Question #29 asked participants what would inhibit them from applying what they learned. Nine participants responded and the dominant theme appears to be lack of time. All responses to Questions #28 and #29 can be found on Table 4.

These results suggest that participants found the training content to be relevant to their respective jobs, but they were unsure if they would have the time to apply the new skills. The project team may want to consider how participants can overcome this issue in future programs.

Overall Rating and Recommendations

Questions #21, #22, and #23, asked participants about the overall program with mean responses of 4.56 (SD=0.53), 4.00 (SD=0.87), and 4.22 (SD=0.83), respectively, suggesting overall Agreement. However, it should be noted that the mean response to Question #22 (Was there enough time to cover the course content?) was tied with Question #13 as the second lowest of all responses in the February 2012 Teaching Strategies program.

The majority of participants Strongly Agreed, with a mean response of 4.67 (SD=0.50), that they would "recommend this training program to others" (Question #26). In fact, Question #26 was tied with Questions #5 and #12 as the highest mean response for the February 2012 program. When asked "What would you suggest to improve this training program?" (Question #33), two participants noted additional time, while one noted "nothing". All the comments are provided in Table 4.

These results suggest that participants were satisfied with the overall Teaching Strategies program. However, the project team may consider possible participant concerns about "enough time" to cover the course content. Clarification may be necessary because only one participant noted on Question #18 – "short of time". The project team should review all participant comments provided in Table 4.

Table 4 – End-of-Course Questionnaire, February 2012

	Questions	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	n	Mean	Std Dev
1	Was registering for the course easy and straightforward?	0%	0%	0%	**75%**	25%	8	4.25	0.46
2	Were communications (phone calls, emails, etc.) regarding the course clear and straightforward?	0%	0%	11%	**44%**	**44%**	9	4.33	0.71
3	Was the course schedule well planned (restroom breaks, lunch, etc.)?	0%	11%	11%	22%	**56%**	9	4.22	1.09
4	Was the training environment appropriate for learning?	0%	0%	22%	33%	**44%**	9	4.22	0.83
5	Were the environmental conditions - comfort, heating, noise, visibility - conducive to learning?	0%	0%	0%	33%	**67%**	9	4.67	0.50
6	Was there enough workspace for class activities?	0%	0%	22%	**44%**	33%	9	4.11	0.78
7	Was the food provided appropriate (variety, type, etc.)?	0%	0%	11%	33%	**56%**	9	4.44	0.73
8	Would you recommend the facilities be used again?	0%	0%	11%	33%	**56%**	9	4.44	0.73
9	Did the content meet the stated objectives?	0%	0%	11%	**56%**	33%	9	4.22	0.67
10	Were the materials consistent with the training objectives?	0%	0%	13%	38%	**50%**	8	4.38	0.74
11	Were the course exercises relevant to the program objectives?	0%	0%	0%	44%	**56%**	9	4.56	0.53
12	Were the group discussions helpful to participants in exchanging ideas with each other?	0%	0%	0%	33%	**67%**	9	4.67	0.50
13	Was the content of the material easy to understand?	0%	0%	22%	**56%**	22%	9	4.00	0.71
14	Were the presentation technologies used in the course effective?	0%	0%	22%	33%	**44%**	9	4.22	0.83
15	Did the instructors present content clearly?	0%	0%	0%	44%	**56%**	9	4.56	0.53
16	Were the instructors well-prepared?	0%	0%	11%	22%	**67%**	9	4.56	0.73
17	Was the length of the program appropriate for stated objectives?	0%	0%	22%	22%	**56%**	9	4.33	0.87
18	Was there enough time to practice course objectives?	0%	11%	33%	11%	**44%**	9	3.89	1.17
19	Was the training content relevant to your job?	0%	0%	22%	11%	**67%**	9	4.44	0.88
20	Do you expect your organization to support your use of skills learned in this course?	0%	0%	11%	22%	**67%**	9	4.56	0.73
21	Was the overall instructional environment conducive to learning?	0%	0%	0%	44%	**56%**	9	4.56	0.53
22	Was there enough time to cover the course content?	0%	0%	**33%**	**33%**	**33%**	9	4.00	0.87

Table 4 – End-of-Course Questionnaire, February 2012 (Cont'd)

	Questions	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	n	Mean	Std Dev
23	Did the training program meet your intended needs?	0%	0%	22%	33%	**44%**	9	4.22	0.83
24	How committed are you to attaining the goals you developed for applying your new knowledge and skills to your job?	0%	0%	11%	33%	**56%**	9	4.44	0.73
25	How confident are you in the strategies you outlined to achieve your goal(s)?	0%	0%	11%	**67%**	22%	9	4.11	0.60
26	Would you recommend this training program to others?	0%	0%	0%	33%	**67%**	9	4.67	0.50

27	What part of today's course surprised you the most? Maybe you would consider it a "lightbulb" moment.	
	- Parking lot	*- Different key of adult learning*
	- On the fence	*- The sage on the stage concept*
	- Multiple learning intelligences	*- Role playing & interaction*
	- A lot of interaction	*- How well role playing can work & not be silly*
28	What will encourage you to apply what you learned to your job?	
	- Using Module 3 & 4	*- Response from group*
	- Improved learning in training events	*- I want to give better courses*
	- To help trainee's	*- To improve communication at my job*
	- Have a better effective way to communicate safety topics	*- Opportunity*
	- A positive feedback from learners.	
29	What factors will inhibit you from transferring what you learned?	
	- Time	*- Time - Time - Time (lack of)*
	- Lack of opportunity	*- None*
	- Module 3 & 4	*-- None*
	- Time & resources	*- None*
	- N/A. I don't think I will have any problem using the knowledge I learned today.	
30	What do you think is your greatest strength as a trainer/teacher?	
	- Experience	*- Knowledge/passion*
	- Engaging the student to participate	*- Able to talk*
	- Utilizing different mediums for delivery	*- Ability to rely information*
	- Experience	*- Using culture related experience*
	- Group interaction	
31	What do you think is your greatest weakness as a trainer/teacher?	
	- Public speaking	*- Lack of structure*
	- Lack of different strategies	*- Time. Given to trade*
	- My vocabulary	*- Not enough experience in mining.*
	- Not doing proper preparation time	*- Becoming a sage on the stage.*
33	What would you suggest to improve the training program?	
	- More time	*- Nothing*
	- More time/Improve prossess of students implementing new skills in presentation	

CHANGES IN THE LEARNER

As discussed previously in this report, the Decision-Based Evaluation model includes changes in the learner as one of the three target areas for evaluation and focuses upon affective, cognitive and behavioral outcomes. Some research suggests that affective learning outcomes may impact learner behavior and/or performance (Kraiger et al, 1993; Gagne, 1984). For this evaluation we focused specifically on motivational outcomes (motivational disposition, self-efficacy, and goal setting/commitment) because research suggests that these outcomes may impact participants transfer of their new knowledge and skills.

Prior to the start of the Teaching Strategies program, participants were given a Pre-Course Questionnaire (Appendix B) containing eight questions for motivational disposition – five forced choice, two ranking, and one rating question; and one question regarding self-efficacy. Additionally, three questions on the End-of-Course Questionnaire were also used to assess the participants' goal setting/commitment and their self-efficacy AFTER the training.

Affective Outcomes

Based on the work of Kraiger et al. (1993), we assessed the motivational dispositions of the participants prior to the Teaching Strategies training program. Additionally, we asked about their self-efficacy both prior to having the training and after having the training, to assess for change. Participants were asked about their level of commitment to implementing their new knowledge and skills at the end of the training.

Motivational Outcomes

The motivational outcomes were divided into three parts – motivational disposition, self-efficacy, and goal setting/commitment. These results are presented on Tables 5 and 6, and are discussed below.

Motivational disposition

Question #1 of the Pre-Course Questionnaire asked participants if when learning new knowledge and skills if they preferred "doing well" or "working hard". The majority of participants (67%) indicated they preferred to do well even though they didn't have to work hard, while only 33% preferred to work hard even though they didn't do very well. In contrast, however, Question #2 of the Pre-Course Questionnaire asked participants to rank in order of importance, five behaviors for being successful in a course, "showing improvement" was ranked first and "working hard" and "getting along with others in the course" were tied for second. Question #3 inquired about participants preferred "feedback" when learning new knowledge and skills. "Progress or improvement" and "effort" were tied for the first place ranking, with "effort" and "your grade on assignments/evaluations" being tied for the second place. In

Questions #4 and #5, learners were asked to identify their preferred tasks. The majority of students (56%) identified "a project that would involve a minimum of struggle and likely result in success" as the better project (Question #4). However, in contrast, the majority (89%), chose "continue to work at it" (rather than "find another project where success is more likely") when having difficulty with a project (Question #5).

Participants were asked in Question #6 to rate their "current level of performance training/teaching". Five-six percent rated themselves as "could do a little (or a lot) better", while 44% rated themselves as "doing your best". Additionally, when asked in Question #7 "what factor best explains your level of performance at training/teaching", 38% identified "ability", while only 13% identified "effort". When comparing their ability to others in their field, the majority of participants ranked their ability from moderate to high (Question #8).

The results of the Pre-Course Questionnaire suggest that only about half of the February 2012 participants held a mastery orientation to learning, prior to the beginning the Teaching Strategies program. The project team may wish to consider establishing alternative activities for those participants having a performance orientation to learning.

Self-Efficacy

Question #11 of the Pre-Course Questionnaire and Question #32 of the End-of-Course Questionnaire asked participants to estimate, between 1 and 10, how many of the teaching strategies would be able to implement in their jobs (Table 6). In addition, the question asked what level of confidence they had in their ability to implement the strategies. Only four of the nine participants responded to the question on the Pre-Course Questionnaire. Of those responses, only one participant believed he/she could implement at least six teaching strategies. The three remaining participant responses suggested they could implement less than six strategies. However, when the same question was asked on the End-of-Course Questionnaire eight of the nine participants responded. Two of the participants believed they could implement six or more strategies. The remaining six respondents estimated they could implement five or less strategies.

These results suggest participants may have been confused by the question on the Pre-Course Questionnaire, but after the program had a better understanding of the strategies. This may be an issue for the project team to consider further.

Goal Setting

At the completion of the Teaching Strategies program, participants were asked to write down one or more goals for applying their new knowledge and skills to their jobs. They were also asked to outline a few strategies for achieving these goals.

Questions #24 and #25 of the End-of-Course Questionnaire (Table 1) asked participants how committed they were to attaining their goals (#24) and how confident they were in the strategies they outlined (#25). The majority of participants Strongly Agreed that they were committed to attaining their goals. It is important to note that the mean response to Question #24 was 4.75 (SD=0.46), was tied with Question#26 as the highest mean response on the End-of-Course Questionnaire. In addition, in response to Question #25, the majority of participants Agreed that they were confident in the strategies they outlined for attaining their goals (M=4.25, SD=0.71).

These results suggest that participants were committed to attaining their goals and confident in their ability to do so.

Table 5 – Pre-Course Questionnaire (Motivational Dispositions), February 2012

	Questions	
1	When learning new knowledge and skills, do you prefer to:	
	a) do well in a course even though you don't have to work very hard; or	67%
	b) work hard in a course even though you don't do very well.	33%
2	When in a course to learn new knowledge and skills, rank order which is most important to your success (1=most important and 5=least important).	**Rank**
	Getting a good grade/evaluation	3
	Showing improvement	1
	Working hard	2
	Getting along with others in the course	2 and 4
	Doing as well or better than others in the course	3 and 5
3	In a course to learn new knowledge and skills, rank order what feedback is most important to you (1=most important and 5=least important)	**Rank**
	Your grade on assignments/evaluations	2
	Performance relative to other learners in the course	3 and 5
	Progress or improvement	1
	Effort	1 and 2
	Performance relative to grade level norms	3
4	Choose the better project for you.	
	a) A project where I'll learn a lot of new things but also make a lot of mistakes; or	44%
	b) A project that would involve a minimum of struggle and likely result in success	56%
5	When having difficulty with a project do you	
	a) continue working at it; or	89%
	b) find another project where success is more likely.	11%
6	How would you identify your current level of performance training/teaching?	
	a) Doing your best; or	44%
	b) Could do a little (or a lot) better.	56%
7	What factor best explains your level of performance at training/teaching?	
	a) Ability	38%
	b) Effort	13%
	c) Quality of past training and experience	25%
	d) Requirements of the job/role	25%
8	How would you rate your ability to perform your job - compared to others at your work or in your field?	
	1 - One of the lowest	0%
	2	11%
	3	22%
	4	56%
	5 - One of the highest	11%

Table 6 – Pre-Course and End-of-Course Questionnaire (Self-Efficacy), February 2012

Of the adult learning teaching strategies presented in this course, I will be capable of implementing….		
	Pre-Course	**End-of-Course**
1	25%	0%
2	0%	0%
3	25%	25%
4	0%	0%
5	25%	50%
6	25%	13%
7	0%	0%
8	0%	13%
9	0%	0%
10	0%	0%

SUMMARY

The Aim #2 Evaluation Plan presented the model (Decision-Based Evaluation model) used to guide our evaluation efforts. As we discussed in the plan, the design, delivery and content validity of the program are the three foci in the content and design evaluation target. Specifically, the evaluation under this target area seeks to assess many aspects of the program – were the objectives appropriate, was it structured properly, how were the materials, etc. Furthermore, to evaluate potential changes in the learners, we focused on affective outcomes, specifically motivational outcomes - motivational dispositions, self-efficacy, and goal setting, seeking to assess if the training should incorporate aspects that would change participant's motivations.

The evaluation findings from Aim#2 – Teaching Strategies for the Mine Safety Trainer, February 2012 program, suggest that the majority of participants were satisfied with the design and implementation of the program. Additionally, it suggests that only about half of the participants arrived with a mastery orientation to learning. This is important because some research suggests that learners having a mastery orientation may have greater transfer of training (Kraiger et al, 1993; Stevens & Gist, 1997). Furthermore, most participants arrived with moderate to low levels of self-efficacy that did not change during the program. Researchers consider high self-efficacy as important as it "may provide a resiliency to any difficulties faced in trying to apply what was learned back to the work setting" (Ford et al, 1998, p. 230). These outcomes suggest that while the participants were highly satisfied with the program, they may struggle with transferring their training to their respective jobs. However, participants did respond that they were highly committed to their goals of applying their new knowledge and skills at their respective workplaces. Kraiger et al (1993) suggest this is important because "Research indicates that individuals who set specific, difficult goals and who are committed to those goals are more likely to exert effort and perform at a high level (Locke, Latham & Erez, 1988; Mento, Steele & Karren, 1987; Tubbs, 1986)".

In summary, the findings from this evaluation suggest that the February 2012 program was appropriately designed and implemented, but participants may struggle with transferring their training. Based on the both the quantitative and qualitative data we collected, we make the following recommendations for consideration by the project team.

Recommendations

- Consider adding American Express as a payment option.
- Evaluate the training room setup to ensure everyone has a clear view of the screen.
- Review Module 1 to assess if it could be presented differently to alleviate any participant confusion.

- The project team may wish to provide additional training or practice time for participants.
- Perhaps provide guidance and direction that helps participants to better understand how to find the "time" to transfer their learning and/or how to overcome possible management objections/complaints to the new knowledge and skills.

THE UNIVERSITY OF ARIZONA

EVALUATION REPORT

AIM 3
ADVANCED COURSES IN OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE

WESTERN MINING SAFETY AND
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MARCH 31, 2012

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EVALUATION REPORT

AIM #3 – ADVANCED COURSES IN OCCUPATIONAL HEALTH AND INDUSTRIAL HYGIENE

INTRODUCTION

The National Institute for Occupational Safety and Health (NIOSH) has funded The University of Arizona (Grant #5U60OH010014) to develop training and educational programs for those working in the mining industry in the Western U.S. The overarching goal of this grant is to not only reduce the number of illnesses and injuries in the mining industry, through targeted training and educational programs, but also to increase the capacity of high quality mine safety and mine safety trainer programs. The University of Arizona team is comprised of experts from the Colleges of Public Health, Education, and Department of Mining and Geological Engineering. The project team developed four specific Aims to reach the project goal. The specific aims of this project are:

1. Training Capacity,
2. Adult Learner/ELL/Low Literacy Training (Teaching Strategies for the Mine Safety Trainer),
3. Advanced Courses in Occupational Health and Industrial Hygiene; and
4. Fatalgram Gaming Scenarios.

Because each Aim targets very specific aspects of the project goal, stand-alone Evaluation Plans and Evaluation Reports were developed for each Aim. This Evaluation Report is for Aim #3 – Advanced Courses in Occupational Health and Industrial Hygiene.

As discussed above, the overarching goal of this project is to not only reduce the number of illnesses and injuries in the mining industry, through targeted training and educational programs, but also to increase the capacity of high quality mine safety and mine safety trainer programs. The purpose of Aim #3 is to develop and implement high quality occupational health and industrial hygiene courses and materials for miners, trainers, and supervisors. The courses and materials are focused on chemical exposures, noise, ergonomics, safety, heat stress, wellness, and behavior risk management and communication.

Aim #3 includes broad dissemination of advanced mining health and safety information at two programs - the 7th Annual Joint Western Regional Mine Safety & Health Conference and the Mine Institute for Supervisor Leadership. We discuss each program below.

7TH ANNUAL JOINT WESTERN REGIONAL MINE SAFETY & HEALTH CONFERENCE

The conference was held in Henderson, Nevada on October 25-26, 2011 and had the stated purpose of:

- building relationships in the mining industry that focus on zero fatalities, injuries and occupational illnesses;
- creating and building relationships and lines of communication between federal agencies and industry; and
- establishing knowledge of how to return miners home safely every day.

Three members of the Aim #3 project team presented at the conference - Dr. Terrence Stobbe, Dr. Eric Lutz, and Shannon Newton. However, it should be noted that team members from the other specific aims also participated at the conference, presenting on their Aim's activities. Dr. Patty Anders and her project team presented on their Teaching Strategies program (Aim #2) and Leonard Brown presented on Fatalgram Gaming Scenarios (Aim #4). Although these grant team members were presenting on their specific aims, they are included in this evaluation.

