Equipment, Innovation & Services

This rise of autonomous mining and remote operations

Photo courtesy of Kinross.

Three of the biggest challenges facing the mining sector revolve around decreasing its environmental impact, attracting enough young talent to overcome a growing skills shortage, and accessing new deposits. Long before the pandemic declining ore grades had been the stimulant to develop technology that could lower the cost per pound produced and increase the safety of extracting metal. Covid-related work-from-home restrictions accelerated the adoption of remotely operated equipment and now, in 2022 inflationary pressures and supply chain delays have added further elements to the mix in an industry undergoing transformation to ensure it remains competitive from both a cost and ESG standpoint.

Autonomous mining and remote operation are two of the key themes enabling the sector to address these issues. Teck's Quebrada Blanca 2 (QB2) will be the first of the company's operations to incorporate a remote Integrated Operations Centre (IOC), bringing together the resources and data necessary for centralized decision making to help achieve better operational performance. Furthermore, being based in Santiago, the IOC can attract a new generation of mining professionals who may not want to be located at the mine site.

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John Swift, Managing Director – Chile, Epiroc

"As QB2 is a greenfield development you can build the autonomous operation as the customer is building the mine. You have the benefit of being able to establish a culture and you can build a team which is centered around this new way of operating," observed Sebastián Guridi, senior VP of mining – South America at Finning.

In 2019, Finning signed a contract with Teck to supply a fleet of Caterpillar 794AC electric drive off-highway trucks and other large mining machines for QB2, as well as Cat's Command for Hauling system and 794AC AHS (Autonomous Haulage Technology) kits. "One of the most valuable things about the QB2 project is that we are demonstrating that we can successfully do autonomous mining in deep, hard rock copper mines at 4,000 m of altitude," said Guridi, adding that autonomous vehicles also help in reaching areas which would otherwise not have been accessible.

Guridi believes that autonomous hauling is a real game changer for the industry, giving the example of Finning's autonomous underground equipment being used at El Teniente: "Everything can be done autonomously with only small sections which require manned operations, allowing you to have one operator for several vehicles."

John Swift, Epiroc's managing director for Chile, highlighted digitalization and the company's automated suite of products as ar-

Sebastián Guridi, Senior VP of Mining – South America, Finning

Rodrigo Couto, President – Latin America, Hexagon's Mining Division

eas of the business that have been in high demand. He gave the example of Epiroc's involvement at Anglo American's Los Bronces project where automated Pit Vipers are operated from a distance. On the subject of innovation, Swift revealed that Epiroc is looking at remotely doing tasks not only operating the machines: "For example, cognitive reality, where we can advise technicians from a distance, and micro-adjustments to pumps and motors to keep people away from physically running the machines."

Swift underlined the importance of collaboration between suppliers, such as such as Epiroc's work with Chilean company, ROCMIN, to create equipment that is customized to suit Chilean conditions: "I believe the era of siloed competition is behind us. Collaboration, not only amongst business partners but also between competitors, is vital to deliver the solutions that the world needs and our customers need."

Blasting specialist and technology company Orica has collaborated with Epiroc to create Avatel, the first fully mechanized development charging system. The company is currently trying to implement Avatel at projects in Chile and expects this to materialize in 2022, according to Oscar Castaneda, Orica's general manager for Chile and Argentina.

"My experience at Codelco and BHP made me see that mining companies are thinking outside of the box because nowadays if you continue producing on deposits in the traditional way you are going to hit a plateau, especially at some of the older mines in Chile," observed Castaneda, who also emphasized the collaborative nature of innovation, giving the example Fundación Chile, a mechanism of rapprochement between mining companies with technology companies, entrepreneurs and universities to connect and combine capacities. "It is a cultural change that has been taking place in recent years," he added.

One of the pioneers of remotely operated mining technology is Canadian company HARD-LINE. Brian Larocque, HARD-LINE's general manager in Chile, explained the transition from line of site control (an operator standing in front of the equipment watching it work from a safe distance) to teleoperation. He gave the example of autonomous blasting at a sublevel stoping operation as an illustration of how productivity can be increased:

"Autonomous operations allow for much less down time as usually after a blast you will not be able to send anyone into the mine for two hours, but now the autonomous equipment can be operating."

