

INNOVATIONS IN MINING ENGINEERING 2013

MARRIOTT HOTEL AT LAMBERT INTERNATIONAL AIRPORT
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IME 2013 TECHNICAL ORGANIZING COMMITTEE

Paul A. Lang, Co-Chair, Chief Operating Officer, Arch Coal, Saint Louis, MO

Samuel Frimpong, Co-Chair, Professor and Chair, Missouri S&T, Rolla, MO

Dianna Tickner, Vice President, Peabody Energy Corp, Saint Louis, MO

Cory Cook, Vice President – Americas, Immersive Technologies, Salt Lake City, UT

Jim Humphrey, Senior Marketing Professional, CAT Global Mining, Decatur, IL

Tom Barnes, Director for Product Support, Joy Global Inc., Milwaukee, WI

Greg Sutton, General Mine Manager, The Doe Run Company, Viburnum, MO

Roussos Dimitrakopoulos, Professor, McGill University, Montreal, QUE

Gen Bodnar, Sr. Environmental Engineer, The Doe Run Company, Viburnum, MO

J.D. Wientjes, Manager, Application Engineering, Komatsu America Corp., Peoria, IL

Kurt Oakes, Manager, Olson Explosives Inc., Decorah, IA

Grzegorz Galecki, Associate Professor and Director of Global Learning, Missouri S&T, Rolla, MO

Jamal Rostami, Associate Professor and Centennial Mining Eng. Chair, Penn State University, State College, PA

Ursula Thorley, Assistant Professor, Queens University, Kingston, ONT

Michael Scherr, Section Manager – Mine Technical Services, Cliffs Natural Resources, Eveleth, MN

DRAFT TECHNICAL PROGRAM

Monday, September 09, 2013; 1:00 pm – 5:00 pm

SHORT COURSES

Mine Ground Control Principles and Techniques; Maochen Ge, Associate Professor, Missouri S&T, Rolla, MO

Diesel Particulate Matter (DPM) Monitoring & Control; Stewart Gillies, Professor and Director of RMERC and Jerry Tien, Associate Professor, Missouri S&T, Rolla, MO

Surface Mine Bench Design for Efficient Fragmentation; Paul Worsey, Professor, Missouri S&T, Rolla, MO

Truck-Shovel Simulation Using Arena[®]; Kwame Awuah-Offei, Associate Professor, Missouri S&T, Rolla, MO

Mechanical Mining and Rock Excavation; Jamal Rostami, Associate Professor & Centennial Mining Eng. Chair, Penn State University, University Park, PA

Monday, September 09, 2013; 6:00 PM – 9:00 PM

RECEPTION AND DINNER

6:00 PM – 6:30 PM RECEPTION

7:00 PM – 7:10 PM Greetings and Welcome from Organization Committee; Paul A. Lang, Chief Operating Officer, Arch Coal

7:15 PM – 7:35 PM Greetings and Campus Strategic Initiatives; Cheryl B. Schrader, Chancellor, Missouri University of Science and Technology (Introduction by Paul Lang)

Tuesday, September 10, 2013; 8:00 AM – 9:45 AM

BREAKFAST AND OPENING KEYNOTE ADDRESS

8:00 AM – 8:45 AM BREAKFAST

9:00 AM – 9:45 AM Conference Opening Introduction and Keynote Address

[Gary Halverson, President, Barrick Gold North America](#)

Challenging Markets in a Changing World: *Barrick operates 27 mines across four continents, in nearly a dozen different countries. The company has grown dramatically since its creation in 1983, through several major acquisitions and the successful development of the world's leading gold mining operations. The company's size and profitability reached new heights over the past decade as rising production met climbing gold prices to generate unprecedented margins and several large capital investments. Today, the company faces a variety of threats to its position atop the gold mining industry. A prolonged period of high gold prices created the perception that host jurisdictions were missing out on Barrick's success, and demands for a "fair share" in the form of increased taxation are heard from Tanzania to the Dominican Republic to Nevada. Resource nationalism, often fueled by sophisticated activist campaigns, is a rising threat in all host countries, discouraging foreign investment and casting doubt on future projects. The timeline from discovery, permitting, development and construction of major mining operations is now measured in decades, with capital costs exceeding \$10 billion for the largest projects. Gold prices peaked at more than \$1,900 per ounce in 2011 but have now fallen to a level where some operations are no longer profitable, even as local and national governments clamor for increased tax revenue. Barrick and other major miners face many tough decisions as they work to overcome the growing risks of supplying the world's demand for metals and minerals – while returning a profit to their shareholders.*

Tuesday, September 10, 2013; 10:00 AM – 12:00 NOON

EXECUTIVE FORUM I: GLOBAL OPPORTUNITIES AND CHALLENGES

CHAIR	Stephen A. Lang, Board Chairman and Fmr. President and CEO, Centerra Gold, Canada
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[Jeane Hull, Executive Vice President, Peabody Energy, USA](#)

Building One Peabody: Technical Centers of Excellence: In our dynamic and global business environment, cross-functional, global information sharing is more important now than ever. The mining industry has always depended on qualified, experienced technical talent. Peabody Energy seeks to leverage its wealth of technical talent through Technical Centers of Excellence. These Centers are designed to connect subject matter experts across the global business platform and establish career pathways to maximize attraction, retention and development of this key talent pool. Effective utilization of this talent across a global platform, especially in lean economic times, is critical to maintaining a competitive advantage. The presentation will explore Peabody's approach to meeting this challenge.

[Janpeter Bekkering, General Manager Global Accounts, CAT Global Mining, USA](#)

Challenges and Opportunities of Deploying Technology in Mine Sites Around the World: The speaker will touch on five key technology deployments around the globe that Caterpillar has been instrumental in implementing. Each one had its own unique challenges ranging from regulatory, people, process and technology; to remote locations that ultimately proved to be great opportunities for the customer. Lessons learned will be explored that the audience can take-away and utilize for their own successful technology deployments.

[Len Dimbongu, Group Executive – Mining, Debswana Diamond Company, Botswana](#)

Debswana Jwaneng Cut 8 Mine Design: Jwaneng Mine is owned and operated by Debswana Diamond Company, a joint venture between the Government of the Republic of Botswana and De Beers. The Mine is the world richest diamond mine by value and is currently an open pit mine. Mining started in the late 70's with waste stripping, and ore mining started in 1982. The resource has been mined by open pit methods through a series of cuts or pushbacks. The pit is currently 350 meters below surface, with ore mining taking place in Cut 6 and 7, and waste stripping in Cut 8. Mining of Cut 8 started in 2010 and it is planned to expose the ore by mid-2017, thereafter Cut 8 pushback will supply ore to plant until 2028, by which time the pit will be 650 meters deep. The Cut 8 Project is a \$3.0 billion pit expansion project and this paper will

detail the mining options that were investigated to arrive at the current Cut 8 design. The presentation will also highlight the parameters used for designing the Cut 8 layout.

[Rudy J. Matetic, Director of Mining Research Division, CDC-NIOSH, USA](#)

Mine Safety and Health Research Challenges – The NIOSH Mining Research Program: The NIOSH Office of Mine Safety and Health Research (OMSHR) has developed a strategic plan to address the greatest occupational health and safety needs of the mining industry as determined by surveillance data and stakeholder input. The strategic plan is periodically reviewed and updated to maintain alignment with their needs. Based on the goals of the plan, OMSHR, with its limited resources, develops a research portfolio of specific projects that provide the research that leads to scientific information and products to address occupational health and safety problems of the mining industry. In this presentation, current and future health and safety research challenges of OMSHR will be discussed, including research to address issues related to coal dust explosibility, to reduce respirable coal dust levels to meet the MSHA proposed 1 milligram per cubic meter dust standard, to investigate ground control issues in metal/nonmetal mines, to develop a more viable oxygen supply, to address knowledge and technology gaps of refuge chambers, to study self-escape from mine emergencies, and to study application of health and safety management systems for mines. In addition, examples of significant research outputs that have been developed to reduce injuries, fatalities and health hazard exposures will be provided.

