Iron Ore Production and Logistics via Integer Programming
Network Planning

**Beneficiation**
- Primary Products
  - Quality
  - Capacities

**Transportation**
- Capacities
  - Costs

**Yards**
- Types of Products
  - Blending

**Pelletization**
- Demand feed
  - Pellet Supply

**Port**
- Blending
  - Shipment Programming

**Demand**
- Price
  - Especifications
  - Delivery
Network Planning and Blending

UB1

UB2

UB3

Demand
Blending

Final Product Composition

<table>
<thead>
<tr>
<th></th>
<th>FE</th>
<th>SIO2</th>
<th>AL2O3</th>
<th>P</th>
<th>MN</th>
<th>PPC</th>
<th>H2O</th>
<th>-0,15</th>
<th>1</th>
<th>6,3</th>
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</thead>
<tbody>
<tr>
<td>PF1</td>
<td></td>
<td></td>
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<td>0,26</td>
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<td>24,00</td>
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<td>10,00</td>
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<tr>
<td>Min</td>
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Several Different Final Products

Blend to form final product PF1

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<tr>
<th>Product</th>
<th>%</th>
<th>FE</th>
<th>SIO2</th>
<th>AL2O3</th>
<th>P</th>
<th>MN</th>
<th>PPC</th>
<th>H2O</th>
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<td>PP1</td>
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<td>0,07</td>
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<td>61,00</td>
<td>15,00</td>
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<td>5,12</td>
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Different compositions to obtain a same final product
Network Planning and Blending

UB1

UB2

UB3

Demand
Iron Ore Supply Chain

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>4</td>
<td>Productive Complexes</td>
<td>~ 280 Clients</td>
</tr>
<tr>
<td>6</td>
<td>Ports</td>
<td>~ 356 Primary Products</td>
</tr>
<tr>
<td>50</td>
<td>Beneficiation Plants</td>
<td>~ 60 Final Products</td>
</tr>
<tr>
<td>88</td>
<td>Yards</td>
<td>~1000 Origin-Destination</td>
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<td>6</td>
<td>Modals</td>
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Objectives

- Plan the productive chain to fulfill the demands aiming at maximizing:

  - Volume
  - Revenue
  - Profit
Organization Context
Organization Context

Process
- Independent planning of the productive systems
- Planning process based on trial and error, too time consuming.
- Mostly aimed at maximizing volume

People
- Totally dependent on “feeling”
- Search for information to do the planning
- Focus on obtaining a feasible plan

Technology
- Electronic Spreadsheets
- Information distributed over several productive systems
Decides the share of the annual production of each mine complex will be used to fulfill the annual demand of each client.

Decides the share of the monthly production of each mine complex will fulfill the annual volume of each client’s demand. Treats production excess and shortages, iron ore in stock from one month to the next.

Decides which Lot is loaded in each mine complex to fulfill the shipments already programmed and the demands of the local market in the within the agreed time frames.
Modules – Vertical Integration

- Primary Products
- Demands
- Capacities
- Prices and Costs
- Commercial Commitments

Long Term (10 years / year)

Medium Term (3 years / month)

Short Term (5 months / day)

- Production
- Demand Fulfillment
- Final Product Blending’s
- Flows
- Shipments
- Ship Hiring
Optimization Problems

- Network Use
- Blending
- Scheduling
- Handling
Decision Support Systems’ Integration

DCP

ETD ETB

Demand of Iron Ore

Feed DCP

ETD ETB

Pellet DCP

DCP
Organizational Context

**Process**
- Integrating planning of all productive systems
- Agile process, based on the scenario quasi-optimal plans
- Planning can now move the focus from maximizing Volume to maximizing Revenue or Profit

**People**
- Focus on scenario optimal plans analysis
- Agility to plan and plan, and plan again
- Minor dependency of planning experts’ “feeling”

**Technology**
- One single planning tool integrated with company legacy systems
- Scenario management
- Allow incorporating new Planning features
Now... Integer Programming...