For the open-put market Larocque discussed HARD-LINE's partnership with Hexagon to develop autonomous situations such as collision avoidance, GPS and drilling patterns: "We marry Hexagon's systems with HARD-LINE's systems and based on the combined technologies the equipment can move from teleoperation to semi-autonomous operation to fully autonomous operation."

Rodrigo Couto, president Latin America for Hexagon's Mining division, explained how the two companies are combining technologies so that mine workers can be removed from dangerous environments, and he also spoke of Hexagon's partnership with Liebherr to deliver automation solutions: "The most impactful aspect of this is Hexagon's autonomous mission management system, which orchestrates fleet and unmanned mine traffic movements throughout the mine for optimized haulage".

Changing mindsets

As a leading mining jurisdictions Chile is advanced when it comes to the adoption of innovation at mine sites. "The mining boom in the 1990s triggered the growth of mining expertise in Chile and the industry has grown alongside emerging technologies," explained Eduardo Coloma, CEO of Maptek.

However, Coloma acknowledged that the mining industry on a global level is struggling to attract new, young talent. Fostering a younger generation of mining professionals is not only important to keep up with demand, but will also help from the standpoint of technology adoption.

"The main barrier to adoption is culture, not only in the mining market but across industries, and thus change management is extremely important," commented Mauricio Gregorio, Siemens' digitalization manager for Chile and Peru, adding that the mining market has come to understand that digitization will be the main driver of increasing main KPIs such as productivity, safety and reliability.

"Today, all the elements that operate in a mining operation produce data, and the big question is how to handle, manage, protect, and use that data effectively. The issues of cybersecurity, data protection, data management and analysis are all very big opportunities."

Philippe Hemmerdinger, President, Association of Industrial Mining Suppliers (APRIMIN)

Hexagon's Rodrigo Couto remarked that Chilean mining is advanced with respect to the adoption of many technologies, but catching up when it comes to collision avoidance systems and fatigue monitoring. Many of Chile's largest mines have had unionized workforces for decades, which have contributed to better working conditions and fairer pay. However, new technologies can be seen as a threat to a traditional way of doing business. "We have been talking with the unions in Chile to explain that collision avoidance systems and fatigue monitoring technologies are not meant to expose drivers but rather to protect them instead so that they can return home safely," said Couto.

Some of Chile's most important mining operations are also their oldest. Mining at El Teniente, for example, is reported to have started as early as 1819, before the Chilean government bought a 51% interest in the mine in 1967 from Kennecott Copper Corporation. Introducing technology at operations that have operated in a certain way for many years can be a challenge, but State-run mining company Codelco has invested heavily in modernizing its operations. Speaking at the World Copper Conference, CEO Octavio Aranedo underlined the company's focus on digital transformation.

César Ortega, founder and general manager of Chilean company Telemining, worked at Codelco for 34 years and became director of telecommunications, information and automation technologies for all divisions before founding Telemining in 2011. Telemining provides digital services installations, automatization and access control systems for underground mining settings, and Ortega emphasized the importance of installing the requisite digital infrastructure to support autonomous operations. "Today a 1 GB network is too small; you need at least 10 GB to communicate between camps," he stated, noting that the demand for communication networks has never been higher. "Broadband communication is a must, because shovels and trucks are now automatic. That is the tendency of the future where mining will become completely automated; all the operations will be driven and managed from control rooms through broadband communication networks."

Telemining has worked with Rajant at El Teniente, a US-based company focused on enabling wireless communications in real time. Sagar Chandra, vice president business development Americas at Rajant, explained that with underground tunneling comes a myriad of challenges such as space constraints, difficult ground conditions, unmovable underground structures, and work that must be done in an environment where it is difficult to deploy reliable network systems. He described how Rajant's private wireless network enables tunneling operators to overcome the networking challenges inherent in enabling communications, and improves productivity inside tunnels: "Our Kinetic Mesh network comprises compact, lightweight BreadCrumb nodes that can be flexibly deployed throughout the tunnel, on both fixed infrastructure and moving equipment, to form a robust mesh network underground."