MINE INSTITUTE FOR SUPERVISOR LEADERSHIP (MISL)

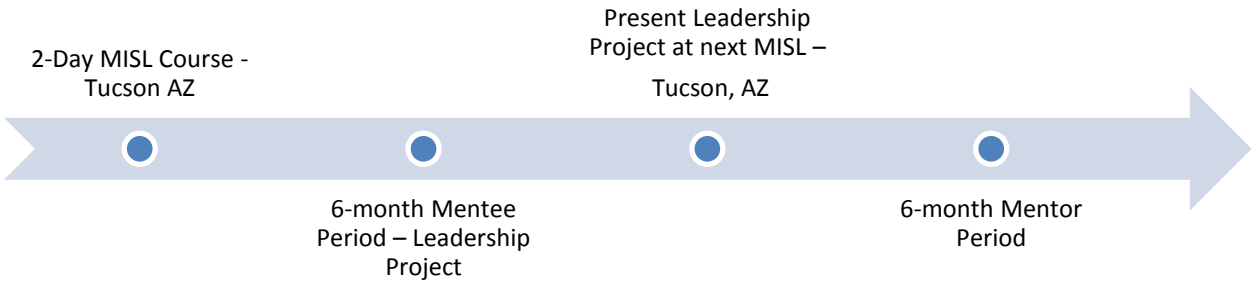
On December 1-2, 2011, Aim #3 project team members, Ros Hill and Dr. Eric Lutz hosted the Mine Institute for Supervisor Leadership (MISL). The University of Arizona (UA) has gathered the expertise of top educators in leadership across the Institute for Mineral Resources (IMR), Department of Mining and Geological Engineering, and the Mel & Enid Zuckerman College of Public Health to provide the Mining Institute for Supervisor Leadership (MISL). The MISL is offered 2-times per year at the UA San Xavier Mining Laboratory Training Center in Tucson, Arizona. In collaboration with 14 top mining and mining-related health and safety leaders, representing the breadth of mining industry sectors in both surface and underground operations, this unique, mining-specific, mentored, leadership institute provides techniques that balance safety with optimized operations so front-line supervisors, managers are positioned to become tomorrow's mining operation leaders.

Available to all supervisors, managers, and executives involved in mining operations, each bi-annual institute is limited to 24 registrants. The intensive, participatory institute follows a novel Progressive Learning Model. Starting with a 2-day course covering topics such as: culture-specific communication, legal issues, hazard identification, each participant builds skills on improving conflict resolution, workplace training and meetings, time management, and leadership and team-building. The information for each topic area is delivered by current leaders in mining operations and safety and requires active student participation throughout the program. Past examples of MISL instructors include: Eric Lutz and Ros Hill (UA), H.L. Boling, Tom Bassier and Tim Kilbreath (Barrick Gold of North America), David Hales (BHP Billiton), Jill

Schultz (FMI), Chris Mabey (Newmont), Mark Savit (Patton Boggs, LLP), Bill Beaver (Peabody Energy), Tim Fox and Steve Gravely (Rio Tinto), Tom Vanderwalker (SRMG), and Chris Knudson (3M).

At the conclusion of the 2-day, in-class institute each participant (Mentee) is assigned a professional Mentor who guides the Mentee for 6-months in applying the MISL techniques in their daily work activities to complete a Leadership Project. Then, the Mentee returns to the next institute in Tucson to present the outcomes of their Leadership Project. Following project presentations, Mentee's become 6-month Mentors to the new incoming cohort of participants, providing further opportunity to hone and refine leadership skills through practice.

As a condition of acceptance into the institute program, supervisors and their managers must obligate to the full program (initial 2-day training, Mentored Leadership Project period, return to MISL for Leadership Project presentation, and participation as Mentor to Mentee of subsequent cohort until next MISL). An example of the MISL timeline is provided below.



The preliminary findings from each of the Aim #3 programs are presented below.

EVALUATION FINDINGS

7TH ANNUAL JOINT WESTERN REGIONAL MINE SAFETY & HEALTH CONFERENCE

The project team used the conference as an opportunity to broadly disseminate information about occupational health and industrial hygiene (Aim #3), fatalgram gaming scenarios (Aim #4) and adult learning teaching strategies (Aim #2). Team members presented materials and information in 75-minute "breakout sessions". At the completion of each breakout session, participants were asked to provide feedback via an 18 question, 5-point (1=Strongly Disagree, 5=Strongly Agree) End-of-Course Questionnaire (Appendix A). Additionally, all participants received the session materials and topic-relevant supplementary information on a jump-drive. As we noted in the Evaluation Plan for Aim #3, our evaluation focused on dimensions that the project team were able to influence; such as course objectives, materials, delivery methods, and instruction. Other important metrics were out of the control of the project team, such as room size, length of program, scheduling, etc, as these were determined by the conference organizers.

Responses from each session's questionnaires were compiled and are presented in Tables 1 through 6 of this report. The data tables include the relative frequency of participants ratings, the number of participants responding, the mean or average response, and the standard deviation. Additionally Questions #14 through #18 were open response and we have included each participants notations without determining its value or meaning. For example, if the participant responded "none" or "???" to a question, we have included it as a response on the data tables.

ERGONOMICS

Dr. Terrence Stobbe presented two, 75-minute, sessions of his course titled "Ergonomic Implications in Mining". Nine participants were counted at the beginning of the first session and nine participants were counted at the beginning of the second session. It was noted throughout the conference, that a few participants came in some time after the start of the course, and others left prior to its completion. Six participants completed and returned questionnaires for each of the sessions. The results are presented on Table 1.

Program Objectives

Question #1 on the End-of-Course Questionnaire asked participants if the content of the session met the stated objectives. The mean response was 4.25 (SD=0.62), with the majority of participants Agreeing.

Program Materials and Delivery Technologies

Participants were asked in Questions #2 and #3 if the materials provided were consistent with training objectives and if the content of the materials were easy to understand. Overall, participants Strongly Agreed with a mean response for #2 of 4.22 (SD0.83) and for #3 of 4.50 (SD=0.67). Participants also Agreed that the presentation technologies were effective (Question #4), with a mean response of 4.00 (SD=0.60).

In Questions #14 and #15, participants were asked what information surprised them the most and what confused them the most. Four participants responded to Question #14 and two responded to #15. The only common theme appears to be that two participants noted they were surprised in learning why people don't lift properly, the other responses varied and can be seen on Table 1.

Instructor

Questions #5 and #6 asked if the instructor presented the content clearly and if they were well-prepared. Participants Strongly Agreed with mean responses for #5 of 4.50 (SD=0.67) and for #6 of 4.58 (SD=0.51).

Program Length

Question #7 asked if the length of the session was appropriate for stated objectives. The mean response was 4.00 (SD=0.60), with the majority of participants Agreeing.

Transfer Expectations

Questions #8 and #9 asked participants if the training was relevant to their jobs and if they expected their organization to support their use of their new skills. While the mean response for Question #8 was 4.33 (SD=0.78), with the majority Strongly Agreeing, the mean response for Question #9 was 4.00 (SD=0.85) with the responses being equally distributed between Neutral, Agree, and Strongly Agree.

Questions #16 and #17 asked participants what would encourage them to apply what they learned to their job and what would inhibit them from applying it. Three responded to Question #16 and four responded to Question #17. Responses to Question #16 (What will encourage you to apply what you learned to your job?) seem to be focused on keeping workers safe. Two participants noted in their response to Question #17 (What factors will inhibit you from applying what you learned?) that nothing will inhibit them, while two others noted that money, peers, and management would inhibit them.

Overall Rating and Recommendations

Questions #10, #11, #12, and #13 asked participants about the overall training session, with mean responses of 4.08 (SD=0.90), 3.75 (SD=0.75), 3.92 (SD=0.90), and 4.08 (SD=1.00), respectively. The lowest mean response was for Questions #11 which asked participants if there was enough time to cover the content, with responses equally distributed between Neutral and Agree. A response of "longer" to Question #18 (What would you suggest to improve this course?) suggests that participants did want a longer time to cover the topic. Other responses to Question #18 are provided on Table 1.

Table 1 - Results of End-of-Course Questionnaire - ERGONOMICS

	Question	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5	n	Mean	Std Dev
1	Did the content meet the stated objectives?	0.0%	0.0%	8.3%	**58.3%**	33.3%	12	4.25	0.62
2	Were the jump-drive materials provided, consistent with the training objectives?	0.0%	0.0%	22.2%	33.3%	**44.4%**	9	4.22	0.83
3	Was the content of the material easy to understand?	0.0%	0.0%	8.3%	33.3%	**58.3%**	12	4.50	0.67
4	Were the presentation technologies used in the course effective?	0.0%	0.0%	16.7%	**66.7%**	16.7%	12	4.00	0.60
5	Did the instructors present content clearly?	0.0%	0.0%	8.3%	33.3%	**58.3%**	12	4.50	0.67
6	Were the instructors well-prepared?	0.0%	0.0%	0.0%	41.7%	**58.3%**	12	4.58	0.51
7	Was the length of the program appropriate for stated objectives?	0.0%	0.0%	16.7%	**66.7%**	16.7%	12	4.00	0.60
8	Was the training content relevant to your job?	0.0%	0.0%	16.7%	33.3%	**50.0%**	12	4.33	0.78
9	Do you expect your organization to support your use of skills learned in this course?	0.0%	0.0%	**33.3%**	**33.3%**	**33.3%**	12	4.00	0.85
10	Was the overall instructional environment conducive to learning?	0.0%	8.3%	8.3%	**50.0%**	33.3%	12	4.08	0.90
11	Was there enough time to cover the course content?	0.0%	0.0%	**41.7%**	**41.7%**	16.7%	12	3.75	0.75
12	Did the training program meet your intended needs?	0.0%	8.3%	16.7%	**50.0%**	25.0%	12	3.92	0.90
13	Would you recommend this training program to others?	0.0%	8.3%	16.7%	33.3%	**41.7%**	12	4.08	1.00

14 - What part of today's course surprised you the most? Maybe you would consider it a "lightbulb" moment.

- *The simple solutions!*
- *Eye camera*
- *Made me aware of things I never thought of why people don't lift properly static load*
- *Proper lifting w/ back straight requires most energy no wonder why not used constantly*

15 - What was the most confusing idea we addressed in the presentation?

- *So many issues!*
- *None*

16 - What will encourage you to apply what you learned to your job?

- *Injury prevention!*
- *Continue what we are doing.*
- *Safety*

17 - What factors will inhibit you from applying what you learned?

- *$$$*
- *None*
- *Peers & mgmt*
- *None*

18 - What would you suggest to improve this course?

- *Sell it as a cost savings!*
- *Great job!*
- *Longer*

FATALGRAM

Leonard Brown presented two, 75 minute, sessions of his course titled "A Platform for Interactive Fatalgram Simulation Using Commodity Gaming Hardware". Thirty-eight participants were counted at the beginning of the first session and ten participants were counted at the beginning of the second session. Although, it was noted throughout the conference, that a few participants came in some time after the start of the course, and others left prior to its completion. Twenty-five participants completed and returned questionnaires for the first session and seven returned questionnaires from the second session. The results from both sessions are presented on Table 2.

Program Objectives

Question #1 on the End-of-Course Questionnaire asked participants if the content of the session met the stated objectives. The mean response was 3.77 (SD=0.86), with the majority Agreeing.

Program Materials and Delivery Technologies

Participants were asked in Questions #2 and #3 if the materials provided were consistent with training objectives and if the content of the materials were easy to understand. The majority of participants Agreed, with mean responses for #2 were 3.42 (SD=0.70) and for #3 were 3.77 (SD=0.96). Participant responses were 3.84 (SD=0.86) for Question #4 (Were the presentation technologies used in the course effective?).

In Questions #14 and #15, participants were asked what information surprised them the most and what confused them the most. Fourteen participants responded to Question #14 and nine responded to #15. Responses to Question #14 appeared to center around the innovative technology, while the common theme in responses to Question #15 were focused on the timeline for rollout of the technology.

Instructor

Questions #5 and #6 asked if the instructor presented the content clearly and if they were well-prepared. Participants mostly Agreed with Question #5, with a mean response for #5 of 3.97 (SD=0.95) and the majority Strongly Agreed with Question #6 with a mean response of 4.03 (SD=1.08).

Program Length

Question #7 asked if the length of the session was appropriate for stated objectives. The mean response was 3.94 (SD=0.85), with the majority Agreeing.

Transfer Expectations

Questions #8 and #9 asked participants if the training was relevant to their jobs and if they expected their organization to support their use of their new skills. The mean response for Question #8 was 4.03 (SD=1.05) and the mean response for Question #9 was 3.74 (SD=1.03).

Questions #16 and #17 asked participants what would encourage them to apply what they learned to their job and what would inhibit them from applying it. Eleven participants responded to Question #16, with responses focused on the availability of the technology. Most of the 11 responses to Question #17 centered around lack of availability of the finished product as inhibiting them from applying it to their jobs.

Overall Rating and Recommendations

Questions #10, #11, #12, and #13 asked participants about the overall training session, with mean responses of 4.00 (SD=0.89), 3.71 (SD=0.97), 3.73 (SD=0.94), and 3.60 (SD=1.13), respectively. The majority of responses to Question #18 (What would you suggest to improve this course?) appear to echo those comments noted earlier - participants were anxious for the technology to be further developed and rolled out for use.

Table 2- Results of End-of-Course Questionnaire - FATALGRAMS

	Questions	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5	n	Mean	Std Dev
1	Did the content meet the stated objectives?	3.3%	0.0%	30.0%	**50.0%**	16.7%	30	3.77	0.86
2	Were the jump-drive materials provided, consistent with the training objectives?	3.8%	0.0%	46.2%	**50.0%**	0.0%	26	3.42	0.70
3	Was the content of the material easy to understand?	0.0%	12.9%	19.4%	**45.2%**	22.6%	31	3.77	0.96
4	Were the presentation technologies used in the course effective?	0.0%	6.5%	25.8%	**45.2%**	22.6%	31	3.84	0.86
5	Did the instructors present content clearly?	3.2%	3.2%	16.1%	**48.4%**	29.0%	31	3.97	0.95
6	Were the instructors well-prepared?	3.2%	6.5%	16.1%	32.3%	**41.9%**	31	4.03	1.08
7	Was the length of the program appropriate for stated objectives?	3.2%	0.0%	19.4%	**54.8%**	22.6%	31	3.94	0.85
8	Was the training content relevant to your job?	3.2%	3.2%	22.6%	29.0%	**41.9%**	31	4.03	1.05
9	Do you expect your organization to support your use of skills learned in this course?	3.2%	6.5%	29.0%	**35.5%**	25.8%	31	3.74	1.03
10	Was the overall instructional environment conducive to learning?	3.2%	3.2%	9.7%	**58.1%**	25.8%	31	4.00	0.89
11	Was there enough time to cover the course content?	3.2%	6.5%	25.8%	**45.2%**	19.4%	31	3.71	0.97
12	Did the training program meet your intended needs?	3.3%	3.3%	30.0%	**43.3%**	20.0%	30	3.73	0.94
13	Would you recommend this training program to others?	3.3%	10.0%	**40.0%**	16.7%	30.0%	30	3.60	1.13

14 - What part of today's course surprised you the most? Maybe you would consider it a "lightbulb" moment.

- *Interactive development - potential to change outcome*
- *The possibility of using this tech. Yes, this is the future.*
- *Interesting*
- *Very interesting and enlighting concept*
- *Using technology my son uses - multi-generational*
- *Good idea*
- *How tech can & will help the future*
- *Potential*
- *Good idea & teaching tool*
- *Multiple actors*
- *Thought the simulations would be more extensive*
- *How this may be used as a training tool*
- *Training has come a long way since I started with the overhead projector!*
- *None. I expected a product but was introduced to a concept, with great potential.*

17 - What factors will inhibit you from applying what you learned?

- *Still in development stage. Timeline unknown for availability.*
- *Speed of operation, transitions. Timing is important.*
- *None*
- *Old guy, not a gamer*
- *Availability*
- *Not available*
- *Applicability*
- *Lack the extensive computer skills*
- *There is no workable simulation yet*
- *Lack of development of finished product*
- *Final product*

Table 2- Results of End-of-Course Questionnaire - FATALGRAMS (CONT'D)

15 - What was the most confusing idea we addressed in the presentation? - *Software just isn't there yet. Not the right time for this audience. Well spoken instructor however.* - *When it will be available* - *What next* - *Interfacing* - *When will it be available* - *The software development* - *Making the different fatal grams* - *NA* - *Nothing was confusing*	18 - What would you suggest to improve this course? - *I anticipated training on a program ready to use I could incorporate into my training program* - *More development is needed. Good idea.* - *Demo closer to finished product.* - *Make personal, give names to characters, show reward positive reinforcement.* - *Continued research and application* - *Want to see more - keep at it!* - *Keep at it* - *Come back when available. It will be very useful for training* - *Further development* - *Focus on practical end use* - *Hands on use of simulator* - *If we had a workable model in the future* - *Very good* - *??*
16 - What will encourage you to apply what you learned to your job? - *Learned outcomes & decisions can prevent accidents.* - *There is a great need for safety simulation* - *Bring to use* - *Product that you can buy* - *Keep up with tech* - *Avoiding the scenario in the futures* - *Very interested in the this type of training* - *If it would benefit the people being trained* - *More development of product* - *Product*	

ADULT LEARNING TEACHING STRATEGIES

Dr. Patty Anders and her Aim #2 team presented one 75-minute session of their course titled "Teaching Strategies for the Mine Safety Instructor". Forty-three participants were counted at the beginning of the session. Thirty-nine participants completed and returned questionnaires and the results are presented on Table 3.

Program objectives

The mean response to Question #1 "Did the content meet the stated objectives?", was 3.59 (SD=0.75), with the majority of participants Agreeing. One participant noted "Filling out first 2 sheets - didn't hear objectives". This comment references two informational surveys the project team handed out prior to the start of the session.

