Welcome

Integrated Planning & Optimization for Mining

SolveIT Software

Schneider Electric
About Us

• Australian founded and based: Brisbane, Melbourne, Adelaide, Perth, Toronto, RSA, Europe, Brazil.
• Acquired by Schneider Electric August 2012
• Predominately focused on mining & bulk materials. Also deployed in metals, F&B, Chemical, Wine, etc.
• Enterprise applications for integrated planning, scheduling, optimization and simulation.

• Simulation & Optimization Solutions (Greenfield, & Established)
• Integrated Pit-to-Port Planning, Scheduling, Optimization & Decision Support
• Next Generation, Integrated Mine Planning
Schneider Electric 2012

Large, Global Company

24 billion € of sales in 2012

140 000+ employees in 100+ countries

5% of sales devoted to R&D

Mining & Metals

+517 m€ Sales in 2012

+300 People

+11% Growth in 2012

14 Global Strategic Customers

Balanced Geographies Sales, employees

North America 25% 28 300

Western Europe 30% 44 200

Rest of World 18% 22 000

Asia Pacific 27% 42 600

Schneider Electric - MMM
Our Experience in Mining
Integrated Decision Support

Simulation & Optimization

Mine Planning -> Ore Processing -> Mine Stockpile -> Rail Logistics -> Port Stockpile -> Port Logistics

Workforce
Maintenance
Production
Energy
The “Prize”: Silo vs. Global Optimisation

Local Optimisation: What’s best for an operating silo

Global Optimisation: What’s best for the entire supply chain
Optimizing Enterprise Resources

- Energy
  - Power
  - Water and Environmental
  - Consumables
  - Omissions

- Assets
  - Fixed Plant
  - Mobile Fleet
  - Logistics Infrastructure
  - Maintenance

- Production
  - Demand/Throughput
  - Sales Contracts
  - Capacity
  - Quantity
  - Quality
  - Blending

- Workforce
  - Competencies
  - Rosters and Schedules
  - Tasks
  - Transport
  - Training

- Simulation
- Optimization
- Prediction
Fast ROI Model – Mine to Port

• Cost Reduction
  • Demurrage
  • Penalties
  • Rail Variability

• Product Specification Improvement
  • Blending
  • Net Revenue objectives

• Energy Optimization
• Workforce Optimization

• Asset Utilization Increase
  • Reduce downtime
  • Synchronized production and maintenance visibility
Manage & Improve Performance: Sustainability – Across the Supply Chain
3D Visualization of Supply Chain, Constraints, etc.
3D Visualization of Supply Chain, Constraints, etc.
Customer Business Case & ROI

• Need
  - Maximize throughput under expansion phases
  - Integrate upstream mine operations with port for dynamic and cargo assembly terminals

• Integration with SAP, other 3rd party solutions

• Scope
  - 8 mines, 3 rail corridors and 3-5 ports
  - Competitive rail network including multiple owners and operators
  - Production logistics
  - Complex port operation with multiple stockpiles, expanding fixed asset infrastructure and new port modelling

• Why SolveIT
  - Next generation optimisation capability
  - Management of moving bottlenecks, non-linear and dynamic push/pull factor
  - Proven ability on other bulk commodity supply chains

• Outcome
  - September/October 2012 - two months record throughput at Hay Point Coal terminal
    - Achieved 4 Mt+ attributed to APS
Managing Coal from Pit-to-Port in Bowen Basin

- Multiple coal mines in the Bowen Basin, connected by a single rail network to multiple port facilities.
- Multiple mine stockpiles are fully integrated to permit aggregate resource inventory management.
- Visualize, Select & Transport the right product based on need, constraints, throughput, quality, etc.
Current Mining Customers

- **Mine Planning, Scheduling and Optimization**
  - Multi-commodity – iron ore, coal and base metals
  - Multiple planning horizons
    - Optimization for LOM, 5 year and medium to short term requirements
    - Live run quality optimization
    - LOM risk and uncertainty models

- Open pit and underground

- Simulation capability
  - Fleet capacity/productivity
  - Fast what-if
  - Multiple scenario analysis
  - Optimum excavation sequence
Current Mining Customers

- Integrated Pit-to-port planning, scheduling and optimization
  - Multi-commodity: iron ore, coal and base metals
  - Multiple planning and scheduling horizons
    - Strategic planning and simulation
    - Complex blending, stockpile management
    - Planning - 5 year+; 2 year rolling
    - Dynamic scheduling
      - 12 week
      - 1 week
      - day of operations
  - Rail schedules
  - Port / berth / hatch plans
  - Multi-mine sourcing/inventory
  - Optimizing throughput (pit-to-port)
Current Mining Customers

- Accommodation Planning and Optimization
  - Travel and accommodation forecast demand management across dispersed geographical territory
  - Optimize utilization of rooms, travel routes and crew/shift location

