

Student mine rescue in today's mining engineering curriculum

by Nicole R. Henderson, Helmut Mischo and Jürgen F. Brune

Many mining engineering graduates enter the mining industry lacking training in mine emergency management. As a result, mining universities in the United States and other countries are beginning to form volunteer student mine rescue teams to train mining engineering students in handling mine emergency situations and give them hands-on experience managing potential emergency scenarios underground. In the early 1980s, the Missouri University of Science and Technology developed the first collegiate mine rescue team in the United States. For approximately 30 years, it was the only successful collegiate team until the Colorado School of Mines (CSM) started its program in 2009. Currently, there are at least five collegiate teams in the United States and one in Canada.

At the Freiberg University of Mining and Technology in Germany, the goal is to adapt the Colorado School of Mines Mine Rescue Program to develop a collegiate team of its own. Currently, mining engineering students cover the theoretical basics of mine rescue in an occupational health and safety lecture and take a basic, one-day mine rescue training course at the Central Mine Rescue Station in Leipzig. The course covers the basic mine rescue topics and gives students the opportunity to experience working in elevated heat and smoke conditions while wearing breathing apparatus. This training gives students a small insight into the importance of mine rescue and mine emergency management.

Collegiate mine rescue teaches students the importance of mine rescue and mine safety by giving them hands-on learning experiences before entering the mining industry.

Colorado School of Mines Mine Rescue Program

CSM currently has three student mine rescue teams: the men's Blue Team, the women's Silver Team and the co-ed White Team. Both the Blue and Silver teams are upperclass students and experienced members of the program, while the White Team is comprised of underclassmen. This



allows new members to gain exposure to mine rescue before moving up to the Blue and Silver teams, as senior members graduate.

The Blue Team was originally formed in 2009 as a co-ed team and competed in its first official mine rescue contest in Rolla, MO that same year. The Blue Team went on to earn second-place overall in its second contest in the spring of 2010. In the 2010-2011 school year, the CSM program expanded to form two teams, including the first all-female mine rescue team. The CSM program grew to three teams the following year.

Team organization

Membership in the CSM Mine Rescue program is voluntary and

Team mentor discusses possible solutions with the student team at the 2013 Biennial Intercollegiate MERD.

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Student Mine Rescue Training



A rescuer tests his skills in the model mine at the Central Mine Rescue Station in Leipzig.

open to students of all majors. Currently, the teams are made up of students majoring in mining engineering, physics, math, civil engineering, mechanical engineering and geology. Being a part of the student team requires dedication and significant training time outside of normal studies; students do not receive school credit for participation. In order for the program to be successful, the students involved must have a desire to learn and help advance the program. The only condition of membership is that the students are able to meet basic physical requirements in order to ensure their safety and the safety of the team during program activities.

Each team has a minimum of seven members, with five people on the underground team and two members located at the fresh air base (FAB). The underground team is made up of the captain, the gas specialist, the map specialist, the medic and the co-captain. The FAB is located at the furthest point of bare-face exploration in the mine. Inby the FAB, teams must often wear breathing apparatus. Two team members are located at the FAB — one member stays in contact with the rescue team, while the other relays information back to the incident command center (ICC) at the surface.

Student mine rescue teams at a recent competition at the Colorado School of Mines' Edgar Mine in Golden, CO.

Program leadership

The CSM mine rescue program is completely student run. The three-team captains decide on training topics and often ask specialists from the industry to come in and help host practices on those topics. The program's faculty advisor

assists with the logistics of the trainings and helps to organize practices and drills. In addition to the three captains, there are three other leadership roles: the president, treasurer and records and logistics lead. These positions are filled by members who are willing to dedicate extra time to help with the organization of the program.

Training

At CSM, the teams practice more than 2,000 man-hours per year. The practices are typically held every other Wednesday evening and the following Saturday. Before competitions, additional practices are scheduled every weekend. Training objectives for the year are established at the beginning of the fall semester by the team leadership and adjusted at biweekly leadership meetings to fit the teams' needs. Practices may include completing mine rescue problems from past contests, exploration exercises, technical rescue training and specialty practices.

By completing past contest problems, the team is able to demonstrate proficiency and understanding of the mine rescue rules and regulations. Teams must master mine exploration routines. Contest field problems are not like real mine rescue disasters; they typically have a simplified mine layout and do not have the obstacles or environmental conditions that rescuers would face in real emergencies. Mining conditions and mining equipment are represented by placards with the information written on them. Contests are used mainly as a way to train the teams to think through specific situations and to tell, rather than show, the judges what they are doing, and to relay the information they have to the FAB.

Mine exploration exercises allow teams to develop team communication skills and to practice the ability to work as a cohesive unit. A well-practiced team is efficient during exploration and demonstrates effective communication within the team as well as with the FAB and ICC. It is crucial that a mine rescue team is able to thoroughly and safely explore an accident site, while still identifying and retrieving the victims in the quickest time possible. An example of an exploration-focused practice would be to create a scavenger hunt in a smoky and dark portion of the mine. Without clear visibility, the team must find and map a specific number of objects and report their locations to the fresh



air base. This exercise not only tests the team's ability to move in smoke, but it is a great tool to practice communication among the map man, the co-captain and the fresh air base.