[Jeffrey A. Roschyk, Vice President, Joy Global, USA](#)

Tuesday, September 10, 2013; 12:00 NOON – 1:00 PM

LUNCH AND KEYNOTE ADDRESS

12:00 PM – 1:00 PM LUNCH

12:30 PM – 12:50 PM Keynote Presentation

[Rod Schrader, Chairman and CEO, Komatsu America Corp.](#)

Mining in 2014 - Today's Techniques and Tomorrow's Tools: The core principles of mining engineering stand the test of time and changes in technology because they are based on laws of nature. Data driven planning, tool selection and the rigor to close the feedback loop to adjust actions have worked for the mining industry for hundreds of years. Improved safety results globally are an example where these principles have been successfully applied. However, there is a constant friction point where new tools from equipment manufacturers work to disrupt existing processes and infrastructure. New maintenance planning tools, autonomous haulage fleets, and high-accuracy dozing tools require changes in paradigm and expectations of the mining process. Two voices are almost immediately heard, "They tried that before and it never works," and "this is the single most revolutionary tool in history and will be the one thing that makes this mine successful." The key to successfully navigating through the tools of tomorrow is filtering them through the core mining principles with an attitude of cautious optimism. This presentation will give examples of new tools and how they can be thoughtfully evaluated through the mining engineering process.

Tuesday, September 10, 2013; 1:15 PM – 2:45 PM

TECHNICAL PRESENTATIONS AND COMPANY SESSIONS

COMPANY SESSION I: IMMERSIVE TECHNOLOGIES

CHAIR [Cory Cook, Vice President North America, Immersive Technologies](#)

[Adam Norris, Senior Account Executive, Immersive Technologies](#)

Predicting Operational Improvements with Training Competency Data: In this market environment, costs are a big deal. How can I control costs? Better yet, how can I better predict costs that are going to come from my operations before they happen? In this presentation we will explore a few processes and technologies that can help do just that, control costs now, and predict costs in the future.

[Chris McElman, Manager, Value Add Services, Modular Mining](#)

Immersive and Modular – a Data Driven Case Study: *Most of us come out of meetings and board rooms everyday*

scratching our heads asking how do I...? We do. We ask ourselves “how can we maximize productivity,” “how do we maximize equipment availability,” “how can we improve corporate safety,” etc. Immersive Technologies and Modular Mining teamed up at Kinross’ Fort Knox site to explore a model to combine fleet dispatch numbers and simulator training to answer some those very questions. In this presentation we will explore the methodology used in this initiative, its results, and its impact on the operation.

Chad Johnson, Senior Vice President, Kiewit Mining Group

Technology and Data Driving Results—A Kiewit Case Study: Our systems, whether they are equipment, simulators or fleet management, provide us with thousands of lines of data every day. This data can be used to help us be a safer, more cost competitive company if we first learn how to boil it down. The information available today can help ensure we spend the right time working with the right people to make a difference. Companies that successfully navigate the use of technologies will differentiate themselves and create an environment where people want to come to work. The presentation will review a few ways these technologies have helped us toward our goal of being safe and efficient.

Greg Karadjian—Product Development Manager and OEM Relationships—Immersive Technologies

Underground Simulation for Both Hard Rock and Soft Rock Environments: Key deliverables that can be achieved in safety and production with underground mining simulation.

Cory Cook—Vice President North America—Immersive Technologies

Technology’s Role in the Future of Workforce Development Strategies: Today’s mining projects are becoming increasingly complex. They require a new type of miner to understand and build these enterprises. Building a pool of qualified, skilled operators to meet these new conditions is a key success factor, particularly for large enterprise projects. This presentation will discuss developing best practice for building pools of labor from which to draw as determined by the project’s short-term and long-term plan. We will discuss new ways industry is using mine plans to determine operator pool development and the reduced risk these approaches are producing for miners worldwide.

TECHNICAL SESSION I: INVESTMENT RISKS AND OPPORTUNITIES I

CHAIRS	Dianna Tickner, Vice President Peabody and Grzegorz Galecki, Associate Professor, Missouri S&T
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Richard L. Bullock, DEng, PE, QP, Professor and Quenon Chair Emeritus, Missouri S&T

Mine Feasibility Studies Still Need Improvement: That fewer than 10 percent of all mining projects are completed within budget and schedule and less than 20 percent achieve the ROI or NPV projected by their Feasibility Study. So with this lack of mineral industry accountability, what return do you think the Investment Community will be expecting to finance your next geologic prospect to develop a mine, since they must discount whatever we tell them? So this is the crux of the problem: we HAVE to CHANGE that which we are doing in Managing Feasibility Studies leading to project development and this is what I will talk about today.

S. H. Amini and R. Q. Honaker, University of Kentucky, Lexington, KY, USA and M. Osanloo, Amirkabir University of Technology, Tehran, Iran

The Optimization of short term Iron Open-pit production scheduling while minimizing stripping ratio: Open pit mine production planning determines the sequence of blocks extraction with the objective of maximizing the net present value (NPV) subject to physical, logistical and contractual constraints. In case of iron mines, the quality specifications are included iron, phosphor, and sulfur content of run-of-mine as well as oxidation degree of the processing plant feed. This research addresses three-year production scheduling for an operating of “Chadormaloo” iron open pit mine of Iran with respect to maximizing NPV, minimizing the stripping ratio (SR) and fulfilling the quality and the quantity specifications of run-of-mine. The results revealed that during the specified life of the mine, the maximum NPV value of \$1,490,813,031 and the least SR value of 0.23 are achievable. Moreover, this scheduling provides the required 14 million tons per year run-of-mine for the processing plant with minimum iron content of 54.5% and the maximum allowable phosphor content of 0.8%.

TECHNICAL SESSION II: TECHNOLOGY TRANSFER RISKS AND OPPORTUNITIES I

CHAIRS	Jim Humphrey, Sr. Marketing Professional – Mining Autonomy, CAT Global Mining and Roussos Dimitrakopoulos, Professor, McGill University
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Roussos Dimitrakopoulos, COSMO – Stochastic Mine Planning Lab, McGill University

Mine Planning Optimization with Uncertainty: A Review of Concepts and Applications from Single Mines to Mining Complexes: Over the last decade a new mine planning paradigm has been developed where new technologies are developed to account for core sources of uncertainty, namely the orebodies being mined (supply) and commodity prices (demand). The presentation reviews core concepts of a new generation of applied technologies leading to substantially improving the way uncertainty is managed leading to substantially better financial assessments. New technologies are first considered at the scale of single mines and then mine complexes that are conceptualised as a specific type of a supply chain. Concepts are demonstrated through examples of applications at different open pit metal mines.

Hedi Hastriawan, University of Sriwijaya, South Sumatera, Indonesia

Prospect of Coal Transportation Technology by Pipeline System: The increasing use of coal as a source of energy has increased coal production in Indonesia. The production and transport of coal over long distances on difficult terrain increases overall costs, reduces efficiency and impacts significantly the environment with negative social impacts. These negative technical, economic, social and environmental impacts have caused the need to examine and select methods that minimize these impacts for a sustainable coal production future. This paper examines the technical, economic, social and environmental sustainability of using pipeline systems for transporting coal slurry in Indonesia. In particular, the paper will examine the following areas associated with the slurry transport system: (i) slurry preparation plant; (ii) pipeline and the required pumping system; and (iii) dewatering of the slurry system.

