Integrated Mine Operations
Visibility and Optimization from Mine to Port
The mining industry today
The main challenge is productivity improvement

Productivity in tons / person / year

- Manual production
- Mechanical production
- In-situ remote production
- Automated production

Four key mining industry requirements
- Productivity
- Safety
- Environment sustainability
- Reliability

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
- More responsive demand and supply
- Higher level of automation driven by labor shortages and remote mining locations
- Limiting bottlenecks by adopting more continuous processes
- High levels of visibility across the value chain and between operations
ABB in Mining today
Fostering a one-system approach

Extended operator workplace
Operation, engineering and maintenance
Process optimization
Production management
Headquarter
ERP and business systems

Corporate network

Mobile / remote operation engineering and maintenance

Automation system network

AC800 M process controller

High integrity control
safety shutdown
fire and gas

Sub-system controller
AC800 M

Wireless communication

Firewall router

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Main process and power control

800xA based integrated sub systems

Grinding drive systems
Automatic stockpile loading, unloading transport
SpectraFlow on-line analyzer laboratory

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Next level mining
Expanding customer value proposition beyond the simple system provider approach

Plan / design ➔ Build ➔ Operate

Moving forward
Consulting
New software tools
- e.g. RobotStudio
- e.g. grid planning

Today
- e.g. Asset Health
- e.g. life-cycle services

New software-based products and services

Planning partner
Product, solutions, systems provider
Operations partner
Next Level mining
Through power and automation integration

Integration of equipment, systems and people...

...enabled by technology...

...to get one common view

- An infrastructure that can represent all the assets
- Embed all applications and systems
- Share information without barriers
- Bring teams together and get the best from all teams
- Empower people to perform their best

Aspect Objects™

- Object centric information access
- One Click to all information
- Direct navigation from any aspect to the next
- Information filtering based on job role/function
- Real-time decisions and action

Integration of communication infrastructures
Integration of subsystems
Integration of systems at different sites
Integration of higher level applications
ABB in Mining solution suite
A holistic approach to the entire mine operation

Financial Layer

Planning Layer

Process Management Layer

ERP Functions

Business intelligence
Asset health center
Ellipse inventories

Ellipse maintenance
Intelligent mine solutions
Customer applications

Collaborative Production Management
Asset Monitoring – Stockyard Management – Integrated Mine Supply Chain Operations

Minerals control & Optimization applications
Ventilation on demand – Ore monitor – Grinding & Flotation – Dispatch & Scheduling

Process and power control systems core
Electrification – Wireless communication – Localization

Mine → Transport → Ore processing plant → Transport → Port

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Integrated Mine Operations

-Mission
-Architecture
-Results
The future of mining – extended automation
Bringing things, services and people together

Analyse | Plan | Schedule | Monitor | Automate | Communicate | Control | Sense

Sales / Contracts | Corporate headquarters | Minerals / Metals price volatility | Electrification | Mine | Concentrator | Smelter

Transmission & Distribution | E-houses | MCC & Drives | Drilling, charging and blasting | Loading and transport | Crushing | Ore hoist and feeding | Ore feeder | Grinding | Flotation | Thickening | Filtering | Dryer | Furnace | Converter

Concentrator transport
Integrated Mine Operations
Ultimate link between control and enterprise levels

Plan, Dispatch and Activity follow-up
Ore Monitor and Predict

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

Work orders
Activity report
Machine operation data
Production data
  Machine position

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
Control system

Drilling Rig
LHD/Trucks
Hoists
Mills
Flotation
Material Handling
Stockyard
Port

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Integrated Mine Operations
Production scheduling and dispatch

- Software package where mine operators dispatch and track operations in real time, increasing operational transparency and enabling decisions for best operations in real time.

