

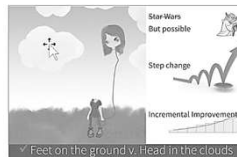


## Underground Diesel Emissions

**Mission Statement:** *The Mining Diesel Emissions Council (MDEC) is committed to providing a global forum for the dissemination of the latest scientific and technologically advanced research to reduce and control diesel emissions in the mining workplace environment.*

## FOCUS: Underground hard rock mining...

1. Mines are getting deeper and *productivity* continues to decline
2. We need to find a way to *improve* productivity
3. Where can we look for inspiration – *Manufacturing O&G?*
  1. What about *mechanization – automation* and autonomous and the Smart Factory?
4. Where is *underground mining* heading with automation? Our Smartset...
  1. What about *soft rock*?
5. Are we making any progress?
6. What about *Digital*?
  1. Case studies
  2. Roadmap
  3. Where to start
7. What is the *Agile Ecosystem*?

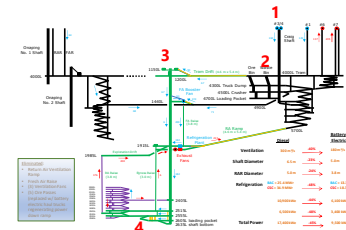


## ...and how to improve productivity <sup>3</sup>



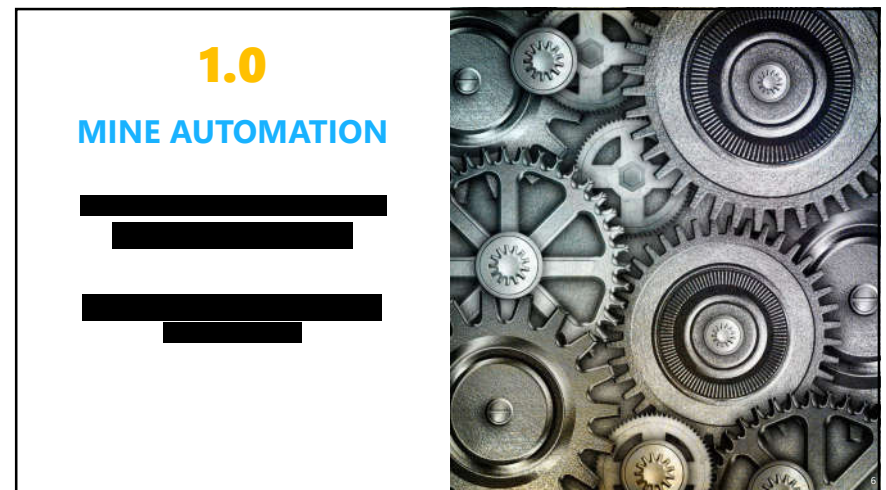
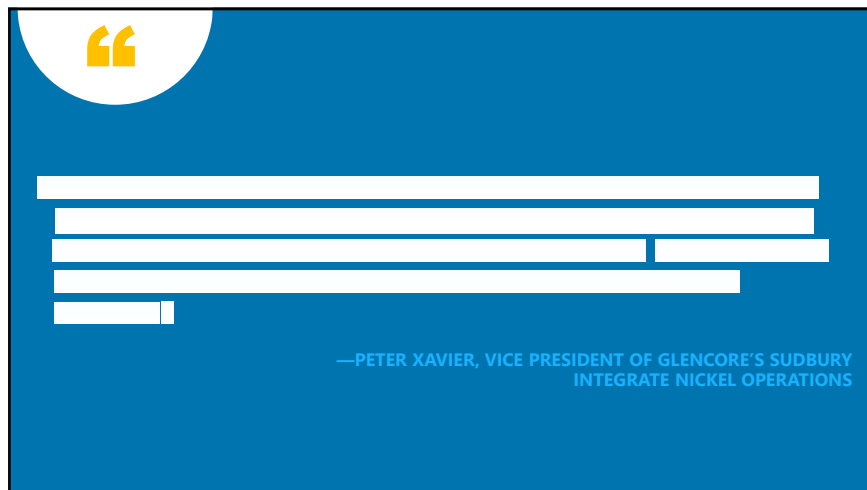
## A look into Glencore's "Mine of the Future"

Deeper mines are logistically complex with long travel times to the work place...



...underpinning declining productivity.

