Objectives and Summit Introduction
Helius Guimaraes
- Helius welcomed and thanked everyone for coming to this year’s Summit
- A special thank you was given to all the volunteers who contribute to GMSG throughout the year
- He challenged participants to consider how they can bring value from GMSG to their respective organizations and vice versa

Welcome Message
Helena Hedblom
- Update on split and creation of Epiroc from Atlas Copco
  - Epiroc will consist of everything in mining and hydraulic attachment tools
  - Epi means at/close or on in latin
  - Roc means rock in latin
- Trends:
  - Fossil-free mining
- Battery technology is the way of the future – that shift has already started and will keep moving towards that
  - Interoperability
  - Automation
  - Digitalization
  - Mechanical rock excavation

DAY 1: DECEMBER 4, 2017

Think Bigger – The Machine Learning Revolution and What it Means for You
Greg DeMichillie, Director of the Product Management, Office of the CTO, Google Cloud, Google
- Machine learning and AI help us start to answer questions we don’t even know how to ask
- Key elements for successful machine learning:
  - High-quality datasets – important to think about the data to be represented in what your scenrios would be
  - High compute power
  - Powerful tools – build on already established platforms
  - Cooling is the single biggest expense in running a data center
  - Traditional architecture is not sustainable
Machine learning needs to be completely open

He discussed Google's Tension flow platform:
- To let companies leverage Google's experience
- Helps companies build their own models

Getting started with machine learning – AI

Need a cloud data strategy

What data

How do you migrate

Default to open (openness in culture) – think about open data

Invest in people and skills

Training is a lot different from original programming from the past. Need to retrain.

Q: Cyber security is a large threat and we as an industry are quite behind. What do we do to catch up?
A: Data is more secure in the cloud
- But not all data is personal and needs to be secure and protected
- Expect to see certification in the future

Q: Please comment on shortage of skills
A: We have to make it so that we don’t require PhD students
- Training of your existing staff
- Already understanding of your industry

Q: Do you think we will see a complete shift in skill sets?
A: 10 years from now will look very different from what it is today
- A shift in programming
- Next steps – Autonomous – Machine learning (ML systems building ML systems)

Q: How can we address the shortage of skills in the digitized future of mining?
A: Help platform become simpler to use so it doesn’t take top experts to use it
- Training is being developed so you don’t need PhD experts
- Training existing staff is the fastest way – they already understand the business
- Criteria to look for in identifying who to train:
  - Intellectual curiosity
  - Statistical data monitoring
  - Math background
  - Self-motivated

Q: Will there be a shift in skill set?
A: What the computer programmer does in 10 years will be very different from what they are doing now. There will be machine learning systems that build machine learning systems.

The Digital Mine

Peter Burman, Program Manager Mine Automation, Boliden

Why innovate?
- High labour cost
- Strict environmental regulation
- Low tolerance for work related injuries
- All of the above are reasons to embrace new technology

Optimization on system level: helps bridge gaps between breaks and shift changes
- Will start to see benefits

What to automate: see slides
- They have communication coverage throughout the entire mine
  - Mesh hopping = lower band width and latency
Driving Improvements: A Details Game
Olav Kvist, Vice President, Mining Technology, Epiroc

The mine ecosystem is built of the interactions of all the various equipment working together. By understanding that flow, you can map equipment utilization and areas of waste to focus on. Olav talked about the need for the effective use of data and gave examples of KPI utilization to increase machine performance.

Chain of Custody: Blockchain to Enable Traceability across the Commodity Lifecycle
George Long, Senior Manager, Resources, Digital Transformation, Accenture

- What is the value that Blockchain offers?
  - It is an encrypted and secure centralized place to input/extract information
  - Every input is encrypted/recorded so you can look back to see where a problem arose
- Consolidating and encrypting saves money

Q: Should there be a GMSG Working Group on this subject?

