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

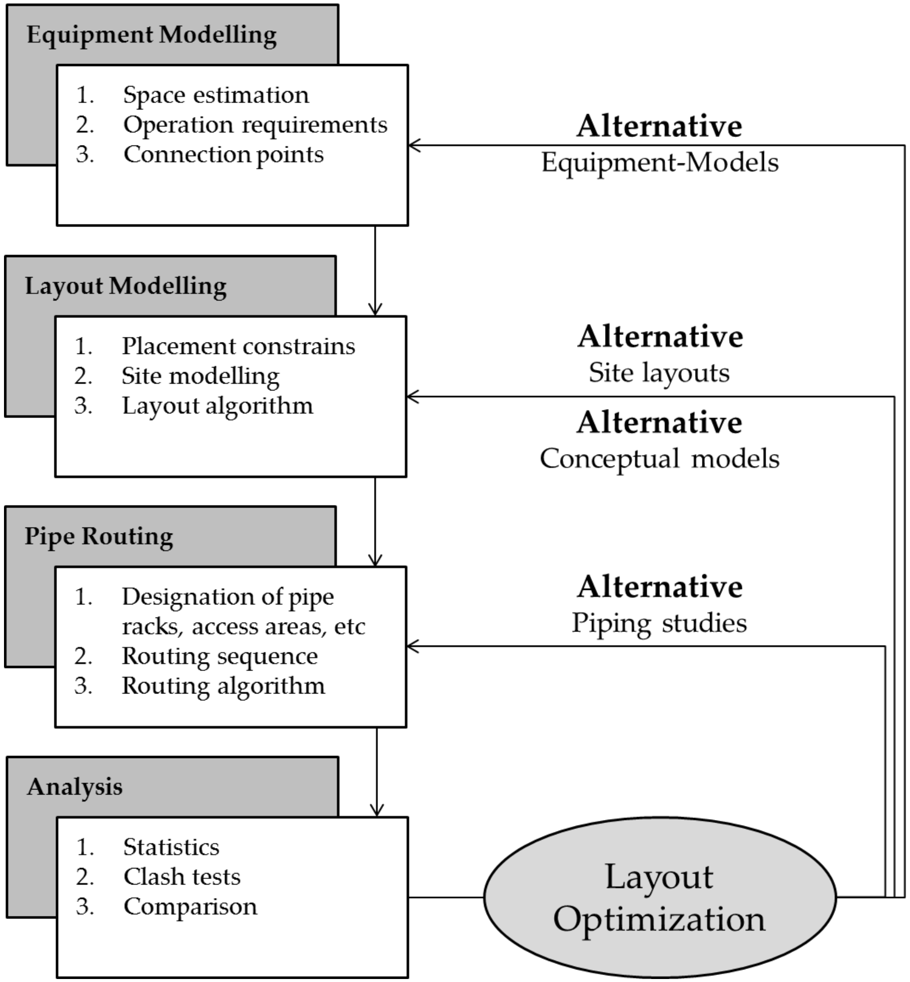
The plant design and layout have a major impact on capital cost driven by:

- 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

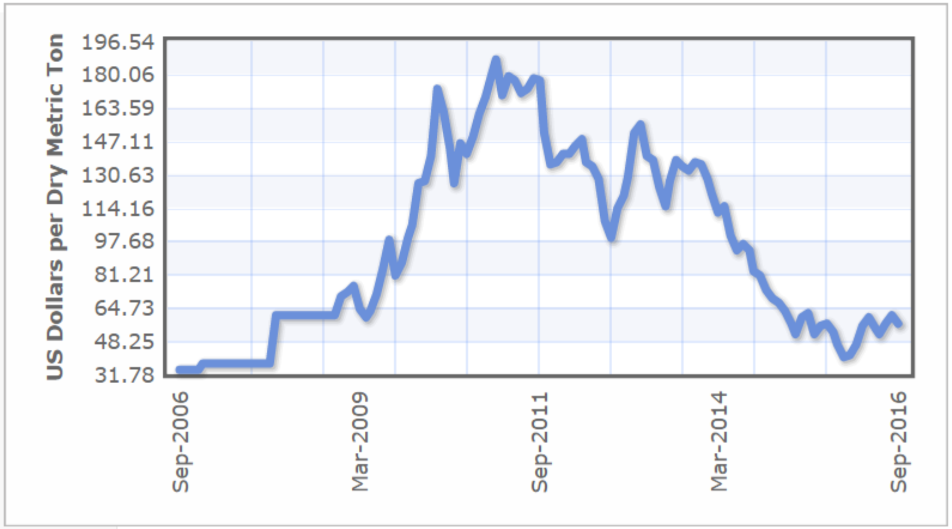
- Scope is poorly defined
- The execution strategy meanders
- Simplicity is replaced with opportunism
- Pipe rack locations are used as the basis of plant layout or plant areas are spread apart requiring long pipe racks
- Allowance for “expandability” is a necessity