MDEC 2021



## How can the mining industry leverage this thinking?

Industry	Key Technology	Year
Industry 1.0	Steam	1784
Industry 2.0	Electricity	1870
Industry 3.0	Computing	1969
Industry 4.0	Intelligence	Today

Industry 4.0 refers to a new phase in the **Industrial Revolution** that focuses heavily on **interconnectivity, automation, machine learning, and real-time data**. Industry 4.0 encompasses IIoT and smart manufacturing, coupled with smart digital technology, machine learning, and big data to create a more holistic and **better-connected ecosystem**.

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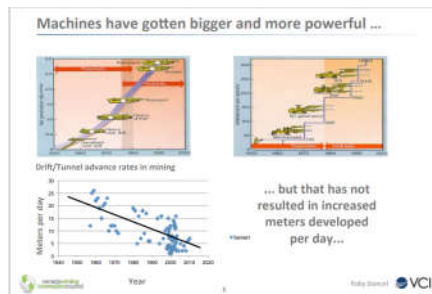
## Mechanization vs Automation

Refers to the replacement of human power with mechanical power of some form.

Can also be defined as the process of following a predetermined sequence of operations with little or no human intervention. The equipment performs and controls the manufacturing process.



## The mining industry needs automation



Worldwide mining operations have reached an inflexion point and are 28% less productive today than they were a decade ago. McKinsey 2020

Automation technologies can dramatically improve the performance of the industry.

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## More work from surface

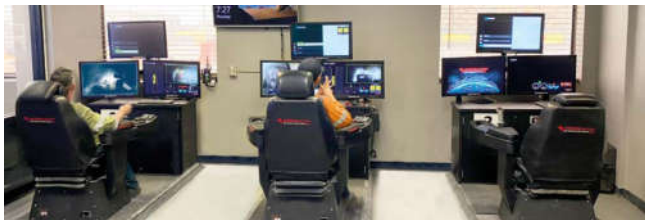
We have been successful in automating our fixed plant.



- [Redacted]
- [Redacted] "Doing more work from surface" [Redacted]

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## Tele-remote mining operations



## Underground Development Mining Process



- [Redacted]
- [Redacted]
- [Redacted]
- [Redacted]
- [Redacted] (removing people from the process operations) [Redacted]
- [Redacted]

Autonomous Machines

### Remote Scaling Pilot with JAMA

Watering, Loading, Scaling

**Goal:**


- Develop a prototype for remote controlled scaling, together with Jama
- The purpose is to be able to do scaling without people close to the face or risky areas, and to be able to do scaling during lunches and at night.

**Current status:**

- System prototype developed with 2D and 3D operator environment
- Sharp tests done in Kankberg
- Positive feedback from operators
- Project is done, report writing ongoing.

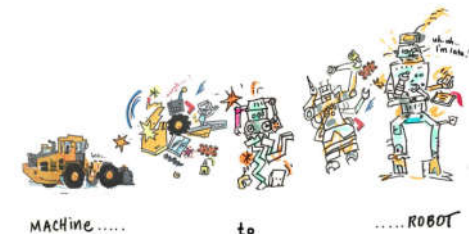
**Next step:**

- Discussion with Jama regarding next step. Concept is proven and developed enough for Jama to take lead in the next step.
- Contact: Lisa Ö Project Manager



