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ON THE COVER

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GUEST COMMENT

ANNEKA RANDHAWA (PARTNER) & LUCY ROGERS (ASSOCIATE)

WHITE & CASE LLP

The mining and metals sector is gaining renewed global macro-economic prominence and will be critical to the success of the global energy transition towards a low-carbon future. However, it is a sector that has traditionally been highly exposed to bribery and corruption risks.

As businesses and investors take advantage of the opportunities presented by the transition, they should remain mindful of these risks so that they can create systems and controls in order to effectively manage them.

Minerals including lithium, graphite, and cobalt are critical to the manufacture of renewable energy technologies and are only found in a small number of countries, many of which are considered very high-risk from a bribery and corruption perspective.

The challenge of interacting with government officials in these countries is one contributing factor to this risk. Such interactions are high-risk because of the very low test for bribery under international bribery laws. The risks are acute in the sector because of the need to work closely with government officials throughout the development and operation of projects. The challenge is to maintain good working relationships with government officials, whilst avoiding conduct that could be perceived as falling foul of bribery and corruption laws.

It will be particularly important to avoid making payments, including 'facilitation' payments, to government officials (directly or indirectly). Facilitation, or 'grease' payments, are made to government officials to expedite routine action. They are illegal in an ever-growing number of jurisdictions, but remain a common and expected part of doing business in some countries.

Engaging third parties also poses bribery and corruption risks, as businesses can be held criminally liable under international bribery laws for bribes paid by those acting for them or on their behalf. Businesses should undertake due diligence into third parties before, and continually monitor them during, engagement. Such monitoring should be conducted by employees with the skills and experience to spot potential bribery and corruption issues.

Meanwhile, the energy transition will likely result in increased investment in the mining and metals sector. Pre-deal due diligence should include checking whether an anti-bribery and corruption framework exists, since it is important to know how typical financial crime risks are managed and establish whether risk-management tools are likely to have been effective. This will enable potential investors to be fully informed of the risks presented by a transaction.

Bribery and corruption risks in the sector will not vanish as a result of the energy transition. Cooperation between agencies at an international level has helped facilitate the enforcement of anti-corruption laws globally, with a significant proportion of enforcement actions in bribery and corruption occurring in the mining industry.

Businesses in the mining and metals sector should therefore spend time focusing on assessing bribery risk and creating and implementing systems and controls to effectively mitigate risks, whilst allowing operations to run smoothly. Such systems and controls should be tailored to the country in question, given that each country will have its own systems and present unique challenges. GMR

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WORLD NEWS

CANADA Newcrest agrees to acquire Pretium Resources

Newcrest Mining Ltd has entered into an agreement (the arrangement agreement) to acquire all of the issued and outstanding common shares of Pretium Resources Inc. that it does not already own by way of a Canadian Plan of Arrangement (the transaction).

The Board of Directors of Pretivm have unanimously recommended that Pretivm shareholders vote in favour of the transaction, and have entered into voting support agreements with respect to all of the Pretivm shares that they own or control.

Pretivm is the owner of the Brucejack operation in the highly prospective Golden Triangle region of British Columbia, Canada. Brucejack began commercial production in July 2017 and is one of the highest-grade operating gold mines in the world. The Pretivm technical report of 9 March 2020 estimated gold production of 311 000 oz/y at an AISC of US$743/oz of gold over a projected 13 year mine life.

Brucejack and surrounding tenements are within the traditional territories asserted by the Tsetsaut Skii km Lax Ha (TSKLH) and Tahltan Nation, and in the Nass Area of Nisga'a Nation as defined in the Nisga'a final agreement. Brucejack is approximately 140 km from Newcrest's majority-owned and operated Red Chris mine, located on Tahltan territory. Newcrest will become the operator and 100% owner of Brucejack following completion of the transaction, which is currently targeted for 1Q22.

In line with its vision of being the miner of choice, Newcrest is focused on safety, the environment, developing its people, and fostering strong relationships with the communities near its operations. Newcrest deeply values the relationships it has developed to date with the Tahltan Central Government, Band Councils and the host communities of Iskut, Telegraph Creek, and Dease Lake. Newcrest looks forward to developing similar relationships with the Nisga'a Nation, the Gitanyow Hereditary Chiefs, the Tsetsaut Skii km Lax Nation, and the host communities in the Brucejack mine area.

Newcrest believes that its concurrent operation of both Red Chris and Brucejack mines will provide enhanced opportunities for both workforces, allow for aligned and optimal engagement with the First Nations and the broader community, and will provide the foundation of ongoing future investment in the region.

CHILE SQM joins Race to Zero programme

SQM, one of the leading global producers of world-class lithium, based in the Salar de Atacama in Chile, has joined the Race to Zero programme as part of its 'Business Ambition for 1.5˚C' campaign science-based targets initiative.

As part of the campaign, SQM is committing to the goal of reducing emissions across all its activities in line with the Paris Agreement, with transparent action plans and robust near-term targets.

Race to Zero is a UN global movement that brings together non-state actors across the global economy to take immediate action to halve global emissions by 2030 and deliver a healthier, fairer zero carbon world in time. The Business Ambition campaign is the world's largest and fastest-growing group of companies that will seek to limit global warming to 1.5˚C and halve global emissions by 2030.

By participating in the Race to Zero, SQM will have to fulfil four requirements: pledge, plan, proceed, and publish.

SQM has already begun exploring its options for making its logistics routes low carbon, by introducing Chile's first high-tonnage electric truck to be used in large scale mining onto an 86-km route from the company's Coya Sur plant in María Elena to the port of Tocopilla. The 90 diesel trucks which currently make this journey cover an estimated 7500 km per month.

Switching SQM's fleet of 320 diesel trucks to e-trucks would eliminate approximately 3840 tpy of carbon dioxide.

SQM is currently testing the range, capacity and operability of the trucks, which were designed by Enel X.

If the project is successful, the e-trucks will also be introduced onto the Salar de Atacama-Carmen Lithium Chemical Plant route. This is the highest traffic route for the lithium process, with 230 trucks in service.

WORLD NEWS

DIARY DATES

Mines and Money London
01 – 02 December 2021
London, UK
https://minesandmoney.com/london

International Mining and Resources Conference (IMARC)
31 January – 02 February 2022
Melbourne, Australia & Virtual
https://imarcglobal.com/

IME 2022
15 – 18 February 2022
Kolkata, India
www.miningexpoindia.com

MINEXCHANGE 2022 SME Annual Conference & Expo
27 February – 02 March 2022
Salt Lake City, USA
www.smeannualconference.com

PDAC 2022 Convention
07 – 11 March 2022
Toronto, Canada
www.pdac.ca/convention

Future of Mining Australia 2022
28 – 29 March 2022
Sydney, Australia
https://australia.future-of-mining.com

Euro Mine Expo
14 – 16 June 2022
Skellefteå, Sweden
www.euromineexpo.com

To stay informed about the status of industry events and any potential cancellations of events due to COVID-19, visit Global Mining Review's events page: www.globalminingreview.com/events

MIDDLE EAST KIZAD and Lepidico sign agreement for lithium production facility

Khalifa Industrial Zone Abu Dhabi (KIZAD), a subsidiary of AD Ports Group's Industrial Cities & Free Zone (IC&FZ) cluster, has signed an agreement with Lepidico Ltd, a global lithium exploration and development company, for the establishment of the first lithium production facility in the Middle East, utilising a first of its kind designed process.

Covering a land area of 57 000 m^2, the first phase of Lepidico's development for the AED 348 million (US$95 million) chemical plant will house clean-tech L-Max® and LOH-Max® process technologies. The process extracts lithium and recovers valuable by-products from lithium-mica and phosphate minerals. As an eco-friendly, zero-waste facility, the residue predominantly gypsum, will be repurposed for use in the construction industry.

The vertically integrated Phase 1 Project (P1P) comprises two small scale opencast mines that will feed a mineral concentrator in Namibia, following which the lepidolite concentrate will be shipped to the facility being developed in KIZAD via Khalifa Port.

Lepidico plans to invest approximately US$95 million for the chemical conversion plant in Abu Dhabi for an initial term of 25 years, which will employ the company's proprietary process technologies, L-Max and LOH-Max. The project is a significant step forward in developing a sustainable lithium hydroxide industry and supports the global clean energy revolution.

MALI Kodal Minerals granted Bougouni Lithium Project mining licence

Kodal Minerals, a mineral exploration and development company, has announced that it has been granted a mining licence for its flagship Bougouni Lithium Project in Mali. The project is now fully permitted for development, with the previous approval of the environmental and social impact assessment (ESIA) in November 2019.

Permis d'Exploitation number No2021-0774/PM-RM (mining licence) was granted to Kodal Minerals' Mali subsidiary company, Future Minerals SARL, and is valid for an initial 12-year term and renewable in 10-year blocks until all resources mined.

The mining licence is granted under the 2019 Mining Code and extends over 97.2 km^2, covering the proposed opencast mining and processing operation at Bougouni.

As a next step, Kodal has commenced a programme of work to update the feasibility study announced in January 2020 ahead of securing funding for mine development and construction. The programme has a six-month time estimate and will focus on: metallurgical test work for variability testing and confirmation of process flowsheet, investigating the potential for increased metallurgical recoveries; completion of geotechnical and hydrogeological reviews for opencast and the tailings dam; update and finalisation of capital cost estimates and operating costs for the proposed development; and community development and stakeholder engagement activities at Bougouni.

Strongly rising prices for spodumene concentrate highlight opportunity for project development with recent average pricing levels exceeding US$1250/t 5% lithium oxide (Li_2O) spodumene concentrate, compared with the initial US$680/t for 6% Li_2O spodumene concentrate used in the 2020 feasibility study.

WORLD NEWS

CANADA Weir to acquire Motion Metrics

The Weir Group has agreed to acquire Motion Metrics, a leading Canada-based global mining technology business, for an initial consideration of £89 million payable in cash upon completion, subject to customary net debt and working capital adjustments.

Motion Metrics is a developer of innovative artificial intelligence (AI) and 3D rugged machine vision technology used in mines worldwide. Its technology helps miners increase the safety, efficiency, and sustainability of their operations. As part of the agreement, Motion Metrics Vancouver headquarters will become Weir's global centre for excellence in AI and machine vision technology.

Motion Metrics' applications are highly complementary to Weir's product portfolio. The company will join the ESCO division reflecting the early adoption of its technology in ground engaging tools (GET). Motion Metrics AI and machine vision capabilities are expected to be leveraged across the whole mining value chain served by the Weir Group.

Initial integration efforts will focus on leveraging Weir's global sales network and the ESCO division's large installed base to rapidly expand adoption of this value enhancing technology by its mining customers, thereby driving significant revenue growth.

Motion Metrics is expected to be accretive to ESCO's margins by 2023, with returns expected to exceed the group's cost of capital by 2024 in line with Weir's capital allocation policy. Up to a further £59 million will be payable in cash by Weir at the end of 2024, depending on revenue and profit performance. The transaction will be funded through cash and existing banking facilities. Over the next two years integration costs are expected to total £3 million.

Miners are increasingly focused on improving the safety, efficiency and sustainability of their operations. Motion Metrics has developed proprietary products and solutions that supports these critical ambitions leveraging innovative Machine Vision, distributed AI, and machine learning.

Motion Metrics will become part of Weir's ESCO division, with its extensive team of researchers, data scientists, and engineers also supporting the increased digitisation of the broader Weir product portfolio.

The acquisition is expected to complete in 4Q21.

INDONESIA Altilium to promote sustainable nickel extraction

Booming demand for electric vehicles (EVs) and insufficient investment in processing looks likely to result in a global shortage of the metals needed to manufacture lithium-ion batteries, especially nickel. Indeed, global demand for nickel is set to increase dramatically over the next 20 years.

Against this backdrop, British company Altilium Group has announced an agreement with PT Indo Mineral Research, a member of the Sebuku Group (one of Indonesia's largest mining groups), to co-operate in the development and promotion of the DNi Process™ in Indonesia, the country with the world's largest reserves of nickel. The two companies have agreed to commit financial, technical, and logistical resources to accelerate the adoption of the DNi Process and to play a key role in the EV battery supply chain.

Discussions are now underway with several parties to construct DNi Process plants in Indonesia, with the first plant likely to deliver at least 20 000 tpy of nickel in mixed hydroxide precipitate (MHP), sufficient nickel and cobalt for the equivalent of around 500 000 and 250 000 lithium-ion batteries, respectively. In addition, the DNi Process is capable of producing additional saleable products such as: hematite, magnesium oxide, aluminium hydroxide, and scandium oxide.

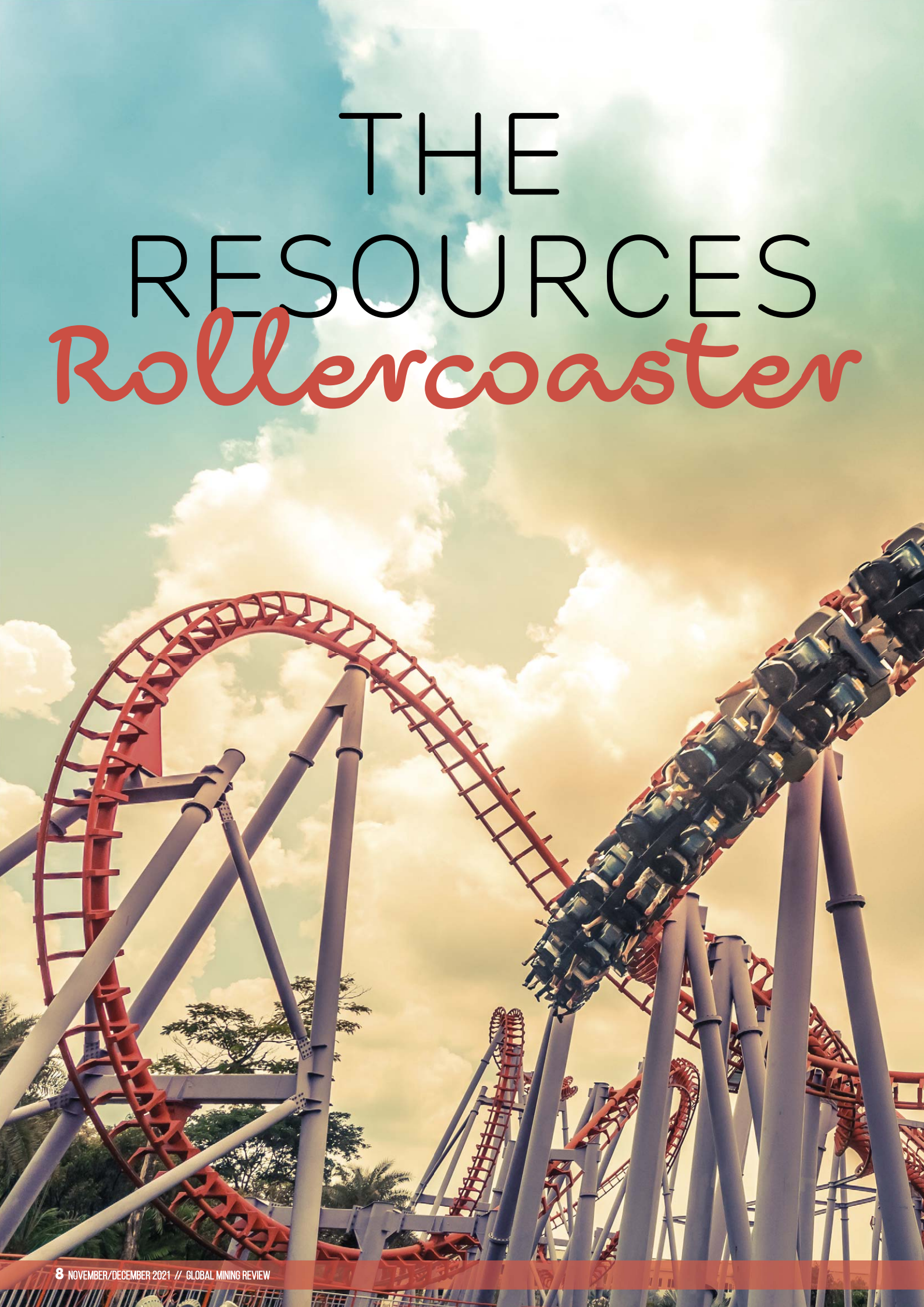
The lack of sensitivity of the DNi Process to ore grade is one feature which has Indonesian resource owners excited. This is because it can treat all the ore in a laterite mine and extracts all the metals available in that ore, such that the economics of the process make the utilisation of low-grade ores both possible and profitable.

