Dr Eduardo Gallestey, Global Technology Manager Process Industries, ABB.

Optimizing Process Industries in the Digital Era
**ABB today**

A global leader in power and automation technologies

<table>
<thead>
<tr>
<th>What (Offering)</th>
<th>Power &amp; Automation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Power ~40% of revenue</td>
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<table>
<thead>
<tr>
<th>For whom (Customers)</th>
<th>Utilities</th>
<th>Industry</th>
<th>Transport &amp; Infrastructure</th>
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<tbody>
<tr>
<td></td>
<td>~35% of revenue</td>
<td>~45% of revenue</td>
<td>~20% of revenue</td>
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<table>
<thead>
<tr>
<th>Where (Geographies)</th>
<th>Globally</th>
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<td>AMEA¹ 37%</td>
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</tbody>
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| ~ $36 bn revenue | ~100 countries | ~135,000 employees | Single “A” credit rating | HQ Zurich |

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¹ AMEA: Asia, Middle East, and Africa
ABB in Metals – System and Service
All in One-system approach

Extended operator workplace

Operation, engineering and maintenance

Process Set-up Model and Optimization

Production management

Headquarter ERP and business systems

Firewall router

Mobile / remote operation engineering and maintenance

Corporate network

Automation system network

AC 800 High Integrity Controller

AC 8000 Single / Redundant Controller

AC 800 High Performance Controller

AC 800 High Integrity Controller

IEEE 95, OPC...
ABB in Mining today
Fostering a one-system approach

Main process and power control
800xA based integrated sub systems

Extended operator workplace
Operation, engineering and maintenance
Process optimization
Production management

Headquarter ERP and business systems

Wireless communication
High integrity control safety shutdown fire and gas

Mobile / remote operation engineering and maintenance

Firewall router

AC800 M process controller

Grinding drive systems
Automatic stockpile loading, unloading, transport
Mine Hoist

Corporate network

Automation system network

Sub-system controller AC800 M

Operation, engineering and maintenance

Process optimization

Production management

Headquarter ERP and business systems

Wireless communication

Firewall router

AC800 M process controller

Grinding drive systems
Automatic stockpile loading, unloading, transport
Mine Hoist
ABB in mining today

- 1200+ Distributed control system
- 600+ Mine hoist solutions
- 720+ Km of belt conveyor system
- 250+ Bucket-wheel excavators
- 200+ patents into mining industry
- 125+ Gearless mill drives systems
- 80+ Turnkey electrification & automation
- 50+ Countries references
The mining and metals industry today
The main challenge is productivity improvement

Productivity in tons / person / year

- **Mechanization**
  - Standardization of processes
  - Mechanization means dramatic shifts in production capabilities
  - Operation of equipment still requires human interaction

- **Automation**
  - Integrated modeling and planning for higher quality yield
  - Greater visibility into parts of the value chain
  - More detailed information coming from equipment and plant to enable remote mining

- **Optimization**
  - Reduce total ownership cost
  - More responsive demand and supply
  - Higher level of automation driven by labor shortages and remote locations
  - Limiting bottlenecks by adopting more continuous processes
  - High levels of visibility across the value chain and between operations

Five key mining industry requirements
- Productivity
- Safety
- Sustainability
- Reliability
The Internet of …
Global trend – 4th industrial revolution

Industry 1.0 – 1712
First practical steam engine

Industry 2.0 – 1870
First elevated conveyor belts

Industry 3.0 – 1969
Electronics / software based control

Industry 4.0 – today and tomorrow
Internet of …

Things

Services

People

ABB leads proactively with new connected offerings
The mining and metals industry future
Attractive changes moving forward

<table>
<thead>
<tr>
<th>People further away from processes</th>
<th>Equipment closer to processes</th>
</tr>
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<tbody>
<tr>
<td>Reduce cost, increase productivity, and safety by remote monitoring, diagnostics and interventions</td>
<td>Move automation and electricity to where the ore is extracted, minimize haulage, and transport</td>
</tr>
</tbody>
</table>

The traditional way | Remote monitoring of equipment, preventive maintenance | The traditional way | Underground electrical and autonomous equipment

... enabled by integrated operations from pit to port, fully automated, and remotely controlled

Key features of future mining and metals operations

- Limited human presence in production area
- Continuous production and mechanical excavation
- Central control room
- Continuous availability of ore, people, and equipment
Integrated Mine Automation
Improvement potential

