Blasting technology:
Delivering economic value for mining customers

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Key drivers of mining efficiency

Production = Producing hours x BCMs per hour = Utilisation x dig rate
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Industry context
Customer needs

Bigger is only better if you maximise availability and utilisation

Payload - Tonnes

- Rock Factory
- Big Asset Productivity
- Keep up!
- Dump Truck Capacity

Years:
- 1960
- 1970
- 1980
- 1990
- 2000
- 2010
- 2020
Volatility is a good indicator of control and productivity.
You can ‘interrogate’ the causes of volatility

Maximise ‘Capital Asset Utilisation’ through fewer blasts, timely, good quality, BROKEN STOCKS
Role of blasting
Objective: Use explosive energy for optimal ‘factory feed’

Customers have different ground conditions and end objectives.

End Objective
- Lumpy and fluffy
- Small but not too small
- Smash it!
- Throw it!
- Crack it!

Start Point
- 5mpa Jointed
- 50mpa Jointed
- 100mpa Jointed
- 250mpa Massive
EnergyMap™
A way to choose the right energy
EnergyMap™
A way to choose the right energy

Velocity of Detonation (km/s)

Relative Bulk Strength

- Flexigel™
- Fortis™
- Fortan™
- Vistis™
- Vistan™
- ANFO
Can we vary the feed?
Energy distribution and accurate timing play an equal part.
Value-add examples
Energy level – basic
Soft-medium wet rock
Energy level – basic
Soft-medium wet rock

Productivity Vs System

- Pala O&K 170 B - Camión CAT 777D
- Pala O&K 170 B - Camión CAT 789D
- Pala O&K 120 E - Camión CAT 777D
- Pala O&K 120 E - Camión CAT 789C

Productivity (Bcm/hr)

System

Flexigel
Fortis
Energy level – Can we do low energy in wet holes?
Cap-rock – Energy level and distribution

Zona de Pared.
Sin piedras grandes en zona de taco

Piedras grandes en zona de taco. Tamaño máximo < 70 cm

Detalle fragmentación Pala 263. Zona de taco [producción]

Stem (7m)

Fortan (11m)

OLD
Cap-rock solution – Energy level and distribution

OLD

Stem (7m)
Fortan (11m)

NEW

Stem (5.5m)
Flexigel (3.5m)
Fortan (9m)
Cap-rock solution – Energy level and distribution

NEW

OLD

Flexigel™
(Stem= 6.5m)

Fortan™
(Stem= 8m)
Better wall and production solution – Energy level and distribution

Vibration reduced by 27%

Measured fragmentation

Fortan™ => 65% passing 9”

Flexigel™ => 73% passing 9”
Energy level –
High energy and timing for ‘suck’
Energy level – High energy and timing for ‘suck’
Reduced spillage

- Reduced clean up, faster road access, lower haulage cost – spilled rock is more expensive to truck out
Split benches = narrow working areas = slower production

P&H 4100 - <4500 tph
Production rates in the ‘trim’ are much lower

P&H 4100 - <3500 tph
Increase dig rates with increased mining width for narrow cutbacks – use timing, energy and distribution.

P&H 4100 - >5500 tph
Energy level –
High energy for increased throw

**ANFO**
0.51 pf
20% Cast to Final

**Vistan™ 250**
0.66 pf
29% Cast to Final

High productivity increase, low capital, low cost
Ultra-High Intensity Blasting value model throughputs/revenue advantages

Conclusion: A step change in blast energy is required to obtain benefit

Only a marginal change in throughput

Large increase in mill throughput for powder factor increase of 2.8 times
How to practically achieve very high powder factors?

Innovative Energy Control
What’s the potential value?

<table>
<thead>
<tr>
<th>Mine</th>
<th>Margin Improvement ($/lb)</th>
<th>Addition Profit ($pa)</th>
<th>Addition Profit ($pa)</th>
<th>Cash Flow Improvement ($pa)</th>
<th>Cash Flow Benefit ($pa)</th>
<th>Total Benefit ($pa)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal Production Rate</td>
<td>New Production Rate</td>
<td>New Production Rate</td>
<td>New Production Rate</td>
<td>New Production Rate</td>
<td>New Production Rate</td>
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<tr>
<td>Large Chilean Mine</td>
<td>$ 0.033</td>
<td>$ 56m</td>
<td>$ 92m</td>
<td>$ 758m</td>
<td>$ 264m</td>
<td>$ 355m</td>
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<tr>
<td>Large Aus Mine</td>
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<td>$ 43m</td>
<td>$ 306m</td>
<td>$106m</td>
<td>$ 150m</td>
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</tbody>
</table>

Step change achieved with minimal incremental capital
Neighbours 350m away?
Energy, Geometry, Timing
Complex geology constrains production

- Dividing Seams
- Anticline / Syncline Seams
- Layered & thin Seams
- Faulted Seams
- Multiple Dipping Seams
Complex geology constrains production

Exercise Productivity

Blast Walk

Disruption due to blast, walk, blast

300k BCM Excavation

Walk & Blast time, no excavation

Set up & bench preparation

Disrupted excavation

Excavation for full shifts

6 Blasts

174 hours

(Average of time for excavation)

Ave Dig rate: 1,726

9 individual blasts required for this section of the mine
Solution – Complex thru-seam blasting but simple productive mining
Through-seam results

- Conducted over 260 Through-seam blast shots
- Blasted over 46 million bcm using Through-seam blasting
- Average Blast size 26 K to 178 K bcm
- Increased blasted inventory by 145%
- Dig Rates LB9350 Increased by 300 BCM/hr
- **Vertical Advance Increase of 60%**
You can produce more without big capital spend

Production = Producing hours x BCMs per hour = Utilisation x dig rate
Thank you for your time