DNi Process plants will supply markets around the world. Currently, almost all the hydrometallurgical plants operating in Indonesia (which produce MHP) are Chinese owned or backed high pressure acid leach plants which supply the Chinese market.

The process has already been proven in Australia and endorsed by Commonwealth Scientific and Industrial Research Organisation (CSIRO). The process was tested and proven at a pilot plant located at the CSIRO facility in Waterford, Perth, Western Australia.

The first DNi Process plant, delivering 16 000 t of nickel in MHP, is currently being developed by Queensland Pacific Metals Ltd in Australia, with construction expected to commence in April 2022.

THE RESOURCES Rollercoaster



Benedikt Sobotka, Eurasian Resources Group, Luxembourg, reviews the highs and lows of the iron ore market.

Iron ore rode the resources rollercoaster from the beginning of the COVID-19 outbreak, enduring the fiscal rigmarole and surpassing all kinds of economic forecasts. Yet it was not all smooth sailing, as when the virus began to spread across the world, the market stood static in anticipation; the benchmark price for iron ore slumped to US$80/t, stemming from widespread fears about steel demand in major ore importing regions.

However, with the prompt recovery of China's economy and the rattling of seaborne supply chains which stood testament to the legacy of lockdowns in key exporting regions, global iron ore prices rebounded and reached a position by the beginning of 2021 that was more than double the 2020 lows. Moreover, the ripples of China's economic recovery, coupled with effective fiscal stimulus policies, had re-catalysed iron ore prices to an all-time high of US$233/t by May 2021.

Even though the iron ore market was overheated throughout 1H21 and the price correction was inevitable, the 40% decline in prices in August (from US$230/t to below US$150/t) seems to be unsustainable. Nevertheless, global steel output is on the rise with seaborne demand for medium and high-grade iron ore consolidating, regardless of how strictly the Chinese government would enforce its 'zero growth' target for crude steel production.

Forecasts by analysts set the benchmark iron ore price at above US$150/t in 2021, up by approximately 50% from 2020.

Demand

On the demand side, while the beginning of the COVID-19 outbreak spurred worries about the short to medium-term demand across commodity markets, overall impact on iron ore prices has been positive – mainly due to a specific supply-demand balance within the market.

Multiple lockdowns in key exporting regions, including Brazil, Canada, Peru and South Africa, cut seaborne supply by almost 5% compared to initial expectations, adding to already existing worries about the availability of seaborne ore.

Notwithstanding the ongoing distortions, seaborne iron ore demand has been outperforming throughout 2020 – 2021, with much of the onus placed on China's sustained appetite for seaborne raw materials. In fact, country steel output grew by 5% y/y in 2020 and by 12% y/y in 2021, significantly exceeding the market expectations of 1 – 2% y/y growth forecast back in 2018 – 2019. China's outperforming iron ore demand and dampened seaborne supply had pushed the market into a strong deficit, with market shortage estimations for 2021 forecast at approximately 90 million t, or almost 6% of the global iron ore imports.

While the short-term deficit has eased due to China's steelmaking restrictions, the seaborne market is still expected to remain in deficit until at least 2024 – 2025, due to a delayed recovery in the seaborne supply of iron ore.

Meeting global demand

China's shift from an investment-driven economy to a demand-driven one is expected to limit the country's appetite for finished steel. Nonetheless, with the continued increase in per capita steel consumption and the overall growth in country's population, China's steel demand could have the potential to peak beyond 2025.

With China's participation in the global steel industry's fight for lower carbon dioxide (CO_2) emissions, Eurasian Resources Group (ERG) expects a switch to high-grade fines and pellets in the medium-term, leading to both Chinese and global demand for seaborne iron ore to continue its growth throughout 2021 – 2025. Furthermore, ERG expects China's domestic iron ore supply to gradually decline in the coming years, driven by the constant depletion of domestic mines, tightening of safety regulations, and, most crucially, increasing demand for iron ore pellets, which require high-grade seaborne pellet feed. The latter is expected to sustain China's iron ore imports, at least at current levels, for the next 3 – 4 years.

The upcycle in global ferrous demand has gone far beyond market expectations throughout 2020 – 2021. Economic stimulus policies in China, related to the anti-COVID fight, prompted a surge in global demand and subsequently drove commodity prices to new highs. Even though ERG expects the upcycle to end in the near future, China's infrastructure spending is set to remain as robust as ever, especially due to recent increases in local bonds issuance. The group also expects China's infrastructure investment to maintain its 5 – 6% y/y growth rates in 2021 – 2022, in line with the average 6.1% y/y growth throughout 2016 – 2020. Further, the two other major steel end-using sectors – property and manufacturing – are expected to maintain at least 4 – 5% y/y growth rates, not much below 5 – 7% y/y growth rates observed in 2016 – 2020.

Yet, despite this, steel demand from the automotive industry remains dampened. Whilst most operational lockdowns in key producing regions were lifted by the end of 2020, production recovery is being delayed due to semi-conductor shortages, which followed disruptions in Japan, Taiwan, and Malaysia. Manufacturers across the US and Europe have already driven their goods inventories to a 30-year low, whilst economic forecasts on automotive production recovery have now been delayed until the new year. That said, this delay will prop up metal consumption in 2022 – adjusting for this, ERG expects the momentum in iron ore and steel end-use demand to slow, but still remain at solid levels for the medium term.

Figure 1. Machinery operating at Eurasian Resources Group's BAMIN subsidiary in Brazil.

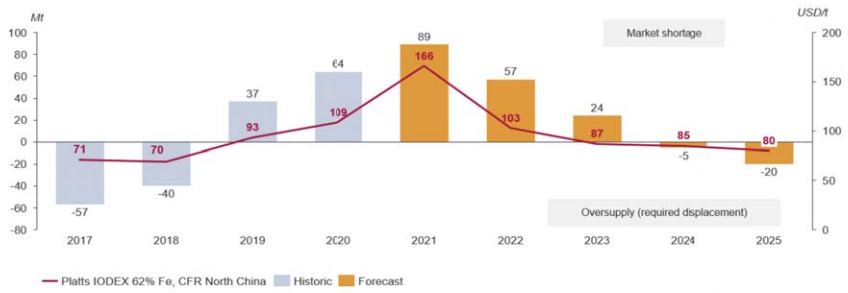


Figure 2. Seaborne market balance (million t).

Supply

After a weak performance throughout 2019 – 2020, seaborne supply is yet to recover to normal levels. The supply side has been unable to respond to the high prices as the major producers in the market are already producing as much as their systems allow, while there are few new projects coming to the forefront of

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the market in 2021 – 2022. Operational difficulties in South America, due to the tightening of tailings dam regulation, and port restrictions in many parts of the world made it even more challenging to deliver iron ore from the vessels to the steelmakers in 2021. As a result, the weak performance of key exporting regions in 2Q21, as well as the focus of major suppliers' on sustaining current production rates, suggests global exports will take longer to recover to full capacity.

Looking forward towards major capacity additions announced for the next 2 – 3 years, ERG expects the biggest chunk of 300 – 330 million tpy capacity, coming from both greenfield and brownfield projects, to mainly substitute depleting 150 – 180 million tpy in Australia, China, North America, and a few other regions. Having said that, ERG expects global seaborne supply to increase by up to 150 – 170 million t by 2023 – 2024, which, however, will not be sufficient to offset the current market deficit of 90 – 100 million t, combined with an expected 85 million t increase in seaborne demand. Hence, the group expects the seaborne market to remain in deficit until 2024 – 2025. Moreover, multiple supply risks remain in place, including weather-related disruptions, the delayed starts of new projects, and delays in the construction of new infrastructure.

Factors incentivising iron ore production

ERG's integrated mining and logistics project in Brazil, BAMIN, is well-placed to enter the iron ore market in the medium-term, primarily thanks to the heightened market focus on high-grade iron ore materials. This is reinforced by BAMIN's agreement with the Brazilian federal government to complete and operate a section of the FIOL railway, connecting ERG's Pedra de Ferro mine in Caetite to the Porto Sul port in Ilhéus in the Bahia state. These operations are set to transform Bahia into the third largest iron ore producer in Brazil, with a target capacity of 18 million tpy of iron ore.

Aside from the global steel industry's focus on reducing CO_2 emissions, it is worth emphasising the specifics of iron ore quality market segments. Medium and high-grade products (i.e. above 60% iron) account for almost 70% of the seaborne market, and are forecasted to gain an even bigger share going forward. In particular, quality premiums are expected to stipulate iron ore producers to focus on the improvement of their iron ore products in the nearest term achievable.

High-grade iron ore premiums surged throughout late 2020 and across 1H21, due to China's outperforming hot-metal output and healthy steel margins. These premiums are set to sustain at high levels in 2021 – 2022, with steelmakers in both Europe and the Middle East and North Africa (MENA) experiencing severe difficulties in sourcing pellet feed for their operations. Recovering steel margins in all parts of the world means that there is an increasingly strong demand for high-quality material, such as: pellets, high-grade fines, and concentrates. At the same time, pellet supply has struggled due to operational issues in Brazil and labour strikes in North America. Trade data shows that European steel mills were importing very low volumes of Brazilian pellets in 2021, even though overall steel output was improving. Even India, which typically supplies pellets to domestic customers or China's steel market, has started to export pellets to the European consumer base. Moreover, some traditional pellet demand in Europe and MENA was substituted by imports of the South-African lump, whilst recently introduced pellet export duties in Russia pose further risks to the seaborne pellet market.

Figure 3. Eurasian Resources Group's integrated mining and logistics project in Brazil.

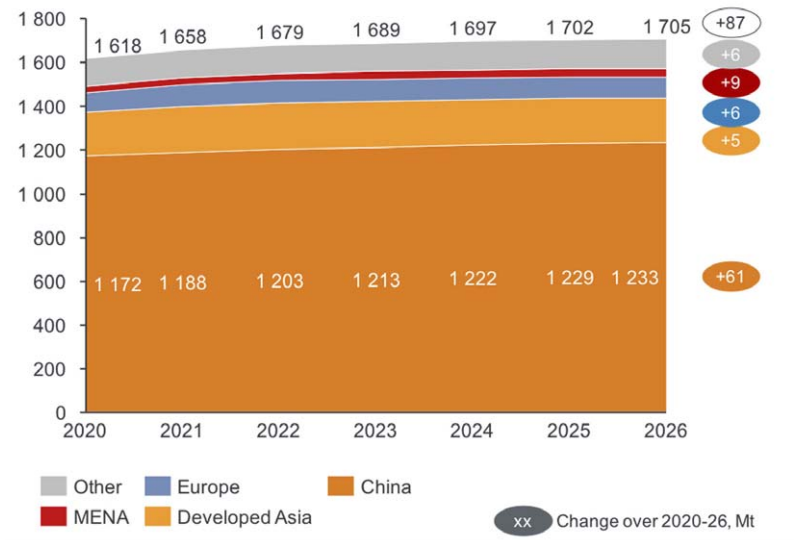


Figure 4. Seaborne iron ore imports (million t).

Conclusion

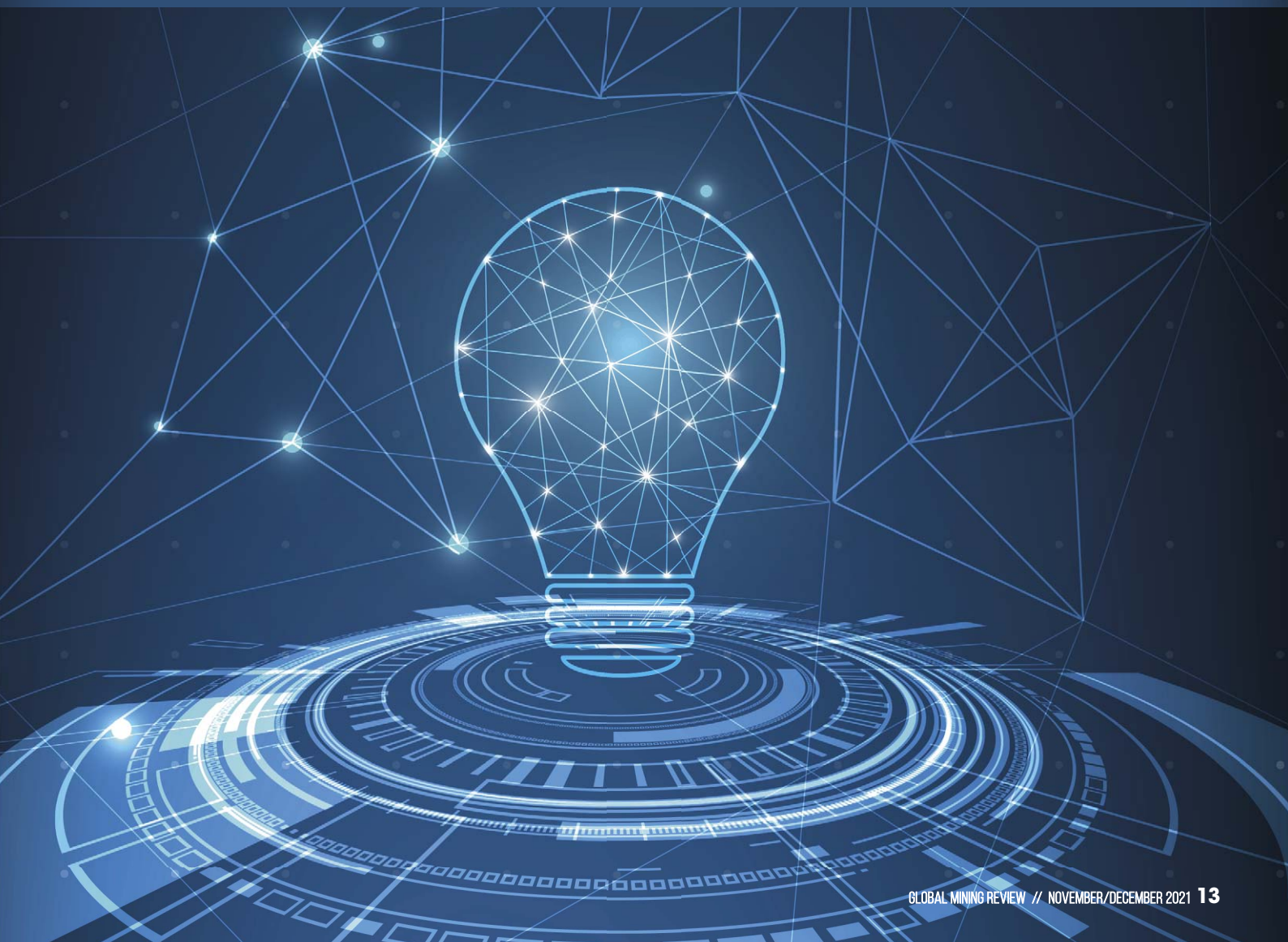
ERG expects the tightness of high-grade iron ore material to remain throughout 2021 – 2022, mainly due to production issues in Brazil and the additional risk of Russian pellet exports falling. GMR

CONNECTED TECHNOLOGY WITH A PURPOSE

John McGlone, SKF Group, UK, considers the importance of keeping purpose in mind when implementing digital solutions in mining applications.

