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MINING & QUARRY WORLD

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6 mobile metal separators sold in 3 months

Following a surge in orders for their mobile metal separator, *Steelweld Enviro Products Ltd* and *CRJ Services* have ordered six (6) Bunting Eddy Current Separators and Rare Earth Drum Magnets in the first quarter of 2021. The Eddy Current Separators separate non-ferrous metals from non-metallic material with the Rare Earth Drum Magnets recovering magnetic materials.

Bunting is one of the world's leading designers and manufacturers of magnetic separators for the recycling and waste industries. The Bunting European manufacturing facilities are in Redditch, just outside Birmingham, and Berkhamsted, both in the United Kingdom.

Steelweld Enviro, from Cookstown in County Tyrone, designs and manufactures a world class range of innovative solutions for the waste recycling sector. CRJ Services hires and sells quality machinery from world-renowned OEMs for recycling companies. In 2017, CRJ identified a need for a mobile metal separation system for sale and rental. CRJ contacted Steelweld, who already manufactured mobile chassis for a number of large OEMs. Steelweld designed the metal separation system with the help of CRJ and Bunting (Drum Magnet and Eddy Current Separator). The resultant mobile metal separation system was named the STROBE and features Bunting's *Eddy Current Separator* and *Rare Earth Drum Magnet*.

Figure 1: STROBE Mobile Metal Separation System.

CRJ Services presently operates eight (8) STROBE Mobile Metal Separators in their hire fleet and is the official distributor of Steelweld Enviro's equipment in both the United Kingdom and Ireland.

The STROBE ECS features crawler tracks and an on-board diesel generator and hydraulic power pack, allowing for easy site manoeuvrability and transportation on a low loader trailer without permits. The unique low feed height of the mobile separator enables a direct feed from a trommel and, with quick set up times and an easy-to-use push button control panel, the innovative design ensures a trouble free, low maintenance service life.

Bunting's 1.5m wide Eddy Current Separator handles approximately 25 tph, depending on the application. The model High-Intensity Concentric (HIC) ECS, with a magnetic rotor diameter of 300mm, maximises the separation of non-ferrous metals. A high-strength Rare Earth Drum Magnet, mounted prior to the Eddy Current Separators, recovers ferrous metals.

The surge in demand for mobile recycling plant following a challenging 2020 resulted in ordering six (6) Eddy Current Separators with Rare Earth Drum Magnets between January and March 2021. Four (4) of the metal separators have feed widths of 1.5 meters, with the remaining two (2) a third wider at 2 metres.

"Although business in the recycling sector was steady throughout the 2020 pandemic, there has been a real surge in orders and enquiries since the start of 2021," explained Adrian Coleman, the General Manager of Bunting-Redditch. "We have a long-standing working relationship with Steelweld and CRJ and their STROBE 1500 ECS mobile metal separator has proved particularly popular with recycling companies."

For further information, please contact us on press@buntingeurope.com or visit our website.

Figure 2: STROBE Mobile Metal Separation System.

Resolute's Syama gold mine begins blasting with fully wireless system to improve safety and productivity

Today marks a significant milestone for the Resolute and Orica partnership with the commencement of production blasting at the Syama mine in Mali using WebGen™, the world's first fully wireless initiating system developed by Orica.

Syama Mine Managing Director and General Manager, Mohamed Cisse said: "This milestone exemplifies our business values, specifically the adoption of new methods, systems and technology to improve safety and performance."

Wireless blasting will support Resolute's strategic vision of being a successful low-cost gold producer.

The WebGen™ system completely eliminates the need for down-lines and surface connecting wires by sending firing commands through hundreds of metres of rock, air and water to initiate blasts reliably and safely without re-entry into high-risk areas.

Orica President Europe Middle East and Africa, Tom Schutte said: "We are grateful to Resolute for their long-term cooperation in achieving this milestone. Our latest technologies, including WebGen, will create value for Resolute by enabling Syama mine to eliminate exposure of personnel in higher risk areas through safer pre-charging practices."

WebGen™ will drive efficiency and optimisation throughout the production cycle for the mine. Including increased cave flow performance and overall ore recovery by reducing the consequences of hole dislocation or loss and redrilling required.

Resolute intends to utilise WebGen™ across its underground production operations and see WebGen™ technology as a critical enabler to achieving its automated mine of the future vision at Syama.

Guy Valerie Mbinga, WebGen™ Technician Orica Mali, firing the first WebGen™ blast at Syama under the authority of John Wheeler, General Manager – Operations, Syama Mine.

Orica seeks sale of Minova

Orica has put subsidiary Minova up for sale following hampered market conditions and the halving of overall earnings.

Minova specialises in ground control solutions for the mining, civil, geotechnical and construction industries.

Its total sales revenue for 2021 was $219.1 million, 17% less than the $263 million it delivered in 2020.

According to Orica managing director and chief executive officer Sanjeev Gandhi, Minova is a non-core asset for the company.

"While Minova has delivered a substantially improved performance in recent times, it has been identified as non-core. Therefore, we will consider selling at an appropriate price," he said.

Orica stated that tensions between Australia and China and a decline in the US coal market was to blame for the decline.

Australia and China's strained relations resulted in a ban on Australian coal imports in China last year.

Orica stated that Minova has performed well despite the setbacks and its diversification into the infrastructure and hard rock mining markets.

Orica earned $152 million in the six months ended March 31, 2021, marking a 51% decline from the previous corresponding period.

"Our first half financial results are in line with our February market update and reflect the impact of various market factors," Gandhi said.

"As we detailed in the update, ongoing COVID-19 disruptions, geopolitical issues and unfavourable foreign exchange movements impacted us in the half."

In May, China's National Development and Reform Commission (NDRC) suspended economic communications with Australia, which further signalled Beijing's transition away from Australian commodities.

More than 60% of the world's seaborne coal is from Australia, a Minerals Council of Australia report revealed.

"Metallurgical coal is a critical component for steel making and Australia's quality attracts customers from around the world from Asian countries such as India, China, Japan, South Korea and Taiwan all the way to the EU (European Union)," MCA chief executive officer Tania Constable said.

Orica is the world's largest commercial explosives provider with the mining industry as one of its key areas.

No place for new coal in $5tr/y transition to net-zero by 2050 – IEA study

A new and far-reaching study of how to transition the global energy system to one with net-zero carbon emissions by 2050 highlights the need for a dramatic acceleration in the pace and scale of renewable-energy and grid investment, while simultaneously halting new fossil-fuel supply projects and abandoning any new unabated coal plants.

Published by the International Energy Agency (IEA) as part of preparations for the twenty-sixth Conference of the Parties, or COP26, climate gathering scheduled for Glasgow, Scotland, in November, the 'Net Zero by 2050: A Roadmap for the Global Energy Sector' report concludes that the world has a viable, albeit narrow, pathway for limiting the global temperature rise to 1.5 °C above preindustrial levels.

Central to the pathway is a rise in the role of electricity, derived primarily from increasingly cost-competitive renewable plants, in achieving net-zero.

Electricity, the IEA shows, will need to account for almost 50% of total energy consumption in 2050 and play a key role across all sectors, from transport to buildings and industry, including becoming a key input for producing low-emissions fuels such as hydrogen.

To achieve this, total electricity generation increases over two-and-a-half times between today and 2050 and no additional new final investment decisions are taken for new unabated coal plants, while the least efficient coal plants are phased out by 2030, and the remaining coal plants still in use by 2040 are retrofitted to capture carbon.

"By 2050, almost 90% of electricity generation comes from renewable sources, with wind and solar photovoltaic (PV) together accounting for nearly 70%. Most of the remainder comes from nuclear," the report states.

Described as the world's first comprehensive study of how to transition to a net-zero energy system by 2050, while also ensuring stable, affordable and universal energy access, the report calls on policymakers to prioritise the following:

- Raising total yearly energy investment to $5-trillion by 2030, which would add an extra 0.4 percentage point a year to annual global gross domestic production (GDP) growth, and place global GDP 4% higher in 2030 than it would be based on current trends.

- A rapid scaling up of solar PV and wind this decade to reach a yearly additions tempo of 630 GW of solar PV and 390 GW of wind by 2030, four times the record levels set in 2020.

- Enabling infrastructure and technologies key to transforming the energy system, such as transmission and distribution grid expansions and electric vehicle (EV) charging points. Yearly investment in transmission and distribution grids will need to expand under the pathway from $260-billion today to $820-billion in 2030, while the number of public charging points for EVs rises from around 1-million today to 40-million in 2030, requiring yearly investment of almost $90-billion in 2030.

- A massive roll-out of efficient energy technologies to support a world economy in 2030 that is some 40% larger than today but which uses 7% less energy.

- The implementation of policies to limit, or provide disincentives for, the use of certain fuels and technologies, such as unabated coal-fired power stations, gas boilers and conventional internal combustion engine (ICE) vehicles. The report states that, beyond projects already committed as of 2021, no further new oil and gas fields should be approved, while new coal mines or mine extensions are not required. One of the 400 milestones in the report is a halt to all ICE vehicle sales by 2035.

- An intensification of research and development, as well as demonstration projects to unlock and commercialise advanced batteries, hydrogen electrolysers and direct air capture and storage, which are seem as the highest-potential new technologies to support the net-zero transition.