José Pablo Domínguez, General Manager – South America, ME Elecmetal

Christian Cavagnaro, Managing Director, TAKRAF Chile

Another mining tech company founded in 2011 is MC System Chile, representatives of Leica Geosystems. Its Machine Controls (MC) are topographic systems onboard machines (such as excavators) that help the operator work to the desired quota, eliminating over-excavating, markings on the floor, and the need for people controlling the floor or staking pegs. The company has worked at operations including Los Pelambres, Los Bronces and Quebrada Blanca, and Christophe Boinelle, director of MC System Chile, suggested that this technology should be provided by a small company due to the flexibility needed.

"When you start working with these systems the machine will work much faster, but if something goes wrong with the system, such as something getting unconfigured or a wire getting cut, the operator goes blind because there are no markings on the floor like before. We are very fast at fixing it," explained Boinelle, noting that all the protocols larger companies have to comply with make them less efficient.

Innovation in the valve segment of the mining industry, through smart flow control solutions, is enhancing the sustainability of mining operations. Gonzalo Silva, regional manager of Neles Chile SpA, which is now part of Valmet after the merger of Valmet and Neles was completed on April 1st, 2022, explained how the company's software helps avoid unnecessary stoppages, reduces waste from the process, reduces the replacement of equipment, and avoiding contamination due to excessive consumption of any product. Silva gave the following example: "To this end, we have solutions called Zero Leakage. These solutions guarantee that everything being controlled by our valves is going to stay within the process and not go out into the atmosphere."

Ancillary vehicles

Suppliers of ancillary and construction vehicles, such as the trucks and tippers that move ore, dirt and concentrate or the buses that transport mining workforces, have seen rejuvenated demand since the height of the pandemic.

To keep up with demand from mining in the Antofagasta region, Swedish OEM Scania has decided to invest US$5 million to ex-

pand its workshop, with construction due to start in September/October 2022, according to Pascal Zappone, managing director of Scania Chile. When asked about the focus of this demand, Zappone pointed to solutions that increase the sustainability of operations, such as fleet managements systems (FMS) that enable customers to utilise data from a connected vehicle, lowering fuel consumption and reducing wear and maintenance needs.

Zappone highlighted Scania Super, a new engine platform that will be launched at the end of 2022: "This new powertrain has sustainability at its core and is the most advanced combustion engine we have ever built, promising a reduction in fuel consumption between 8% and 10% and more uptime than ever before. All engines have inherent HVO (hydrotreated vegetable oil) fuel capabilities and two of them can be ordered as FAME biodiesel versions."

Luis Izquierdo, general manager of Andes Motor, the equipment distributor that represents Maxus, Foton, Karry, Iveco, Agrale and Sany in Chile, spoke of the progress made in electric vehicle adoption for mining passenger transport, which Andes Motor is advancing with SQM and Teck. He detailed that the company's sales in the EV area increased by 44% in 2021, and revealed the company will be testing electric tractors at mine sites in 2022.

Discussing the challenge of transitioning to electric mobility because of the significant technological change, Izquierdo added: "We created a specific electromobility unit to grant support to customers and help them learn. In the same way we went to factories to learn; we have to transmit that knowledge to advance adoption."

Tailor-made equipment

During interviews with companies involved in the comminution and material handling space in Chile, one of the common trends has been the importance of tailoring solutions to the needs of the client and the mine environment rather than offering a standardized solution. This is particularly relevant for large-scale projects where incremental improvements to productivity can make a significant difference to mining output, while at the same time reducing waste and increasing the safety of an operation.

José Pablo Domínguez, general manager South America of ME Elecmetal, spoke of the company's work at INCO and QB2. "We proposed AMSA and Teck to perform an optimization process of the mill liners designed for the specific processes of each operation so new equipment could be installed ready to use," said Domínguez, stating that he expects both projects will achieve a smooth ramp-up of their mills and equipment because they will start with liners designed specifically for those environments.

