APPENDIX O: DIRECT OBSERVATION PROTOCOL

INFORMATION NEEDS OF UNDERGROUND COAL MINERS

1/24/2021

RESEARCH SUMMARY

BACKGROUND

This protocol is a subtask for the NIOSH/OMSHR project *Assessing and Evaluating Human Systems Integration Needs in Mining*. This research will be conducted by members of the Cognitive Engineering (CE) Team in the Human Factors Branch (HFB) of the Office of Mine Safety and Health Research (OMSHR).

With the second highest fatal injury rate in 2010, mining remains one of the most dangerous occupations in the United States . Despite continued efforts in research and regulation, tragedies like Upper Big Branch (2010) and Sago (2006) still highlight a lack of consideration for human systems integration (HSI). HSI is "…a disciplined, unified, and interactive approach to integrate human considerations into system design to improve total system performance and reduce costs of ownership" .

The lack of HSI consideration is becoming a greater problem as the adoptions of the MINER Act of 2006 as well as health and safety initiatives (End Black Lung Campaign) are trending towards mandate of the increased use of safety devices by mine workers (wireless communication systems, personal dust monitor, and proximity detection). These devices offer attractive health and safety benefits – improved tracking and communication, real time monitoring of respirable dust levels, and the prevention of accidental crushing by large mobile machinery. However, while the benefits of such wearable devices are easy to understand within their own context, they inevitably increase the burden on the mine worker who must carry, interact with, and ultimately make decisions with each one of the devices. The increased amount of information being presented by multiple devices divides the miner's attention and may overload him or her. Overload and distraction may lead to a reduction in his or her understanding of the environment and ability to make informed decisions. It is our goal to understand what the miner has to do to perform his or her job and what information is needed to aid in the development of better interfaces.

A first step to determining the impact of the informational and attentional demands is to understand a miner's job from the perspective of the miner. Therefore, we begin our research by observing miners working in a natural setting by using direct observation. For a direct observation, the researcher(s) will observe miners at work, take notes, take photographs, and collect voice recordings where appropriate. The observation will focus on understanding the following aspects of the critical tasks performed by miners (1) the steps involved, (2) the information necessary, (3) the constraints (environment, interfaces, human performance), and (4) potential sources of errors or weaknesses in the interfaces.

DIRECT OBSERVATION

1. INFORMED CONSENT, TALENT WAIVER, & INTRODUCTION

Prior to the start of the shift, the subjects who have volunteered to participate in the study will be consented and given an explanation of what the observation will entail. The subjects will also be asked to sign a talent waiver, allowing the use of voice recording and photography. The consent form and photo waiver can be found in appendices C & D. A script introducing the study can be found in appendix F.

2. DEMOGRAPHIC INFORMATION

NIOSH researchers will be collecting basic information about the miner and his or her mining experience. The questions are listed in appendix A. Depending on the mine setup and schedule these questions may be administered verbally or written. If administered verbally, the questions can be answered during travel time to the face, during down time while observing, or even by the safety director/mine representative. At a minimum, the following critical information will be collected:

- Age
- Gender
- Job Title
- Current Shift
- Years in current job title
- Years of mining experience

3. OBSERVATION UNDERGROUND

Observation of the subjects underground will take place during the subjects' normal working hours at the discretion of the mines and the miners involved. Ideally, the observation will take place at the beginning or end of the shift for 4 hours with two NIOSH employees acting as observers. However, the actual time allotted to observe and number of researchers present will be at the discretion of the miner being observed as well as the mine. There may be instances where only one NIOSH observer is present underground. However, any NIOSH personnel underground will escorted by a shift supervisor (foreman or fire boss) or safety director.

During the observation, the researchers' interaction with the miner will be minimal. The goal of this observation is to capture the natural progression of the tasks with as little interference from the researchers as possible. The researchers may occasionally ask for clarification of what occurred in a task or what was being examined; but these questions will be noted and only asked during down time. Any responses by the subject may be recorded using a permissible[1] voice recorder. Additionally, pictures will be periodically taken in areas allowed by the mine[2]. The note-taking tool will look similar to the one provided in appendix B and be modified according to the task/position being observed.

Following the observation period, a short debrief will occur. At this point, the researcher will ask any follow up questions and be available to answer any questions the subject may have. The debrief will be recorded as well. The debrief may occur during a lunch break underground, on the trip back to the surface, or above ground at the conclusion of the shift.

RESEARCH TEAM

All tasks described in the protocol below will be performed interchangeably by all members of the team including (1) Justin Patts, BS, (2) Jennica Bellanca, MS, (3) Brianna Eiter, PhD, (4) Lisa Steiner, MS, and (5) Brendan Demich.

[1] **Permissibility** is a federal approval that is granted by the Mine Safety and Health Administration (MSHA) to electrical machinery or accessories that are not **intrinsically safe**, but have been designed to mitigate the dangers of causing an explosion in a potentially flammable environment. **Intrinsically safe** is defined as being incapable of releasing enough electrical or thermal energy under normal or abnormal conditions to cause ignition of a flammable mixture of methane or natural gas and air of the most easily ignitable composition. Permissibility allows the device to be used anywhere underground.

[2] If a device is not **permissible** or **intrinsically safe** it can only be used underground in areas/situations defined in the mine's safety control plans that have been approved by MSHA (i.e. in intake airways of the mine). We will adhere to these safety plans.