Digital tools for equipment monitoring are getting smarter, more powerful, and more cost effective. However, as they implement these new technologies, mine operators should always keep their purpose in mind.

Predictive machine maintenance has traditionally been a business used by early adopters with a clear understanding of how strategic maintenance management can contribute to overall profitability. High costs and high complexity limited the application of the approach to the



most critical, industrial assets. Today, exciting changes are underway. New developments – including mobile computing, wireless communications, the Internet of Things (IoT), and artificial intelligence (AI) – make it feasible to add smart monitoring capabilities to a much wider range of machines.

In a fast-changing and dynamic environment, it is easy to get carried along by the hype. With technology companies and service providers offering to wire up anything and everything, the key question for mine operators is no longer 'can we monitor our assets?', but 'how do we manage the increasing volumes of data?', or even 'should we?'.

A sense of purpose

To answer that question, equipment operators need to begin with a clear vision of their end goals. What is trying to be achieved with the overall maintenance and reliability programme? How could digital technologies contribute to those aims?

In conversations with miners, SKF has heard several different answers to these questions. Most often, they have strong financial goals; for example, to maximise the return on capital investments, or to minimise the total cost of ownership (TCO) of their assets. In demanding and hazardous mining environments, improved safety is another universal priority. Increasingly, however, natural resources companies are also prioritising actions which can improve the environmental sustainability of their operations, as part of the license to operate, and make it easier to attract and retain a skilled and motivated workforce.

Setting out the goals of a potential machine monitoring and predictive maintenance programme provides a framework that helps owners prioritise their actions and implement the most appropriate solutions. Mining equipment will always be exposed to wear and the risk of damage, but by identifying the assets and failure modes that have the largest impact on their reliability goals, operators can identify technologies that help them detect, predict, and prevent those failures.

Elements of a solution

Once the objectives of a monitoring and predictive maintenance project have been defined at the asset level, it is time to select the right solution. That solution will typically comprise several connected hardware, software, and human elements. SKF finds it helpful to break down the solution into four distinct parts: connect, detect, inform, and improve.

Figure 1. Hand-held devices can be used to collect data periodically during walkarounds by maintenance staff.

Connect

The 'connect' part of the solution refers to the equipment and infrastructure needed to measure and record reliability-related data. For bearings and rotating machines, that usually involves vibration sensors, since vibration is still the best way to spot the early signs of problems. Increasingly, however, condition monitoring systems are combining multiple data types, such as process data from machine control systems or lubrication oil temperature and condition information from dedicated sensors.

Sensors combined with hand-held devices can be used to collect data periodically during walkarounds by maintenance staff. Or they can be permanently fixed to the machine, transmitting data via wired or wireless connections at an appropriate rate for the application. The best approach depends on the type of asset being monitored, and its role in the process. Traditionally, permanent sensors and wired connections were expensive to install and were used only on the most critical assets. Balance of plan assets, such as pumps and fans, could be effectively monitored using hand-held devices.

Today, however, attitudes are beginning to change. This is being driven by the development of lower-cost wireless sensors, which are quick and easy to install. Switching from handheld devices to these sensors frees up maintenance staff for more value-adding work, and reduces the need for personnel to get close to running machinery for data collection, which has obvious safety benefits. In addition, continuous monitoring can facilitate the identification of problems more rapidly than the traditional two or three-week manual data collection cycle.

Detect

The 'detect' part of the solution describes the analytical techniques used to identify anomalies in machine data and diagnose potential faults. That is a highly specialised task, requiring a combination of sophisticated algorithms and human expertise. Difficulty accessing the latter can be a critical bottleneck for predictive maintenance programmes, especially for miners operating in remote and inaccessible locations.

Today, the need for on-site expertise has been lessened by the development of centralised remote monitoring facilities. These use cloud technologies to share data from multiple sites and assets with a single hub, where specialist staff can analyse the data and diagnose problems. Some large organisations have chosen to staff and run such facilities themselves, but this is also a service that can be outsourced to specialist providers. For example, it is something that SKF offers all of its customers around the world, through its network of remote diagnostics centres (RDCs).

In parallel with the use of remote human experts, there is an ongoing drive to automate more anomaly detection and problem diagnosis using AI technologies. AI systems are already showing tremendous promise in machine monitoring applications, both by reducing the workload placed upon human experts and by spotting subtle signals that they might miss.

Inform

The 'inform' part of the solution is about translating the anomalies detected by the remote monitoring system into actionable information for the end user. If a problem is detected in a bearing, for example, the user knows they will need to inspect the machine. What they really want to know is whether they should stop now, or whether it will be safe to keep the machine running until the next scheduled maintenance intervention, when the required people, equipment, and expertise will all be on site. In SKF's experience, this 'inform' phase works best when it involves close collaboration between condition monitoring and data analysis experts and the miner's own operations and maintenance teams.

Improve

The need for collaboration is even more pronounced in the final 'improve' part of the solution. This phase does not involve much smart digital technology, but it is often the key to the most significant performance and value improvements. It is about the robust application of traditional reliability improvement tools, in order to prevent the reoccurrence of failures identified by the predictive maintenance system. SKF often works with its customers to identify changes in bearing selection or lubrication strategy that can prolong the life of equipment and extend the mean time between failures of critical assets.

From purpose to practice

To see how these steps work in practice, this article will conclude with a look at two recent examples of their implementation in the mining industry.

Figure 2. By identifying the asset's failure modes, operators can identify technologies that detect, predict, and prevent failures.

Case study: Brazil

The first comes from Brazil, where an SKF customer has adopted remote monitoring technology to improve the reliability, availability, and productivity of its fleet of 34 haul trucks. The customer worked with SKF reliability specialists to implement a sophisticated online monitoring system for these vehicles.

Due to the nature of the application, the use of extremely robust sensors and cabling designed to offer a high level of environmental protection was required. Data from the sensors and from the trucks' on-board control bus is fed to SKF IMX data collection units installed on each vehicle, then transmitted wirelessly to a central hub for analysis.

Because truck operations are highly variable, the monitoring system uses sophisticated gating algorithms to ensure that vibration data is only collected when vehicles are operating at specific loads and speeds. This enables effective monitoring because analysts know they are always comparing like with like. From start to finish, the design, installation, and implementation of the monitoring system took approximately six months, and data collection commenced at the start of 2021.

Case study: Australia

The second example comes from a horizontal grinding mill installed at a mineral processing site in Australia. This application presented some significant challenges. First, the site was remote, so it was difficult to ensure that experienced staff were available all times. In the past, the customer had experienced a situation where a critical failure was picked up too late, leading to a major unplanned shutdown. A second challenge arose from the nature of mill operations. The asset rotates at low speeds of approximately 10 rpm, which necessitates the use of highly sophisticated vibration analysis algorithms to extract valid data on the condition of bearings and gearbox elements in an extremely noisy environment.

SKF took on the monitoring of the mill on behalf of the customer, installing the necessary sensors and communication equipment and conducting analysis remotely from one of its RDCs. After only three months of continuous monitoring, the RDC identified an anomalous signal and was able to pinpoint the problem to a particular pinion gear within the machine. In this case, timely action to address that single issue saved the customer enough in avoided lost production to cover the full cost of the remote monitoring system.

Conclusion

New developments make it feasible to add smart monitoring capabilities in a much wider range of machines, but it is easy to be carried away in the hype. Break down the solution into four parts: connect, detect, inform, and improve.

The key question that follows is what is trying to be achieved with the overall maintenance and reliability programme? Once this question is answered, the solution can begin to be implemented. GMR

Tailings management, meet Science Fiction

Amanda Adams, Debra Johnson and Kwestan Salimi, Stantec, USA, explore how further steps can still be taken to better manage dam safety.

Science fiction fans can appreciate how easily characters in shows such as Star Trek and Doctor Who are able to diagnose every issue. There is no explanation of how the methods work, or what data they are collecting, they simply deliver exactly the right information the instant it is needed. Imagine if that were possible today for applications such as dam safety and tailings management.

What if everything one needed to know about slope stability, soil saturation, production rates, impoundment density, embankment deformation, etc. was available at one's fingertips? And not just the individual data sets, but a

synthesised diagnostic that combines the design, construction and operation, along with inputs such as climate data, seismic readings, and real-time inspections? This sounds like science fiction, but the reality is closer than one might think.

Global Standard on Tailings Management

Tailings disasters have triggered an overhaul of global safety guidelines, leading to the introduction of the Global Industry Standard on Tailings Management (GISTM). In August 2020, co-conveners International Council on Mining & Metals (ICMM), United Nations Environment Programme (UNEP), and Principles for Responsible Investment (PRI) launched the GISTM with input from a multi-stakeholder advisory group. The GISTM aims to prevent catastrophic failure and enhance the safety of mine tailings storage facilities (TSFs).

Figure 1. Stantec engineers monitor many remote tailing storage facilities, like this one in the mountains of Peru. An all-encompassing, largely automated tool would be extra useful at sites that are difficult to visit.

Figure 2. Apollo 11 moon landing.

The GISTM sets a new, global benchmark to achieve strong social, environmental, and technical outcomes in tailings management. It also highlights that "while the mining and metals industry has come a long way in improving how it operates, there's still much more that can be done to safeguard lives, improve performance and demonstrate transparency."[1]

Data overload

Mines are working with ever-lower grade ore bodies, which means that the percentage of waste to mineral product is increasing. This translates to more and larger TSFs than ever before, although alternatives to TSFs are in various stages of development. Increased disclosure requirements, as well as more complex designs and monitoring systems, timely and accurate data collection and analysis, make reporting of TSF performance more critical than ever.

Types of data collected include:

- Production data from the mill.
- Grain size/grind of the tailings.
- Deposition locations and quantities placed in the impoundment.
- Construction quality control/quality assurance testing.
- Survey data including bathymetry.
- Piezometer or other instrumentation readings.
- Weather and climate data.

Data may be generated monthly, weekly, daily or even by the minute, depending on the collection system. Many mining companies are utilising satellite imaging and remote sensing data, which can generate millions of data points across a site. It is great to have so much data, but the sheer volume can be overwhelming. According to NASA, "Over the last years, the volume of SAR has grown to 9 PB, predominantly from the recent Sentinel-1 satellite with 7 PB of data. This volume is expected to grow at an unprecedented rate of approximately 86 TB per day with the launch of NISAR in May 2022."[2] Mine operators need sophisticated data storage and management systems, but they also need efficient ways to pull and analyse the data for it to be useful in practice.

Turning science fiction into fact

Tailings engineers and operators must be able to quickly visualise information and be alerted long before any monitoring points reach a critical level. Looking at datasets individually may not tell the whole story. Perhaps a piezometer reading appears to be below the trigger level, but if it is placed in a zone of finer grind material, the trigger is no longer accurate. Or perhaps the available stormwater storage is sufficient based on the original design, but not when the effects of climate change are considered.

This is where mines need a futuristic data analysis tool: a device so sophisticated that it can analyse endless data points instantly, as well as run countless scenarios to identify critical risks in a timely manner, faster than human engineers can currently create the analyses. It would understand and compare disparate datasets, extrapolating how the impacts of changes in one or more

parameters could impact the entire facility. Furthermore, most importantly, it could also immediately warn stakeholders of impending risk based on situational and environmental changes so that relevant action could be taken.

Shoot for the Moon

In 1961, John F. Kennedy asked Congress to "commit itself to achieving the goal, before this decade is out, of landing a man on the Moon and returning him safely to the Earth."[3] JFK created a vision and a challenge that Congress, NASA, and the American people could rally around.

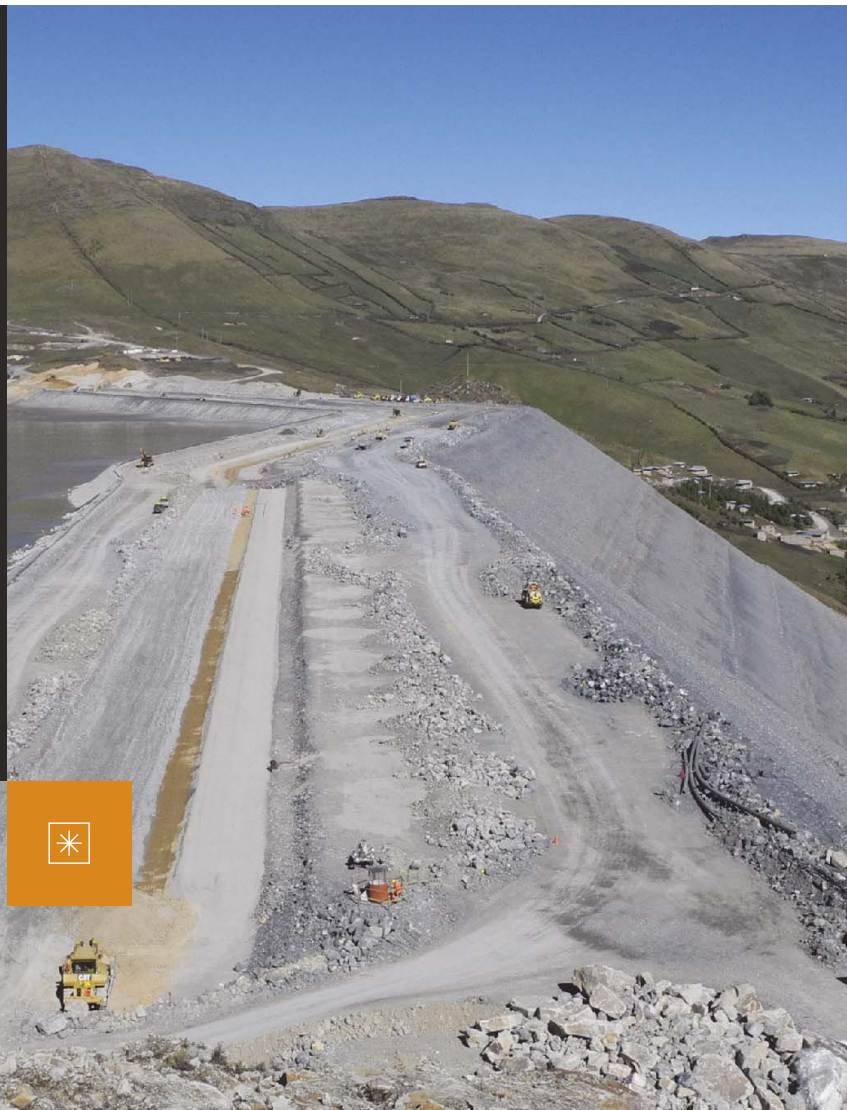
No one company or technology made this moonshot vision a reality. It required collaboration, ecosystems of diverse partners (including companies who were traditionally seen as competitors), creativity, and a lot of hard work to solve both big and small challenges. There was a lot of incremental innovation that had to happen to achieve JFK's moonshot vision. Because of that 60-year-old vision, current space journeys (such as the highly publicised trips by Richard Branson and Jeff Bezos) continue to leverage the resulting technological advances.