Technical rescue practices can include high-and-low-angle rope rescues, confined space training and firefighting. The CSM teams are fortunate to have access to a variety of training resources offered by the CSM Edgar Experimental Mine and the CSM Mine Safety and Health Program (MSHP). MSHP has specialists experienced in ropes training who teach the students various rope rescue techniques and how to complete a safe and effective rope rescue. The Edgar Mine also features a confined-space maze. This is a maze of tunnels, ladders, vertical drop-offs and other obstacles designed to give teams experience in negotiating complex, confined space rescues, often in smoke and under apparatus. Confined-space trainings are physically and mentally demanding and require effective team movement and excellent communications within the team.

CSM's MSHP also offers fire training with live fires. A burn pan is located on the surface of the Edgar Mine and gives the students the opportunity to experience different firefighting strategies in a safe environment. A Bullex propane powered fire generator can also be set up inside the mine to offer students the ability to practice live firefighting underground.

Finally, CSM Mine Rescue Teams develop skills in special interest areas that include first aid and rescue equipment maintenance (benching). During these drills, the teams split up into technicians and first-aid specialists and use the time to perform any upkeep on the team equipment and practice for competition style technician and first aid tests. Generally, two members on each team are designated technicians, and three members are focused on first aid.

Mine Rescue competitions

Each year all three CSM mine rescue teams compete in professional mine rescue contests. These contests are a great opportunity for the teams to test their skills against professional mine rescue teams and to expand their network within the industry. Mine rescue contests evaluate the competitors on their knowledge of mine rescue rules and regulations, ability to work as a team, technical understanding of their equipment and first-aid abilities. The contests are split into four sections: written test, field competition, technician competition and first aid competition. Each portion challenges a different aspect of the team's mine rescue knowledge and is a way for judges and trainers to easily identify areas needing improvement.



A student mine rescue team practices helping an accident victim.

Each spring, the Blue and Silver teams travel to Winnemucca, NV to compete in the Northern Nevada Mine Rescue Contest. The participants include professional metal/nonmetal teams from all over the United States and the competition involves problems at skill levels comparable to the U.S. National Mine Rescue Contest. Even with the high level of the competition, the student teams are able to hold their own. CSM teams earned third-place in the field portion of the contest in the spring of 2013.

Typically, the White Team competes in the North Central Regional Mine Rescue Contest in Wilmington, IL. The contest is held later in the spring semester, allowing the team more time to practice. In the spring of 2013, the White Team won first-place in the field and first aid competitions and third-place in the technician competition, resulting in the team being named the overall champions.

Every other year when the Society of Mining, Metallurgy and Exploration (SME) holds its Annual Meeting in Denver, CO, the CSM

Student Mine Rescue Training



Student rescuers extract a fall victim in the Edgar Mine.

Mine Rescue Program hosts the Biennial Intercollegiate Mine Emergency Response Development Exercise (MERD) at the Edgar Mine in Idaho Springs, CO. While all collegiate teams regularly compete in the professional mine rescue circuit, this competition is for student teams only. The First Biennial Intercollegiate MERD was held in the spring of 2011, the four participating teams were from the Colorado School of Mines (2), the University of British Columbia and The Pennsylvania State University. The second MERD was held in the spring of 2013, five teams participated and were from the Colorado

School of Mines (3), the University of British Columbia and Missouri University of Science and Technology. Representatives from the University of Arizona and Bergakademie Freiberg, University of Mining and Technology in Germany observed the competition and obtained info on how to start their own student mine rescue teams. The student MERDs are a great opportunity for students in the mining industry to interact and learn from each other, while also getting advice from safety specialists. Each team is assigned a mentor, an expert in the mine rescue field, to follow the team throughout the competition and to provide advice, allowing the students to learn as much from the competition as possible.

Support and equipment

The CSM Mine Rescue Program appreciates the support of many corporate sponsors within the mining industry. Companies see the importance of training students in mine rescue and placing an early emphasis on mine safety. They support the collegiate mine rescue system by providing funding for travel, donating equipment and volunteering their time.

CSM mine rescue teams also frequently borrow equipment from the Freeport-McMoRan Henderson Mine Rescue Team, the state of Colorado Front Range Mine Rescue Team and Newmont Mining Corp.'s emergency response group. From the inception of the CSM Mine

Rescue Program, these three organizations have been strong supporters of the teams by allowing access to their equipment and donations of time and money. The CSM teams are working toward acquiring all the equipment necessary to be an independent and fully equipped mine rescue team. During the 2012-2013 school year, the program was successful in expanding its equipment inventory, with the donation of five new Sentinel BG-4 rebreathing apparatus from Dräger and a MineARC permanent, mine refuge chamber.

