EVALUATION OF MINING ACTIVITIES USING A SCENARIO INTERVIEW APPROACH

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NIOSH researchers have been examining underground coal mining activities in order to evaluate work crew hazards. In 1994 a continuous mining machine operator was killed by falling roof during extended cut mining. Many aspects of the incident were used by NIOSH researchers to develop a scenario interview. The goal was to provide a realistic framework for acquiring frank and detailed insights. The interview consists of two sections. The first describes the underground mining conditions. The second recounts the fatal incident. Each section is supplemented by a diagram and a set of questions addressing relevant safety issues. The interview was administered at three mines that actively take extended cuts. Researchers found the scenario approach to be an effective interview tool as well as an effective hazard awareness and safe work practices training platform.

INTRODUCTION

Underground coal mining is unpredictable by nature and presents workers with numerous hazards. Many of these hazards, including roof falls, occur near the working face. During the 1970s remote control technology was introduced to increase productivity and improve safety. Because of this innovation, mine workers were able to take longer cuts of coal. A face advancement that exceeds twenty feet is considered an extended cut. Extended cut mining was first allowed by the Mine Safety and Health Administration (MSHA) in 1979 and has since been widely adopted.

The use of extended cut mining has resulted in industry wide safety concerns. Removal of the operator from equipment may reduce exposure to equipment hazards but may increase exposure to other hazards and/or create new hazards. Human factors researchers at the National Institute for Occupational Safety and Health (NIOSH) were charged with examining extended cut mining activities in order to better define work crew hazards. This information is to be used to develop generalized innovations for work procedures, equipment redesign, and training strategies that improve safety.

Ground falls have been the largest cause of underground coal mining fatalities. In addition, many victims were found to be in an area of unsupported roof at the time they were killed (Bauer *et al.,* 1994). In 1994 a continuous mining machine (CM) operator was fatally injured while turning a cross cut during extended cut mining. The CM operator was struck by falling roof while extracting coal and may have been under unsupported top. An exploratory study of this incident was conducted as part of NIOSH extended cut mining research.

One key finding by NIOSH researchers was the desire of CM operators to view the face while extracting coal. Establishing a physical location that provides a clear field of view and having adequate illumination were viewed as critical needs by CM operators (Steiner *et al.*, 1997). It was discovered that these issues were exacerbated when turning a cross cut.

In response to these findings, researchers developed a scenario interview that addressed cross cut safety issues. Many aspects of the 1994 fatal injury were incorporated into the scenario interview

guide. The goal of the scenario interview was to provide a realistic hands-on approach to acquiring insights from face crew members.

THESIS

NIOSH researchers assert that the use of a realistic scenario interview will result in frank and detailed responses from face crew members. This approach provides an effective means of acquiring worker perceptions of the types of hazards that exist, the relative magnitude of the hazards, and what could be done to reduce or eliminate hazards.

SCENARIO INTERVIEW APPROACH

A prototype version of the interview was developed to test the efficacy of this approach. Four face crew members were interviewed individually at a single underground mine site using laminated hand-held diagrams. Interviews were administered by two ergonomists with considerable experience interviewing underground mine workers.

Respondents found the scenario to be realistic and easy to relate to. More important, interviewers were able to engage face workers in meaningful dialogs related to target safety issues. Results were reviewed by NIOSH human factors and mining researchers and characterized as open, honest, and insightful. A final version of the interview was developed using prototype findings and reviewer recommendations. Three mines that actively take extended cuts were identified for the scenario interview evaluation.

The scenario interview consists of two sections. The first section, background information, describes underground mining conditions for a face crew turning a left cross cut. The second section recounts briefly a fatal injury that resulted from a roof fall that occurs shortly after the scenario presented in the background section. Each section is supplemented by a diagram that specifies the location of face crew members and equipment, and a set of questions. The final version of the scenario sections and accompanying diagrams are presented as Figures 1 through 4.

