Visions of the Future
Concentrator

Increased Productivity
Reduction in Operating Costs
Improvements in Long Term Sustainability

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Introduction
Traditional Process Flowsheet

Final Product

Mill KPI’s: Safety, throughput, milling cost/ton, recovery etc

Mine KPI’s: Safety, production tons or bcm, mining cost/ton etc
Traditional Process Flowsheet

- Mine and mill are under different management structures and reporting systems
  - cost centres
- Each process has production targets and cost budgets
  - endeavours to meet targets and budgets
  - focus on quantity (volume) rather than quality
  - Little understanding on the impact on other processes and overall value
- KPI’s do not encourage to understand risks and maximise the overall value and risks
- Inadequate systems to measure the outcomes in a timely and reliably manner
- Inadequate communication between different processes to understand the interactions and changes
- Cost focus rather than value maximisation and risk mitigation
Ore Characterisation
Information is Key
Adding Value to Project Delivery

Ramp up of Greenfield Copper Concentrators

- McNulty Series 1
- 225 Axb values
- 21 Axb values

NPV ≈ USD 300 M
Drill to Mill – Downstream Prediction Using Blast Hole Data

Self-Learning System Building Ore Body Knowledge

Rock mass characteristics

Geological Model
Face Mapping
Measure While Drilling
Blast hole logging

Process performance indices

Mining characterisation
e.g. Blasting and blending

Process characterisation
e.g. Grinding and flotation

Grade
Blastability
Grindability
Separability

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Ore Fragmentation
Ore Fragmentation Opportunities

Based on total power draw of 49872 kW for Ab = ~35

**Throughput estimates:**
- Lower 95%: 1904 tph
- Mean: 2178 tph
- Upper 95%: 2545 tph

**Throughput**

1. **1st intervention**
   - Pre 2011
   - Mine to Mill Fragmentation
   - Throughput: 2820 tph

2. **2nd intervention**
   - 2011 - 12
   - Advanced Blast Fragmentation
   - Throughput: 3112 tph

**Industry standard**
- 3400 tph

Can we go further?
Breakage in the Mine-to-Mill Value Chain

![Graph showing breakage in the Mine-to-Mill Value Chain](image-url)
Baseline - Current Practise

Throughput = 100
Relative energy intensity / unit metal = 100
Relative capital cost / unit metal = 100

Feed Characteristics
• F80 > 120mm
• Fines (-10mm) < 10%
• Ab = 35
• Bwi = 14
• Grade – 5 -10% dilution

D&B cost = $0.30/ton
Best Case – Mine to Mill Practise

Throughput = 110 - 120
Relative energy intensity / unit metal = 80 - 90
Relative capital cost / unit metal = 100

Feed Characteristics
• F80 < 100mm
• Fines (-10mm) > 15 - 20%
• Ab = 35
• Bwi = 14
• Grade < 5% dilution

D&B costs = $0.60/ton
Future Feed

Throughput = 130 - 140
Relative energy intensity / unit metal = 70 - 80
Relative capital cost / unit metal = 100

Feed Characteristics
- F80 < 50mm
- Fines (-10mm) > 40%
- Ab = 45 (micro fractures)
- Bwi = 12 (micro fractures)
- Grade < 3% dilution

D&B costs ≈ $1.50/ton
Super Fine Feed with Future Concentrator

Feed Characteristics
- F80 < 50mm
- Fines (-10mm) > 40%
- Ab = 45 (intense micro fracturing)
- Bwi = 10
- Grade < 2% dilution

D&B costs ≈ $1.50 /ton
- Δ ≈ $1.00 /ton

Throughput > 150
Relative energy intensity /unit metal < 60
Relative capital cost / unit metal < 60
Ore Pre - Concentration
Ore Pre - Concentration

- Early Gangue Rejection
- Reduced Mass for Grinding and Mineral Separation
- Reduced Maintenance in Comminution Circuit
Classification
Classification

Optimum range for grind size

Recovery

Typical product size

Recovery losses

P₈₀

% passing

Size

Recovery losses + energy + slimes

Leverage of classification?

- Energy savings
- Minimise production of slimes
Classification
Classification - Opportunities

- Site energy consumption
- Circulating load in ball mill circuit

- Water Consumption

- Throughput
- Flotation Feed P80

- Valuables Recovery
Classification – JKMRC Research

- JKTech Promoted Research - Current Hydrocyclone Technology v Screening
  - Measure the size of the opportunity for screening

- Novel Cyclone Design
  - Proof of concept tests completed with 250mm cyclone with synthetic ores and a real ore
  - Results show that the new cyclones
    - Cut much coarser with lower water split compared to standard cyclone
    - Performance is comparable to that of fine wet screening

Next Steps:
1. Prototype development and detailed parametric testing
2. Industrial testing
Flotation & Regrind
Effect of Flotation Feed Size on Overall Performance

- Overall Metal Recovery at Target Grade
- Typical Region for Optimum Flotation Recovery
- Metal Sulphide Liberation for Rougher Flotation Feed
  - 56kt/a Metal in Concentrate
  - 80kt/a Metal in Concentrate
  - 3kt/a Metal in Tailings
- Potential Throughput Variation
  - 43% per unit time
- Throughput Relative to Basecase, %
- Metal Sulphide Liberation, % & Metal Recovery, %
- Primary Grind Size, ($P_{80}$ microns)
Liberation for Rougher Recovery

- Valuable Sulphide or Precious Mineral A
- Valuable Sulphide or Precious Mineral B
- Gangue Mineral

Floatable

Target - Low Grade Composite Particles

Non - Floatable

- Valuable Sulphide or Precious Mineral A
- Valuable Sulphide or Precious Mineral B
- Gangue Mineral
Low Grade Composite Flotation – Some Considerations

- Increase in Rougher Concentration Mass Recovery
- More Regrind Capacity
- Staged Regrind


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Conclusions
Future Concentrator Process Flowsheet

- Mine and Concentrator as one business unit
- Integrate and optimise the total process rather than an individual process
- Focus on maximising the overall value and minimising the risk to total business rather than unit cost minimisation
- Understand the interactions between the key processes in value chain
Future Concentrator Opportunities

- Improved Ore Characterisation
- Comminution & Waste Rejection Starts in the Mine
- Ore Pre-Concentration
- Classification
- Separating Coarser Particles containing Lower Valuable Mineral Content
- Higher Rougher Mass Recoveries
- Staged Regrind and Flotation
- Improved Dewatering
- Reduced Environmental Exposure

Not Considered but Important
- Separation and Water Chemistry, Mill Design Options, Flotation Cell Options, etc...
Breakage in the Future Process Flowsheet

![Graph showing size distribution of Flotation Feed, Grass Mill Product, crusher Product, ROM, and In-situ.](graph.png)
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