The professional mine rescue teams of local Colorado mining companies and local fire departments are also major supporters of the CSM Mine Rescue Program. They volunteer their time to assist with practices and help advance the students' learning. Professional mine rescue teams bring a wealth of new suggestions and advice for the student teams, teaching from their real life experiences. There are also several professional mine rescue trainers, with years of experience in the field of mine safety, who attend the student practices and competitions to give advice and teach classes in their areas of specialty. These experts serve as mentors for the students and are a great resource throughout their collegiate careers and often into their professional ones as well.

Outreach to Bergakademie Freiberg University of Mining and Technology, Germany

Representatives from the Freiberg University of Mining and Technology in Germany attended mine rescue practices at CSM in 2013. Impressed by what they observed, the authors met during the summer of 2013 in Freiberg to discuss the potential of establishing a student mine rescue team at Freiberg, which will be the first German university to have a collegiate team.

Currently, the students at the Freiberg University of Mining and Technology learn about mine rescue through an occupational health and safety lecture, an emergency staff section exercise, and additionally through a one-day seminar offered at the Central Mine Rescue Station in Leipzig. In the morning, the students go through a lecture covering the basics of mine rescue. Students discuss the rules and regulations, the need for mine rescue, the equipment and technology used, the application of the Dräger BG-4 and general respiratory protection.

Following the morning session, the students participate in a practical exercise. During this exercise the students perform a simulated mine rescue while wearing a breathing apparatus and working in elevated heat and smoke levels. This

gives the students the opportunity to experience the harsh conditions that may occur during a mine disaster and to give them a greater appreciation for the mine rescue community.

There are several differences between mine rescue regulations in Germany and in the United States. In Germany, the students, as well as every mine rescue member, must pass an extensive physical examination and must receive medical clearance by a trained physician before they are permitted to wear breathing apparatus in mine rescue. This includes stress tests on an exercise bike, lifting weights and climbing an infinite ladder, all while wearing the breathing apparatus. In the United States, rescue team members need only to be examined by a physician who will determine whether they are capable of performing the tasks necessary for a mine rescue operation. These tests are also conducted before and during every exercise. The physical fitness requirement for mine rescue team members must be met through practices and team workouts.

There is one central organization in Germany that sets the standards for equipment and training. The Berufsgenossenschaft Rohstoffe und Chemische Industrie (BGRCI) runs four central mine rescue stations throughout Germany. Teams are required to come to these locations every other year to participate in a mine rescue testing and training seminar. BGRCI provides facilities for mine rescue training, but they also test new mine rescue equipment and give recommendations to the teams.

In Germany, each mine rescue team member is fully cross-trained and could perform in any of the five underground positions. Team members do not receive their assigned positions until they arrive at the scene of the incident. This allows for the first six people to arrive on scene to make up the first full team, irrespective of their affiliation with a particular mine rescue team. Many mines in the United States have employed a similar set up as this, but it is not required that everyone must be cross-trained on all positions. In the US, the emphasis on training for mine rescue competitions encourages members to become more specialized in one area of mine rescue, rather than having a general knowledge of all the positions. To compensate for this difference, practice sessions would have to be more generalized. Instead of training individuals in specific areas of their own expertise, the practices would need to target everyone and make sure that each member is able to perform each position.

At times, it can be difficult to motivate students to participate in mine rescue on a volunteer basis. In the United States, mine rescue competitions provide strong incentives for the students who

are proud to compete with professional teams. In Germany, such competitions do not yet exist so it may be more difficult to entice students to participate in mine rescue. Motivation requires personal interest, enjoyment and satisfaction, which can be difficult to stimulate in the students. The CSM Mine Rescue Program students' interests are often piqued by the idea of participation in a professional competition. Throughout their involvement with the mine rescue teams, the students experience the real life application and importance of their training.

Students at Freiberg University of Mining and Technology have access to a training facility at the university's Reiche Zeche experimental and research mine, an extensive, former lead-zinc-silver mine located on campus and the largest underground mine in the state of Saxony. The experimental mine provides an ideal venue for a variety of rescue practices. The university has received a donation of six Dräger BG-4s and one MSA Auer Air Elite for student training, but additional industry support must be solicited. Currently, the mine rescue training center near Leipzig is offering the school its facilities for testing and maintaining the apparatus, but establishing its own mine rescue station in Freiberg would offer students better opportunities to actively participate in both training and equipment preparation. The university must also develop sources of financial support for the teams, as industry support is crucial to maintain student mine rescue capabilities.

Conclusions

Student mine rescue training is a unique way to emphasize the importance of mine safety and mine emergency management to young engineers. It allows students to enter the industry with valuable skills, including recognition of safety and health hazards in mining, while providing an opportunity for professional networking. Participation in student mine rescue also benefits students from majors other than mining engineering by developing skills that lead to responsible performance under pressure, while emphasizing the importance of working as a team in the challenging environment of an underground mine rescue. ■

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