



## COLLABORATION TOWARDS FUTURE MINING

# GMSG Edmonton Forum 2017 October 18-19, 2017



Organized by GMSG in partnership with CIM with support from the University of Alberta

GMSG held a collaborative forum at the University of Alberta in mid-October to discuss several ongoing projects at GMSG as well as topics of interest for the industry. These presentations included discussions around interoperability, autonomous operations, benchmarking and data exchange, among others. The event included panels and breakout sessions to engage participants and cull expertise from a wide variety of suppliers, operators, and even some regulators in the audience. The following is a brief summary of the days' presentations and sessions, as well as the discussion points that followed each.

### DAY 1: OCTOBER 18, 2017



**Gord Winkel, Chair and Industrial Professor, Engineering, Safety and Risk Management, University of Alberta**

University engineering programs have historically left safety and risk management off of their syllabi. However it has been proven that a focus on safety training and education leads to safer operations. That is why the University of Alberta created a mandatory safety program for all engineering students. This presentation established safety as a theme that would permeate throughout many of the presentations over the following two days.

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### Trialing an Autonomous Blasthole Drill: Unforeseen Operational Improvements with Command for Drilling

**Dan Lucifora, Director, Research and Development, Peck Tech**

Dan Lucifora presented Peck Tech's autonomous drilling system (ADS) trial at ArcelorMittal's Mont-Wright operation near Fairmont, QC. The main goals of the project were to increase productivity by continuing drill work during lunch breaks and shift times, reduce cycle times, and measure the quality of an autonomous drill. Peck Tech would go on to partner with Caterpillar as the project went along.

#### **Discussion points:**

- Peck Tech's partnership with Caterpillar allowed operators to use a tablet to control ADS
- CAT's Terrain system acted as the dispatcher for this trial
- Geo-fencing was used to mark the drill paths and ensured safety
- With Terrain, one operator using one tablet can operate three machines
- This is a purely retrofit solution
- Lack of interoperability presents a challenge and Peck Tech is in talks with OEMs to open the system up
  - If these talks are unsuccessful, Peck Tech will have to find an electrical interface workaround
- The ADS is monitored so that if there are any irregularity or there is a safety concern, it is possible to shut the system down



### Jonathan Moore, Chief Engineer, ASI Robots

Jonathan Moore reviewed strides being made in the automotive and mining industries in regards to automation.

#### Discussion:

- Clarity around the terms “automation” and “autonomous” needs to be better established
  - An autonomous machine is one that can make decisions for itself
  - Mining is more concerned at this moment with automation (i.e. automated haul trucks)
- There was consensus that safety is important and needs to be a necessary consideration in thinking about automated operations
- Volvo announced that it will accept full liability in the event of a collision with their autonomous vehicle
  - Blame is being transferred from the individual behind the wheel to the engineers who designed the machine
  - This announcement has a ripple effect down to suppliers of Volvo parts who must accept this liability if their parts are involved in an accident
- The future of autonomy, no matter what the industry, will be dictated by which performance metrics are selected
  - For example, an emphasis on measuring production will have a different outcome than if safety becomes an important metri

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## NA Autonomous Haulage-Current State, Challenges, and Future in NA Surface Operations

**Adam Brumwell, Autonomous Solutions Manager, Finning (moderator)**

**Steve Little, Senior Engineering Advisor, Mine Equipment, Suncor Energy**

**Ron Jungkind, Lead-Mine Technology, Mine Technical Services, Canadian Natural Resources Limited (CNRL)**

**Dylan Bennett, Manager, Operational Technology, Teck**

Autonomous projects are taking off in Australia but North America is still lagging behind. Why is that, and what is the future of autonomous operations in North America?

