Information Collection Request for

"Enhancing Mine Workers' Abilities to Identify Hazards at Sand, Stone, and Gravel Mines"

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February 20, 2015

Part A

Part A: Justification

List of Attachments

- This submission is for a new request.
- The goal of this work is to understand how cognitive processes, such as attention and risk perception, are involved in hazard recognition.
- The resulting data will be used to create training materials to address those cognitive processes in order to increase SSG miner worker's ability to recognize worksite hazards.
- Data collection methods are varied and include the use of qualitative methods such as open-ended questions, research questionnaires, as well as experimental design.
- All data will be collected from surface stone, sand, and gravel mine workers working within the United States.
- Data will be analyzed using a variety of methods including inferential statistics such as ANOVA and ANCOVA for research questionnaires and experimental data as well as thematic analysis for qualitative data collected through the open-ended questions.

The Center for Disease Control and Prevention (CDC) the National Institute for Occupational Safety and Health (NIOSH) Mining Program request OMB approval for a 2-year period of a new ICR.

A. Justification

1. Circumstances Making the Collection of Information Necessary

<u>Background</u>

This information collection request (ICR) is a new request. This collection request describes data collection tasks under the project entitled "Enhancing Mine Workers' Abilities to Identify Hazards at Sand, Stone, and Gravel Mines." This study is being conducted by the National Institute for Occupational Safety and Health. NIOSH, under P.L. 91-173 as amended by PL 95 -164 (Federal Mine Safety and Health Act of 1977), and PL 109-236 (Mine Improvement and New Emergency Response Act of 2006) **(See Attachment A)** has the responsibility to conduct research to improve working conditions and to prevent accidents and occupational diseases in underground coal and metal/nonmetal mines in the U.S.

For the years 2007–2011, the average number of occupational injuries that resulted in the loss of one or more days from the employee's scheduled work, or days of limited or restricted activity while at work (non-fatal days lost - NFDL) reported by the Mine Safety and Health Administration (MSHA) for the stone mining industry was 2.3. Comparatively, the average number of NFDL injuries reported during that same time period for all U.S. private industry workers was 1.9 (Bureau of Labor Statistics, BLS). Research is needed to determine the most effective ways to reduce injuries at stone operations – this includes stone pits and quarries, plants, and maintenance and repair shops. In addition, the overall number of violations in the Sand, Stone and Gravel (SSG) industry, as well as the standards most frequently cited by MSHA during mining inspections, have not changed considerably from 2008 to 2012. The most frequently cited standards are related to: missing guards around moving machine parts (30 CFR 56.14104 and 56.14112), electrical hazards (30 CFR 56.12004, 56.12028, and 56.12032), inspection and maintenance of equipment (30 CFR 56.14100), and inadequacy of berms and guardrails (30 CFR 56.9300). SSG mine workers are not experiencing incidents and injuries for each of the citations listed above. However, there are potentially a number of injuries and near-miss events occurring at mine sites related to the hazards that have been identified in the citations listed above. From this data, it's unclear whether SSG mine workers are not recognizing worksite hazards or are recognizing the hazards but are not accurately assessing the associated risk.

Hazard recognition, the realization that a condition or behavior can cause harm and a necessary skill for all miners, is only the first step to a safe work environment. A miner must be able to identify a hazard, recognize the risk associated with the hazard, and then make a decision of how to mitigate the risk and perform the task safely. Risk is defined as the combination of the likelihood an event will occur and the adverse consequences of that event (Brown & Groeger, 1988). Risk perception, the recognition of the risk inherent in a situation, influences decision making with regards to job safety (Hunter, 2002). Being able to recognize worksite hazards and then accurately perceive the associated risk are critical skills that lead to the work behavior decision-making process that is used to eliminate or reduce mining hazards related to operations and maintenance of machinery, operation of powered haulage, material handling, etc. that can result in injury or death. Hazard recognition abilities and risk perception can be improved through training; for example, Barrett and Kowalski (1995) used simulation exercises and three-dimensional slides to train mine workers to perceive the visual cues that precede hazardous or dangerous events (see also Rethi et al., 1999). Experienced workers also tend to be more accurate at recognizing work site hazards, though this finding is true only for workers with safety-specific training (e.g., safety directors) as compared to the performance of superintendents and novices, such as civil engineering students (Perlman, Sacks, & Barak, 2014).