- Functionalities
  - Visibility of all resources across the mine
  - Plan continuously updated, based on truly existent resources.
  - Optimal response to disturbances in real time
  - ISA 95 based data store holds mine’s past, present and planned activities
  - Scheduling engine supporting optimal decision making, including constraint checking mechanisms to enforce resource availability
Integrated Mine Operations Architecture
Integrated Mine Operations
A cockpit to provide full visibility & enable optimization
Integrated Mine Operations
Integrated energy and water management

- Predict accurate energy demand schedules to lower purchase costs and avoid penalties
- Manage complexity from varying energy price and power availability by allocating energy consumption to off-peak hours and energy production to peak hours
- Same framework can be used to manage of other limiting factors such as water and fuels

Select resources to enable production schedule at minimum cost
How will “Integrated Mine Operations” influence productivity, agility and yield?
Wireless communications and Integ. Mine Operations Enable just-in-time optimal process management

Integration of mobile equipment communications improves production efficiency

Computerized mobile and fixed equipment report local environmental data, their status and location

The old way
- No information about the location of status of mobile or fixed equipment
- Can’t prioritize work plans and loading sequences
- Operational teams working working sub optimally

The new way
WLAN enables high degree of automation and information access. Optimized communication improves production efficiency.

Production reports, analyses and statistics can be retrieved on-line in real time

New work plans and loading sequences for the production machines can be calculated and executed
Reacting to asset condition in real time
Reduces losses due to equipment failure

1. Asset monitor detects condition
2. Predictive maintenance alarm is triggered
3. IMO responds to abnormal condition to reduce failure risk
4. Operators raises work order with site maintenance crew
5. Asset condition informs real time decision

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

The new way
Control system integrated with maintenance system

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Process optimized according to ore properties
Plant can react to ore variability ahead of time

The old way
- No information on upstream downstream impact
- Can’t prioritize significant data volumes - manual
- Production, equipment and other control systems not integrated
- No optimization of grinding or floating

The new way
Optimized grinding and flotation using data from real-time analyzers detecting changes to ore grade as it is extracted.

1. Real time ore analyzer detects changes to ore grade
2. IMO alerts plant dispatcher
3. Predictive adjustments made to mining, grinding and flotation according to ore properties
5. The result is higher equipment utilization, increased recovery and lower energy consumption
Optimization from rock face to end customer
Integrated product delivery & mining

The ultimate goal of future mining projects

1. Stock levels at stockyard or customer site low
2. IMO schedules the fully automated mine
3. Remote operations centers enable the vision
   Holistic approach featuring
   • smart devices and equipment,
   • enabled for autonomous configuration,
   • efficient operation,
   • self-diagnostics,
   • real-time transparency
   • even to mobile devices
4. Mine digs, blends and mixes ore automatically
5. Delivers to product to stockyard or customer
Production targets optimized for market conditions
Process set points refined to maximize financial returns

IMO stand to link business systems and process control systems

Information from sales and global pricing index is used by planning systems

The old way
- Unable to contextualize information on relative product pricing and sales contracts because information is stored on disparate systems

The new way
Convergence of business IT systems and process control systems enables implementation of optimal production plans

IMO maximizes financial returns for current feed material and product pricing
IMO allows process control systems to implement new process set points
Conclusions
Next level mining – attractive changes moving forward
Mines of the future will have...

... people further away from processes
Reduce cost, increase productivity, and safety by remote monitoring, diagnostics and interventions

... equipment closer to processes
Move automation and electricity to where the ore is extracted, minimize haulage, and transport

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

Key features of future mining operations
- Limited human presence in production area
- Continuous production and mechanical excavation
- Central control room
- Continuous of ore, people, and equipment

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# Internet of Things, Services and People (IoTSP)

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

## Top benefits

<table>
<thead>
<tr>
<th>Benefit</th>
<th>Improvement</th>
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<tbody>
<tr>
<td>Improve operations visibility</td>
<td>By providing complete, accurate and timely data</td>
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<td>Improve coordination between functional silos</td>
<td>By providing better visibility and real-time management system integration</td>
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<td>Support improved production rates and throughput</td>
<td>By providing better planning capabilities to minimize bottlenecks</td>
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<td>Reduce hazard exposure</td>
<td>By removing people from hazardous environments through better information and communications systems</td>
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Securing the future of mining
ABB’s vision for mining companies is now closer

- ABB portfolio provides visibility and optimization across the value chain
- ABB products and systems will drive fundamental change in the way a mining 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™