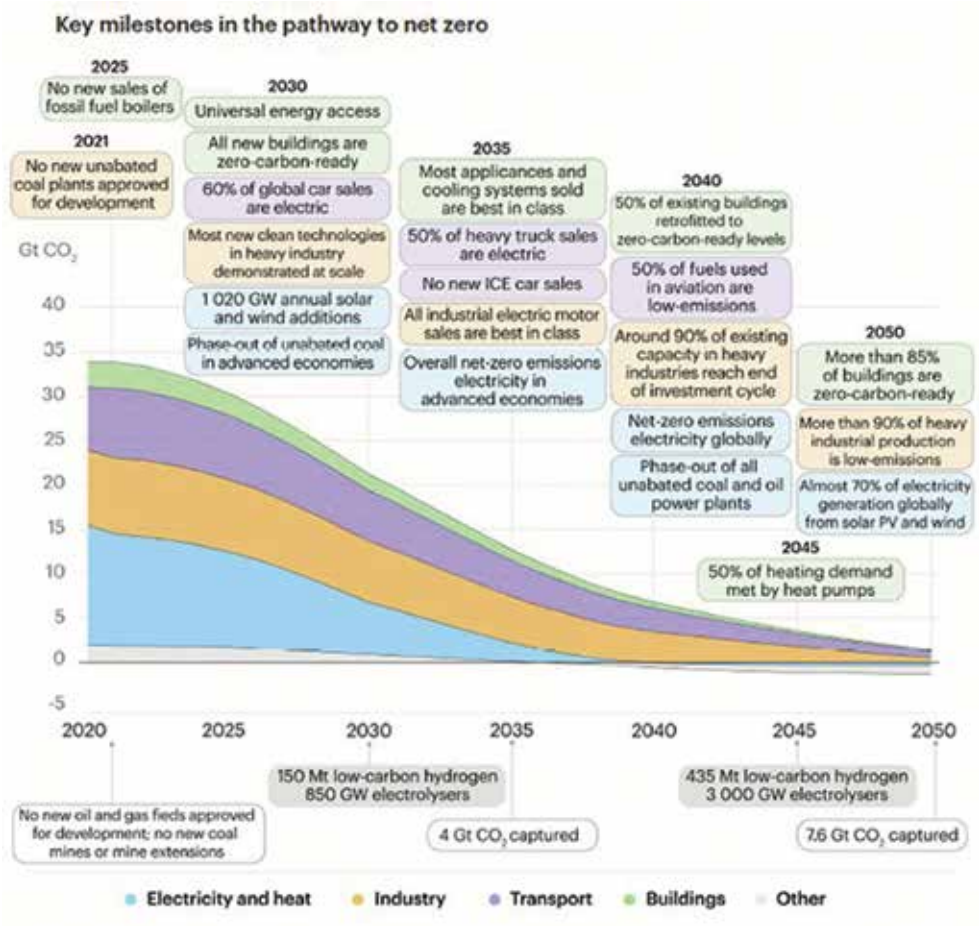


Photo by IEA

About $90-billion of public money needs to be mobilised globally to complete a portfolio of demonstration projects before 2030, with only $25-billion currently budgeted. The report shows that most of the global reductions in carbon emissions between now and 2030 can come from technologies readily available today but that, in 2050, almost half the reductions come from technologies that are currently only at the demonstration or prototype phase.

- Facilitating substantial investment in critical minerals, with the total market size for minerals such as copper, cobalt, manganese and various rare earth metals to grow by almost sevenfold between 2020 and 2030 in the net zero pathway. Revenues from those minerals are larger than revenues from coal well before 2030, creating substantial new opportunities for mining companies, but also raising energy security concerns.

- Placing people at the centre of the energy transition to ensure public support in light of an IEA estimate that about 55% of the cumulative emissions reductions in the net-zero pathway are linked to consumer choices such as purchasing an EV, retrofitting a house with energy-efficient technologies or installing a heat pump. At the same time, the pathway envisages the provision of electricity to the some 785-million people that currently have no access, as well as clean cooking solutions to 2.6-billion people that still lack those options.

- Ensuring that clean energy jobs, which will grow rapidly, are evenly spread. The report estimates that the transition to net-zero could create 14-million jobs and 16-million construction jobs by 2030, but that five-million fossil-fuel jobs will be lost.

- And intensify international cooperation to tackle the global challenge through coordinated action rather than simply through individual governments seeking to bring their national emissions to net zero.

The IEA said that new energy security challenges will emerge on the way to net zero by 2050, even as the role of oil and gas diminishes.

"The contraction of oil and natural gas production will have far-reaching implications for all the countries and companies that produce these fuels . . . [while] OPEC's share of a much-reduced global oil supply grows from around 37% in recent years to 52% in 2050, a level higher than at any point in the history of oil markets."

In addition, there could be energy security challenges arising as a result of the increasing importance of electricity. These could include the variability of supply from some renewables, cybersecurity risks and a rising dependence on critical minerals, with associated risks of price volatility and supply disruptions.

IEA executive director Fatih Birol sad that report showed that the prospects for achieving net-zero emissions by 2050, while challenging, was not yet lost and also held potential economic and social benefits.

"The IEA's pathway to this brighter future brings a historic surge in clean energy investment that creates millions of new jobs and lifts global economic growth. Moving the world onto that pathway requires strong and credible policy actions from governments, underpinned by much greater international cooperation."

Nevertheless, he stressed that each country would need to design its own strategy, taking into account its own specific circumstances.

"Plans need to reflect countries' differing stages of economic development: in our pathway, advanced economies reach net0-zero before developing economies," Birol concluded.

New software provides a smarter, streamlined way to manage geological data

Accessing your geological data no matter where you are, and working from a single source of truth, just got a whole lot easier.

One of the challenges facing geologists, often observed by the team behind acQuire's mining software solutions, is the accurate field collection and transfer of geological observations and measurements to a centralised database.

Ensuring the integrity of data can be difficult, especially when transferring data between systems or tools.

Geologists may be collecting information from a range of data sources using multiple tools, but there's unlikely to be common threads holding geological data together.

The process of connecting and mapping data from one system to another becomes time-consuming, requiring several manual steps in the process. When more manual intervention is required, the likelihood of unintentional errors being introduced into datasets increases.

The problem is compounded by the still popular practice of manually logging geology and sample data on paper, a practice which is prone to human error.

By not complying with business rules when the data is logged, regardless of when and where the logging occurs, the integrity of the data may be questionable.

With acQuire's upcoming software release, GIM Suite 5, these historical field geology data management problems are alleviated, giving geologists and miners a single source of truth everyone in the organisation can trust.

This is true from the point of capture and throughout the life of a mine. Everyone who relies on geological data to do their job or make decisions benefits from having confidence in the data.

Field workers and geologists collecting samples and observations are able to seamlessly manage their entire field data collection workflow across web and mobile with a raft of brand-new, purpose-built interactive features added to GIM Suite.

They're the culmination of years of design and planning, which help make GIM Suite a leading geological data management software.

25 years of investment into GIM

The new features are introduced as acQuire celebrates their 25th year in business. Their quarter-century commitment to geoscientific information management (GIM) has made it possible to offer miners a glimpse into the future of geological data management. Drillhole logging and sampling are approached with a mobile interface designed to work equally well for exploration and production.

- **Single data interface for all drilling methods** – Geology teams no longer need multiple tools for logging and sampling RC, RAB, air core or diamond drillholes.

- **Improved logging consistency with interactive, graphical drillhole logging** – GIM Suite 5's graphical logging interface lets geologists visually inspect and dynamically adjust intervals using a touch-friendly screen. Logging consistency is improved with cross-referencing of downhole datasets.

- **Built-in rules for improved data quality** – Common rules can be configured and applied across logging and sampling interfaces. Database managers can consistently apply and enforce the rules across all data capture tasks.

- Flexibility to work in any environment – Field workers can capture drillhole data in any environment, whether they're working online or offline. If they're in a remote environment, they can continue to capture drillhole data using the acQuire Arena mobile app.

These new features are designed to help teams working against the pressure of time, by accurately collecting data and synchronising it across the digital environment.

GIM Suite 5 smoothly integrates all steps from mobile data capture in the field to creating sample despatch reports on the web.

The future of geological data management is here

According to acQuire product director Steve Mundell, acQuire's continual focus on evolving GIM Suite brings the future of geological data management to today's mining workplace.

"GIM Suite 5 removes reliance on non-integrated software tools and siloed data so the value of geological information can be extended across the mining value chain," Mundell said.

"You can now rely on one seamlessly integrated solution across web, desktop and mobile devices. It doesn't matter if you're working in remote areas with no internet connection when collecting data.

"This release puts our customers, the largest miners in the world, another step further into the future of geological data management.

"Our roadmap for GIM Suite is to continue providing more capability across the web and mobile. We're excited to lead the way for how mining companies manage their geological data, whenever and wherever they need it."

Other key features of the new GIM Suite 5 release include:

- Clever web-based data imports from third-party solutions
- Rapid drag-and-drop construction of complex data queries and data views
- Improved data quality with centralised and consistent data definitions.

In practice, GIM Suite 5 allows geologists and miners to dispense with multiple tools and rely on GIM Suite to create a trusted, single source of truth used throughout the organisation. The result is a fast, efficient and accurate way to manage geological data for a range of drilling and surface sampling scenarios.

GIM Suite 5 is scheduled for release in July 2021.

Liebherr rolls out new 305-tonne mining truck

Liebherr has released the T 274 haul truck with a class-leading 305-tonne payload capacity.

The T 274 is designed to fit between the Liebherr T 284 and T 264 haul trucks, offering fast cycle times, high production and reduced fuel costs.

The T 274 features the largest payload capacity in its class and is powered by a 3650-horsepower engine and Liebherr Litronic Plus AC Drive system allowing the machine to move material in shorter times.

It also features 6035-horsepower dynamic braking power which allows the truck to operate efficiently on downhill hauls.

Liebherr has designed the T 274 to work across harsh environmental conditions with a wide range of options available to suit bespoke applications and demands of mine sites.

Based on the 400-tonne T 284, which has achieved more than 20 million operating hours, the new mining truck brings reliability and a long history of field experience.

Liebherr has designed the T 274's cab with an ergonomic design to provide maximum comfort and safety for operators, enabling high levels of visibility through tinted safety glass windows.

The cabin is also certified for roll-over and falling-object protection, with two safety exit routes from the cab to the ground.

The T 274's reliability is enhanced by its double A-arm suspension which allows for the right amount of ground contact of the tyre within the suspension stroke, which reduces tread and wear with its optimised camber and toe angles.

"These properties of the front suspension system deliver superior comfort, safety and handling for the T 274 operators, improving the ride quality and reducing overall body vibration exposure," Liebherr stated.

The Liebherr Trolley Assist System is one of the options available on the T 274, which acts as a first step to achieving zero emission mine sites. Liebherr uses an overhead pantograph to connect the electric-drive system to the electrical network.

"The main advantage is the significant reduction of diesel fuel consumption and truck fleet CO_2 emissions," Liebherr stated.

Copper heats up as global demand spikes

While gold mergers and acquisitions were the talk of the town last year, copper activity has been spiralling upwards in the background.

It's no secret that clean energy technologies require a large amount of copper.

After climbing to near-decade highs on the London Metals Exchange this year, there are signs that the red metal will become as vital as ever as demand for these technologies grows.

Local copper exports already achieved a record revenue of $10.4 billion in 2020, according to the Australian Bureau of Statistics.

While global copper production is dominated by major mining companies, Cyprium Metals is pushing towards becoming a mid-tier producer in Australia to make its mark on the industry.

The Perth-based company is comprised of mining executives with strong experience working in both local and international copper projects.

In February, Cyprium made a key move in this direction by acquiring Metals X's copper portfolio for $60 million.

The buyout includes the mothballed Nifty copper mine in the Pilbara region of Western Australia, which Metals X placed on care and maintenance in 2019 after acquiring the site three years earlier.

Nifty was first discovered in the 1980s but progress at the site stalled due to a lack of exploration.

For Cyprium Metals, however, all systems are go at Nifty as the company looks to advance its path towards the mid-tier sector.

"It always was attractive for us in terms of the size, the copper metal, in terms of the fact it's a stressed asset, that it's in Western Australia, and the infrastructure surrounding it," Cyprium Metals managing director Barry Cahill stated. "We're really happy to get a hold of it."