- Exploration Drilling Program Optimization
  - Maximise drilling budget expenditure
  - Track and schedule drill rig performance
  - Optimize drill rig routing
Current Infrastructure Customers

- **Workforce Optimization**
  - Crew Rostering
  - Crew Scheduling
  - Crew Tracking

- **Capacity Optimization**
  - Track Management
  - Throughput Maximization
  - Maintenance and Outage management
Mine Planning

How are we applying this science to Mine Planning and What is the Future?
Value provided by SolveIT

● Use SolveIT to determine the optimal excavation sequence
  ● Other mine planning solutions consider the excavation sequence as a fixed input (or use basic rules) from which material movements are optimised. This is only solving half the problem and significant value could be left unrealised.

● Goes beyond using averages of averages
  ● Because SolveIT models the business problem, and not a mathematical representation of the problem, the accuracy of the output can be trusted by mine planners. Average inputs result in average outputs.

● Ability to adapt
  ● Changing mining strategies can be configured within the application without the need for script creation/software engineering. Configuration is performed easily by the mine planner themselves.
Advanced Mine Planning/Optimization

The problem:

What is the best increment excavation sequence and the best material blending combination such that tonnage, quality, cost, and NPV targets are optimized?
The challenge: Increasing Complexity

Material complexity
Over 1,000,000 blocks of material within 10,000 increments containing multiple material types in each.

Integrated Supply chain complexity
From excavation to haulage to blending to material destination, the best plan may be different if the business priority is tonnage, cost or quality.

Business rule complexity
30 year planning horizon broken up into quarterly buckets, with the ability to configure 100’s of business rules differently for each bucket.

Decision making complexity
Business problems requiring non-linear approaches to providing realistic, optimal and most of all, executable business outcomes.

Material complexity * Supply chain complexity * Business rule complexity * Decision making complexity
High level decision points

1. Where does the digger move next?
2. How much does a digger excavate?
3. Is material waste or ore?
4. Is back filling now possible?
5. Which waste dumps do we send the waste to?
6. Is the ore to be sent to crusher or to a stockpile?
7. Which crusher to send to?
8. Which stockpile to send to?
9. What material to draw from which stockpile?
10. How much haulage is needed from pit to crusher?
11. How much haulage is needed from pit to stockpile?
12. How much haulage is needed from stockpile to crusher?
13. Which plant to use?
Utilizing Next Generation Optimization

Non-linear optimization techniques are required to solve non-linear models:

- Genetic Algorithms
- Simulated Annealing
- Hybrid Neural Networks
- Evolutionary Strategies
- Hill-Climbers
- Ant Systems
- Tabu Search
- Evolutionary Programming

SolveIT Optimization Platform
Optimization of Extraction Schedule, Block Sequencing, Resource Assignments, KPI’s

<table>
<thead>
<tr>
<th>Tonnage Schedule</th>
<th>Increment Schedule</th>
<th>MultiView</th>
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<td>Color scheme:</td>
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One Unified Application: Mine Planning, Pit-to-Port

Configuration of Mine Resources

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<th>Trimming Speed (t/h)</th>
<th>Operating Cost (Tonnes)</th>
<th>Rate (Tonnes)</th>
<th>Effective Utilisation</th>
<th>Start Increment</th>
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One Unified Application: Mine Planning, Pit-to-Port

Optimizing the Extraction Sequence to your KPI’s, Constraints
One Unified Application: Mine Planning, Pit-to-Port

Visualize and Optimize the Removal of Blocks/Increments
Integrated Pit-to-Port Planning, Scheduling & Optimization
Pit-to-Port: Port Stockpiles, Ship Assignments, Hatch Plans, Rail, Stacker/Relcaimers
Scheduling Board - Optimization of Coal Movement:
Pit - Wash Plant – Stockpile – Rail – Stockpile – Ship (and Blending)

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</table>
Thermal and coking coal wash plant processing is balanced with production constraints and targets for each product:
Ship Scheduling & Assignments, Maintenance Windows, Tidal Chart

**Ship Scheduling**
- Port Scheduling
- Rail Scheduling
- Inventory
- Scheduling KPIs
- Alerts/Notifications
- Configuration
- Audit Trail

**Scheduling Board**

<table>
<thead>
<tr>
<th>14/04/13</th>
<th>15/04/13</th>
<th>16/04/13</th>
<th>17/04/13</th>
<th>18/04/13</th>
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<th>26/04/13</th>
<th>27/04/13</th>
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**Maintenance Details**
- **Name:** Unassigned
- **Window Start:** Mon Apr 15 08:00:00 CST 2013
- **Window End:** Sat Apr 20 08:00:00 CST 2013
- **Activity Start:** Mon Apr 15 08:00:00 CST 2013
- **Capacity:** 0.0%
- **Duration (Hours):** 125.0

