

***ReThinkMining* Webinar** **June 9, 2020** **Questions and Answers**

Mechanical Rock Excavation: Opportunities for Non-Competitive Collaboration

- 1. How much will this open up deeper mine fronts like Creighton due to cleaner drifts and shift mineral resources into mineral reserves...how will this be tracked as a benefit?***

The key to enabling deeper reserves is ensuring that there is value to extract that ore at an acceptable risk. Mechanical cutting is an enabler of this, but it is important to look at the entire ecosystem which the cutter can be part of. We are starting at the start to understand whether the oscillating disc can extract the ore effectively and efficiently with consideration of the application of mining (today and in the future). In other words we need to understand the cost (now and future) and productivity (now and future) to extract waste/ore; and if this can compete with conventional methods, we plan to implement this technology in the base plans. So, tracking will come later once we understand better the potential and validate our simulations / modelling.

ReThinking Surface Mining Collaboration

- 1. Great to see a foundation of horizontal collaboration between companies, but do you understand the commercial architecture for delivery yet?***

The collaborative projects range from paper type studies of technology scan and assessment to deployment of existing technology to co-development of new technology. All companies have similar internal project management and delivery processes that we will leverage. The commercial architecture will depend on the type of “project” being executed, the participants involved in the project and disposition of background and foreground intellectual property of any intellectual property. In other CMIC projects we have established different commercial architectures for each type of project and will use these as a baseline and modify as necessary to address any nuances of new projects.

- 2. We are in the process of partnering with a third party to develop a technology roadmap together with the mining team under Luke. The question I had was for the presenter to share their experience on development of roadmaps and what we should pay attention to as well as how the work at CMIC could be integrated into this process.***

First and foremost, we would strongly suggest that you use the existing surface mining roadmap created by multiple mining companies convened by CMIC. This would provide a foundation and ensure Vale is drawing on lots of existing effort and thought leadership.

In terms of the roadmap and process, understanding the purpose is critical. That being to determine the future state in 15-20 years and map a pathway to get there as well as to align personnel within Vale and external organizations that work with Vale. For example, we have included additional inputs to our original CMIC Roadmap, based on alignment discussions with COSIA and other organizations.

It is important to hire an external facilitator that has done this kind of work using the design thinking process or even going further, one of the facilitators that have created roadmaps for CMIC. A facilitator that is familiar with mining or has worked with mining but is not necessarily a miner should be considered. This ensures thought processes and examples from outside of mining are brought to the table. You also have to realize that creation of the roadmap is only the first step and its creation may in fact require more than one workshop. Determining how to deliver and then delivering on the roadmap is more important than the actual roadmap.

CAHM/MonoRoll

- 1. How do ore characteristics (hardness etc.) affect the effectiveness of tension force development on the rock?***

This is a complex question and there are multiple levels of answer to this question. Rocks typically fail along a plane orientated with the applied force and its reaction point(s) (the F&R plane) when squeezed between two or more points. At the points of loading, the rock is in compression and the particle produces fine crumbles of rock. However, some (most) of the rock undergoes tensile failure normal to the opposing F&R plane to produce larger fragments. Hardness, in general, indicates a more brittle rock and does require a greater force to load the rock to the point of fracture. Rock morphology and geologically weakened planes increase the complexity of predicting failure

modes. Thus, we need to take a statistical/stochastic approach to such problems.

2. *What is the effect on water use in this approach?*

Both variants are intended to operate in a dry mode. Thus, a concern for both variants would be ores with a high moisture content or high clay content. Fatal flaw piston and die test work completed at UBC using company seed funding leveraged with MITACS funding showed that even high moisture ore was able to be processed through the tooth and pocket arrangement. If needed, water could be added to both variants, and we intend to test the MonoRoll in particular with slurry feed as part of the test work program, although the intent is to capture the benefits of operating dry.

3. *Could current tooth detection technologies be used to monitor wear? Optical systems at the top of both the inner and outer rolls (away from the material)? Embedded sensors may be too difficult.... I guess ultimately a KPI is needed to identify when enough wear/lost teeth has occurred to require a repair.*

Yes, we had envisioned using a 3D imaging camera to generate an image of all tooth and pockets in real-time to both look for failures and record wear progression over time. We also plan to include other sensors to determine if the machine is subject to a rapid change in hammer vertical position, hydraulic force, or power that will flag a potential anomaly to instigate a shutdown.

CanMicro

4. *Any concern with materials containing As or Pb? Do the particles promote sulphide surfaces to oxidize and then impact flotation?*

There are no problems encountered from an environment, health or safety perspective. Pb (lead) in the form of galena is excellent to have as it is one of the most microwave responsive minerals.

With regard to oxidation, this can be a problem when treating with low microwave power and long exposures (how most lab work is done). However, because we are treating with high powered microwaves (150 kW), we only need to expose the ore for max 2 seconds (usually less) and the bulk temperature remains low so oxidation is not a problem. Effects on flotation are typically positive due to improved mineral liberation, increased flotation feed grade and a reduction in slimes.