#### Discussion:

- Autonomous vehicles are a difficult and unique challenge in Canada due to the winter season
- There is also concern around the risk/reward of bringing in a new technology that changes how you operate a haulage fleet
- One panel participant challenged the thinking that North America is really all that far behind given the relative scarcity of autonomous haul trucks 5 years ago
- Communication networks are another challenge in Canada, where operators are forbidden from implementing LTE
- The Australian mining industry has an advantage because it receives support from government
- The social implications of autonomous operations is another challenge
  - Operations in Canada are often near communities and have employment obligations that may not exist in other FIFO operations around the world
- Autonomous haulage is more palatable at a greenfield operations where the cost is incremental
- Autonomous operations pose a real safety risk that needs to be addressed if it's going to be implemented. Need to be sure that functional safety is in place before deploying it
- Acceptance rate of autonomous operations is slow, but it will improve with exposure and education
- It was clear there is a concern about the value of automating an operation, which is likely leading to low acceptance rates
- The implementation of autonomous systems has to be a managerial decision and must be viewed as a priority for it to be a success
- Safety benefits from autonomous operations can also come in the form of first aid reduction, reducing ankle injuries from truck operators mounting and dismounting in the winter for example
- There was debate as to whether there is a business urgency in North America
  - The adoption of autonomy in the Pilbara was swift because they were looking to solve a supply chain issue
  - On the other hand, the technology may create the business urgency if mines start to implement it
- The business case comes down to cost reduction and revenue generation
- A lack of interoperability at the moment limits your ability to run a mixed fleet

## Break Out Session: Addressing the Barriers and Requirements for Interoperability

Breakout session of six groups tasked with coming up with a definition of interoperability.

### Common themes:

- Interoperability requires an agnostic approach that isn't restricted, allows machines to share information and has an open architecture
- Common standards are a necessity
- It must enable operators to perform the necessary tasks and improve awareness
- There must be a common platform
- Non-competitive data must be shared between systems
- There is a systematic ecosystem of systems working together in harmony
- There has to be a common and clear objective
- Everything must work together safely

Participants were broken into groups to develop use case for interoperability.

Here were some of the use cases discussed:

- Accident reports
- Machine learning
- Communication
- Real-time feedback
- Coordinating between operational activities
- Operating mixed equipment fleets and mixed components
- Mixed equipment functions (haulage, auxiliary, loading)
- Maintenance
- Generate maintenance work orders
- Unified event management
- Dispatching
- Combining the "best-of-breed" equipment for each type of purpose
- Integrated analytics (e.g. machine health)
- Sharing equipment location

The following are specific examples of interoperability definitions created by the individual groups

### An ability to solve objectives in a collaborative system that leverages all hardware & processes available simply.

- |                                     |                           |                              |
|-------------------------------------|---------------------------|------------------------------|
| • Open Standards (ish)              | • Collaborative Learning  | • Simplicity to all          |
| • H-H, M-H, M-M, ANY-ANY            | • Large Data Flow Support | • Training Skills            |
| • Value Stream Optimum Optimization | • Security                | • Flexibility/Fail safe      |
| • OEM Agnostic                      | • Safety                  | • Positive Value Proposition |