Mining activities during 24 hours

- The effect of autonomous machines
- The effect of introducing a mining operational centre
- Today

Improvement potential

Autonomous Machines 40-80%
- Work through shift changes
- Work through blasting
- Safety

Mining Operational Centre 10-20%
- Improved processes
- Improved face utilization

Source: Boliden
MineOptimize
State of the Art Mine
Automation systems
The Intranet of Things
MineOptimize
Building blocks enable integrated value chain

Collaborative Production Mgt.
- IMO: dispatch and schedule
- Knowledge Manager: information, energy manager
- AssetVista: condition monitoring

Power & Process Control
- 800xA APC: advanced process control
- Minerals Library: engineering and operation
- MIDAS Library: electrical integration

Electrification & Automation Solutions
- Panels, safety, CCTV, communication network
- E-Houses, HV Substation, MV Skids, MCC
- Cabling, lighting, fire detection, air conditioner

System Engineering
- Infrastructure
- Energy distribution & drives system
- Power & process control

Project Management
- One point of contact
- Experience and competence
- Reduced execution risk

Power, Control & Drive Products
- PLC, Instrumentation, Switch, 800xA System
- Transformer, Switchgear, PFC, Relay
- Drives and Motors
MineOptimize Condition Monitoring
React to asset condition in real time

The MineOptimize way

Reduce maintenance costs while improve equipment reliability and reduce unplanned shut-downs

The traditional way

- Reactive maintenance
- High operating costs
- Unexpected breakdown of critical assets
- Catastrophic impact on production targets

- Asset management integrated into control system
- Asset monitor detects condition
- Predictive maintenance alarm is triggered
- Work order with site maintenance crew is raised automatically
- Reduces losses due to equipment failure
- Maintenance and operation responds ahead to reduce failure risk

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September 6, 2016 | Slide 14
MineOptimize Advanced Process Control
Process optimization according to ore properties

The MineOptimize way

Higher equipment utilization, increased recovery and lower energy consumption

Model predictive control engine integrated into control system

Real time ore analyzer detects changes to ore grade

Real time operations reports changes in ore properties

The traditional way

- No information on upstream downstream impact
- Can’t prioritize significant data volumes

More metal ore is recovered

Plant react to ore variability ahead of time

Predictive adjustments made to mining grinding

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September 6, 2016 | Slide 15
MineOptimize Scheduling & Dispatching
Just-in-time optimal process management

The MineOptimize way

High degree of automation and information access enables safety and production as per plan

Personnel, mobile and fix equipment integrated into control system

Mine operators schedule, dispatch and track operations in real time

Mobile and fixed equipment report local conditions, task status and location

The traditional way

- No information about the location and status of mobile/fixed equipment
- Cannot prioritize works plans and loading sequences

Operations team working in the optimum level

Production analyses and statistics can be retrieved on-line

New task plans and loading sequences are calculated and executed
Make goal-oriented decisions

**The MineOptimize way**

- Make the right decisions based on consolidated, consistent and transparent information

**The traditional way**

- Manual data collection and calculations
- Information available in segregated documents
- Difficulty to identify differences among multiple sources and versions

Single information platform integrated into control system

Automated data collection, consolidation and calculation

Report process, production, energy and maintenance KPIs

Targets achieved based on transparent information

Information empowering goal-oriented decisions

Consistent distribution of information at the plant and corporation
Integrated Mine Operations
Ultimate link between real time and medium term goals

Plan, Dispatch and Follow-up
Monitor and Predict

Production plan  Asset availability  KPI report & visualization  Status on-line

Work orders  Activity report  Machine operation data  Production data

Mine Design  Production Planning  Assets  Work Force  Customers  Investors  Finance

Control system  Control system  Control system  Control system  Control system  Control system  Control system  Control system  Control system

Drilling Rig  LHD/Trucks  Hoists  Mills  Flotation  Material Handling  Stockyard  Port
Technology & Business Models
Internet of Things, Services and People (IoTSP)
The Internet of Things (IoT) is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data [1].

The Internet of Things allows objects to be sensed and controlled remotely across existing network infrastructure [2].

