Integrated Planning, Scheduling & Optimization

Optimizing for:

- Resource to Market
- Advanced Mine Planning
- Energy Management / Downtime / Metal Accounting / Production Analysis

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Agenda

● Introduction to Schneider Electric
● Customer Examples & Optimization of Complex Business Problems
● Business Unit (Silo) vs. Global Optimization of your Supply Chain
● Optimizing Operations in Times of Increasing Change & Volatility
  ● Resource to Market and Advanced Mine Planning
  ● Optimizing your Pit-to-Port Value Chain
● Integrated Planning & Optimization Solution (IPOS)
  ● Mine Operating System
● Advanced Mine Planning & Optimization
We work with major mining companies
Product Scope – Resource to Market

Resource to Market

- Mine Planning
- ROM Processing
- Ore Processing
- Mine Stockpile
- Rail Logistics
- Port Stockpile
- Port Logistics
Realize Your Resource-to-Market Potential

- **Mineral resources** and **commodity prices** are externally determined
  - Only **HOW** the resource-to-market chain is managed is controllable
  - Goal is to deliver to the market at the right quantity, right time, right grade, right quality and right cost

- **Make the most of your Resources** by:
  - Planning and scheduling to **optimize the Resource-to-Market** chain (local plans are driven by the global plan, not vice versa)
  - Making production, asset and process performance more **RELIABLE** and more capable
  - Making **better decisions** through reliable and timely information
  - Reducing cost and improving environmental performance by **reducing excess energy** and water usage
Basic Observation

In the face of constant change and increasing volatility & uncertainty, businesses are interested in two fundamental things:

• Knowing what is likely to happen in the future (prediction); and
• Making the best decision right now (optimization)

We specialise in providing advanced science capabilities within our software solutions for planning, scheduling, optimization and predictive modelling, which address these two fundamental needs.
The Value: Silo vs. Global optimization

Local optimization: What’s best for an operating silo

Global optimization: What’s best for the entire supply chain

Local Visibility: What’s best for a time period silo

Global Visibility: How does a decision now impact the future horizons
### Integrating and Optimizing drivers of productivity

#### Objectives
- Efficiency
- Emissions
- Throughput
- Quality
- Yield
- Utilisation
- Fulfilment
- Cost
- Profit

- Power
- Water and Environmental
- Consumables

- Demand
- Capacity
- Quantity
- Quality
- Blending

- Fixed Plant
- Mobile Fleet
- Logistics Infrastructure
- Office
- Administrative

- Competencies
- Rosters and Schedules
- Tasks
- Training
Integrated Planning and Optimization Solution (IPOS)

Level 4
Enterprise

ERP / EAM / Corporate Reporting

Level 3
Operations

Supply chain schedule optimization from resource to market (Mine Planning, Logistics Planning, Scheduling, Scenario Analysis, Simulation)

End-to-end material tracking and inventory management (Inventory Tracking, Material Quality, Production Accounting, Metal Accounting)

Mine Model, Mine Design, Mine Plan

Manage Performance & Improve Performance (Downtime, Shift Log, Dispatching, Energy, Process Quality)

Level 2
Control

Fleet Dispatch

Operations Technology (SCADA, Control)

Level 0
Physical Process

Mine Planning

Mine Operations

Processing

Logistics

Schneider Solution

Complementary Solution

Schneider Electric

Supply Chain Operations

Mine Planning

Plant Operations

SCADA Expert

Process Expert

Integrated Planning and Optimization Solution (IPOS)
IPOS (Integrated Planning & Optimization Solution)

Real time decision support systems – Holistic optimization

**Visualization of Planned Production, Production Execution, OEE**

**Fleet Delays**

**Downtime, Metal Accounting, Production, Shift & Maintenance Reporting, Product & Inventory Tracking**
Optimizing the Resource to Market Value Chain
The problem

What is the best sequence of material movements, blending combinations, plant/processing and shipment/logistics options through the supply chain such that fixed and variable demand is fulfilled while optimizing competing KPI’s (i.e. throughput, cost, utilization, quality, revenue, & other objectives).
The challenge

Within 10 minutes, SolveIT …

Changing market complexity
The ability to prioritize objectives without changing the optimization engine as market conditions changes, from throughput to cost to variability to utilization

Integrated Supply chain complexity
Tens material types, numerous quality attributes, determining the best source, the best route, the best blend and the best timing of activities through hundreds of supply chain components

Business rule complexity
Day of operations to 3.5 year planning, broken up into aligning time 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.

