Intelligent Mining Solutions

With ABB and Ventyx
Agenda

Corporate Overview

Market & Thought Leadership

Mining – An Industry Transforming

Solution (Product) Capability

Questions
Corporate Overview
ABB

- Publicly owned company with head office in Switzerland. Operating for 130 years
  - Predecessor Swiss/Swedish companies founded in 1883/1891
  - Mincom founded in 1979 and acquired in 2011

- $39bn Revenue (2012)
  - $2.2bn mining revenue

- 145,000 employees ≈ 100 countries
  - ≈ 2000 employees in mining business unit

- Strong Growth Outlook in Mining, Software and Services
Who is Ventyx, an ABB Company?

Ventyx brings together industry leaders Ventyx, Mincom and ABB Network Control to create the world’s most complete industrial enterprise software and solution provider, backed by the global reach of ABB, that optimizes the assets and operations of customers in asset intensive industries.
Global Operations and Customers

2,600+ employees in 33 offices (●) and over 2,000 customers worldwide
### Our Customers Are Industry Leaders

#### Energy and Utilities
- Entergy
- Xcel Energy
- Xcel Energy
- Suncor
- Horizon Power
- Duke Energy
- AES
- National Grid
- EDF
- Verge
- NES
- PPL
- TVA
- Snowy Hydro
- Scottish Power
- Pacific Gas and Electric Company
- Ontario Power Generation
- Kansas City Power & Light
- Luminant
- Dominion
- Duke Energy
- Alinta
- Entergy
- Exelon
- TransGrid
- Wolf Creek
- First Energy
- Alliant Energy

#### Mining
- Vale
- MolyCorp
- Alcan
- Goldcorp
- Barrick
- Gold Fields
- Rio Tinto
- BHP Billiton
- Newcrest Mining Limited
- Anglo American
- OZ Minerals
- HudBay Minerals Inc.
- DIAvik
- Centerbridge
- Rejkon
- Banpu
- Ok Tedi Mining
- Kiewit
- LGL
- Mitsui
- Yanacocha
- Mibrag
- PGE
- Queensland Alumina Limited
- Severstal
- Ulukali
- Inkai
- Cambodia Del Olcario

#### Public Infrastructure
- AC Transit
- COTA
- VR
- Valley Metro
- TAC
- OCTA
- MTS
- Yarra Trams
- RailCorp
- Amtrak
- NSW
- NFTA
- Public Transport Authority
- QBuild Queensland Government

#### Oil, Gas Petrochemicals
- Shell
- ConocoPhillips
- Transocean
- ExxonMobil
- Eni
- Osaka Gas
- Peoples Energy
- CAT
- LOGISTICS
- Tenix

#### Government & Defense
- United States Navy
- Australian Government
- Defence
- Forces.ca
- Raytheon
- Boeing
- Thales

#### Telecom & Cable
- Rogers
- CenturyLink
- Comcast
- American Tower
- TDC
- Tele Danmark
- MTS Allstream
- Eircom
- Optus
Market & Thought Leadership
ABB is World’s Largest Process Control and Automation Solutions Vendor

Supervisory Control and Data Acquisition (SCADA) can now provide a wealth of information and knowledge as a means to modify business processes for electric utilities.

 Supported by intelligent field devices, expanded communications networks, and improved compatibility with enterprise level systems, SCADA systems are increasingly utilized to encompass both robust control and automation functionalities.

More importantly, these systems are being leveraged to support higher-level systems that overlap into enterprise optimization and strengthen horizontal integration of the business processes of utilities.*

Source: ARC Advisory, Scada Systems Worldwide Outlook 2009

## ABB + VENTYX in the Market

### Industrial Enterprise Lifecycle

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Control Devices</th>
<th>Communications</th>
<th>Control Software</th>
<th>Industry Apps</th>
<th>Work &amp; Assets</th>
<th>Supply Chain</th>
<th>Admin</th>
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<tbody>
<tr>
<td>• Mining</td>
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<td>• Work mgmt</td>
<td>• Materials</td>
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<td>• Power</td>
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*Broadth spanning the entire asset intensive lifecycle*

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**ABB + VENTYX**

**SIEMENS**

**Schneider Electric**

**ORACLE**

**IBM**
IT/OT Convergence Transforms Real-time Data into Actionable Insights That Drive Operational Excellence

**Information Technology**
Synthesizes big data into critical insights and automated actions

1. Large volumes of data for visibility into condition and status
2. Insights drive just-in-time work to optimize enterprise

**Operational Technology**
Monitors and controls critical assets

1. Respond faster to real time conditions
2. Gain insight for business process improvement
3. Prioritize work to reduce the risk of outages

*Benefits of the IT/OT Converged Enterprise*
Unique Convergence of IT/OT

- **Single strategic supplier** bringing together Operational Technology (SCADA, OMS, DMS etc) and Information Technology (EAM, ERP)

- **Expertise and experience** deriving customer value from the convergence between operational and IT solutions

- **Integration** of Control software (OT) and enterprise software (IT) are two key components of a strategic solution. No ERP software vendor can ever match this tightly capability.