HSRB Issues

Research Subjects

Research subjects will be currently employed coal miners working in the contiguous United States with the following criteria:

1. Working more than 20 hours a week at an underground coal mine
2. Have at least 3 years of experience in their current position
3. Have at least 3 years of experience at their current mine company
4. Have at least 8 years of total mining experience
5. Have trained/apprenticed at least one other miner at current position
6. Have approval from the mine/safety director to engage in the study

Since the goal of the research study is to understand the timing, amount, and purpose of the information needed during tasks, the recruitment of volunteers will focus on two cognitively demanding positions that require a large amount of information processing: the fire boss (mine examiner) and the continuous miner operator. However, different mines may divide the tasks differently; therefore, other positions performing the same tasks may be targeted as well.

Subject Recruitment

NIOSH researchers will recruit subjects through the safety directors and mine management to ensure the mine's wiliness to participate. Mine management will be approached through a phone call and potentially a follow-up email based on existing professional relationships. Lisa Steiner, along with the other members of this team, has long-standing relationships with various mines and mining organizations (i.e. UMWA) across the country from which we can recruit. A script to be used in these initial contacts can be found in appendix E. If the mine is interested in participating, volunteers will be recruited that meet the criteria described above.

Individual subject recruitment will be initiated by mine management or the safety director. If volunteers exist and are available prior to the shift, NIOSH researchers will then meet with the prospective subject(s) outside the mine. NIOSH researchers will introduce the study (using the script in appendix F) and obtain their informed consent (appendix C) if they wish to proceed. A talent waiver will also be obtained to permit the capture of the subject's voice and image (appendix D). If the talent waiver is refused, the study will still continue without the use of the voice recorder, and no pictures of the subject will be taken. If volunteers are not available prior to the shift, a verbal consent to take part in the study and record audio and photographic materials will be taken underground. For documentation, the miner will be asked to sign the waiver at the conclusion of the shift.

A maximum of 20 participants will be recruited for the direct observation. Participants will be split between fire bosses and continuous miner operators.

Informed Consent

Because of the nature of the direct observation task, we are likely to interact with only one or two subjects per visit. At the beginning of the shift, we will meet the prospective subject(s) at a pre-determined location – this location will be determined by the mine safety director or mine management and may be above or below ground. NIOSH researchers will review the informed consent with the subject(s) being observed. The subject(s) will then be given the option to participate. Upon agreement, the subjects will then be given the option to take a copy of the consent form home with them for future reference. The consent form that will be used can be found in appendix C. The consent form is rated at a 12.1 Flesch-Kincaid Reading scale, which is acceptable since miners have a high school level of education. Following the obtainment of informed consent, the miners will also be asked to sign a talent release waiver to enable the photographic documentation and voice

recording during the direct observation (appendix D). If the talent waiver is refused, the study will still continue without the use of the voice recorder, and no pictures of the subject will be taken. If this meeting occurs underground, a verbal consent will be taken and written documentation will be obtained at the conclusion of the shift.

Benefits and Risks

There is no direct benefit to the miners for participating in this study, other than the satisfaction of assisting with research that will influence the development of future interfaces in mining.

The activities of this study pose no more than minimal risk to human subjects. Interaction with the miners being observed will be minimal and at the discretion of the miner being observed and the safety director (or escort). Additionally, if our presence significantly affects the safety of any of the miners (in either the subject's, the escort's, or our opinion) the experiment will be terminated.

Reimbursement

A $25 gift certificate to a local retailer will be offered as reimbursement for participation in this voluntary program. This amount is an appropriate reimbursement and does not provide undue incentive. An estimated 1 hour of burden time outside of normal working hours will be required to participate in this study, where approximately 45 minutes of the testing will actually occur outside of normal work hours, and we will ask questions during their typical breaks, which we approximate at 15 – 20 minutes of time. The median hourly wage for a continuous miner operators in coal is $24.98 per hour and the median of all construction and extraction occupations in coal is $24.41 per hour . Since our subject pool is expected to be in the upper range of these salaries due to their increased experience and status (training ability and value) and are being paid for their normal hours of work, we believe we are reimbursing them fairly for their participation. Subjects choosing to withdraw will be reimbursed according to their percentage of participation.

Data Management

The photographs and notes collected from this study will be stored on an encrypted hard drive, on a password-protected computer, locked in the principle investigator's (PI's) office. Only the PI and key personnel will have access to the data. No personally identifiable information will be able to link notes with the participants.

Analysis Plan

The qualitative data collected in this study will be used to create a better picture of the informational and attentional needs of mining tasks. First, the voice recordings collected at the mine site will be transcribed in-house and integrated with the notes and photographic data. Then, the combined data will be separated by job title and task. Within a task, the data may be further broken down into methods of completing a task if the task is performed in a significantly different way. The steps involved in each task will be collapsed across method and subject resulting in a task diagram for each method of each task. The informational needs and sources of errors will be coded based on what interface or system aspect(s) are involved. This coded data will then be analyzed using summary statistics (mean, standard deviation, correlation) to quantify the importance and frequency of device use as well as the most frequent sources of problems. The unreduced qualitative data will also be examined for trends, root causes of problems, and any other implications of informational needs that surface.

All of the data, reduced and raw, will also be used to support the design of secondary experiments in the HSI project, such as a planned cognitive task analysis, the redesign of mining interfaces, and the development of an integrated development interface.

Confidentiality

There will be no personally identifiable links between the observational notes and the subject. The voice recording, photographs, photo release waivers, and consent forms that do contain personal information will be stored in a locked office and on a secure server, where only the PI and key personnel will have access.

Emergency Procedures

NIOSH researchers will receive “site-specific” safety training, which will identify the particular and unusual hazards (if any) that are unique to the mining facility. Mine management will review their safety and emergency evacuation procedures with NIOSH researchers before the tests are conducted. No specific procedures need be introduced for the miners who will volunteer as subjects. Mine employees will follow their normal emergency procedures.

References