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

Project / Context	Lang Factor
S.E. Asia norm	1.9
Ausenco South America	2.1
Australian	2.4
Norm for major projects	2.6 to 2.8

- 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

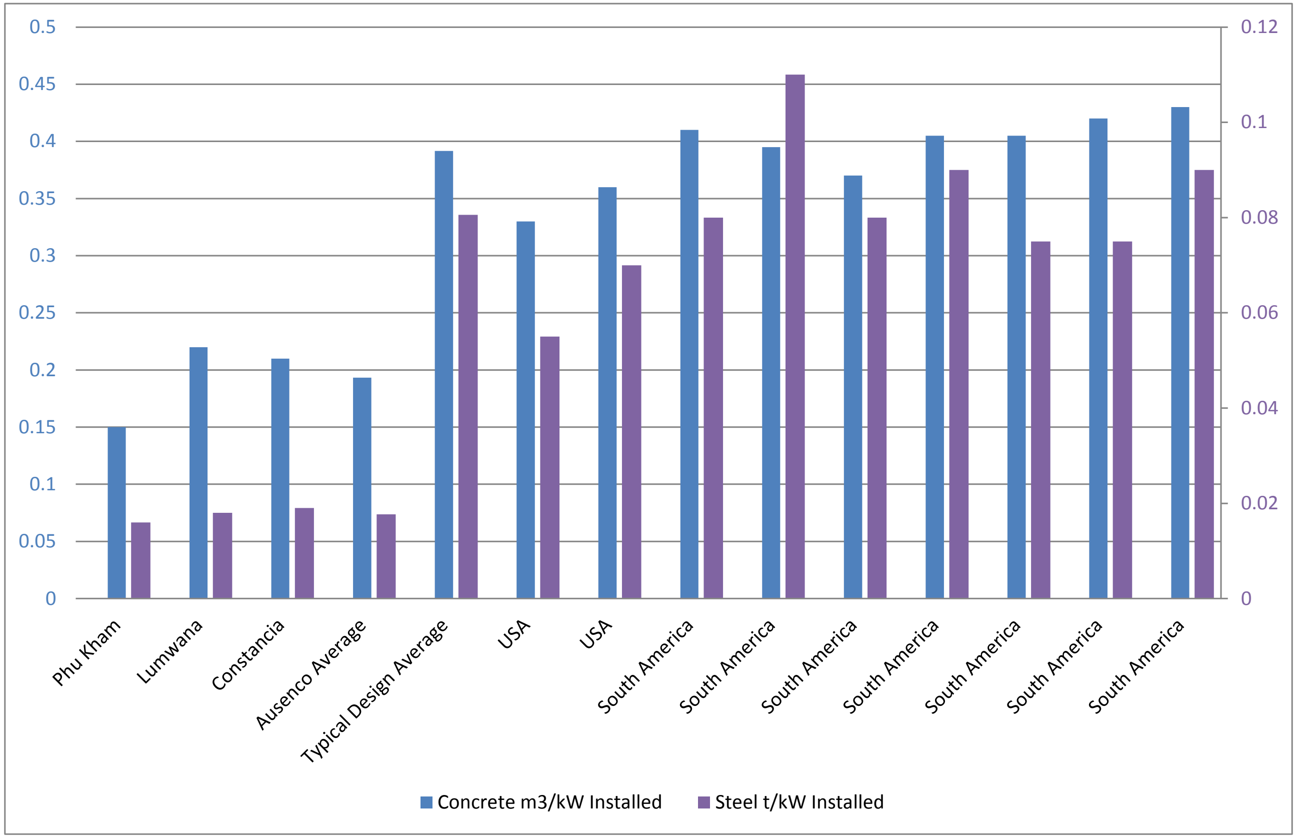
- Half of the direct capital cost of a copper concentrator is associated with the comminution circuit

Typical cost breakdown for a comminution circuit

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

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

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 m^3 concrete per installed kW.

