A Day in the Life of a Mineworker in 2040

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Keywords: Integrated Operations; Analytics; Decision Support; Optimisation; Value Chain;

ABSTRACT

By 2040, the world's first carbon-neutral mines will be economically producing products that are vital for the world's transition to renewable energy. After overcoming significant technical challenges (and the investment of significant capital), these mines have eliminated the use of diesel and other fossil fuels by introducing a wide range of new technologies to support decarbonisation, The leaders in this transition will be reaping the benefits of lower production costs, stable and predictable operations, and easier access to capital for their future projects.

Some miners have failed in their attempt to decarbonise, offloading their assets to be acquired by more competent operators, or, in some cases, to indigenous or community-based enterprises with vested interest in making operations viable and sustainable. Regardless of ownership structure, all successful mining operations will have fostered strong and positive community relations that bring education, health, security and economic development opportunities to the communities while respecting their traditions, land-uses and culture.

As shallow, easy to mine deposits become increasingly scarce, the majority of new mines are underground. Advancements in electric underground technology and the feasibility of 'zero entry mining' (no personnel in active mining zones) has made it increasingly possible to economically operate underground mines, even at shallow depths. The newest mines have a near zero footprint on the surface, produce no by-products, and are employing in-situ methods of extraction that are efficient and low impact. Surface land-uses, such as agriculture and renewable energy generation, continue in the immediate vicinity of the mine, with no significant ground disturbance, community impact or environmental footprint .

Integrated and Remote Operations Centres (IROC) have been in use for almost 30 years, but their role has now changed significantly. Machine learning and optimisation algorithms are reliably running stable and predictable operations and continually adjust operational parameters to maximise value across the value chain. All equipment autonomously executes scheduled missions during normal operating periods, and the remote operations centre has become a 'lights out' centre that is only used to control operations during abnormal situations or emergency response.

The IROC facility has therefore been largely re-purposed to support the introduction of new technologies and for adapting the automated decision models to optimise around the ever-changing technology of the mine. Driven by the huge number of technology changes required to achieve net-zero, successfully miners have become exceptionally good at integrating and operationalising new technologies. The IROC is also actively connecting to other remote facilities, including the company's Remote Design Centre as well as a variety of Remote Support Centres run by partnering companies who specialise in monitoring and optimising equipment performance.

A small cohort of diverse, energetic professionals manage the mine. They focus their skills and energy on analysing data to find opportunities to continually improve the operation, increase reliability and tune the operating envelopes of the autonomous systems. On-site personnel are still required to service machines, maintain stable operating environments for autonomous machines, supply consumables and perform other tasks that are not easily automated, but these personnel are never required to directly enter the active mining area.

Enabling the entire automated mining operation is a network of cyber-physical systems that work inter-operably. Fleets of second and third generation small autonomous equipment work together in ‘swarms’ to extract and surface minerals with increased selectivity. A defining feature is that the equipment is designed around electrification, automation, connectivity and remote maintainability. Visibly, the size of equipment is smaller, and operator cabins have been removed , along with other changes to optimise the function of the equipment.

While large amounts of data are captured and stored to enable analysis and continuous improvement, the operation has learnt that only a subset of metrics are necessary to efficiently make operational decisions at the value-chain level. Therefore, an array of AI, Machine Learning and video analytic techniques are processing and detecting patterns in the vast streams of incoming data to detect abnormal situations and run equipment efficiently and without deviations. The human supervisor is mainly focused on finding opportunities to further improve the algorithms or retrain the AI.

At a strategic level, the whole value chain is dynamically optimised in real time to maximise value and the mission-objectives are automatically cascaded down to the cyber-physical production systems. Most importantly, the optimisation algorithms consider multiple objectives so that humans are primarily responsible for adjusting the weighting of the objectives and setting of assumptions, but not making or executing the short-term decisions.