- **Sustainment of critical assets throughout lifecycle** by automating EAM practices via integration to real-time condition information to derive value

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"As we see it, software vendors such as Oracle and IBM are moving more into the operational technology space, while vendors such as ABB are moving into software. These moves promise to bring reality to the talk of convergence of IT and OT. This acquisition does shift the competitive landscape for EAM, strengthening ABB's position in the market."

IDC Energy Insights. 
Extending the Asset Management Footprint - ABB Acquires Mincom. 

"Bridging the IT/OT gap further enables the use of advanced analytics to deliver improved business processes—such as lower costs, reduced risks, better decisions and faster response to new opportunities."

Gartner. The Management Implications of IT/OT Convergence. 
Mining – An Industry Transforming
Industry Macro Challenges

External Pressures

M & A Activity
- Energy and Water Availability
- Increasing Price Inputs

Challenging Geographies
- Digging Deeper
- Exploration Risks
- Mine Development Costs
- Long Planning Cycles
- Expensive Assets & Parts

Security
- Safety

Political & Regulatory Challenges
- Pressure to Reduce Environmental Impact

Internal Factors
- Aging Workforce
- Energy Volatility
- Maintaining Aging Infrastructure
- Recruit & Maintain Skills
- Safety

Energy Volatility
- Minerals / Metals Price Volatility

Safety
- Transportation Costs and Bottlenecks

Minerals / Metals Price Volatility

Pressure to Reduce Environmental Impact
Steps Toward Mining 2.0

Visibility
- Connect management plan with production operations solutions
- Get visibility across business silos
- Connect execution control systems with operational planning
- Get visibility of operations using telemetry, field force mobility solutions, and advanced reporting

Automation
- Real-time condition based monitoring can significantly improve maintenance effectiveness
- Ability to drill down into asset details allows detailed root-cause analysis
- ‘What if’ style predictive analytics helps prioritize work

Mining 2.0
- The ‘mining factory’ connects demand and supply to automatically adjust production outputs
- More of the materials handling process is automated focusing on continual vs batch style supply
- Use of mass flow technologies to limit potential bottlenecks
Mines for the Future

- Continuous mining on demand
- High automation level
- Batch and tag tracking
- Blending and mixing stations on-line
- Centralised control room
- High instrumentation level
- On-line statistics of production
- Benchmark for underground
The Future of Mining: Key Principles

- Review & Improve
- Plan
- Schedule
- Monitor
- Automate
- Communicate
- Control
- Sense

Ventyx
Mining Value Chain – Measuring Progress Every Step of the Way

- Drill-blast cost/ton
- Dig rate by shovel
- Fuel/ton
- Dilution
- Availability
- Throughput
- Reagents/ton
- KW-hours/ton
- Delay penalties per month
- Ship over-under load/month
- Shipping queue length

Metric per Unit-Product-Produced

Equipment-incidents/month

Corporate Headquarters

- VP Health, Safety & Compliance
- VP OPS
- CFO
- CIO
- VP Procurement
- Human Resources
- Budget & Finance
- Governance & Compliance
- Technology

Mine Exploration & Development

- Mine Operations
- Maintenance
- Plant Operations
- Logistics Service Providers

Customers
Transformational Productivity Shift Required

The mining industry has been through a number of technology ‘step-changes’ which have driven dramatic increases in productivity. Research into mining technologies indicate significant new technologies heralding the next era of mining productivity.

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

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

**Optimization**
- More responsive demand and supply
- Higher levels of automation driven by labor shortages, and remote mining locations
- Limiting bottlenecks by adopting as more continuous
- High levels of visibility across the value chain and across operations with artificial intelligence

![Graph showing the transformation of mining productivity from 1900 to 2025](image-url)
How Will We Drive Fundamental Change?