Tony Wickenheiser, Application Engineer - Mining Division, Komatsu America Corp.

Haulage Fleet Definition Tool: Inherently, haulage fleets are subjected to a vast amount of operating variables, many of which are highly unpredictable and hard to quantify. Thus, the mining industry experiences, at times, great difficulty in trying to define a proper fleet configuration and then project meaningful performance estimates. To aid with this fleet definition complexity, the Komatsu Mining Division has developed a software tool that addresses haulage fleet definition and the variables common to haulage systems. This tool avoids defining finite performance figures, as typically done in like software programs, but instead illustrates performance values for variable haulage applications and fleet configurations. Thus, the user has the ability to evaluate multiple haulage scenarios without having to conduct and comprehend a series of individual analyses. This presentation will introduce this mining system tool and its major design principles. An overview of these principles will give the attendee an understanding of the key functions and capabilities of the program. In addition, evaluation examples will be presented to further insure understanding of how this tool can be applied for a haulage application analysis.

Wedam Nyaaba and Samuel Frimpong, Missouri S&T, Rolla, MO

Optimal Microseismic Sensor Placement by Integer Linear Programming Approach: The precise location of a microseismic event source is useful for understanding and forecasting rockburst hazards and for assessing mine planning and design efficiency and safety. Microseismic events monitoring is achieved by an array of sensors. Sensor array optimization presents the basic procedure to plan, install, and improve the monitoring configuration. The accuracy of an event location estimate is partially dependent on the precision of the signal recording equipment, the assumed velocity model accuracy, sensor array geometry and suitability of the location estimation technique. Previous studies have used MINMAX and MAXSRC algorithms for optimal sensor placements. However, none of these algorithms provides a generic procedure for placing additional sensors in the expansion regions. In this study, a grid coverage strategy based on integer linear programming is proposed to solve this problem. Plausible AE/MS source locations in the mine expansion regions are represented as grid points (2- or 3-D). Sensors are positioned such that every grid point in the field is covered by a unique subset of sensors. The grid coverage strategy provides a fast and intuitively simple procedure to place additional sensors in the expansion regions. The algorithm is then applied to a number of simple and virtual sensor placement problems, using a 2-D grid of microseismic sources and/or sensor positions. The result, for each case, identifies an optimum placement of additional sensors that minimizes the error associated with the location estimator.

Gbadam, Eric and Frimpong, Samuel, Missouri S&T, Rolla, MO

Bench Structural Integrity for Optimum Performance of Cable Shovels: The ultimate bearing capacity of bench and haul road formations are essential for the health and longevity of shovel crawlers. This study uses the Buisman-Terzaghi (1943) model to develop bench/haul road bearing capacities and their structural integrity of an oil sand at an environmental temperature of 25°C. 3D finite element (FE) model of the formation is developed in ABAQUS to examine the average stresses and deformations on the formation during excavation. The results show that the deformation of oil sand occurs

during the first 30 seconds of crawler interaction. Three distinct regions are observed from the plastic strain failure pattern: the region below the tracks has larger strain at failure, and the regions adjacent the tracks expand deeper and wider in all directions. Failure of the formation was observed to occur mostly under the tracks and this progress nonlinearly to the base of the formation. These failure patterns were triangular in nature and agree well as reported in Terzaghi's (1943) early work on shallow foundation. The deformation were observed to be nonlinear Future works would include a virtual prototype of cable shovel crawler-oil sand interaction to measure real-time stresses; crack initiation and propagation under dynamic conditions.

TECHNICAL SESSION III: NOVEL TECHNOLOGIES AND KNOWLEDGE GAP I

CHAIRS	Tom Barnes, Director of Product Support, Joy Global and Cory Cook, Vice President, Immersive
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M. Haddock (Golder Associates), S. Otto (Golder Associates) , Z. Hladysz (Golder Associates), M. Luxbacher (Lhoist North America) and S. Schiele (Maptek)

Comprehensive Geotechnical Assessment Using Laser Scanner Imaging at Underground Mines: Accurate prediction of rock behavior and use of this information to select optimum ground control methods is of paramount importance to ensure safe, sustained mine operations. To respond to the needs of the mining industry, laser scanning technology has been developed to provide enhanced geotechnical assessment from laser-based mapping of structural features to analysis of data, culminating in the design of safe and stable excavations. In 2011 Golder Associates and Maptek, Inc., supported by engineering personnel from an active underground mine, performed laser scanning, underground excavation mapping and geotechnical assessment of room-and-pillar operations at a mine in the Eastern USA. The significant size of the excavations (100 ft in height and 60 ft in width), and the required accuracy and digital resolution presented a mapping and surveying challenge that was successfully addressed. The 3D digital models of the excavations and rock structure were used to develop a probabilistic assessment of structural controls on excavation stability for mine planning purposes.

M. Haddock, B. Waters and K. Davis; Golder Associates Inc., St. Charles, MO

Subsurface Imaging of an Underground Mine Using Electrical Resistivity Imaging: Advances in electrical resistivity imaging (ERI) have led to more detailed and accurate prediction of subsurface conditions even in complex and highly irregular karst terrains. Geophysical data, when constrained by and calibrated to borehole data, can be used to fill in wide data gaps at a site in between intrusive borehole data and improve the overall understanding and conceptual model of subsurface conditions. This can result in better estimation of reserve and overburden volumes and can be used to provide geotechnical information such as identifying areas of weak fractured rock, karst solutioning, and groundwater inflow. A case study is provided where an extensive, detailed ERI survey was completed where an underground limestone mine is being planned. The land surface is characterized as a karst peneplain with a high density of sinkholes. The ERI data clearly delineate the top of bedrock and reveal the presence of lower resistivity cavities, interpreted as sediment and water filled karst voids, beneath the sinkholes. The ERI data are compared with borehole data and used to project a 3-dimensional model of the bedrock surface and subsurface voids.

Saeid Dindarloo and Samuel Frimpong, Missouri S&T, Rolla, MO

A Simulation Framework for Modeling Truck-Shovel Operations: Material haulage in surface mining operations accounts for 50% of production cost. The selection and deployment of efficient, safe and economic haulage systems are thus critical to the production process. Previous researchers have used different techniques such as linear, non-linear and mixed Integer programming, AHP, genetic algorithm, repair model, and conventional spreadsheets models have been used to solve the problems associated with equipment selection and sizing plan. Critical survey and analysis of the literature have also shown that deterministic, stochastic and experimental methodologies result in considerably different outputs. This paper focuses on developing a stochastic methodology for solving this problem. The paper develops a comprehensive simulation framework for the truck-shovel problem in surface mines based on the random processes underlying the network-continuous-discrete event nature of the mining operation. The stochastic processes governing the uncertainties underlying the material haulage functional variables are defined and built into the stochastic model. The Monte Carlo technique is used to simulate the stochastic model using large number of iterations and runs. The stochastic model is validated with a real-world case study and compared with the corresponding deterministic model. The results show that the stochastic technique is superior to deterministic for solving materials haulage problems.

COMPANY SESSION II: KOMATSU AMERICA CORP.

Exploring the Future

CHAIR | J.D. Wientjes, Manager Application Engineering and Joe Shoemaker, Product Manager – Mining

Joe Shoemaker, Product Manager – Mining, Komatsu America Corp.

State of Autonomous Haulage: In November of 2011, large scale Autonomous haulage became a reality with the announcement of a major mining company's purchase of 150+ autonomous haul trucks. This driverless fleet is currently being deployed in mines throughout the Pilbara Iron Ore Range in Western Australia. This presentation will provide an update on the status of the Komatsu Autonomous Haulage System (AHS), including a discussion of the milestone achievements along the development path. The presentation will also cite specific examples of how AHS technology has proven its value across numerous mines in terms of bucket loads, tons, and dumps. In conclusion, this presentation will explore the multitude of improvements inherent in an autonomous haulage system. By breaking down the haulage cycle into load, haul, and dump activities, Komatsu will illustrate the many ways in which an autonomous fleet enhances personnel safety, improves operating efficiency, and increases overall productivity.