Cahill says Cyprium is firing on all cylinders to make its mid-tier prospects possible.

"Really the focus is on copper production," he says. "We're not explorers, we're resource developers, operators, producers and financiers.

"We like to get copper resources and turn them into operating projects and make them commercial – that's what gets us excited."

Cyprium is looking to develop the Nifty mine exclusively into an open pit site, unlike previous owner Metals X, which operated an underground operation at the site.

This strategy continued into Metal X's reset plan at Nifty, but Cyprium has other ideas for how to approach mining of the resource.

"The reset plan didn't work is the fundamental answer," Cahill says. "Whatever was in the plan didn't work. The reset plan involved underground, we're involving an open pit instead."

Rather than using the Nifty concentrator, Cyprium plans to use a heap leaching method, which it believes is more economically viable.

"We're producing copper metal plate with the heap leaching instead so it's a finished product rather than a concentrate, which was done at Nifty previously," Cahill says.

"Copper metal plate sells all over the world mainly into Asia at the moment but also into the Europe and the United States."

The company hopes to commission the plant and produce first copper by the end of 2022, followed by full production in 2023, with current targets of 20,000 tonnes of copper per annum.

A feasibility study is also due by September this year to upgrade the proof of concept study that was completed as part of the due diligence process prio to the purchase, Cahill continues.

"Metals X released their scoping study last year," he says. "We don't agree with the concepts in there, but it goes to show there's a lot

Cyprium plans to turn Nifty into an open-pit operation.

of data available to turn into the feasibility study."

A cause for copper

To be a copper producer in 2021 comes with its own success and opportunities.

"I'd love to be a copper producer this year," Cahill says. "Who wouldn't? You'd be laughing."

Like many miners, Cahill sees copper demand only increasing in the long run.

He says copper does not fluctuate to the extremes of speciality metals, making it a safer choice of investment for a new technology future.

"From our point of view, copper is a safe bet for worldwide electrification," he says.

"No matter what you do with electrification, it all requires copper, and copper production is required for all of those things.

"It's such a safe bet without having those fluctuations of supply and demand. That's why we went for copper."

A large slice of Australia's copper is exported from BHP's Olympic Dam mine in South Australia, which is one of the world's largest deposits of copper.

BHP, which last year became the world's top copper producer, has a massive portfolio in the base metal, including the Escondida joint venture operation in Chile, the largest copper mine in the world.

Speaking at the CRU World Copper Conference in Chile, BHP president minerals Americas Ragnar Udd says copper demand is expected to double in the future.

"In a Paris-aligned, 1.5-degree scenario, we expect that investment in areas such as copper-intensive solar generation, nickel-intensive batteries, and steel-intensive wind turbines will contribute to a more than doubling of the amount of primary copper and a quadrupling of the amount of primary nickel demand over the next 30 years relative to that was produced over the last 30 years," he says.

Udd says industry efforts decarbonise will also increase commodity demand for new infrastructure.

"This effort will require substantial investment in infrastructure and the technologies that will leverage them," he says.

BHP has also revised its internal EV penetration forecast as demand climbs, with Udd pointing to these vehicles requiring significantly more copper to manufacture than petrol-based cars.

"Policy signposts for rapid EV adoption were distinctly favourable over the last 12 months and we have revised our internal EV penetration forecasts upwards," he says.

"These vehicles use four times as much copper as petrol-based cars, and they will also need more infrastructure to connect charging stations to the grid."

Goldman Sachs believes "copper is the new oil", according to a report released by the company in April.

"We estimate that by-mid decade this growth in green demand alone will match, and then quickly surpass, the incremental demand China generated during the 2000s," the report states.

"Ripple effects into non-green channels mean the 2020s are expected to be the strongest phase of volume growth in global copper demand in history."

The report anticipates that by 2030, copper demand from electrification will grow by almost 600% to 5.4 million tonnes.

If there is a "hyper adoption" of sustainable technologies, copper demand would increase even by 900% to 8.7 million tonnes.

Future opportunities

With copper demand stirring, and strong optimism from the world's leading producer, Cahill is eager to progress Cyprium's assets to help meet future supply needs.

"To get Nifty back up and running properly is going to require a lot more support from stakeholders like government and government departments," he says. "We want to be copper producers – we're not talking about it, we're doing it."

Through the Metals X copper acquisition, Cyprium also secured the Maroochydore and Paterson Exploration projects, both in the Paterson Province in Western Australia.

Cyprium's new assets join its Nanadie Well project and an 80% interest in the Cue Copper project in Western Australia.

Drilling at Maroochydore has unveiled a resource of 486,000 tonnes of copper and 18,500 tonnes of cobalt.

"We have a view with our intellectual property that we can crack the metallurgy there (at Maroochydore)," Cahill says.

"Nifty is hopefully running to full production in January 2023, so we need to have Maroochydore ready for our next project after Nifty."

Cahill anticipates that Maroochydore will follow suit and enter production by 2025 at 20,000 tonnes of copper per annum.

"The approval process on a new build might be a bit longer and the cost is much greater," he says. "But we're very bullish on it."

The Paterson project is a joint venture (JV) with IGO, which has committed $32 million to earn 70% interest in the project.

The JV was formed in 2020 with IGO agreeing to fund exploration activities for 6.5 years.

With Paterson located near Nifty, Cahill is excited to see what IGO can help it achieve there.

"We're quite happy with the expertise of IGO in terms of their exploration," he says. "They have other tenements in the Paterson province and we're happy to let them do their due and ride off the back of it."

Cyprium's strategy to turn itself into a mid-tier looks promising, and Cahill is hoping the company can build its copper presence within Western Australia with the three acquired assets.

"By sheer luck, we've ended up solely in Western Australia," he says. "One of the things we've taken into our strategy is our regional presence, which is why Nifty, Maroochydore and Paterson work so well for us."

The splice of life

Finger splicing

– How going back to the old ways can help increase reliability and save costs

THE WEAKEST POINT

The area where the open ends of a conveyor belt are joined together to create one continuous loop (better known as the splice joint) is, almost without exception, the weakest point of any conveyor belt. In fact, it is estimated that nearly 80 percent of all conveyor stoppages are caused by splice joint problems. Because of the potential loss of output, as well as the safety implications caused by splice joint failure, it has always been critically important to maximize the strength and long-term durability of the joint.

The most popular method of making a splice joint is the use of vulcanized splicing, which can be either a hot or cold (glue) splice. Within this, the two most common techniques used to create a vulcanized splice joint is the step splice and the finger splice. Historically, finger splicing was the favoured technique. Although it remains standard practice for joining solid woven belts used underground and for most fabric ply mono and dual ply rubber belting, the use of the standard step splice technique has now become the most popular because they are generally easier and quicker to make. But has this been at the expense of reliability and longer term cost effectiveness? Here, Dunlop Conveyor Belting's chief application engineer, Rob van Oijen, provides reasons why in many cases a return to finger splicing can improve reliability and reduce downtime.

HANDLING THE DEMANDS

Over the years, I have witnessed customers expending a great deal of time and effort trying to choose the correct specification of belt for their critical conveyor applications. Painstaking calculations and lengthy inspections are carried out to identify the specification that will maximize output and achieve the longest belt lifecycle. At the same time, much less consideration is often given to the installation of the belt and, in particular, what is the best kind of splice joint to use. All too often, this can result in a critical error. While the quality of the belt is paramount, the type and quality of the splice is equally important.

It can be easy to forget that industrial conveyor belt splice joints need to be capable of handling several different demands. Firstly, the splice must withstand a wide range of changes in tension, including conditions where belt tension may reach levels of 150% of rated load. Other challenges that are placed on the splice joint include short transitions, 'S' drive arrangements and impact from heavy materials falling from height onto the joint. Added to that, there is the dynamic stress caused by the continual flexing over drums and pulleys. Even though a great deal of time and care may have been taken in calculating the correct belt specification and buying a good quality conveyor belt, it can all be easily wasted if the splice joint proves to be unreliable.

THE ADVANTAGES OF FINGER SPLICING

For those who may not be familiar with splicing terminology and techniques, a step splice requires the removal of one of the layers of fabric plies so that the two belt ends can be overlapped and then either cold glued or hot vulcanised together.

Finger splicing is where a zigzag pattern is cut into both sides of the belt ends, creating several interlocking 'fingers'. These fingers are carefully aligned, interlocked together and finally bonded using a hot vulcanising press to make a splice that is typically very strong and flat.

Regardless of the splice method or technique used, it is not physically possible to join a belt without some loss of longitudinal tensile strength. With this in mind, especially on more critical conveyors, it is important to optimize the strength of the splice joint. Although easier and some 30% faster to make, the main disadvantage of a standard step splice is that it will always create a proportional loss of tensile strength equivalent to one ply.

As can be seen in **Table 1**, a 2-ply step splice only retains a maximum of 50% of the belts longitudinal tensile strength, a 3-ply step joint can only achieve a maximum tensile strength of 67%. In contrast, the primary advantage of the finger splice method is that it retains up to 90% of the belt's 'static' tensile strength. Another area of advantage in favour of the finger splice is that, crucially, in dynamically stressed conditions (when the belt is working and under load) the finger splice is again vastly superior to a stepped splice in terms of resistance to dynamic failure.

MAXIMISING SPEED AND ACCURACY

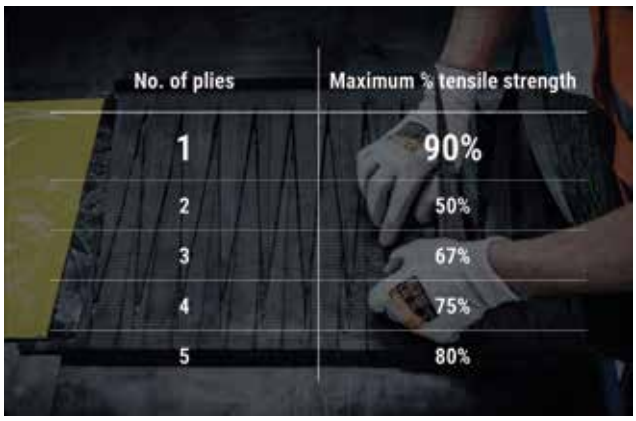
Although much is made of how much longer it takes to make a good quality finger splice, that is often more of a reflection on the skill of the person actually making the splice. Skill, experience and making the best use of available tools makes a big difference. For example, when preparing to make a finger splice it is a good practice to make use of dedicated templates with the finger shape predefined and ready to trace onto the belt. This helps to speed up the process and greatly improve accuracy.

Templates are not available for stepped splices so the accuracy depends much more on the skill and attention of the splicer who is measuring and cutting. The use of a template allows very accurate preparation and enables perfect alignment and matching and therefore the perfect splice between of both belt ends. The end-result is the achievement of maximum strength and durability between both belt ends.

