BAML Smart Mine Conference 2019
Leveraging ideas to unlock value
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Our global nickel business

2018 Production Including Third-Party Feed – Nickel Assets

- Raglan Mine
- Nickel Rim South Mine
- Fraser Mine
- Sudbury Smelter
- Onaping Depth (project)
- Nickel Rim Depth (project)
- Koniambo 26.3 kt FeNi
- Murrin Murrin 39.7 kt Ni 3.2 kt Co

Integrated Nickel Operations (INCO)
90.8 kt Ni
20.6 kt Cu
37.7 kt Co Prepar
4.2 kt Co

Nikkelvenn Refinery
We are using a Strategic Innovation program to manage the introduction of new technology. Our “Proof of Concept” at our future Sudbury INO underground mines – Designed for Depth – is demonstrating significant potential value.

Marc Boissonneault
It’s not simply technology …

… it’s solving problems to unlock value

- Identify the key Problem to solve
  - Not the symptom
- Use a process
  - Divergent-convergent
- Use existing technology in new ways
- Stay connected to significant value
- Configure the Ecosystem to support execution
Sudbury INO Operation

In the face of a challenging operating environment, how can we unlock hidden value?

- Sudbury INO Project constraints
  - High capital cost based on reserve size
  - Long project period to first production
  - Margins under pressure even with high grade
  - Challenging work environment: Depth – heat – logistically complex
How value is created

What does it mean to focus on VALUE?

Good Investment?

Total Shareholders Return = \frac{\text{Expected Cash Flows}}{(1 + \text{Discount Rate})}

Value

Good Company?

Return

Cash Flow Basics

Investment Growth

Discount Rate

"Financing"

Revenue Growth

Operating Margin

Asset Efficiency

"Operating"

Grow Revenue

Expand margin

Improve capital performance

- Production rate
- Price combination
- Revenue
- Less costs
- More $/capital base

Source: Deloitte

How to translate value measure into a mine operation?

Macro Technical Drivers of Value

Labour productivity

Energy Intensity

Mining Intensity

Capital Intensity

- Margins being squeezed
- Capital performance reducing

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"Operating"

Labour Intensity

Energy Intensity

Mining Intensity

Capital Intensity

- Revenue
- Production rate
- Price combination
- Margin
- Energy costs
- Less $/base
Technology Portals

Unifiers across Translators

Energy  Water  Digital  Ecosystem

Value Translators

Find  Mine  Mill  Smelt  Refine  Renew

Our Footprint
Powering the design for depth
Safer – Greener – Efficient – Sustainable – Faster to 1st Ore

Digital Transformation
Towards Continuous Mining
Agile Ecosystem
Balancing OE and Innovation

Optimization Zone

• Depth
• Grade
• Mining sequence
• Smaller stopes
• Logistics complexity
• Increase safety

Innovation Zone

• Optimisation driven by OEMs and service providers around existing mining platform. Often a series of point solutions.
• Step change needs a new End-to-End mining system change. From batch to continuous.

Bigger equipment
Tele automation
OEM Innovation

Inputs ($) & Time

Performance
Realizing value
Putting it together – configured for success

Technology Roadmap - Projects

Later
Next
Now
Our future mines
Safely and sustainably designing for depth

- Zero Emission
- Real Time Information
- Maximized Asset Utilization
- Safe, Efficient Mining
- Industry Collaboration
- Minimize Waste Generation

- Diesel-less
- Real-time Digital Smart
- Continuous Automated Operations
- Mine Designed for Depth
- Agile Ecosystem

Complete Electric Mines
Fully integrated digital operations management
Leveraging Step Change in Mining Technology
Engineering out Deep Mining Challenges
Working with our peers to develop solutions

Concentrate along the path
Reduce our environmental footprint
Strategic innovation
Powering the Design for Depth

Sudbury INO Mining Strategy

Strategic Portals
- Digital Transformation
- Towards Continuous Mining
- Agile Ecosystem

Technology Pillars
- Real-time
  - Digital Smart
- Diesel-less
- Towards Continuous machines
- Mechanical Rock Excavation

MVP’s (now)
- Connected Mine
- In-shift Performance
- 7-21 Task Planning
- Real-time Optimization
- BEV’s
- Safe-Deep Dev
- Tele/Auto Production
- For BEV
- For Continuous
- For Hybrid
Value proposition
Onaping Depth Project

Opportunity Value ($M)

- Diesel-less: $50
- RD-Smart: $300
- Continuous: $60
- Designed: $240M

Amplified benefit
Craig Mine
Onaping Depth Project

- Feasibility Study completed end of 2016
- Received project approval of US $700m in Dec 2017
- Bottom up mining approach supported by a single shaft development
- 100% battery electric operated mobile fleet
Craig Mine
Onaping Depth Project

Approx. 1km between Craig and OD shafts

Craig shaft

2600m below surface
Craig Mine
Onaping Depth Project – electrification case study

100% BEV BENEFITS
- Energy Savings (41%)
- Ventilation savings (40%)
- Cooling System Size (-31%)
- Shaft Diameter (-23%)
- Improved health benefits
- Increased opportunity to improve production profile

ELIMINATED
- Return Air Ventilation Ramp
- Fresh Air Raise
- (3) Ventilation Fans
- (5) Ore Passes (replaced w/ battery electric haul trucks regenerating power down ramp)

AGILE ECOSYSTEM
Industry Trend Setters
22+ Companies & OEM’s

ANNUAL GHG EMISSIONS REDUCTIONS
- Diesel: 17,130
- Reduction: 44%
- Battery: 9,620 tCO2e/yr

AVAILABILITY
- Prime movers are the main concern (needed mid 2022)
  - 40T trucks available now
  - First 14T LHD available 2019
  - Multiple OEM 14T/18T LHD Operating in 2020
  - 40T+ trucks available in 2020

All testing to date showing better than feasibility study metrics (less heat produced, ergonomic, cost to run) and all equipment performing at least as good as theory – CAT, Maclean, FVT, Artisan

EQUIPMENT TRIALS
2016
- UT150 MineCat at Fraser
- UT150 MineCat at NRS

2017
- Papa Bravo personnel carrier at OD
- Maclean Bolter gen 3 at NRS
- Atlas Copco Bolter at NRS
- UDMN project – IFI 250HP Marcotte shotcrete carrier converted to BEV
- CAT 7T LHD BEV Dec 2017 – Field Follow
- Maclean Boom Truck Trial at NRS – Q4 testing and trial

2018
- T&W Commander being tested at Onaping Depth