Recently, the National Academy of Science (NAS) released the report "Improving Self-Escape from Underground Coal Mines" (NAS, 2013). While this report focused mainly on miners' abilities to self-escape during mine disasters, the NAS's recommended areas for research are more broadly applicable. Specifically, Recommendation 5 from the report indicates that more research should be performed related to the use of decision science research in the development of protocols and training materials to enhance miners' attention to unexpected risks, situational awareness, and self-escape competence. Hazard recognition is integral to risk perception, situational awareness, and decision making—that is, if the mine worker is unable to recognize worksite hazards, then steps cannot be taken to eliminate or mitigate them. Thus, the mine worker must first be able to recognize that a hazard is present in the environment and then understand the risk the hazard poses to their safety and health in order to make the best decision possible about how to deal with the hazard. Hazard recognition is a necessary skill for all mine workers; therefore, a better understanding of the hazard recognition process within the mining environment is a critical need that this research will fulfill for the industry.

Given the aforementioned, the objective of the project is to characterize SSG mine workers' ability to recognize worksite hazards, to understand how this ability relates to perceived and measured risk as well as to other factors internal and external to the SSG mine worker.

2. Purpose and Use of Information collection

Since mining is a hazardous environment, it is extremely important for NIOSH to collect this information as it is our goal to improve the health and safety of all mine workers. Data to be collected for the study does not exist in any similar study for this population or application. This data collection effort is currently funded by the Office of Mine Safety and Health Research (OMSHR) through fiscal year 2017.

The participants for the study are mine workers (30 mine workers from Stone, Sand and Gravel mines will participate – 15 of these mine workers will be considered experienced miners and 15 will be considered less experienced or novice mine workers. In addition, 16 safety professionals and 16 students enrolled in mining programs at a college or university will participate. Overall, we plan to perform full data collection with 62 participants. Prior to participation, potential participants will be pre-screened to ensure that they meet the qualifications for the study (**see Appendix D)**.

Data will be collected from each mine worker, safety professional, and student who volunteers and meets the qualification criteria from the pre-screening for the study. Meaning, each participant will complete each research instrument once during the course of the study. For the study participants will first be presented with large scale panoramic scenes. These scenes will be presented in a 360° virtual environment in the Virtual Immersion and Simulation Laboratory (VISLab). Participants will be asked to search the panoramic pictures to find potential worksite hazards. Each panoramic picture will be available to the participant for two minutes if the participant decides he has found all of the hazards in the panoramic picture, he can press a button and the picture will disappear.. Once all panoramic scenes have been searched, participants will complete the remaining data collection instruments. Data will be collected through the use of several survey instruments, these survey instruments are included as appendices to this document (**see Appendix C through G, & Appendix K**) as well as open-ended questions (**see Appendix H**). This data will be used in conjunction with behavioral metrics (e.g., eye-movement, reaction time, body position, etc.) in order to better understand how mine workers, safety professionals, and students search for and find hazards. Eye-movement data will be collected using eye-tracking glasses, reaction time will be measured with a button the participant holds in the dominant hand, and body position is measured using a motion capture system.

Mine workers, safety professionals, and students will be recruited through the use of contacts that project personnel have accumulated through experience within the mining industry. Mine workers and safety professionals will be recruited from several mine sites within the Pittsburgh area. These mine workers and safety professionals will be recruited through contacts that research personnel have made at stakeholder meetings as well as from previous research contacts. Students will be recruited from nearby universities with mining programs (e.g., University of Pittsburgh and West Virginia University). Those students who are recruited will be enrolled in mining engineering programs or occupational safety health programs. Students will be recruited through faculty and previous research contacts.