= Market complexity * Supply chain complexity * Business rule complexity * Decision making complexity
Current Mining Customers

● Pit-to-port planning, scheduling and optimization
  ● Multi-commodity: iron ore, coal and base metals
  ● Multiple planning and scheduling horizons
    ● Strategic planning and simulation
    ● Planning - 5 year+; 2 year rolling
    ● Dynamic scheduling
      – 12 week
      – 1 week
      – Day of Operations
  ● From product stockpiles at the mine to loading products onto the ship at berth
  ● End to end multi-objective optimization
  ● Decision support tool
  ● Supporting the Integrated Planning process with simultaneous multi user functionality
Pit to Port APS Supply Chain Model

- **Integrated Planning**
  - Ship Berth Planning
    - Known nomination demand and TBN shipments
    - Proposed shipment generation
  - Ship Load Planning
    - Port inflow (rail)
    - Port outflow (ship)
  - Rail Planning
  - Port Stockyard Planning & Optimization
  - Maintenance Planning
    - All assets
  - Inventory forecast
    - Mine inventory
    - Production forecast
  - Processing and Haulage Planning
    - Field inventory
    - ROM inventory
Resource to Market – Optimizing to Profit
Pit to Port, Iron Ore

- Integrated plan showing ship berth and stockpile management
- Minimize movement of material, direct feed ship where possible
Mine Planning
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?

Optimization Intelligence to Solve Complexity
The problem

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

Within 10 minutes, SolveIT …

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 changes (i.e. 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
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
Value provided by SolveIT

- Optimised excavation sequences
- Minimise the assumptions
- Adaptable to changing requirements
- Aggregate at the right level, right time
- Optimize to NPV, Cost, Revenue, Quality, etc.
Key Highlights of Mine Planning System

- Optimisation
  - Multi-Heuristic, non-linear and multi-objective
  - Intelligent decisions with flexible, configurable weightings
  - “White Box” methodology allows clear visibility of decision making.
Thank you
Monthly Stockpile Change Report for January Beginning "Friday, 1 January 2010"

This report shows the stock levels at the end of each day, including the tonnes moved onto and off of the stockpile.

- Daily product movement into and out of stockpiles
- Up-to-date accounting of all inventory movements
- Access to inventory data when you need it – to make better decisions
- Now you can optimize your decisions & understand the impact on the business
Daily Operational Report for Sunday Beginning "Sunday, 17 January 2010"

Inventory

<table>
<thead>
<tr>
<th>CV1</th>
<th>CV2</th>
<th>CV3</th>
<th>CV4</th>
<th>CV5</th>
<th>CV6</th>
<th>CV7</th>
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<tr>
<td>3,450</td>
<td>12,050</td>
<td>53</td>
<td>23,854</td>
<td>31,478</td>
<td>47,665</td>
<td>47,665</td>
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</tbody>
</table>

Combined Asset Utilization

- Availability [81.4%]
- Performance [96.72%]
- Utilisation [43.89%]
- MTBF [1,300.4 hrs]

CHPP Red Production

Production Rate vs. Target

KWh per Tonne

Downtime

<table>
<thead>
<tr>
<th>Start Time</th>
<th>End Time</th>
<th>Duration (min:sec)</th>
<th>Cause Location</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>11/17/2010 7:00:00 AM</td>
<td>11/17/2010 7:16:16 AM</td>
<td>16:16</td>
<td>1500CR103 Sizer - NSP-Primary 2</td>
<td>Operating Daily - OBO</td>
</tr>
</tbody>
</table>

CHPP Blue Production

Production Rate vs. Target

KWh per Tonnes

Downtime

<table>
<thead>
<tr>
<th>Start Time</th>
<th>End Time</th>
<th>Duration (min:sec)</th>
<th>Cause Location</th>
<th>Classification</th>
</tr>
</thead>
<tbody>
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<td>11/17/2010 7:00:00 AM</td>
<td>11/17/2010 8:43:23 AM</td>
<td>763:23</td>
<td>CHPP Blue</td>
<td>Planned Production - NSP</td>
</tr>
</tbody>
</table>

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Dashboard – Site (long wall within site)
Dashboard – Site Energy

24 Hr Energy Usage

- Gas: 12,060 m³, 458.8 GJ
- Electricity: 649.5 MWh, 2338.2 GJ
- Fuel: 112,000 L, 4323.2 GJ

Hourly Peak Electricity Demand

15 Min Electricity Consumption

Current price: $0.045 / kWh
Dashboard – Site (crushing within site)
Dashboard – global iron ore