Today, there is an opportunity for the mining industry's own moonshot vision – an application on the mining company CEO's phone that shows the status of every TSF in the company, enabling the CEO to sleep soundly knowing that everyone who could be impacted by TSFs will be safe tonight. As with JFK's moonshot, in order to achieve this vision, a lot of very 'unglamorous' incremental technologies need to be developed and matured. It will require creativity, collaboration and data sharing between the entire industry, including companies who may be competitors.

Incremental change to achieve the vision

Industrial Internet of Things (IIoT), data lakes, data fusion, predictive analytics, machine learning (ML), artificial intelligence (AI), Cloud and Edge devices – technology words that are tossed around every day – mean nothing if the right data is not available, the ML and AI models have not been trained with expert knowledge of the impact of diverse events and conditions, or data aggregation is delayed or corrupted due to unreliable communication networks or cybersecurity issues. A future state vision for TSFs needs to be embedded into the organisation at every level to be successful. The vision should also incorporate a clear technology roadmap. Without this level of dedication, the crucial foundational technologies that may lack standalone return on investment (ROI) will be at risk of ending up on the budgetary cutting room floor.

Additionally, if mining as an industry does not improve its ability to advance incremental technologies required to develop a holistic solution and achieve this vision, TSFs will continue to operate at unacceptably high-risk levels. Like those first steps on the Moon, this vision will only happen with collaboration between ecosystem partners who understand the bigger vision of responsible mining



with exceptionally high expectations for timely, accurate visibility into TSF risks.

TSF tools of the future

Although this futuristic TSF tool is not yet a reality, many of the required elements already exist. For example, interferometric synthetic aperture radar (InSAR) is an effective technique to evaluate the stability and behaviour of earthen structures (e.g. TSFs) continuously. InSAR is capable of measuring and accurately mapping ground deformation through monitoring the changes in land surface altitude using radar images of the Earth's surface collected from Earth-orbiting satellites at high degrees of measurement resolution.[4] Radar signals are reflected off a target area to produce images at different times, then two images are combined, resulting in maps called interferograms that show ground-surface displacement between the two time periods. InSAR techniques can, for example, help determine if the drainage system works properly and, if not, where the additional drainage wells should be installed.[5]

InSAR data, when harnessed and fused with other data sources in a holistic solution, will greatly extend the ability of TSF engineers and operators to:

- Rapidly and accurately monitor any potential deformation of a TSF, such as embankment movement or sinkhole development.
- Identify those conditions that require subsequent manual onsite investigation.
- Provide a reliable early warning system with millimetric precision.[6]

Building the tool vs trusting the tool

Another way to think about the journey to getting to an automated, smart TSF safety tool is to think about the development of self-driving cars. People have dreamt of self-driving cars for decades. Developing the concept from the initial idea through to a fully autonomous, safe passenger vehicle requires many iterations, with continuous testing in countless scenarios conducted in low-risk environments, before the vehicle is ever trusted to navigate in real-time on an operational road. To be successful, a self-driving car must be 'intelligent': it must sense obstacles, react to changing road conditions, and, above all, preserve the safety of passengers, pedestrians, and other vehicles.

The mining industry is in the early stages of defining how an intelligent TSF safety tool would work. It will likely be a long road to developing a 'self-driving' TSF. TSFs are currently monitored by people assimilating information from numerous sources. Even when the best datasets and information dashboards are available, that information is still reviewed, analysed, and verified by an operator or engineer. Stability analyses, trigger alert systems, and critical failure mode assessments are ultimately the product of people, not computers. The future of tailings management will be an intelligent system, informed by the site engineers, but smart enough to extrapolate information, make recommendations, identify problems, and suggest modifications without human oversight and constant input. The key will be to address the unique barriers to developing this system and effectively leveraging the expert knowledge of engineers.

While self-driving cars must be able to react to stimuli and conditions, their job is distinctly different from the role to be played by a TSF tool. No two mines are the same, and no two TSFs are the same, each with quite unique physical properties. All cars have wheels and engines and can drive on asphalt, concrete, even dirt roads. Training the ML and AI models for a TSF tool must rely on engineering calculations, since repetitive scenario testing is not feasible. At what point will a 'self-driving TSF' be trusted? What level of testing and validation will be required to be confident that every analysis and recommendation output by the tool does not still need to be duplicated and validated by a person? These questions will need to be answered sooner rather than later as ecosystem teams work together to build this tool.

Conclusion

Although the diagnostic tools of TV science fiction do not yet exist, there have been advances light-years beyond the technology that existed at the time of the first Moon landing. Catastrophic TSF failures, and the associated outcry from the public, have resulted in the GISTM. This standard strives for nothing less than "to achieve the ultimate goal of zero harm to people and the environment with zero tolerance for human fatality". The technology step-change which will be required, in order to get from current design and monitoring practices to fully utilising sophisticated ML and AI models, will not happen overnight. However, many foundational elements of a tool like this already exist and the use of InSAR and other automated sensing and monitoring data grows daily.

There is more collaboration and innovation happening in the mining industry today than ever before. Now is the time for the entire industry to set the goal of an 'intelligent' TSF tool to better manage dam safety. With this unified goal, the industry will be able to achieve not only the technological vision, but more importantly, the goal of ensuring that everyone who could be impacted by those TSFs will be safe. GMR

References

1. *Global Tailings Review*, https://globaltailingsreview.org/
2. 'Enabling Cloud-Based InSAR Science for an Exploding NASA InSAR Data Archive', *EarthData*, https://earthdata.nasa.gov/esds/competitive-programs/access/cloud-based-insar
3. 'May 25, 1961: JFK's Moon Shot Speech to Congress', *Space.com*, https://www.space.com/11772-president-kennedy-historic-speech-moon-space.html
4. COLOMBO, D. and MACDONALD, B., 'Using advanced InSAR techniques as a remote tool for mine site monitoring', *The Southern African Institute of Mining and Metallurgy*, (2015).
5. HU, X., et al., 'Consolidation settlement of Salt Lake County tailings impoundment revealed by time-series InSAR observations from multiple radar satellites', *Remote Sensing of Environment*, Vol. 202, (2017), pp.199 – 209.
6. THOMAS, A., et al., 'Earth observation data and satellite InSAR for the remote monitoring of tailings storage facilities: a case study of Cadia Mine, Australia', *Paste 2019: Proceedings of the 22nd International Conference on Paste, Thickened and Filtered Tailings*, pp.183 – 195.

TAKING THE *sting* OUT OF *tailings*

Ronan Bray, K2fly, Australia, explains how technology can help the mining industry meet environmental obligations and manage tailings.

The upcoming new year will mark the third anniversary of one of the biggest tailings dam catastrophes on record and the start of a new era in safety management, with advanced technologies playing a critical role in how the mining industry of the future will monitor and manage its waste infrastructure.

Resource companies around the world have since rushed to review their tailings management processes and look for ways to improve monitoring, reporting and governance, in order to prevent another human and environmental tragedy.

The technology sector has been one of the first to respond, led by companies such as K2fly, an Australian software company, which has been working with leading Tier 1 and International Council of Mining & Metals (ICMM) member companies to harness state-of-the-art technologies, helping miners achieve new standards of governance, monitoring, reporting, and disclosure of tailings data.

The world's biggest tailings dams are some of the largest manmade structures, and one of the greatest risks for mine owners is the devastating damage dams can cause when they fail.

The Brumadinho dam disaster

When Brazil's Brumadinho tailings dam broke, releasing a wave of noxious mud from the Córrego de Feijão iron ore mine, the disaster triggered an unprecedented overhaul of global safety regulations for tailings storage facilities (TSFs).

Although by far the biggest, this was only one of 60 major TSF failures in less than 20 years. In 2019, China's biggest tailings leak in 20 years sent 2.53 million m^3 of mining waste into local river systems.[1]

Industry researchers Bowker and Chambers predicted that failure trends would escalate, leaving the global public with a US$6 billion unfunded clean-up bill within five years.[2] Not only was much of the tailings infrastructure ageing, but the problem of mine waste was getting bigger, with TSFs reaching a capacity of more than 5 million m^3. This was driven by the higher volumes of material being processed to achieve a return from lower grade ores.

The full financial impact of a significant tailings failure also resonated with insurers, prompting an overhaul of underwriting policies as they moved to reduce their exposure and protect their own businesses. As a result, premiums for miners skyrocketed and access to cover became more difficult.

Mine operators are now required to be more transparent in their assessment of tailings risk and are likely to have their insurance cover refused altogether if they do not comply with new global governance requirements.

Within two days of the Brazilian disaster, a group of investors, co-led by the Church of England Pensions Board and the Swedish Council of Ethics of the AP Funds, announced the Investor Mining and Tailings Safety Initiative. They called for a new independent and publicly accessible international standard for tailings dams. Four high level investor round tables were held in London between March and June 2019,

providing a forum for affected communities to express their concerns.

Global tailings standard

This led to the creation of the world's first TSF database, which was launched with 1900 entries, at the Global Tailings Summit in January 2020. By April, 45 of the world's top 50 mining companies had publicly disclosed information on their websites about thousands of tailings facilities. More than 86% of the mining industry by market capitalisation had responded and all 23 public ICMM company members had fully disclosed their tailings assets.

In August 2020, the Global Tailings Review, comprising the ICMM, the United Nations Environment Programme (UNEP) and the Principles for Responsible Investment (PRI), successfully launched the first global standard for the safe management of mine tailings. The landmark initiative covered the entire TSF lifecycle – identifying six topic areas, 15 principles, and 77 auditable requirements. It significantly raised the bar for the industry to achieve strong social, environmental and technical outcomes, by elevating accountability to the highest organisational levels and adding new requirements for independent oversight.

With an estimated 3500 active TSFs, covering approximately 1 million ha. of land, it was clear that a fresh approach was needed to efficiently manage data, reporting, monitoring, compliance, and governance of facilities to reach the ultimate goal of zero harm to people and the environment.

Miners estimated it could take up to six weeks per site to collate their tailings data using manual processes and often disparate and siloed datasets – for those with more than 50 sites, this would be a costly and demanding process.

The cost of tailings

Tailings disposal is a cost of doing business for miners – a potential multi-billion dollar social and environmental risk that is expensive to manage and even harder to re-mediate. Experts say it costs at least US$1 billion to decommission a tailings dam – some estimate the real cost of rehabilitation is 10 times that much.

Increasing pressure from governments, regulators, insurers, and investors to comply with new global standards and public disclosure requests means miners are looking for ways to improve their tailings storage facility management.

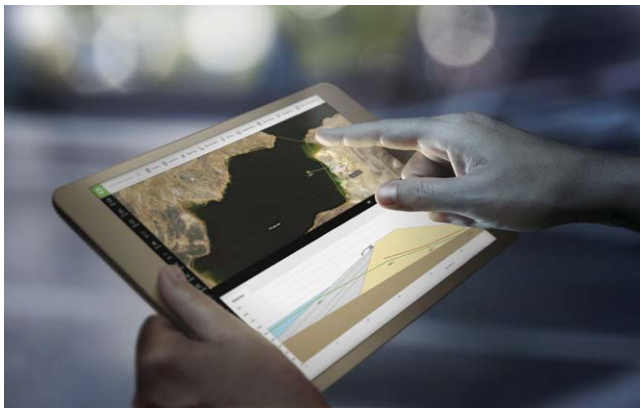


Figure 1. K2fly's Dams & Tailings Solution: cross-section view.

Mining companies collect massive amounts of TSF monitoring data from a myriad of sources and are then required to collate this and provide constant reporting, both internally and to regulators.

Furthermore, for mining companies to achieve satisfactory insurance renewal outcomes, they need to demonstrate that their facilities adhere to governance processes and standards, that they are fulfilling their obligation to do whatever is necessary to avoid a safety incident, that they can work in collaboration with auditors and underwriters, and that they comply with industry public disclosure expectations.

Taking the sting out of tailings monitoring and compliance

In response to the launch of a global tailings standard, K2fly, a leading mining software company with customers in 54 countries, developed a cloud-based platform that would provide new tools for companies to demonstrate TSF standards compliance, visualisation, reporting, and disclosure.

The company's software aligns with the international standards enabling accurate, real-time information to be securely stored and shared with industry regulators, insurers, engineers, and operators involved in managing each tailings facility.

K2fly has also been working with developers of the Global Tailings Portal to create a tool that automatically updates tailings data from the company's platform directly to the international TSF database. This offers massive time and cost savings, while enhancing the accuracy and currency of the records.

The company built their platform with input from all these stakeholders so that data collection is simplified and automated as far as possible. The results are presented visually on a map and supported by tools to take action, with key reports generated at the click of a button.

K2fly's Dams & Tailings solution allows Tier 1 miners to operate with integrity while still protecting and improving their bottom line. The solution has evolved following K2fly's acquisition of Decipher to offer a unique end-to-end solution for the monitoring, management, and governance of tailings operations.

ICMM is an international organisation dedicated to a safe, fair, and sustainable mining and metals industry. In 2020, it released the Global Industry Standard on Tailings Management, which has brought the need for operators to comply to the forefront of priorities. The adoption of K2fly's Dams & Tailings solution by leading ICMM members has resulted in serious interest in the market.

The cloud-based application combines regulatory compliance management, mining waste management, stakeholder engagement, environmental monitoring, and environmental management system into a single feature-rich package, with secure global access (to industry, regulators, designers, and operators), which can be used to share data and monitor facilities from anywhere in the world, at any time. Importantly, this is all underpinned by strict governance giving operators and executives greater confidence in the accuracy and auditability of data being reported.

The solution draws on K2fly's monitoring capabilities and has been built with the Google Earth Engine at its core,

consolidating tailings data from many different sources, including Internet of Things (IoT) devices (monitoring piezometers, inclinometers, seismometers etc.), light detection and ranging (LiDAR), radar, CCTV, drones, inspections and interferometric synthetic aperture radar (InSAR) remote sensing, all in one central location.

Rich data is overlayed with earth observations, landform, erosion, weather and blast data, providing key insights to reduce risk, effectively manage tailings facilities, and monitor environmental compliance.

Tailings dams are often large, complex structures and many have embankments cresting at a height of over 25 m and stretching for more than 5 km. They can be difficult to monitor for ground movement using conventional methods, yet most failures occur due to factors such as: foundation weakening, seepage, overtopping, and earthquake damage.

The company's system incorporates InSAR, a remote sensing technique that uses satellite radar images of the Earth's surface to track landform changes with millimetre accuracy. Working with InSAR providers to harness radar signals from earth-orbiting satellites, K2fly visualises land displacement on an interactive map with an accuracy within millimetres.

This means that the solution is a cost-effective mechanism to monitor, measure and detect deformation of land surfaces over time, and to set up alerts when geotechnical parameters are exceeded, in order to reduce the risk of tailings dam failures. Results are highly accurate and large areas can be captured in a single overpass without the safety risk of having people on location.