Ron Crawford, Senior Technical Advisor – Product Planning and Research, Komatsu America Corp.

KomVision: KomVision is Komatsu's integrated camera and radar system that was developed to increase operator awareness of the area surrounding the haulage truck. The presentation will deal with targets of the development, features and operation of the system, and some of the challenges that were overcome during design and validation.

Bill Nassauer, Product Manager, Machine Guidance and Safety Systems, Modular Mining Systems, Inc.

MineAlert™ – A Tool for Proactive Fatigue Management: Operator fatigue is a leading root cause of earth-moving equipment accidents within the mining industry. To address this problem, Modular has formed a strategic alliance with Fatigue Management International (FMI) to develop the MineAlert™ Fatigue Management tool. While technology plays an important role in addressing operator fatigue, it is not a solution in itself. Effective risk management requires a holistic approach, including operator awareness training, management training, ongoing monitoring, and real-time intervention when necessary. Accordingly, this presentation will discuss the implementation of a comprehensive fatigue risk management plan, including consulting, training, and change management. The core technology behind the Fatigue Management tool is FMI's Advisory System for Tired Drivers™ (ASTiD). ASTiD is a predictive, model-based fatigue detection technology. It continuously identifies emerging operator fatigue on haul trucks, by measuring real-time vehicle dynamics, combined with the input of operators' historical sleep data. Using the correlation between steering correction patterns and early stages of fatigue, the onboard sensor detects resulting changes in machine movement. Based on these factors, ASTiD generates a "fatigue score" in real time for each operator and communicates this score, through the Fatigue Management tool, to the DISPATCH system. The system was developed at the Loughborough Sleep Research Center in Leicestershire, UK, based on nearly twenty years of sleep research. The Fatigue Management tool offers one of the few fatigue detection technologies that does not use cameras or sensors attached to the driver. More importantly, it is among an even smaller number of products that have been extensively tested and proven effective in mining environments.

Chris Pritchard, Natural Gas Product Manager, Cummins, Inc.

Dual Fuel for Mining: Same Power, Substantial Savings: The abundance of shale gas reserves around the world has made natural gas an attractive fuel source for mining equipment. How do you harness the savings associated with a natural gas fuel source while retaining the power needed for mining equipment? Two words: Dual fuel. Dual Fuel engine technology provides the ability to substitute natural gas for diesel in the combustion process, delivering the same transient response, torque curve and power density critical to high horsepower engine operations, while at the same time lowering operating costs. Learn about the technology and economics of a dual fuel solution and the impact it will have on mine site operations.

Ken Calvert, Director Product Support Systems, Komatsu America Corp.

Machine Telematics: Where are you on the adoption curve? Off highway machine telematics have been around for more than 10 years and many fleets may believe that they have yet to embrace the technology. The purpose of this presentation is to encourage and stimulate attendees by presenting a case that the adoption of telematics is progressing at a normal rate and that figuratively speaking, "the train is yet to leave the station". Supporting this argument will be two case studies: The first is a summary of the "No Idle" Initiative and management's role in effecting change. The

second is a production study of a metallurgical coal mine and again management as a change agent.

Tuesday, September 10, 2013; 2:50 PM – 4:20 PM

TECHNICAL PRESENTATIONS AND COMPANY SESSIONS

COMPANY SESSION III: CATERPILLAR GLOBAL MINING

Challenges in Deploying New Technologies and Products

CHAIR | [Jim Humphrey, Sr. Marketing Professional, CAT Global Mining](#)

[Joe Bontje, Underground Mining Marketing Support Rep, CAT Global Mining](#)

Underground Automation Technology - It's about People, not Iron: The author has evaluated autonomous LHD units in underground hard rock mines around the world. The implementation of this technology can provide substantial safety, productivity and utilization benefits but only if an operation can overcome integration challenges with people and processes. The author addresses the best practices from multiple deployments to ensure a successful roll-out of this technology to a new mining operation.

[Griffin Reome, Service Technical Rep](#)

Introduction of a New Technology North of the Arctic Circle: During 2010-2012 the author was the Field Follow Engineer responsible for the deployment of the first production electric drive Caterpillar 795F AC mining trucks. In this role he was responsible to implement the preparation, assembly, operator training, and maintenance practices; additionally he along with the local Cat dealer faced technical issues related to the application and product along with communication with the manufacturer. The deployment of this new technology provided challenges of its own, but it was made all the more interesting by the mine location, north of the Arctic circle in Sweden. The remote location, extreme environment, new technology and unique culture made for an interesting combination of elements that effected this deployment. The speaker will relate his experiences and lessons learned during this unique and exciting project.

[Dave Edwards, Product Support Manager, CAT Global Mining](#)

Challenges of Introducing Fatigue Management Technologies: As more and more mines are choosing to mitigate the risks of operator fatigue at their sites, there are lessons learned for what makes for successful implementation. The speaker will provide background on operator fatigue, how these technologies works and discuss the benefits and challenges of implementing fatigue detection technologies on site.

[Terry Vance, Mining Technology Solutions Manager, CAT Global Mining](#)

Challenges and Rewards of Implementing Fleet Management Systems at your Mine: The speaker will talk about what key items operators should focus on when looking to implement a fleet management system. This includes some key items that can really make a deployment challenging if not addressed appropriately in the planning phase. He will also discuss areas that operators should see benefits from implementing a fleet management system and some expected gains if implemented correctly.

[Jim Humphrey – Sr. Marketing Professional - Mining Autonomy, CAT Global Mining](#)

Overcoming Preconceptions to ensure the successful Deployment of Autonomous Haulage: In 2011, the author deployed the first autonomous haulage system in North America and has been working to deploy systems in Australia. One of the key drivers for autonomy is the desire to improve safety in mining operations. The deployment of this technology has involved multiple challenges addressing regulatory, process and policy concerns. Autonomous operations will challenge existing operations that have oft times strongly embedded concepts of how various rules should be applied. Overcoming

some of our safety preconceptions is leveraging to the successful deployment of this technology and the author will discuss real world examples and solutions that ensured the success of current operations.

TECHNICAL SESSION IV: GLOBAL VENTURE CAPITAL ACQUISITION AND FINANCING I

CHAIRS

TECHNICAL SESSION V: INTERNATIONAL PROJECT MANAGEMENT

CHAIRS

TECHNICAL SESSION VI: GLOBAL MINERALS ENGINEERING EDUCATION

CHAIRS | Samuel Frimpong, Professor, Missouri S&T and Khaulani Fichani, Sr. Lecturer, University of Botswana

Samuel Frimpong, Professor & Chair, Missouri S&T; Jerry M. Whiting, Professor & Chair Emeritus, University of Alberta and Raymond Suglo, Professor & Head, BIUST

Preparing Graduate Talent for the Mining Industry: A New Metric System based on an Old Tradition: As leaders, mining engineers must manage operations, lead project teams, mentor junior engineers, chart the technological directions of companies, and deal with several organizations for maintaining the technical and economic feasibility of operations within strategic and tactical framework. Traditionally, the completion of the BS degree curriculum, with a minimum cumulative grade point average (CGPA), has been used as a graduation measure by Missouri University of Science and Technology (Missouri S&T). Companies have long realized the limitations of the CGPA for recruiting graduates, because mining engineering is an applied engineering discipline. Company recruiters have sought to correct the limitations by factoring experience and behaviors into the selection process when recruiting knowledgeable and well-rounded graduates. In this paper, the authors introduce a new metric, which combines the current CGPA (***Knowledge***) with ***Experience*** and ***Attribute (KEA) Metrics*** to gauge the job readiness of graduating engineers. The ***KEA*** process has been applied to a graduating class in Missouri S&T to demonstrate the value of the new metric system. *Overall, the KEA Metric System provides a better picture of the capacity and job readiness of graduates entering the workforce.*

