UNDERGROUND MINING'S DIGITAL TRANSFORMATION

COVER STORY

Emily Esterson, E-Squared Editorial, and Innovative Wireless Technologies, Inc., USA, discusses how digital technologies have become increasingly important in improving both the safety and productivity of underground mines.

As digital technology has become more ubiquitous in our everyday lives and businesses, mines are adopting wireless systems that are proving revolutionary to the safety and efficacy of mining operations, resulting in an improvement to the bottom line.

The old way

Mines have long been dependent on hard-wire communications systems, thanks to the fact that most above-ground systems are rendered useless, or at least highly inefficient, in the deep below-ground environment. In the US, the implementation of the MINER act in 2006, following a series of coal mine accidents that resulted in fatalities, caused the government to mandate new, more reliable systems for communication and tracking, according to the Centers for Disease Control and Prevention.

Communications technologies frequently used in mining include radio node networks, very high frequency (VHF)/ ultra-high frequency (UHF), and leaky feeder systems. Each of these has its downfalls. Traditional wire systems require laying cable, ensuring there are no cuts or breaks in the lines, and then abandoning or retrieving those lines when the mining operation moves on. Wireless underground systems, such as radio frequency systems using VHF or UHF, can be useful in certain scenarios, but obstacles, such as turns or corners in mines, can interrupt signals, impacting on reliability. The commonly used leaky feeder system is designed to radiate signals out of a coaxial cable that reaches transmitters up to 200 m from the cable itself. Although the leaky feeder system improves transmission distance over traditional

coaxial cabling, it still requires laying and maintaining wires and antennas. The leaky feeder, with its gap-prone wires, along with the inefficient necessity of line amplifiers at regular intervals, is expensive to operate and prone to failure.

These legacy systems are also rife with costly business inefficiencies. When a cable breaks, for example, it requires someone to get in a mine truck, travel to the surface, gather the needed cable to repair the breakage, and drive back down to site. This involves man-hours of lost productivity. In the meantime, important lines of communication might be interrupted. Additionally, when the operation moves on, those cables need to either be removed or abandoned.

The above ground environment in some mines may also lack infrastructure. Cellular towers are far and few between in remote mining locations, meaning that even communication from the mine entrance to the office can be unreliable.

The digital transformation

Other industries have fully embraced digital technologies, but the mining industry has been a slower adopter. The Boston Consulting Group's Digital Acceleration Index 2021 notes that the metals and mining industry is roughly 30 – 40% less digitally mature than the automotive or chemical manufacturing, for example. The index noted

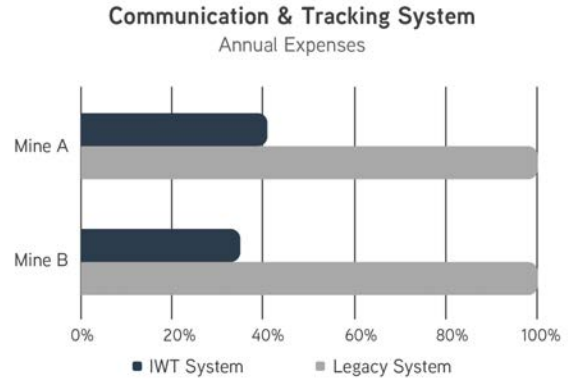

Figure 1. Graph to show the savings in annual recurring labour and expenses that two mines experienced after switching from legacy systems to IWT's wireless system.

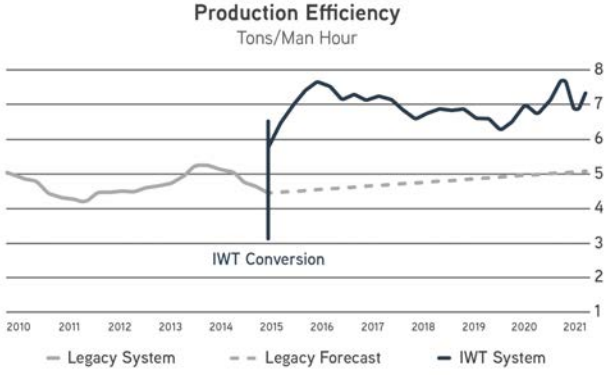

Figure 2. Conversion graph to show the efficiency gain in tonnes/man hour after improving connectivity with an IWT system.

obstacles in mining operations that hinder digital adoption, such as remote locations with poor bandwidth, a less technologically savvy workforce, rugged terrain, and a mistrust of automation thanks to its connection to workforce reduction. And yet, when mines did ramp up their digital systems, throughput improved by 10 – 20%.

The report notes business benefits as well. The ability to track custom data in real time through sensors, rather than through manual inputs at the end of a shift, for example, can have a positive impact on accuracy in forecasting, overhead and operating cost reduction, fuel costs, and productivity increases. Specifically, the DAI noted that in the digitally connected mines that BCG studied, productivity increased up to 30%.[1]

What does digital transformation in the mining industry look like? "Connectivity is a big part of that story," says Eric Hansen, CEO of Innovative Wireless Technologies (IWT), Inc., based in Virginia. "Connectivity solutions that worked in manufacturing, pharmaceuticals, or oil and gas do not work well in the dynamic mining environment," he adds, because mining operations are always on the move. "The foundational network systems are an important part of any digital transformation," Hansen says. A better connected mine can track people and assets, integrate multiple siloed systems in mine operations and data collection, and lower maintenance time. It is data-driven and agile, and enables the better compliance and safety. A wirelessly connected underground eliminates costly hard-wired systems, and makes communication and tracking more efficient and reliable.