POTENTIAL COST SAVINGS

When trying to establish the correct specification of belt for a specific conveyor. It is very important that the loss of longitudinal tensile strength is taken into consideration. Therefore, the calculation should always include the safety in the splice at the given efficiency. The much higher retention of tensile strength provided by a finger splice means that it may well be possible to install a lower and therefore less expensive specification.

For example, it could mean that a 630/3-ply belt could safely be fitted instead of the 630/4-ply that would otherwise be necessary if a step splice was being used. The superior strength and durability of finger splices also reduces the frequency to repair and re-splice. This is an



No. of plies	Maximum % tensile strength
1	90%
2	50%
3	67%
4	75%
5	80%

Table 1.

Templates speed up the process and improve accuracy.

Using a finger splice can mean that a lower and less costly spec belt can be used.

Finger splicing allows super-tough belts such as Ultra X to be used on demanding applications.

important consideration because it can significantly lower both direct (actual repair) and indirect (lost output) costs.

Even greater economy can be achieved by significantly reducing belt repair and replacement costs on applications where belts are prone to being damaged. This is because using the finger splice means that specialist mono-ply and dual-ply belts such as Dunlop Ultra X and Dunlop UsFlex specifically designed to handle very tough working conditions can be used. Both belts have an outstanding resistance to ripping and tearing and impact, which makes them far more durable and longer lasting compared to conventional multi-ply belts. In fact, their strength is actually enhanced by the finger splice joint.

SUMMARY

Do not be put off by warnings from your service provider or the potentially higher initial outlay. As I touched on earlier, reluctance to make a finger splice is usually based on the skillset needed to complete the task rather than the suitability and benefits of the joint that the technique creates.

As for the 'higher' cost, I would argue that this is invariably compensated for many times over by the improved reliability and avoiding the need to fit a higher than necessary specification of belt in the first place. The cost of making the splice is a small fraction of the cost of a system shutdown or the many thousands that have will have been spent buying and installing the belt in the first place. In my view, it surely makes no sense to try and 'save' a few hundred euros by opting for the less durable step splice or by not having the work carried out by the most skilled service provider available.

ABOUT THE AUTHOR.

Rob van Oijen is Manager Application Engineering for Dunlop Conveyor Belting in The Netherlands. Rob has specialised in conveyors for some 14 years, supporting businesses throughout Europe, Africa, the Middle East and South America.

The cost of making the splice is a small fraction of the cost of a system shutdown.

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SMITHERS

In record time

The total conveying length of the Pipe Conveyors is approx. 6.6 kilometres, the conveying capacity 5,500 tons per hour.

An economical solution was required for transporting large quantities of iron ore from the Chinese port of Langshan to the plant of steel manufacturer Shandong Steel Group & Rizhao Steel Group. The general contractor Shandong Harbour Engineering awarded BEUMER Group with the installation of additional efficient Pipe Conveyors. Project implementation took around eight months. In only four months, the system provider installed the mechanics of the systems with a total conveying length of approx. 6.6 kilometres and a conveying capacity of 5,500 tons per hour.

Shandong is an eastern Chinese region on the Yellow Sea. More people live here than in Germany and Austria combined, while the area of Shandong is only about half the size of Germany. Its name translates to "East of the mountains" and refers to the Taihang mountain range, east of which lies this coastal province, strategically located between the Chinese economic metropolises Beijing and Shanghai. Another advantage is its access to the Yellow River: the region has a dense network of waterways and several important trade and transhipment ports. The steel manufacturer Shandong Steel Group & Rizhao Steel Group is also headquartered here.

For its manufacturing, the company requires large quantities of iron ore which is delivered to the port of Langshan. In order to transport the material to the plant, the company previously relied on a closed Pipe Conveyor, but the capacity was gradually exhausted and was no longer able to handle the transport volume. The managers were looking for an economical solution and approached the Shandong Harbour Engineering Group. The engineering service provider was commissioned as general contractor to create the infrastructure. Now the question was: Should the plant use a well-developed expansive railway and road network or invest in a conveyor system solution?

Shandong Harbour Engineering Group turned to BEUMER Group. The system provider develops conveying solutions for a variety of bulk materials - for example open troughed belt conveyors or closed Pipe Conveyors. BEUMER engineers were also involved in the system, which is already in operation.

PIPE CONVEYORS - DOES IT PAY OFF?

"Of course, we had to prove that this investment was worthwhile", says Zhengwei Zhang, project manager at BEUMER Machinery (Shanghai) Co., Ltd. "In advance, we performed an economic evaluation." This included a feasibility study, an investment calculation, the project schedule and a cost-benefit analysis. Different variables are required to compare the costs of Pipe Conveyors with those of trucks or trains, for example the transport costs per ton, the material volume that needs to be moved within a set period of time, and also the specific investment costs and the tax depreciation plan. "More costs are added for the construction and the supply of the conveyor as well as for the mechanical and electrical installation", explains Zhengwei Zhang. Complex construction work is also often necessary. The initial investment in a conveying system is usually very high, but the operational costs of a

Pipe Conveyor can be considerably lower depending on the application. Important factors include the estimated cost of a ton of material to be moved or, in the case of vehicles, the number of round trips per hour. "Our Pipe Conveyors lead directly to the destination and we can immediately adapt it to the corresponding site structure," explains Zhengwei Zhang. A significant advantage of BEUMER technology is that it enables horizontal and vertical curves.

Depending on the characteristics of the conveyed material as well as of the system's geometry, it is possible to implement vertical curves with angles of inclination up to 30 degrees and horizontal curves with a deflection angle of up to 90 degrees. This ability to navigate curves reduces the number of supports and replaces the transfer towers, which results in substantial cost savings for the customer. The system transports the iron ore safely enclosed across various terrains such as roads, residential areas or rivers. During the projection phase of the system, BEUMER technicians use proprietary calculation software to determine the static and dynamic loads - loads, which do not only affect the belt but the steel structure frame as a whole. This is a prerequisite for safe and correct dimensioning of the structures.

ECOLOGICAL AND ECONOMICAL

BEUMER Group provides their belt conveyors with environmentally safe electric drives and low-energy belts. Therefore, especially in these times of climate change and increasing greenhouse gas emissions they are considered a more sustainable option. The motors used are usually adjustable, which permits the loads to be optimally distributed on the drive units under various operating conditions. The closed design of this conveying system also protects the environment from falling transported goods. Another advantage is the elimination of dust development on the running line. This is important because the section between the port and the plant leads through public roads and residential areas.

"Our evaluation of the various transport options enabled us to consider the total costs per ton over time", says Zhengwei Zhang. "With this application, the Pipe Conveyor will pay for itself quickly, and the system is more environmentally friendly than truck transport."

OPTIMALLY TAILORED CONVEYING SOLUTION

"Together with the managers in Shandong, BEUMER engineers developed a solution that is optimally tailored to their requirements. The system supplier delivered a conveying system consisting of two Pipe Conveyors. The overall length is approx. 6.6 km, the diameter 500 mm. At a speed of 5.15 m/s, the systems operating together convey up to 5,500 tons of material per hour considerably supporting the already existing conveying solution. In addition, a transfer tower is used.

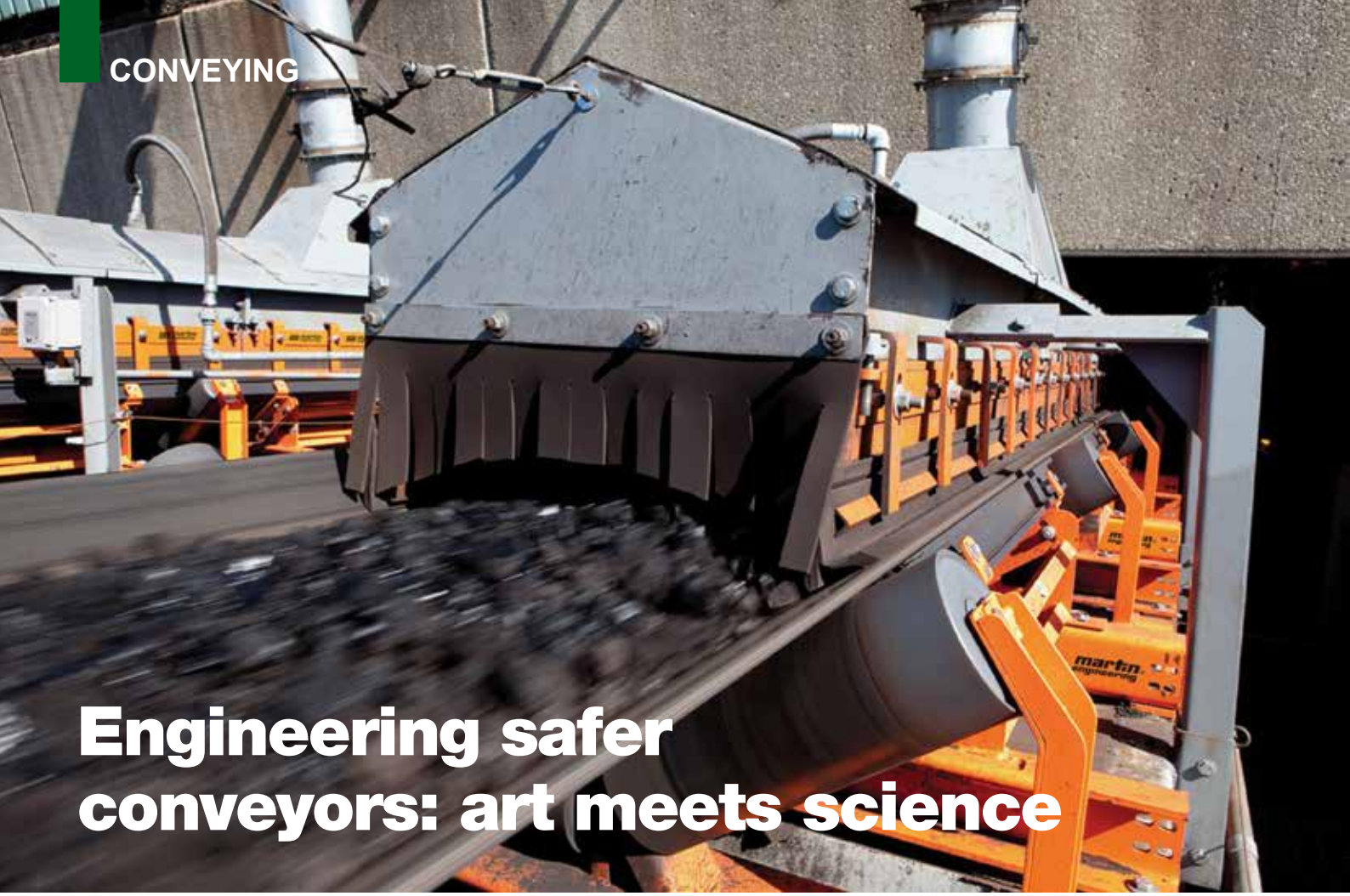
BEUMER Group was responsible for the overall project, which included the design of the system and the entire steel structure. The completely enclosed conveying system ensures an environmentally safe, dust-free and low-energy transport of the iron ore. The system provider started the installation in September 2018 and commissioning took place only four months later. The complete project implementation took only eight months. "We are very satisfied with BEUMER Group's single-source solution and the handling of the project", states Liu Qiang, executive director and general manager at Rizhao Port Shipbuilding & Machinery Industry Co.,Ltd, Shandong Harbour Engineering Group. "The two Pipe Conveyors allow us to work in a more economical way and we are optimally prepared for future capacity expansions at our plant."