The company's integrated software harnesses the power of existing, current, and future data stored in a secure and accessible cloud platform. It replaces manual processes, disparate and siloed datasets, and outdated information. The solution has been built to industry best practice and to meet compliance requirements from the Investor Mining and Tailings Safety Initiative, ICMM, Global Tailings Portal, PRI, UNEP, and the Global Industry Standard on Tailings Management.

Conclusion

Technology such as this can help provide clients with the data and insights they need to ensure they are meeting environmental obligations, and to demonstrate their commitment to good governance and implementation of the standards.

Of equal importance, it also provides the information they need to plan for the closure and rehabilitation of their sites in a way that has a positive impact on their sustainability and social license to operate, as well as the company's bottom line. GMR

References

1. 'China's recent tailings leak the worst in 20 years,' *Mining[dot]com*, (20 April 2020), www.mining.com/chinas-recent-tailings-leak-the-biggest-in-20-years/
2. BOWKER, L. N. and CHAMBERS, D. M. 'The Risk, Public Liability, & Economics Of Tailings Storage Facility Failures,' (21 July 2015), www.earthworks.org/cms/assets/uploads/archive/files/pubs-others/BowkerChambers-RiskPublicLiability_EconomicsOfTailingsStorageFacility%20Failures-23Jul15.pdf

UNEARTHING OPERATIONAL EXCELLENCE: PART ONE

In the first of a two-part article, **Bob Hooper, Hexagon, USA,** discusses how operational excellence can aid the mining industry's long-term success.

Operational excellence (OpEx) is a holistic approach to business change that requires small, ongoing modifications capable of producing significant effects. Within mining operations, some managers may apply the practice as a means to reduce the high capital expenditure of modernising mining facilities or tethering multiple entities to enhance operations. In doing so, OpEx is applicable to every person across an organisation. It flourishes best with a well-defined transformation strategy and a shared culture of improvement that, when implemented properly, is clear, concise, practical, actionable, and teachable. In return, achieving sustainable OpEx can yield greater efficiency, with reduced costs and increased customer satisfaction for a more competitive business.

OpEx sounds straightforward and feasible to implement, but unfortunately, due to variations in interpretation and implementation, organisations must work hard to create a viable plan with the appropriate level of execution to achieve it.

Therefore, this article (the first of a two-part series on OpEx in mining) will explore some of the triggers that can spur an organisation's OpEx journey, the role a healthy culture of continuous improvement can play, and what operators can do to develop and nurture a sustainable OpEx organisation for long-term success – with special consideration given to the cyclical nature of commodity-based industries.

The key drivers of OpEx

According to a recent report from PricewaterhouseCoopers (PWC), mining is one of a small number of industries that survived the global COVID-19 pandemic crisis in excellent

financial and operational shape. This report also states that 2020 was a banner year for the mining sector in comparison to 2019: net profits were up 15%, cash on hand increased 40%, and market capitalisation jumped by nearly two-thirds.[1]

Nonetheless, evergreen business pressures remain much the same, such as: managing costs, decreasing cycle times, reducing waste, and eliminating errors and variances in processes. However, as a billion-dollar global industry critical to dependent markets (including technologies and electronics, construction and infrastructure, and green energy resources), mining, like other process industries, is also subject to three main key drivers. As noted in the 'The Global State of Operational Excellence: Critical Challenges & Future Trend' report by the Business Transformation & Operational Excellence Summit (BTOES), these major influences include customers, competition, and technology.[2]

Figure 1. Demonstrating small improvements achieved through OpEx will engage people throughout the organisation.

Figure 2. Companies are reporting that digitalisation is accelerating their ability to deliver sustainable OpEx.

Customers

In mining, customers can range from regulatory bodies and company stakeholders to regional and local communities – all desiring a seamless and transparent relationship with a mining operation in some form or fashion. Any experience perceived outside of their respective expectations can cause a negative reaction, especially regarding compliance. Therefore, it goes without saying that companies should seek out who their customers are, understand their concerns and consistently engage with them to provide information that fits within their customer experience expectations. PWC (2021) states that local communities are crucial, but so are regulators, investors, analysts, suppliers, end users, and employees.[1] Without understanding the non-financial drivers of all the stakeholders, mining operations will find it hard to access new mineral resources, affordable capital to develop these resources, and workforces to operate their mines. In addition, decarbonisation and the green agenda has become a more prominent issue, as social responsibility and broader stakeholder demands intensify in the wake of the pandemic, according to Ernst Young (EY).[3]

Competition

As organisations move to meet these customer expectations, competition continues to grow as new entrants enter the market and emerge alongside incumbent operators to vie for market share and resources. In addition, in a post-COVID-19, green new world, the global shift to reduce carbon emissions and increase investment in renewables will provide new opportunities. Companies that sharpen their focus on environmental, safety, and governance issues can strengthen their license to operate and boost their competitive edge in the fight for capital. According to researchers from EY (2020), companies that are unable to (or refuse to) embrace these changes are likely to struggle and, ultimately, will be squeezed out of the market.[3] Those determined to move forward, even if starting from square one, will reap the benefits. Today's amplified competition underlines the importance of OpEx. Unfortunately, a lack of strategic vision is one of the most common reasons why OpEx implementations fail. While increased competition and satisfying customer expectations are key drivers, it is essential to introduce and implement OpEx the right way from the start.

Technology

If anything has been learned in the last year from COVID-19, it is that its disruptive impact has highlighted the benefits of various technologies – such as automation, artificial intelligence (AI), and blockchain – to help ensure business continuity. As stated in the report from EY (2020): "Businesses that had already invested in advancing their digital journey are reaping the benefits now and will continue to have a competitive edge beyond the pandemic."[3]

More than 73% of companies have reported that digitalisation – the advancement of Industry 4.0 technologies, such as: the Industrial Internet of Things (IIoT) smart sensors, digital twins and threads, machine learning, AI, and cloud solutions – is accelerating their ability to deliver sustainable OpEx. The ability to harness 'big data', and to connect previously siloed information, allows organisations to make better, more timely decisions along the value chain.

The decreasing cost of implementing applications, hardware and cloud computing has encouraged organisations of all sizes to move away from costly, manually intensive, risk-laden, non-digital processes, and instead to boldly and rapidly embrace digital initiatives, such as: digital twin technologies, connected worker solutions, cloud computing, and automation. By seizing this opportunity, companies are realising the benefits and return on investment in digitalising operations to remain competitive, lower operational risk, reduce downtime, increase worker productivity, and facilitate compliance with important regulatory requirements.

A culture of continuous improvement

In order to reap the greatest rewards, it is essential that the key drivers of OpEx are balanced by support across the organisation. The most vital component of any OpEx programme is building a culture of continuous improvement – doing the right thing, the right way, every time – from top to bottom within an organisation.

As Jeffery K. Liker writes in *The Toyota Way*: "More important than the actual improvements that individuals contribute, the true value of continuous improvement is in creating an atmosphere of continuous learning and an environment that not only accepts, but actually embraces change. Such an environment can only be created where there is respect for people."[4]

The role of management here – and, arguably, its sole purpose – is to engage personnel to work as a team. In order to achieve the company's common OpEx goals, management must clearly articulate what the goals are, why they are important, and how the organisation will get there.

Ultimately, OpEx is not simply about reducing costs or increasing productivity in the workplace. It is about creating a company culture that allows companies to produce valuable goods and services for their customers and supports long-term sustainable growth: a people-first culture, where the person who faces an issue can identify the problem, is empowered to act, and is confident to resolve the issue at hand.

Identifying obstacles

Changing mindsets throughout the company is usually the first and most difficult challenge encountered by those attempting to drive forward OpEx strategies. According to a BTOES (2019) survey, 40% of companies stated that they had an enterprise-wide OpEx programme.[2] However, 53.1% of respondents named

changing and improving company culture as their top critical OpEx challenge.

Some of the main difficulties faced by those implementing improvement programmes have also been outlined in the BTOES survey, illustrating where the most prominent obstacles are encountered on the road to OpEx.

Lack of leadership understanding and buy-in was the biggest threat for many. Without this buy-in, there is an absence of role models, budget, resources, and long-term commitment to the OpEx programme.

For others, sustaining the improvements made through OpEx was another key factor, with many organisations tending to move on to the next challenge once they felt an improvement had been successfully implemented, despite the lack of a plan to sustain it.

In the report, a third of the companies felt they faced major difficulties in driving an end-to-end business transformation, even though failing to complete the transformation strategy will always produce sub-optimal results.

Achieving buy-in across every level of the organisation is essential to achieve OpEx. According to a Gallup survey, companies with highly engaged workforces outperform their competitors by 147%.[5]

OpEx is also closely linked with increased digitalisation. Only by achieving the greater level of data insight that digitalisation provides can companies make better, more informed decisions and implement them quickly. Thus, allowing organisations to rapidly identify the vital yet small improvements that will make a big difference to performance and build confidence in the programme across the company.

Overcoming challenges

Achieving OpEx requires a conscious decision to embark on a continuous journey of improvement that involves every aspect of an organisation. However, this process does not come without challenges. Some of the common obstacles encountered include:

Figure 3. Within mining operations, some managers may apply OpEx as a means to reduce the high capital expenditure of modernising mining facilities or tethering multiple entities to enhance operations.

Detachment

People are often not connected enough to broader business needs. It is common for employees to not understand the business strategy or see how their role contributes to customer value.

Lack of progress

People may be working very hard, but are tasks under way that are moving the needle on growing the business? Do leaders make room for growth-related activities?

Lack of adaptation appetite

Organisations need to be able to adapt their infrastructure to change quickly and efficiently. Many organisations do not change courses in time to keep up with their competition.

Overly complex data

More data is better, but only up to a point. When data becomes too complex and difficult to understand, people begin making decisions without it.

Siloed management

Systemic thinking is a principle of OpEx, but unfortunately it is somewhat rare. Many organisations do not have a management plan in place to bridge the gaps between processes and functional areas.

These are the issues that can deter staff and management from fully buying into OpEx. To overcome them, many organisations use a business methodology, such as: lean manufacturing, Six Sigma, kaizen, or total quality management.

Whether or not an organisation chooses one of these models or develops its own, OpEx can be achieved when the principles become part of the organisation's DNA.

Demonstrating small improvements will also engage people throughout the organisation and help them to understand the value of the cultural changes required.

The second article of this two-part series will highlight the milestones on the road to OpEx, the role of leadership and change champions, and mechanisms companies can use in their mining operations for sustained and continuous improvement. GMR

References:

1. 'Mine 2021: Great expectations, seizing tomorrow', *PricewaterhouseCoopers*, (June 2021), https://www.pwc.com/gx/en/energy-utilities-mining/assets/mine-2021/pwc-mine-2021.pdf
2. 'Key drivers pushing change in the Operational Excellence Ecosystem', *The Global Sate of Operational Excellence: Critical Challenges & Future Trends*, Business Transformation & Operational Excellence Summit, (2019/2020), https://insights.btoes.com/research-report-2018/19-the-global-state-of-operational-excellence-critical-challenges-future-trends#Key_drivers_pushing_change_in_the_Operational_Excellence_Ecosystemwidget_1541177121844
3. MITCHELL, P., 'Top 10 business risks and opportunities for mining and metals in 2021', *Ernst Young*, (2020), https://www.ey.com/en_us/mining-metals/top-10-business-risks-and-opportunities-for-mining-and-metals-in-2021
4. LIKER, J. K., *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*, (2003).
5. '2017 Global Customer Experience Benchmarking Key Findings Report: Digital crisis or redemption, the uncomfortable truth', *Dimension Data*, (2017).

GOING UNDERGROUND (SAFELY)

Image courtesy of Getman Corp.

Mario Tremblay, Getman Corp., describes how safely and efficiently transporting explosives underground led to success for a Michigan mine.

When it comes to mining operations, the highest priorities are safety, equipment reliability, and productivity. While safety and productivity are optimum (but not always possible), they can be tied together completely when explosives are being transported underground.

Transporting explosives in larger quantities reduces the number of trips to the magazine or storage sites, thus reducing wear and tear on the equipment. Parts and maintenance costs associated with excessive travel include wear on tyres, brakes, transmissions, axles, and more. As fuel consumption decreases, so do emissions, resulting in improved air quality for miners.

Heavy equipment, such as load and haul, graders and scissor lifts, must travel the ramps daily, and as traffic increases, so does the potential for accidents. Therefore, minimising heavy equipment travel and time spent on this endeavour is critical.

Explosives are transported in various scenarios: from surface to underground magazine, from surface to

underground work areas, or from the magazine back to work areas. In some cases, the best (or often only) means of transporting the explosives is with an explosives charger. No matter the means of transport, additional equipment on ramps can lead to accidents.

Transporting using dedicated equipment

To mitigate this probability, transporting the explosives with dedicated equipment designed to carry larger quantities helps reduce the frequency of explosives transport, and may increase productivity by up to 150%. When loading a large stope, it is best to keep the explosives charger in the stope and bring the explosives to it, limiting the number of trips by maximising the quantity transported. De-mobilising and re-mobilising an emulsion charger are time-consuming: the loading hose must be cleared and stored, initiating systems must be gathered and stored, and the area secured unless someone is left behind. Upon return to the stope, equipment must then be re-deployed.

Getman Corp. offers an option for emulsion transport in the form of a 1000-gal. (3785 l) tank mounted to a cassette. The cassette, equipped with a tank and a 3 in. diaphragm pump for transferring the emulsion, may be unloaded in the stope. The tank may be filled to provide as much as 11 000 lbs (5000 kg) of emulsion at 1.34 g/cc density. Cassettes may also be placed in a nearby underground magazine for day usage in development rounds. The cassette carrier may then be utilised for other work.

Another option includes Getman's dedicated emulsion transporter. This low-profile, manoeuvrable machine is equipped with two 750-gal. (2839 l) emulsion tanks providing as much as 16 700 lbs (7600 kg) of emulsion at a 1.34 g/cc density, as well as a 3 in. diaphragm pump for transfer into the explosives chargers underground. Contrary to explosives chargers returning to the magazine for refilling, this transporter can go to each charger for refill.

For mines that receive their emulsion in 20 ft ISO tanks, the company also has an ISO tank transport to carry the tank underground for storage.

Finally, for mines using ammonium nitrate/fuel oil (ANFO), the company has an ANFO transporter with a fully lined cargo space capable of carrying up to 80 bags (weighing 55 lbs [25 kg]). With this capacity, more than four 1000 lbs ANFO pots can be refilled, in order to avoid the chargers returning to the magazine. Alternatively, this transporter can take bags from the surface and bring them down to the underground magazine designated for ANFO storage.

Figure 1. Getman 1000 gal. emulsion cassette.

Figure 2. Emulsion transfer pump and fill port.

Case study: Lundin's Eagle Mine, USA

Background

Lundin Mining is a diversified Canadian base metals mining company with operations in Brazil, Chile, Portugal, Sweden, and the US. At Lundin's Eagle Mine in Northern Michigan, USA, an underground mine producing nickel and copper concentrates, Lundin has used Getman's Emulsion Transport Cassette for over two years.

Eagle Mine is an approximately 2000 tpd underground nickel-copper mine. The mine is relatively shallow, with ramp access from the surface to the Eagle mine orebodies. Mine services and infrastructure extend from the bottom of the Eagle orebody to the Eagle East orebody. Backfilling is undertaken using cemented and uncemented rockfill. Ore from the mine is stored in a covered coarse ore stockpile facility before transport by road approximately 105 km to the Humboldt mill.

