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

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

Mechanization

- 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

Automation

- 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

Optimization

Four key mining industry requirements

- Productivity
- Safety
- Environment sustainability
- Reliability

Productivity in tons / person / year

- ’000 tons
- 1890: Manual production
- 1930: Mechanical production
- 1960: In-situ remote production
- 1980: Projected
- 2020: Automated production

Productivity trends over time:

© ABB
ABB in Mining today / ABB Video
Fostering a one-system approach

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

Headquarter ERP and business systems
ECS, ISA-95, OPC...

Corporate network

Mobile / remote operation engineering and maintenance
Automation system network

Firewall router

AC800 M process controller

High integrity control safety shutdown fire and gas

Sub-system controller AC800 M

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

800xA based integrated sub systems

Operation, engineering and maintenance
Process optimization
Production management

Main process and power control

Firewall
Router

Corporate network

Wireless communication

High integrity control safety shutdown fire and gas

Sub-system controller AC800 M

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

800xA based integrated sub systems
Next level mining
Expanding customer value proposition beyond the simple system provider approach

Customer value chain penetration

- Plan / design
- Build
- Operate

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

Today

Moving forward
New software-based products and services
- e.g. Asset Health
- e.g. life-cycle services

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

Integration of equipment, systems and people…

Integration of communication infrastructures
Integration of subsystems
Integration of systems at different sites
Integration of higher level applications

...enabled by technology...

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

...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
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

© ABB
Integrated Mine Operations

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

<table>
<thead>
<tr>
<th>Analyze</th>
<th>Plan</th>
<th>Schedule</th>
<th>Monitor</th>
<th>Automate</th>
<th>Communicate</th>
<th>Control</th>
<th>Sense</th>
</tr>
</thead>
</table>

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

- Ore feeder
- Concentrate transport

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

Ultimate link between control and enterprise levels

### Production planning

<table>
<thead>
<tr>
<th>Mine Design</th>
<th>Production Planning</th>
<th>Assets</th>
<th>Work Force</th>
<th>Customers</th>
<th>Investors</th>
<th>Finance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Production plan</td>
<td>Asset availability</td>
<td>KPI report &amp; visualization</td>
<td>Status on-line</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Control System

<table>
<thead>
<tr>
<th>Control system</th>
<th>Equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control system</td>
<td>Drilling Rig</td>
</tr>
<tr>
<td>Control system</td>
<td>LHD/Trucks</td>
</tr>
<tr>
<td>Control system</td>
<td>Hoits</td>
</tr>
<tr>
<td>Control system</td>
<td>Mills</td>
</tr>
<tr>
<td>Control system</td>
<td>Flotation</td>
</tr>
<tr>
<td>Control system</td>
<td>Material Handling</td>
</tr>
<tr>
<td>Control system</td>
<td>Stockyard</td>
</tr>
<tr>
<td>Control system</td>
<td>Port</td>
</tr>
</tbody>
</table>

### Activities

- Work orders
- Activity report
- Machine operation data
- Production data (Machine position)

### Processes

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

© ABB
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
Operator View
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 sub optimally

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

The new way
Reacting to asset condition in real time
Reduces losses due to equipment failure

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
Asset condition informs real time decision
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
4 The result is higher equipment utilization, increased recovery and lower energy consumption
5 The old way
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. Mine digs, blends and mixes ore automatically
4. Delivers to product to stockyard or customer

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
Production targets optimized for market conditions
Process set points refined to maximize financial returns

1. IMO stand to link business systems and process control systems

2. 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

3. Price index (2012 = 100)

4. IMO allows process control systems to implement new process set points

5. IMO maximizes financial returns for current feed material and product pricing
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

The old way Remote monitoring of equipment, preventive maintenance
Underground electricals and autonomous equipment
## Top benefits

<table>
<thead>
<tr>
<th>Benefit</th>
<th>How we can help</th>
</tr>
</thead>
<tbody>
<tr>
<td>Improve operations visibility</td>
<td>By providing complete, accurate and timely data</td>
</tr>
<tr>
<td>Improve coordination between functional silos</td>
<td>By providing better visibility and real-time management system integration</td>
</tr>
<tr>
<td>Support improved production rates and throughput</td>
<td>By providing better planning capabilities to minimize bottlenecks</td>
</tr>
<tr>
<td>Reduce hazard exposure</td>
<td>By removing people from hazardous environments through better information and communications systems</td>
</tr>
</tbody>
</table>
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 environments