Picture credits: BEUMER Group GmbH & Co. KG

The BEUMER solution permits Shandong Steel Group & Rizhao Steel Group to work in a very economical way.

For the entire project, BEUMER Group was able to ensure that the iron ore is transported safely and quietly, without disturbing the residents or disrupting the surrounding nature.

Liu Qiang, executive director and general manager at Rizhao Port Shipbuilding & Machinery Industry Co.,Ltd, Shandong Harbour Engineering Group: “We are very satisfied with BEUMER Group’s single-source solution and the handling of the project”.



Engineering safer conveyors: art meets science

All new conveyor systems will inevitably succumb to the punishing bulk handling environment and begin the slow process of degradation. The system will eventually require more time and labor for maintenance, shorter spans between outages, longer periods of downtime and an ever-increasing cost of operation. This period is also accompanied by an increased chance of injury or fatality as workers are progressively exposed to the equipment to perform cleaning, maintenance and to fabricate short-term fixes to long-term problems. A total system replacement is cost prohibitive, but to remain compliant and/or meet ever-increasing production demands, upgrades and repairs are unavoidable.

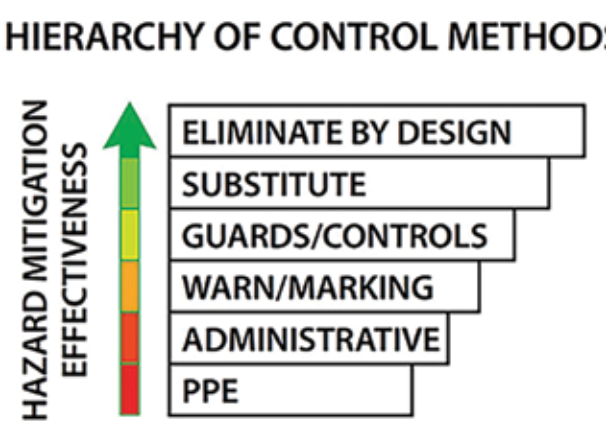
When examining the safety of a system, improving efficiency and reducing risk can be achieved by utilising a hierarchy of control methods for alleviating hazards. The consensus among safety professionals is that the most effective way to mitigate risks is to design the hazard out of the component or system. This usually requires a greater initial capital investment than short-term fixes, but yields more cost-effective and durable results.

THE SCIENCE: HIERARCHY OF CONTROL METHODS

Examining the US Occupational Safety and Health Administration (OSHA) accident database reveals the dangers of working around conveyors[1]. Studies have revealed that the highest prevalence of accidents are near locations where cleaning and maintenance activities most frequently take place: take-up pulley, tail pulley and head pulley.

Designs should be forward-thinking, exceeding compliance standards and enhancing operators' ability to incorporate future upgrades cost-effectively and easily by taking a modular approach. Designing hazards out of the system means alleviating causes with the intent to bolster safety on a conveyor system, but the methods of protecting workers can vary greatly. In many cases, it will be necessary to use more than one control method, by incorporating lower ranked controls. However, these lower-ranking approaches are best considered as support measures, rather than solutions in and of themselves.

PPE includes respirators, safety goggles, blast shields, hard hats, hearing protectors, gloves, face shields and footwear, providing a barrier between the wearer and the hazard. Downsides are that they can be worn improperly,



Safety improves as the type of hazard control moves higher up the hierarchy of methods±].

may be uncomfortable to use through an entire shift, can be difficult to monitor and offer a false sense of security. But the bottom line is that they do not address the source of the problem.

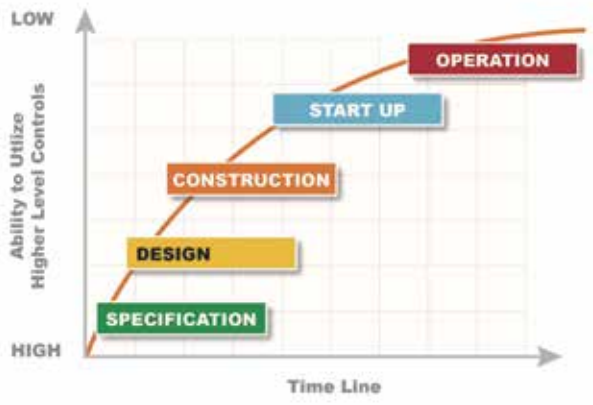
Administrative Controls (changes to the way people work) create policy that articulates a commitment to safety, but written guidelines can be easily shelved and forgotten. These controls can be taken a step further by establishing "active" procedures to minimise the risks. For example, supervisors can schedule shifts that limit exposure and require more training for personnel, but these positive steps still do not remove the exposure and causes of hazards.

Warning Signage is generally required by law, so this is less of a method than a compliance issue. It should be posted in plain sight, clearly understood and washed when dirty or replaced when faded. Like most lower-tier methods, signs do not remove the hazard and are easily ignored.

Installing systems such as *Engineering Controls* that allow remote monitoring and control of equipment – or Guards such as gates and inspection doors that obstruct access – greatly reduce exposure, but again, do not remove the hazard.

Using the *Substitute* method replaces something that produces a hazard with a piece of equipment or change in material that eliminates the hazard. For example, manual clearing of a clogged hopper could be replaced by installing remotely triggered air cannons.

Examples of *Eliminate by Design* are longer, taller and tightly sealed loading chutes to control dust and spillage or heavy-duty primary and secondary cleaners to minimise carryback. By using hazard identification and risk-assessment methods early in the design process, engineers can create the safest, most efficient system for the space, budget and application.



Incorporating effective hazard control techniques is easier and less costly in the early stages of a project[2].

ECONOMIC ANALYSIS OF PREVENTION THROUGH DESIGN (PTD)

Another way of saying "Eliminate by Design" is PtD (Prevention through Design), the term used by The National Institute of Occupational Safety and Health (NIOSH). As a department of the U.S. Centers for Disease Control (CDC), the organisation spearheaded the PtD initiative[3]. In its report, the Institute points out that, while the underlying causes vary, studies of workplace accidents implicate "system design" in 37% of job-related fatalities.

Risk Assessment Matrix				
Probability / Severity	Catastrophic (1)	Critical (2)	Marginal (3)	Negligible (4)
Frequent (A)	High	High	Serious	Medium
Probable (B)	High	High	Serious	Medium
Occasional (C)	High	Serious	Medium	Low
Remote (D)	Serious	Medium	Medium	Low
Improbable (E)	Medium	Medium	Medium	Low
Eliminated (F)	Eliminated			

Risk assessment applied to design helps create a safer conveyor system.

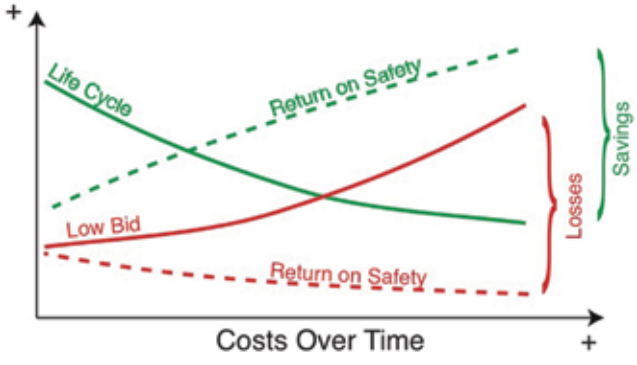
Cost is most often the main inhibitor to PtD, which is why it's best to implement safer designs in the planning and initial construction stages, rather than retrofitting the system later. The added engineering cost of PtD is often less than an additional 10% of engineering but has enormous benefits in improved safety and increased productivity.

The cost of PtD initiatives after initial construction can be three to five times as much as when the improvement is incorporated in the design stage. The biggest cause of expensive retroactive improvements is cutting corners initially by seeking lowest-bid contracts.

LOW-BID PROCESS AND LIFE CYCLE COST

Although the policy is generally not explicitly stated by companies, the Low-Bid Process is usually an implied rule that is baked into a company's culture. It encourages bidders to follow a belt conveyor design methodology that is based on getting the maximum load on the conveyor belt and the minimum compliance with regulations using the lowest price materials, components and manufacturing processes available.

But when companies buy on price, the benefits are often short-lived, and costs increase over time, eventually resulting in losses. In contrast, when purchases are made based on lowest long-term cost (life-cycle cost), benefits usually continue to accrue and costs are lower, resulting in a net savings over time[4]."



The return on better design and quality is realised over the extended life and safety of the system.

Red, Amber, and Green List for Designing Better Belt Conveyors	
RED LIst	*Procedures, techniques, products, and processes to be prohibited in the Specification and Design stages of a conveyor project.*
	Prevent loading on the transition of the belt.
	Prevent transition of more than 1/3 trough.
	Prevent loading against the direction of the receiving belt.
	Prevent loading conveyor to 100% of CEMA standard cross section capacity.
	Prevent control and sequencing that allows conveyor(s) to run empty longer than necessary.
	Prevent belt identification stamps in top cover.
	Prevent installing equipment in elevated locations without provision of safe access or tie-offs.
	Prevent Component Selection Based on 'Or Equal' Specifications or 'Price Only' Bidding.
AMBER LIST	*Procedures, techniques, products, and processes to be eliminated or reduced as much as reasonably possible. Only allowed with a change in the specification and notice to project owner/manager explaining potential issues and ability to address them in the future.*
	Avoid reversing conveyors.
	Avoid multiple load points on a single conveyor.
	Avoid designs created with the intention to increase capacity in the future by increasing conveyor speed; design the system to accommodate future needs
	Avoid combined vehicle and personnel travelways or uncontrolled exits from buildings into traffic patterns.
	Avoid a site layout that does not allow for safe and efficient delivery, storage, lifting of major components such as pulleys, drives, and belting.
GREEN LIST	*Procedures, techniques, products, and processes to be encouraged in specification and design stages of a conveyor project.*
	Consider ergonomics in the design and access of frequently cleaned or maintained equipment.
	Consider use of pulleys with diameters larger than minimum required for the specified belting.
	Consider access and clearances according to CEMA recommendations.
	Consider the use of design to reduce exposure to hazards.