### Interoperability

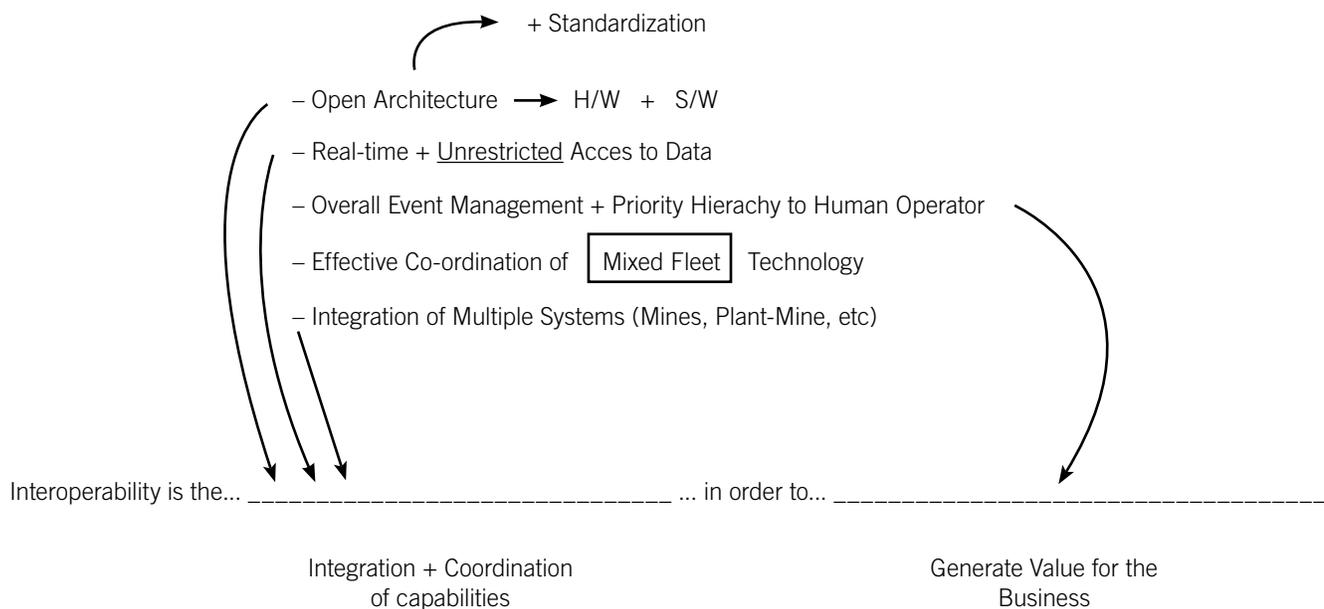
- Holistic
- Synergy
- Standards/Code of practice
- People, process, technology
  - Alignment of people, process and technology to meet a common goal/objectives/expectations/desired outcomes
- Integration of PPT
- Eliminating silos
- **An ability to integrate various forms of people, process, technology to meet a common objective**

**Ability of systems or machines or people to work together safely**

- Mixed fleet
- Mixed systems
- Data sharing
  - o Positional
  - o Perception
  - o Who's correct

**Interoperability**

- |  |  |
|--|--|
| <ul style="list-style-type: none"> <li>• Agnostic Solution</li> <li>• OEM Independent                     <ul style="list-style-type: none"> <li>o Any machine (full fleet)</li> <li>o Any application</li> </ul> </li> <li>• Open standards architecture                     <ul style="list-style-type: none"> <li>o Standards-based platforms</li> </ul> </li> <li>• Interaction/interdependency between technology, people, processes</li> </ul> | <ul style="list-style-type: none"> <li>• Certification independent</li> <li>• Set up a common framework                     <ul style="list-style-type: none"> <li>o Customization on top of a standard backbone (analogous to android, OS)</li> </ul> </li> <li>• Open standard, but not necessarily open source</li> <li>• Ability to communicate and drive action across interfaces to drive value</li> </ul> |
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### **Tim Skinner, SMART Systems Group and GMSG Vice Chair International Standards**

Tim gave an update on the interoperability working group. GMSG plans to use the lessons learned from the successful and timely creation of battery electric vehicles guideline and apply it to interoperability. GMSG is targeting late 2018 for publication of interoperability guidelines.

#### **Discussion:**

- GMSG will need engagement from the US in order for this project to be a success

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### **The Interoperable Mine of the Future: from Supplier to Customer**

**David Dickson, Associate Partner, IBM**

David Dickson discussed the importance of “an integration architecture servicing open standards-based data exchange capabilities” (i.e. cloud computing) and the benefits it can lead to, such as its ability to support interoperability, machine learning, artificial intelligence, and integrated operations throughout the entire value chain for a more predictable operation.