Program materials and delivery technologies

Questions #2 and #3 asked if the materials were consistent with the training and easy to understand, while Question #4 asked if the presentation technology was effective. Question #2 confused some participants who did not realize that the jump-drives they were given at the end of the session contained the training materials and as such, only 31 participants responded. The mean response for those answering Question #2 was 3.52 (SD=0.57). In the Comment section of Question #2, four participants responded with the following - "Did not get one yet"; "Don't know"; "I do not know"; and "Have not seen the materials".

The mean response for Questions #3 and #4 were 3.79 (SD=0.86) and 3.54 (SD=0.85), respectively, with the majority Agreeing to each. One participant noted on Question #4 - "Technical problems & A/V quality hurt presentation".

In Questions #14 and #15, participants were asked what information surprised them the most and what confused them the most. Nine participants responded to Question #14 and seven responded to #15. Responses can be found on Table 3.

Instructor(s)

Questions #5 and #6 asked if the instructor(s) presented content clearly and if they were well-prepared. The mean response for Question #5 was 3.82 (SD=0.82) and 3.69 (0.98) for Question #6, with the majority Agreeing to each. One participant commented in Question #5 - "Need to stop with 'uhm'".

Program length

The majority of participants Agreed that the length of the program was appropriate for stated objectives (Question #7), with a mean response of 3.79 (SD 0.83).

Transfer expectation

Questions #8 and #9 asked participants if the training was relevant to their jobs and if they expected their organization to support their use of their new skills. The majority of participants Agreed with both questions, with mean responses of 3.87 (SD=0.83) and 3.74 (SD=0.83).

When asked what factors would encourage participants to transfer their learning to their jobs (Question #16), 11 participants responded. Several noted that they already used the teaching strategies presented. Additional responses are presented in Table 3. Nine participants responded to Question #17 which asked which factors would inhibit them from transferring what they learned. Six participants noted that nothing would inhibit them from applying the teaching strategies.

Overall Rating and Recommendations

Questions #10, #11, #12, and #13 asked participants about the overall training session, with mean responses of 3.79 (SD=0.61), 3.67 (SD=0.77), 3.42 (SD=0.83), and 3.82 (SD=0.77), respectively. A participant noted on Question #11 that "Could have been a bit longer with more examples". While another participant noted on Question #12 that they had "No pre-conceived notion of need". The same participant noted in regard to recommending the session to others (Question #13) - "Good for initial training already apply many concepts & approaches in my efforts".

Question #18 asked participants for their suggestions to improve the course. Sixteen participants responded (Table 3). Several responses suggest that more time to present examples of the teaching strategies would be useful.

Table 3 - Results of End-of-Course Questionnaire - TEACHING STRATEGIES

	Question	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5	n	Mean	Std Dev
1	Did the content meet the stated objectives?	0.0%	5.1%	41.0%	**43.6%**	10.3%	39	3.59	0.75
2	Were the jump-drive materials provided, consistent with the training objectives?	0.0%	0.0%	**51.6%**	45.2%	3.2%	31	3.52	0.57
3	Was the content of the material easy to understand?	0.0%	12.8%	10.3%	**61.5%**	15.4%	39	3.79	0.86
4	Were the presentation technologies used in the course effective?	0.0%	15.4%	23.1%	**53.8%**	7.7%	39	3.54	0.85
5	Did the instructors present content clearly?	0.0%	7.7%	20.5%	**53.8%**	17.9%	39	3.82	0.82
6	Were the instructors well-prepared?	0.0%	12.8%	28.2%	**35.9%**	23.1%	39	3.69	0.98
7	Was the length of the program appropriate for stated objectives?	0.0%	7.7%	23.1%	**51.3%**	17.9%	39	3.79	0.83
8	Was the training content relevant to your job?	0.0%	7.7%	17.9%	**53.8%**	20.5%	39	3.87	0.83
9	Do you expect your organization to support your use of skills learned in this course?	0.0%	7.9%	26.3%	**50.0%**	15.8%	38	3.74	0.83
10	Was the overall instructional environment conducive to learning?	0.0%	0.0%	30.8%	**59.0%**	10.3%	39	3.79	0.61
11	Was there enough time to cover the course content?	0.0%	10.3%	20.5%	**61.5%**	7.7%	39	3.67	0.77
12	Did the training program meet your intended needs?	2.6%	10.5%	31.6%	**52.6%**	2.6%	38	3.42	0.83
13	Would you recommend this training program to others?	0.0%	5.3%	23.7%	**55.3%**	15.8%	38	3.82	0.77

14 - What part of today's course surprised you the most? Maybe you would consider it a "lightbulb" moment.

- *No comment*
- *Learning about the strategy of vocabulary differences*
- *Thought would be giving us insights instead of telling us about another seminar*
- *Dry delivery*
- *The research into the class*
- *Very dry delivery, no enthusiasm, lots of slide reading*
- *None*
- *Knowledge of course*
- *Lack of clarity in what was being offered = selling the class?*

17 - What factors will inhibit you from applying what you learned?

- *None*
- *You didn't teach us! You told us what you did in your program & try to get us to attend your classes.*
- *N/A*
- *None*
- *None*
- *Nothing*
- *MSHA requirements*
- *Nothing*

Table 3 - End-of-Course Questionnaire - TEACHING STRATEGIES (CONT'D)

15 - What was the most confusing idea we addressed in the presentation? - *No comment* - *N/A* - *Not sure* - *None* - *None* - *None* - *Discussion on language translation*	18 - What would you suggest to improve this course? - *Nothing specific* - *Cover the material in the synopsis not promote your class.* - *You must use the change you're wanting the group to learn.* - *Instructors need to be entertainers* - *For this context, more about the course & less of how the course was developed.* - *A little better preparation* - *None* - *More interactivity, less lecture, smile enthusiasm* - *Go to mine sites for annual refresher to learn their techniques* - *Show more examples of hands-on activities/exercises* - *To much of "uhm". Summarize the study in a few slides, don't read to audience off the ppt. Gave a lot of examples of barriers in learning but you did not offer ideas of how to address them. Handouts would also be helpful.* - *Consider different colors for background of slides* - *Better interface of ppt & video clips* - *Jump around to instructors* - *Ladies would benefit from speaking louder. We are hearing impaired miners* - *Good introduction*
16 - What will encourage you to apply what you learned to your job? - *Not a trainer but it will be given (info) to our trainer* - *Trying these strategies myself* - *I already utilize most techniques you were telling us about from your previous seminars* - *Real life examples* - *A desire of self-improvement* - *What was presented I already apply* - *The actual training practices* - *More knowledge* - *Consideration of class first, verification of literacy prior to training* - *Importance of course content that needs to be delivered.* - *Using mining language in safety training*	

MSHA CONTAMINANTS

Shannon Newton presented one 75-minute session of her course titled "Exposure and Control of Ten High Priority MSHA Contaminants in Metal Mining". Twenty-eight participants were counted at the beginning of the session. Twenty-five participants completed and returned questionnaires and the results are presented on Table 4.

Program objectives

The majority of participants Agreed with Question #1 (Did the content meet the stated objectives?), with a mean response of 4.04 (SD=0.84).

Program materials and delivery technologies

Questions #2 and #3 asked if the materials were consistent with the training and easy to understand, while Question #4 asked if the presentation technology was effective. Question #2 confused some participants who did not realize that the jump-drives they were given at the end of the session contained the training materials and as such, only 13 participants responded. The mean response for those answering Question #2 was 4.15 (SD=0.90), indicating Strong Agreement. In the Comment section of Question #2, five participants responded that they had not viewed the materials yet, so they weren't sure if the materials were consistent with training objectives.

The mean response for Questions #3 and #4 were 4.04 (SD=0.98) and 3.88 (SD=1.03), respectively. One participant noted on Question #3 - " Minimize acronym use".

In Questions #14 and #15, participants were asked what information surprised them the most and what confused them the most. Five participants responded to Question #14 and three responded to #15. No common themes were apparent in the responses.

Instructor(s)

Questions #5 and #6 asked if the instructor presented content clearly and if they were well-prepared. The mean response for Question #5 was 4.08 (SD=1.22) and 4.40 (SD=1.15) for Question #6, suggesting the majority of participants Strongly Agreed with each question.

Program length

Question #7 asked participants if the program length was appropriate for the session objective. The mean response was 4.04 (SD=0.93), with the majority Strongly Agreeing. However, one participant noted that " A lot of info (I know time is limited)".

Transfer expectation

Questions #8 and #9 asked participants if the training was relevant to their jobs and if they expected their organization to support their use of their new skills. The mean response for Questions #8 and #9, were 4.04 (SD=1.08) and 3.74 (SD=1.21).

When asked what factors would encourage participants to transfer their learning to their jobs (Question #16), 11 participants responded (Table 4). Seven participants responded (Table 4) to Question #17 which asked which factors would inhibit them from transferring what they learned. Management appeared to be a common theme in what may inhibit participants from applying what they had learned.

Overall Rating and Recommendations

Questions #10, #11, #12, and #13 asked participants about the overall training session, with mean responses of 3.96 (SD=1.00), 3.83 (SD=1.05), 3.83 (SD=0.92), and 4.08 (SD=1.02), respectively, indicating the majority of participants Agreed. Question #18 asked participants for their suggestions to improve the course. Eight participants provided varied responses (Table 4).

Table 4 - End-of-Course Questionnaire - MSHA CONTAMINANTS

	Question	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5	n	Mean	Std Dev
1	Did the content meet the stated objectives?	0.0%	4.0%	20.0%	**44.0%**	32.0%	25	4.04	0.84
2	Were the jump-drive materials provided, consistent with the training objectives?	0.0%	0.0%	30.8%	23.1%	**46.2%**	13	4.15	0.90
3	Was the content of the material easy to understand?	0.0%	12.0%	8.0%	**44.0%**	36.0%	25	4.04	0.98
4	Were the presentation technologies used in the course effective?	0.0%	12.5%	20.8%	**33.3%**	**33.3%**	24	3.88	1.03
5	Did the instructors present content clearly?	8.0%	4.0%	8.0%	32.0%	**48.0%**	25	4.08	1.22
6	Were the instructors well-prepared?	8.0%	0.0%	4.0%	20.0%	**68.0%**	25	4.40	1.15
7	Was the length of the program appropriate for stated objectives?	0.0%	4.0%	28.0%	28.0%	**40.0%**	25	4.04	0.93
8	Was the training content relevant to your job?	4.0%	4.0%	20.0%	32.0%	**40.0%**	25	4.00	1.08
9	Do you expect your organization to support your use of skills learned in this course?	8.7%	4.3%	21.7%	**34.8%**	30.4%	23	3.74	1.21
10	Was the overall instructional environment conducive to learning?	4.2%	4.2%	12.5%	**50.0%**	29.2%	24	3.96	1.00
11	Was there enough time to cover the course content?	4.2%	4.2%	25.0%	**37.5%**	29.2%	24	3.83	1.05
12	Did the training program meet your intended needs?	4.2%	0.0%	25.0%	**50.0%**	20.8%	24	3.83	0.92
13	Would you recommend this training program to others?	4.2%	4.2%	8.3%	**45.8%**	37.5%	24	4.08	1.02

14 - What part of today's course surprised you the most? Maybe you would consider it a "lightbulb" moment.

- *The fact that we need to be looking more closely @ diesel particulates*
- *The amount of work I need to do.*
- *None*
- *Ever changing evaluations of contaminants in work area*
- *Basic IH not specific to 10 contaminants*

17 - What factors will inhibit you from applying what you learned?

- *I need to do more sampling to understand it better. Practice makes perfect*
- *Cost - time factors*
- *Management not wanting to know if a problem exist*
- *The depth needed by students may not require the information at the level provided*
- *Management*
- *Management from making changes*
- *Sampling equipment date*

Table 4 - End-of-Course Questionnaire - MSHA CONTAMINANTS (CONT'D)

15 - What was the most confusing idea we addressed in the presentation? - *Confusing concepts were well explained.* - *None* - *All*	18 - What would you suggest to improve this course? - *List of citations ordered by MSHA. This is ammunition for us to XO back to our mngmnt and ask for funds to do sampling.* - *I thought it was very good, can't think of anything to change.* - *Good presentaiton for safety professionals* - *Would be good to see range of quantitative data* - *Less information per slide* - *Very well addressed presentation* - *Not easy to understand* - *Directed to mine specific items*
16 - What will encourage you to apply what you learned to your job? - *Silica concerns in workplace. MSHA requirements* - *Having the available resources (e.g. website)* - *Protecting my employees from future ailments* - *Better understanding of the agents of concern* - *Good use as training support* - *MSHA monitoring initiative* - *Help students appreciate methods of control* - *Better testing procedure* - *Yes -evaluations* - *Helps me learn about IH to do a better job at legal defense to MSHA citations.* - *IH flow process*	

IMR WEBSITE

Dr. Eric Lutz presented one 75-minute session of his course titled "Institute for Mineral Resources (IMR) Industrial Hygiene Website". Eighteen participants were counted at the beginning of the session. Thirteen participants completed and returned questionnaires and the results are presented on Table 5.

Program objectives

Thirteen participants responded to Question #1 (Did the content meet the stated objectives?), with a mean response of 3.62 (SD=1.39), indicating the majority of participants Agreed.

Program materials and delivery technologies

Questions #2 and #3 asked if the materials were consistent with the training and easy to understand, while Question #4 asked if the presentation technology was effective. Question #2 confused some participants who did not realize that the jump-drives they were given at the end of the session contained the training materials and as such, only 10 participants responded. The mean response for those answering Question #2 was 3.60 (SD=1.07). In the Comment section of Question #2, two participants responded that they had not viewed the materials yet, so they weren't sure if the materials were consistent with training objectives.

The majority of participants Strongly Agreed with Questions #3 and #4, with mean responses of 4.23 (SD=0.93) and 4.46 (SD=0.66), respectively.

In Questions #14 and #15, participants were asked what information surprised them the most and what confused them the most. One participant responded to Question #14 with nothing noted as surprising and two responded to #15 - one noting that nothing was confusing and the other noting that the "material did not seem to meet the course description".

Instructor(s)

Questions #5 and #6 asked if the instructor presented content clearly and if they were well-prepared. The majority of participants Strongly Agree, with mean responses for Question #5 of 4.62 (SD=0.87) and 4.54 (SD=1.13) for Question #6.

Program length

Question #7 asked participants if the program length was appropriate for the session objective. The mean response was 4.00 (SD=1.35).

Transfer expectation

Questions #8 and #9 asked participants if the training was relevant to their jobs and if they expected their organization to support their use of their new skills. The mean response for Questions #8 and #9, were 3.85 (SD=1.07) and 3.92 (SD=1.04).

When asked what factors would encourage participants to transfer their learning to their jobs (Question #16), only one participant responded (Table 4). Two participant responded to Question #17 which asked which factors would inhibit them from transferring what they learned. One participant noted that "closed minded leadership of our company" would inhibit them from applying what they learned.

Overall Rating and Recommendations

Questions #10, #11, #12, and #13 asked participants about the overall training session, with mean responses of 4.00 (SD=1.22), 4.15 (SD=1.14), 3.62 (SD=1.04), and 4.00 (SD=1.22), respectively. Question #18 asked participants for their suggestions to improve the course. Three participants provided varied responses (Table 4).

Table 5 - End-of-Course Questionnaire - IMR WEBSITE

	Question	Strongly Disagree 1	Disagree 2	Neutral 3	Agree 4	Strongly Agree 5	n	Mean	Std Dev
1	Did the content meet the stated objectives?	7.7%	23.1%	0.0%	**38.5%**	30.8%	13	3.62	1.39
2	Were the jump-drive materials provided, consistent with the training objectives?	10.0%	0.0%	20.0%	**60.0%**	10.0%	10	3.60	1.07
3	Was the content of the material easy to understand?	0.0%	7.7%	7.7%	38.5%	**46.2%**	13	4.23	0.93
4	Were the presentation technologies used in the course effective?	0.0%	0.0%	7.7%	38.5%	**53.8%**	13	4.46	0.66
5	Did the instructors present content clearly?	0.0%	7.7%	0.0%	15.4%	**76.9%**	13	4.62	0.87
6	Were the instructors well-prepared?	7.7%	0.0%	0.0%	15.4%	**76.9%**	13	4.54	1.13
7	Was the length of the program appropriate for stated objectives?	7.7%	7.7%	15.4%	15.4%	**53.8%**	13	4.00	1.35
8	Was the training content relevant to your job?	7.7%	0.0%	15.4%	**53.8%**	23.1%	13	3.85	1.07
9	Do you expect your organization to support your use of skills learned in this course?	0.0%	7.7%	30.8%	23.1%	**38.5%**	13	3.92	1.04
10	Was the overall instructional environment conducive to learning?	7.7%	7.7%	0.0%	**46.2%**	38.5%	13	4.00	1.22
11	Was there enough time to cover the course content?	7.7%	0.0%	7.7%	38.5%	**46.2%**	13	4.15	1.14
12	Did the training program meet your intended needs?	0.0%	23.1%	7.7%	**53.8%**	15.4%	13	3.62	1.04
13	Would you recommend this training program to others?	0.0%	15.4%	23.1%	7.7%	**53.8%**	13	4.00	1.22

14 - What part of today's course surprised you the most? Maybe you would consider it a "lightbulb" moment.
- None

15 - What was the most confusing idea we addressed in the presentation?
- *None*
- *Material did not seem to meet course description*

16 - What will encourage you to apply what you learned to your job?
- *None*

17 - What factors will inhibit you from applying what you learned?
- *None*
- *Closed minded leadership of our company*

18 - What would you suggest to improve this course?
- *Nothing*
- *Online capabilities*
- *"I" met*

OVERVIEW OF FINDINGS

The Aim #3 Evaluation Plan presented the model (Decision-Based Evaluation model) used to guide our evaluation efforts. As we discussed in the Evaluation Plan, the design, delivery and content validity of the program are the three foci in the content and design evaluation target. Specifically, the evaluation under this target area seeks to evaluate many aspects of the program – were the objectives appropriate, was it structured properly, how were the materials, etc. The findings from this portion of the evaluation are to be used as feedback to the project team, for possible revisions to the content structure, and to optimize future training. Furthermore, the evaluation of the content and design will allow NIOSH to make decisions about the overall effectiveness of the program.