Discussing ME Elecmetal's approach, Domínguez added: "When we take on a project, we are not only looking for excellence in the manufacturing of the spare part or the liner, but also on the interaction of that component with the mill, the crusher, the equipment, the way they operate and the impact that will have on the tonnes per hour the mill or the crusher will yield, and/or in the mineral recovery."

On the topic of equipment customized to a particular project, Christian Cavagnaro, managing director of TAKRAF Chile, gave the example of his company's work at Codelco's Chuquicamata underground mine, noting that a project of this scale and complexity requires a lot of work to lower operating costs and reach the deposit.

Cavagnaro revealed that TAKRAF installed a high-power, high-capacity conveyor belt system, introducing gearless drive technology. "Gearless technology is not new, but it has only recently been introduced to conveyor belt systems," he said, elaborating: "We chose gearless technology because of its energy efficiency – CO2 emissions are reduced by ~66% as compared to diesel truck engines for the same copper production volume – and operational costs are reduced, as they require much less maintenance."

Considering the size of the conveyor, TAKRAF's belt technology partner also developed a new tension range belt to transport the material under such an extreme condition. "Since you cannot make a 6 km long belt, you have to do it in parts and splice the joints," explained Cavagnaro, concluding: "In the case of Chuquicamata this project achieves a number of world firsts, boasting the highest conveyor drive power of 58 MW and the strongest resistance belt in the world."

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Oscar Castaneda, General Manager - Chile & Argentina, Orica

Another company working at Chuquicamata is High-Res Tecnología Antidesgaste (High-Res), a Chilean company dedicated to the development and manufacturing of innovation in the area of anti-wear coatings for abrasion, impact or corrosion. Rodrigo Diaz, general manager of High-Res, revealed that initial contact was made with Codelco when they were working on their first production line for crushing, during which time they were having issues with the process, stopping every 15 days to change the coating in the middle conveyor belt. "Stopping a mining operation for eight or nine hours every 15 days is too much, so we proposed a solution – a High-Res design using rubber, plasma and tungsten carbide – which meant operations stopped only once every three months, rather than every 15 days," said Diaz, adding that High-Res is now working on the entire line of wear products for Chuquicamata, and in certain areas can improve equipment wear from 20 days of durability to over six months.

Drillco is a Chilean company in the drilling equipment space that has been active for over 50 years and today has seven offices worldwide. Javier Varela, CEO, explained that the company differentiates itself by observing operating conditions and making modifications in collaboration with clients to achieve better performance. He elaborated: "This involved a lot of studies to understand variables such as the rocks, the conditions that the equipment works under, how they operate with compressors, etc."

Trinidad Carmona, Drillco's sales and marketing director, gave the example of an automatic replacement system for drilling components that the company developed with one of its mining partners: "The operator, with the press of a button, can go through the entire process of replacing the component, which reduces the replacement time from around 55 minutes to 3 minutes, as well as eliminating the risk to the personnel and energy usage."

Sustainable chemical solutions

The chemical industry shares a common struggle of public perception with mining – both sectors are necessary for everyday items we take for granted, but neither are generally thought of in a positive light. In reality, responsible chemical use has a multitude of benefits, from increasing crop production to feed a growing global population, to improving metal recovery or treating water in the case of mining.

Ricardo Capanema, global marketing director mining solutions at Solvay, spoke about Solvay's global plans to grow in the copper business: "Solvay is investing in capacity building to meet increasing demand for flotation equipment and concentrators. This is partly driven by the industry's decarbonization push."

Capanema expanded on how sustainability is a driving force in R&D, detailing how Solvay's solutions can help different areas of the mining business: "Additionally, we have developed solutions to help mining companies treat challenging ores that contain problematic waste. We also help companies address their energy and water conservation, especially during the comminution stage."

Photo courtesy of Neles Chile SpA (Part of Valmet).

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