Figure 1: Background Story and Questions

The centers had been marked on the mine roof and ribs to start the 2 to 1 left crosscut. The # 2 entry had been mined 2-3 feet off center up to the last cut mined. The last cut in the #2 entry was brought back to center by offsetting to the right about 3 feet. The last row of bolts for the crosscut was not in direct alignment with the left rib bolts of the entry.

Visible warning was not posted to prevent persons from inadvertently traveling inby permanent roof supports. The miner operator, using a Jeffery radio remote controlled continuous miner (CM) with left-mounted cable, had taken the initial lift from entry 2 to 1 (left xcut) on the left side and was taking the 2nd lift on the right side. The operator mines the 2 to 1 left crosscut to about 31 feet in depth. The helper was outby the operator monitoring the trailing cable.

As a CM operator on this section,

A. What concerns would you have before starting this cut?

B. What could be done about these concerns?

C. Where would you position yourself to take this lift?

Figure 2: Background Diagram

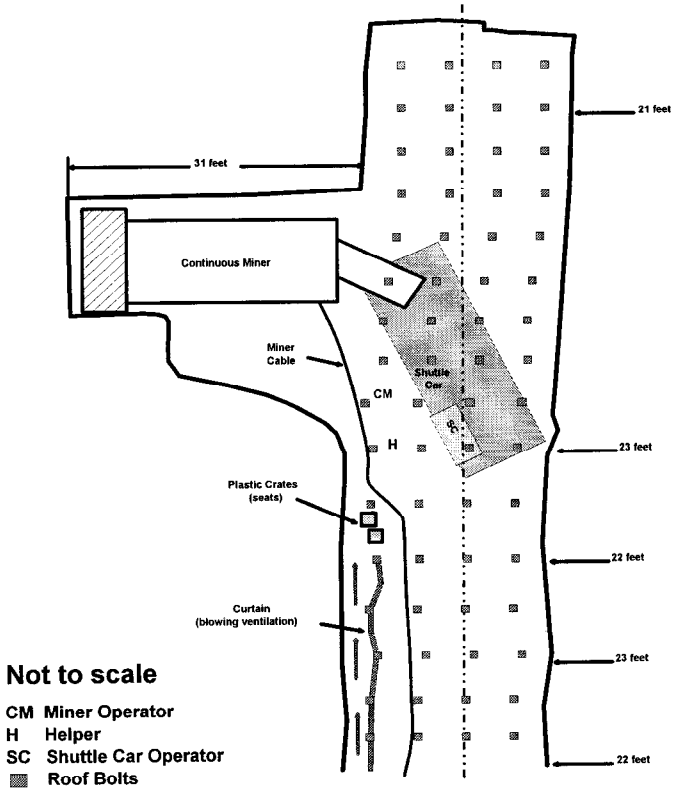


Figure 3: Fatal Injury Story and Questions

The shuttle car was nearly loaded when the CM operator, standing at the last row of bolts, was pinned to the floor by a large piece of rock that fell from the top. CM operators had been warned to stay at least 2 rows of bolts back. This particular operator had been warned twice in the 2 months before the incident and just minutes before the fall.

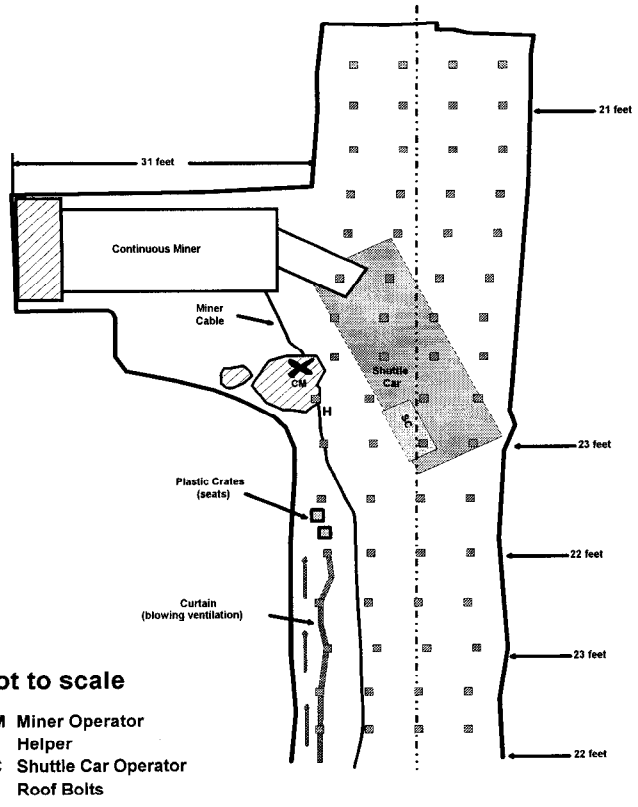
The width of the opening from 2 to 1 left crosscut was 27.5 feet. The approved roof plan requires the opening to be limited to 26 feet in width.