For Aim #3, we identified expert judgment, advisory panels, and course ratings as the most appropriate methods for determining the content and design of the conference programs.

Expert Judgment

The occupational health and safety conference programs were designed by Dr. Eric Lutz, Dr. Paloma Beamer, Dr. Terrence Stobbe, and Shannon Newton, with Ros Hill serving as the team leader. The project team has more than 100 years of experience in occupational health and industrial hygiene experience; therefore, we believe their personal involvement in the design and implementation of the program is representative of expert judgment not only the design and delivery, but also the validity of the content.

The Teaching Strategies program was designed by Dr. Patricia Anders and her team. Dr. Anders is the Jewell M. Lewis Distinguished Professor of Education at the University of Arizona and considered internationally as an expert in the fields of language, reading, culture, adult learning and literacy. Therefore, we believe that Dr. Anders personal involvement in the design and implementation of the program is representative of expert judgment not only the design and delivery, but also the validity of the content.

Leonard Brown is a PhD-Candidate in Computer Science and has 15 years experience in the field of human computer interaction. He is considered an expert in his field and we consider his design and development of the Fatalgrams Gaming program appropriate.

Advisory Panels

The TAC, comprised of 14 safety and health professionals from broad commodity surface and underground mine and mine-related companies, serve as an Advisory Panel for this aim. The programs presented at the conference were based on the results from the TAC - Industry Needs Assessment presented during the Mining Safety and Health Workshop held at the University of Arizona on April 1, 2010. We

believe the content identified by the TAC is valid because of their expertise and knowledge of the mining industry.

Course Ratings/End-of-Course Questionnaire

While some researchers express concern over "novices" providing feedback on content and design of the training program, we believe this is not an issue because the conference participants are mostly experts in their respective fields (training, operations, etc). Therefore, we deem their feedback to be both relevant and appropriate. The End-of-Course Questionnaire is presented in Appendix A. Mean response data from each of the conference program sessions are compiled on Table 6.

The dimensions of the questionnaire used for conference are program objectives, program materials, and delivery technologies, instructor(s), program length, planned transfer expectation, overall rating and recommendations for program improvement.

Program Objectives

Question #1 on the End-of-Course Questionnaire asked if the content presented met the stated objectives of the session. The mean responses ranged from 3.59 (SD=0.75), for Teaching Strategies to 4.25 (SD=0.62), for Ergonomics. These results suggest that overall, participants Agreed that the content of the program met the stated objectives.

Program Materials and Delivery Technologies

Questions #2 asked if the materials provided on the jump drives were was consistent with the training objectives. Mean responses for Question #2 ranged from 3.42 (SD=0.70), for Fatalgram Gaming, to 4.22 (SD=0.83), for Ergonomics. Many participants were confused about the materials presented on the jump drives they received at the end of each session and as a result many did not answer Question #2. Additionally many participants made comments that they were unable to discern if the materials provided were consistent with the training because they had not yet viewed the files on the jump drives. If distribution methods such as jump drives are used in the future, presenters may consider showing the contents of the drive during the presentation so participants fully understand what materials are provided.

Question #3 asked participants if the content of the material was easy to understand, while Question #4 asked if the presentation technology used was effective. Mean responses for Question #3 ranged from 3.77 (SD=0.96), for Fatalgram Gaming, to 4.50 (SD=0.67), for Ergonomics. Question #4 mean responses ranged from 3.54 (SD=0.85), in Teaching Strategies, to 4.46 (SD=0.66) for the IMR Website. The results from Questions #3 and #4 suggest that participants Agreed that the content of the material was easy to understand and the presentation technologies used were effective.

Instructor(s)

Questions #5 and #6 asked if instructors presented content clearly and if they were well-prepared. Mean responses for Question #5 ranged from 3.82 (SD=0.82), for Teaching Strategies, to 4.62 (SD=0.87) for IMR Website, while mean responses for Question #6 ranged from 3.69 (SD=0.98), for Teaching Strategies to 4.58 (SD=0.51) for Ergonomics. These results suggest that overall participants believed the instructors were well-prepared and presented the content clearly.

Program Length

Question #7 asked participants if the length of the program was appropriate for the stated objectives. Mean responses ranged from 3.79 (SD=0.83), for Teaching Strategies, to 4.04 (SD=0.93) for MSHA Contaminants. These results suggest that overall participants agreed the length of the program was appropriate for stated objectives.

Transfer Expectation

Four questions (#8, #9, #16, #17) inquired about participants plans for applying their new knowledge to their jobs. For Question #8 (Was the training content relevant to your job?) mean responses ranged from 3.85 (SD=1.07), for the IMR Website, to 4.33 (SD=0.78), for Ergonomics. For Question #9 (Do you expect your organization to support your use of skills used in this course?) mean responses ranged from 3.74 for Fatalgram Gaming, MSHA Contaminants, and Teaching Strategies to 4.00 (SD=0.85) for Ergonomics.

Question #16 was an open response format and asked participants what would encourage them to apply what they learned to their job. Responses varied for each session, without a common theme developing. However, a common theme for Question #17 (What factors would inhibit you from applying what you learned?) appears to focus upon lack of support from management.

The responses from these questions suggest that while participants found the sessions relevant to their jobs and believe their organizations will support their use of these new skills, some of them believe that management many inhibit them from applying the skills. This may be a point of consideration for both the TAC and the project team prior to any additional sessions.

Overall Rating and Recommendations

Question #10 asked participants if the overall instructional environment was conducive to learning. Mean responses ranged from 3.79 (SD=0.61) for Teaching Strategies to 4.08 (SD=0.90) for Ergonomics, suggesting that overall participants agreed the instructional environment was conducive to learning.

Question #11 asked participants if there was enough time to cover the course content. Mean responses ranged from 3.67 (SD=0.77) for Teaching Strategies to 4.15 (SD=1.14) for the IMR Website. It should be noted that when participants were asked in Question #7 if the length of the program was appropriate for the stated objectives, the mean responses were higher for each session (with the exception of the IMR Website)

than they were for Question #11. This may suggest that while the presentation length was appropriate for the stated objectives, participants may want additional time to cover course content, especially for complex subjects such as Ergonomics.

Participants were asked in Question #12 if the training program met their intended needs. Mean responses ranged from 3.42 (SD=0.83) for Teaching Strategies to 3.92 (SD=0.90) for Ergonomics. The mean responses to Question #12 were the lowest of all questions asked. This suggests that while participants may have been satisfied with the sessions, the TAC and project team may need to gather additional information about participants needs.

Question #13 asked participants if they would recommend this training program to others. Mean responses ranged from 3.60 (SD=1.13) for Fatalgram Gaming to 4.08 (SD=1.00) for Ergonomics and MSHA Contaminants, suggesting overall, participants agreed they would recommend the program to others.

Question #18 was open response and asked participants what they would suggest to improve the course. The number of participants responding ranged from three for both Ergonomics and the IMR Website to 16 participants responding to the question for the Teaching Strategies session. The project team may wish to review their specific program recommendations for inclusion in future sessions.

SUMMARY

The evaluation findings from the Aim #3 - 7th Annual Joint Western Regional Mine Safety & Health Conference suggest that the conference was an appropriate setting for the presentation of the materials designed by the project team. Based on responses to the End-of-Course Questionnaire, we recommend the following.

- If jump drives are to be used in future programs, ensure that each project team member reviews the relevant content of the jump drive during their presentation.
- The project team should work with the TAC to further clarify the potential problem of management inhibiting the transfer of participants new knowledge and skills. Additionally, project team members should ensure that future presentations include possible methods for participants working with management to gain their support.
- The project team and TAC should work to identify what participants "needs" were not met by the conference presentations. Were the sessions too short for complex subjects? Did participants want more "hands-on" or "how-to" strategies. Additional participant feedback is needed here.
- All project team members should review the open responses to Questions #14 through #18 to gain additional understanding of participant's views.

Table 6 - Summary Results of End-of-Course Questionnaire

		Ergonomics		Fatalgram Gaming		MSHA Contaminants		IMR Website		Teaching Strategies	
	Question	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
1	Did the content meet the stated objectives?	4.25	0.62	3.77	0.86	4.04	0.84	3.62	1.39	3.59	0.75
2	Were the jump-drive materials provided, consistent with the training objectives?	4.22	0.83	3.42	0.70	4.15	0.90	3.60	1.07	3.52	0.57
3	Was the content of the material easy to understand?	4.50	0.67	3.77	0.96	4.04	0.98	4.23	0.93	3.79	0.86
4	Were the presentation technologies used in the course effective?	4.00	0.60	3.84	0.86	3.88	1.03	4.46	0.66	3.54	0.85
5	Did the instructors present content clearly?	4.50	0.67	3.97	0.95	4.08	1.22	4.62	0.87	3.82	0.82
6	Were the instructors well-prepared?	4.58	0.51	4.03	1.08	4.40	1.15	4.54	1.13	3.69	0.98
7	Was the length of the program appropriate for stated objectives?	4.00	0.60	3.94	0.85	4.04	0.93	4.00	1.35	3.79	0.83
8	Was the training content relevant to your job?	4.33	0.78	4.03	1.05	4.00	1.08	3.85	1.07	3.87	0.83
9	Do you expect your organization to support your use of skills learned in this course?	4.00	0.85	3.74	1.03	3.74	1.21	3.92	1.04	3.74	0.83
10	Was the overall instructional environment conducive to learning?	4.08	0.90	4.00	0.89	3.96	1.00	4.00	1.22	3.79	0.61
11	Was there enough time to cover the course content?	3.75	0.75	3.71	0.97	3.83	1.05	4.15	1.14	3.67	0.77
12	Did the training program meet your intended needs?	3.92	0.90	3.73	0.94	3.83	0.92	3.62	1.04	3.42	0.83
13	Would you recommend this training program to others?	4.08	1.00	3.60	1.13	4.08	1.02	4.00	1.22	3.82	0.77

MINE INSTITUTE FOR SUPERVISOR LEADERSHIP (MISL)

The Mine Institute for Supervisor Leadership (MISL) was held December 1-2, 2011, in Tucson, Arizona at the UA San Xavier Mining Laboratory Training Center. The MISL provides a venue for participants who are actively employed in mining to gain greater understanding of leadership characteristics, such as: supervisor roles, legal responsibilities, health and safety hazard identification and control, as well as pragmatic tools to resolve conflicts, manage time and tasks, drive culture change, and improve the delivery of training using effective adult learning techniques. This content was delivered via one to two hour, independent sessions taught by members of the TAC. At the completion of the intensive two day course, participants in the MISL were partnered with a Mentor (from the TAC) that provides guidance and coaching while the participant undertakes a Leadership Project, allowing them to apply their new knowledge and skills in their respective workplaces. The participants (Mentees) will return to the 2012 Spring MISL to present their projects and transition to becoming Mentors to the next cohort of participants.

The findings from this portion of the evaluation are to be used as feedback to the project team and the TAC, for possible revisions to the MISL program. Furthermore, it will allow NIOSH to make decisions about the overall effectiveness of the program.

As noted in the Evaluation Plan for Aim #3, our evaluation targeted both the Content and Design and Changes in the Learner for the 2011 Fall MISL program. Each of these target areas is discussed below.

CONTENT AND DESIGN

Participants provided their feedback on the content and design of the 2011 Fall MISL via a 26 question, 5-point (1=Strongly Disagree, 5=Strongly Agree) End-of-Course Questionnaire (Appendix B). As we noted in the Evaluation Plan for Aim #3, the relevant dimensions of the evaluation for the MISL included logistics/administration, training environment, program materials, instructional activities, delivery methods/technologies, instructor/facilitator, program time/length, and planned action/transfer. The responses are compiled in Table 7, which provides the relative frequency of participants ratings, the number of participants responding, the mean or average response, and the standard deviation. Additionally, Questions #27, 28, and 30, were open response and we have included each participants notations without determining its value or meaning. For example, if the participant responded "none" or "???" to a question, we have included it as a response on the data tables.

Expert Judgment and Advisory Panel

The MISL was designed by Dr. Eric Lutz with the TAC providing guidance, direction and content, as the advisory panel. The TAC is comprised of 14 top mining safety and health leaders, representing all major commodity sectors in both surface and underground operations. They are subject matter experts and leaders

in their respective commodity sectors, therefore we believe their personal involvement in the design and implementation of the program is representative of expert judgment not only in the design, but also the validity of the content.

Course Ratings

While some researchers express concern over "novices" providing feedback on content and design of a program, we believe this concern is not applicable here because MISL participants were identified as knowledgeable and highly skilled in their respective fields. They are participating in the MISL to increase their knowledge and skills in the area of leadership. Therefore, we deem their feedback to be both relevant and appropriate. The results of the participants' course ratings are presented below.

Logistics and Administration

Three questions (#1, #2, #3), inquired about the scheduling and registration for the program. Most participants Agreed or Strongly Agreed that registering for the course was easy and straightforward (mean=4.26, SD=0.81) and that communication regarding the course was also clear and straightforward (mean=4.20, SD=0.77). Question #3 asked participants if the "course schedule was well planned (restroom breaks, lunch, etc)" and the majority Agreed or Strongly Agreed with a mean response of 4.15 (SD=0.81).

Participants were able to write-in comments for each question on the survey and on Question #1, two participants noted the need to be able to pay registration fees via credit card. On Question #2, one participant noted the helpfulness of Shannon Newton (UA) and another noted that the meeting point on the first day (at the hotel) needed to be clarified. Seven participants commented on Question #3 – three noted the need for earlier (and more) restrooms breaks and the need for additional restroom facilities; three noted lots of material was covered in two days and some presentations ran long; while one stated "excellent presenters, good balance, good scheduling".

These results suggest that overall, participants were satisfied with the logistics and administration of the MISL program, although the project team may consider providing ability for credit card payments. Additionally, when preparing the 2012 Spring MISL schedule, the TAC and project team may want to include additional restroom breaks and/or additional restroom facilities.

Training Environment

Questions #4 through #8, asked participants about the MISL training environment. Participants Strongly Agreed (mean=4.20, SD=1.20) that the "training environment was appropriate for learning" (Question #4) and they Strongly Agreed (mean=4.16, SD=0.96) that "there was enough workspace for class activities" (Question #6). Two participants commented on Question #6, that more "elbow room"

was needed to work in. A similar comment was made in Question #4. Additionally, in response to Question #4, one participant noted that the lack of cell phone serviced helped with focusing, while another commented that "some place less remote" would be better.

Question #5 asked if "environmental conditions – comfort, heating, noise, visibility – conducive to learning?" While most Agreed with Question #5, it had the lowest mean response, 3.90 (SD=0.79), of any question on the End-of-Course Questionnaire. Two participants commented about the inability to darken the room, one noted the room was too cold, and another participant commented that it should been explained earlier that "mentors" were sitting behind participants in the room.

Participants were asked in Question #7 if the food provided was "appropriate (variety, type, etc)". This question, along with Question #8 (discussed below) were tied with the second lowest mean response, 3.95. Two participants commented on this question, one noting the food was "okay", while the other commented that more waters and sodas were needed.

Question #8 asked participants if they would "recommend the facilities be used again". As noted above, the mean response was 3.95 (SD=1.15). One participant commented that the hotel conference facilities would be better, while another noted "wish I had one just like it".

These results suggest that while most participants were satisfied with the training environment, some would like more space. The lowest scores for the MISL program were in this category and appear to be related to environmental conditions such as room temperature, visibility, and food/beverages. Additionally, the project team may consider introducing everyone in the room at the start of the day, so participants are aware of the mentors in the room.

Program Objectives

The majority of participants Agreed (mean=4.26, SD=0.65) that the content presented in the program met the stated objectives. One participant noted the Hazard Recognition and 3M sessions were least helpful.

Program Materials, Instructional Activities and Delivery Technologies

Questions #10 and #13 asked participants if training materials were "consistent with the training objective" (#10) and if the "content of the material" was easy to understand. The majority Strong Agreed with Question #10, having a mean response of 4.45 (SD=0.64), and the majority Agreed with Question #13, having a mean response of 4.30 (SD=0.57).

In Questions #11 and #12, participants were asked about the course exercises (#11) and group discussions (#12). The mean response for Question #11 was 4.40 (SD=0.60), suggesting the majority of participants Agreed that the "course exercises were relevant to the program objectives". The mean response for Question #12 was 4.55 (SD=0.60), suggesting the majority of participants Strongly Agreed

that the group discussions were "helpful to participants in exchanging ideas with each other". One participant commented in Question #12 - "excellent group activities".

Participants also Agreed that the "presentation technologies used in the course" were effective (Question #14), giving a mean response of 4.26 (SD=0.45).

These results suggest that participants were satisfied with the program materials, activities and delivery technologies.

Instructors

Questions #15 and #16 asked participants if instructors presented "content clearly" (#15) and if they were "well-prepared" (#16). Participants Strongly Agreed with both questions giving mean responses of 4.60 (SD=0.50). The mean response to these two questions were tied for the second highest response. One participant noted the some instructors "were better than others".

These results suggest overall participants believed the instructors were well prepared and presented the content clearly.

Program Length

Participants were asked if the "length of the program was appropriate for the stated objectives" (Question #17) and if "there was enough time to practice course objectives" (Question #18). The majority Agreed with mean responses of 4.28 (SD=0.60) and 3.98 (SD=0.80), respectively. One participant noted, in response to Question #18 – "will pan out during mentoring period".

The results suggest that the participants believed the length of the program was appropriate and there was enough time to practice the course objectives.

Transfer Expectation

Participants Strongly Agreed that the training content was relevant to their jobs (Question #19) and expected their organizations to support their use of skills learned (Question #20), with mean responses of 4.43 (SD=0.71) and 4.48 (SD=0.64), respectively.

Question #27 asked participants "What will encourage you to apply what you learned to your job?" Sixteen participants responded to the question and a dominant theme appeared to center on the ability to improve safety, while another focused upon personal motivation to improve. While Question #27 focused on what would encourage participants to apply what they learned, Question #28 asked participants what would inhibit them from applying what they learned. Fourteen participants responded and the dominant theme appears to be lack of time or a heavy workload. All responses to Questions #27 and #28 can be found on Table 7.