Comments:
- Blockchain and cybersecurity an area of great importance
- Industry is not mature enough for guideline – need discussions
- Normal database is centralized therefore not trusted
  - BC data distributed evenly – everyone has same data and can check if someone changes data
- We as industry need to do some further work around that

A: Need for Working Group? ABSOLUTELY

Digital Twins as Change Agents in Mining
Jeff Hamilton, Director, Brand Strategy and Alliances, Dassault Systemes, GEOVIA

- The digital twin is a tool that will become more heavily utilized
- It offers strong project communication advantages, including as visualization and/or simulation tools
- It will be able to ease concerns or be used for training for project management and/or planning, etc

Q: Is LTE good enough to meet all requirements?
A: Depends on structure of mine whether LTE is sufficient
**Integrated Operations**

Laura Mottola, President, Flow Partners

- The Integrated Operations Working Group will drive value through collaboration:
  - Accelerate knowledge-sharing and provide a platform for growth
  - System-wide integration and managing variation
  - Sustaining the long-term viability of industry and companies with a focus on people and process.
    - Laura gave an overview of the following three projects:
  - Research collaboration
  - Business Case Guideline
  - Architecture Reference Framework
    - Leadership + Project Managers + SME’s + Regional Groups = tangible outcomes
    - Go from working in silos to working together

**The Open Mining Format**

Rob Ferguson, Director of Product Strategy, Mine and Minerals, Seequent

- Who owns the data?
- Data should flow from application to application flawlessly
- Goal is to come up with a format to enable that
- More information can be found in the document published in November 2017 (LINK)
- Shift paradigm of thinking that it should be painful to move data around
- Seequent and Deswik using V1 – V1 shows that a solution is possible
- Mining companies are invited to join a steering committee
**Empowering the Underground Mine of the Future**

David Sanguinetti, President, Sanguinetti Engineering

- Presentation of Canadian Mining Innovation Council's underground mining technology roadmap as a framework for the underground mine of the future. Three current GMSG projects directly address specific requirements needed to achieve that ideal future mine:
  - Battery Electric Vehicles (Version 2)
  - Short interval and real-time control
  - Underground Communications Infrastructure
    - All three guidelines will be published in 2018

**Q:** Is the BEV guideline applicable to open-pit or is it only for underground mining?

**A:** Right now in underground only but no reason not to do open-pit
**The Connected Mine: Smart, Safe and Secure**  
*Sujeet Chand, Senior Vice President and CTO, Rockwell Automation*

- Spoke about the need to be purposeful in approach to technology implementation and data usage, specifically to be business-outcome driven
- Some key points:
  - "Machine learning cannot replace application (human intuition)"
  - Structuring your data is more important than having Big data
- Structured data reports on specifics and diagnostics
  - Processing data at the edge can prevent repetitive data
- Cybersecurity is paramount in growing importance
  - He suggests that collaboration on security be considered as an aspect of safety

**Overcoming Paradigms on the Road to Innovation**  
*Kevin McAuley, Manager of Technical Services and Innovation, Glencore  
Greg Sandblom, Operations and Business Technology Lead, Glencore*

Kevin spoke about Glencore being an old, rich mining camp. New mines are under development to extend the mine life, but they are at depth, requiring innovation to make them viable. He walked through some of the new technology areas they are focusing on for the new mines coming on board, such as Battery Electric Vehicles.

Greg highlighted the shift in relationships between IT and OT towards a true team collaboration, which is necessary to enable an innovative workplace. He shared the timeline of their journey in building the deep mine as well as examples of employee ownership of the process.

**Q:** How was the 40% reduction in ventilation determined?  
A: Most of ventilation requirements removed just by eliminating diesel

**Q:** Haul passes for BEV? Or financial benefits?  
A: Passes can be used for regenerating batteries

**Q:** Have they thought of commercializing their app?  
A: Thought: yes, have they: no – they do not want to become a software company – their approach is if there is something already out there that they can buy, that is the approach they would take. There is an open invitation out to anyone who would like to partner towards the development of technology that would help solve their challenges. They have no interest in IP.