While legacy systems, such as the leaky feeder communication and tracking systems, have some capabilities, underground communication systems that run on a network of nodes provide an alternative. Built to self-heal, these nodes are not reliant on a single central server which routes data signals along a central highway, but rather on a network – if one should go down, signal traffic is instantly rerouted to a different node. The nodes can be placed in any number of locations, depending on the needs of the mine, to link miners and operations to each other, as well as emergency personnel and managers in the office. Thanks to the dynamic roaming feature in mesh networks, calls remain uninterrupted as users travel throughout an underground mine.

A wireless mesh network node can be recovered and quickly moved to another location by simply picking it up and moving it. Importantly, the digital nature of such a system means it is highly customisable and always up to date – equipment does not require removal or abandonment, nor does it require the storage of multiple spools of cables. Instead, communications are enabled through clear underground radios, with texting and embedded tracking capabilities available for any Wi-Fi enabled device, connected to a wireless high-speed fibre infrastructure that provides Wi-Fi access points at each node.

Safety and compliance first

An underground network greatly improves safety and the ability for mines to comply with the US' Mine Safety and

Health Administration (MSHA) rules. Of the top 10 cited standards, a wireless mesh network can improve efficient handling and management of nearly all of them. From the ability to notice and address blocked paths, to mine ventilation and gas monitoring, a network backbone can communicate via radio, tablet, phone, or atmospheric monitoring devices in real time. It routes data quickly out of the underground and allows companies to manage the mine in real time.

These networks can – and have – saved lives. Take, for example, the true story of a miner who was involved in a crash underground and was seriously injured. Using a legacy system, it might have taken hours to find help, clear the tunnels, and get the miner medical attention. With IWT's wireless mesh system's ability to track people in real time, the miner's exact location was instantly known, as was the closest emergency medical-trained miner, who arrived quickly to the scene. They were able to call outside the mine and maintain communication with each other, but also with the first responders on their way to the scene. The mine was able to quickly clear people and machinery out of the evacuation route, as emergency services were arriving at the mine entrance. "A network like this allows you to identify when people have problems and enables you to get to them much quicker," says Hansen. Furthermore, battery powered communication systems allow rescue personnel to go much deeper underground without losing connectivity.

Productivity gains: Who shut down the belt?

A 2016 McKinsey & Co. white paper detailed the impact of the digital technology on mine productivity. The study predicted that these innovations in communication and data tracking, as well as the resulting robust analytics, would drive productivity gains.[2] McKinsey noted that mining productivity declines can be offset by the embedding sensors, and by gathering vast amounts of data that can provide granular level insights into mining activities. Data can be synthesised to provide managers with insights into operations.

Figure 3. IWT's battery-operated, wireless mesh node allows for fast deployment and enables communications in the working section.

While safety is surely one of the best uses of such a network, the productivity gains can be significant. In real time, operators can see where equipment has broken down, and rapidly deploy repair or maintenance personnel to fix it. With underground wireless connectivity, the path to bringing that equipment back online is much faster. A text or radio message, the real-time tracking of personnel, and the ability to track the hours spent on the task improves efficiency. One company in the US noted that installing a remote wireless mesh network resulted in US$8 – 10 million in productivity gains per quarter, and saves them US$750 000 annually in total cost of ownership. Another example compared the productivity of two co-located mines on the same vein with the same workforce. One switched to IWT's wireless communication system and saw 1 – 1.5 tph improvement in its operation. The sister mine, located six miles away, did not update its system, and, over the five-year time span, operated at a lower productivity rate.

Digital systems also allow mines to retrieve and reallocate labour hours too. Maintenance personnel can be deployed more efficiently, working proactively rather than reactively. With the mining labour market in short supply, workers need a good reason to join and remain in the mining workforce, and mines need to ensure their labour hours are efficient.

What is coming down the tunnel?

As the digital transformation of mining picks up momentum, future innovations will depend on reliable, flexible, and high-speed underground connectivity. Whether for productivity or health and safety, nearly all will need access to remote sensing and high-speed networks to connect people and information. Wireless communication plays key roles in proximity detection to prevent accidents; tele-remote and autonomous mining; and potential MSHA regulations that will require dust monitoring. These innovations – driven by a wireless, high-speed underground communication technology – will improve business, make it easier to attract workers to mining jobs, make them safer and more technologically enabled, and allow mine companies to deploy all their resources – human or otherwise – in a safer, more efficient manner. GMR

References

1. GANERIWALLA, A., HARNATHKA, S., and VOIGT, N., 'Racing Toward a Digital Future in Metals and Mining', *BCG*, (2021), www.bcg.com/publications/2021/adopting-a-digital-strategy-in-the-metals-and-mining-industry
2. LALA, A., et al., 'Productivity at the mine face: Pointing the way forward', *McKinsey & Company*, (2016), www.mckinsey.com/~/media/McKinsey/Industries/Metals%20and%20Mining/Our%20Insights/Productivity%20at%20the%20mine%20face%20Pointing%20the%20way%20forward/Productivity%20at%20the%20mine%20face%20Pointing%20the%20way%20forward.ashx