These results suggest that participants found the training content to be relevant to their respective jobs and that they expected their employers to support the use of their new skills. However, several responses suggest participants may be unsure of how to incorporate their new skills into an already heavy workload. The project team and TAC may want to consider how to incorporate additional time management and "how to" skills into the 2012 Spring MISL and subsequent mentoring sessions.

Overall Rating and Recommendations

Questions #21, #22, and #23, asked participants about the overall program with mean responses of 4.15 (SD=0.75), 4.05 (SD=0.83), and 4.30 (SD=0.66), respectively, suggesting overall Agreement. In response to Question #22 (Was there enough time to cover the course content?), one participant noted that "Friday was a little long" while another noted that more time was needed. Additionally, in response to Question #23, one participant noted that additional information, other than the agenda would have been helpful in knowing what to expect. Another participant commented that the training program provided more "what" than "how" and that many programs fail in the execution.

The majority of participants Strongly Agreed, with a mean response of 4.55 (SD=0.60), that they would "recommend this training program to others". When asked "What would you suggest to improve this training program?", no dominant themes were apparent. All the comments are provided in Table 7.

These results suggest that participants were satisfied with the overall MISL program. The project team and TAC should review all participant comments provided in Table 7.

Table 7 – End-of-Course Questionnaire, 2011 Fall MISL

	Questions	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	n	Mean	Std Dev
1	Was registering for the course easy and straightforward?	0%	5%	5%	**47%**	42%	19	4.26	0.81
2	Were communications (phone calls, emails, etc) regarding the course clear and straightforward?	0%	0%	20%	**40%**	**40%**	20	4.20	0.77
3	Was the course schedule well planned (restroom breaks, lunch, etc)?	0%	5%	10%	**50%**	35%	20	4.15	0.81
4	Was the training environment appropriate for learning?	10%	0%	0%	40%	**50%**	20	4.20	1.20
5	Were the environmental conditions - comfort, heating, noise, visibility - conducive to learning?	0%	5%	20%	**55%**	20%	20	3.90	0.79
6	Was there enough workspace for class activities?	0%	11%	5%	**42%**	**42%**	19	4.16	0.96
7	Was the food provided appropriate (variety, type, etc)?	0%	5%	20%	**50%**	25%	20	3.95	0.83
8	Would you recommend the facilities be used again?	10%	0%	5%	**55%**	30%	20	3.95	1.15
9	Did the content meet the stated objectives?	0%	0%	11%	**53%**	37%	19	4.26	0.65
10	Were the materials consistent with the training objectives?	0%	0%	6%	39%	**56%**	18	4.45	0.64
11	Were the course exercises relevant to the program objectives?	0%	0%	5%	**50%**	45%	20	4.40	0.60
12	Were the group discussions helpful to participants in exchanging ideas with each other?	0%	0%	5%	35%	**60%**	20	4.55	0.60
13	Was the content of the material easy to understand?	0%	0%	5%	**60%**	35%	20	4.30	0.57
14	Were the presentation technologies used in the course effective?	0%	0%	0%	**74%**	26%	19	4.26	0.45
15	Did the instructors present content clearly?	0%	0%	0%	40%	**60%**	20	4.60	0.50
16	Were the instructors well-prepared?	0%	0%	0%	40%	**60%**	20	4.60	0.50
17	Was the length of the program appropriate for stated objectives?	0%	0%	5%	**58%**	37%	19	4.28	0.60
18	Was there enough time to practice course objectives?	0%	5%	16%	**53%**	26%	19	3.98	0.80
19	Was the training content relevant to your job?	0%	0%	11%	32%	**58%**	19	4.43	0.71
20	Do you expect your organization to support your use of skills learned in this course?	0%	0%	5%	37%	**58%**	19	4.48	0.64
21	Was the overall instructional environment conducive to learning?	0%	5%	5%	**60%**	30%	20	4.15	0.75

Table 7 – End-of-Course Questionnaire, 2011 Fall MISL (Cont'd)

	Questions	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)	n	Mean	Std Dev
22	Was there enough time to cover the course content?	0%	5%	15%	**50%**	30%	20	4.05	0.83
23	Did the training program meet your intended needs?	0%	0%	10%	**50%**	40%	20	4.30	0.66
24	How committed are you to attaining the goals you developed for applying your new knowledge and skills to your job?	0%	0%	10%	15%	**75%**	20	4.65	0.67
25	How confident are you in the strategies you outlined to achieve your goal(s)?	0%	0%	6%	**61%**	33%	18	4.24	0.59
26	Would you recommend this training program to others?	0%	0%	5%	35%	**60%**	20	4.55	0.60

27 What will encourage you to apply what you learned, to your job?

- The outcome or what my employees will get out of it. The positive relations it will build.
- Making sure the employees stay healthy
- Desire to teach others
- Contact with my assigned mentor
- My personal motivation
- The desire to improve. Goals.
- The idea that I don't want to be that "bad" trainer, but a role model.
- The mentoring afterwards.
- Acceptance
- To make a better & safer workforce
- Self improvement & better confidence in presentation of my training. This will result in more effective training to my peers
- New safety ideas
- The opportunity to improve safety & enhance our safety program
- The willingness to try new ideas.
- New tools to improve safety.
- Conflict resolution. Keep tally on time in the field.

28 What factors will inhibit you from transferring what you learned?

- Trying to use all of the tools @ once, but otherwise a change in position or duties.
- None
- Time
- Time management - overwhelmed with day to day activities. Will need to put into practice right away
- Management
- Falling back into the "rat race"
- All of the other job duties required.
- Work load.
- Time
- Work load from time to time
- Fear of public speaking
- Time is the only factor - wish there were more hours in a day!
- The management
- Time, day-to-day pressures but should be able to overcome

Table 7 – End-of-Course Questionnaire, 2011 Fall MISL

30	What would you suggest to improve the training program?
	- Day was long & the group presentations would have been better to have more time to research, but that in the end might make it more complicated. Overall, it was very enjoyable & I have a lot of that I will take with me & pass on to others. All of the speakers were excellent & enjoyable, positive atmosphere. Lunches could have been better…
	- As mentioned - training facity being held at, or near, hotel in large conference room would set a nicer athmosphere. Still travel to mine for tour will be nice finish. Group assignments should take place earlier - BEFORE dinner. We were extremely tired and felt like we could have done a better job if not assigned to do that project after dinner. There were some excellent speakers. Taking away some really good ideas.
	- Reduce the amount of time required on Friday. By Friday noon my learning slowed down even though the information was excellent & the activities were good also. I was frankly worried I would be caught in rush hour traffic so I could get home for the weekend.
	- More on legal
	- More space and more time
	- Focus on not just "what" to do but pick some key areas and explore methods of "how" to implement and/or deploy critical systems.
	- It was great
	- Have the students introduce themselves at the beginning.
	- HL Boling was awesome!! Liked the 3M presentation. Thought conflict management was the least well-organized, least effective but it is an important topic. Some free time would be nice for informal networking (golf? Or opening night social).

CHANGES IN THE LEARNER

The Decision-Based Evaluation model includes changes in the learner as one of the three target areas for evaluation and focuses upon affective, cognitive and behavioral outcomes. Kraiger et al (1993), using the work of Gagne (1984), suggests that affective learning outcomes may impact learner behavior and/or performance. For this evaluation we focused specifically on motivational outcomes (motivational disposition, self-efficacy, and goal setting/commitment) because research suggests that these outcomes may impact participants transfer of their new knowledge and skills.

Prior to the start of the sessions on the first day of the 2011 Fall MISL program, participants were given a Pre-Course Questionnaire (Appendix C) containing eight questions for motivational disposition – five forced choice, two ranking, and one rating question; and one question regarding self-efficacy. Additionally, three questions on the End-of-Course Questionnaire were also used to assess the participants goal setting/commitment and their self-efficacy AFTER the training.

Affective Outcomes

Based on the work of Kraiger et al. (1993), we assessed the motivational dispositions of the participants prior to the MISL training program. Additionally, we asked about their self-efficacy both prior to having the training and after having the training, to assess for change. Participants were asked about their level of commitment to implementing their new knowledge and skills at the end of the training.

Motivational Outcomes

The motivational outcomes were divided into three parts – motivational disposition, self-efficacy, and goal setting/commitment. These results are presented on Tables 8 and 9, and are discussed below.

Motivational disposition

Question #1 of the Pre-Course Questionnaire asked participants if when learning new knowledge and skills if they preferred "doing well" or "working hard". The majority of participants (83%) indicated they preferred to work hard even if they did not do well, while 17% preferred to do well even if they did not have to work hard. Similarly, in Question #2 of the Pre-Course Questionnaire, participants were asked to rank, in order of importance, five behaviors for being successful in a course, "showing improvement" was ranked first and "working hard" was ranked second. Question #3 inquired about participants preferred "feedback" when learning new knowledge and skills. "Progress or improvement" ranked first and "effort" was ranked second. In Questions #4 and #5, learners were asked to identify their preferred tasks. Overwhelmingly, participants identified "a project where I'll learn a lot of new

things but also make a lot of mistakes" (Question #4 – 91%) and when having difficulty with a project they prefer to "continue working at it" (Question #5 – 100%).

Participants were asked in Question #6 to rate their "current level of performance training/teaching". Eighty-two percent rated themselves as "could do a little (or a lot) better", while just 18% rated themselves ad "doing your best". Additionally, when asked in Question #7 "what factor best explains your level of performance at training/teaching", 48% identified "effort" and 30% identified "quality of past training and experience". When comparing their ability to others in their field, the majority of participants ranked their ability from moderate to high (Question #8).

The results suggest that the majority of participants held a mastery orientation to learning prior to beginning the MISL program.

Self-Efficacy

Question #9 of the Pre-Course Questionnaire and Question #29 of the End-of-Course Questionnaire asked participants to estimate, between 1 and 10, how many of the leadership strategies would be able to implement in their jobs (Table 9). In addition, the question asked what level of confidence they had in their ability to implement the strategies. Prior to receiving the leadership training, 37% of participants believed they could implement 10 or more strategies, however, by completion of the course, only 13% of participants believed they could implement 10 or more strategies. Similarly, 37% of participants predicted they could implement five of the leadership strategies in the Pre-Course Questionnaire, but in the End-of-Course Questionnaire, only 25% predicated they could implement five of the strategies.

These results suggest that the self-efficacy of participants was reduced during the course. It is unclear why their self-efficacy was reduced, but may be a result of the breadth of content covered in the intensive two day program. The project team and TAC may wish to consider this change as they design and implement the 2012 Spring MISL.

Goal Setting

At the completion of the MISL program, participants were asked to write down one or more goals for applying their new knowledge and skills to their jobs. They were also asked to outline a few strategies for achieving these goals.

Questions #24 and #25 of the End-of-Course Questionnaire (Table 7) asked participants how committed they were to attaining their goals (#24) and how confident they were in the strategies they outlined (#25). The majority of participants Strongly Agreed that they were committed to attaining their goals. It is important to note that the mean response to

Question #24 was 4.65 (SD=0.67), the highest mean response on the End-of-Course Questionnaire. In addition, in response to Question #25, the majority of participants Agreed that they were confident in the strategies they outlined for attaining their goals (mean=4.24, SD=0.59).

These results suggest that participants were committed to attaining their goals and confident in their ability to do so.

Table 8 – Pre-Course Questionnaire (Motivational Dispositions), 2011 Fall MISL

	Questions	
1	When learning new knowledge and skills, do you prefer to:	
	a) do well in a course even though you don't have to work very hard; or	17%
	b) work hard in a course even though you don't do very well.	83%
2	When in a course to learn new knowledge and skills, rank order which is most important to your success (1=most important and 5=least important).	**Rank**
	Getting a good grade/evaluation	4
	Showing improvement	1
	Working hard	2
	Getting along with others in the course	3 and 4
	Doing as well or better than others in the course	5
3	In a course to learn new knowledge and skills, rank order what feedback is most important to you (1=most important and 5=least important)	**Rank**
	Your grade on assignments/evaluations	4 and 5
	Performance relative to other learners in the course	5
	Progress or improvement	1
	Effort	2
	Performance relative to grade level norms	3
4	Choose the better project for you.	
	a) A project where I'll learn a lot of new things but also make a lot of mistakes; or	91%
	b) A project that would involve a minimum of struggle and likely result in success	9%
5	When having difficulty with a project do you	
	a) continue working at it; or	100%
	b) find another project where success is more likely.	0%
6	How would you identify your current level of performance training/teaching?	
	a) Doing your best; or	18%
	b) Could do a little (or a lot) better.	82%
7	What factor best explains your level of performance at training/teaching?	
	a) Ability	4%
	b) Effort	48%
	c) Quality of past training and experience	30%
	d) Requirements of the job/role	17%
8	How would you rate your ability to perform your job - compared to others at your work or in your field?	
	1 - One of the lowest	0%
	2	4%
	3	30%
	4	57%
	5 - One of the highest	9%

Table 9 – Pre-Course and End-of-Course Questionnaire (Self-Efficacy), 2011 Fall MISL

Of the leadership strategies presented in this course, I will be capable of implementing….		
	Pre-Course	**End-of-Course**
1	0%	0%
2	5%	6%
3	11%	19%
4	0%	6%
5	37%	25%
6	0%	13%
7	5%	19%
8	5%	0%
9	0%	0%
10	37%	13%

SUMMARY

The Aim #3 Evaluation Plan presented the model (Decision-Based Evaluation model) used to guide our evaluation efforts. As we discussed in the plan, the design, delivery and content validity of the program are the three foci in the content and design evaluation target. Specifically, the evaluation under this target area seeks to asses many aspects of the program – were the objectives appropriate, was it structured properly, how were the materials, etc. Furthermore, to evaluate potential changes in the learners, we focused on affective outcomes, specifically motivational outcomes - motivational dispositions, self-efficacy, and goal setting, seeking to assess if the training should incorporate aspects that would change participants motivations.

The evaluation findings from Aim#3 – Mine Institute for Supervisor Leadership suggests that the majority of participants were satisfied with the design and implementation of the MISL program. Furthermore, participants arrived at the program with a mastery orientation to learning. This is important because some research suggests that learners having a mastery orientation may have greater transfer of training (Kraiger et al, 1993; Stevens & Gist, 1997). Additionally, participants arrived with high levels of self-efficacy. Researchers consider high self-efficacy as important as it "may provide a resiliency to any difficulties faced in trying to apply what was learned back to the work setting" (Ford et al, 1998, p. 230). However, in the MISL program, the participants level of self-efficacy was reduced after the intensive two day portion of the program and will require further consideration by the project team and TAC.

In addition to the mastery orientation and high initial levels of self-efficacy, participants in the MISL program were highly committed to their goals of applying their new knowledge and skills at their respective workplaces. Kraiger et al (1993) suggest this is important because "Research indicates that individuals who set specific, difficult goals and who are committed to those goals are more likely to exert effort and perform at a high level (Locke, Latham & Erez, 1988; Mento, Steele & Karren, 1987; Tubbs, 1986)".

In summary, the findings from this evaluation suggest that the 2011 Fall MISL program was appropriately designed and implemented. Additionally, it appears that participants were oriented on mastering the content, not just doing well, and were committed to applying it at their workplaces. Based on the both the quantitative and qualitative data we collected, we make the following recommendations for consideration by the project team and TAC.

Recommendations

- The project team may consider allowing the use of credit cards to pay the registration fee.
- If the UA San Xavier Mining Laboratory Training Center is to be used for future MISL programs, provide additional restroom facilities and/or more frequent restroom breaks.

Additionally, project team members should review the arrangement of work tables to ensure adequate "elbow room".

- The project team may consider the variety and amounts of food and beverages available, specifically more waters and sodas – even during the early morning.
- All presenters should strive to identify ways participants can incorporate their new knowledge and skills into an already heavy workload. This may help participants to greater understand "how" to transfer their skills and perhaps help in maintaining their self-efficacy at the completion of the program.

APPENDIX B

Mine Safety Training Handbook: Active Training Tools for Mine Safety Trainers

MINE SAFETY TRAINING

HANDBOOK

Active Learning for Mine Safety Trainers

Brought to you by

THE UNIVERSITY OF ARIZONA®

TABLE OF CONTENTS

INTRODUCTION:

A New Way To Train

USE ACTIVE TRAINING TOOLS TO ENGAGES ADULTS

Mine safety training saves lives. In 1978, the year the Mine Safety and Health Administration was established, 242 miners died in mining accidents. In 2012 the number of deaths had dropped to 36. Training the people who work in the mining industry – and retraining annually – helps reduce deaths, injuries and illnesses.

– Mine Safety and Health Administration

Welcome to your new active training handbook!

As you look through this handbook, you'll discover the key characteristics of active training, strategies for handling group dynamics, tips to enhance your PowerPoint presentation and plenty of engaging activities you can use to help trainees learn, retain and apply safety standards on the mine site.

What is active training? Active training involves asking questions, sharing experiences giving feedback, and teaming up to solve problems; it is a social and memorable way to convey information and encourage active participation.

Passive training, on the other hand, involves sitting and listening to someone lecture. Educational research shows that active training is a more effective way to teach – especially adults. This handbook will help you incorporate active learning techniques to help train your workforce more effectively and reduce the number of accidents, injuries and fatalities in the mining industry.

This handbook will help you understand why active training is more powerful than passive presentations – and show you how to incorporate active training techniques to help you train more effectively. When you understand how your trainees learn and respond to information, you can dramatically improve your training and increase retention of key safety behaviors.

Telling is Not Training

To become a great trainer using active training methods, you need to remember that you are not shirking your responsibility when you step out of the way and allow trainees to interact with each other. When trainees interact with each other, they will learn more. And they will retain more.

Remind yourself as often necessary that "telling isn't training." Not everyone learns the same way. That's why it is so important to incorporate a variety of teaching techniques in your mine safety training. Active training helps you connect with your trainees and helps you have a far greater impact.

Punch Up Your PowerPoint

Icebreaker Interview… Lecture Bingo… Mining Acronym Game... Last Words

These are among the dozens of activities you'll find in this handbook to help you engage your trainees. Decide which activities you want to use – and add them strategically throughout your PowerPoint slides. This will remind you to stop and do the exercise and cue your trainees to pay closer attention.

