

Industry 4.0 in Mining

Johan Hedlin



Short about Johan Hedlin

- ❑ Background as R&D manager in the Swedish telecom and IT business
- ❑ Since 1999 been working for the Mining industry as management consultant and project manager.
- ❑ Since 2010 CEO for the R&D company Rock tech Centre (RTC)
 - RTC AB is a limited company owned by the [Bergforsk Foundation](#), Epiroc, NCC and ABB, while the Bergforsk Foundation is owned by Boliden Mineral, LKAB, Zinkgruvan and [Luleå University of Technology](#).
 - RTC has been establishing consortium and running a number of joint technical R&D projects with partners from Swedish , Europe, Australia and Canada companies and Universities.
- ❑ Since 2016 founder and owner of HeadMining AB(Ltd) company.
 - HeadMining is a management consultant company specialised on analysing and development of strategies for improving mining operations in a sustainable way. The company consist of some of the best expertise people from Swedish mining industry and University.



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Agenda

- 1: The road to Industry 4.0**
- 2: Four main principles of Industry 4.0**
- 3: Towards Industry 4.0 in Mining**
- 4: Some examples of technology**
- 5: Steps on the road**
- 6: Current examples from Swedish mines**
- 7: Key enablers**
- 8: A brief summary**

The road to Industry 4.0

1st industrial revolution: from farming to factory production (19th Century.)

2nd industrial revolution: steel, electrification of factories, the first attempts of mass production (1850s to World War I)

3rd industrial revolution: the change from analogue, mechanical, and electronic technology to digital technology (late 1950s to the 1980s)

4th: the move towards digitization

- communications infrastructure
- Internet of Things and cyber-physical systems such as sensors
- big data and powerful data analytics means









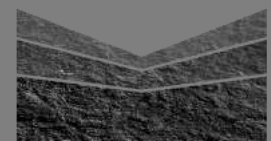
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COMMITTED TO
IMPROVING THE STATE
OF THE WORLD

Navigating the next industrial revolution

Revolution	Year	Information	
	1	1784	Steam, water, mechanical production equipment
	2	1870	Division of labour, electricity, mass production
	3	1969	Electronics, IT, automated production
	4	?	Cyber-physical systems





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4 main principles of Industry 4.0

Interoperability

Information transparency

Technical assistance

Decentralized decisions

“

Humans must adapt to collaborate with machines, and when that collaboration happens, the end result is stronger.

”

Erik Brynjolfsson, Director, MIT Initiative on the Digital Economy, Massachusetts Institute of Technology, USA



Towards Industry 4.0 in Mining → Mining 4.0

- 1) **Mechanization** using hydraulic drills, and steam powered engines
- 2) **Mass production and assembly lines** along with electricity, giving miners access to more and better equipment with the aid of electricity
- 3) **Computers and automation**, giving way to various mining robots to perform dangerous and heavy tasks
- 4) **Industry 4.0!**



Mining 4.0 – examples

- High speed communication networks
- Tele-remote, assisted control, and fully autonomous equipment robotics and sensor technology
- Integrating geological & other information into a single database
- UAVs or underground vehicles with laser scanning technologies
- Real-time data & process control
- Centralised automated operations
- Change in how workers interact (with each other and with machines)
...etc etc



→ increased safety

→ increased productivity

→ production according to plan

→ decreased energy consumption

→ lower costs



Steps on the road

Manned operations

Assisted Operations

Remote controlled operations

Tele-Remote Controlled operations

Semi-autonomous and fully autonomous
mining operations

Mining 4.0



Steps on the road

Manned operations
Assisted Operations
Remote controlled operations
Tele-Remote Controlled operations
Semi-autonomous and fully autonomous
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**Semi-autonomous and fully autonomous
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Mining 4.0



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Mining 4.0

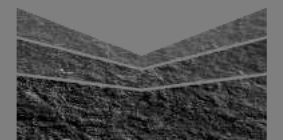
Key enabler: high speed
communication network



Mining 4.0 –current examples from Swedish mines

Boliden Kankberg mine (2017-2018)