D. Could this type of situation occur at this mine? YES or NO Why or why not?

E. If YES, When would something like this most likely happen?

F. Have you had any special training that would have helped you to better assess this situation? YES or NO If YES, what?

Figure 4: Fatal Injury Diagram



At the first mine site ten face crew members were interviewed. In an attempt to get a representative sample of face crew workers, participants were chosen from different sections and different shifts. Prior to collecting scenario data, background data on each participant was collected. All participants were assured that their responses would be held in confidence and that their participation was strictly voluntary. During the interview participants were encouraged to examine diagrams closely and to make sure they understood the conditions of the scenario. They were encouraged to draw on the diagrams and make diagrams of their own to clarify answers. Eight interviews were administered individually at various underground sites. One interview was conducted above ground and administered using flip chart sized diagrams to two members of the same crew.

The above ground interview was conducted by three researchers concurrently. One ergonomist administered the interview and the other two facilitated data collections and respondent participation. Examination of results from the first mine revealed that the above ground results were superior in terms of the ability to accurately collect data and to elicit more in depth responses. Researchers felt that dialogs between the two workers allowed for a broad discussion of relevant safety issues.

Interviews at the second and third mine sites were conducted above ground with face crew members from various sections that work the same shift. Large diagrams were posted on a wall and the groups sat facing the diagram. Again, all participants were assured that their participation was strictly voluntary and they were encouraged to use the diagrams when responding to questions. Twenty-two face crew members were interviewed at the two mine sites. At the second site two groups were interviewed, a group of three and a group of six. At the third site two groups were interviewed, a group of six and a group of seven.

FINDINGS

Findings consist of responses to questions that follow the background and fatal injury sections of the interview. Information from drawings was incorporated into responses. The findings presented are summaries of the most common responses to each question.

Background Responses

As a CM operator on this section,

Question 1: *What concerns would you have before starting this cut?*

- With this mining setup and cut pattern, it would be hard for the CM operator to be well back from unsupported top and see face and avoid shuttle car
- Where CM operator is standing a fall can occur
- An offset bolt pattern increases the chances of being under unsupported top
- A large unsupported roof area will be opened up as the turn is developed
- Bolts are not close enough to rib
- Curtain is too far from CM, the #2 entry is not getting ventilated and there would be too much dust at face

Question 2: *What can be done about these concerns?*

- CM operator should stand well back from unsupported top
- Put ventilation and cable on right when take left turns so CM operator can work well back on right side of CM
- Take a notch cut and bolt it before cutting turn
- CM operator should check roof conditions and ask bolters for an assessment before cutting turn
- Always bolt as tight to ribs as possible and use extra bolts used when you have an offset entry
- You should shorten cut to 20 or 30 feet if you have concerns about conditions
- Extend curtain closer to CM

Question 3: *Where would you position yourself to take this lift?*

- On the cable side and as close to the shuttle car as possible
- In the center of the entry next to the shuttle car, I would let shuttle car operator know I was there, I might even be a little behind the shuttle car
- Even with the rib line where cut was started but two rows of bolts over. If the distance is greater than 3 feet between rib and bolts, I won't stand by rib.
- Initially, on left rib further back from turn. You have room here since closer to rib and the shuttle car has room. When shuttle car moves in, move closer to shuttle car.
- In a bolted notch cut if available
- Where helper is on drawing, you need to be further back

Fatal Injury Responses

Question 1: *Could this type of situation could occur at this mine? YES or NO*

- Thirty of thirty-two respondents said YES.
- Two respondents said NO. Both No respondents were interviewed individually at the first mine site.