**BOLIDEN**

## Turning machines into robots

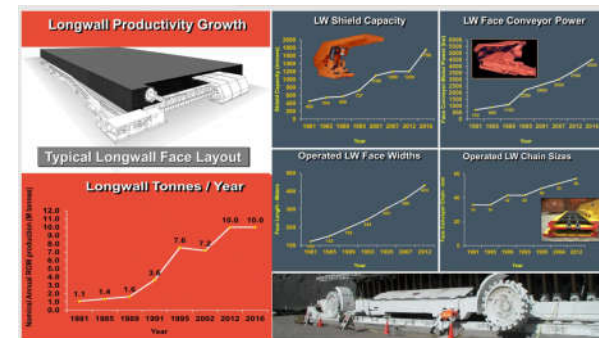


**BOLIDEN**

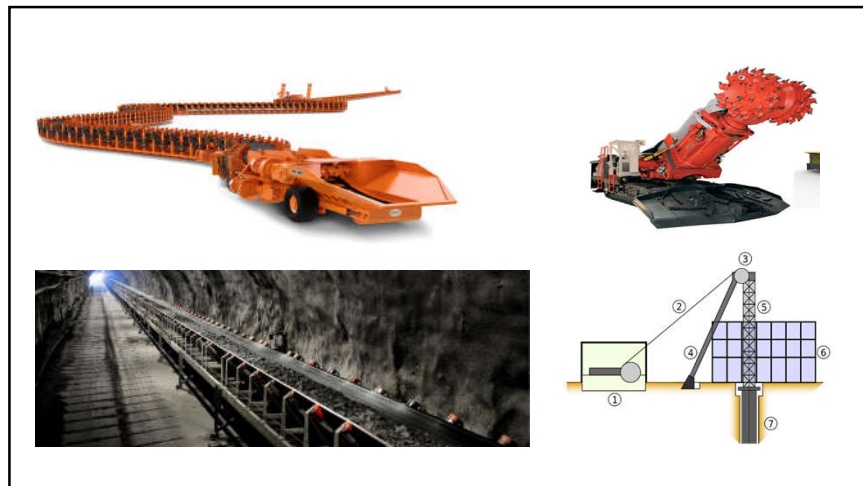
## Turning machines into robots



## What can hard rock mining learn from soft rock?







## Osisko – Cariboo Mine (MT720 Roadheader)

- The roadheader was assembled in February 2021.
- It has cut over 100 m of drift (5.8 m wide x 5.3 m of height) with up to 7 m of advancement achieved during a 12-hour shift including rock support, services installation and mucking.
- The company states: "This equipment is engineered to mechanically cut the hard and abrasive rock mass and is expected to improve the development performance by 25%, and to reduce costs by 50% compared to traditional 'drill and blast' development." Osisko



Roadheader operating on Cow Mountain

## Komatsu MC51 – Garson Mine

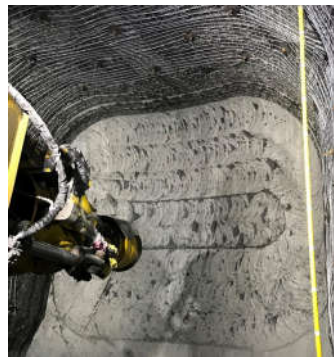
**Komatsu's MC51 ready to rock at Garson**

2020-11-02/November 2, 2020/9:55 am



Komatsu's MC51 hard rock continuous miner. CREDIT: KOMATSU

Hard rock continuous miner undergoing 1-year trial at Vale mine in Sudbury



## Komatsu MC51 – Hillgrove's Kanmantoo Mine



## Epiroc and Sandvik – latest prototypes



## Norway's Oil Workers Fear for Future as Rigs Go Remote

By Nerdun Admalita | October 20, 2020



## Ghost Rigs Could Become The New Normal In Offshore Oil


By Felicity Bradstock - Nov 06, 2020, 2:00 PM CST



- OSLO (Reuters) Some 160 kilometres (99 miles) from land, Equinor's EQNR.OL Valemon oil and gas field became the first in Norway to be operated entirely onshore in 2017.
- Aker BP [AKERBP.OL](#) took a step further last year when its Ivar Aasen field became the first manned offshore platform to be managed remotely.

## 2.0

### DIGITAL TRANSFORMATION TO DRIVE PRODUCTIVITY




INDUSTRIAL INTERNET OF THINGS

## Digital Transformation

A roadmap for digital transformation...


### Digital transformation Definitions

Digital transformation is the novel use of digital technology to accelerate your company's business strategy, not technology for technology's sake.




**Digitization**

Making information available in a digital format




**Digitalization**

Digitizing information to simplify specific operations



**Digital transformation**

Developing new business applications that integrate data and applications



Considered as an Integrated Set

- 1. Digitization**
  - Move from paper base to digital – Straight forward
- 2. Digitalization**
  - Digital data flows based on a system – Hard
- 3. Digital transformation**
  - Digital now transforms the operation at a strategic level (i.e. breaks the Bigger is Better paradigm) – Really hard

...to unlock sustainable value over the long run.

## Priority is to move from paper to DIGITAL

Electronic Log – marginally better than paper

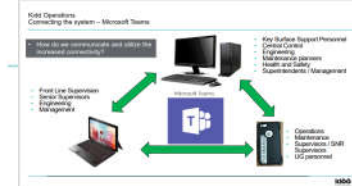
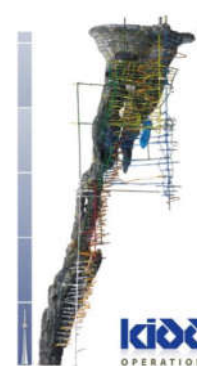
**What good is all that data if it doesn't lead to faster, smarter decisions?**

Adjust to anything that comes your way with a single system for finance, HR, and planning. With the right data, controls, and tools, forecasts and their policy that your people and processes are essential to success. Because planning for change requires a secure tool with change in mind.