COMPANY SESSION IV: THE DOE RUN COMPANY

Developing and Improving for a Bright Future

CHAIR | Greg Sutton – General Mine Manager, The Doe Run Company, SEMO Mining and Milling Division

Karonica Brice, Safety Manager, The Doe Run Company, SEMO Mining and Milling Division

Safety Performance versus Compliance:

Lisa Henn, Talent Management Specialist, The Doe Run Company

Recruiting for a Bright Future:

Adam Kresler, Mine Superintendent, The Doe Run Company, SEMO Mining and Milling Division

Three Safe Years and 10,000 Feet – The North Viburnum Trend Developments

Bruce Chamberlain, Operations Manager, The Doe Run Company, Primary Smelting Division

History and Highlights from the last remaining primary Lead Smelter in the United States

Genevieve Bodnar, Senior Environmental Engineer, The Doe Run Company, SEMO Mining and Milling Division

How to Eat an Elephant - Reclamation at the Viburnum Mill:

Wednesday, September 11, 2013; 8:00 AM – 9:45 AM

BREAKFAST AND OPENING KEYNOTE ADDRESS

8:00 AM – 8:45 AM BREAKFAST

8:50 AM – 8:55 AM Welcome Address

[Sara Parker Pauley, Director of Natural Resources, Jefferson City, Missouri](#)

9:00 AM – 9:45 AM Keynote Address

[Daniel M. Harrington, President & CEO, Lehigh Hanson, Inc.](#)

Challenges, Evolution & Growth: *Dan Harrington offers a look at how the economic downturn changed the construction materials industry in North America and how his company managed through the challenging market conditions to be well-positioned for continued recovery and growth in the coming years. He will also give an overview on the economic drivers and global megatrends that support growth in the construction materials industry.*

Wednesday, September 11, 2013; 10:00 AM – 12:00 NOON

EXECUTIVE FORUM II: TALENT FOR GLOBAL OPPORTUNITIES

CHAIR	Andrew Slentz, Senior Vice President Global Talent, Peabody Energy, Saint Louis, MO
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[Leigh Freeman, Manager, Downing Teal, Denver, CO](#)

Mining Talent Relevant in Washington DC: The importance of the mining workforce serving the US economy is receiving national attention. The National Research Council's workforce study published in March provides a first-ever, holistic view of critical talent serving the US mining and energy sectors. Results of this study will be presented in the context of the global mining industry and a forthcoming discussion paper on 'The Future of Mining' for the National Academy of Engineering.

[Kurt Salvatori, Vice President Human Resources, CONSOL Energy, Pittsburgh, PA](#)

Creating a Powerhouse of Skilled Labor Force for Growth: CONSOL's Experience:

[Marshall Koval, President & CEO Anfield Nickel Corp](#)

Navigating the Experience Gap: The global mining industry currently lacks enough experienced scientists and engineers. There is a significant gap between the demand for these professionals and available university graduates entering the industry. This trend is expected to continue into the future, making it increasingly difficult to develop future industry leaders. Case histories of how two TSX-V listed junior mining companies (Anfield Nickel Corp and Lumina Copper Corp) advanced major projects in this environment. Realizing the importance of developing future industry leaders, the author has funded a Mining Excellence Endowment at the Missouri University of Science and Technology.

[Fouzi Bushait, Vice President Human Resources, Maaden Mining Company, Saudi Arabia](#)

[Richard Marston, Principal & Senior Practice Leader – Mining, Golder, STL, MO](#)

Wednesday, September 11, 2013; 12:00 NOON – 1:00 PM

LUNCH AND KEYNOTE ADDRESS

12:00 PM – 1:00 PM LUNCH

12:30 PM – 12:50 PM [Mac McFarland, CEO, Luminant Energy](#)

Wednesday, September 11, 2013; 1:15 PM – 2:45 PM

TECHNICAL PRESENTATIONS AND COMPANY SESSIONS

COMPANY SESSION V: JOY GLOBAL INC.

CHAIR	Tom Barnes, Director - Product Support, Joy Global Inc.
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Eric Hsie, Product Manager - Technology, Joy Global Inc.

Automation and Productivity: Using Proximity/Object Detection to Increase Shovel Productivity in the Open Pit Mine: Proximity detection in the open pit mine can be used effectively as an operator assist strategy which improves digging production through enforcement of best practices, although it is normally thought of first as a safety tool, and second as a step toward full automation when combined with object avoidance. This paper explores how the path to increased production will likely follow operator assist tools and systems that help a human do his or her job better.

Scott Shields, Manager – Mining Application, Joy Global Inc.

Pass Match Considerations for Optimized Production: Pass match between loading and haulage systems can have tremendous effects on productivity and life of machine. This case scenario provides a potential protocol change to increase production and reduce stress and strain on loading equipment. This paper explores various loading scenarios in practice and compares against productivity simulations. Results are presented in the form of payload and cycle time histograms with discussions regarding benefits beyond productivity for both loading and haulage equipment.

Brian Thompson, Director – Marketing and Application Engineering, Joy Global Inc.

Equipment to People Interface - From Proximity to Remote Operation in Underground Equipment

Ben Snyman, Product Director – Longwall Systems, Joy Global Inc.

Equipment Enhancement – Low Seam Long-wall Lean Mining/Process Optimization

Mike Rikkola, Program Manager – Remote Health Monitoring, Joy Global Inc.

Focused Equipment and Process Improvement – A Key Pillar in Total Productive Management (TPM) of Global Mining Processes

TECHNICAL SESSION VII: GLOBAL SUSTAINABLE DEVELOPMENT I

CHAIR	Gen Bodnar, Sr. Environ. Engineer, Doe Run and Kwame Awuah-Offei, Associate Prof., Missouri S&T
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Greg Smith, Chief Information Officer, Missouri S&T

Nonprofit Partnership to Support Sustainable Development in Mining Communities: The case study of GeoAid, a non-profit international development organization, is presented as an alternative option for carrying out corporate social responsibility. Partnering with local community organizations and leveraging US and international aid organizations to improve healthcare, establish food security, support education and training and encourage creation of micro enterprise. Building programs to strengthen the relationships between mining companies and their local communities by offering a hand up rather than a hand out.

Mark Birchler and Terry Entwistle, CDG Engineers, Saint Louis, MO

Phytoremediation at Pea Ridge Mine: In response to regulatory compliance issues on the Pea Ridge mine near Sullivan, Missouri, a stream restoration plan (SRP) was developed to mitigate the effects of stockpiled mine tailings in the stream valley, restore about 15 acres of wetlands and relocate the magnetite tailing stockpiles. Testing revealed a low level of metals in solution in the stormwater runoff and in the onsite spring fed creeks. While these levels were moderately low, they were higher than allowed in the NPDES permit. In order to comply with the NPDES requirements, phytoremediation was added to address selenium and copper. This plan was designed to include native Missouri plants, which provide uptake of selenium and copper. The 5 plant palettes consist of over 100 plant species including 13 possible accumulators and six possible hyper-accumulators for selenium and copper. To verify the effectiveness of the phytoremediation system, six surface water samples and flow rates are collected on a weekly basis from locations throughout the mine site. Analyses indicate a reduction in the contaminant levels at the site due to the phytoremediation methods that are below established NPDES limits. Plantings have gone to seed and propagated; native wildlife has been observed during each site visit. The restoration area has certainly become a home to an increasing number of Missouri native flora and fauna.