Active training means you'll have participants talking to one another – so you'll want to time the activities closely to keep things moving along. Decide how long each activity will be, then use a timer so you can direct trainees to stop what they're doing before you move on to the next topic.

You can also use a timer to keep track of your speaking time. Plan to talk no more than 20 minutes at a time before you pause and do something more interactive.

Choose Your Activities

Let's get started.

We invite you to use these active adult training tools and see for yourself how well they work – for both you and your trainees. We encourage you to be creative about when and how you incorporate these activities throughout the day.

Experiment and see what works best. And please give us your feedback along the way. We plan to update this handbook with suggestions from your experiences in the field.

MOTIVATION IN TRAINING

Mining companies spend millions of dollars each year on training, including MSHA-required courses such as annual refresher. Yet illnesses, injuries and accidents continue to occur. Research from other industries suggests that active learning can result in increased training effectiveness and reduction in health and safety incidents.

– Western Mining Safety and Health Training Resource Center

Guide Trainees to Actively Participate

As we all know, folks who sit through mandated safety trainings don't necessarily want to be there. Motivating a group like that can be very difficult.

Here are a few insights from research on motivation that will help you understand – and motivate – the unmotivated.

There are two types of motivation for trainees – mastery and performance.

- Mastery means the trainee wants to do well at the task for the sake of doing well at the task – for his or her own personal satisfaction. This is internal motivation.
- Performance means the trainee wants to do well in the training or on the task because he or she is concerned with getting evaluated by his trainer or supervisor. This is external motivation.

Transfer is the term that means the trainee can take what is learned in training and apply it to situations in the workplace. Transfer is more likely to happen when the trainee is motivated by mastery, rather than just performance.

Transfer is more likely to happen when the trainee:

- Believes he or she can successfully produce desired outcomes.
- Understands why the training is important. The trainee is not just sitting there "putting in the hours."
- Knows what the training objectives are. Training objectives are the goals for the training – what you want the trainees to know or be able to do by the end of the training.

A lot of safety trainings stay within the realm of performance. The trainees remain passive, waiting for the end of the day when they will take a multiple choice quiz – often with the instructor giving them the answers – then get their certificates leave.

Training activities that motivate trainees to master the knowledge are more active – the trainee is required to think, explain procedures to others and interact with the group and the trainer. All of these things tap into a deeper internal motivation that we all share. We want to be good at our jobs – not for others, for the trainer or the boss – but for ourselves, for our own well-being and satisfaction.

Start the Day

The way you begin the day in an active training can make all the difference.

Trainees need to understand right away that you will be asking them to participate in their learning – actively. You need to stress why this is so important – because they work together on site, they also benefit from work together in training.

When trainees have a chance to get to know each other – to learn each other's names, and a few details about each other – safety training comes alive and is more meaningful.

It's easier to care about the safety of people we know than people we don't know. Giving trainees time to interact with one another can create motivation for learning and for transfer back at the worksite.

CHARACTERISTICS OF ADULT TRAINING

As adults, we learn in specific ways. There are four key characteristics that we share as adult learners:

- **Experience** – We come to the classroom with life and work experiences that can help motivate us to learn.
- **Collaboration** – We like to take responsibility for our learning. We like to collaborate with the instructor and our co-workers – to design training, do activities and evaluate ourselves.
- **Problem solving** – We are problem-centered or task-specific in our orientation to learning. We learn best by solving problems or completing tasks that require us to think for ourselves or think outside the box. We would rather think for ourselves than be told the answers.
- **Motivation** – We need to know why what we are learning is important. Training is easier when we can directly experience the real-life situations where we will apply the knowledge. We are motivated by internal pressure, not external.

Each activity in this handbook is linked to one or more of these learning characteristics. Keeping these characteristics mind makes training more meaningful, effective and efficient.

Tap into Experience

One way to bridge the experience gap between trainees is to call upon experienced miners to explain some aspect of safety to the new miners. This can keep both engaged in the training process. Other training challenges are "translating" complex safety regulations into everyday language or navigating the maze of acronyms. These are opportunities to ask questions and keep trainees involved.

Personal experience, group collaboration and mentoring are all effective ways to train adults. Group experiences allow learners to assist each other in understanding the material. Trainees also benefit from knowing how what they learn will be applied to their workplace.

This handbook gathers in one place a variety of training activities designed specifically for the mine safety trainer.

GETTING STARTED:

Motivation & Beginning the Day

CREATE CONNECTIONS TO MINE SAFETY TRAINING

Creating connection among workers is a key to mine safety training that we often ignore.

Class members are a critical element of active training. And as a trainer, part of your job is to develop a sense of camaraderie among the workers in your training session.

From experience you know that every training has its own group vibe. Some groups are fun and lively while others are flat and quiet. You can influence group dynamics and energize your trainees. The sense of camaraderie and working together that happens at the work site can be encouraged in your safety training room and lead to a stronger safety culture at your site.

Start by having the miners in your training introduce themselves to one another. This is a pivotal aspect of active training. It's simple – yet very effective.

When you have people introduce themselves, you're acknowledging the important role they will play in the training. You're also communicating that active training is about training people, not covering content.

In any group, but especially those with more than 30 participants who don't know each other, use name tags. The more you use people's names the more involved and acknowledged they feel. Name tags also help the trainees get to know one another.

In this section, you will find adult training activities to make connections and build trust in creative ways.

Optional

Add this four-minute video to your PowerPoint slides to highlight the importance of active learning:

David Spade
http://www.youtube.com/watch?v=0WXhtyVs9Gk

CLASSROOM SETUP

Activity description – This activity you do before the training begins can change the classroom interaction significantly.

When to do this activity – Before class.

Objectives – To encourage interaction, make training more interesting and enjoyable. Adult learners enjoy learning from each other and getting to know one another.

Adult training characteristics addressed – Experience and motivation

In-class time – 5 minutes

Steps before class

- We recommend using a circle or U-shape for active training. This set-up allows the trainee to see everyone else in the training and creates an environment that includes everyone. In a circle or U-shaped setup you're less likely to have people drifting off, hidden in the back of the room. This also takes the focus off of you and puts it on everyone in the room – reminding trainees that they are learning safety for the sake of each other.
- If possible, provide comfortable chairs for the training.

Steps during class

- Allow the group to casually interact. Encourage discussion so trainees can share their background and experiences. Enjoy the conversation and discussions you see happening amongst your trainees.
- Listen and learn. What you hear may help you connect with individual trainees later in the training process.
- **Remember** – It's easier to care about the safety of people we know than people we don't know. Giving trainees time to interact with one another can create motivation for learning and for transfer of safety principles to the worksite.

Evaluation

You will know this activity is successful when trainees talk among themselves during the training session. This adds to and does not take away from the training experience.

DEVELOP TRAINING GUIDELINES

Activity description – Start the day by letting the trainees know right away they'll be participating in mine safety training in a new way. Ask them to come up with their own guidelines for the training.

When to use this activity – Open your training session with this activity. This sets the tone and lets the trainees know that you expect them to participate and contribute throughout the training, not just sit passively and listen to you lecture.

Objectives – To create a feeling of involvement in the training. To encourage group participation – trainees are more likely to follow their own recommendations for group interactions. To motivate trainees to take responsibility for their own training experience – just as when they are in the workplace they have to take responsibility for their own safety and those around them.

Adult training characteristics addressed – Experience, collaboration and motivation

In-class time – 10 minutes

Materials needed – White board or poster paper, markers and a timer.

Steps before class

- If using PowerPoint, add this text to your slide:

  Developing Training Guidelines
  Group decides on parameters for interaction

Steps in class

- Introduce yourself, then explain that today's training will be "active training" – which is far different from passive presentations where they just sit and listen. Tell the trainees that you plan to encourage them to solve problems, explain procedures and share their experience with others. The first step in this new approach is to develop guidelines for interacting as a group.

- Ask the group to suggest some basic guidelines for interacting during the training process.
- These are parameters that everyone agrees upon about how to communicate and interact during the training. The guidelines the group develops together – basic courtesies like turn off cell phones, don't interrupt others and expect participation from everyone – will likely be the same as you would have chosen. But now you have "buy in" – consensus on how the group wants to function.
- Write the guidelines suggested by the trainees on a poster paper or on a whiteboard so everyone can see them.
- If no one mentions active participation you could prompt them by saying something like "Keep in mind that this is an active training and it works best when everyone is involved. Should we add that?" Call on people who have not yet contributed.
- If there are other guidelines that you'd like to suggest include, ask the group "What about…" Then you can add new items with their agreement.

Suggestions

- Here are some suggested guidelines:
- Respect everyone. Every question and opinion is valued.
- Do not interrupt when someone is speaking.
- Turn off cell phones. Use them only during breaks. No texting please.
- Participate. If you usually talk a lot in groups, hold back and give others a chance to jump in. If you usually don't talk much in groups, make an effort to jump in and contribute.

Evaluation

You will know this activity is successful when trainees suggest all the guidelines for you. It is moderately successful when you need to prompt them with your ideas.

ICEBREAKER INTERVIEW

Activity description – The Icebreaker Interview helps trainees get to know each other and sets the tone for the day of active training.

When to use this activity – At the beginning of the day, after setting group guidelines or after lunch – to get trainees out of their seats and talking to each other.

Objectives – To create stronger work relationships, which translate into a stronger safety culture on site. When trainees have a chance to get to know each other – to learn each other's names and a little more about each other – safety training comes alive and is more meaningful.

Adult training characteristics addressed – Experience, collaboration and motivation

In-class time – 20 minutes

Materials needed – 3x5 cards, pens, timer

Steps before class

- If using PowerPoint, add this text to your slide:

  Icebreaker Interview
  Getting to know each other helps create a stronger safety culture

Steps during class

- Have the trainees number off to form in groups of three.
- Give index cards and pens to everyone.
- After groups have formed, describe the activity, saying "Now we're going to take some time to do mini-interviews with each other. In your group, decide who will be interviewed first, who will do the interview, and who will observe. After 2 minutes, you'll switch. Listen for the bell.
- Set the timer for 2 minutes while groups conduct mini-interviews – including name, background, goals and other information.
- Do two more rounds of mini-interviews.
- Depending on the size of the group, you can ask each trainee to introduce someone else to the whole group. If the group is too large, ask individuals to share something interesting they learned about their co-worker.

Evaluation

You will know this activity is successful when trainees have fun with it. It is successful when trainees who didn't know each other before the training get to know each other and refer to each other by name throughout the day.

SPARK THE CONVERSATION

Activity description – Facilitating a discussion is one of the most powerful and important skills you can use when training adults. Adult learners like to share their experiences and take responsibility for their own learning. Lively and informed discussions help them remember details of the topic – especially when they hear from a variety of voices in the group.

When to use this activity – In some trainings, you may have a lively, talkative group where everyone wants to chime in about every topic. That's when your facilitation skills can help you guide the discussion. Other times you may have a very quiet bunch. That's when forming small groups or teaming up in pairs can be helpful – especially for those trainees who don't want to talk in the larger group.

Objectives – To give you an idea of what your trainees do and do not understand. To keep trainees engaged and actively participating by asking questions that touch on important points of the safety topic.

Adult training characteristics addressed – Experience, collaboration, problem-solving and motivation

In class time – 10-15 minutes. (For talkative groups, you might want to set a timer so you can keep on schedule.)

Steps before class

Review these useful phrases and questions:

Questions and comments to keep the conversation going:

- Interesting. What do the rest of you think about what was just said? Do you agree?
- Has anyone else experienced something similar?
- Who here has experience with this subject?
- Say more about that…

Guiding questions include:

- What surprised you about that?
- What did you learn that you didn't know before?
- What was confusing to you?
- What would you like to know more about?
- How would you explain that to someone new to the job?

In Class

When facilitating discussions, ask questions that are open-ended – for example, "What do you know about working in high wall areas?" That is more engaging than a yes or no question like "Do you work in a high wall area?"

Encourage conversation. As a group gets to talking, participants are more likely to feel a sense of camaraderie and pride in their work. This contributes to awareness and safety on site.

You are an excellent facilitator when a discussion, debate or conversation sparks throughout the room – not when you simply ask a question, a trainee answers and you move on to the next question.

Remember – Interactive discussion is one of the most effective ways to "cover the material" and make a lasting impact. In facilitating discussion, you are showing trainees you appreciate their knowledge, expertise and experience.

Evaluation

You will know this activity is successful when trainees engage in a discussion in the group, rather than just sitting quietly or speaking to you only when you ask a direct question. This activity is very successful when trainees continue a natural conversation about safety throughout the day.

WANTED POSTER INTRODUCTIONS

Activity description – Working in pairs, trainees interview one another and develop an old-fashioned "Wanted Poster" to introduce each person to the group. This is a fun – and funny – alternative to typical get-to-know-you exercises.

When to use this activity – This is a novel way to do group introductions at the start of any training. This is also works well for groups where trainees already know each other well – like the annual refresher.

Objectives – To build connections and camaraderie. To engage the group and set the stage for interactive team-building and problem-solving activities yet to come.

Learning characteristics addressed – Experience, collaboration and motivation

In-class time: 30 minutes (depends on size of group)

Steps before class

- Print out blank Wanted Posters. Provide pens or markers.
- If using PowerPoint, add this text:

  Wanted Poster Introductions
  Who is this desperado?

In class

- Tell the group to get ready to have some fun. The plan is to introduce one another by using an outlaw theme and creating Wanted Posters. They'll work in pairs to interview each other, create the Wanted Posters, then use them to introduce the trainee to the whole group.
- Ask each trainee to pair up with someone in the room – ideally with someone they already know.
- Encourage the group to be creative, silly, G-rated – and most of all – kind. Remind them to avoid insensitive answers that could make others uncomfortable.
- Give the trainees 2 minutes to do the first interview and fill out the Wanted Poster. Set the timer. When it rings, it's time to interview the other person and complete the second poster. Again set the timer for 2 minutes.
- Now bring the group back together and have the trainees introduce one another with details from the Wanted Posters.

WANTED

Trainee's name: _____

AKA – the Alias: _____

Reward: _____

Wanted by: _____

Wanted for: _____

Known hangout
(what part of the mine?): _____

Distinguishing features: _____

Specialized skills: _____

Known to say: _____

Survival secret
(key point to remember
about safety): _____

Evaluation

At a minimum this activity gets trainees to share information with one another. At a maximum, the whole group is engaged and energized.

APPENDIX C

MISL Graduates

List of graduates from the Mining Institute for Supervisor Leadership

December 1-2, 2011

Scott Boyes	Salt River Materials Group
James Brown	Resolution Copper Company
Jami Dwyer	Barrick Goldstrike Mines Inc.
William Hyde	ASARCO LLC
Bruce Dixon	Southwest Energy LLC
Cathy Fontes	Freeport McMoRan Sierrita Inc.
Francis Johnson	BHP Billiton
Dustin Rockwell	Southwest Energy LLC
Jody Beck	Freeport McMoRan Sierrita Inc.
George Jones	Freeport McMoRan Sierrita Inc.
Sherry Green	Resolution Copper Company
Jonathan Ruiz	Freeport McMoRan Sierrita Inc.
Frederick Osborne	North American Salt Company
Orleen Barber	BHP Billiton
James Randall Rogers	Southwest Energy LLC
Alberto Castro	Western Industrial
Ryan Westra	Freeport McMoRan Sierrita Inc.
Shane Bloomfield	Salt River Materials Group
John Hawley	Freeport McMoRan Sierrita Inc.
Brandan A. Lyons	Barrick Goldstrike Mines Inc.
Nate Shechter	Western Industrial
Jaymie Donna Nordwall	Barrick Goldstrike Mines Inc.
Clyde Rivera	Western Industrial

April 26-27, 2012

Samuel W. Chief	Peabody Western Coal Company
John Bierhaus	Freeport McMoRan Copper/Gold
Tony Daniels	Barrick Goldstrike
Xavier Burrola	Granite Construction Co
Ramon Gonzalez	Hamm, Inc
Mike Hamill	Freeport McMoRan Copper/Gold
Lance Johnson	Freeport McMoRan Copper/Gold
Warren Hawkridge	Hinkle Contracting Co, LLC
Kyle R Nelson	Barrick Goldstrike
Chris Sallee	Western Industrial
Diana Kelts	Freeport McMoRan Copper/Gold
Wade Young	Freeport McMoRan Copper/Gold

Benny Yazzie Jr	Peabody Coal Kayenta AZ
Aaron Weight	Barrick Goldstrike
Martha G Mottley	Freeport McMoRan Copper/Gold
Chris Zeiler	Barrick Goldstrike
Annette Gelfi	Freeport McMoRan Copper/Gold

December 6-7, 2012

Juan Marquez	Freeport McMoRan Copper/Gold
Tony Amaro	Freeport McMoRan Copper/Gold
Britton Kiefer	Resolution Copper Company
Gregory Riley	Freeport McMoRan Copper/Gold
Jeff Wallace	Freeport McMoRan Copper/Gold
Laurie Swartzbaugh	ASMIO
Carin Kosmoski	NIOSH

April 24-26, 2013

Andrew Siersma	Freeport McMoRan
Elton Dalmolin	FNF Construction
Eric Gerdes	FNF Construction
Terry Hill	Freeport McMoRan
Phil Jaurequi	Freeport McMoRan
James Skinner	Freeport McMoRan
David Verner	Freeport McMoRan
Sarah Foster	Freeport McMoRan
Tony Bilunka	Thyssen Mining
Daniel Valenzuela	Freeport McMoRan
John Badilla	Freeport McMoRan
Thomas Enriquez	Freeport McMoRan

April 22-25, 2014

Astolfo Cota	Freeport McMoRan
Charles Gutierrez	Freeport McMoRan
Christopher Tilton	Freeport McMoRan
Dan Flatt	Stillwater Mining
Diana Wilkinson	Freeport McMoRan
Don Mills	Stillwater Mining
Eric Guin	Freeport McMoRan
Frans Pigome	Freeport McMoRan
Hans Bishop	Freeport McMoRan
Jimmy Herbert	Freeport McMoRan
Jodi Black	Freeport McMoRan
Joe Fletcher	Vulcan Materials
Jose DeLaO	Freeport McMoRan