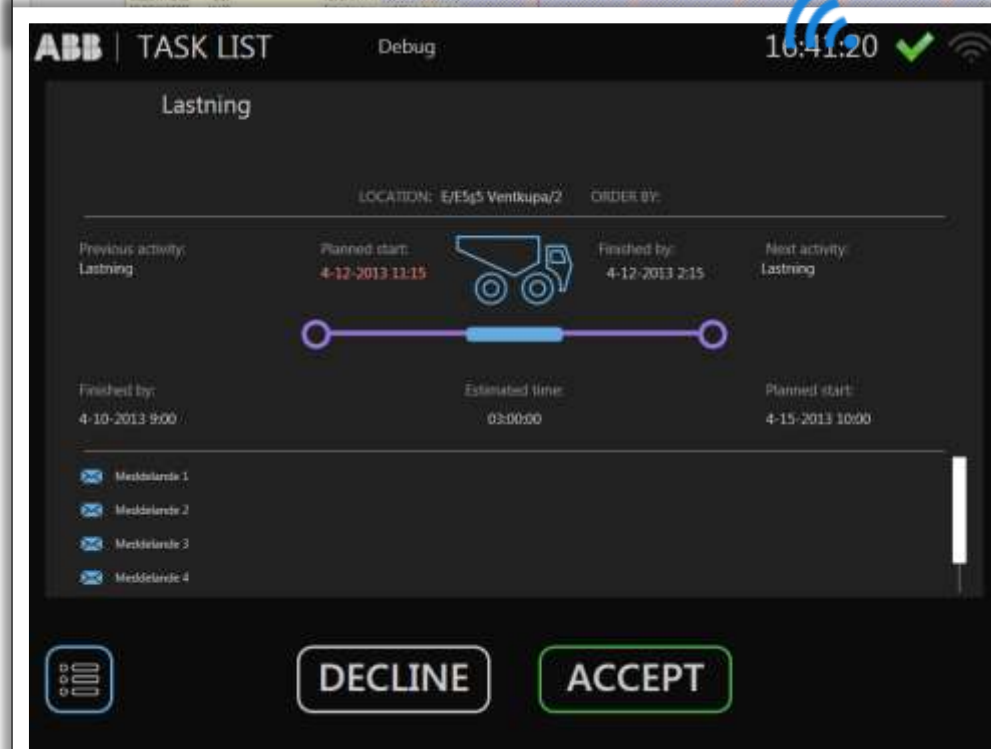
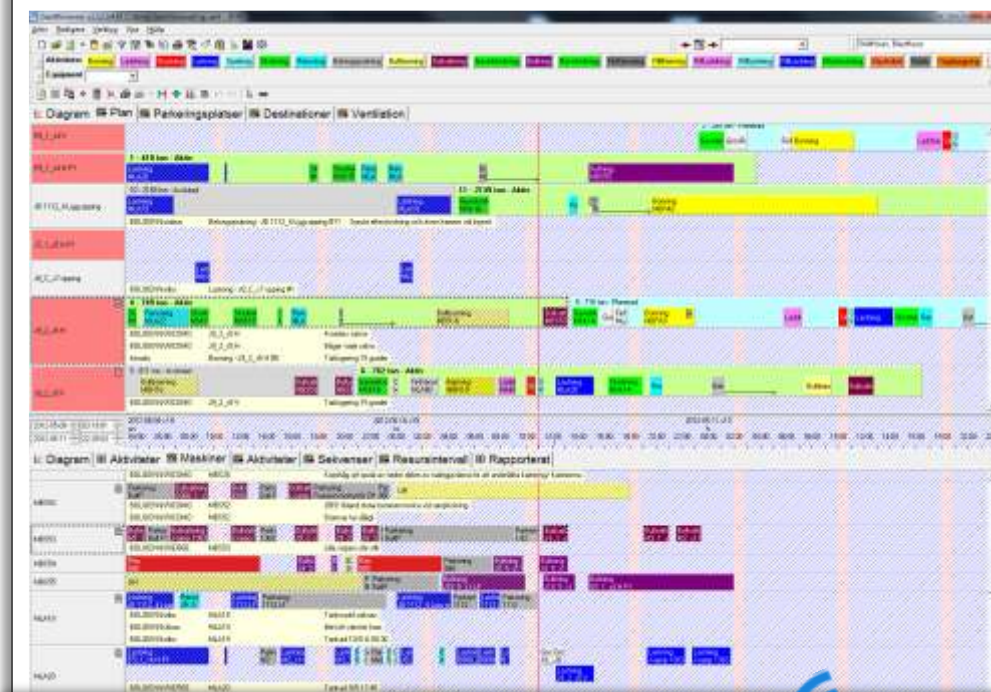
- 5G enabled industrial communication network
- 5G connectivity for automation and robotics
- High-precision positioning and close range emergency data communication mesh network
- High-precision positioning of mobile equipment & personnel
- Semi-Autonomous UAVs (drones) for inspection activities