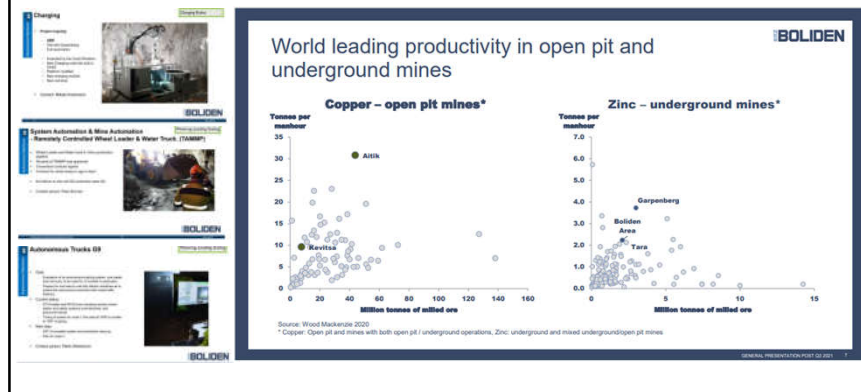
Workday: For a changing world.



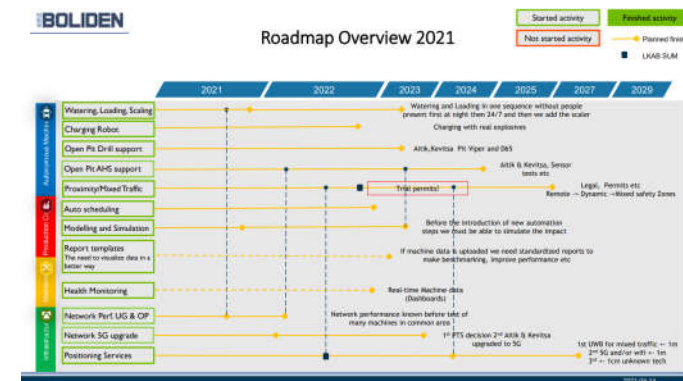
## Kidd Creek – Transition is just starting



## Boliden is focused on productivity



## Boliden has developed a road map





## Sitting on a gold mine of future technology

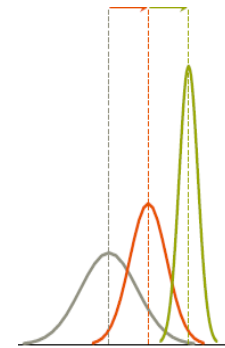
In an industry that, globally, is struggling to adapt to digitization, Boliden stands out as having undergone a digital transformation and having positioned itself in the vanguard of automation.  
-Skellefteå

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## Some are beginning at the enterprise level

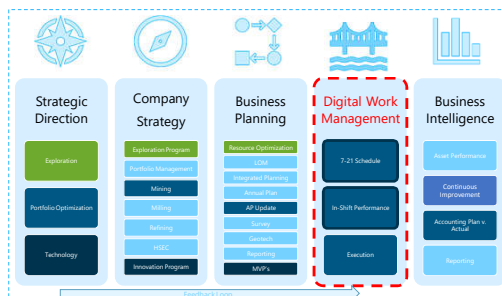


Industry-first digital transformation platform for data-driven decisions



## Integrated Business Systems

A new system bridges the gap between Engineering Planning and execution by providing structure and focus for Operational Planning...



... for the purpose of making a step change in *Operational Excellence* resulting in industry leading productivity.

### Importance

- This will digitize the last major piece of the Integrated Planning and Execution process and lay the foundation for the next step in the digital transformation. **Complete the move from paper based.**

### Objective

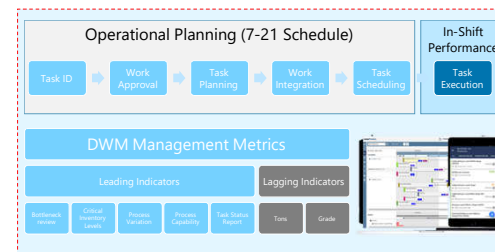
- Install a better mine execution process to consistently realize the value of continued optimised mine plans. **Higher productivity.**

### Focus

- Complete the digitization of Integrated Planning and Execution processes.

## Digital Work Management

Is a system that provides structure and focus for Operational Planning...