#### **Discussion:**

- David believes mining engineering of the future will be software engineering and roles will change as companies move to the cloud
- Reduction in jobs is obviously a main concern of the technologies that can be implemented with cloud computing. David discussed two schools of thought on how this should be dealt with:
  1. If there is an inherent savings from machines taking over roles humans used to perform, that money needs to go back to people who can no longer work as much as before and are no longer able to support themselves
  2. That workforce will simply be replaced, and they'll have to find other jobs in other fields
- There was a general consensus that moving forward into some of these technologies is difficult and the journey from A to B is abstract
  - David suggested organizing that complexity into gaps (e.g. data, operations, performance, and strategy). Addressing as many of those gaps as possible will bring operations along the way.
- David said that from his experience, mid-tier mining companies are more interested in implementing this technology than major miners

## DAY 2: OCTOBER 19, 2017

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### Welcome and Day's Objectives

Heather Ednie, GMSG Managing Director

Heather kicked off Day 2 of the GMSG Forum with a group discussion on the main themes that jumped out at participants and had stuck with them from Day 1.

Key takeaways:

- It is important to build safety right into the culture of a company and put it at the forefront of everyone's mind
- There is a difference between the words "autonomous" and "automate" and the industry needs to be more conscious of which word it uses
  - Tim mentioned that ISO wrestled with these terms
  - The starting point for the GMSG autonomous working group is to agree upon language
- Interoperability, what it means and what its value is to operators
  - It's specific to each individual operator and what their needs are
  - It's not about a specific technology, it's looking at the operation as a whole and how easily all the pieces fit together
- A lot of the topics from Day 1 describe a big shift in how businesses currently operate. However, it is impossible to create a generic roadmap for every company to follow to get to the same place. Each company is starting from a different point and has different goals
- The GMSG autonomous mining working group has decided that the business case for implementation has to be upfront in any company's strategy. In other words, it makes no sense for a company to implement autonomous systems for the sake of it

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### Operational Time Model and KPIs

Zoli Lukacs, Gibraltar Mine

Zoli presented on the time usage model being developed by the GMSG Data Access and Usage Working Group, and what the challenges have been so far. (This model has not yet gone live.) This endeavor is essential for accurate benchmarking in the industry.

#### Discussion:

- The definition for waiting and queuing was of particular importance to participants at the forum as it is notoriously difficult
  - For many operations, that definition will be determined by what drives cost at their project
  - Wait and queue information collected by mines is the most affected metric depending on the type of system you use, for example for dispatch
- There are several issues that still need to be addressed before the time usage model can go live:
  - For example, how to define taking a truck out of service or when a truck freezes. Is that a hit on availability or operations?
- From the preliminary tests that GMSG has done, the definitions in this model changes operator behaviour
- Of the 10 companies that gave their data to GMSG for testing, 6 were close to the GMSG model
  - Two or three were extremely far off, and they tended to be the biggest mining companies in the world
- Different companies have different ways of defining downtime
- Companies do not necessarily need to internally collect and store this data using this model for it to be successful. It is only necessary for external reports for benchmarking purposes
- There was agreement among participants of this test about 90% of the categorizations used in the time usage model, but on the issues where there is disagreement, it is marked
- There was lots of interest among GMSG Forum participants in the overall operating effectiveness (OOE) metric, as it is seen as an equalizer
- GMSG is seeing the largest variability in how companies define utilization



James Marsten, Golder Associates Inc

James presented SMART's benchmarking program, of which Golder is a third-party administrator. It is a paid anonymous web-based reporting program of comparative benchmark metrics. Golder is planning on enhancing the program to improve user interface and user experience.

#### Discussion:

- Because this is the largest database of availability for this type of equipment (besides what OEMs have), it was suggested by a forum participant that there is more the industry could be doing with that information
  - There was some concern among other participants about liability when the above was brought up
- There was agreement that more context around the data available on the SMART/Golder platform would be helpful to operators comparing their data

## Roundtable Discussion: Global Benchmarking

Lead by Zoli Lukacs, Gibraltar Mine

GMSG recognizes the importance of benchmarking, but the question is what to do about it. There are options when it comes to benchmarking, but GMSG has been in talks with Golder and SMART because they've been involved in it for some time and have an infrastructure already in place. GMSG was hoping to get some feedback from this session on what direction to go in in terms of benchmarking. What should the industry benchmark? Is it important or a distraction?