Joseph Chapman	Freeport McMoRan
Kaycie Kynett	Stillwater Mining
Kendra Meier	Stillwater Mining
Kristen Rost	CDC
Lowell Burris	Stillwater Mining
Mark Rapkoch	Stillwater Mining
Rob Payne	Stillwater Mining
Shawn Jones	Stillwater Mining
Vinson Russell	Freeport McMoRan

APPENDIX D

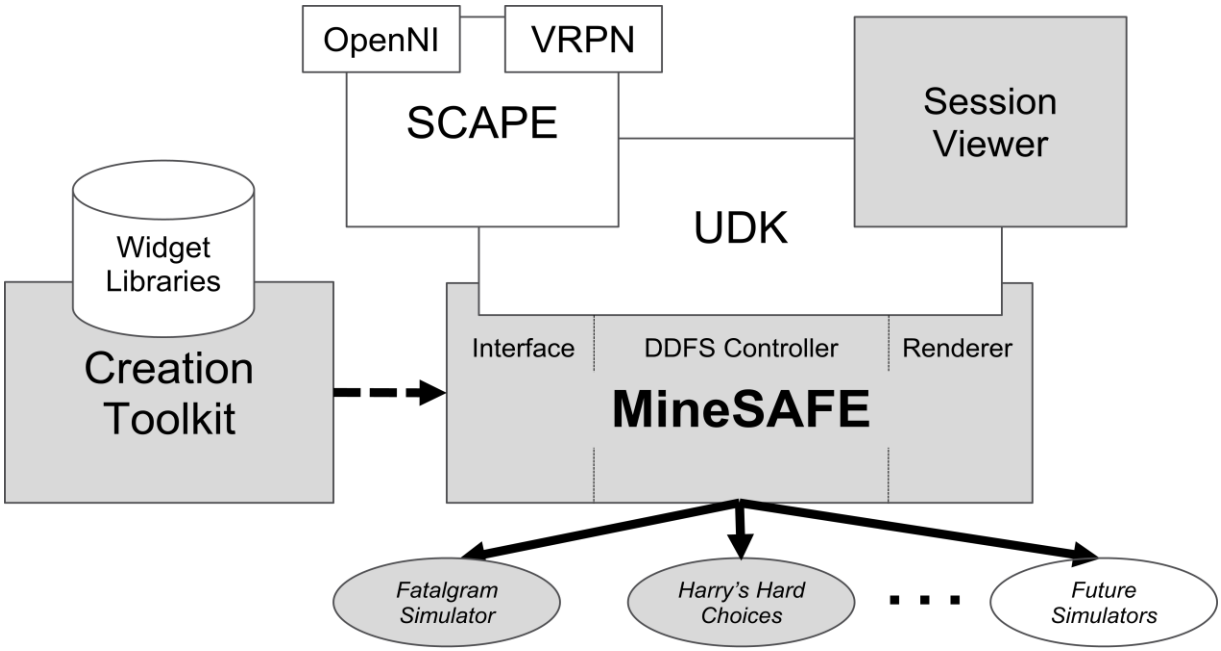
MineSAFE

New Approaches in Computer-based Training Software. We realized early in our planning stages that existing training software and simulations would be insufficient to meet our training objectives. In year one, we assessed the body of existing software products targeted to the mining industry to identify limitations and areas for improvement. Along these lines, we conducted a triangulated needs assessment with three data sources: 1) product surveys conducted by a group of experts within our team, 2) informal user studies of existing training software, and 3) feedback from industry stakeholders. Our needs assessment identified five vital characteristics to drive the design of computer simulations for mine safety training:

1. Accessible: Software should be accessible to a broad range of user demographics, engaging a new generation of miners in addition to experienced miners. Reasonable accommodations should be made to address computer and workplace literacy issues, as well as second language learners.
2. Team-Oriented: Training simulations should attempt to capture the social interactions and team dynamics present in the mining workplace. An emphasis should be placed on promoting good communication and cooperative thinking.
3. Contextualized: The virtual training environment should provide a believable and immersive context that allows for situated learning. The environment should be immersive and multi-modal, replicating the sights, sounds, and dynamic interactions of the mining workplace. The software should support a mentoring style of learning.
4. Consequent. Choices should have tangible consequences that impact both the individual player and his or her team. Consequences should be persistent and cumulative, resulting in realistic changes to simulation state and user options. Both positive and negative outcomes should be memorably reinforced.
5. Competitive. The training session should foster a competitive spirit and a desire to replay through metrics such as high scores and time limits, as well as rewards that are based on the quality of outcome. Training software should incorporate varying degrees of difficulty and randomize events to promote competitive replay.

Supporting these findings, Peters *et al* (2010) point to the research by Burke *et al* (2006) and Robson *et al* (2010) that suggests realistic and engaging training is more effective and may result in greater transfer to the job. The researchers also identified the potential of "serious games" using virtual reality to create more realistic and engaging training, noting "the more experience people gain through participating in such role playing simulations, the better prepared they will be to handle real-world events." This view is strongly supported by the findings of Alexander *et al* (2010), who calls for the development of "virtual reality theatres" (p. 41) for mine emergency rescue training. Toward this end, we have developed a scalable platform called MineSAFE to enable serious games for mine safety.

MineSAFE: The Software Architecture For Education in Mine SAFEty. MineSAFE was built atop the Unreal Engine (<http://www.unrealengine.com/udk/>), a commercially available game engine with advanced graphics and interaction capabilities. Our platform uses well-established workflows and software practices employed by the gaming industry to expedite development and reduce costs. As opposed to linear stories, game scenarios can be programmed as decision trees that fork to different sequences of events. For example, users can be assigned



Structure of the MineSAFE gaming platform. Its dependencies include UDK and our proprietary Creation Toolkit; supplementary external APIs (SCAPE, OpenNI, and VRPN) provide optional functionality for experimentation in user interaction, virtual reality, and gaming strategies. MineSAFE's derivatives include the serious games "*Harry's Hard Choices*" and "*Interactive Fatalgram Simulator*." The shaded components were built in whole or in part under this contract.

task objectives with competing choices that lead to different outcomes and impact all future choices available to the user. A corresponding physics engine enforces interactions with the virtual world. The physics engine provides believable interactions with objects in the environment, as well as ambient conditions such as propagating fires and smoke and destructible objects. Finally, the platform allows for sophisticated rendering through programmable shaders to realistically portray skin, duress to actors, and various particle-based mine disaster events. MineSAFE games can run on computer hardware ranging from mid-range laptops to higher-end workstations and virtual reality theatres, with support for interface devices that include keyboards, mice, gamepads, as well as emerging gesture-enabled interfaces such as Leap and Kinect.

In addition to the core simulation engine, MineSAFE also incorporates a suite of tools to speed scenario development and assist in evaluation. The data-driven capacity of the platform makes games modular and easier to modify. A specialized scripting language, called Data-Driven Function Script (DDFS), was developed in-house to support the creation of new training scenarios. We have also developed the Creation Toolkit, which provides generic mine safety assets suitable for future games and expansion modules, and the Session Viewer, which provides logging and playback capabilities. Each of these tools is discussed further below.

Using Data-Driven Function Script, developers can create training scenarios by defining sequences of high-level events and behaviors, which we collectively refer to as a "story." DDFS has many elements of a procedural programming language, but with a particular emphasis on the call pragmatics between sequences that illustrate cause-and-effect relationships. Through DDFS, we can define game event triggers, invoke sounds and visual effects, play cut scenes, define traps, and characterize the actions and reactions of non-player characters (NPCs). Sequences can be called serially, conditionally branched, or even nested into loops and recursive calls. A particular strength of DDFS rests in its event triggers and trap system. Through this system, we have defined a variety of traps and hazards that can be placed into game maps. Through DDFS sequences, the platform can set traps at run time with randomized frequency and location. Traps may be triggered based on proximity or user actions; the triggering semantics are context-dependent. Several traps have been developed using this framework, including roof falls, explosive gases, broken life lines, defective refuge chambers, defective breathing apparatus, fall traps that cause leg injuries, fire traps leading to burn injuries, and mantrips that spontaneously break down.

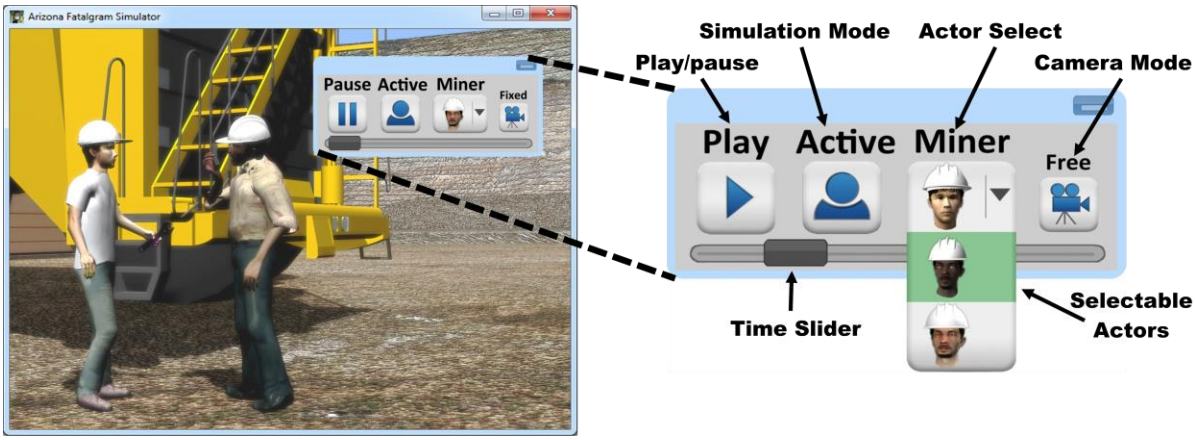
Mine environments developed for the Creation Toolkit. A variety of mine environments and methods are represented, including underground coal (room and pillar), underground metal (narrow vein with overhead stopes), and surface metal (recessed multi-level pit).

A Creation Toolkit provides an expanding asset database of mine models, equipment, sounds, and animations that can be reused in game scenarios. The Creation Toolkit currently includes support for underground coal, underground metal, and surface metal mining. Three stock environments have been constructed: Bottleneck, San Xavier, and Yar Open Pit. Bottleneck is an underground coal mine with room-and-pillar mine method. It spans approximately one square mile and is based on a greatly modified free data set originally furnished by NIOSH with their Map Reading Basics computer

Donning the M-20 Self-Contained Self-Rescuer (SCSR). The game follows MSHA-sanctioned protocols for all mine emergency equipment. For example, the in-game donning procedure for the M-20 (left) was carefully reconstructed using the MSHA video training lessons (right).

exercise (available online at <http://www.cdc.gov/niosh/mining/products/product165.htm>). Air flow, smoke, and fire spread patterns were also developed for the data set. The San Xavier data set is based on the University of Arizona's San Xavier (SX) mining laboratory. The SX mine features four levels connected by a main shaft, with several raises and overhead stopes. It is an active research and training facility that is being used for mine rescue and emergency preparedness training, and it has the distinction of being the only multi-level mine training facility in the United States. The 3D model of SX was reconstructed by our team using 3D laser scans, Vulcan survey data, and image atlases. Air flow patterns are also provided with the data set. Finally, Yar Open Pit is a fictional surface metal mine. It was constructed using aerial and surface photographs from representative pit mines in the US Southwest. The model spans more than a square mile and has support structures for haulage tie down, as well as maintenance garages and minerals processing facilities.

In addition to these mine environments, the Creation Toolkit provides a variety of method-specific mine equipment and safety gear. Mine equipment includes heavy machinery such as ultra-class haul trucks, continuous miners, and shuttle cars. Smaller equipment such as mantrips, pickup trucks, conveyors, power centers, and ore cars are also included. Each model has a suitable interior or cockpit with working mechanical elements. As MineSAFE is a platform for emergency prevention and preparedness, the Creation Toolkit has a particular focus on assets for mine emergencies and rescue. For instance, the toolkit includes two types of breathing apparatus (short and long duration), refuge chambers, gas meters, escape lines and tethers, fire extinguishers, and first aid kits.



Control console for the Interactive Fatalgram Simulator. Left: The control console may be accessed at any time during gameplay; Right: The console affords access to simulation and camera modes and provides a slider to control over the flow of simulation time.

As a final element of our platform, MineSAFE provides integrated evaluation and assessment capabilities. During gameplay, a variety of events can be automatically logged, including users movement and equipment usage patterns, interactions with other characters, scoring increments, and autonomous game events. After a session, these game logs can be visually inspected by the trainer using the MineSAFE Session Viewer. This stand-alone application overlays user's decisions, movements, and interactions onto the game map. Paths are illustrated by various line colors for both walking and driving, with major game events indicated with specific symbols. The mouse-driven interface allows a trainer to pan the map, zoom in on details, and mouse over items for a detailed explanation. A tools menu provides basic annotation, loading, and saving capabilities.

Using the MineSAFE platform, we have developed "serious games" to address specific aspects of mine emergency prevention and preparedness training. The *Interactive Fatalgram Simulator* (a preventative tool) allows users to view the events of an MSHA Fatalgram as an immersive story and to then dive into it to change the outcome. In *Harry's Hard Choices* (a preparedness tool), users role play as a section foreman in the midst of a mine disaster. Each of these training simulations is discussed further below.

Interactive Fatalgram Simulator. As a component of MSHA Part 48 annual refresher courses, all workers must review the industry accidents resulting in fatalities during the previous year. These "fatalgrams" provide a detailed write-up and figures that are available via MSHA's website (<http://www.msha.gov>). Traditionally, fatalgrams have been taught by trainers using write-ups and slideshows, with minimal interactivity with the workers in the audience. This method of learning is limited in that it does not connect well with workers or show the complete picture of the accident. For instance, spatial relationships are often unclear, and causality of events may be difficult to interpret. Understanding may be further hindered by trainees' intrinsic language barriers.

A sample interactive fatalgram showing multiple view and interaction modes. Left: A Picture-in-Picture presentation allows the same action to be seen from different angles simultaneously; Right: The fixed (i.e. first-person) active mode allows a user to dive into the simulation and change its outcome.

Through the *Interactive Fatalgram Simulator* (*IFS*), users can watch a fatalgram as a 3D movie or dive into the simulation to change its outcome. By actively engaging users, *IFS* compels them to practice safety protocols that would prevent these accidents. We can build interactive fatagrams that demonstrate many common and recurring types of accidents. At present, we have created a haulage fatalgram for *IFS* as a proof of concept. *IFS* allows for modular, 10 minute games that are suitable for integration into a Part 48 refresher training curriculum. Additional fatalgrams may be developed rapidly, using MineSAFE's Creation Toolkit and DDFS story scripting capabilities outlined above.

Central to *IFS* is its control console, through which a user may change the mode of interaction, alter camera constraints, and manage the progression of time. The console's time slider allows the user to skip forward or backward in time, and to fork off a new sequence of events. The console allows access to a variety of interaction and presentation modes "fixed" and "free" camera modes, as well as active ("dive in") and passive ("movie") modes of interaction. In addition, *IFS* provides a “Picture in Picture” (PIP) View, through which a user can see the scene from alternate angles.

As an example, consider a use case where a trainer uses *IFS* to help a group of trainees to understand a haulage fatality scenario. The fatality was caused by a pickup truck driver parking too closely to a haultruck, in the haultruck driver’s blind spot. To help the trainees understand the blind spot condition, the trainer might play through the scenario in "Movie" mode to let the events unfold. As the action plays out, she might invoke a PIP view to show both a 3rd person “bird’s eye” view of the scene in addition to the 1st person view of the haultruck driver. This allows users to understand both the site configuration at the time of the accident as well as the blind spots for the actors involved. Once she feels that the events of the scenario are understood, she might rewind the time slider and enable “Active” mode to test trainees’ responses under similar circumstances. A trainee could then take over for one of the

Fatalgram scenarios created for the Interactive Fatalgram Simulator. Left: Haulage fatality at surface metal mine (Ray, AZ); Right: Haulage fatality at underground coal mine (Delbarton, WV).

simulation's actors, for instance the pickup truck driver, and make better choices to change the outcome. As the trainee makes choices that alter the timeline, the group can watch the unfolding action from both the primary and secondary viewing windows, and later replay the new timeline for further discussion.

To date, we have prototyped game environments and stories for the following fatalgrams:

- Powered Haulage, surface metal (1 fatality, Ray, AZ, 6/20/10)
- Powered Haulage, underground coal (1 fatality, Delbarton, WV, 5/10/10)
- Fall of material, underground metal (1 fatality, Galena, ID, 6/18/10)

Harry's Hard Choices. Leveraging funds from Brookwood-Sago Grants #BS-22468-11-60-R4 and #BS-23833-12-60-R-4, we have also developed *Harry's Hard Choices* (*HHC*), a broadly scoped and open world sandbox for mine emergency repsonse training. Our interactive game is based on a paper-based training scenario developed by NIOSH, "Harry's Hard Choices: Mine Refuge Chamber Training" (Vaught *et al*., 2009). Extending upon the paper exercise, our game was designed to promote situated learning through a visually and audibly rich environment that mimics the distractions, chaos, and pace of an authentic mine emergency. In contrast the *IFS,* which presents training in a modular format using 10-minute mini-games, *HHC* was designed to be a comprehensive training package that exposes trainees to the entire gamut of safety-related procedures, equipment, and problems that they might face in an authentic mine emergency. In the course of an hour-long gaming session, players are exposed to a whole gamut of dangers: rapidly spreading fires, limited visibility, dangerous gases, explosions, injuries, roof falls, coal bursts, faulty equipment, blocked escapeways, and personal conflicts.

The UA-developed simulation represents a significant advancement over available training software and pedagogies for mine emergency response. Significantly, players are not confined to a linear set of decisions with preset outcomes. Instead, players can follow many diverging paths, each of which presents realistic and contextualized choices. Choices often have moral implications and will force the player to pick from amongst several less than desirable options.