Sisi Que and Kwame Awuah-Offei, Missouri S&T, Rolla, MO

Ranking Determinants of Mining Community Acceptance Mining for Quantitative Community Engagement: Project sustainability has implications for local community acceptance as the development and operation of a mine can be viewed as a development intervention with concrete social, economic and environmental impacts. There has been very

little research done to quantitatively model the relationship between project sustainability and community preferences. The absence of community acceptance models limits the ability of engineers and managers to account for community concerns in planning, design, and management. Discrete choice modeling (DCM) and choice experiments (surveys) provide a viable framework for data-driven community engagement. Two important challenges in the design of such surveys for DCM are: (1) what are the most important characteristics of mine? (2) what are the key demographic factors? A ranked list of key mine characteristics and important demographic factors have been identified based on literature review and an online survey. The results will facilitate better choice experiment (survey) design for a discrete choice modeling. Such discrete choice models will provide objective input on the relationship between mine sustainability and community acceptance.

Paul Eger, Global Minerals Engineering LLC, Hibbing, MN and Peggy Jones, Doug Green, Bob Forder, American Peat Technology, Aitkin, MN

Getting the Lead Out (and other Trace Metals) - Solving Mine Water Problems with Peat-based Sorption Media:

American Peat Technology (APT) has developed and patented a carbonization process to convert raw reed-sedge peat into a granular, hardened ion exchange material (APTSorb™). These granules have a high internal surface area, maintain their structure when wet, and can be crushed to any size, making them easily adaptable to existing treatment system technologies. Since the product is crushed to a uniform size, flow rates are consistent and controllable, with an estimated hydraulic conductivity around 1 cm/sec. The material has a high affinity for trace metals, particularly lead. In lab experiments, maximum lead loadings of 15% dry weight Pb were observed. Feasibility tests showed that APTSorb™ was effective in removing Pb from a variety of mine waters with 81- 96% efficiencies. In column testing, the media reduced lead from 50-70 ug/l to less than 2.5 ug/l. The media also has been successfully removing suspended and dissolved copper from the discharge of the Soudan Mine in northern Minnesota. Copper input typically ranges from 30 – 60 ug/l; significantly above the discharge limit of 17 ug/l. Since November 2011, over 10 million gallons (> 20,000 bed volumes) have been treated with an average removal of 75% suspended copper and 60% dissolved.

TECHNICAL SESSION VIII: GLOBAL MINE SAFETY AND HEALTH I

CHAIRS	Maochen Ge, Associate Prof., Missouri S&T and Ursula Thorley, Assistant Prof., Queens University
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Maryam Abdi Oskouei and Kwame Awuah-Offei, Missouri S&T, Rolla, MO

Testing for the Effects of Operators on dragline energy efficiency: Draglines are dominant machines and the most significant electricity consumers in surface coal mines. With the growing price of energy and environmental concerns and the high sensitivity of mine profitability to dragline productivity, any improvement in efficiency of dragline will be beneficial for mines. Research has shown that operator practices have a significant impact on energy efficiency of mining loading tools. However, not enough work has been done to provide guidance on how to quantitatively assess the effect of operator practices on dragline energy efficiency. A better approach to identify good operators will help improve operational efficiencies through training programs that allow other operators to know what the superior operators do well. The goal of this work was to: (i) develop a methodology to evaluate the effect of dragline operator practice; and (ii) to illustrate this methodology with a real-life case study. Data from an 85 yd³ (BE-1570W) dragline from an actual mine was used to validate the tests and method in the study. The results show that energy efficiency is significantly different for the five operators. Such inferences can provide the basis for operator training to improve energy efficiency.

Angelina K. Anani –and Kwame Awuah-Offei, Missouri S&T, Rolla, MO

Modeling Room and Pillar Operation with Pillar Retrieval as Mixed Integer Linear Programming: Recent attempts at modeling underground operations as mixed integer linear programming (MILP) problems are related to stoping methods (Kutcha, Newman, and Topal, 2004) and longwall mining, room and pillar, and retreat mining (West-Hansen, 2003). These attempts do not account for pillar recovery and risk in determining optimal mining sequences in room and pillar operations. This paper introduces a novel MILP formulation of room and pillar production sequencing that incorporates pillar recovery and project risks. The goal is to develop a MILP model that determines the optimal sequence of extraction in underground room and pillar operations by maximizing the net present value of the project and minimizing project risks while meeting all constraints. The objective function of the MILP problem minimizes risk per period while maximizing the net present value of the blocks. The constraints include availability of resources such as a continuous miner and shuttle cars; reserves; mining rate; and vertical and horizontal precedence of mining ore blocks and pillars. The results from this model will be compared with current off-the-shelf production sequencing algorithms for underground mining (e.g. Geovia’s MineSched) to evaluate the model performance.

Craig Bunger, P.E., Civil/Geotechnical Engineer, BARR Engineering Company, Jefferson City, MO

Utilization of Innovative Geotechnical Investigation and Design Methods to Remediate a Historic Mine Tailings Site:

Remediation activities have been completed on a historic mine tailings site and the area has been partially developed as an industrial park. Remediation addressed complex geotechnical design challenges while minimizing disturbance to adjacent residential and commercial properties. Very weak layers of mine waste were identified within the National Mine Tailings Site in Park Hills, Missouri, during a preliminary geotechnical investigation of the site. These weak layers comprise mainly very fine-grained material known as “slimes”. Identifying the extent of these weak layers of mine waste within a pile that consisted of mostly angular, coarse chat was challenging. In addition to the use of standard investigation techniques such as test pits and hollow-stem auger borings, Barr also utilized cone penetration testing (CPT) to identify and characterize the strength properties of the thin layers of saturated fine-grained mine waste located under the chat pile. Using the data gathered, slope stability modeling and a liquefaction analysis were performed to design a modified slope geometry that would (1) effectively buttress the weak layers of mine waste beneath the chat pile, (2) reduce the risk of a slope failure due to liquefaction, and (3) reduce the amount of weak materials that needed to be excavated. The final design met static and seismic stability criteria and addressed liquefaction concerns. Construction activities to stabilize the chat pile slopes were completed in 2011. The project was successfully completed in 2013 with minimal disturbance to the adjacent residential and commercial property owners.

Rob K. Morrison, P.E., Sr. Water Resources Engineer, BARR Engineering Company, Jefferson City, MO

Innovations in Water Quality at Remote Mining Locations: This presentation focuses on the installation of several alternative domestic wastewater treatment systems that combine simple, proven wastewater treatment concepts with classic drip irrigation technology that eliminates any surface discharge of treated wastewater to streams. Effluent from the treatment system is dosed to adjacent infiltration fields at a rate commensurate with the surrounding soil media. Water quality goals were developed based upon protection of the groundwater resources. An innovative monitoring system was designed to ensure that the effluent discharged to the infiltration system meets the treatment objectives and groundwater resources are protected. The design flow of the system is 4500 gallons per day and treated effluent from the facility is discharged into a 12,000 square foot irrigation field lons per dosing cycle per field. Monitoring of the dosed effluent in the subsurface is accomplished through the installation of 10 pressure/vacuum suction cup lysimeters. The lysimeters are each installed to depths up to 6 to 8 feet below ground surface and employ a vacuum and pressure cycle to collect subsurface fluid in the collection cup and transmit the collected subsurface water to sample collection locations.