Extended Automation → Extended Operations Management

- **Unparalleled view of breadth and depth of a mining site/enterprise enabling operation as a single coherent system, locally or remotely**
- **Automate complex mining operations functions**
- **Integrate systems, technology and people to deliver sustainable improvements**
- **Provide a framework to deliver expertise and support independent of location**
Using ABB Extended Automation and Ventyx Extended Operations Management, we will:

- Provide an unparalleled view of the full breadth and depth of a mining site or enterprise, and to allow it to operate as a single coherent system, locally or remote.
- Automate complex mining operations functions.
- Integrate systems, technology and people to deliver sustainable improvements.
- Provide a framework to deliver expertise and support independent of location.
Intelligence Across Your Operations

Intelligent Production

<table>
<thead>
<tr>
<th>Mine Short Term Plan</th>
<th>Crusher Plan/Performance</th>
<th>Concentrate Plan</th>
</tr>
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<tbody>
<tr>
<td>Drill Plan/Performance</td>
<td>Mill Plan/Performance</td>
<td>Stockpile Modeling</td>
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<tr>
<td>Blasting Plan/Performance</td>
<td>Agglomeration Plan/Performance</td>
<td>SX &amp; EW Plan &amp; Performance</td>
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<tr>
<td>Dump Plan/Performance</td>
<td>Leaching Performance</td>
<td>Shipping Plan &amp; Performance</td>
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<tr>
<td>Hauling Plan &amp; Performance</td>
<td>Flotation, Tricking and Filtering Plan and Performance</td>
<td>Overall Mine Plan/Performance</td>
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</tbody>
</table>

Intelligent Asset Operations

- Mine Asset Management Strategy
- Asset Health
- Fleet Location and Productivity
- Maintenance Contractor Dashboard

- Field Crew Assignments, Location, Backlog, Productivity
- Critical Work Dashboard
- Critical Inventory Levels
- Control Centre in the Field

Intelligent Commercial Operations

- Sales Targets/Performance
- Revenue Analysis
- Commodity Market Indicators
- Supplier/Contractor Performance
- Market Indicators
- Site/Division Performance
- Staff Turnover/Retention
- Opex/capex Project Status
- Health and Safety
- Cost Control and Analysis
- Hedging and Contract Analysis
- Environment Indicators
## Integrated Solution: Driving Business Benefits

*Improve overall operational performance through vastly improved visibility, planning capability and real-time coordination.*

<table>
<thead>
<tr>
<th>Top benefits</th>
<th>How we can help</th>
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</thead>
<tbody>
<tr>
<td>Improve operations visibility</td>
<td>Complete, accurate and timely data helps optimize and operational coordination</td>
</tr>
<tr>
<td>Improve coordination between functional silos</td>
<td>Better visibility and real-time/management system integration enables much better coordination between functions to achieve more global operational optimization</td>
</tr>
<tr>
<td>Support improved production rates and throughput</td>
<td>Better visibility and planning capability minimizes delays at key bottleneck areas improving overall system throughput</td>
</tr>
<tr>
<td>Reduce hazard exposure</td>
<td>Removing people from operational environments through better communications and information systems reduces exposure to potentially hazardous environments</td>
</tr>
</tbody>
</table>
Enabling new ways of doing business
ABB leads the market for integrated IT/OT solutions

Operations Intelligence Center
Industrial Control Centers
Optimization of Assets and Work
Operations Intelligence Centre Initiative Overview
Driving whole of operations visibility and performance

**Scope:** All workflows for 6-7 key sales and operations roles in Operations Intelligence Centre setting.

**Result:** Integrated decision support to maximize value of asset and production.

**Examples:**
- Spot Sales workflow
- Mine-Mill optimization
- Operations recovery/reschedule on equipment downtime
Business Performance Management

- Asset Management
- Fleet Production Monitoring
- Product Quality
- Work Management
- Corporate Performance
- Asset Reliability
- Energy Management
- Capital Spend Tracking
Blend Process Leveraging IT/OT Convergence

**The old way:**
- No information on upstream downstream impact
- Cant prioritize significant data volumes - manual
- Production, equipment and other control systems not integrated
- Blend
- No optimization of coal delivery chain

**Value Proposition**
Optimize coal allocation and blending by using online contractual information that leverage real-time condition monitoring and stockpile quality data to drive automation and visibility.
Mining Plant Operations Optimization
Leveraging IT/OT convergence