Mining 4.0 –current examples from Swedish mines

Boliden Renström mine (2017-2018)

- On-line process control
- On-line maintenance data from machines



Mining 4.0 –current examples from Swedish mines

Boliden Kristineberg mine

2011: Ventilation on demand (in several Boliden mines)

20xx: mine wide WLAN

2017-2019: Automated Volvo truck (lorry)



Mining 4.0 –current examples from Swedish mines

LKAB Kiruna mine

1974 Automatic remote controlled
underground train

1998: Semi-autonomous drill rig (Atlas
Copco Simba)

2000: Semi-autonomous LHDs (Sandvik)

2019: Robotized Charging Machine
(explosives) (ABB)



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Key enablers

Communication platforms

-Wifi, 4G, 5G

Positioning systems

Sensors

Integrated process control systems

Sufficient personnel competence level

Safety and legal regulations needs to be developed

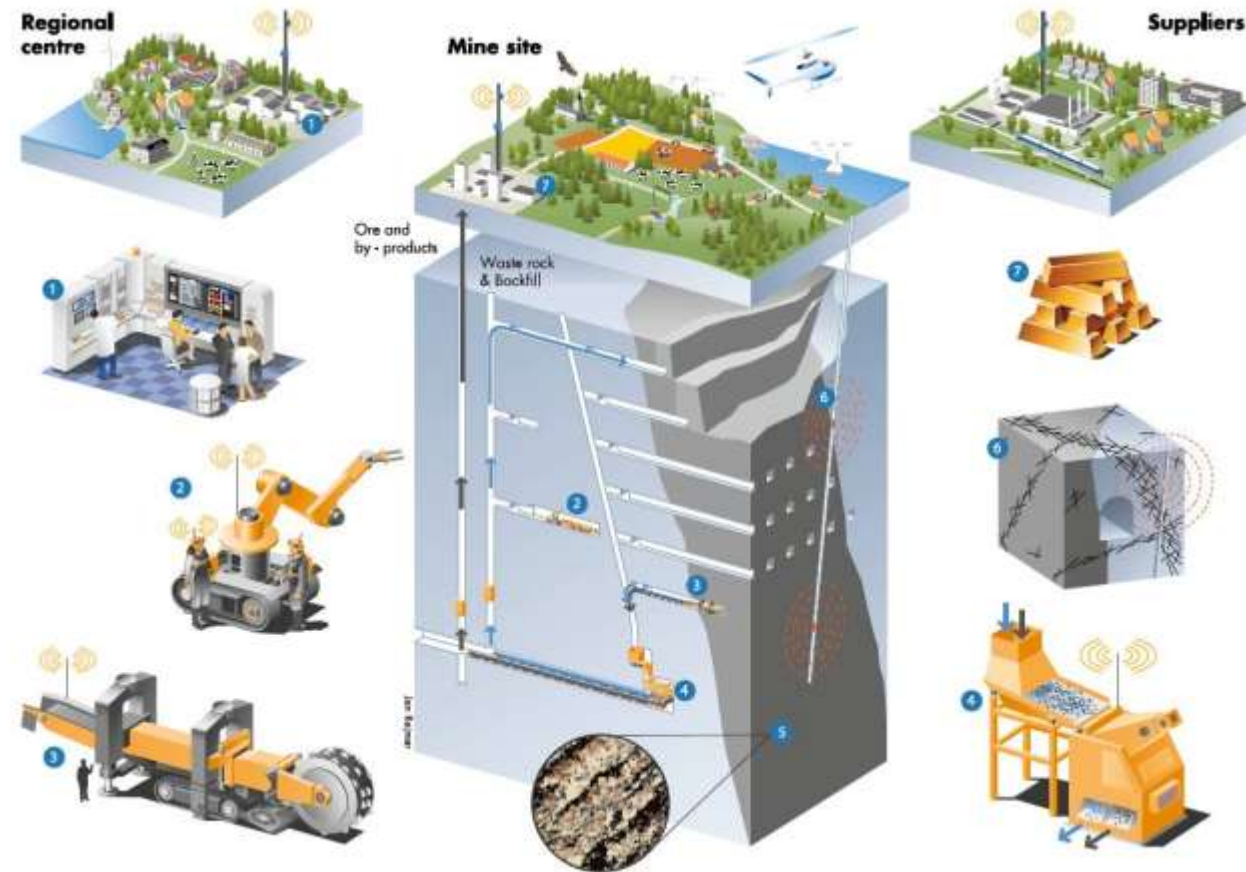


Adopting Mining 4.0

A step-wise implementation can give early benefits. Identified needed technologies and don't apply all new technologies at once.

