



Zero-Entry Mining: Roundtable | September 20, 2022

These outcomes are from the zero-entry mining roundtable held on September 20, 2022. Participants discussed defining the concept of zero-entry and the implementation challenges and opportunities. Key discussion points were around mine design, technology, and ESG aspects.

Defining the Concept of Zero-Entry Mining	
What it is	What it is not
<ul style="list-style-type: none"> • The final stage of automation. • The definition of no entry requires more work because it is a journey to zero entry. • Removing people from the active areas/potentially entire site. • Growing automation to take over more of the operation (i.e., change how miners operate). • Machine health reporting. • Tele-remote enables zero-entry. The value is due to the nature of autonomous systems. • All areas in mining (I.e., logistics areas/functions, support areas/functions, area around a piece of equipment, processing plant). • Reducing risk and increasing health and safety of an operation (i.e., minimize hazard exposure). • The mines must be designed for zero-entry while considering maintenance concepts. 	<ul style="list-style-type: none"> • It's not just a forbidden area, work must be done in there. • It is predominantly different between surface and underground. • Time consideration and not permanent. • Not about taking people out of the mining organization/ecosystem. • Once the main mining operation, but not during transitions or maintenance. • This concept may not target all phases or sectors or actions in the mine.

Potential Use Cases
<ul style="list-style-type: none"> • Production drilling for blasting. • Haulage circuits. • Equipment (i.e., watercart automation, service trucks, refueling). Some equipment is available or becoming available globally (e.g., haul trucks). • Open stope. • Concrete sheds. • Remote operations (i.e., autonomous/remote surveys). • Autonomous shovels and loading (i.e., explosives loading). • Focus on mainly dangerous zones (less low-risk cases). • Focus on certain aspects of mining. • Deep underground mining.

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Challenges	Opportunities
<p>Design and Processes</p> <ul style="list-style-type: none"> • Achieving a mining plan for the entire process. (i.e., Hard to apply new designs to existing mines or change the culture of existing mines). • Organizational design. • Change control procedures. • Differences between underground and surface (e.g., different tonnages). • Design for separation of equipment and people and designing for zero-entry vs current equipment. • Change Management and adding to business models within the business and how they adopt and adapt to this way of working. • Impact to production and efficiency. • Demonstrate the value behind this way of mining (productivity and safety). <p>Technology Management</p> <ul style="list-style-type: none"> • Communication network and current infrastructure capabilities. • Multiple OEM vehicles living and working together (i.e., interoperability standards). • Machine servicing and re-loading with supplies, charging, etc. • Autonomy will be done by systems not by individual equipment. This will require a change on the way mining companies operate. We will see technologies coming in from the automotive industry. • There is an opportunity by using hydraulic equipment in open pit, but that would play against the decarbonization goal. • Maturity of robotics. • Behave like human operators but always at peak performance. • Separation of areas for maintenance and equipment providing their own repairs. <p>Environmental, Social, and Governance (ESG)</p> <ul style="list-style-type: none"> • Human factor is the main concern in the deployment of autonomous systems. • Firm RACI (roles accountability etc.) for departments (i.e., who is responsible?) • License to operate (community engagement/expectations and local regulations). • Supportability (Network, consumables etc.). • Sustainability 	<ul style="list-style-type: none"> • Reducing variability. • Complete system can be highly responsive and coordinated. • Eliminate unproductiveness (e.g., reduce unplanned maintenance, working over shift change) • Long trolley assist ramps. • Standards adherence. • Possibility of multiple classes, types, OEMs of robots - all working together in the same area. • Lots of data can be collected. • When moving to an autonomous system there is the ability to move people from not only harm but repetitive tasks (haulage in an open pit) but also uplift those operators to maintainer or more technical roles. • Ability to learn from others in the industry. • Remote operations maturity. • Attract new talent into the industry. • Robotics. • License to operated Community engagement. • Potential energy savings due to nobody there in these areas. • Health and safety aspects (i.e., zero injuries). • Sustainability

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