The Humboldt mill is a former iron ore processing plant site that was converted and refurbished to process Eagle Mine ore. Ore is

processed using a conventional three-stage crushing and single-stage ball mill process flotation, in order to produce separate nickel and copper concentrates. Tailings from the plant are deposited sub-aqueously in the adjacent former and repurposed Humboldt iron ore pit.

Nickel and copper concentrates are stored in a covered concentrate building on site before transport. The concentrates then travel via rail car directly to smelter facilities within North America or ports for shipment overseas.

Getman's relationship with Eagle Mine extends across several years following Eagle's investment in numerous Getman machines, including: scissor lifts, explosives chargers, pallet handlers, service lube pallets, and emulsion transport pallets.

Nolan Black, Project Superintendent for Cementation and Vendor Partner responsible for mine operations, asked Getman to propose a solution to limit the amount of travel required for explosives chargers to reload. Eagle Mine has surface storage for its emulsion located approximately 5 miles from the underground magazines. One-way travel, depending on working location in the mine, takes between 25 – 60 minutes.

Requirements

Getman's challenge was to create an emulsion transport cassette for Eagle Mine's existing Getman cassette handler. With guidance from Black and his team, Getman engineers designed and manufactured the first emulsion transport cassette.

Results

By using the emulsion transport cassette, Eagle Mine and Cementation cut up to four trips to the surface for every large stope, saving both time and money. Travel distance was reduced by 70% to 1.5 miles, instead of 5 miles, for the trip to the surface magazine when performing development or sill production rounds. Additionally, the benefits from the downstream effects of fewer trips to the surface led to both reduced traffic on the ramps and wear and tear on the equipment. Subsequently, Eagle Mine has purchased two additional cassettes to supplement its growing operations.

Eagle Mine continues to implement a strategy to do more with less by maximising the productivity of the Getman emulsion transport cassettes.

Conclusion

Reducing traffic on ramps and keeping explosives chargers at work improves safety and increases productivity. High capacity emulsion loaders and transport vehicles offer these features and reduce time wasted in travel, as well as wear and tear on the mobile equipment. Whenever possible, limiting trips back and forth to the magazine is always best. GMR

Note

Lundin and Eagle Mine information courtesy of Lundin Mining Corporation.

STAYING AHEAD OF THE

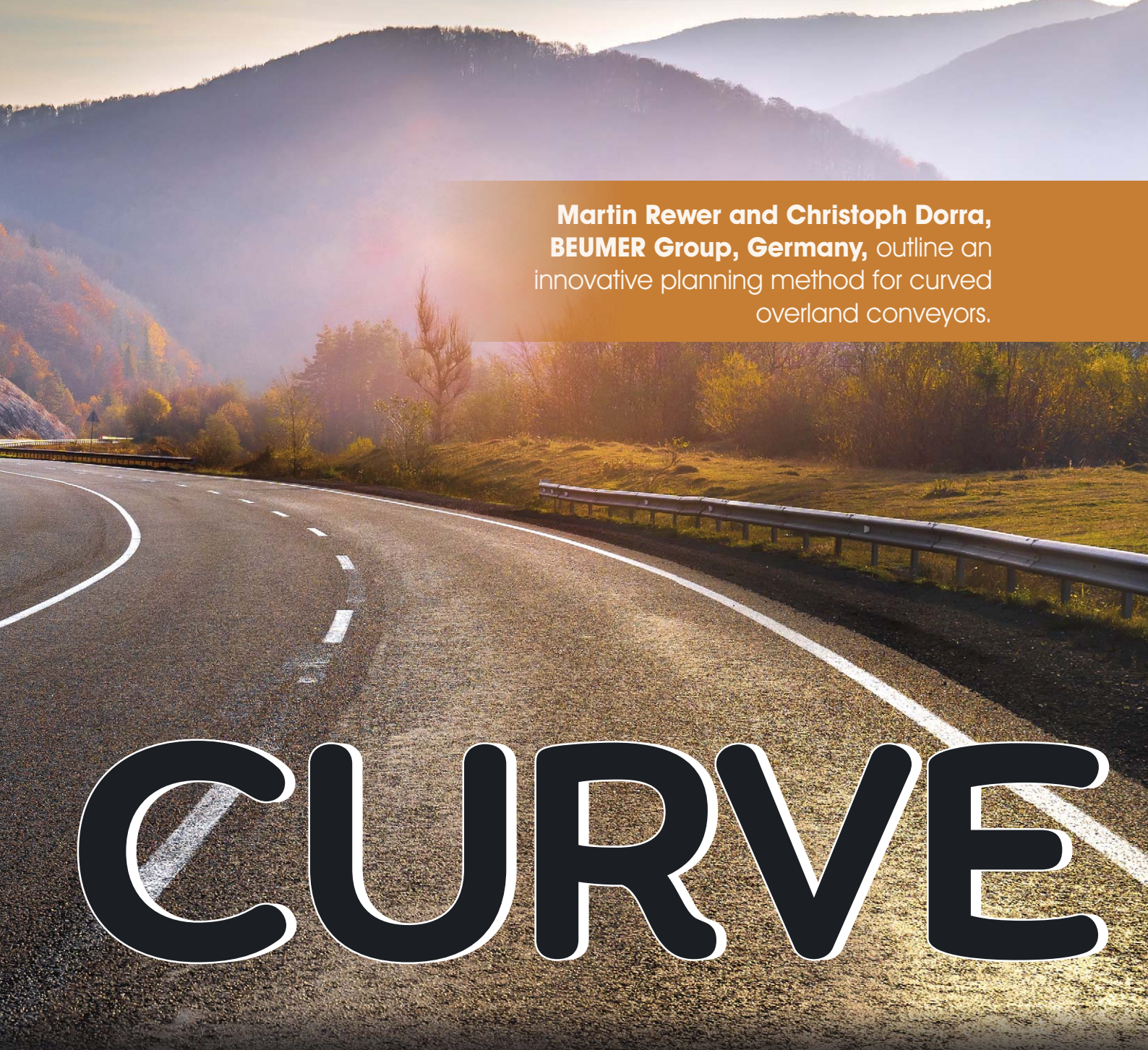
Nothing has fundamentally changed in the functional principles of curved overland conveyors since the late 1960s, when BEUMER Group began developing and producing this technology, except for the feasible limits: with highly developed core components, precise calculation methods and own planning tools, the system provider is able to push the limits of what is technically feasible, while reducing the time and costs involved in both the planning phase and the handling of projects.

Curved overland conveyors

The company's belt conveyors help solve complex problems with regard to the transport of any bulk material, both in the mining and cement industries. While the basic task of transporting bulk material from the material feed up to the final discharge point seems to be comparable, on closer inspection, no system is similar to the other. The spectrum of potential conveyed materials alone requires the individual consideration of the components to be used with regard to wear resistance or the maximum permissible gradients of a conveyor.

In addition, the mass flow to be conveyed and the height to be overcome are the main factors determining the dimensioning of the drive unit of an overland conveyor. A further challenge is posed by systems at high altitudes. At altitudes exceeding 4000 m, as is often the case in the South American Andes, for example, it must be considered that the air pressure, and thus the density of the air, decreases with increasing altitude. This reduces both the cooling effect and the insulating capacity of the air. As a consequence, the drive units, such as frequency converters and electric motors, do not achieve the specified rated power that applies for installation heights up to a maximum of 1000 m above mean sea level. This is the so-called derating factor.

Morever, as well as the pure material specification and the mass to be conveyed over a certain height, the topography along the conveying route is of particular importance in the project planning stage.



CURVE

Martin Rewer and Christoph Dorra, BEUMER Group, Germany, outline an innovative planning method for curved overland conveyors.

The topography

In 2009, the company implemented an overland conveyor in China that is able to curve on 85% of the 12.5 km long conveyor line between the quarry and the cement plant. The system winds its way to the destination, without any transfer point.

Potential obstacles appeared in the form of residential areas, roads and rivers that had to be crossed, and larger bodies of water or mountains that could not be crossed. The target is to have as few transfer points as possible along the entire conveyor line: this reduces both wear and tear and the environmental impact of dust, for example, whilst also increasing the availability of the overall system and significantly improving ease of maintenance.

Case study: USA

One example of such challenges is represented by a project carried out at an American coal mine. Here, a BEUMER overland conveyor, with a length of approximately 6.5 km, conveys coal from a new underground mine portal to the main coal preparation plant. In the original request for quotation, the client requested four straight conveyors, which would have needed three transfer towers. For BEUMER Group, there was clear potential for optimisation here, of which the system provider was able to convince the customer.

Case study: Belgium

The BEUMER team was also faced with challenges in a Belgian project. Since the 1970s, the residues of a coal-fired power plant were landfilled on a fly ash stockpile. It was later intended to transform the terrain into a nature park. In order to make this possible, the fly ash had to be conveyed to the Mass river, approximately 2 km away, where it was loaded onto ships for further transport. These ships brought the fly ash downstream to an adjacent cement plant, where it was recycled as an aggregate.

A pipe conveyor was recommended; the enclosed design prevents the volatile material from spilling into

the environment, while enabling low-noise transportation. This was of particular significance in this project as the conveyor runs over roads, railroads, and residential areas. In the residential areas, a noise-reducing idler design developed by BEUMER is used, which meets the high noise protection requirements in this area. The prescribed limit of 35 dB at a distance of 10 m from the conveyor roughly corresponds to a very quiet room fan at low speed. Here, the system also achieves a slope of 23˚, which can be easily implemented with a pipe conveyor. Because of the rough terrain, special cranes and, at times, helicopters were used during the installation.

The individually fitting system

In order to provide the appropriate solution for each of these applications, the company draws on its experience, having installed the first conveyor of this type with horizontal curves in 1969, and the first downhill conveyor with regenerative

Figure 1. BEUMER Group implemented an overland conveyor in China that is able to curve on 85% of the 12.5 km long conveyor line.

Figure 2. A 6.5 km long overland conveyor for coal: the concept of only one conveyor prevailed against four straight conveyors with transfer towers.

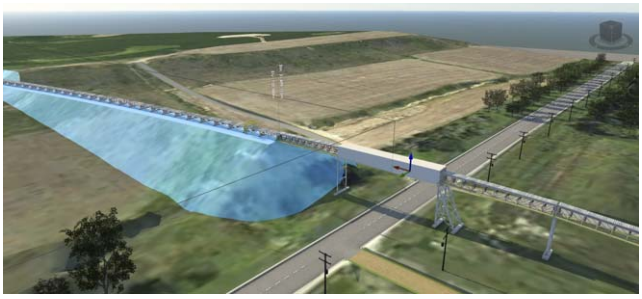


Figure 3. A 3D model of terrain and conveyor: earthworks (cut and fill) or steelwork structures can be quickly and precisely balanced against each other in terms of drawings and calculations.

drive in 1980. Since the 1990s, BEUMER Group has also developed into one of the leading suppliers of pipe conveyors. In 2019, two systems were commissioned in China that, with 5500 tph of iron ore, defined the current performance peak of globally installed systems.

Since the construction of the first curved overland conveyor in 1969, components such as idlers, belts, and drives have continued to develop. In addition, the systems are becoming larger and longer, and the routes more complex. This has resulted in the necessity to also constantly improve the calculation and planning tools, in order to not only withstand the requirements, but to even be one step ahead.

In the first step of project planning, the systems must be dimensioned for the respective task. Using BEUMER calculation programmes, a team of experts calculates the existing motion resistances and the related static and dynamic tractive forces of the belt of the system. These, on the other hand, determine both the drive power to be installed and the belt strength, and are also considered in the dimensioning of the horizontal curves.

The energy consumption of long, horizontal belt conveyors is determined by the main resistance in the upper and return strand in stationary operating conditions. The energy consumption consists of the running resistance of the idlers, the indentation rolling resistance, and the flexing resistance of both the conveyed material and the belt when running over the idlers. The forces required for overcoming these resistances depend on various operational and design parameters, but can be determined with the 'single resistance method'. If components with low running resistances are considered, such as belts with reduced indentation rolling resistance or running-optimised idlers, the calculations of the systems nowadays show considerably lower tractive forces of the belt than a few years ago. This not only results in lower energy costs, but since the tractive forces of the belt are at a lower level, the radii of the horizontal curves can also be selected so as to be correspondingly smaller since these forces are decisive for the design of these curves. Accordingly, the routing of overland conveyors can now be realised in a more flexible way and with smaller radii.

From the virtual toolbox

In order to plan the conveyor for the individual application, the company uses its virtual toolbox to arrange the whole routing of the system before discussing it with the customer as a 3D plan. The BEUMER Overland Layouting Tool (BOLT), developed specifically for this purpose, generates almost automatically a digital 3D model of the conveyor in the virtual landscape during the project planning. The required topography data is available in the public domain or can be provided by the customer, often using drones. The aerial photographs include topographical information, which is then processed into digital terrain models.

In the simulation environment, the experts can adapt the conveyor to the route. The almost-real illustration of the conveyor in the landscape also serves to recognise possible obstacles and to consider them accordingly in the project planning. Furthermore, the technicians are able to add the

Figure 4. A 3D model of the highway crossing during the project planning phase (left); real picture after commissioning of the same section (right).

earthworks (cut and fill) and the steelwork structures in a simple and precise way and evaluate them. BOLT not only ensures a very fast first project planning of the route, but can also account for any modifications or adaptations during the project within a short time period. Project-critical data can be supplied at short notice by BOLT. It includes the definition of the entire equipment inventory used on the route, as well as the coordinates for foundation and earthworks. Since this data is generated automatically and updated by BOLT in case of modifications, possible required adaptations of the route are not further time-critical. All necessary data can be generated immediately after rescheduling.

This procedure enables the company to considerably accelerate the project planning. It has the possibility to provide the customer in advance with a concrete 3D project planning, which can be easily modified during the project life. This procedure therefore means the time frame for the project can be tightened.

Conclusion

With the addition of highly developed core components, precise calculation methods and planning tools (such as those offered by BEUMER), these systems can be constantly optimised, reducing the time and costs involved in design and project execution. GMR

PICKING UP SPEED ON THE DIGITAL HIGHWAY

Tyler Berens and Mayya Popova, Epiroc, explain how a new world of automation and remote operations is drawing ever closer.

As the world continues to struggle with a range of unprecedented challenges – the aftermath of the COVID-19 pandemic, declining productivity, economic and political uncertainty, sustainability and climate change, to name a few – it sometimes seems as if nothing will ever be quite the same again. However, there is another way to look at this. Arguably, the mining world is in the midst of a transition to autonomous operations and increased levels of digitalisation that can once and for all tie the value chain together.

Epiroc Surface division is one company that has continued to focus on the opportunity to help its customers concentrate on improving safety and optimisation, in order to become world class miners.

Historically, mining has been slow at best and reluctant at worst to adopt new technologies. Over the last few years, due to a perfect storm of events, the industry appears to be moving significantly faster towards the vision of full-fledged automation and remote-controlled operations. Other factors contributing to this surge in interest in the digital future include increased environmental demands and tighter rules on health and safety, as well as a number of ground-breaking digitalised solutions that have proven their ability to boost productivity in the mining environment.

All this has sharpened the focus on products and systems that combine information and operational technologies as the key to long-term viability and future prosperity.

