Underground Mining: Tackling Challenges to Achieve Company Goals | Sudbury | 2022

	AUTONOMOUS MINING	CONTINUOUS MINING FOR HARD ROCK	BATTERY SWAPPING VS OPPORTUNITY CHARGING	INTEROPERABILITY AND TELEMETRY
ALREADY HAPPENING	• Semi-autonomous mucking to the dump • Autonomous loading for blasting • Autonomous haulage • Large hole drilling • Test facilities	• Continuous mining is mainly for soft rock • Excavation and ground support	• Mines currently do both battery swapping (with cranes or self-swapping) and opportunity charging (for smaller vehicles)	• Open data sets • Symbiotic wave • Analytics services
CHALLENGES/REQUIREMENTS	**Safety and Performance** • Machine utilization and productivity • Proximity and variability (e.g., operation detection) **Economics** • Benchmarking, safety, confidence • Robustness of technology **Existing capabilities and interoperability** • Setup, time, and connectivity • Workforce and skillsets (retaining and lack of technologists) • Human-machine integration • Mine design comparisons • Autonomous mining integration from drill to surface for different cycles and stages to interact	• Host rock hardness • Data availability • Speed (mobility) and load time • Comparison with traditional methods • Risk aversion, capital restraints • Resource availability and infrastructure	• Opportunity charging is possible for larger vehicles, but sufficient infrastructure needed for faster charging • Standardization for batteries around connectors and chargers is limited	**Producers:** • Granularity and transparency • Design data for the outcome • Standardized input/output (I/O) • IP and how to share **Consumers:** • OEE (time usage and utilization) • Managing machine health data • Access to reliability engineers Knowing what data to ask for
NEXT STEPS	• Case studies – E.g., Implementation and onsite testing (acceleration of development) • Specific guidance for cybersecurity	• Geotechnical knowledge (destressing) and host rock chemistry • Best suited application (long-term vs short-term) • Articulating the business case for different continuous mining technologies and their applications • Process optimization methods • Preventative maintenance analytics	• Develop models to help access performance limitations • Guide to access mine design input (e.g., is it possible to optimize ramps?) • Standardize charging protocols	**For mine operators:** • What KPIs are needed? • What do you want to control? **For OEMs:** • What can be standardized? • Incentives for performance for high availability

Note that this document captures some key discussions among a small cross-section of industry participants at a workshop held in Sudbury, Canada on June 16, 2022. It is intended to be one of many inputs into the working group and is not intended as industry guidance or a formal report.