**Discover Your Untapped Assets: How Digitalization is Revolutionizing the Industry**  
*Mikael Leksell, CEO of Process Solutions, Siemens*

Mikael talked about the journey to full digitization, gave examples of what is possible, and identified a few of the challenges and pitfalls to be aware of. He highlighted that there is a lot of value to be realized from digital twins and emphasized the importance of working with partners. You can’t try to do it all on your own.

**Redefining Productivity in Future Mining**  
*Torbjorn Holmstrom, Senior Advisor, Research & Technology, Volvo Group*

- Volvo committed to reducing CO2 emissions but changing fuels was not enough
  - Strategy is two-fold: electrification and autonomy
  - Prediction that before 2030 there will be a lot of electrified trucks in use
- Different applications can be feasible using the same autonomy platform
- He highlighted that there is a challenge around battery charging that will require collaboration
Q: Has Volvo encountered any issues with lasers and dust interference?
A: Their lasers are protected in order to avoid that – it is in test phase

Q: Has Volvo looked into how much more electricity will be needed
A: It is not a question of how much but is it distributed in the right way that is more important
   o Need to have the electrical grid CO2 neutral in order to make it worthwhile

Q: When does he think a cableless truck will be real?
A: Complete autonomy (step 5) before 2030 – Steps 1-4 faster (by 2025)

Q: Do you see yourself compatible with other vehicles?
A: There will have to be automotive industry collaboration on vehicle to vehicle, vehicle to truck and vehicle to cloud communication

Q: Does he foresee a cableless shuttle car?
A: The tipper truck is already on its way to becoming real

Q: What standards and with who?
A: European Julien and SAE

Q: Are there standards designed today for the smart city concept?
A: Not a complete traffic management system

Q: Has there been a study of the mineral supply chain needed to go into making batteries?
A: There are enough minerals to supply, they are just awkward to get to
   o People are trying to find the minerals necessary in more accessible locations

GMSG PROJECT PRESENTATIONS:
Autonomous Mining Implementation
Andrew Scott, Senior Director, Innovation, Barrick Gold Corporation

Andrew shared an example of an autonomous shuttle bus trial in Perth, Australia, by a leading insurance company and the government, where they are working towards identifying all the regulatory and liability requirements. Of note, they have identified over 700 regulations that the current autonomous shuttle bus is breaking. The example highlights the myriad challenges and aspects to be considered when moving towards implementation of autonomous mining. To assist that process, the Autonomous Mining Working Group is working towards the development of an implementation guideline to be published in 2018.

Open Data: The Key to the Future
David Sanguinetti, President, Sanguinetti Engineering

David highlighted the need for open data as a very foundational aspect to enable new technology and innovation in mining. GMSG published the Mobile Equipment Open Data Consensus Guideline in 2016 and is now working on Version 2. Version 2 will be published in 2018 and will include Open Data Use Cases and considerations of new equipment.

Interoperability
Sergio Burdiles, Advisor, Smart Mining, CORFO

Sergio spoke about smart mining, which is the integration of knowledge, technology and decision-making in order to achieve productivity and safety. Interoperability is a requirement to support:
- End-to-end process integration
- Remote operations
- Multi-vendor autonomous mining
- The collection, management and processing of massive field data.

The GMSG Interoperability Working Group provides the international platform connecting a number of partner organizations focused on advancing interoperability.

Optimizing Performance with KPIs and Best Practices
Zoli Lukacs, Manager, Reliability, Gibraltar Mine

Zoli spoke about two GMSG Working Groups focused on driving effective use of KPIs and sharing of best practices in order to optimize performance. The GMSG Operational Time Model and KPIs will enter final review in January based on input from over a dozen mining companies. The Reliability Working Group will launch a series of Best Practices Projects to develop a reliability knowledge centre for the industry.