**Ship Schedule**
- **SL8**
- **SL7**

**Voyages**
- **Outage ID:**
- **SL8 Safety Check**
- **SL8 Safety Check**
- **SL8 Safety Check**
- **SL8 Safety Check**
- **SL8 Safety Check**
- **SL8 Safety Check**
- **SL8 Safety Check**
- **SL8 Safety Check**
- **SL8 Safety Check**

**Maintenance Type:** Unassigned

**End:** 31/10/11

Schneider Electric - MMM
Validate Maintenance Activities with Supply Chain Model
Managing Constraint Violations Across Supply Chain

- Ship loader – double booked due to delay in loading
- Ship Hatch Plans missing
- Could apply to delays in ships, rail, shortages in production, stockpiles, etc.
Monitoring Inventory Flow & Stockyard/Port
KPI’s – From Pit-to-Port

Dashboard

KPI Report
- Shipping Demurrage
- Port Throughput
- Railling Throughput
- Terminal Availability
- Rail Demand Variability
- Terminal Utilisation

Constraints
- Constraint Violations

Stockyard Report
- Hay Point Coal Terminal
- Dairymple Bay Coal Terminal
- Ke Rings Coal Terminal
- Barney Point Coal Terminal
- Abbot Point Coal Terminal

Maintenance Report
- Detail
- Summary

Summary Report
- Rail Schedule (Port)
- Rail Schedule (Mine)
- Ship Loading
- Rail Order Report
- Rail Plan Report

Scenarios
View for
- Next 24 hours
- Next 48 hours
- This Week
- Next Week
- Date range

View by
- Days
- Weeks
- Months

Corridor
- Capricornia
- Goonyella
- Newlands

Target

Rail Demand Variability (Deviation = 6.0, Mean = 8.6)
IPOS (Integrated Planning & Optimization Solution)

Real time decision support systems – Holistic Optimization

Visualization of Planned Production, Production Execution

Fleet Delays
Downtime, Metal Accounting, Production, Shift & Maintenance Reporting, Product & Inventory Tracking

Mine Planning
Ore Processing
Mine Stockpile
Rail Logistics
Port Stockpile
Port Logistics
Ampla – the Leading MES for Bulk Materials

- MES designed from the ground up for mining and mineral processing
- 78% of Schneider Electric MES business is MMM
- Of this 78%, over 60% is iron ore and coal (bulk commodities)
- Iron Ore & Coal companies with Ampla MES implemented in multiple sites are:

  **Iron Ore**
  - Rio Tinto Iron Ore – Australia
  - Cliffs Natural Resources - Canada
  - Rio Tinto Iron Ore – Canada
  - BHP Billiton Iron Ore – Australia
  - Vale Iron Ore – Brazil
  - AngloAmerican – Brazil

  **Coal**
  - BHP Billiton Coal – Australia
  - BMA Coal – Australia
  - China Coal – China
  - Shenua Coal - China
  - Xstrata Coal – Australia
  - Rio Tinto Coal – Australia
  - Peabody Energy – USA
  - BHP Coal - USA
Ampla in Mining and Metals

Since 2001 Starting with BHPB Cannington Mine

- **Queensland**
  - BMA Coal (all 8 sites)
  - BHPB Cannington (all areas)
  - Queensland Alumina (Refinery)
  - Rio Tinto Coal Australia (3 sites)
  - Xstrata Newlands Coal
  - Xstrata Zinc

- **Western Australia**
  - BHPB Iron Ore (all 8 sites)
  - Rio Tinto Iron Ore (all 10 sites)
  - BHPB Nickel West (all 5 sites)
  - Cockburn Cement
  - Sino Iron (Citic Pacific Mining)

- **Northern Territory**
  - Rio Tinto Alcan Gove
  - BHPB GEMCO Manganese
  - Rio Tinto ERA

- **New South Wales**
  - BHPB Illawarra Coal
  - Tomago Aluminium (Smelter)
  - OneSteel Sydney Mill
  - Bluescope Steel (2 sites)
  - Xstrata Newpac Coal
  - Centennial Coal

- **Victoria/Tas**
  - TruEnergy (Coal Mining)
  - Nyrstar Zinc (Smelter)

- **South Australia**
  - Adelaide Brighton Cement (2 sites)
  - BHPB Olympic Dam (all areas)

- **North America**
  - BHPB San Juan Coal USA
  - Peabody Energy USA
  - Cleveland Cliffs Canada
  - Rio Tinto IOC Canada

Total: 60 sites
Where do we Deliver Value?

Pit to port (product stockpile to port)

Pit to port

Block to port

Simulation - mining

Port to plant – steel

Next Generation Mine Planning

SolveIT utilizes existing 3D models to optimize sequence considering multiple constraints. Excellent fit for Oil Sands, & Open Pit mine operations.