## 9:00 AM | ROOM L100B

# Health & Safety: Got Safety? See What Tech Savvy Companies Are Doing to Improve the Safety and Health of Their Workers II

*Chair:* J. Sattarvand, University of Nevada Reno, Reno, NV

### 9:00 AM
Introduction

### 9:05 AM
A Framework to Evaluate Safety Competencies Through Serious Games

*L. Brown[1] and B. Granillo[2]; [1]Lowell Institute for Mineral Resources, University of Arizona, Tucson, AZ and [2]Mel and Enid Zuckerman College of Public Health, University of Arizona, Tucson, AZ*

Well-designed computer games can be effective tools for stealth evaluation and assessment of training outcomes. In this work, we illustrate a process for mapping workers' gaming behaviors to safety competencies. A computer-based framework was developed consisting of three parts: 1) A serious game with instrumentation to record worker choices and activities; 2) A client-side dashboard for inspection and debriefing; and 3) A relational database to aggregate game logs and interpret results. Data mining algorithms allow trainers to assess and track competencies for individual users and across cohorts over time. Furthermore, a modular approach allows serious games to be re-mapped into arbitrary competency models, thereby enabling customization for each company's standard operating procedures. We discuss the design of our evaluation framework and data mining algorithms, and provide examples of competency-based assessment through serious games, with initial results on field deployment and training efficacy.

### 9:25 AM
Safety in Hand: Challenges and Opportunities of Mobile Enabling Safety Programs

*R. McLain; Health & Safety, Freeport-McMoRan, Phoenix, AZ*

As we attempt to place more mobile technology in the hands of employees to foster safer and more productive workplaces; we are faced with myriad implementation challenges. There are generational challenges with the adoption and rollout of new technology. Policy decisions and usage guidelines to consider when deciding when the use of a mobile technology outweighs the potential for on the job distraction. Mobile enablement also brings with it cross departmental issues such as device selection, network access, security, and cost considerations when planning for mobility. However, the opportunity for creative solutions to long term safety problems often lies with bringing simple solutions to where they are needed the most, in the hands of our workforce. In this discussion we will address these challenges and opportunities against the backdrop of several recent projects at Freeport-McMoRan.

### 9:45 AM
Safety 4.0 – Engineered Solution for a Safer Underground Excavation. The Bzerotondo Tunnel Support System

*R. Perlo; Tunnelling, Officine Maccaferri, Zola Predosa, Italy*

Safety in construction is tightly linked to the engineering choices, as much as to the necessity of reducing time and costs of realization. Therefore, it is of paramount importance to address it properly from the earliest stage of the design, identifying the risks connected to the work and the variability of such during the different stages of the project. Regarding to occupational safety and health, the risk is the likelihood that a person may be harmed of suffers adverse health effects if exposed to a hazard, e.g. the risk is often measured as the expected value of an undesirable outcome. However, a real case scenario is often more complex than a single binary possibility case. The automatic tunnel support system proved to be a solution able to reduce the time and yet to deliver an enhanced, quality-aware and safer working environment for the operators. The implementation of the system was shortlisted in 2015 for the ITA Award for the Safety Innovation of the Year. In a market industry driven by safety and time constrains the efficiency shall be the ultimate goal, in order to provide solutions able to negotiate with the most challenging ground conditions.

### 10:05 AM
Emerging Machine Learning-Based Technologies for Ground Control Hazards Identification Through Aerial Photography

*J. Sattarvand and R. Battulwar; Mining and Metallurgical Engineering, University of Nevada Reno, Reno, NV*

The paper discusses an ongoing NIOSH supported project for automatic identification/monitoring of the signs of ground control hazards, in particular, the tension cracks, through aerial photography and machine learning to enhance the conventional visual inspection of the site, finding of the cracks and installation of the appropriate monitoring instruments that is a hard, time consuming, unsafe, and sometimes an impossible practice. Automatic photography from the open pit terrains with consistent resolution is challenging due to a considerable altitude difference in the mine. The other challenge is to build a mosaic map based on the taken pictures to be suitable for image processing. Moreover, processing of a large size mosaic image, training of the tension crack definition in a fitting artificial neural network as well as handling of all cloud-based computations are other challenging areas of the technology. Training of this neural network involves intensive data acquisition from different types, shapes, and extents of the cracks from several mine sites, which is a quite practical challenge. Simplicity and plug-and-play features that are also designed to be provided in the system.

### 10:25 AM
Comparison of Multiple Continuous DPM Monitors to the NIOSH 5040 Standard Method

*C. Barrett[1], E. Sarver[1], J. Volkwein[2], J. Noll[3], E. Cauda[3], J. Dixon[2], B. Cary[2] and S. Vanderslice[3]; [1]Mining and Minerals Engineering, Virginia Tech, Blacksburg, VA; [2]Consultant, Pittsburgh, PA and [3]NIOSH, Pittsburgh, PA*

For monitoring personal diesel particulate matter (DPM) exposures, the NIOSH 5040 Standard Method is well established for analysis of filter samples, and the FLIR Airtec handheld monitor is used for real time personal elemental carbon analysis. However, there is a gap in capabilities for real-time, continuous monitoring in mines, which would support a range of other practical needs. Currently, few instruments may offer such capability. The continuous Magee AE33 Aethalometer is designed to measure atmospheric black carbon. The Airwatch monitor is currently prototyped and is a continuous version of the Airtec. Both instruments have seen only brief field testing and would benefit from calibration to the 5040 Method. Sunset Laboratory Semi-Continuous OCEC field monitor is an automated and deployable version of its full-scale counterpart used for the 5040 method, but has never been tested in a mine setting. In this study, these instruments were tested head-to-head in a controlled laboratory setting to generate calibration curves against the 5040 Method. Additionally, the instruments were tested briefly in an underground stone mine, and results were compared to the 5040 Method results.