Break Out Session: The Value Driven Collaboration Pipeline: What are the Critical Areas for Collaboration- Appendix 2
BREAKOUT SESSION DAY 1

Participants were asked to identify the most critical challenges across the global mining industry today.

Critical Challenges – Company Level

RISK/DERISK

- Lowest cost
  - Short term thinking
- Data quality
- Data Strategy
  - Speed
  - Platform
- Speed to change
  - Culture
  - IP paralysis
  - Who $ innovation?
- Mergers/Acquisitions
  - Effective use of capital
  - Access to capital
  - Disruptors
- Open source information
- Safety
- Sustainability
- Skills/talent
- Create buy-in across the corp.
- Training

- Community/Labour
- Disruption/Interruptions
- Supply Chain-Parts supply
- Lack of ability to optimize
  - Lean mining
- Mindset
- Swing in the cycle
- Time + resources to implement new technology
- Organizational design
  - Functional silos
- Reliance on industry reputation
- Too lean…not enough resources to think
- Energy
- Regulations
  - Permitting
  - Safety + Security
- Purpose lacking (Technology lens driven)

Lack of Shared Vision

Internally

- Competing Interests
- Not willing to share within own company
- Project prioritization
- Time/resources to sustain
- Acceptance of new commercial models
- Embedding change- managing WRKFC change
- Absorptive capacity to adopt change
- R&D Engagement with research providers
- Engaging with real customers
- New mindset news within univ's
Critical Challenges-Industry/Ecosystem Level

- Grade/Resource scarcity
- Depth/Input insecurity (e.g., Tires)
- Social License/China (variable demand)
- Skillset risk/Commodity market
- Resource Nationalisms/Commodity cycles
- Regulatory/Cyber security
- Carbon footprint/risk aversion
- Water
- Job losses due to automation
- Resistance to change: conservative, slow adopters
- Recruitment, training & retaining
- Social license
- Nationalization
- Data ownership/access sharing & model for collaboration
- Mine design for automation
- Planning
- Social acceptance
- Regulation & permitting
- Attracting talent
- Attracting investment
- Define the value of synergy
- New mining methods
- New business models
- Mine design
- New exploration methods
- Health & safety
- Environmental accountability
- Abandoned mines/closure
- Mining culture
- Commodity price
- Measure/determine uncertainty
- Politics/nationalization
Critical Challenges – Individual Level

- People/Talent
- Silos
- Competition between silos
- Mines getting remote
- Personal safety in global context
- Talent
- Location location location
- Autonomy & empowerment
- Growing regulation (national/global)
- Expectations increase while time to execute decrease (meetings etc.)
- Succession planning
- Lack of long-term thinking
- Right technology available
- Push for more productivity
- Work lifestyle balance
- Disparate tams/no single source of truth
- Can’t keep up to new technology & concepts
- Skills
- Changing skills requirement
- Managing the upturn
- Relocation to undesirable locations- threat to family & self
- Insufficient training to keep pace with digital era
- Lifestyle
- Innovation resources
- Technology risk aversion
- Retaining highly specialized employees
- Strategic/non-core role instability
- SL management, lack of awareness of effort needed to provide information
- Competing priorities
- Lucky personal growth opportunities
- Digital tools I don’t know
- No job security
- Lack of trust from counterparts
- Attractiveness of industry in future
- Lack of development resources
- Digital tools
- Attracting talent
- Lack of sense of urgency (to move forward)
- Ability to focus amid rapid changes in technology
- Project risk, people do not fit, technology expectations
- Work-life balance
- Lack of a technology strategy
- Ability to resources innovation
- Knowledge new technology areas
- Too many technology providers, what is best or better?
- Company/industry conservation
- Pace- keeping up with rapid technology changes
- Skill development/retention
- Email/information overload- what to focus
- Rate of change