1. Advanced process control (APC) manages reagent dosing and flow rates in real-time (OT).

2. Geological model and real-time material tracking provides short term feed characteristic schedule to APC.

3. Sales system monitors global index pricing for products.

4. APC refines control set points to maximize returns for current feed material and product pricing.

5. Sales system periodically provides relative pricing updates to APC.

6. On stream analyzers in plant reconcile actual feed with model to further improve predictability and optimization.

The old way:
- No information on relative product pricing
- No information on feed material
- Plant set points static
- Production, equipment and other control systems not integrated

Value Proposition
Increase plant recovery and optimize product mix based on current pricing.
Solution (Product) Capability
# Point Solution Operations: Driving Business Benefits

*Improve demand chain performance, reduce product quality issues, coordinate operations better.*

<table>
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<tr>
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<tbody>
<tr>
<td>Improve demand chain throughput</td>
<td>Complete, accurate and timely data helps optimize and improve demand chain coordination</td>
</tr>
<tr>
<td>Reduce off spec product shipments</td>
<td>Detailed and regularly updated stockpile models, visibility of in transit coal quality and blend management help keep products within quality specifications and raise alerts when products go out of spec</td>
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<tr>
<td>Accurate and timely invoicing</td>
<td>Comprehensive contract management for local and export sales. Deep integration with logistics ensures all service fees, delay allocation, quantities and qualities are accounted for.</td>
</tr>
<tr>
<td>Revenue and hedging profit/loss allocation</td>
<td>Full tracking from each individual mine through to final shipment allows fair and auditable allocation of shipment revenue to source operation</td>
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</table>
**Point Solution Operations: Driving Business Benefits**

*Improve demand chain performance, reduce product quality issues, coordinate operations better.*

<table>
<thead>
<tr>
<th>Example Business Outcomes</th>
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<tbody>
<tr>
<td><strong>$2M</strong> per year</td>
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<tr>
<td><strong>$35M</strong></td>
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<tr>
<td><strong>$1M</strong> per shipment</td>
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<tr>
<td><strong>70%</strong></td>
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Intelligent Mining Solution (IMS) Suite

**MineScape** is a suite of integrated geological modeling, mine design, and mine planning solution designed for open cut and underground mining operations for coal and metalliferous deposits. It is in use by more than 200 of the world’s most complex mining operations.

**MineMarket** is specifically designed to manage the product logistics chain, shipping, transportation, and related commercial operations in the mining industry.

**CCLAS** is a Laboratory Information Management System (LIMS) which automates processes in an analytical laboratory including sample registration, barcode label printing, work list generation, on-line data capture from a wide range of analytical instruments and automatic reporting and transfer of results.

**Assay Management** is a web-based solution that tracks and stores both analytical data and sampling protocols for all types of samples in the mining value chain – even the most complex metallurgical test work samples.

**Production Accounting** is a flexible and configurable web-based metallurgical accounting system purpose-built and designed for the mining and metal processing industries.
Ventyx Intelligent Mining Solution (IMS)

MineScape
- Geological Modeling
- Mine Planning/Scheduling
- Mine Operations

MineMarket
- Material Logistics/Blending
- Inventory Management
- Sales and Marketing

CCLAS / Assay Management
- Lab Management
- Sample Tracking
- QA/QC Quality

Production Accounting
- Plant Reporting
- Mass Balance
- Plant Efficiency
Ventyx IMS – Technical Mining Systems

- Ventyx Production Accounting
- Ventyx MineMarket
- Ventyx MineScape
- Ventyx Assay Management
- Ventyx CCLAS (LIMS)

- Geological Exploration & Evaluation
- Mine Plan
- Mine Operation
- ROM
- Process Plant
- Product Stockpiling
- Product Transportation
- Reclaiming & Ship loading
- Shipping
- Sales
Ventyx IMS – Technical Mining Systems

Ventyx Production Accounting

Ventyx MineMarket

Ventyx Assay Management

Ventyx CCLAS (LIMS)

Geological Exploration & Evaluation
Mine Plan
Mine Operation
ROM
Process Plant
Product Stockpiling
Product Transportation
Reclaiming & Ship loading
Shipping
Sales
Overview

MineScape is a product for businesses who need to store geologic data, build geologic models, develop mining plans and forecast mine production.