### 10:45 AM
When a Safety Product is Not a Safety Product: Examples of Safety Benefits and Categories from Applied Automation

*B. McBain; IMP Automation Canada Ltd., Oakville, ON, Canada*

There are several primary drivers for the implementation of automation, including production efficiency, quality management and "big data" devel-

## MONDAY, FEBRUARY 26

*AFTERNOON*

## 1:30 PM | ROOM L100A

### Dreyer Lecture

**Recipient and Lecturer:** *Robert Schafer*

Lecture: TBD

## MONDAY, FEBRUARY 26

*AFTERNOON*

## 2:00 PM | ROOM 200ABC

### 6th North American Iron Ore Symposium: Mining & New Projects

**Chairs:** *G. Hudak, University of Minnesota*
*D. Gagnon, DRA Americas*

**2:00 PM**
**Introduction**

**2:05 PM**
### Advantages of Using UAVs in Pueblo Viejo
*J. Ozoria; Mining, Dominican College Of Engineers, Architects and Surveyors (CODIA), Santo Domingo, Santo Domingo, Dominican Republic*

The time in projects of any kind has always been a fundamental issue from the start of construction to the operation itself, when it comes to earthworks on a large scale such as an open-pit mining operation; it is when we realize how valuable it's the time. The main objective of this presentation is to expose the advantages that make the UAV technology in mining a valuable and important tool for the management of geospatial information more efficiently and the control of the different material types in a mine with space limitation asPV. it will show the benefits of managing a mining operation with UAV. Substantial improvements in Pueblo Viejo from the area of safety, efficiency, quality and planning once implementation began. Today in Pueblo Viejo there are many applications that are carried out day by day with the use of UAVs. From the end of month report, stockpile inventory, construction monitoring, mine plans, slope monitoring, blast analysis, chess reporting. Undoubtedly, the UAVs in Pueblo Viejo came to stay, since the limitation of space and having different material types being dumped on top or beside each other. With the incorrect tracking the control of grades will be lost.

**2:25 PM**
### An Evaluation of Rock Weathering Experiments at the MN DNR Hibbing Laboratory and Field Research Site and Their Importancein Developing Geochemical Models
*S. Koski and Z. Wenz; Minnesota Department of Natural Resources, Hibbing, MN*

Since the mid 1970's, a focus of the DNR Hibbing laboratory and field research site has been the development and evaluation of the humidity cell kinetic test procedure and field scale rock weathering experiments. These experiments have allowed for the assessment of the relationship between sulfur concentrations, leachate pH and solute release rates for varying rock types and mine wastes along with the ability to understand rock weathering geochemistry over decades of monitoring. In 2014 an experiment was initiated to develop a laboratory rock weathering procedure that would allow leachate solute concentrations to become limited by mineral saturation and sorption. The experiment consisted of standard humidity cells, a variant of the humidity cell, and 4 kg rock filled columns. The different experiment methods using the same two rock types have shown that similar rock types may generate different leachate compositions when following different experiment protocols. This can provide insight into geochemical processes occurring in these experiments and may allow for more accurate representations of full scale mine waste weathering and data to be used in geochemical modeling.

**2:45 PM**
### Automation Application Realities for North American Iron Ore Laboratories
*B. McBain; IMP Automation Canada Ltd., Oakville, ON, Canada*

Extensive experience has been gained in the mechanization and automation of iron ore laboratories since the mid-2000s, when the first series of IMP automated labs gained a foothold in the Australian mining sector. Because of the large scale operations that often handled sample streams from several mines, these labs feature front-to-back automation that manage several hundred to a few thousand samples per day. In addition, a stringent focus on safety and regulatory compliance resulted in design strategies to limit worker access and ergonomically-challenging demands. IMP's first North American iron ore lab opened in 2014 at the TATA Steel Mineral Canada site near Schefferville, Quebec, but for various reasons this lab is a hybrid of manual and pseudo-automated processes. For the North American market, there are automation considerations to be made on the basis of lessons learned in both Australian and Canadian labs. This presentation will review the practical importance of such factors as mine output and ore type, labour factors, safety requirements and specialty iron production. It will also discuss some of the aspects to be considered in port laboratory specifications.

**3:05 PM**
### Dominga Iron Project Update – Andes Iron
*M. Rojas[1], H. Alegria[1], F. Porcile[1], M. Mlinar[2] and B. Eisenbraun[3];*
*[1]Dominga Project, Andes Iron, Saniago, Las Condes, Chile; [2]Coleraine Labratories, Natural Resources Research Institute, Coleraine, MN and [3]Barr Engineering Company, Hibbing, MN*

A Chilean mining company Andes Iron SpA owns and is developing the Dominga Mine and associated port project. This is a greenfield project located in La Higuera, some 70km from La Serena in Chile's Coquimbo region. Andes Iron SpA, founded in 2011, acquired the Dominga project from its former owner, Minería Activa. The mine design will be consist of two open pits and include a processing facility for the extraction and beneficiation of magnetic iron ore, with copper as a byproduct. The Dominga project is expected to have a 26-year project life span. The initial investment is expected at $2.5