- Understanding **mine specific** needs and possibilities
- Understanding processes & recognizing potential gains
- Establishing communication systems
- Organizing proper data management and analysis.
- Educating personnel

→technology, infrastructure,
humans & organisation

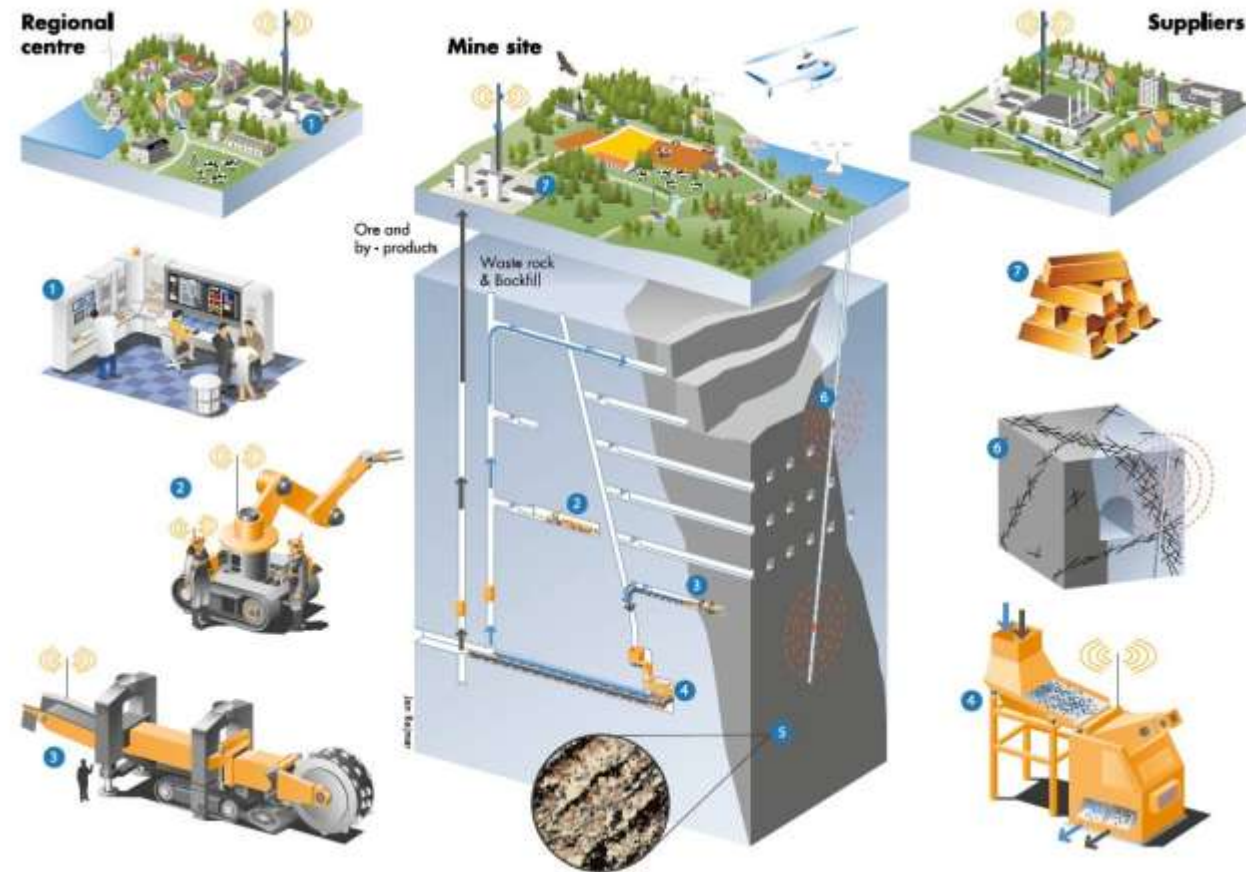


IMPACTS and conditions:

It is expected to achieve positive impacts on productivity, safety and environmental.

To go in the direction will also have strong impacts on:

- Organisations of work
- Management, of operative levels
- Production processes
- Education level, for all kind of workers and management
- Investments
- and much more...



Thank You for Your attention

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