Why data matters in mines

Data management and system integration tools play an essential role in automation and in tying all activities together – enabling more accurate planning and efficient management, with better waste treatment and optimisation across the entire value chain.

For one thing, the extensive use of interrelated data and metrics allows managements to optimise their time, helping them to focus more on strategic level tasks, such as reducing energy consumption and production efficiency. What is more, better data and visualisation of operations in real time improves safety for all.

Systems integration and the ability to control an entire fleet of equipment in every stage of the mining process has been a major hurdle – until recently. Platforms and control systems are now available that can unlock the true potential of connected mining equipment.

Mixed fleet control

2021's MINExpo INTERNATIONAL event in Las Vegas gave an indication of what the future holds. Epiroc was one of the equipment suppliers showcasing its newest innovations at the show, in particular providing visitors with a sneak peek at a common control panel from which a mixed fleet of Pit Viper and SmartROC D65 drill rigs can be operated simultaneously.

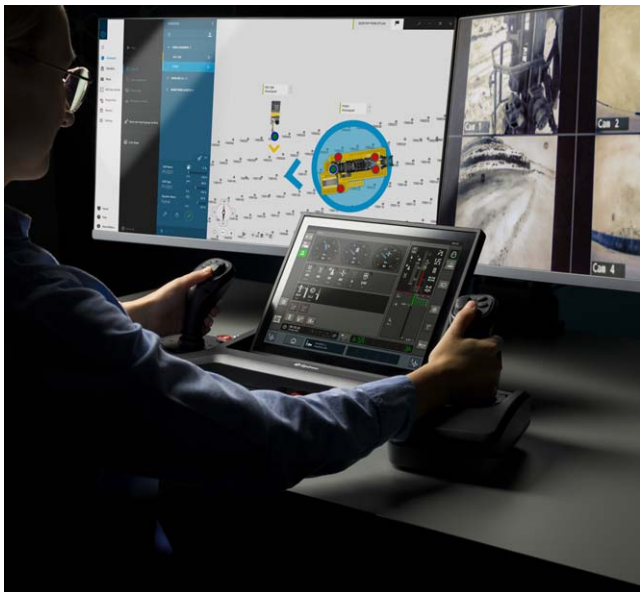


Figure 1. Common Automation Panel (CAP).

Figure 2. A CAP showcased at the MINExpo exhibition in Las Vegas (Photo courtesy of Olga Minkevich).

Called a Common Automation Panel (CAP), it has been described as one of the first surface drilling products that links the value chain in the drilling process with the future of drill rig operators. This system for mixed fleet control also creates opportunities for complete transformation, ranging from a different layout and footprint in the control room and the way operators are trained and work, to reduced variability and spare parts costs. CAP challenges the tradition whereby every rig type requires a separate operator station, and it claims to bring immediate value to daily mining operations that focus on automation.

There is no question that many mining companies are seeing the direct benefits of machine automation, such as higher and enhanced safety for operators. In addition, automation prolongs the effective life of the equipment and drilling tools, since it eliminates potential abuse by operators, thereby lowering repair costs.

These benefits, combined with solutions for tele-remote and autonomous operations, lead to more consistent and predictable operations and a lower overall cost of ownership.

The Nordic incubator

Interestingly, a great many of today's advanced solutions emanate from the Nordic countries and from Sweden in particular, a hard rock mining nation which is also home to many global suppliers, as well as some of the most automated mines in the world. Like Ericsson, ABB and a host of other Swedish companies at the heart of the automation movement, this is where Epiroc invented its CAP system.

Sweden has arguably become the incubator for the technologies and strategies that mining houses will need in order to focus on sustainability, climate change, enhanced health and wellbeing of workers, and increased productivity to make up for lower budgets and revenue in the industry.

Is the smart mine getting closer?

Despite the relatively slow pace of development in the past, more and more companies are now reaping the benefit of remote-control centres. These centres, featuring integrated functions for automation, data-based fleet management, software integration, control of equipment and more, are seen as a major stepping stone on the road to full digitalisation.

Judging by the innovations showcased at MINExpo, the digital landscape is currently changing fast, and there are now several forecasts pointing toward exponential growth in technology investments. According to ABI Research, a global tech market advisory firm, miners' spend on digital technologies will grow by a compound annual growth rate (CAGR) of 5.2% over this next decade, and reach US$9.3 billion in 2030.

Previously, there were common leading markets that pioneered the implementation of technologies and automation. However, now the interest being generated by these products is coming from all over the world. This interest represents a significant increase in recognition of the value that digitalisation and automation can bring.

Figure 3. SmartROC D65 surface drill rig.

Figure 4. Pit Viper blasthole drill rig.

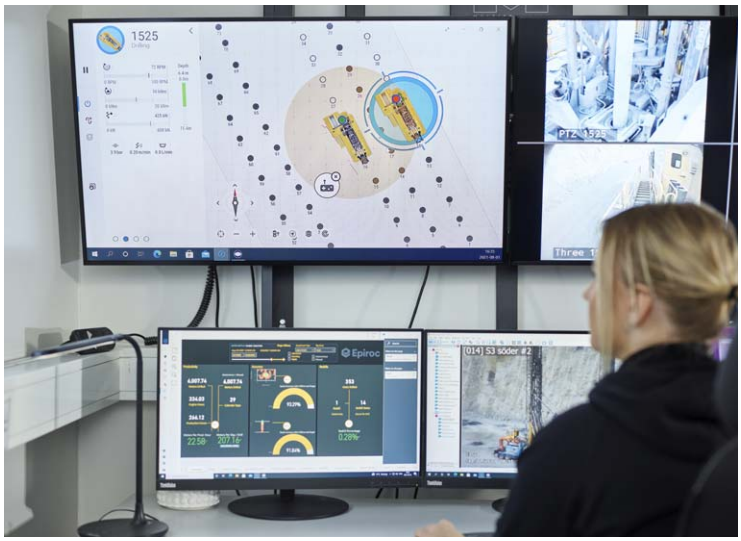


Figure 5. Mobius for Drills.

Over the next five years, it has been estimated that Epiroc Surface division will experience a substantial increase in the implementation of machine and control room automation and digitalisation solutions based on its Epiroc RCS (rig control) platform and system integration solutions. Moreover, solutions, such as CAP, are expected to unlock the true potential of these technologies and create immediate value to daily mining operations. If this proves to be the case, then the next decade is certain to bring numerous projects for tele-remote and autonomous mining operations, data management solutions, and mixed fleet control and choreography.

As always, however, progress never comes without challenges. Connectivity is the key word in the transition to the 'smart mine' – which cannot come to fruition without available cellular networks that are also reliable. In this context, many mines are undoubtedly maturing.

Nonetheless, that is just the starting point. For example, behind the scenes of the Epiroc CAP system is an advanced single platform that ties all the layers of data together from drilling, blasting, haulage, rock reinforcement, and mine development. Called Mobius for Drills, this platform was developed in partnership with ASI Mining to facilitate the harmonised mine where the value chain is connected and every level is optimised. It features embedded artificial intelligence, as well as multiple functions for monitoring and mission control in one screen view. Based on the real-time insights of a working fleet delivered through the platform, mine managers and operators can make fast and effective decisions.

Mobius for Drills was designed from the ground up to harness the full benefits of robotics and digitalisation, and also interacts with operator-controlled drilling.

A bright future ahead

New technologies and increasing automation will create better employment job opportunities and positive changes for all stakeholders.

As the pace of transition varies within countries and companies, it will be crucial for 'slower' countries to establish strong ties with market leaders, in order to acquire knowledge and become early adopters of digitalisation and automation. In this respect, governments, local communities, and investors will play a key role in making the process successful.

With such a plethora of technologies available – such as fully and semi-autonomous robots, artificial intelligence, 3D and 4D printing, big data and analytics, and real time information – it seems that the mining industry has a unique opportunity to reinvent itself as a modern, safe and sustainable workplace, as well as a profitable business.

All in all, it seems there are few industry professionals today who view digitalisation as optional, rather than as the only way to go. For the moment at least, the current pace of change is more than encouraging. GMR

THE RIGHT TOOL FOR THE JOB

Casey Springer, Weir ESCO, USA, outlines the factors to consider when selecting lip systems and ground engaging tools for mining class machines.

In an industry where equipment has evolved for over 100 years, from the Bucyrus 50-B steam shovel to fully autonomous 400-t haul trucks, it is no wonder that equipment operators have a wealth of options when it comes to selecting lip systems and ground engaging tools (G.E.T.). The surplus of options available to miners, coupled with the fact

that G.E.T. spend can fall well below that of other consumables (fuel, tyres, etc.), makes it easy to fall into an 'if it ain't broke, don't fix it' mentality when selecting G.E.T. for new or refurbished attachments. Unfortunately, that approach can significantly impact mine productivity and safety, by preventing operations from leveraging more recent advancements and expanded, more flexible offerings in G.E.T. and lip systems.

This complicated selection process is further compounded by the fact that each machine class faces its own unique set of challenges and target key performance indicators (KPIs). That being the case, a one-size-fits-all philosophy towards G.E.T. and lip systems is unlikely to deliver optimal results across the full operation.

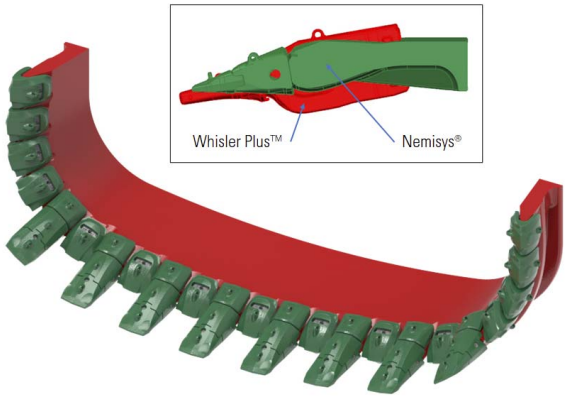


Figure 1. Weir ESCO N1 Nemisys Integral Nose Cast Dipper Lip.

Figure 2. One of two Weir ESCO Integral Nose Dippers being installed at a North American coal mine.

Instead, a more tailored approach is needed, where the advantages and disadvantages of each type of lip system must be evaluated against site and machine class specific preferences, risks, and target KPIs. Only then can operations get the most out of their G.E.T. and lip systems and drive improvements in productivity, equipment uptime and safety, while reducing their total cost of ownership.

Cable shovels

The choice of G.E.T. and lip systems is perhaps nowhere more complex than with cable shovels: for cable shovels, lip options abound with operations having to choose between: integral nose cast lips; Whisler-style lips with mechanically attached adapters; and, for smaller shovels, even weld-on or bolt-on mono-block teeth. Within each of those categories, there are also lip geometry options related to straight and wide radius lips before the operation even gets to G.E.T. selection. For larger cable shovels, the choice between an integral nose cast lip and Whisler-style lip with mechanically attached adapters largely comes down to the site's application severity, as well as their willingness to assume the associated risk of either nose fatigue or breakage on an integral nose cast lip.

For mining operations where an integral nose cast lip is a viable option, the slimmer profile of the integral nose lip and its associated G.E.T. can deliver significant benefits for both system weight and the dig energy required for penetration. As an example, a Weir ESCO N1 or N3 Nemisys® integral nose cast lip can save between 5700 – 8700 lbs in system weight, relative to a traditional Whisler-style lip with mechanically attached adapters.

The reduced weight and streamlined profile of the integral nose lips help customers achieve increased payloads, improved fill factors, and reduced lip maintenance over multiple bucket campaigns.

In addition to the previously described weight and system penetration benefits, integral nose cast lips can also deliver stock keeping units (SKU) and inventory management benefits to the organisation. Relative to a lip running a mechanically retained adapter system, an integral nose lip and G.E.T. system can reduce the number of unique components an operation needs to manage by over 50%. Moreover, because the integral nose dipper lips support the same G.E.T. as large mining hydraulic excavators and draglines, there is an opportunity for operations to standardise the G.E.T. across their entire fleet. This benefits operations by reducing the total number of SKUs to be managed and stocked, and simplifying site maintenance and safety training.

For heavier duty or more risk averse operations, the weight, penetration, and SKU reduction benefits of running an integral nose cast lip may not warrant a migration away from more traditional mechanically retained adapters

Table 1. Weir ESCO Dipper Lip comparison

Lip style	Adapter		Point		Shroud		Total weight (lbs)
	PMID	Weight (lbs)	PMID	Weight (lbs)	PMID	Weight (lbs)	
N1 Dipper Lip	N1H	265	N1S	117	N1SHSH322A	217	30 570
N3 Dipper Lip	N3H	375	N3S	161	N3SDSH430	393	33 600
WHP12 Lip	N90-WHP12W60	939	N90R	220	WHP12X239HCS-1NP	278	39 332

on a Whisler-style lip. In the event that an integral nose on a cast lip requires replacement due to an overload event, either the dipper will need to be swapped out so the lip repair can be completed in a workshop, or an in-field repair will be needed. A dipper swap can be a full shift operation (assuming a spare is available), while the installation of a weld-on replacement nose can take as long as two full days. The swap of a mechanically retained adapter can be completed in under an hour, allowing the shovel back into production in significantly less time, and in turn saving a considerable amount of unplanned downtime. In applications where the cost of downtime can be measured in the tens or even hundreds of thousands of dollars per hour, one to two days of unplanned downtime due to a cast lip nose breakage can be enough of a deterrent that a traditional Whisler-style lip is the preferred approach.

Mining excavators over 350 t

While large mining excavators are almost exclusively supported by integral nose cast lips, eliminating one potential decision-making variable, there are still a wealth of options available to tailor equipment performance to the most important site-specific KPIs. For example, an EX5600 face shovel falls squarely within the operating range for both N3 and N5 nose sizes within Weir ESCO's Nemisys line of cast lips. For operations that skew towards extra heavy duty (XHD), or those that prioritise system reliability and wear life, an N5 lip will likely be the most appropriate choice. Lighter duty applications and operations wanting to prioritise system penetration or to free up additional bucket capacity may be better served by selecting an N3 lip.

The decision-making process does not stop there. Partnering with a lip and G.E.T. vendor that has a broad and flexible offering can be critical to tailoring attachment G.E.T. configurations for optimal performance against site KPIs. Expanding on the EX5600 example, there are various lip system and G.E.T. configurations from Weir ESCO's Nemisys offering that could be utilised on this particular machine. Even if lip selection were limited to the N5 nose size due to the severity of the application, there would still be multiple options available to deliver optimal performance.

At one end of the spectrum, the combination of XHD intermediate adapters and shrouds coupled with a heavy-duty point will deliver the best possible reliability, wear life, and lip maintenance. This G.E.T. selection also features extended bottom wear shoes on the components, to provide additional shadowing and protection for the structural members on the underside of the cast lip, in order to further minimise maintenance and extend lip life.

At the opposite end of the spectrum, is a Weir ESCO N5 V2 lip, which allows smaller, lighter N3 points and shrouds to be run without sacrificing nose strength on the cast lip. This option shaves more than 3500 lbs off the aforementioned XHD configuration, potentially increasing the functional payload of the attachment or freeing up weight that could be reallocated to enhancing the wear package in other problem areas on the bucket.