Shuttle car scene from the Prologue of Harry's Hard Choices*. A shuttle car has just dropped off a load at the belt feeder and is returning for another cut.*

For example, the player may have to decide a course of action for a crew member -- and close friend -- that is injured and unable to walk efficiently, in the context of deteriorating conditions or rapidly increasing crew fatigue levels. The consequences of difficult choices are also enforced and persistent; the user may see crew members trapped, incapacitated, or killed through poor choices or inaction. Conditions may become unwinnable, resulting in the loss of the entire crew. Furthermore, although the game teaches a core set of principles for mine emergency response, the particular situational elements are randomized and will present players with differing sets of choices and outcomes each time the game is played. During initial testing, players' qualitative responses suggested that the randomization increased their engagement and made them more eager to replay the game to explore different story elements and potential outcomes.

As a vital component of real mine emergencies, *Harry's Hard Choices* attempts to simulate fluid, team-based interactions and decision making. By role-playing as a section foreman ("Harry"), a player interacts with his or her section crew, which consists of eight other "actors" which are controlled by computer-driven artificial intelligence (AI). The AI is reasonably robust. For instance, each AI-controlled character has a unique personality defined by metrics for morale, charisma, and composure under duress. Morale in particular is influenced by the current environmental situation and the quality of a players' decision making. A chemistry develops among the AI team members which, in conjunction with this morale factor, will impact the scenario outcome.

A sampling of bad outcomes. Top: A roof collapse takes the life of a crew member; Middle: A gas pocket ignites, killing the entire crew; Bottom: Trapped by fire, the crew retreats to a refuge chamber in hopes of a rescue.

Relevance to MSHA-mandated Training Topics. The Mine Safety and Health Administration mandates specific topics in health, safety, and hazards awareness for new miner and annual refresher training, Our games bring together a variety of these topics in a comprehensive story centering on a disaster simulation; it compels users to think critically and explore each topic in context. A survey of these topics and their coverage by games is outlined below.

Topics in Newly Hired Experienced Miner, Annual Refresher, and New Miner Training	**Game Mechanics and Story Elements in *MineSAFE* Training Games**
Mandatory health and safety standards	Employs OSHA specs for irrespirable air: carbon dioxide, carbon monoxide exposure have direct impacts on crew health; coal dust and smoke visibly effect crew fatigue; Fire hazards, flammable materials, and fire propagation; Errant ground control, such as unbolted top and collapsed pillars, compels users to survey and be aware of environment
Transportation controls	Selective use of powered haulage: SC24 type shuttle car and diesel-powered pickup truck with appropriate vehicle physics
Barricading/Escape and Emergency evacuation/firefighting plans	Primary focus of simulation: Escape protocols following primary, secondary evacuation routes; decision making process encouraging use of refuge chambers as shelters of last resort; use of fire extinguishers for small fires, e.g. such as engine fire breaking out
Roof/ ground control, ventilation	Ventilation patterns: realistic air flow with designated entry and return air paths supporting appropriate physics model; Fires spread along established ventilation paths according to airflow, encouraging users to consider fire propagation and rate of spread in their evacuation decision making; access doors and ventilators control fire spread and/or enable fire spread when damaged or left unclosed; Vent tubing to face. Roof/Ground control: dynamic roof falls; collapsed pillars may block evacuation routes
First aid	User must consider crew health and fatigue in evacuation strategy and adapt based on current events; Leg injuries: user may assist injured miners in evacuating or getting to shelter; First-aid assistance to miners suffering chest pains, leg injuries, and burns
Recognition and avoidance of electrical hazards and other hazards	Power centers and electrical cabling as electorcution hazards; battery connections within powered haulage as spark/fire hazards
Prevention of accidents	"Know your ground": roof falls may lead to serious team injuries; various hazards-based real-time risk analysis and decision points: longer evacuation routes and uneven ground increase the risks of leg injuries and increase fatigue; venturing near fires subjects crew to potentially severe burns; gas pockets may lead to explosions; use of vehicles in limited visibility conditions; response to broken escapeway lines
Self-rescue and respiratory devices	Self-rescuers: M-20 SCSR and SRLD, with full donning procedures; game encourages management of usable breathing time and utilization of spares; defective breathing units, cross-checking, and crew response; MineARC refuge chamber

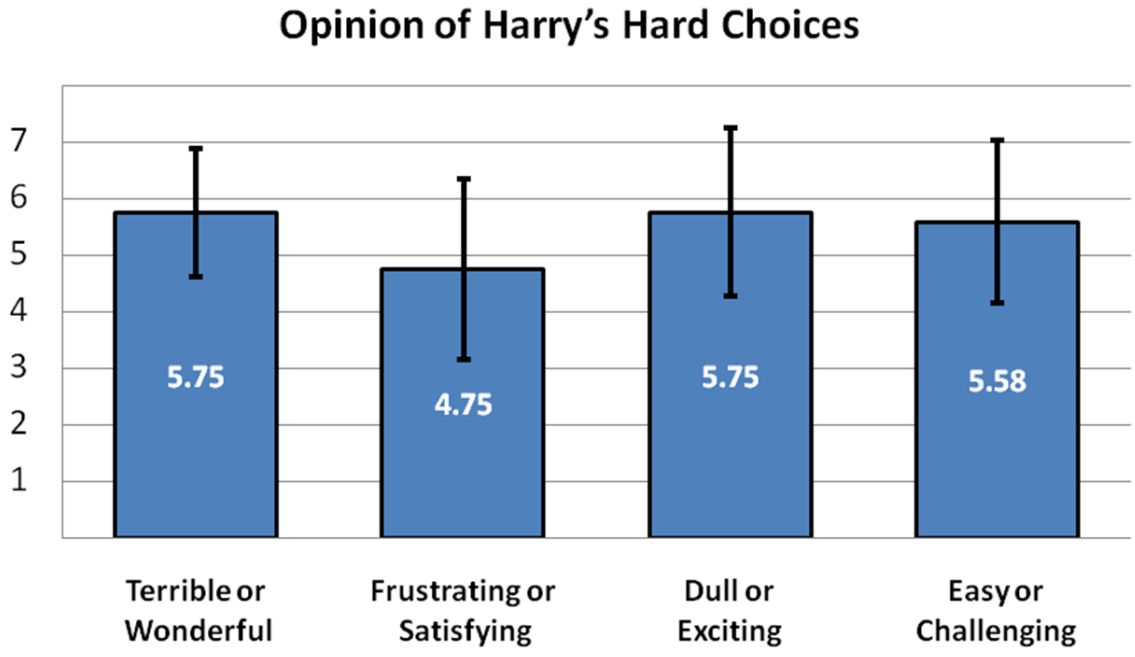
Mine gases	Encourages proficient use of gas meters - carbon dioxide, carbon monoxide, methane levels impact outcomes; explosions possible
Emergency medical procedures; escapes and emergency evacuation plans; fire warning signals and firefighting procedures	Primary and secondary escapeways with game metrics to encourage adherence to proper protocols; safety tethers and lifelines; response to broken lines and/or blocked escapeways; carbon monoxide alarms, gas meters, and visible smoke as fire indicators; fire extinguishers placed at strategic locations indicated on map; use of goggles and effects of smoke on visibility; crew may become lost or separated in dense smoke; use of fire extinguishers
Health and safety aspects of the tasks to be assigned	Crew health and fatigue factor into outcomes, influence crew morale; risk-analysis required by user to balance fast evacuation versus current environmental hazards
Introduction to the work environment	Four minute prologue introduces the environment and sets up conditions for mine emergency; Future: a pre-game tutorial introducing the workplace, crew, interface mechanics, and game rules
Authority and responsibilities of supervisors and miners' representatives	Communication with designated Responsible Person and emergency response team as part of end-game denouement establishing outcomes
Other topics as needed	Leadership skills: management of crew morale, objectives; second language communication; map reading and workplace navigation; Workplace literacy aids and learning point provide assistance via a virtual clipboard

Usability Studies. Through a series of focus groups and qualitative pilot studies, our game software has been tested with 32 users at three sites. Test participants included students, professors, certified trainers, and professional miners. Overall opinions of the software have been highly favorable, with users providing summary feedback that it is a "Great simulation," and "A fun learning experience." Users mentioned that they were "Surprised by the level of accuracy," and added that the games were "Very real," with "lots of options" and "graphics were pretty good." In a recent evaluation of Harry's Hard Choices, participants graded their overall game experience using 7-point Likert scales, rating the game as significantly better than the "No Opinion" level (4) on 3 of 4 metrics. The lowest rated metric, "Frustrating or Satisfying," scored only slightly better than 4 and with high standard deviation, which were attributed through user comments to a latent bug in the path following algorithm; that has since been fixed. Moreover, all participants in the study replied in the affirmative when asked if they would like to play the game again.

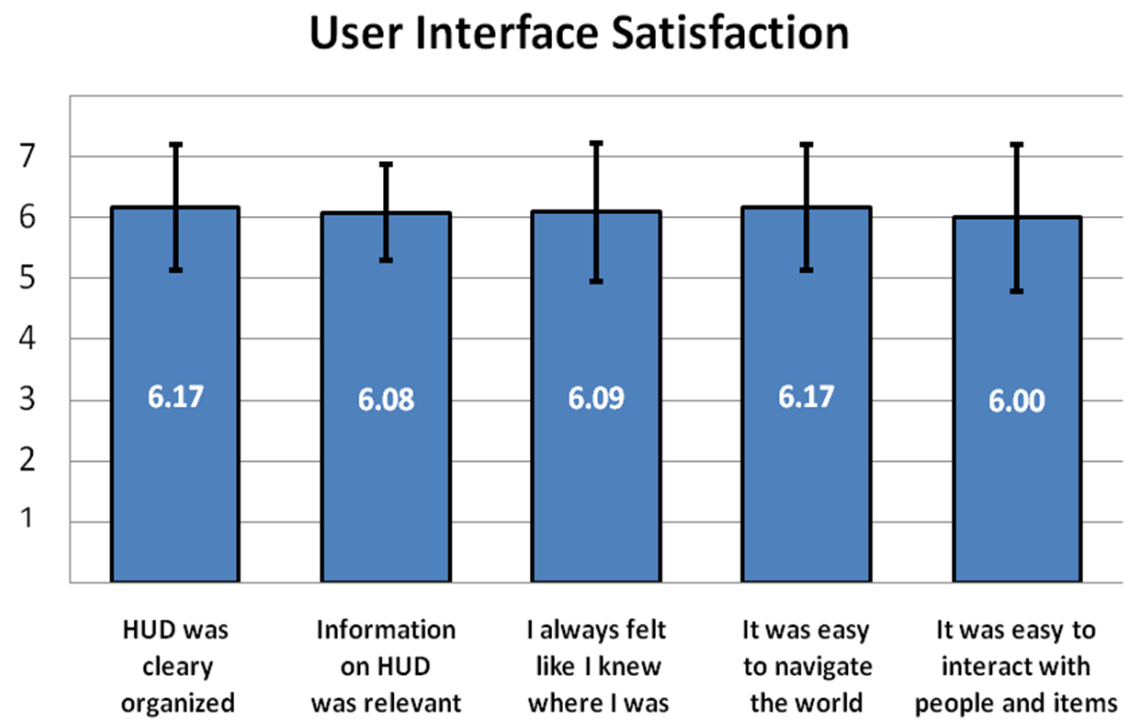
Our needs assessment identified accessibility as a major objective in designing our gaming software. Specifically, serious games should be usable and engaging for an audience with broad demographics, including both new and experienced miners, as well as users with varying degrees of computer and workplace literacy. Our user studies suggest that MineSAFE games have the potential to achieve this goal. In evaluating *Harry's Hard Choices Interactive*, Users indicated high degrees of both satisfaction with the user interface and ease of use, with scores consistently at or above 5 for most metrics; higher scores indicated 6, "Strongly Agree." Experimenter observations suggest that most users were quick to pick up the gameplay controls

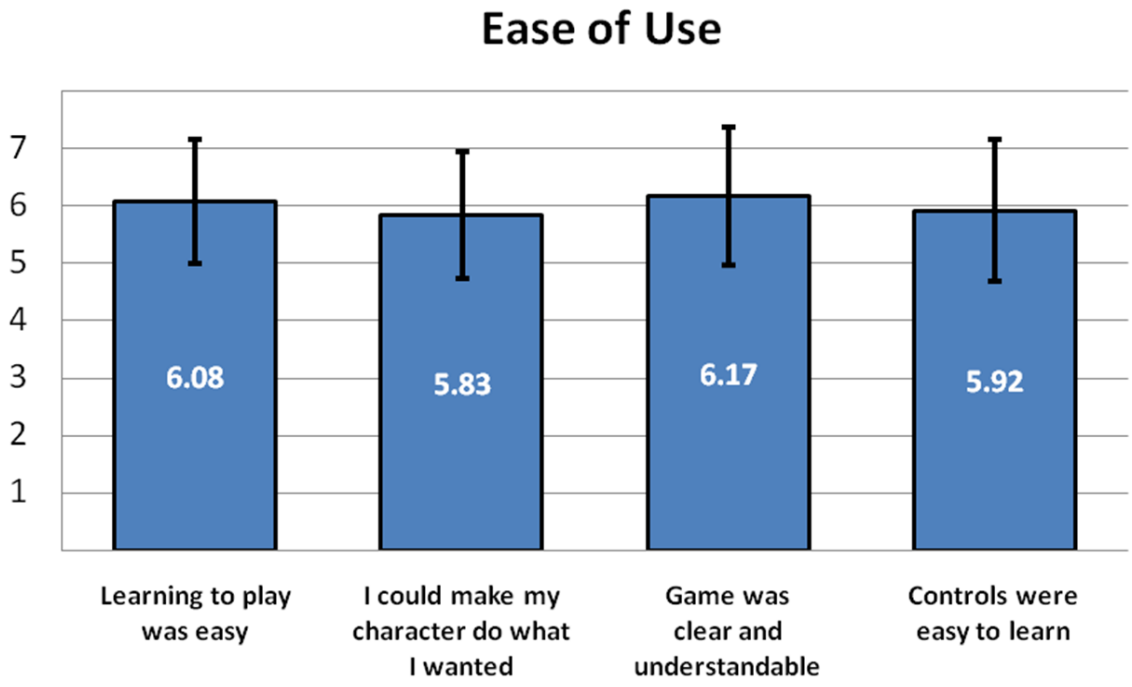
and could comfortably interact with the game within a few minutes. Results were similar for users identifying themselves as gamers and non-gamers.

We noted that game outcomes also improved significantly as users played through several iterations of the game. Improvements were reflected in final scores, where higher scores meant "better" decisions, and in the number of crew members evacuated from the mine. In a typical first play iteration, users often made "bad" decisions in the face of game hazards that would lead to point deductions and/or crew members being injured, lost, or killed. In subsequent play iterations, users were typically able to avoid the same mistakes, leading to better game outcomes. We should note that the game randomized hazards and decision events, such that users could not improve their outcomes simply by anticipating events or by using rote sequences of actions; the randomization was meant to enforce critical thinking based on the current situation. User's results improved from 0 or 1 crew members successfully evacuated in the first iteration to a mean of 3.80 (out of 9 maximum) on the player's best attempt, which was typically the last iteration of play. Game scores showed a similar, monotonic improvement over subsequent attempts for most users. Although the mean scores were relatively low versus the ideal solution, the game was meant to be challenging; it simulated a "worst case" mine emergency where compounding hazards and bad luck led to many difficult choices. We do note that, despite these circumstances, two users evacuated most of their crew (8 of 9) and ended the game with benchmark high scores by making excellent choices and efficient use of time and crew resources.



User opinions of Harry's Hard Choices*, as reported by test participants (p=12) via 7-point Likert scales. Higher scores are better. Evaluation instrument based on (Chin 1988).*





User evaluation of Harry's Hard Choices*, as reported by test participants (p=12) via 7-point Likert scales. Higher scores are better, indicating "Strongly Agree." Evaluation instruments based on (Chin 1988; Davis 1989; Federoff 2002).*

References

Alexander, D.W., Bealko, S.B., Brnich, M.J., Kowalski-Trakoler, K.M. and Peters, R.H.(2010).*Best Practices for Escape and Rescue from Underground Coal Mines.* Dept. of Health and Human Services, CDC, Information Circular 9522, NIOSH Publication.

Burke, M., Sarpy, S., Smith-Crowe, K., Chan-Serafin, S., Salvador, R., and Islam, G. (2006). Relative Effectiveness of Worker Safety and Health Training Methods. In: *American Journal of Public Health, 96(2), 315-324.*

Chin, J.P, Diehl, V.A. and Norman, K.L. (1988). Development of an Instrument for Measuring User Satisfaction of the Human Computer Interface. In: *Proc. Human Factors in Computing* (CHI), ACM Press: 213-218.

Davis, F.D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. In: *MIS Information Quarterly*, 13(3): 319-340.

Federoff, M.A. (2002). *Heuristics and Usability Guidelines for the Creation and Evaluation of Fun in Video Games.* Master of Science Thesis, Indiana University, Dept of Telecommunications.

Peters, R., Vaught, C. and Mallett, L. (2010). A Review of NIOSH and US Bureau of Mines Research to Improve Miners' Health & Safety Training. In J. Brune (Ed), *Extracting the Science: A Century of Mining Research.* Littleton, CO: Society of Mining, Metallurgy, and Exploration.

Robson, L.S., Stephenson, C.M., Schulte, P.A., Amick, B.C., Irvin, E.L., Eggerth, D.E., Chan, S., Bielecky, A.R., Wang, A.M., Heidotting, T.L., Peters, R.H., Clarke, J.A., Cullen, K., Rotunda, C.J., Boldt, L. and Grubb, P.L. (2010). *A Systematic Review of the Effectiveness of Training & Education for the Protection of Workers*. Dept. of Health and Human Services, CDC, Publication 2010-127, NIOSH Publication.

Vaught, C., Hall, E.E., and Klein, K. (2009). *Harry's Hard Choices: Mine Refuge Chamber Training.* Dept. of Health and Human Services, CDC, Information Circular 9511, NIOSH Publication.