The successful completion of the research will have several impacts. The goal of this research project is to further our understanding of the SSG miner's ability to recognize worksite hazards. To do this, we plan to collect data from experienced and less experienced/novice mine workers to understand how experience affect hazard recognition ability. In order to fully understand how experience – not just work experience, but also hazard recognition and risk assessment training experience – affect ability, we are including safety professionals and students as participants. Within a mining company, safety professionals are likely to people administering hazard recognition and risk assessment training. They are also likely to be the people responsible for performing health and safety audits at mines. Therefore, these people should have a great deal of knowledge about mine site hazards and the risk associated with them. Students on the other hand are considered true novice mine workers because they likely have no work experience at a mine site. However, students are likely to have recent hazard recognition and risk assessment training. Therefore, the safety professionals and students are included to understand how work experience influences hazard recognition and risk assessment abilities.

Only by better understanding hazard recognition and the specific factors that influence the miner's abilities to recognize hazards will we be able to produce effective training materials so that the SSG mine worker is empowered to proactively identify hazards during pre-shift inspections and worksite examinations. Failure to acquire the data for the study would halt these efforts. On a broader scale, it is anticipated that this research will benefit other industries given that hazard recognition and risk perception have been a challenge in the industrial sector for many years. Specifically, today's industries contain many hazards that cannot be seen, cannot be easily or fully understood, or are latent or dependent upon a chain of events. Understanding the hazard recognition process within a dynamic work environment is therefore critical.

3. Use of Improved Information Technology and Burden Reduction

During the telephone call, A NIOSH researcher will ask potential participants the questions from the prescreening questionnaire. The NIOSH researcher will record the potential participant's responses on a copy of the prescreening questionnaire. After the prescreening questionnaire is completed, it will be scanned and saved, either as the only data file for a potential participant (if he/she did not pass the prescreen) or along with all of the other completed data collection instruments (if he/she does pass the prescreen and agrees to participate in the study). All data will be collected on site at the NIOSH/OMSHR Bruceton Research site. While we understand that OMB considers electronic respondent reporting a critical issue, data collection has to take place on site because of the nature of the study. While we cannot collect data electronically, all attempts have been made to minimize the amount of time it takes to complete data collection.

4. Efforts to Identify Duplication and Use of Similar Information

To determine whether duplicate or similar information currently exists, an extensive literature review was conducted and we determined that no published results exist that specifically address the research questions proposed in this study.

Several years ago, the Bureau of Mines published an Information Circular (Perdue, Kowalski & Barrett, 1995) that includes a summary of the psychological principles that could be applied to hazard recognition as well as a relatively simple information processing model that conceptualizes hazard recognition. In general, the Information Circular suggests the importance of visual attention and visual search to finding and identifying hazard recognition. However, no research studies were ever conducted by the Bureau of Mine or later by OMSHR researchers to support this suggestion.

Within the construction industry, recent work has been done to investigate the influence of experience on hazard recognition and risk perception. While there are differences in construction jobs and processes compared to mining jobs and processes, both industries rely on the use of similar tools, personal protective equipment (PPE), and machinery. Moreover, construction workers encounter some of the same hazards that mine workers encounter – for instance, both encounter electrical hazards that can be avoided by locking and tagging out an electrical source. In one study, Perlman et al., (2014) asked construction superintendents, safety directors, and civil engineering students searched for hazards within a virtual construction site and then assessed the level of risk associated with construction site hazards. Counter to the author's predictions, superintendents were unable to identify all of the hazards in the work environment. In fact, safety directors outperformed both superintendents and civil engineering students when recognizing hazards, a difference Perlman et al. attribute to experience and formal safety training which the other two groups respectively did not have. One issue with the Perlman et al. study is that data was not collected from construction workers. Because of this, it is not known how construction workers perform on a hazard recognition task relative to the safety directors, superintendent, and civil engineering students. In the current research study, data will be collected from safety directors and students. In addition, and critical to the study of mine worker hazard recognition abilities, we will collect data from mine workers currently employed at a SSG mine. In order to be able to draw conclusions about how a group of people performs, it is necessary to collect data from that group. To our knowledge, this has not been done with any type of mine workers – and specifically it has not been done with SSG mine workers.