Rather than meeting minimum compliance standards, conveyor systems should exceed code, safety and regulatory requirements.

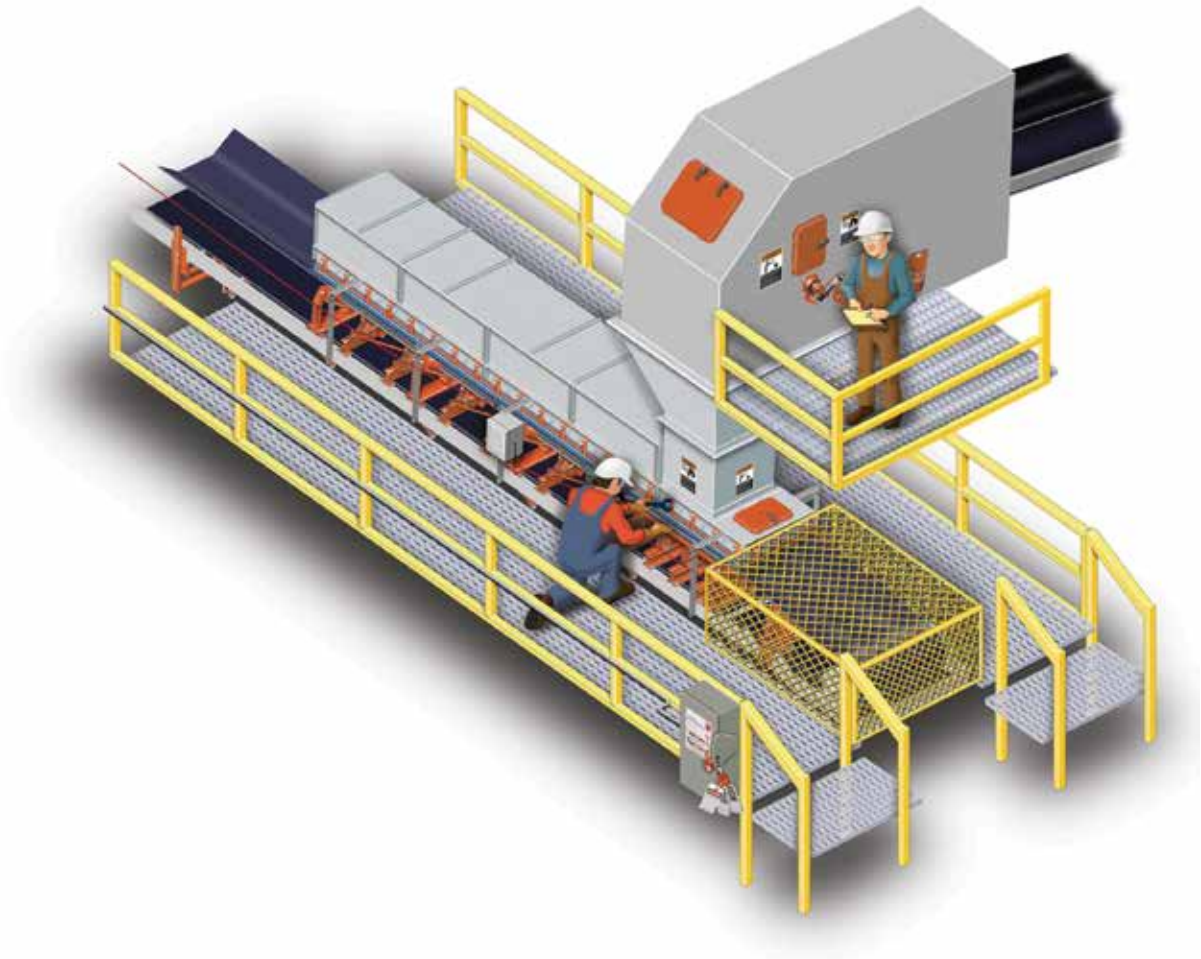
THE ART: DESIGN HIERARCHY

Rather than meeting minimum compliance standards, the conveyor system should exceed all code, safety and regulatory requirements using global best practices. By designing the system to minimise risk and the escape and accumulation of fugitive material, the workplace is made safer and the equipment is easier to maintain.

Life cycle costing should play into all component decisions. Buying on Life Cycle Cost and anticipating the future use of problem-solving components in the basic configuration of the conveyor provides improved safety and access, without increasing the structural steel requirements or significantly increasing the overall price. It also raises the possibility for easier system upgrades in the future.

Best Practices: The "Evolved™ Basic Conveyor"

Using the Hierarchy of Controls along with the Design Hierarchy, engineers will be able to construct an "Evolved Basic Conveyor" that meets the needs of modern production and safety demands. Built competitively with a few modifications in critical areas, an Evolved Basic Conveyor is a standard bulk material handling conveyor designed to allow easy retrofitting of new components that improve operation and safety, solving or preventing common maintenance problems.



Installing or providing for maintenance-minded solutions in the loading zone can greatly improve safety and reduce man-hours and downtime. These components include slide-in/slide-out idlers, impact cradles and support cradles. On larger conveyors, maintenance aids such as overhead monorails or jib cranes assist in the movement and replacement of components. Also, designers should ensure adequate access to utilities – typically electricity and/or compressed air – to facilitate maintenance and performance. Next-generation conveyor designs may even feature a specially-engineered idler capped with an independent power generator that uses the conveyor's movement to generate power for a wide array of autonomous equipment.

Dust, spillage and belt tracking are top concerns for many safety professionals. Field tests have shown that enlarged skirtboards and engineered settling zones promote dust settling and reduce fugitive material. Curved loading and discharge chutes control the cargo transfer for centered placement and reduced turbulence. As the load is centered on the belt, guides ensure even travel through the takeup to promote consistent belt tracking.

Any transfer point is prone to buildup and clogging under the right conditions, be it ambient humidity, material wetness, volume or surface grade. Flow aids such as vibrators or air cannons on chutes can sustain material movement, improve equipment life and reduced the safety hazards associated with manually clearing clogs.

A properly configured conveyor minimises emissions for improved safety and easier maintenance.

CONCLUSION

Engineering safer conveyors is a long-term strategy. Although design absorbs less than 10% of the total budget of a project, additional upfront engineering and applying a life cycle-cost methodology to the selection and purchase of conveyor components proves beneficial.

By encouraging the use of the Hierarchy of Controls at the planning stage, along with the Design Hierarchy at the design stage, the system will likely meet the demands of modern production and safety regulations, with a longer operational life, fewer stoppages and a lower cost of operation.

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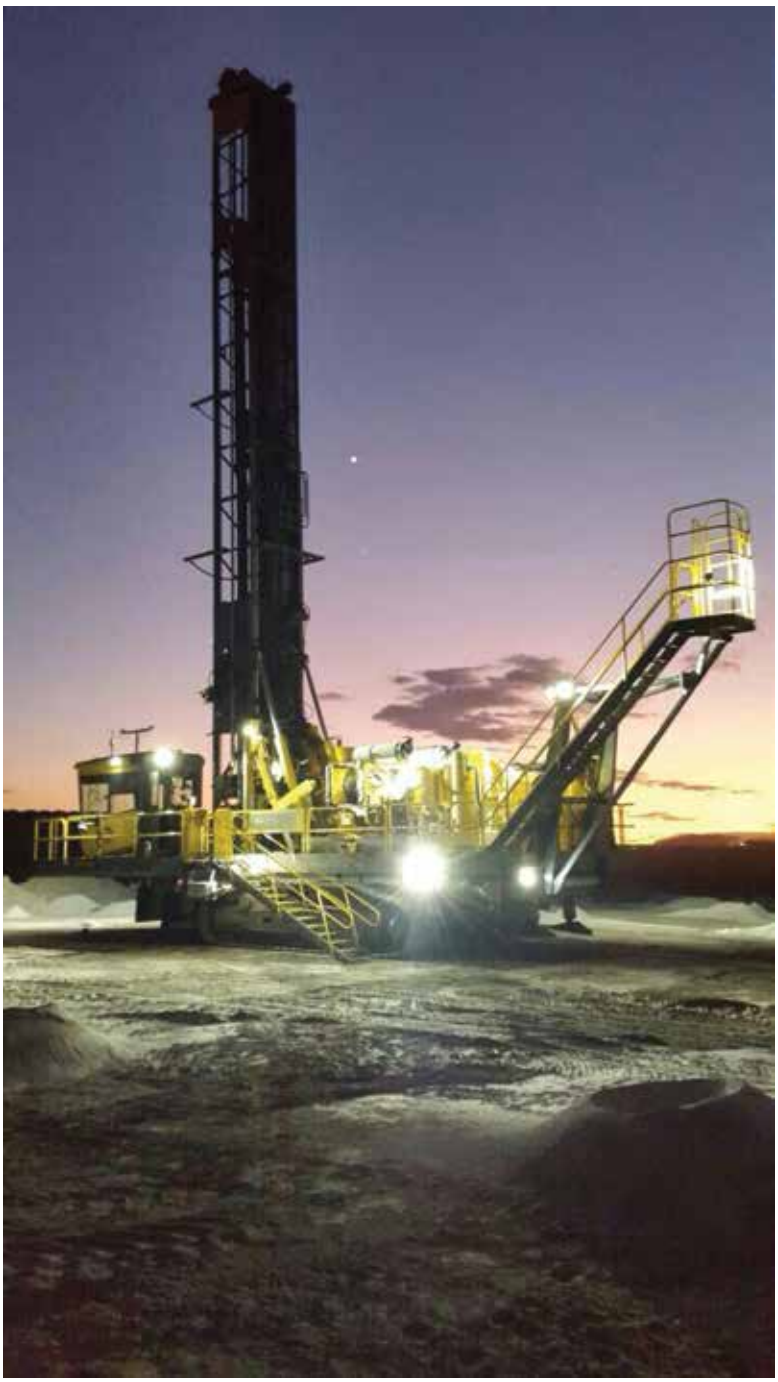
Rotary blast hole drilling



The precision in drilling blast holes to a particular depth and size is of utmost importance for a successful explosion of the mining area. Most rigs are fitted with bits made of tungsten and other material, which can be changed depending on the softness or hardness of rocks at the mining location. The global rotary blasthole drilling rig market was valued at $2.60 billion in 2017 and is projected to reach $3.50 billion by 2025, growing at a CAGR of 3.7%.

