INNOVATING TO ZERO

Processing & Energy Chair
Simon Hille, VP Global Innovation, Process & Metallurgy GOLDCORP
Process & Energy Chair

• Roadmap Update
• Collaboration Projects
• CAHM Project update
• Water Curves collaboration
• Current Challenges
CMIC 10 year VISION
Mineral Processing

- 50% reduction of Energy
- 50% reduction in Water and
- 50% reduction in Footprint

➔ All of this by 2027

• Footprint = Mineral Processing + Mining inclusive of tailings being +50% of the overall footprint

Other Identified Benefits & Results

- Better characterization, models, chemistry knowledge, recovery, flexibility
- Better grade control (ore vs waste)
- Ability to extract in-situ
- More pre-sort / pre-process
- Less handling
- Reduced chemical intensity
- Improve industry reputation
Mineral Processing Grand Challenges

**Metallurgical Mineral Analytics**
Integrated Geo-Mine-Met-Env based data to collaboratively understand, track and control resources that enable smart decisions to create value from resource to product.

**Eco Liberation & Separation**
Achieve a 50% reduction in energy consumption, while simultaneously improving selective liberation and mineral recovery through the application of novel technology.

**100% Resource Utilization**
Maximize value from all stages of the mine-to-market supply chain by developing new products from current waste streams, optimizing flowsheets to reduce waste and minimizing impact on the environment by developing “green” reagents.

**Bright Minds Ecosystem**
Lead industry imperative to better tell our story (i.e. do good, be seen to do good) that engage customers and end users.
Bring in outside perspectives and expertise (from other sectors and disciplines) and improve internal communication to encourage collaboration within mining industry.

[canadamining innovation council]
CMIC Collaboration projects overlap

• Tailings
• Water and Water Treatment
• AI analytics, machine learning
CAHM Project ~ Update

Initial technical evaluation complete
  – Proceed to Pilot

Challenges
  – Pilot delayed 10 months
  – IP issues
  – Resources

Next Steps
  – Recruit dedicated project resource
  – Create detailed business case and project plan
  – Identify and acquire financial resources ($4M - $14M)
  – Resolve IP
Water Curves ~ Collaboration CEEC & CMIC

- Deliver a new industry tool – free Global Water Curves.
- Empower mining industry to benchmark and improve water consumption.
- **Comminution circuit focus** – demonstrate consumption before/after design changes across the mining value chain.
- Free Global Water Curves available to all, hosted via CMIC and CEEC websites.

### PROJECT STAGE-GATES (18-24 months)

1. **Secure seed funders**
   - Appoint Principal Sponsors, MSc lead, governance committee. Define approach and database structure.

2. **Industry liaison and data**

3. **Sponsor/industry testing**
   - Test with Principal Sponsors and collaborators. Create secure web portal. Develop case studies, information.

4. **Delivery**
   - Publicity & Launch via CEEC, CMIC and Principal Sponsors. Releases, features and tools.

**Towards Zero Waste. Driving the future – Efficient Mineral Processing**

canadamininginnovationcouncil
Current CMIC Challenges

Collaboration
• large scale OK for roadmaps & alignment
• project execution will be at smaller scale (3-5 companies)

Capital
• Funding secured on a project by project basis

Resources
• Chasing government funding removes resources
## Potential Mineral Processing Initiatives

<table>
<thead>
<tr>
<th>Theme</th>
<th>Description</th>
<th>Proposed Initiative</th>
<th>CMIC Role</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Metallurgical Mineral Analytics</strong></td>
<td>Integrated Geo-Mine-Met-Env based data to collaboratively understand, track and control resources that enable smart decisions to create value from resource to product.</td>
<td>Define information needs to make key decisions throughout resource lifecycle.</td>
<td>Learn / Convene / Lead</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Near real-time element/mineral tracking during drilling in exploration and during extraction</td>
<td>Learn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Using near real time data to control process operations</td>
<td>Convene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Detection methods/sensors for near real time data of different particle size (eg at face, in a bore hole, crushed ore, waste rock, slurry) including: metals, minerals, hardness, density, size, distribution, ore texture</td>
<td>Learn</td>
</tr>
<tr>
<td><strong>Eco Liberation &amp; Separation</strong></td>
<td>How can we achieve a 50% reduction in energy consumption, while simultaneously improving selective liberation and mineral recovery through the application of novel technology.</td>
<td>Defining and understanding liberation by engaging materials scientists, physicist, mineralogist</td>
<td>Lead</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Selective sorting; Once liberated, separate valuable from non-valuable at multiple size fractions</td>
<td>Convene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waterless Processing: Dry grinding flowsheet and technology; How can we economically liberate through dry processes, How can we manage dust, Can we economically dry feed, Can we improve current grinding technology, Can we prove dry processes is robust and economical</td>
<td>Convene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waterless Processing: Measure, impart and selectively separate based on surface charge and magnetic properties; Can we measure surface charge, Can we impart surface charge, Can we selectively separate based on surface charge</td>
<td>Lead</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Waterless Processing: Fluid mechanics and air classification and separation by SG; Can we move particles selectively in air to separate</td>
<td>Convene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Energy efficient liberation – comminution researchers, vendors</td>
<td>Convene</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Improved recovery techniques for liberated products – mineral processing researcher, vendors</td>
<td>Learn</td>
</tr>
<tr>
<td>Theme</td>
<td>Description</td>
<td>Proposed Initiative</td>
<td>CMIC Role</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-----------------------------------------------------------------------------</td>
<td>----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>100% Resource Utilization</td>
<td>Maximize value from all stages of the mine-to-market supply chain by developing new products from current waste streams, optimizing flowsheets to reduce waste and minimizing impact on the environment by developing “green” reagents</td>
<td>Transform process and production waste into value by: characterizing / quantifying the material, developing technologies and monetizing the material contained in tailings, waste rock, residues, slag, etc.</td>
<td>Lead</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Develop “green” reagents that can be used by the resource industry</td>
<td>Lead</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Develop flowsheets that reduce/eliminate waste/tailings/hazards (e.g. in situ processing)</td>
<td>Learn / Convene</td>
</tr>
<tr>
<td>Bright Minds Ecosystem</td>
<td>Using a strong narrative about the importance of mining to strengthen and expand the mining ecosystem through better communication and collaboration with existing partners and engagement with new outside players.</td>
<td>Industry imperative to better tell our story (Do Good, Be Seen To Do Good; Be part of the journey to reimagine mining; Engage customers and end users)</td>
<td>Lead</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mobilize talent: Bring in outside perspectives and expertise (other sectors, industries and disciplines)</td>
<td>Lead</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mobilize talent: Increase internal communication to encourage collaboration within mining industry</td>
<td>Lead</td>
</tr>
</tbody>
</table>