TECHNICAL SESSION IX: GLOBAL MARKETS AND TRADING DYNAMICS

CHAIRS	Barbara Busby, Vice President and Paul Demzik, President, International Coal Trade, Peabody
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COMPANY SESSION VI: MISSOURI UNIVERSITY OF SCIENCE AND TECHNOLOGY

Placing Missouri S&T at the Global Frontier of Education and Research

CHAIRS	Samuel Frimpong, Professor and Robert H. Quenon Endowed Chair, Missouri S&T and Venkata Allada, Vice Provost for Graduate Studies, Missouri S&T
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Samuel Frimpong, Professor and Robert H. Quenon Endowed Chair, Missouri S&T, Rolla, MO

Global Expansion of Missouri S&T’s Mining Engineering Education and Research: The Strategic Objective 5.0 of the FY 2010 – 2020 Strategic Plan for Missouri S&T’s Mining Engineering Program focuses on strengthening national and global partnerships. Missouri S&T seeks to engage national and global universities, industries and research organizations as partners in education and research. Toward this objective Missouri S&T will (i) Maintain a Strong Development Board; (ii) Enhance Missouri S&T-University of Botswana Partnership; (iii) Develop S&T-Saudi Initiative on Mining Education; (iv) Develop Other S&T International Initiatives in the Asia/Pacific Region (China, Australia, Mongolia and Indonesia), Africa (Ghana, Nigeria, Zambia and South Africa) and South America (Brazil, Chile, Peru and the Dominican Republic). These initiatives will increase Missouri S&T’s global footprints in expanding its impact on the global mining industry. It will also increase the research capacity, provide opportunities for faculty/student exchange and deepen the United States relationships with partner countries.

David Enke, Professor and Chair, Missouri S&T, Rolla, MO

Utilizing Distance Education Technology to Expand Engineering Management and Systems Engineering Education: The

technology for providing distance education capability has made tremendous progress over the last 15 years. Course technology that once required the mailing of VHS videotape lecture recordings to remote students now allows students to not only watch a lecture live as it is being delivered, but also interact with the instructor in real-time, allowing for questions, feedback and group activity. In addition to making it possible for universities to offer their degrees and programs to students located anywhere in the world, such technology is also allowing for the tailoring of courses and programs of study for individual company needs, as well as allowing for new educational partnerships with industry and between universities. Within the Engineering Management and Systems Engineering department at Missouri S&T, technology is making it possible to offer Engineering Management and Systems Engineering degrees to students working for international companies, such as the Boeing Corporation, and students located at international universities, such as King Saud University in Saudi Arabia. This presentation will discuss the aforementioned distance education success stories, as well as the current opportunities and efficiencies that are available to universities and companies that adopt and support the use of distance education technology.

[Jeanie Hofer, Director of International Affairs, Missouri S&T, Rolla, MO](#)

[Gregory Gelles, Professor and Chair, Missouri S&T, Rolla, MO](#)

[Jerry C. Tien, Associate Professor, Missouri S&T, Rolla, MO](#)

Wednesday, September 11, 2013; 2:50 PM – 4:20 PM

TECHNICAL PRESENTATIONS AND COMPANY SESSIONS

COMPANY SESSION VII: GOLDER ASSOCIATES (TO BE CONFIRMED)

CHAIRS	
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TECHNICAL SESSION X: INVESTMENT RISKS AND OPPORTUNITIES II

CHAIR	Chris Ward, Vice President/GM, Lehigh Hanson and
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TECHNICAL SESSION XI: TECHNOLOGY TRANSFER RISKS AND OPPORTUNITIES II

CHAIRS	Greg Sutton, General Mines Manager, Doe Run and J.D. Wientjes, Manager, Komatsu
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[Nathan Priegnitz, Application Engineer - Mining Division, Komatsu America Corp.](#)

Mining Systems Planning Tool: Utilization of large-scale bulldozers in production roles has existed for years. The economic advantages of such applications can be very prominent, but these rewards can also be easily negated by misjudging any of the many variables that impact these applications, and how these applications interact with other mining systems. Thus, the industry has historically struggled with effectively studying production dozing applications due to their complexity and notable manpower requirements. To aid in addressing the evaluation needs of these multi-system operations involving production dozing, the Komatsu Mining Division has developed a software tool that utilizes valid earthmoving principles and incorporates proven equipment performance characteristics. This presentation will introduce this mining system tool and its major design principles. An overview of these aids will give the attendee an understanding of the key functions and capabilities of the program. In addition, evaluation examples will be presented to further insure understanding of how this tool can be applied in a mining operation analysis.

[Luis Montiel Petro and Roussos Dimitrakopoulos, COSMO – Stochastic Mine Planning Lab, McGill University](#)

Optimizing Mining Complexes with Multiple Processing and Transportation Alternatives: An Uncertainty-based Approach:

This paper presents a method to generate mining, processing and transportation schedules that account for the previously mentioned activities (or stages) associated with the mining complex simultaneously. The method uses an initial solution generated using conventional optimizers and improves it by mean of perturbations associated to three different levels of decision: block based perturbations, operating alternative based perturbations and transportation system based

perturbations. The method accounts for geological uncertainty of several deposits by considering scenarios originated from combinations of their respective geostatistical orebody simulations. The implementation of the method in a multipit copper operation shows its ability to reduce deviations from capacity and blending targets while improving the expected NPV, which highlight the importance of stochastic optimizers given their ability to generate more value with less risk.

Robert Davis, Mark Haddock, and Brent Waters, Golder Associates, Saint Louis, MO

Subsurface Imaging of an Underground Mine using Electrical Resistivity Imaging: Advances in electrical resistivity imaging (ERI) have led to more detailed and accurate prediction of subsurface conditions even in complex and highly irregular karst terrains. Geophysical data, when constrained by and calibrated to borehole data, can be used to fill in wide data gaps at a site in between intrusive borehole data and improve the overall understanding and conceptual model of subsurface conditions. This can result in better estimation of reserve and overburden volumes and can be used to provide geotechnical information such as identifying areas of weak fractured rock, karst solutioning, and groundwater inflow. A case study is provided where an extensive, detailed ERI survey was completed where an underground limestone mine is being planned. The land surface is characterized as a karst peneplain with a high density of sinkholes. The ERI data clearly delineate the top of bedrock and reveal the presence of lower resistivity cavities, interpreted as sediment and water filled karst voids, beneath the sinkholes. The ERI data are compared with borehole data and used to project a 3-dimensional model of the bedrock surface and subsurface voids.

Clay McNail, Mine Superintendent, The Doe Run Company, SEMO Mining and Milling Division

Eight Years of Developing and Mining RCWF Ore Bodies – Lessons Learned:

Bill VanHorn, Senior Process Engineer, The Doe Run Company, SEMO Mining and Milling Division

Underground Mobile Equipment Monitoring:

TECHNICAL SESSION XII: NOVEL TECHNOLOGIES AND KNOWLEDGE GAP II

CHAIRS | Kurt Oakes, Manager Olson Explosives and Jason Baird, Associate Professor, Missouri S&T

Jamal Rostami, Ali Naimipour and Soheil Bahrampour, Penn State University, University Park PA; Craig Collins, JH Fletcher & CO, Huntington, WV; Sair Kahraman, Hacettepe University, Ankara, Turkey

Ground Characterization While Drilling Roofbolts in Mining Operations: This paper will discuss the current efforts underway between Penn State University and J.H. Fletcher & Co for developing instrumented roof bolters which can detect bedding and discontinuities and provide a rough estimate on the rock strength along the borehole. The results of full scale laboratory testing in a series of concrete blocks as well as the selected sedimentary rock types from various formations in southeast PA and central WV and related data analysis will be presented in this paper. The recent efforts has enabled the system for higher accuracy in detecting the joints and faults and reduced false detections. Recent improvements on performance of MWD and borehole probing methods as an effective way to train and validate this roof mapping system will also be presented. Finally, the initial results of combining this information into a dynamic 3D visualization program for ground characterization will be demonstrated.