5. Impact on Small Businesses or Other Small Entities

Small mines will be included in the data collection because a large number of SSG mines are categorized as small mines (with operations of 50 or fewer employees). All data collection will take place on site at the Office of Mine Safety and Health Research (OMSHR) Bruceton location in Pittsburgh, PA. Efforts will be made to minimize the amount of time it takes to complete data collection. In order to minimize the burden on small mines, the number of data collection instruments and the number of questions have been held to the absolute minimum required for the intended use of the data.

6. Consequences of Collecting the Information Less Frequently

This is a request for a one time data collection. All participants will be asked to complete all data collection instruments one time only.

The goal of this research project is to understand how SSG mine workers with varying levels of mining experience search for and recognize worksite hazards, and to also understand how this hazard recognition ability relates to perceived and measured risk. The results of this research study will be used to develop necessary training programs and recommendations documents that will be used to address critical issues related to safety not only for SSG mines but also for surface coal and metal/nonmetal mines. Given that this type of research has never been conducted within the mining industry, a consequence of not collecting this data would be that NIOSH/OMSHR would not be able to use the results to inform the development of much needed training programs and recommendations documents focused on increasing hazard recognition knowledge, skills and abilities for the mining industry.

7. Special Circumstances Relating to the Guidelines of 5 CFR 1320.5

This request fully complies with the regulation 5 CFR 1320.5

8. Comments in Response to the Federal Register Notice and Efforts to Consult Outside the Agency

A 60-day Federal Register Notice was published in the *Federal Register* on April 08, 2015, vol.80, No.67, pp.1884-86 (**see Att B**). CDC did not receive public comments related to this notice.

An extensive literature review was conducted. There were no personal consults outside NIOSH.

9. Explanation of Any Payment or Gift to Respondents

No remuneration will be paid to respondents.

10. Protection of the Privacy and Confidentiality of Information Provided by Respondents

The NIOSH Information Systems Security Officer reviewed this submission and determined that the Privacy Act does not apply to this submission as no personally identifiable information will be collected at any point during the study.

NIOSH Internal Review Board provides researchers with a Model Informed Consent Form. This form is modifiable and is the template that NIOSH researchers use as the basis for the Informed Consent submitted for approval and also with this submission (**see Attachment I for the informed consent**).Miners, safety professionals, and students who volunteer to participate will not be asked to provide any form of identifying information (e.g., name, SSN, etc.). Thus, no IIF will be included in the data records. All participants will be assigned a coding number that will not be linked with a name or any other identifying information. All information provided by participants will be stored by CDC/NIOSH researchers in a secure manner unless compelled otherwise by law. The data will be analyzed in the aggregate form and no individual participants will be identified.

In terms of physical controls, the completed data collection instruments will be stored in a locked file cabinet at NIOSH's Office of Mine Safety and Health Research (OMSHR) Pittsburgh Office. This is a secure, gated facility with 24-hour security guard service. Only personnel with proper identification badges are allowed access to the site. All of the data will be entered and combined into data files that will be stored with technical safeguards in a secure, password-protected location on the CDC/NIOSH computer network. This computer network is only accessible to NIOSH employees. All networks at NIOSH are firewall protected and utilize a virtual private network. Access to this information will be restricted to researchers directly involved with the study and those who need to view the data. A training session will be conducted for all researchers about the data collection and how the data will be stored. At this training session, all researchers will be made aware of their responsibilities for protecting information being collected and maintained. At the end of the data collection, the surveys will be destroyed.

No Individually identifiable information will be collected.

11. Institutional Review Board (IRB) and Justification for Sensitive Questions

IRB Approval

The data collection has been reviewed by the NIOSH Internal Review Board (IRB). The research protocol has been developed. The Informed Consent is included with this submission (**see Appendix I**) as well as documentation of IRB approval **(see Appendix J**).

Sensitive Questions

Participants will not be asked questions of a sensitive nature at any point during data collection.