Wheel loaders

Another machine class that has seen lip and G.E.T. options expand in recent years is wheel loaders. These machines were once reserved for auxiliary roles, material re-handling and road maintenance, but have recently seen their breakout forces increase by 50% or more. This has led to an increased utilisation of wheel loaders as primary production machines, which in turn demands increased attention to lip and G.E.T. selection to align machine performance to site-specific operational objectives. As was the case with cable shovels, one of the primary variables influencing lip and G.E.T. selection in wheel loaders is severity of application and the site's risk tolerance for extended unplanned downtime.

Figure 3. EX5600 in Australia running Weir ESCO N3 Nemisys Lip.

Figure 4. Weir ESCO Nemisys G.E.T. on a wheel loader.

Large wheel loader lip and G.E.T. selection has historically been limited to plate lips with either weld-on or mechanically attached adapters. Weld-on adapters generally provide benefits in terms of system weight and profile, along with interchangeability amongst suppliers – they require no vendor specific lip modifications or weld-on components beyond the adapters themselves. Meanwhile, mechanical adapters afford operations, particularly those in XHD applications, insurance against the extended unplanned downtime that can come with overload-induced adapter breakage. Mechanical adapters can also significantly reduce the amount of hot-work required to maintain an adapter system as only smaller, weld-on bosses need to be applied to the lip and maintained over the course of multiple sets of adapters. That maintenance, as well as the adapter replacements themselves, can be aligned to coincide with broader bucket maintenance intervals, in order to minimise machine downtime.

In addition to traditional plate lip options, integral nose cast lips are now offered for this class of machines. Like their hydraulic machine and cable shovel counterparts, integral nose lips can provide improvements in system profile, weight and lip maintenance, though the amount of savings is highly dependent on the specific lip configuration. For example, compared to a 234 in. inside lip width integral nose cast lip from another vendor, the comparable Weir ESCO Nemisys plate lip with mechanical adapters is within 500 lbs of the cast lip system weight. Similarly, a Weir ESCO Nemisys plate lip with weld-on adapters is more than 750 lbs lighter than its cast lip equivalent. These comparable weights come without the inherent risk of extended downtime that can come with an integral nose cast lip and highlight the need for operations to closely examine all aspects of lip and ground engaging tool selection before deciding.

Conclusion

Regardless of the machine class in question, lip and G.E.T. selection can play a pivotal role in optimising machine productivity, availability, site safety, and even sustainability. Given the complexity and importance of these decisions, operations should seek out lip and ground engaging tool suppliers that offer a broad array of options that help optimise attachment performance and have the experience and engineering capabilities to serve as consultative partners instead of purely a transactional supplier. Through that partnership, operations can leverage decades of lip and G.E.T. expertise and ensure that they are positioned to get the best possible return on investment from their equipment and attachments. GMR

Table 2. Weir ESCO N5 and N3 Nemisys Cast Lip comparison

Lip style	Adapter		Point		Shroud		Total weight (lbs)
	PMID	Weight (lbs)	PMID	Weight (lbs)	PMID	Weight (lbs)	
Standard N3 Lip	N3H	375	N3S	161	N2SH430	500	21 268
	N3XHD	469	N3SBW	207	N3SH430-XHD	686	22 898
N5 V2 Lip	N3-N5H	420	N3S	161	N3SH415	668	22 222
Standard N5 Lip	N5H	507	N5S	222	N5SH415	783	23 620
	N5W	608	N5SW	258	N5SH415	783	24 305
	N5XHD	642	N5SBW	307	NSH415-XHD	1052	25 796

KEEPING BOOTS ON THE GROUND

Figure 1. Image from the Hancock project showing a banded iron formation (BIF) ridge that forms the inferred resources at Hancock.

Bill Brodie-Good, Alien Metals Ltd, UK, evaluates the impact of COVID-19 on exploration and development projects within the mining industry.

While global markets have begun to see a recovery following the COVID-19 pandemic, it is still a difficult time for global travel. Restrictions on entering and leaving countries change on an almost daily basis, and uncertainty around new variants continues to keep people guessing. This can add a great deal of complexity to the running of exploration and development companies, particularly when the projects are in far flung corners of the globe. Bureaucracy has also slowed, almost to a standstill in some regions, and acquiring the necessary permits and approvals to carry out exploration work is taking far longer than some would expect.

Alien Metals Ltd is a junior minerals exploration and development company listed on the AIM market of the London Stock Exchange, with several projects dispersed around the world. Its main areas of activity are projects located in Western Australia and Mexico. With the CEO and Technical Director, Bill Brodie-Good, based in the UK, travel restrictions have meant running these projects remotely for almost two years.

Furthermore, as certain commodity markets have seen excellent post-pandemic recoveries, there has been significant strain placed on service providers in the sector, particularly in Western Australia. Drill rigs and laboratories

all have long waiting lists from junior miners seeking to advance projects. Alien had to consider several factors in its approach to exploration and development, in order to ensure it was able to continue operating its projects effectively.

The importance of boots on the ground

Even with the great technological strides made in the mining sector, with advances in airborne and ground geophysical scanning techniques, 3D modelling and other tools, mineral exploration is still a very hands-on industry, and these methods still require a physical presence to use. In addition, the best geologists in the world see these methods as supplementary to the information they can gather simply by being at a project in person, walking the ground, tapping the rocks, and making their own observations.

For people in the role of technical director, such as Brodie-Good of Alien Metals, being unable to attend projects in person was a challenge. Although modern technology means they can, in theory, run a project remotely without being physically present, it is not an ideal position to be in for someone with a geological background.

In response to this challenge, Brodie-Good appointed technical leads in both Mexico and Australia. These technical leads are responsible for overseeing the projects, implementing field programmes from planning, logistics, HR, stakeholder engagement and final reporting, and the interpretation of geological data. They are also able to add to the planning and field programmes while on the ground, as exploration is often about finding and following information on the ground that might not be on any map or plan. Having technical and administrative expertise in the regions, local to projects, has been a key aspect of maintaining Alien's exploration programmes, in the absence of being able to attend the projects in person.

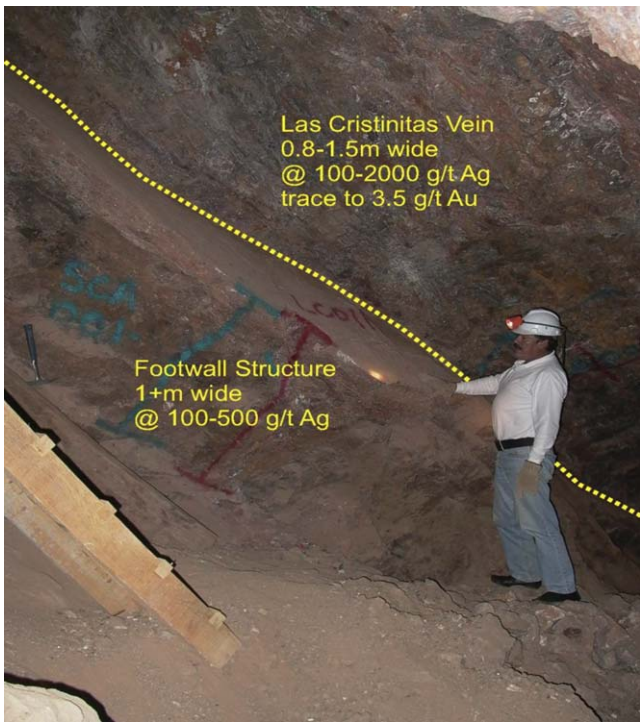


Figure 2. Image from the underground workings at San Celso.

Relationships with third parties

A factor every junior explorer has to consider when developing a project is the use of third parties for exploration. Unlike with major mining operators, it would be too costly to own and employ drill rigs and teams, and to have laboratories for in-house processing sample analysis. Choosing the right third-parties for a project is therefore extremely important for long term success. However, in the short term, this is not always easy.

The appropriate drill rig and team for a project may not be immediately available, or may be located far away from the project. Developers, such as Alien, may use a drill rig for a campaign of drilling and may then need to make a swift decision as to whether to keep a team in situ for further exploration, or let them move on to another project while making a decision regarding next steps.

This need for a quick decision, however, also requires the quick availability of laboratories for analysing samples. As the world has been emerging from the pandemic and markets have seen a rebound, there has been a flurry of activity at mines around the world. This has been particularly problematic for many miners in Western Australia. Given Australia's stringent lockdown rules preventing even inter-state travel at certain periods, combined with the sheer number of operators in this highly mineral-rich part of the world, there has been a surge in demand, with laboratories operating at capacity and drill rigs in short supply. Alien has first-hand experience of this from its own operations in Western Australia.

Case study: Hamersley Iron Ore, Pilbara, Western Australia

Alien owns a 51%-interest, soon to be a 90% interest, in two iron ore licences which make up the Hamersley Iron Ore Project, located in the world-famous Pilbara Region of Western Australia. The Hancock Ranges Iron Ore Licence is within 20 km of the Newman township and borders licences held by Fortescue Metals Group, Hancock Prospecting, BHP Billiton (Mount Whaleback), Hope Downs, and Brockman Mining. The Brockman Iron Ore Licence is located 100 km northeast of the town of Tom Price and is surrounded by several significant iron ore mines.

Alien is pushing ahead with its exploration programme at Hancock, having completed its first two drilling programmes, and is now in the planning stages of phase 3 (as of September 2021). The prospect is firming up as a standalone iron direct shipping ore (DSO) operation, following positive results from drilling phases 1 and 2. In selecting consultants for this exploration work, the company ensured it was partnering only with third-parties that had experience working in the Pilbara, in particular those with experience working with iron ore projects in the region. It was also crucial to choose those that had suitable equipment to maximise results and access, while minimising overheads and costs where possible.

In parallel to the exploration work at Hancock, Alien engaged specialist mining consultants, Mining Plus, to deliver a high-level scoping study for the Sirius Extension prospect. They have extensive experience with similar DSO grade projects that have recently transitioned from explorer to producer in Western Australia, and have provided Alien with valuable data as a benchmark and added robustness to the financial model.

Case study: San Celso and Los Campos Silver, Zacatecas, Mexico

Alien holds two silver projects, San Celso and Los Campos, in Zacatecas state, Mexico, the country's largest silver producing state, which produced over 190 million oz of silver in 2018 alone. The state also accounted for 45% of the total silver production of Mexico for that year.

The progress has been slower than hoped in obtaining drill permits for the silver projects, boiling down to a number of reasons which have stemmed from COVID-19. These include a combination of an extensive reduction in headcount at the relevant government ministries, being unable to hold meetings with local communities to present the company's plans, and, of course, duty of care to Alien's employees to maintain necessary distance or even isolation as required.

To combat these issues, Alien established both a corporate team and a technical team, including a highly experienced exploration manager, in Zacatecas, in order to support the Mexican assets. These teams are acting on behalf of the company to expedite these processes as best they can. They have excellent experience not only in the mining sector in the region, but also in dealing in public affairs with local governments, and have provided welcome support while the management is unable to attend the projects in person.

Conclusion

There are many challenges that exploration companies will face when running a portfolio of projects across different continents, jurisdictions, and time zones. These challenges are all the more apparent when faced with a global pandemic. For a geologist, viewing a project up close, seeing the samples, and observing the lay of the land are invaluable. Being unable to do so can feel like a huge setback.

However, with the right amount of careful consideration, explorers can be prepared to face these challenges head on, pandemic or not. Having geological and administrative teams in situ with the right experience in the region can stem any problems early on, and also reduce the need for heavy involvement from, or the presence of, upper management. Further, choosing the most appropriate third-party contractors and consultants is preferable to choosing the ones that are the most convenient, in order to get the best results. Ultimately, with the right talent in place and the use of modern technology, it is more than possible to run far-flung projects remotely. GMR

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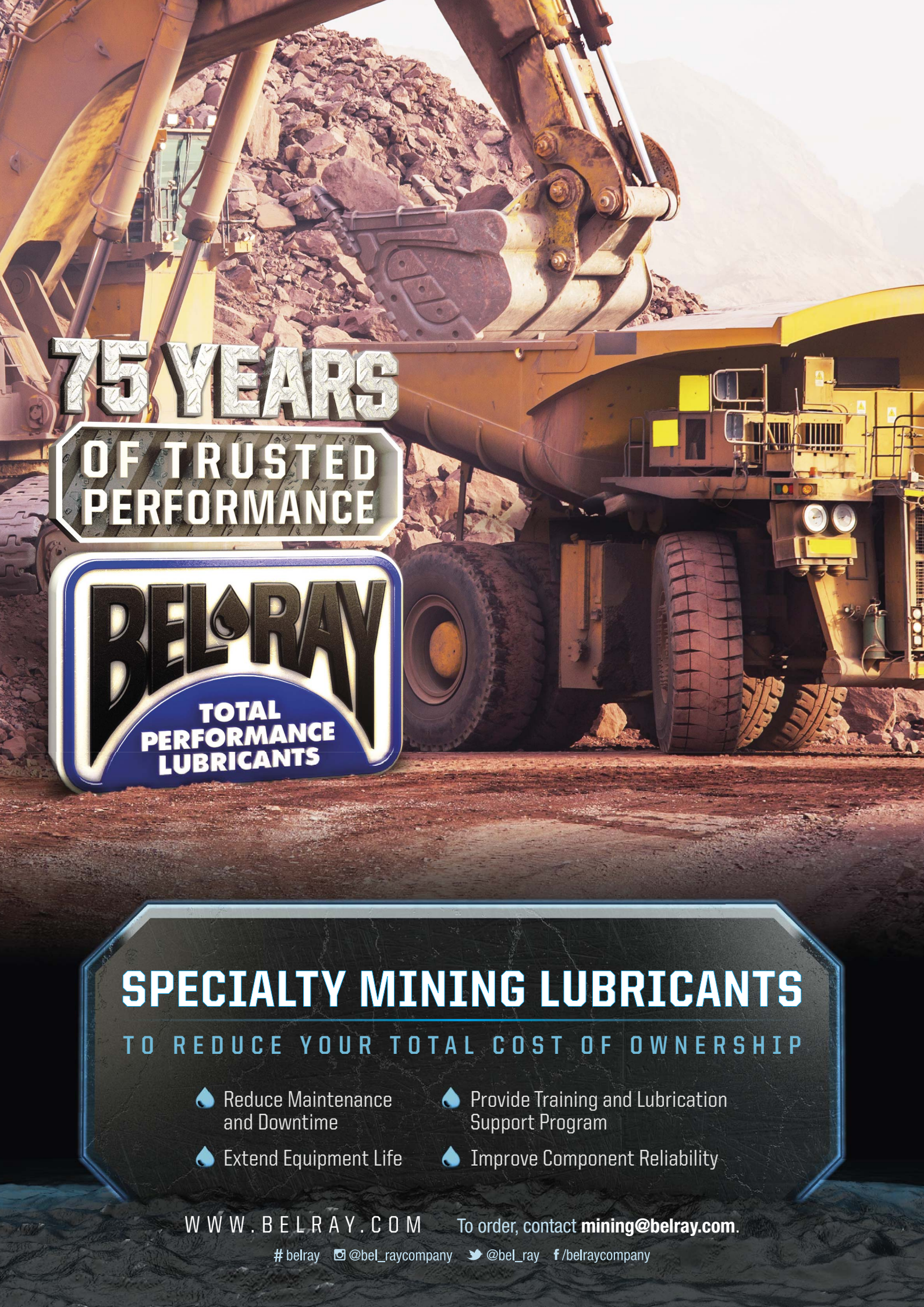
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