- Pace of change & keeping skills relevant
- Reluctance to try something new
- Maintaining relevant skills
- Relations with co-workers in the face of being a change agent
- Work-life balance
- “Travel” away from family
- Master data integrity
- Skill relevance
- Reorganize Displacement of Role
- Change management
- Ability to influence decision-makers
- Freedom to think and experiment
- Continuous learning through collaboration
- Break-through innovation MINDSET
- Safety
- Pay equity
- Find like-minded individuals with common purpose/passion
- Cyber
- Still need people but how to motivate
  - o Boring to look at auto eg.
  - o But they need service
- Focus on today when tomorrow is more fun
- Lack of speed to innovate
- Legacy policies defining change
- Don’t give up
- Culture
- Finding people with proper skill set
- Continued education- growth with technology
- How to determine value
- Find like-minded individuals with common purpose
- Managements disconnect to operations
- Lack of trust
- Mining to leapfrog other industries
- Maintaining focus on goals with new technology emerging
- Grow network of suppliers
- Visibility for innovation initiatives
- Diversity and inclusion for creativity
- Disruption not knowing where
- Money + its relevance
- Want to see value realized
- Designing innovative solutions that work effectively in a larger system
- Productivity
- Ability to learn quality and deeply
- Measure of self-worth in the context of robotics
- Want to transform industry
- Prioritizing technologies technical solutions, partnerships and available capital
- Engaging people to meet their needs with innovative solutions
- Work location
- Visionary leadership to move forward
BREAKOUT SESSION DAY 2

Exploring the critical areas for collaboration.
6 Groups each presented 1 potential collaboration area.

GROUP 1: AWARENESS AND APPLICABILITY OF MACHINE LEARNING AND AI

‘Share’
Guidelines
Value
‘Share’
Partnerships
‘Share’
Use Cases
‘Share’
Awareness
Approachability
What it can do
Mining Co. platform skill sets
GROUP 2: TIME FOR OPERATORS TO DEVOTE TO PROBLEM

- Competition for time
- C-suite
- Value to find/prioritize every other initiative/working group GMSG
- What: CEO/CFO/CTO/CIO/Boards
- How: GMSG-CEO engagement pitch conference call and table
  - 1 hour with appropriate prep docs

GROUP 3: HR PLANNING

- Knowledge transfers
  - Collaborate
  - Education
  - Immigration planning
  - Resource sharing cross companies (EIT Programme) (SME Lending/exchange)
- Attractiveness of industry
  - Positive marketing-long-term career
  - Make mining areas/amenities improved (living conditions)
  - Collaborate location of remote operating centres
- Value
  - Productivity
  - Sustainability
  - Operation costs (HR)
- WHO?
  - Mining companies
  - Regional government
  - Other industries for reference eg. Silicon Valley
  - Education facilities (Trade/technical colleges)

GROUP 4: KPIS

- Benchmarking
- Pilot time model
- GMSG collecting data?
## GROUP 5: CYBER SECURITY

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<thead>
<tr>
<th>AUTONOMOUS</th>
<th>OPERATIONAL</th>
<th>EXPLORATION/RESOURCE</th>
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<tbody>
<tr>
<td>• Less of control</td>
<td>• Data integrity</td>
<td>• Data integrity</td>
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<td>• Unintended consequences</td>
<td>• Loss of time</td>
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<td>• Loss of productivity</td>
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## GROUP 6: INTEGRATED OPERATIONS

### Value of collaboration?
- Bring external expertise
- Accelerate outcomes
- Break-down functional silos
- Sustainability of initiatives
- Visibility of VALUE
- Prototyping/ “fail fast”
- Stakeholder engagement
- Systemic view/global optimization
- Developing new capabilities/skills
- Shared accountability/pain
- Broader buy-in/acceptance
- Driving greater value
- Credibility to gain executive support
- Public relations and recruitment

### Who?
- GMSG
  - Oil & Gas
- OTM/OEM
  - Vendors
    - Suppliers
- Unions
  - Community
  - Employees
  - Management
  - Executive