12. Estimates of Annualized Burden Hours and Costs

A. The respondents targeted for this study includes SSG mine workers, mine safety professionals, and mining engineering students. Up to 45 mine workers, 20 safety professionals, and 20 students will be administered the pre-screening questionnaire **(Appendix D).** The pre-screening questionnaire should take approximately 15 minutes to complete. This will be done over the telephone to identify participants who qualify to take part in the study. Only those participants who qualify for the study will be invited to take part. It is anticipated that some percentage of those participants who are contacted will not be interested in participating in the study or will not pass the pre-screening criteria; therefore, the estimated burden hours for the remainder of the study will be reduced to 62 total respondents (30 mine workers – 15 of these mine workers will be considered experienced and 15 will be considered inexperienced, 16 safety professionals, and 16 students). The 62 total respondents will complete several data collection instruments. The following is a brief description of who will complete each instrument and how long it will take to complete the instrument.

All 62 respondents will complete the demographic questionnaire **(Appendix C)**. This should take approximately 6 minutes for each respondent to complete. All 62 respondents will then complete the experimental task. Completing the experimental task (**Appendix K**) requires the respondent to identify mine site hazards. This should take approximately 60 minutes to complete. All 60 respondents will then complete the Risk Assessment Measure (time to complete, 20 minutes; **Appendix E**), the Risk Propensity Scale (time to complete, 6 minutes; **Appendix F**), the Mine Specific Risk Tolerance Measure (time to complete, 6 minutes; Appendix G), and the Open-ended Questions (time to complete, 30 minutes; **Appendix H**).

We do not anticipate a disruption of the miners' normal work schedules as data will be collected during the winter months when the mine(s) will be shut down. Scheduling students and safety professionals will be arranged to minimize disruption to their class or work schedules as needed. All data will be collected at the NIOSH Visual Interactive Simulation Laboratory (VIS Lab).

The following table provides an estimate of the annualized burden hours over a two year approval period.

Estimated Annualized Burden Hours

Type of Respondent	Form Name	No. of Respondents	No. Responses per Respondent	Average Burden per Response (in hours)	Total Burden Hours
Mine Employee	Prescreening Questionnaire	23	1	15/60	11
Safety Professional		10			
Student		10			
Mine Employee	Demographic Questionnaire	15	1	6/60	3
Safety Professional		8			
Student		8			
Mine Employee	Experimental Task	15	1	1	31
Safety Professional		8			
Student		8			
Mine Employee	Risk Assessment Measure	15	1	20/60	10
Safety Professional		8			
Student		8			
Mine Employee	Risk Propensity Scale	15	1	6/60	3
Safety Professional		8			

Student		8			
Mine Employee	Mine Specific Risk Tolerance Measure	15	1	6/60	3
Safety Professional		8			
Student		8			
Mine Employee	Open Ended Questions	15	1	30/60	16
Safety Professional		8			
Student		8			
Total		31			77

B. The estimated annualized cost for this information collection is $1664.25

Estimated Annualized Burden Costs

Type of Respondent	Total Burden Hours	Mean Hourly Wage Rate	Total Respondent Costs
Sand, Stone, and Gravel Mine Worker	40	$21.00	$840
Sand, Stone, and Gravel Safety Personnel	21	$32.00	$672
University Student	21	$7.25	$152.25

The value assigned for the hourly wage rate is based on the average U.S. hourly wage rate for coal miners available in the following report: Bureau of Labor Statistics, U.S. Department of Labor, NAICS 212300 Nonmetallic Mineral Mining and Quarrying, on the Internet at the following address: http://www.bls.gov/oes/current/naics4_212300.htm (visited March 9, 2015).

13. Estimates of Other total Annual Cost Burden to Respondents or Record Keepers

None.

14. Annualized Cost to the Government

The time allotted for the project is 2 years. During this two year period, instrument development, data collection, analysis and presentation are expected to occur. The estimated hourly cost to the Federal

Government is $33.72 per hour. This includes data collection by CDC/NIOSH employees, data analysis, and report writing. The hours designated for government staff were calculated as shown in the table below. The total cost average for a two year period is $257,775.

	Hours	**Hourly Rate**	**Cost at Hourly Rate**	**Other Costs (data collection, etc.)**	**Total**
Federal Government Employee	6,500	$33.72	$219,375	$38,400	$257,775
Contractor Cost					

15. Explanation for Program Changes or Adjustments

This is a new data collection.