The following comments were made regarding *Why or why not*

- If CM operator not aware of mine conditions
- If CM operator places himself in a dangerous location, it could happen anytime CM operator stands that close to unsupported top
- Adequate bolting is important, when bolting inadequate a fall could happen anywhere
- Whenever you have a significant offset bolt pattern
- It would not happen here because we stand on right of CM when cutting turns to left and can stay well back from unsupported top

Question 2: *When would something like this most likely happen?*

- Bad roof conditions, the cut sequence, and people's attitudes could all result in a situation like this one
- Whenever you get off site lines that much
- Sometimes operators get into a comfort zone and lose the edge in terms of awareness.
- Whenever you run cable on left and make left turns
- Whenever people are tired or in a hurry
- If CM operator trying to get in position to see or focusing too much on what he is doing and not on mine conditions, it is hard to look at everything at same time

Question 3: *Have you had any special training that would have helped you to better assess this situation? YES NO*

- Responses were almost equally mixed between

YES and NO

- None of the mines had a special training program
- One of the mines sent a select group of face crew workers to other mines to observe their mining practices
- In general, they learned from experience and received safety guidelines during annual retraining

DISCUSSION

Responses to background questions indicated that several significant concerns were easily identifiable: the offset entry, the bolt pattern, the mining setup and cut pattern, and the CM operator's proximity to unsupported roof. Each mine had working conditions, equipment, and procedures that differed from those of the scenario. These differences influenced responses to questions regarding corrective actions or preferred methods. There was a definite preference for procedures that face workers were accustomed to using. It was generally believed that if the scenario mine had used procedures similar to their mine then the CM operator would have been able to work from a safer location.

The fatal injury questions elicited more reflective and candid responses. Most participants indicated that this type of accident could occur at any mine given the right set of conditions. It was generally believed that if the CM operator had stayed well back from unsupported roof the fatality would not have occurred. The combination of an offset bolt pattern and working too close to unsupported roof was considered very dangerous. Although this question was not asked, several respondents reported having observed CM operators either at their current mine or at another mine working too close to unsupported top.

Reaction to the scenario interview was universally positive. Participants were eager to share their thoughts and expressed interest in learning about other participant's thoughts. They felt that the scenario presented circumstances that were realistic and easy to relate to. Interviews conducted in small groups with flip chart size diagrams were most effective. They provided a good forum for open discussion and debate of safety issues and concerns in a setting that permitted accurate and complete collection of responses.

The approach presented is by no means a novel one. Variations of scenario-based interviewing have been used for many applications. It was the intent of the researchers to show that if a short but well crafted scenario was developed that it could be effective in acquiring candid and detailed responses from underground coal mine face crews. In particular, each underground mining environment has unique physical and operational characteristics but face many similar work scenarios.

A subjective evaluation of the scenario results by the ergonomists who conducted this work concluded that the results exceeded expectations. In support of this evaluation was the universally positive feedback from participants and mine managers who received reports outlining the findings for their respective mines. Mine managers were genuinely pleased with both the quality and quantity of feedback garnered.

Finally, the most useful outcome of this effort may be the utility of this approach as a training tool. Scenarios can be crafted as simple realistic stories using characteristics of recent serious injuries or a series of common less serious injuries. The mechanism can be used to educate the work force about the types of hazards that exist and injuries that have occurred. The end result would be to survey the work force about safety issues that are important to them as well as creating a participatory platform for hazard awareness and safe work practice training. It is hoped that this example provides a framework for others to further evaluate and utilize this approach in dynamic working environments.

REFERENCES

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