Factors such as increase in demand for metal and minerals, expansion of existing mines, and growth in construction of roads, tunnels, and railways drive the growth of the market. In addition, rise in technological advancements and introduction of various powerful rotary tricone drill rigs supplement the market growth. Rotary drilling with rolling tricone bits is the most widely used method for drilling large-diameter blast-holes in large surface mining operations. This drilling method is applicable to a wide range of soft to hard rock materials and is best suited for sizes 6 to 22 inches in diameter, optimal hole depths range from 15 to 150 feet and average from 30 to 60 ft

In large surface mining operations, drilling, and blasting activities constitute more than 15% of the total costs. In order to optimize performance and minimize costs, a thorough knowledge of drill and blast operations is, therefore, extremely important. Drilling rigs used for rock blasting for surface mines vary in size dependent on the size of the hole desired, and is typically classified into smaller pre-split and larger production holes. Underground mining (hard rock) uses a variety of drill rigs dependent on the desired purpose, such as production, bolting, cabling, and tunnelling.

No story of drilling is complete without a look at what is to come in the drilling world. Today, improvements not only are advancing in drilling equipment but in the accompanying software used. Modern drills are advancing to being self-sufficient without the need for an operator in the cab. These drills are auto-positioning and automatically drilling a hole to the exact depth that is designed – and this is no easy task for a human operator. Drills today are automatically recording key parameters such as penetration rates to develop automatic borehole logs to help understand the rock. This technology is likely to advance into fully autonomous drilling fleets on sites that are not only developing information on penetration rates, but are automatically sampling the rock to give properties such as compressive strengths, tensile strengths, and young's modulus. This can help the blaster to optimize hole loading to get better results, but it can also be used by engineers to delineate different grades of rock and ore. In the future, these drills may even include sampling systems to automatically report the grade of rock/ore that is being drilled. Using explosives has been successfully accomplished, but this faces problems with efficiency and application. While many other drilling technologies have been studied, it is difficult to beat the reliability, ease of use and practicality of percussion or rotary drilling. Perhaps in the distant future we will see other technologies such as thermal fragmentation be developed to change the face of drilling. For now, this seems to be a ways off.

Many of today's leading manufactures continue to add new features to their various ranges to increase both productivity and safety. MQW worlds Managing Editor Trevor Barratt takes a look at some of drilling rigs on offer.

EPIROC ENHANCE QUALITY AND PRODUCTIVITY

Produced out of Garland, Texas, and Nanjing, China, Epiroc machines are built in state-of-the-art production facilities and to the highest quality allowing fabrication to last through multiple repowers. Epiroc has a long history with designing and manufacturing main structures of rigs putting the companies rotary blast hole drills at the top of their class.

The blast hole range includes the Drill Master series, a proven market leader to this day, and the Pit Viper series, a premium range product that delivers highly efficient drilling with fully autonomous capabilities.

The Drill Master series, a product with a legacy so resilient that it has been part of the most master drillers training around the globe. The DM product has proven over the years to be a workhorse for customers all over the world, delivering productivity, reliability, and low operating costs year after year The companies value series drills a hole diameter ranging from 5 1/2 inches up to 9 7/8 inches, and a pulldown range from 30,000 lbs to 75,000 lbs.

The Pit Viper series delivers a hole diameter ranging from 6 inches to 16 inches, and a pulldown range from 60,000 lbs 125,000 lbs. The PV-230, PV-270, and the PV-310 offer single-pass and multi-pass options, building on the highest industry standard of performance and innovation.

The Pit Viper series, a superior mining industry staple, can be configured with our numerous options to provide the customer's specific needs. The industry-leading Pit Viper range delivers productivity and reliability on another level, ultimately contributing to the lowest total cost of ownership in the blast hole drilling industry in its class.

With Epiroc's Rig Control System (RCS), the Pit Viper series can be configured with scalable Automation features such as Auto Drill and Auto Level. It can be run with the operator off the drill as well with the optional Bench REMOTE package, enabling one operator to run one or multiple units. It provides the foundation to add new functionality and options later without a major rebuild of the machine. Autonomous drilling can be implemented with almost no human interaction with the drill.

KOMATSU

Komatsu's 320XPC rotary blasthole drill provides up to 68,038 kg (150,000 lbs.) of bit loading and is specifically designed for large diameter blasthole drilling in extremely difficult rock conditions. Amongst its features are:

Powerful pulldown

Top-drive, rack-and-pinion pulldown has fewer wearing components requiring maintenance, contributing to better machine availability

- Powerful rotary carriages provide ample torque and bit loading to break through the toughest rock conditions

Superior propel

- Mainframes and crawler frames are built for maximum strength and stand up to the most challenging hard rock mine conditions
- Rugged crawlers and powerful hydrostatic propel drives deliver manoeuvrability, gradeability, and fast set-ups

Rugged masts

- Drill mast is designed for high-cycle fatigue resistance, resulting in less downtime and lower costs for crack repair

- Mast, constructed of high-strength alloy steel, provides maximum rotary carriage and drill string support

Excellent operator visibility

- Operator's cab provides a clear, unobstructed view o the drilling area, including the areas surrounding the dril
- Full windows, coupled with video cameras, ensure tha your operator has maximum visibility during drilling anc propelling operations
- Operator's chair can swivel to face the travel direction allowing safer repositioning

Protective and productive operator environment

- FOPS Level II-certified structure and shatter-resistan glass protects your operator during harsh mining conditions
- Operator controls are located within easy reach to allow for maximum productivity

Superior extreme environment capabilities

In addition, the 320XPC has options available that make it ideal for some of the toughest mining conditions in the world:

SANDVIK

Sandvik has launched a new drilling system, Top hammer XL, for large hole size (140-178 mm / 5.5-7 inch) top hammer drilling in surface mining applications.

The system comprises a drill rig, rock drill and rock tools – all newly developed and designed to work seamlessly together for optimum drilling performance and increased productivity.

The system has been proven in several field tests around the world. The results show up to 50% reduction in fuel consumption as well as a significant reduction of total drilling costs compared to the down-the-hole (DTH) drilling method.

Sandvik has also added the DR410i rotary blast hole drill to its iSeries. The DR410i can complete 152 mm to 251 mm rotary and DTH (down-the-hole) holes, with a standard mast and offers a first pass capability of 10 metres with a maximum hole depth of 46.6 metres. The extended mast option delivers a first pass option of 14 metres with a total depth capacity of 32.3 metres across all recommended pipe diameters. The Sandvik DR410i is automation-ready, and can be equipped with the company's AutoMine module. This scalable solution can be used for on-board automation to increase drilling efficiency through to full autonomous operations.

Sandvik expands rock processing solutions division

Kwatani supplies screens and feeders to mining operations in Australia, Europe, Asia and North America. Image: Sandvik

Sandvik has acquired South African-based manufacturer Kwatani, extending its rock processing solutions division, which formed in early 2021.

Kwatani will bring screens, feeders, fine separators, drives and services to Sandvik's range, while also strengthening Sandvik's presence in Africa.

Sandvik president and chief executive officer Stefan Widing said the deal was another step in the growth of the Swedish multinational.

"I am pleased that we are continuing to execute on our strategy to grow through acquisitions and at the same time strengthening our position in rock processing. I look forward to welcome Kwatani to our Group," Widing said.

Kwatani employs around 150 workers and saw around $27 million in revenue for 2020.

President of Sandvik's rock processing solutions division Anders Svensson said Kwatani's extensive range will be a great addition to Sandvik's products.

"Kwatani's offering of large vibrating screens and feeders for the mining industry is in line with our strategy to strengthen our capabilities in comminution and will be a good complement to Sandvik's strong competence and experience within stationary crushing and screening. This will further accelerate our growth within rock processing", Svensson said.

Sandvik expected the deal to be finalised in the final quarter of 2021, dependent on the relevant approvals.

This will mark the first of Sandvik's acquisitions for the rock processing division.

The South African business was formed in 2015 when Joest, an importer of German parts, partnered with Vhatsila Holdings to become Joest Kwatani.

In 2016, the company dropped Joest from its name and became Kwatani to reflect its African heritage. It has since expanded to supply equipment to mining operations across Australia, North America, Asia and Europe.

KUMERA gearboxes: How a customised solution can increase reliability and reduce energy costs

Highly efficient KUMERA 2,500 kW conveyor belt drive.

Powerful conveyors and their drive systems have a key role in surface mining. In ore mines, conveyor belts up to several kilometers long transport ore for further processing or transportation and reduce labor burden. The operational safety and reliability of the systems are of great importance since delays or shutdowns due to damage can cause immense downtime costs.

Environmental hazards such as extreme weather conditions and fluctuations, dust, and dirt pollution, and falling rocks must also be considered for operational safety. Systems are often installed in impassable locations so low-maintenance concepts are required. In the event of service or damage, the downtime should be as short as possible.

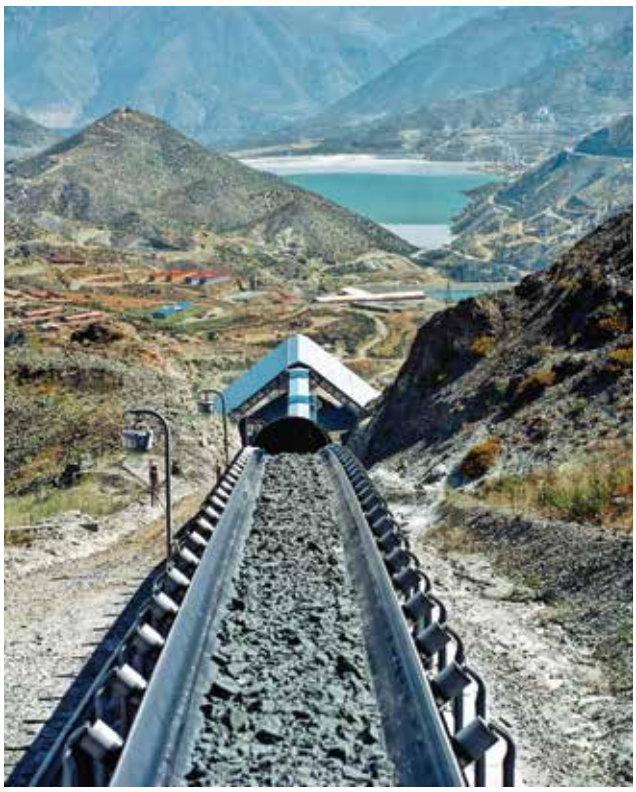
Three-phase AC motors with the following gear variants are typically used as drive concepts for the conveyor belt systems:

Standard gear with or without fan

Advantage:	Fast availability
	Inexpensive
Disadvantage:	Small outputs up to 1,000 kW
	For gear ratios greater than 16:1 in 3-stage design, which results in high power losses.
	Less possibility of variation in terms of installation and environmental conditions.
	Additional lubrication and cooling units are usually required for heat dissipation

KUMERA customised gears

Advantage:	Optimised drive design for the respective application and the specified environmental conditions.
	Outputs over 2,500 kW are possible.
	In the 2-stage design, ratios greater than 20:1 are possible, which reduces the power losses by up to 30% compared to 3-stage gearboxes.
	Large variety of options, including universal installation options thanks to the double foot design.
	Compact design through the flange output shaft.
	No additional lubrication and cooling system.
	Higher operational safety thanks to a significantly lower number of components at risk of failure.
Disadvantage:	Higher design effort and more complicated gear housing design due to the internal oil routing. This means higher costs, which, however, are partially offset by saving the oil supply system.