16. Plans for Tabulation and Publication and Project Time Schedule

Data analyses will be conducted over the life of the project. The project schedules below provide an estimate of data collection activities, analysis, and dissemination. We are requesting OMB clearance for the maximum 2 years because data collection is likely to extend into the second year.

Project Schedule:

Activity	**Time Schedule**
Contact Mines for Data Collection	1-6 months after OMB approval
Contact Colleges and Universities for Data Collection	2-12 months after OMB approval
Conduct Research Study	2-18 months after OMB approval
Analyze Research Study data	6-9 months after OMB approval
Publish findings from studies	9-18 months after OMB approval
Create Training Materials	9-18 months after OMB approval

This is primarily a laboratory based quasi-experimental research study which also uses a mixed methodological approach. Objective data collection will occur during Phase 1 of the study when accuracy and eye movement data will be collected from participants. This is considered a mixed methodological approach (see Johnson, Onwuegbuzie, & Turner, 2007) because additional qualitative data will be collected during Phase 2 of the study. This qualitative data will benefit the overall understanding of the objective data collected during Phase 1 because it will potentially provide a subjective explanation for any observed differences in the accuracy and eye movement data.

Analysis Plan:

Primary Research Question: The overall goal of this research study is to answer the primary research question: Do experienced SSG mine workers visually search static scenes for hazards differently than less experienced and novice mine workers? To answer this question, we plan to collect data from experienced and less experienced/novice mine workers to understand how experience affect hazard recognition ability. In order to fully understand how experience – not just work experience, but also hazard recognition and risk assessment training experience – affect ability, we are including safety professionals and students as participants. Within a mining company, safety professionals are likely to people administering hazard recognition and risk assessment training. They are also likely to be the people responsible for performing health and safety audits at mines. Therefore, these people should have a great deal of knowledge about mine site hazards and the risk associated with them. Students on the other hand are considered true novice mine workers because they likely have no work experience at a mine site. However, students are likely to have recent hazard recognition and risk assessment training. Prior to analyzing the data, regions of interest (ROIs) will be drawn around each of the hazards included within a panoramic scene. The purpose of these ROIs is to establish a series of targets within a scene. This will allow us to determine whether the participant accurately identifies the included hazards as hazards and it also a typical means of studying eye-movement behavior during scene viewing (Holmqvist et al., 2011).

To address the question, data collected using the SMI Eye-tracking Glasses will be used. Visual search is characterized by scanpaths which are comprised of a sequence of fixations and saccades – or eye-movements (Goldberg &Kotval, 1999). For the purposes of this study, we are interested in determining whether there are differences in the number of fixations and the duration of fixations on a hazard as well as the number of saccades, and the length of saccades to a hazard for experienced, less experienced, and novice mine workers. These measures were chosen because Rayner (1998), in his seminal review of eye-movement research, points out that fixation durations decrease and saccade amplitude increase when visual search increases. Thus, measures related to fixation duration and saccade size will likely show differences while mine workers are searching panoramic scenes for hazards.

In addition, prior research indicates differences in eye-movement behavior between experts and non-experts (novices) in a number of areas, for instance driving a car (Chapman & Underwood, 1998), operating a motorcycle (Hosking, Liu, & Bayly, 2010), and playing chess (de Groot 1946, 1965). Crundall and Underwood (1998) provide evidence supporting a difference in how experienced and inexperienced drivers scan roads. Novice drivers have longer fixation durations than expert drivers when scanning a scene (Chapman & Underwood, 1998), this is especially true in dangerous situations. As this is the first study – to our knowledge – designed to identify whether experience level influences how mine workers search for and find mine site hazards, it is critical to determine whether there are differences in these eye-movement measures.

Differences in these eye-movement measures will also be used to begin to define effective search patterns. One way of determining whether search patterns are effective is combining eye-movement data with accuracy data. Accuracy data will be measured through a button press while the mine worker is performing the hazard assessment task. The button press will be linked with fixation location through timestamp within the SMI Eyelink software. A response will be recorded as accurate when the button press/fixation location corresponds with a previously established ROI. A response will be recorded as an error when the button press/fixation location corresponds with an object not previously established as a ROI or when a previously established ROI is not selected. Experienced participants (both safety professionals and experienced mine workers) are expected to find a greater number of hazards than inexperienced and novice participants (both inexperienced mine workers and students). Thus, differences between experts and novices should be evident in both accuracy scores as well as eye-movement measures.