Business Issues

• Geologic modeling and mine planning is a labor intensive process with a shortage of skilled staff.
• Getting it wrong can significantly decrease expected revenue and increase expected costs.
• Commodity price swings, modified sales targets, unplanned equipment downtime and acquiring new data trigger mining plan changes.
• “The majors [miners] seem to be focused on ERP implementation and for the life of me I can’t figure out why. For a miner the money is in the geological modelling of the orebody and running the mine and the logistics of getting the ore to the customer. I argue that if you are excellent at the latter and mediocre at the former you will be far more successful than if you do it the other way around. The reality is the value is in the geotechnical and EAM (enterprise asset management) applications not ERP.” – Dan Miklovic, IT Analyst, Gartner.
Ventyx MineScape

- The most integrated mining planning tool available
- Offers a wide functional coverage on geological modelling and mine design, for both open pit and underground operations
- Currently in use in more than 200 of the most complex operations, that range from Nickel in Russia to Coal in Indonesia
MineMarket Overview

**Overview**

MineMarket provides integrated management of product logistics and sales and marketing for mining operations, in an integrated, traceable and auditable platform.

**Business Issues**

- Product logistics: tracking quantity and quality throughout the logistics chain, while keeping track of related transportation and costs
- Stock management for diverse materials: ores, concentrates, discrete units (cathodes, bars, ingots, etc.)
- Sales and purchase contract management
- Blending for quality
- Invoicing, collection and payments integrated to contract management: flexible and rich contracts to cater for all required contract terms
- Sales forecast aligned with product logistics scheduling
- Production and sales analytics
- Integrate hedging and risk management to the physical process
- Integration to mining execution systems and Assay information sources to automate data capture
Ventex MineMarket Capability Overview

Inventory Management and Accounting
Transport Logistics
Stockpile Modeling
Traceability and Contributors
Blend Planning & Yard Management
Planning & Scheduling
Product Specifications
Sales & Marketing
MineMarket Solution Overview

- **Purpose**
  - Deliver product to the market
  - Compliance / regulations: traceability, audit trail and accountability
  - Financial impact of Product logistics

- **Applies across value chain**
  - Mining/Processing: Produce to meet market requirements
  - Logistics: Deliver efficiently at low cost
  - Sales/Invoicing: Cash realization based on contractual conditions
  - Hedge: Protect the company against market fluctuations

- **Product Logistics is a core business process**
Ventyx IMS – Technical Mining Systems

Ventyx Production Accounting

Ventyx MineMarket

Ventyx MineScape

Ventyx Assay Management

Ventyx CCLAS (LIMS)

Geological Exploration & Evaluation
Mine Plan
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Shipping
Sales
CCLAS Overview

Overview

CCLAS is a Laboratory Information Management System (LIMS). It enables any laboratory to manage the flow of their samples through the laboratory. It also allows checking of standards and production samples. Integration of CCLAS allows upload direct from instruments and publishing of assay results to the client or process systems.

Business Issues

• Faster reporting in to clients and plant process systems
• Proving the quality of assay values to legislative bodies
• Managing running costs effectively
• Tracking samples through the laboratory to highlight capacity issues and bottle necks.
• Reduce transcription errors from instrument to process systems.
Ventyx CCLAS

- Automated Sample Registration
- Online Data Capture from Lab Instruments
- Automatic Data Calculations
- Integrated Audit Trailing
- Spreadsheet-like Manual Data Entry
- Quality Control and SPC Charts
- Instrument Management
- Data Export & Reporting
- Invoicing
- Consumable Tracking
- Sample Storage
- Automation of routine laboratory tasks
- Dashboard & Management Reports.
Ventyx IMS – Technical Mining Systems

- Ventyx Production Accounting
- Ventyx MineMarket
- Ventyx MineScape
- Ventyx Assay Management
- Ventyx CCLAS (LIMS)

Geological Exploration & Evaluation
Mine Plan
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## VAM Overview

### Overview

VAM enables the process of procuring analytical data from laboratories from sample registration, through sample dispatch and results receipt and distribution of the results to decision systems. It enables rigorous quality control of all analytical data across the mining business.

### Business Issues

- Analytical data underlies all significant financial decisions in the mining industry, whether it is confirming the size of the orebody to be mined or agreeing invoice price for product sold based on product quality.
- Errors from manual handling of analytical data are as problematic as error in the analytical data.
- Involvement of numerous parties (including JV’s and external parties).
- Needs to integrate across numerous, often disparate systems.
- Maintaining the chain-of-custody in a mining environment is complex.
- Mining most often provides difficult operating conditions.
- Need to continuously ensure that samples are representative and that the assays are accurate.
Ventyx Assay Management Overview
Register Samples / Review Results ...