Smart, communicating devices by ABB

[1] "Internet of Things Global Standards Initiative",
Device health and performance is derived from the analysis of the devices diagnostic data collected.
Health or performance can also be observed in measurements from devices along mechanical, electrical, or control connections.

Integrating monitoring data from all sources in the plant including electrical and control systems provide thorough information.
Fleet management
Predictive maintenance potential

Good statistical knowledge important for accurate predictive maintenance
Time to react increased with improved predictive methods
Failure patterns observed in the fleet can be identified early in measurements

Integrating and analyzing monitoring data from a variety of installations of the same device type throughout the industry is essential
Optimizing maintenance and operations
Combining plant view with fleet view

Unique combination of asset focused maintenance optimization vs. plant focused operations optimization

**Fleet view**
Data analysis across a fleet of devices installed in different sites
Data analytics potential:
- Predictive maintenance
- Benchmark
- Asset lifecycle optimization
- Usage-driven product improvement

Focus on maintenance optimization

**Plant view**
Data analysis across a site or a number of similar sites
Data analytics potential:
- Data engineering
- Process performance optimization
- Energy efficiency optimization
- Operational excellence

Focus on operations optimization
ABB IoTSP platform

- Standardized integration approach + analytical capabilities
Customer’s situation:
ABB receives an automatically generated e-mail indicating a problem with a gearless mill drive.

Data analysis shows that the device will probably fail within 8 days

ABB solution:
Based on the data analysis, the customer was advised to immediately interrupt production for <30 min to clean dust filters to survive operation until next planned outage

At next planned outage, resolution of the problem by replacing components that were organized in time by the service organization

Outage could be kept at a minimum, avoiding unplanned production loss of ca. 1.4MUSD
MineOptimize
Some References
We are implementing the mine of the future today

Integrated solution for iron ore mine in Brazil

New Iron Ore Mine & Beneficiation Plant
- 90Mtpy
- 11BUSD CAPEX
- Truck-less system

ABB Delivered
- Integrated power & automation control system
- 230 kilovolt in-feed substation and 42 secondary substations
- High, medium and low voltage electrification, motors, and drives
- Main control room design and infrastructure;
- IT / OT integration, advanced asset management
- Condition monitoring solutions & consulting
MineOptimize
Integrated solution for underground mine in Sweden

Underground mine expansion
- from 1.5mn ton/year
- to 2.5mn ton/year

ABB Delivered
- Integrated power & automation control system across the value chain from mine to mill
- IT / OT integration, advanced process control
- Remote monitoring capabilities
- High, medium and low voltage electrification, motors, and drives
- Energy efficiency solutions
- Ventilation on demand, smart switchgear
- Mining specific drive-motor packages
Boliden customer case
World-leading productivities

Source: Wood Mackenzie, 2016. Graph to the right includes open pit and mines with mix open pit-underground.
### Integrated Process and Operation Management

**Improve visibility, planning and real-time coordination**

<table>
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<th>Top benefits</th>
<th>How can help</th>
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<tr>
<td>Improve visibility</td>
<td>By providing complete, accurate and timely data</td>
</tr>
<tr>
<td>Reduce asset utilization</td>
<td>By providing better visibility and real-time management system integration, coordination among functional silos</td>
</tr>
<tr>
<td>Higher throughput</td>
<td>By providing better planning capabilities that minimize the effect of bottlenecks</td>
</tr>
<tr>
<td>Increased safety</td>
<td>By removing people from hazardous environments through better information and communications systems</td>
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Internet of Things, Services and People

- Conclusions

Intranet of Things – Internet of Things
Intelligent devices equipped with sensors are providing large amounts of data that is today used in the controls system
Today’s essential requirements remain valid (safety, reliability), cyber security and data privacy become more important for all players along the value chain

Internet of People
People will not be obsolete in the future context, as they remain in control of the production process. People will be the decision makers

Internet of Services
Services will become more advanced through the use of data analytics. If the analytics results are not turned into improvement actions, customer benefits remain low. Opportunities for new service models that build on collaboration with partners and customers will evolve.
Securing the future of mining and metals industry

- Digital technologies provide visibility and optimization across the value chain.
- These new products and systems drive fundamental change in the way the modern enterprise works, creating dramatic increases in:
  - Process productivity
  - Predictability of operations
  - Asset reliability
  - Energy efficiency
  - Health, safety
  - Protection of the environment
Power and productivity for a better world™