In addition to eye-movements, qualitative data will be used to more fully understand (1) why participants do/do not identify certain hazards within the panoramic scenes and also to subjectively define (2) how participants search for work site hazards during the hazard assessment task. Accuracy data collected during Phase 1 of the study provides general information about which hazards are and are not identified. A limitation to this accuracy data is that it does not provide information as to why the participant did not identify the hazard as a hazard. In order to more fully understand the hazard recognition process, we have to understand why participants do not recognize some hazards as hazards. During Phase 2 of the study, a smaller subset of hazards will be probed. This subset will include hazards that the participant accurately identified as well as hazards the mine worker did not accurately identify (this includes hazards that went unidentified as well as items that were inaccurately identified as hazards). Probes for accuracy and probes for errors (see Appendix H) will be used to gain additional information from participants.

To more fully understand potential differences in scanpaths, probes for visual search (see Appendix H) will be used. Qualitative data will be collected through a series of open ended questions. The questions are designed to provide a subjective account of the eye-movement patterns obtained during Phase 1 of data collection. Qualitative data collection materials and the analysis plan were designed following the retrospective think aloud methodology (RTA; Ericsson & Simon, 1993) where participants verbalize their thoughts after completing a task. It's critical to verbalize after completing the task because the eye-movement data will also be analyzed. Verbalizing while performing Phase 1 is likely to change the way the participant processes the panoramic scene and therefore either change the eye-movement pattern or compromise the eye-movement pattern. Therefore, Phase 1 will be performed in silence. After data collection, all hand written notes will be typed in order to preserve the raw data in as 'hard' a form as possible so that the data can be clearly analyzed through coding. We will follow Ericsson and Simon's suggestion regarding analysis: the encoding scheme is not defined formally, but the search for interpretations proceeds in parallel with the search for an appropriate model or theory. Ultimately, it is of interest to use this qualitative data as a means to describe any differences found in how experienced, less experienced, and novice participants search the work environment.

Additional questions will also be addressed with this study related to risk tolerance and perceived risk. The initial goal in collecting this data from participants is to determine whether there are differences in the risk tolerance measures and the perceived risk measure between experienced, less experienced and novice participants.

And we will also explore possible differences based on risk tolerance. Specifically, risk tolerance will be used as an independent variable in conjunction with demographic information such as experience and age, hazard recognition accuracy scores, eye movement measures, and the perceived risk scores as dependent variables for this exploration. Specifically, two different groups of participants will be created using the risk tolerance measures – those that score high on the measure and those that score low [it is likely we will use the median score as the cutoff to establish these two groups]. Demographics, accuracy scores, eye movement measures, and perceived risk scores for high risk tolerant participants will be compared to those for low risk tolerant participants.

The perceived risk scores will also be used in conjunction with hazard recognition accuracy scores. Specifically, we are interested in determining whether there are differences in perceived risk for accurately identified hazards compared to hazards that participants do not identify during the hazard assessment. This could provide a possible explanation for hazards that are not identified – participants may not perceive certain hazards as risky. .

Descriptive and inferential statistics will be conducted on data including (but not limited to): (M)ANOVA, ANCOVA, multiple regression, and mean and standard deviation reports.

17. Reason(s) Display of OMB Expiration Date is Inappropriate

Not applicable. The OMB expiration date will be displayed.

18. Exceptions to Certification for Paperwork Reduction Act Submissions

There are no exceptions to the certification.

References

Abdelhamid, T. S., & Everett, J. G. (2000). Identifying root causes of construction accidents. *Journal of Construction Engineering and Management*, *126*(1), 52-60.

Barrett-E; Kowalski-K. Effective hazard recognition training using a latent-image, three-dimensional slide simulation exercise Bureau of Mines, RI 9527, 1995 Apr; :1-36

Blignaut, C. J. H. (1979a). The perception of hazard I. Hazard analysis and the contribution of visual search to hazard perception. *Ergonomics*, *22*(9), 991-999.

