The Future is Small
Nick Wilshaw
• The Future is Small
  Or so I believe

Introduction

Background

Explanation

Examples

Solutions
Introduction

- Who is GSL and what do we do

- Nick Wilshaw MSc, ACSM
  - 30 plus years experience in the Minerals Industry

- Grinding Solutions Limited
  - Operating for 10 years
  - Services
    - Consulting
    - Laboratory
    - Agents
  - Global
• Background
  • The Future is Small .... The evidence
• A Small Future ....

• Increasing World Energy Costs
• Reducing Mine Head Grades
• More Complex Metallurgy
• Greater Consumer Demand
• Higher Environmental Demands
Increasing World Energy Costs....

Historic & Projected Oil Prices

- Cushing, OK WTI Spot Price FOB (Dollars per Barrel)
- Europe Brent Spot Price FOB (Dollars per Barrel)
- "OECD Reference Price"
- "OECD Low Price"
- "OECD High Price"

Ref: U.S. Energy Information Administration
• Contribution of current energy use by equipment across mining industry (Powell & Bye 2009)

- Grinding, 40
- Materials Handling - Diesel, 17
- Digging, 6
- Ancillary Operations, 6
- Crushing, 4
- Dewatering, 2
- Blasting, 2
- Separation, 4
- Materials Handling - Electric Equipment, 4
- Ventilation, 10
- Drilling, 5

3% world energy consumption
• Industry Head Grade Trends (Weighted by Paid Copper)

![Graph showing Industry Head Grade Trends weighted by paid copper](chart.png)

Source: Wood Mackenzie
Industry Head Grade Trends — Gold

Declining Head Grades of Top 10 Gold Mines
Source: Raw Materials Group

- Top 10 Highest grade gold mines
  2011:
• Head Grade Versus Tonnes — Copper

There is a trade-off between tonnes and grade
Tonnes-Grade data for 48 copper deposits

Source: MInE's Consulting March 2010
Complex Metallurgy

Iron ore extractive metallurgy is becoming increasingly complicated, especially with more complex geology and declining ore grades. Successful beneficiation of low grade ores requires the chemical composition, physical properties, mineralogy and metallurgical characteristics be thoroughly investigated.

The increased exploitation of low grade iron ore deposits containing magnetite has lead to an increased demand for complex beneficiation circuits. ALS Limited

New ore deposits are becoming more difficult to exploit profitably: locations are sometimes remote, grades are lower than in previous years, and the extraction metallurgy is increasingly complex. HATCH
• Greater Consumer Demand

Jeremy Bentham: The first major advance in the development of consumer demand theory was provided by Jeremy Bentham in the late 1700s. Bentham coined the term "utility" in reference to the satisfaction of wants and needs.
Greater Consumer Demand

- Metalliferous Minerals: Higher purity for better product quality
  - More Refined metals

- Energy Minerals: Improved refining for cleaner fuels
  - Low Sulphur
  - Greater Extraction
  - Oil & Gas Shale

- Industrial Minerals: Finer, whiter & brighter
  - Higher Quality Paper
  - Higher Quality Paint
  - High Performance Polymers
  - Higher Quality Glass Sands
Innovations to meet greater consumer demand

- Selective fracturing
  - Ore sorting
  - Waste rejection
- Improved Separations
- Optimisation of fine grinding
 Developers and industrial operators face increasingly stringent controls of pollution and waste management

- Reduced energy costs
- Green Chemicals
- Short term cost for Mining Operations
- Long term benefits to society
Examples
Copper

Over the last 100 years, the real price and cost of copper has halved
Copper price and (estimated) average operating costs for Western World: 1900-2009

QUESTION:
Is price an input or an output?

... Prices are set by supply & demand

2009 $/lb Cu

$7
$6
$5
$4
$3
$2
$1
$0


Includes, transportation, smelting & refining and marketing costs

Sources: USGS, Brook Hunt, CRU
MinEx Consulting estimates (for 1900-1974)
Innovations — Copper

Key Technical Innovations

Estimated average operating costs for copper mines in Western World: 1900-2009

- Improved transportation
- Froth Flotation
- Bulk mining at Bingham Canyon & Chuquicamata...
- ... which opened up the "Age of the Giant Porphyries"
- Airborne geophysics post-WW2 led to raft of new discoveries
- Development of a good geological model for Porphyries
- Computer controls, modelling and scheduling
- SXEW
- Better work practices
- Low cost mines in new countries
- Improved recoveries 65% to 85%
- Better Smelting & Refining
- Expanding demand led to economies of scale

Sources: Brock Hunt, CRU, Historical reports
MinEx Consulting estimates (for 1900-1974)

Includes, transportation, smelting & refining and marketing costs
Solutions

Selective fracturing

Control of blast patterns
  • Leave waste material in coarse fractions to allow for removal by simple size separation
  • Reduce material delivered to process plant

Crusher selection
  • Encourage inter-mineral boundary fractures – only break for liberation
  • Coarse separation
    • Size
    • Ore Sorting – X-Ray or Optical
    • Flotation
    • Gravity
  • Reduce material delivered to process plant
• Optimising fine grinding

• Greater mineral liberation
  • Increase mineral grade and recovery
  • Reduce smelter charges
  • Increase $ return

• Enhance mineral properties (Industrial Minerals)
  • Increased optical properties
  • Greater surface area

• Reduce costs
  • Optimise grinding media
  • Mill operating conditions
Solutions
Unlocking Cornish (Global) Potential?

• GSL Offers :-

  • Innovative approach to problems – Small Cost
  • Niche capabilities in fine and ultrafine grinding – Small Sizes
  • Fast and reliable project turn around – Small Timeframe

• The Future is Small
Energy Intensity of GDP

- **World**
- **OECD**
- **G7**
- **BRICS**
- **Europe**
- **European Union**
- **America**
- **CIS**
- **North America**
- **Series10**
The Way Forward ....