A review of the options in Concentrator Layout

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Process plant design

Involves a number of interconnecting activities:

- From ore body evaluation
- To critical evaluation of the design in operation

The plant design and layout have a major impact on capital cost driven by:

- The bill of materials
- The constructability of the design
Factors influencing plant design

- Local regulatory standards and requirements
- Requirements for safe working practices
- Operational and maintenance requirements
- Climate – need for buildings
- Paradigms – operator and maintenance requirements
- Contracting strategy – quantity optimisation
- Risk management – benchmarking
Key elements in plant design

Chemical plants are designed based on:

- Linking unit processes with pipe and service racks
- Safety requirements based on the materials being processed
- Operational and maintenance access requirements

This approach does not directly deal with the capital cost implications resulting from the impact of layout on bulk material quantities

Adapted from Schmidt-Traub et al (1999)
Key factors influencing capital cost

- Scope is poorly defined
- The execution strategy meanders
- Simplicity is replaced with opportunism
- Pipe rack locations are used as the basis of plant layout or plant areas are spread apart requiring long pipe racks
- Allowance for “expandability” is a necessity
The impact of the financial climate

High commodity prices

- Project schedule outweighs development costs

Example: Iron ore

Source: http://www.indexmundi.com/
The impact of the financial climate

Consequences

• Impact on the quality of project delivery
• Influx of less experienced personnel
• Increase in project capital cost
• Overruns for iron ore projects averaging 62% in the period of 2009-2014 (EY, 2015)
Project quality, cost and schedule

• Measures of quality are often subjective

• Poor quality design results in:
  ➢ Slow project ramp-up
  ➢ Lost production

• Project cost and schedule have an interesting relationship because optimisation of bulk quantities leads to:
  ➢ Reduction in construction man hours
  ➢ Reduction in capital cost
Standard designs

There have been several attempts to generate “standard layouts” for concentrators

Driving forces
• Cost competitiveness
• Reduction in project schedule and contractors’ EPCM costs

‘Standard design’ approaches:
• Can lead to inefficiencies due to the variation in ore competency across ore bodies

• Can be highly beneficial as long as the “standard” is challenged for every project from the following perspectives:
  ➢ Technical
  ➢ Delivery
  ➢ Operations
  ➢ Maintenance
Quantity targets for large concentrators

Lang factors for copper concentrators

<table>
<thead>
<tr>
<th>Project / Context</th>
<th>Lang Factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>S.E. Asia norm</td>
<td>1.9</td>
</tr>
<tr>
<td>Ausenco South America</td>
<td>2.1</td>
</tr>
<tr>
<td>Australian</td>
<td>2.4</td>
</tr>
<tr>
<td>Norm for major projects</td>
<td>2.6 to 2.8</td>
</tr>
</tbody>
</table>

• Lang Factor has a relationship to the design philosophy and layout of the plant, directly reflecting material quantities and local factors such as labour cost and site location.

• Half of the direct capital cost of a copper concentrator is associated with the comminution circuit.
Typical cost breakdown for a comminution circuit

Percentage cost distribution for a typical South American concentrator comminution circuit:

<table>
<thead>
<tr>
<th>Area</th>
<th>Concrete</th>
<th>Steel Work</th>
<th>Mechanical Equipment</th>
<th>Other</th>
<th>Grand Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary crushing</td>
<td>1.2%</td>
<td>0.1%</td>
<td>2.1%</td>
<td>1.8%</td>
<td>5.2%</td>
</tr>
<tr>
<td>Coarse ore conveyor</td>
<td>0.6%</td>
<td>0.2%</td>
<td>7.0%</td>
<td>1.6%</td>
<td>9.5%</td>
</tr>
<tr>
<td>Coarse ore stockpile</td>
<td>0.5%</td>
<td>1.4%</td>
<td>0.1%</td>
<td>0.6%</td>
<td>2.7%</td>
</tr>
<tr>
<td>Coarse ore reclaim (incl. mill feed conveyors)</td>
<td>2.5%</td>
<td>0.2%</td>
<td>1.9%</td>
<td>1.5%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Grinding</td>
<td>9.3%</td>
<td>5.5%</td>
<td>41.2%</td>
<td>15.2%</td>
<td>71.2%</td>
</tr>
<tr>
<td>Pebble crushing</td>
<td>0.5%</td>
<td>0.6%</td>
<td>2.5%</td>
<td>1.7%</td>
<td>5.4%</td>
</tr>
<tr>
<td>Total</td>
<td>14.5%</td>
<td>8.1%</td>
<td>54.8%</td>
<td>22.6%</td>
<td>100%</td>
</tr>
</tbody>
</table>
Concrete and steel benchmarked quantities

- The concrete and steel ratios vary by project based on the layout of the plant, mill configuration and design basis.
- A typical South American concentrator has 0.4 m³ concrete per installed kW.
Potential reduction in bulk material quantities

An example based on paradigm shift in layout and design:

<table>
<thead>
<tr>
<th>Area</th>
<th>Current</th>
<th>Benchmarked</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Concrete (m³)</td>
<td>Steel (t)</td>
<td>Concrete (m³)</td>
</tr>
<tr>
<td>Primary crushing</td>
<td>6500</td>
<td>125</td>
<td>3500</td>
</tr>
<tr>
<td>Coarse ore reclaim (incl.</td>
<td>8000</td>
<td>300</td>
<td>3000</td>
</tr>
<tr>
<td>mill feed conveyors)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grinding</td>
<td>49500</td>
<td>6500</td>
<td>27500</td>
</tr>
<tr>
<td>TOTAL</td>
<td>64000</td>
<td>6925</td>
<td>34000</td>
</tr>
</tbody>
</table>
Example of paradigm shift in layout & design

This image shows an example of a South American project which demonstrates the benefits of challenging layout paradigms. The original design is shown in light grey and Ausenco’s design is shown in black and other colours. A significant reduction in the bulk quantity requirements, footprint, man-hour requirements and project schedule were achieved.
Conclusion

• It is the engineer’s role to optimize the design to achieve maximum value from the project

• A clear strategy in terms of scope and execution needs to be defined as early as possible

• The owner’s engagement with the engineer allows challenging and optimizing the plant design during engineering phases

By challenging ‘standard design’ convention considerable project savings can be achieved by minimising:

• Footprint
• Associated bulk quantity requirements
• Man-hour requirements & project schedule

The paradigm shift in layout and design reduced the bulk quantity requirements by 47% in Ausenco’s South American concentrator design.
Thank You.

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