### Discussion:

- One of the biggest issue for the SMART benchmarking program is the issue of normalization of data -- if all companies are not classifying things the same way, there is no point in benchmarking because you won't be able to accurately compare two operations
  - There needs to be common definitions in order to effectively benchmark (this is part of the reason why definitions in the previously presented GMSG time usage model are so important)
- It was generally agreed that benchmarking has value, although some companies developed their own internal benchmarking program
- It often is asked why mining can't benchmark consistently. A common answer is that miner's don't want to share cost data to maintain a competitive advantage, however the petrochemical industry does it regularly
- Consensus in the room was that all operations see value in external benchmarking
- Without best practice, however, benchmarking becomes difficult because you can't analyze how other operations are making gains
- The question of capturing safety, training and competence came up in this session. How do you measure that? Definitions in safety change all the time making it difficult to accurately report, and is nebulous to begin with. How do you define a competent operator?
- As operations move to autonomous systems, definitions are set to change, so there is an opportunity to create standard definitions from the beginning
- The necessity of developing a standard definition of wait and queue times was brought up again, and it was generally agreed that this is critical to moving forward
- There will always be a sense of confidentiality when it comes to benchmarking, however it will be easier and more palatable to involved companies if there is an exchange of data because both will see a benefit
- GMSG wants to reduce redundancy, so partnering with SMART and Golder makes the most sense from the organization's perspective
- GMSG will be looking at what is the next step and what other KPIs to focus on



### Zoli Lukacs, Gibraltar Mine

Zoli provided an update on GMSG's new reliability working group. Most recently, the group presented a reliability model to GMSG members at MinExpo 2016 and again to oil sands operators in May. GMSG used these meetings to develop next steps.

### Discussion:

- One issue with developing a best practice model and implementing it in the industry is that the companies that are best prepared to adopt these practices won't benefit the most from them



### Jonathan Moore, Chief Engineer, ASI Robots

Jonathan presented on the various standards related to autonomous operations, and key questions the industry needs to grapple with, such as the shift in risk and responsibility, functional safety, and how to management malfunctions. Jonathan also looked at standards from other industries, such as agriculture, that could apply to mining.

### Discussion:

- Because these standards do not cover what is technically safe per se, but rather what is reasonable, it is important to adopt more rigorous standards if you want to protect yourself from liability
- Jonathan highlighted the importance of complying with standards that fit your environment, otherwise they are useless



### Tim Skinner, SMART Systems Group and GSMG Vice Chair International Standards

Many industries have implemented autonomous controls without regulatory issues, so why is it still an issue in mining? GSMG took initiatives to understand what some of the roadblocks were, which Tim presented in this session.

#### Discussion:

- Suncor is the best example of an implemented autonomous haulage system in Canada
  - Suncor personnel are running six trucks, and the company has worked with Occupational Health and Safety in Alberta
  - OHS is learning about autonomous operations as they go, just like operators. They are trying to determine what risks are introduced by the system and which ones are eliminated
- There are not many frameworks that exist to model, but Suncor and OHS Alberta looked to Australia
- Imperial is trying out autonomous hauling as well
- There was general agreement that educating the public about autonomous hauling is an integral part to successful implementation
- Tim pointed out that the lack of standards is slowing down the implementation of autonomous systems
  - Some in the audience pushed back by saying that while standards are important, the key is to follow risk management processes because if the industry waits for a complete standard to be available before they start, they'll never start
- Since the regulatory framework in this area is in its infancy and its constantly changing, there is the risk that things could change when an operation to implement them
- There is a need for information sharing and collaboration between operators and regulators
- The industry wants to make sure they get this right because they are on the cusp of a revolution in operations with many implications and the potential for productivity and costs is huge
- There was general agreement that GSMG should establish a working group to address the regulatory approach that should be used
- Autonomous operations have a huge advantage when it comes to safety, in the event of a collision for example
- Representatives from OHS Alberta said that safety education and the safety message around autonomous operations is important to the success of it
  - They made it clear they are not trying to restricting technology, but want due process to integrate it into regulation
- It was agreed that an important step to developing standards is bringing regulators to the table
  - Ideally these talks would include technology providers as well to come up with key KPIs. Regulators are ready to integrate technology but they don't have the technical expertise