**Purpose:** To achieve industry leading productivity.

**What is it:** DWM is an Operational Planning process that

- 7-21 Schedule** – Systematically identifies and plans key tasks. Tasks are specified to a level of detailed such that they can be reliably completed on time.
- In-shift Performance** – is a system to track and monitor tasks in real-time to highlight variances and provide the opportunity for the supervisor to make an in-shift course correction as required.
- Introduces new digital tools**

**Key objectives:** higher productivity at OD by reducing variability while maintaining reliable production (using digital tools)

**Key focus:** Compliance to the integrated Mine Plan.

... for the purpose of making a step change in *Operational Excellence* resulting in industry leading productivity.



## Pathway to Digital

New digital tools create a **transparent** environment..



### Connectivity

Everyone/everything is connected  
People to people & assets



### Data Flows Electronically

Eliminate paper – require complete, accurate, timely data  
Digitize the work identification and capture process with mobile devices



### Visibility

See work progress in real-time through voice, data, video



### Mobility

Being able to be anywhere all the time



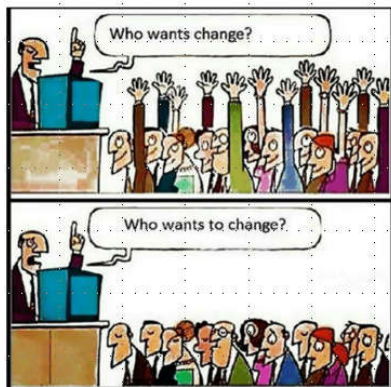
### Collaboration Tools

Unlocking discretionary effort  
Applications with simple intuitive user interfaces  
Limited customization

...that engages people and results in **Execution Excellence**.

# Digital-first Location-independent

## Our biggest challenges



3.0

AGILE ECOSYSTEM



## The old R&D model is dead

Agile ecosystem – what is it and how does it work?

### Why?

We still need innovation and the old R&D model is dead.

### How?

Redefining the employee in order to build a more productive team.

### What?

Agile on common problems to solve.

**The three stages of a collaborative ecosystem, and the source of its value, are sharing, innovating and competing together**



## Bridges to build new ecosystems

What have we learned along the way?

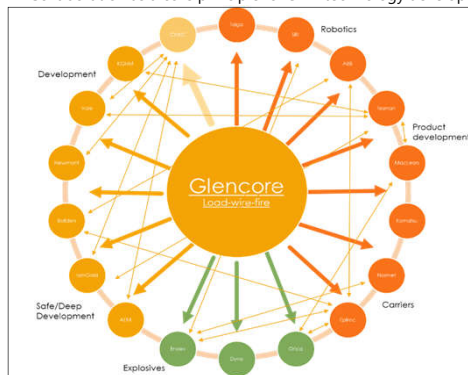


What have we learned along the way

1. Focus on existing technology – combine technologies and build on them. **Think adopt**
2. Find real common **pain points**.
3. Demonstrate all the time: it is **faster and cheaper**.
4. **Just start** and build out
5. **Be flexible** with the "rules".

## Building an ecosystem to support execution

Collaboration as a core principle for SDD technology development...



### Glencore's Safe Deep Develop Program

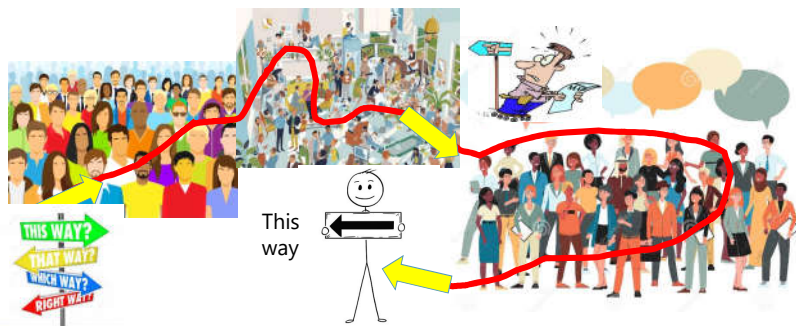
- 1. Big picture** – Do more work from surface
- 2. Purpose** – All work to be completed 4m back from the face
3. Develop new technology development model
4. Encourage as many prototypes as possible
5. Collaboration is a core principle

...to continue to improve safety and drive productivity.

## Safe Deep Development Technology Emerging at Glencore



## Setting the direction is messy



## To consider when developing a productivity road map



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Key-note-MDEC 2021-MacFarlane- 22