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Potential reduction in bulk material quantities

An example based on paradigm shift in layout and design:

Area	Current		Benchmarked		% Change	
	Concrete (m^3)	Steel (t)	Concrete (m^3)	Steel (t)	Concrete (m^3)	Steel (t)
Primary crushing	6500	125	3500	170	46%	-36%
Coarse ore reclaim (incl. mill feed conveyors)	8000	300	3000	340	63%	-13%
Grinding	49500	6500	27500	3258	44%	50%
TOTAL	64000	6925	34000	3769	47%	46%

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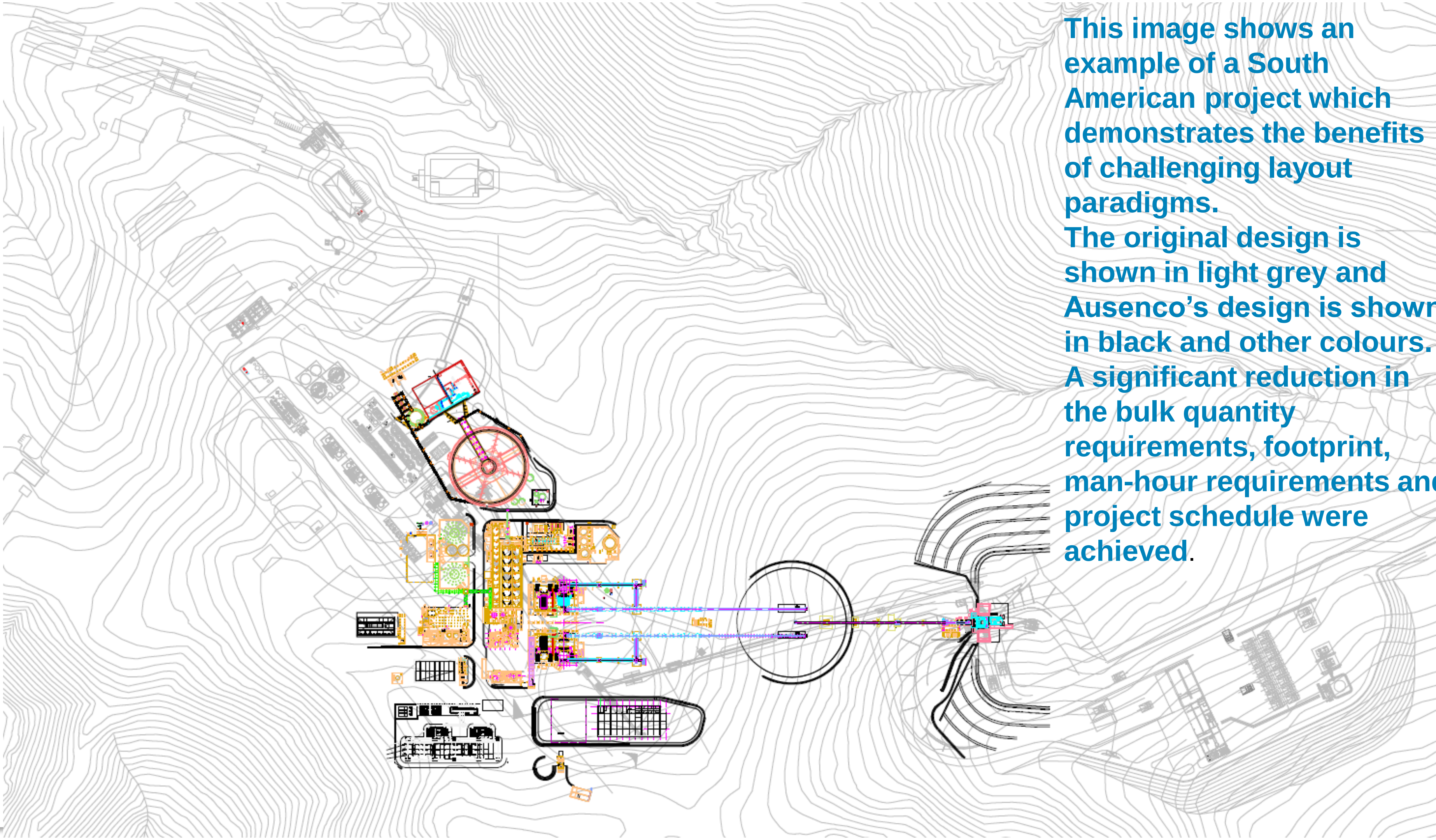
Example of paradigm shift in layout & design



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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