### Rob Labbé, Teck

Mining companies are starting to be the victims of cyberattacks in recent years. In an effort to combat this, several operators have come together to share information and create a common defense strategy against cyberattacks through a Mining and Metals Information Sharing and Analysis Center (MM-ISAC).

#### Discussion:

- There is no such thing as an isolated system, so there is always a hacker can get into a mining company's system
- There has been progress on cybersecurity made on corporate systems but not in mining and control systems
- To know for sure that your system is secure, you need a third party assessment
- Wireless connectivity does not end at the fence, which opens operations up to attacks if someone can get on their system
- It was mentioned that a cybersecurity certification process could help secure systems if OEMs would get onboard
- Rob said he was skeptical that a standard on cybersecurity would help because it is a hard threat to build a standard for

**GMSG Innovation Spotlight:****Heather Ednie, GMSG Managing Director**

Heather gave a quick overview of the battery electric vehicle guideline, on which GMSG collaborated with CMIC. It was released in June 2016, less than a year after the project was launched. Work on version 2 is now underway.

Mobile equipment and open data:

Heather also provided a brief update on this working group, which is looking at how to get information onto mobile equipment. Version 2 of this guideline will hopefully be finalized by the coming winter.

**Adam Pidlisecky, AranzGeo**

All operations transfer data between multiple software vendors (internally and externally), however that data is not always kept intact once that information moves. This challenge speaks to the lack of interoperability from one piece of software to the other. Adam is part of a group at GMSG working on a standardized data exchange format (i.e. an open data format) to solve this problem. Here he presented the latest updates on this project.

**Discussion:**

- One participant at the forum shared his frustration on this topic regarding dispatch systems. All planning is done in a 3D format elsewhere with other software, but dispatch systems can only portray information in 2D, so it creates problems when data is transferred

**Ben Venter, VP & GM ABB Service**

Many other industries are ahead of mining when it comes to digital technologies. Ben Venter from ABB presented on how the marine industry is using some of these technologies and where he sees opportunities for mining to adopt similar strategies.

**Discussion:**

- Ben made it clear that the mining industry should not exclusively operate projects remotely; there needs to be a balance of remote operations and local ownership
- Participants agreed that many in the mining industry are still wary of cloud computing
- One participant brought up the point that technology is simply not possible for a lot of projects where they struggle with basic connectivity
- For Ben, the first step every operation needs to make is to get their data into the cloud so that they can build from there

**Heather Ednie, GMSG Managing Director**

Heather discussed three projects launched for 2017-2018 in relation to integrated operations (IO): an IO research collaboration, an IO business case and an architectural reference framework.

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## Forum Wrap-Up and Next Steps

**Heather Ednie, MSG Managing Director**

Heather led a session on what topics from the second day stuck in the minds of participants at the MSG Forum.

**Topics:**

- The importance of lowering barriers between companies, what is competitive and what doesn't provide a competitive advantage
  - It would be helpful for employees to understand what they can freely discuss about their companies so as to have a useful conversation between different companies without forfeiting their competitive advantage
- There is an opportunity to put an agnostic database in the cloud that everyone can draw from
- Safety needs to be elevated in every conversation being had in the industry
- Regulators need to be brought into discussions around autonomy
- There was consensus that it would be helpful to have a committee dedicated to how to develop collaboration between industry, academia and regulator
- There was general consensus that the meeting was worthwhile
- There is a sense that mining is moving more quickly up the maturity curve and it will make up any distance that it has fallen behind other industries in the years to come