Blignaut, C. J. H. (1979b). The perception of hazard II. The contribution of signal detection to hazard perception. *Ergonomics*, *22*(11), 1177-1183.

Brown, I.D., & Groeger, J.A. (1988). Risk perception and decision taking during the transition between novice and experienced driver status. *Ergonomics*, *31*(4), 585-597.

Chapman, P. R., & Underwood, G. (1998). Visual search of driving situations: Danger and experience. PERCEPTION-LONDON-, 27, 951-964.

Crundall, D. E., & Underwood, G. (1998). Effects of experience and processing demands on visual information acquisition in drivers. Ergonomics, 41(4), 448-458.

De Groot, A. D. (1946). Het denken van den schaker [Thinking processes in chess players]. Den Haag, The Netherlands: Noord Holland.

De Groot, A. D. (1965). Thought and Choice in Chess (traduction remaniée de de Groot, 1946), The Hague.

Duke, W.F., & Bevan, W. (1967). Stimulus variation and repetition in the acquisition of naming responses. *Journal of Experimental Psychology*, *74*, 178-181.

Ericsson, K. A., & Simon, H. A. (1993). Protocol analysis.

Goldberg, J. H., & Kotval, X. P. (1999). Computer interface evaluation using eye movements: methods and constructs. International Journal of Industrial Ergonomics, 24(6), 631-645.

Holmqvist, K., Nyström, M., Andersson, R., Dewhurst, R., Jarodzka, H., & Van de Weijer, J. (2011). Eye tracking: A comprehensive guide to methods and measures. Oxford University Press.

Hosking, S. G., Liu, C. C., & Bayly, M. (2010). The visual search patterns and hazard responses of experienced and inexperienced motorcycle riders. Accident Analysis & Prevention, 42(1), 196-202.

Hunter, D.R. (2002). Risk Perception and Risk Tolerance in Aircraft Pilots. Federal Aviation Administration Report No. PB2003100818.

Johnson, R. B., Onwuegbuzie, A. J., & Turner, L. A. (2007). Toward a Definition Mixed Methods Research. Journal of Mixed Methods Research, 1, 112-133.

Kowalski-Trakofler, K., Barrett, E. (2003). The concept of degraded images applied to hazard recognition training in mining for reduction of lost-time injuries. J Saf Res 2003 34(5): Jul-Sept: 515-525

Lehmann, C.C., Haight, J.M., & Michael, J.H. (2009). Effect of safety training on risk tolerance: An examination of male workers in the surface mining industry. Journal of Safety, Health, and Environmental Research, 4(3).

Medin, D. L. (1989). Concepts and conceptual structure. *American psychologist*, *44*(12), 1469.

Meertens, R. M., & Lion, R. (2008). Measuring an Individual's Tendency to Take Risks: The Risk Propensity Scale1. *Journal of Applied Social Psychology*, *38*(6), 1506-1520.

National Research Council. (2013). Improving Self-Escape from Underground Coal Mines. Committee on Mine Safety: Essential Components of Self-Escape, Board on Human-Systems Integration, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press. Committee members: William S. Marras, David Beerbower, Sian L. Beilock, David Cliff, James Dean, David M. DeJoy, Albert W. Holland, Dennis B. O'Dell, David H. Wegman, Toby Warden, Julie Anne Schuck, Renée L. Wilson Gaines.

Perdue, C., Kowalski, K. M., & Barrett, E. A. (1995). Hazard Recognition in Mining: A Psychological Perspective. IC 9422. Washington, DC: United States Department of the Interior.

Perlman, A., Sacks, R., & Barak, R. (2014). Hazard recognition and risk perception in construction. *Safety science*, *64*, 22-31.

Rayner, K. (1998). Eye movements in reading and information processing: 20 years of research. Psychological bulletin, 124(3), 372.

Rethi-LL; Flick-JP; Kowalski-KM; Calhoun-RA; Barrett-EA; Cornelius-KM; Haggerty-JJ; Saksena-N. (1999). Hazard recognition training program for construction, maintenance and repair activities. (NIOSH) 99-158.