Ryan Goodfellow, Roussos Dimitrakopoulos, COSMO – Stochastic Mine Planning Lab, McGill University

Global Asset Optimization of Open Pit Mining Complexes under Uncertainty: This paper addresses the issue of global optimization of open pit mine production schedules for complex mining supply chains under geological uncertainty. The proposed simulation-optimization framework permits extraction decisions to be made simultaneously with material destination policies and processing stream decisions in order to maximize the net present value of the supply chain. The resulting framework is capable of modelling and efficiently optimizing over the non-linear intricacies that are often present in large mining complexes. The proposed optimizer uses a hybrid of both simulated annealing and particle swarm optimization. The method is tested on a copper-gold deposit and experimental results demonstrate that the optimizer is capable of generating production schedules and destination policies that reduce the risk of meeting production targets, have 14% higher net present value and increase the size of the final pit by 22%.

Boateng, Mark and Frimpong, Samuel, Missouri S&T, Rolla, MO

Optimizing Mill Surge Rehandling by Linear Programming Approach: This study implements a mill surge rehandling program for MMG Gold to minimize head grade variation and the impact of weekly preventive maintenance. Maximizing

profits was constrained by factors such as operating cost, production requirements, availabilities, outputs, mill recovery, reserves and meeting the head grade requirements through ore blending. However, management had to plan to achieve the overall goal of maximizing profit within the given constraints. The approach to determine the optimal mill surge rehandling was iteratively done by management. This paper applies LP optimization algorithm to maximize the profit from mill surge rehandling within the given constraints. The results show that the achieved average head grade of 1.33g/t is between the target average head grade range of 1.16g/t and 1.7g/t. The material from each section of the mill surge was 613,330 tons, which meet the six days production requirement. The results also yielded an overall maximum profit of \$20,799,114. The rehandling cost of \$899,995 was also within the expected minimum and maximum budget of \$780,000 and \$900,000, respectively.

Amina Lamghari, Roussos Dimitrakopoulos, COSMO – Stochastic Mine Planning Lab, McGill University
Progressive Hedging Applied as a Heuristic to Schedule Production in Open-pit Mines Accounting for Metal Uncertainty: A stochastic version of the open-pit mine production scheduling problem is considered, where the uncertainty stems from the orebody metal content. A solution approach based on stochastic integer programming is proposed and then a new solution based on Rockafellar and Wets’ progressive hedging algorithm is developed. The scheduling formulation is decomposed by partitioning the set of scenarios modeling the uncertainty of the mineral deposit into groups, and then the sub-problems associated with each group are solved iteratively to drive their solutions to a common solution. Computational experiments indicate the efficiency of the proposed approach in generating near-optimal solutions. An example at a gold deposit demonstrates the key aspects of the proposed approach.

COMPANY SESSION VIII: GEMCOM (TO BE CONFIRMED)

CHAIRS	
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Wednesday, September 11, 2013; 6:00 PM – 9:00 PM

CONFERENCE BANQUET AND KEYNOTE ADDRESS

- 6:00 PM – 6:30 PM RECEPTION
- 6:30 PM – 9:00 PM BANQUET
- 7:45 PM – 8:20 PM Keynote Address

Jerry Pyatt, President and CEO, Doe Run

Shared Values: Sustainability and the Global Marketplace: *We face many challenges in today’s business climate around the environment, society and providing a return to our stakeholders. While we see our collective job as working together to continue to make advances for the environment, providing jobs, commerce and value for all our shareholders—how do others outside our industry view us? How can we help our stakeholders grasp the connection between their requirements and goals and those of our companies? This session will explore how, through better communication with our stakeholders, we can link values we all share and the sustainability components needed for success in today’s competitive marketplace.*

Thursday, September 12, 2013; 8:00 AM – 9:45 AM

BREAKFAST AND OPENING KEYNOTE ADDRESS

- 8:00 AM – 8:45 AM BREAKFAST
- 9:00 AM – 9:45 AM Keynote Address by Scott P. Lawson, Sr. Vice President, Newmont Mining

Thursday, September 12, 2013; 10:00 AM – 12:00 NOON

EXECUTIVE FORUM III: EDUCATION AND CAREERS

CHAIRS	Michael Allen (MS – Explosives Eng) and Eric Gbadam (PhD – Mining Eng), Missouri S&T, Rolla, MO
	Larry Grayson, Professor & George H. Jr. and Anne B. Deike Chair, Penn State, State College, PA

Dianna Tickner, Vice President, HSE & Project Governance, Peabody Energy, Saint Louis, MO

New Graduates – Strategies for Successful Transition to the Workforce: Provide graduating students some tips and strategies for successfully entering the permanent work force including items such as time management, use of social media and the internet while at work, communicating through corporate email etc. If this is not enough let me know and I can expand.

Ed Merriman, Director of Human Resources, Martin Marietta, Raleigh, NC

Gen Bodnar, Senior Environmental Engineer, Doe Run, Viburnum, MO

What they don't teach you in college: Do you know who you want to be when you grow up? A few lessons learned with some advice on life in general for the college crowd.

Jason Baird, Associate Professor and Deputy Director of RMERC, Missouri S&T, Rolla, MO

Thursday, September 12, 2013; 12:00 NOON – 1:00 PM

LUNCH AND CLOSING REMARKS

12:00 PM – 1:00 PM LUNCH

12:30 PM – 12:50 PM Closing Remarks by Samuel Frimpong, IME 2013 Technical Organizing Committee

Thursday, September 12, 2013; 1:15 PM – 2:45 PM

TECHNICAL PRESENTATIONS AND COMPANY SESSIONS

COMPANY SESSION IX: MAPTEK (TO BE CONFIRMED)

CHAIRS	
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TECHNICAL SESSION XIII: GLOBAL VENTURE CAPITAL ACQUISITION AND FINANCING II

CHAIR	Chance Allen, Vice President/GM, Martin Marietta and Michael Scherr, Section Manager, Cliffs
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TECHNICAL SESSION XIV: GLOBAL SUSTAINABLE DEVELOPMENT II

CHAIRS	Joseph Chuma, Dean of Engineering and Technology, University of Botswana and and James Katende, Dean of Engineering, Botswana International University of Science and Technology (BIUST)
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Michael Dreyer, E.I.T., Robert Davis, P.G., Mark Haddock, P.E., R.G. and Brent Waters, P.G., *Golder Associates, Saint Louis, MO*

Subsurface Imaging of an Underground Mine using Electrical Resistivity Imaging: Advances in electrical resistivity imaging (ERI) have led to more detailed and accurate prediction of subsurface conditions even in complex and highly irregular karst terrains. Geophysical data, when constrained by and calibrated to borehole data, can be used to fill in wide data gaps at a site in between intrusive borehole data and improve the overall understanding and conceptual model of subsurface conditions. This can result in better estimation of reserve and overburden volumes and can be used to provide geotechnical information such as identifying areas of weak fractured rock, karst solutioning, and groundwater inflow. A case study is provided where an extensive, detailed ERI survey was completed where an underground limestone mine is being planned. The land surface is characterized as a karst peneplain with a high density of sinkholes. The ERI data clearly delineate the top of bedrock and reveal the presence of lower resistivity cavities, interpreted as sediment and water filled karst voids, beneath the sinkholes. The ERI data are compared with borehole data and used to project a 3-dimensional model of the bedrock surface and subsurface voids.

TECHNICAL SESSION XV: GLOBAL MINE SAFETY AND HEALTH II

CHAIRS	Stewart Gillies, Professor, Missouri S&T and Jamal Rostami, Assistant Professor, Pennsylvania State University
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