## ATTENDEE LIST

Company	First Name	Last Name
ABB	Gordon	Goucher
	Oleg	Yefremov
Autonomous Solutions	Jon	Moore
BBA Inc	Nikhil	Agarwal
Brandt	Clint	Webster
CNRL	German	Hernandez
	Ron	Jungkind
	Daniel	Sine
Caterpillar	Kevin	Lueschow
Caterpillar of Canada Corp	Trent	Boylan
CIM	Tom	DiNardo
CNRL	Robert	Duval
Dexcent	Peter	Wright
Fedex	Mauricio	Briones
Finning (Canada)	Adam	Brumwell
	David	Morley
Fireball Equipment	James	Foley
Flanders Canada	John A.	Bunton
	Ken	Unruh
Gibraltar Mine	Zoli	Lukacs
GMSG	Heather	Ednie
Golder Associates	James	Marston
	Denis	Mayer
Gov of Alberta	Fazal	Hussain
Gov of Alberta - OHS Mining	Intesab	Ahmed
	Daniel	Beaton
	Alex	Greenshields
	Masud	Khan
	Shahid	Latif
	Muneer	Naseer
	Khademul	Islam
Hitachi Consulting	Gerhard	van Niekerk
Hitachi Vantara	Jim	Scouras
Honeywell	Justin	Smalley
IBM	David	Dickson
	Kevin	Reardon
Imperial Oil	Mark	Dekaban
	Scott	Meyers
	Jim	Ripley

## ATTENDEE LIST

<b>Imperial Oil</b>	Tim	Greene
<b>Independent Consultant</b>	Peter	Becu
<b>KMC Mining</b>	Craig	Dirk
	Bryce	MacNeil
<b>Maclean Engineering</b>	Rene	Dubois
	David	Jacques
	Stuart	Lister
<b>Magna IV Engineering</b>	Gordon	Cross
	Werner	Hildebrand
<b>MM-ISAC</b>	Cherie	Burgett
<b>Modular Mining Systems</b>	Ignacio	Garcia
<b>Motorola Solutions</b>	Lisa	Boutilier
<b>N.A. Construction Group</b>	G Tom	Colbourne
<b>Olio Technology Solution</b>	Paul	Raj
<b>PACPro Automation Ltd</b>	Matthew	Berlinic
<b>Peck Tech</b>	Daniel	Lucifora
<b>Seequent</b>	Nicole	Doucette
	Franklin	Koch
	Adam	Pidilsecky
<b>Siemens Canada Ltd</b>	Josh	Sobil
<b>SIX Safety Systems</b>	Rich	Robillard
<b>SMART Solutions</b>	Tim	Skinner
<b>SMS Equipment</b>	Rob	Ellis
	Dillon	McKinnon
	Scott	Schellenberg
<b>SSR Mining Inc.</b>	Liezl	van Wyk
<b>Suncor</b>	Nicolas	Bouliane
	Chris	Koroluk
	Burman	Weber
<b>Suncor Energy</b>	Allan	Boddy
	Don	Dubois
	Peter	Enns
	Steven	Little
	Michael	Teshima
	Bradley	Brown
<b>Suncor Enterprise Technical</b>	James	Hughes
<b>Syncrude Canada Ltd.</b>	Michael	Anderson
	Mal	Carroll
	Tom	Demorest
	Wayne	Kosik

## ATTENDEE LIST

<b>Team Power Solutions</b>	Brook	Davis
<b>Teck</b>	Glenn	Johnson
<b>Teck Resources</b>	Dylan	Bennett
	Rob	Labbe
<b>Thiess Contractors Canada</b>	Matt	Sayers
<b>University of Alberta</b>	Lukasz	Gaciag
	Ali	Moradi Afrapoli
	Mohammad	Tabesh
	Shiv	Upadhyay
	Hooman	Askari
	Eduardo	Cervantes
	Rob	Hall
	Dario Vivanco	Huaytara
	Tim	Joseph
	Hemanth	Reddy
	William	Robinson
	Gord	Winkel
	Ali	Yaghini
<b>Westcan ACS</b>	Brent	Ness