1. Collect Sample & weigh
2. Register sample & weight
3. Print Barcode
4. Dispatch Samples
5. Integrate Sample Detail
6. Scan Sample & weigh
7. Track Sample
8. Finalise Assay Results
9. Transfer Assay Results
10. Perform QA / QC
11. Publish Assay Results
Ventyx IMS – Technical Mining Systems

- Ventyx Production Accounting
- Ventyx MineMarket
- Ventyx MineScape
- Ventyx Assay Management
- Ventyx CCLAS (LIMS)

Geological Exploration & Evaluation
Mine Plan
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### VPA Overview

#### Overview

VPA is a metal accounting and production reporting system for mineral processing plants (concentrators, smelters, refineries etc). It allows plant metallurgists and production managers to easily compile reliable production and inventory reports taking into account inherent errors in plant related measurements.

#### Business Issues

- Unknown losses through production process remain undetected
- Timely reporting to corporate head office
- Skilled workers are tied up in inefficient reporting processes
- Spreadsheet pose audit risk – metal accounting is a direct input to financial accounting, particularly inventory
- Plant recovery problems remain undetected
- Compliance to new standards (Amira P754)
Ventyx Production Accounting Capability Overview

Metal Accounting
Reagent/Consumable Usage Tracking
Operator Logsheets
Downtime
Services Usage (Water / Power)
Water Balance
Energy Balance
VPA SOLUTION OVERVIEW

Business Management System (e.g. ERP)

Mass, KPIs, Metal Content, Inventories

METAL ACCOUNTING BUSINESS PROCESS

Acquire ➔ Validate ➔ Authorize ➔ Calculate ➔ Report ➔ Publish ➔ Analyze ➔ Audit

Wet tons, volume, assay, mass, moisture, density, transaction, shift, day, week, month
The future of Mining...
Integration between ABB 800xA Distributed Control System and Ventyx MineMarket
System-Bridging the Gap between IT and OT
Ventyx Intelligent Mining Solution (IMS)

MineScape
Geological Modeling
Mine Planning/Scheduling
Mine Operations

MineMarket
Material Logistics/Blending
Inventory Management
Sales and Marketing

CCLAS / Assay Management
Lab Management
Sample Tracking
QA/QC Quality

Production Accounting
Plant Reporting
Mass Balance
Plant Efficiency
Plant/Mill optimization
MineMarket in Intelligent Control Center
Better ore grinding due to integration of automation layers
Technologies: Inventory Management and Model Predictive Control

- **Problem**
  - Ore variability (mineralogy, hardness, composition) is the largest source of disturbance for process stability and performance in ore processing plants, grinding and flotation
  - If ore properties were known ahead, the processing plant can be prepared ahead and minimize the effect on production and quality

- **Solution**
  - As pile is built, use inventory management solution MineMarket to store ore properties in 3D stockpiles models
  - Retrieve the ore property information in real time to be used by model predictive controller implemented in 800xA

- **Business case**
  - Customer: higher performance and process stability
  - Customer data shows that improvements worth tens of millions of dollars are achievable
Business Case Scope

Mining Activities

- Top Soil
- Drilling
- Overburden
- Waste Dump
- Parting Removal
- Loading
- Hauling
- Reject Disposal
- Rehabilitation

Processing

- ROM Stockpiles
- Processing Plant

Transportation

- Transporting
- Rail Head Stockpiles
- Train Loading
- Train Unloading
- Port Stockpiles
- Ship Loading

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Inventory management and MPC for optimal ore grinding
Solution Design

Legend:
1: Yard machinery status data
2: Online analyzer quality data
3: Flow rate, position, direction (very minute)
4: Quality data (every minute)
5A: Aggregated (stack/reclaim transactions (*)
5B: Aggregated quality data ()*
6: Stockpile breakdown query
7: Stockpile breakdown response
8: Control signals (reclaiming)
9: Feed characteristics (moisture, hardness etc.)
10: Visualisation (Smart Client)
11: Advanced Process Control
Concentrator/Mill operations leveraging IT/OT convergence

1. Geological model and real-time material tracking provides short term feed characteristic schedule to APC (IT)

2. Advanced process control (APC) manages grinding and flotation in real-time (OT)

3. Sales system periodically provides quality needs and pricing updates to APC (IT)

4. APC refines control set points to maximize returns for current feed material and product pricing (IT)

5. On stream analyzers in plant reconcile actual feed with geological model to further improve predictability and optimization (OT)

The old way:
- Production, equipment and other control systems not integrated
- No information on relative product pricing
- No information on feed material
- Plant set points static

Value Proposition
Increase plant recovery and optimize product mix based on commercial needs and ore feed properties through integration of processes and business systems
The future of Mining...