Conveyor belt slope downwards – generator mode.

The gearboxes are mounted on a base frame as a drive unit together with all additional components (e.g., brakes, torque support, etc.) and flanged on the belt drums. Depending on the power requirement, a conveyor belt is equipped with one or two driven belt drums, whereby each drive drum can be equipped with a drive on one or both sides. A conveyor belt is thus equipped with up to four drive units. A great advantage of having several drives per conveyor belt is that if one drive fails, the system can continue to operate, albeit with a reduced delivery rate, until the defective drive is repaired or replaced. Another advantage in connection with the universal gearbox design is that in the event of a defect with a replacement gearbox any damage, regardless of the gearbox position in the system, can be repaired at significantly lower costs than if the conveyor belt were driven by just one large drive.

KUMERA conveyor belt drives are designed as a two-stage design when possible. Compared to a three-stage

KUMERA powered overland conveyor in operation in Chile.

KUMERA conveyor belt drive solution – right position.

version with standard gear units, this has the advantage of 1% better efficiency (approx. 98% instead of 97%). What does not sound like much at first glance, however, turns out to be an ecologically and commercially significant advantage.

For example, a KUMERA conveyor belt with 10 MW drive power (4 drives at 2,500 kW each), currently in use in a copper mine in Chile, has a savings of approximately 100 kW/h in motor operation by an efficiency increase of 1%. For a conveyor system consisting of three conveyor belts, with a system utilization of 80% on average and an operating time of 16 hours/day and 250 days/year, this means an energy savings of approximately 960 MW per year. If still considering a system utilization of 80% but 24/7 operation time and 14 days downtime for maintenance per year the savings ending up to 2,016 MW.

In many applications the systems convey the material downhill, which means the operation is in generator mode. The higher efficiency means the systems will generate approximately 100 kW/hour of power more than a three-stage version with standard gear units.

KUMERA endeavors to support plant manufacturers in the implementation of their drive concepts with the best possible gear design. KUMERA also offers support to system operators and tailor-made drive concepts for the renewal and improvement of operational safety and increased performance of conveyor belt drives. The KUMERA belt drives are subject to continuous improvement. At present, new concepts are nearing production, through which both greater power density and an increase in operational reliability under thermal performance limits will be achieved.

AUTHOR
Dr. Heinz-Peter Ehren
Managing Director
KUMERA Getriebe GmbH

MTG TERRA cast lips for toughest mining applications

Ground engaging tools (GET) specialist MTG has provided its TERRA cast lip to the Australian market, delivering high levels of productivity for the harshest applications.

After several years of field experience in iron ore, coal, copper, and gold mines around the world, MTG's TERRA cast lips have delivered a 4% increase in productivity and considerable increase in machine availability due to less and shorter downtimes.

The three reasons for the good performance are the high-quality steel, its slim design and cast lip specific tooth and bucket protection systems.

While MTG Steels offer an optimal balance of hardness and toughness to maximize strength and wear resistance, optimized wear material distribution reduces weight and increases penetration.

Additionally, the high-performance TWINMET tooth system and PROMET lip and wing shrouds optimally protect critical areas and offer safe and quick maintenances thanks to their hammerless locking systems.

The TERRA series is made for mining excavators with an operating weight of 450 to 1000 tonnes.

Its range consists of four sizes (148 inches, 163 inches, 169 inches and 201 inches) with either five or six stations.

MTG is working on smaller TERRA sizes for 250-to-400-tonne mining excavators which will be available by the end of 2021.

The official distributor of MTG's portfolio is 2MT Mining Products, a trusted Australian company specialized in the supply of consumable wear parts.

2MT's full coverage of the Australian market through strategically located branches, its highly trained sales and support representatives, and field expertise in monitoring GET and buckets are backed by MTG's local technical services team to ensure extensive onsite support.

Havieron JV fast tracks project development

Newcrest Mining and Greatland Gold have opened the underground decline at the Havieron gold-copper project in Western Australia.

The project is a joint venture (JV) between Greatland Gold and Newcrest, with the latter allowed to earn up to a 70% interest in the project once exploration and development milestones are achieved.

The regulatory approvals for Havieron's construction were provided on December 29, 2020 with the project rapidly advancing development.

The decline will develop the Havieron orebody along with a drilling program that is currently underway at the site.

Newcrest oversees exploration activities at Havieron.

Greatland Gold chief executive officer Shaun Day said the opening of the underground decline is a significant milestone for the project and the next step will involve a pre-feasibility study.

"This is a momentous step in the development of Havieron as a world-class gold-copper mine. I am delighted by progress on site and this fast-tracked milestone is indicative of the potential scale of the deposit and the opportunity seen by our partners Newcrest," he said.

"By providing access to the top of the orebody, the decline sets Havieron on course to become a large, multi-commodity, bulk tonnage, underground mining operation. Alongside the ongoing growth drilling, the next key milestone will see the completion of a pre-feasibility study and we are on track to deliver this in the second half of 2021."

The Havieron project is located around 45 kilometres east of Newcrest's Telfer gold mine.

Under the joint venture, any material extracted from Havieron will be processed at Telfer.

An aerial shot of the Havieron boxcut.

BHP, Rio and Vale set global design challenge

Majors BHP, Rio Tinto and Vale have launched a global competition for technology innovators to help develop new concepts for large-scale haul truck electrification systems to help significantly cut emissions from surface mine operations and unlock safety, productivity and operational improvements.

The Charge On Innovation Challenge is being run in partnership with Australia's Mining Equipment, Technology and Services (METS) industry body Austmine.

The challenge is expected to attract additional interest from resource companies that maintain substantial haul truck fleets and are looking for innovative concepts to deliver electricity to large battery-electric haul trucks.

The majors said in a joint statement that current stationary charging systems require substantial time to charge large trucks, which would result in significant lost productivity. The mining industry needs multi-megawatt scale fast charging concepts capable of delivering around 400 kWh to charge (and propel) a truck within the truck's haul cycle, the statement said."METS and mining companies are united on the Challenge to reduce emissions across the supply chain," said Austmine CEO Christine Gibbs Stewart.

"With 80% of METS companies supplying products and services outside mining, the challenge leverages the experience and innovation of industries in the automotive, battery makers, aerospace, defence and other sectors."

"We are confident that we will find a solution to the delivery of electricity to trucks in the complex operating environment of a large surface mine. We expect the Challenge will attract companies from a broad range of sectors including mining, automotive, aerospace, agriculture and defence to deliver selected charging concepts to create a standard product that can interface with all trucks," Gibbs Stewart said.

"We expect the challenge will stimulate innovative ideas, some of which could be immediately applied to existing diesel-electric equipment and help fast-track implementation of longer-term solutions. We understand that these challenges will not be solved overnight, but together we can find the best concepts that can be applied across the industry," BHP president of Minerals Australia Edgar Basto said.

Rio group executive safety, technical and projects Mark Davies said that the challenge was a global call-out to innovators to change the way haul truck systems operate in the mining sector.

"Innovation is the key to decarbonisation, and we expect the challenge will deliver exciting new concepts that could drive huge long-term benefits for our industry and the environment.

"Partnerships and collaborations across a diverse range of sectors can drive significant technological change. This is an important, industry-wide approach that has potential to create new jobs and opportunities for suppliers, both globally and locally."

Vale ferrous engineering director Carlos Mello said that mine electrification requires considerable integration between mine planning and operations.

"We need to develop new charging solutions that can be incorporated into our operations in parallel to the development of battery trucks, to ensure we create a truly sustainable electric haulage system in all aspects – clean, competitive and flexible."

The Challenge expression of interest process will open on May 18, and candidates who make the short list are expected to pitch their concepts later during this calendar year.

Volt moves on ZG Group buy

ASX-listed Volt Resources has pulled the trigger on the acquisition of a 70% interest in the Zavalievsky graphite business, in the Ukraine, following a positive due diligence.

The company recently inked share purchase agreements (SPAs) with the existing shareholders of ZG Group to acquire a 70% interest in each of the companies comprising the group, including Zavalievsky Graphite, Stone Found and Graphite Invest.

The ZG Group holds a 79% interest in 636 ha of land on which a graphite mine, processing plant and other facilities are located. The group currently has plans to install a processing plant and equipment to start producing spheronised purified graphite for the anode market within the next 12 months.

Under the SPAs, Volt would acquire the 70% interest in the ZG Group for an aggregate purchase price of $7.6-million, which will be payable in two installments of $3.8-million each, with the first payment due at the completion of the transaction and the second six months thereafter.

Volt told shareholders that the acquisition of a controlling interest in the ZG Group would immediately transform the company into one of the few ASX-listed graphite producers.

The acquisition holds a number of advantages, including its close proximity to Eastern European markets, plans to produce battery anode material by using existing graphite production to become a fully integrated supplier, ZG Group's range of graphite products and its high value 'green' purified 99.5% total graphitic carbon product.

Volt said that it was reviewing a number of debt proposals to fund the first $3.8-million installment of the purchase price, with is due on completion of the transaction, with the second installment due six months later.

Terex Trucks TA400s prove unstoppable in tough Russian mine

A fleet of 14 Terex Trucks TA400 articulated haulers is excelling in tough conditions at a gold-copper mine in eastern Russia, delivering effective and cost-efficient production.

Surrounded by picturesque countryside and soft hills, the Malmyzh mine in the far-east of Russia seems an idyllic place. But this first impression can be deceptive: operating conditions at the gold-copper mine can be tough. The ground contains lots of clay and the soil in the mine can get very heavy, dense and sticky, especially in spring and autumn when rain is pouring down.

In these conditions, having the right equipment is key. That's why Russian mining contractor Sovremenniye Gorniye Tekhnologii (SGT) selected 14 Terex Trucks TA400 articulated haulers for the opencast operation in the Malmyzh mine. Since June last year, the trucks have been delivering heavy-duty, efficient performance, working around the clock in two 12-hour shifts every day.

Terex Trucks has designed its TA400 for the toughest jobsites. Delivering great manoeuvrability and traction, the hauler gets the job done efficiently, even in slippery or muddy conditions. As the hauler's modulating transmission retarder is coupled with an efficient exhaust break and fully enclosed oil-cooled multidisc brakes, operators benefit from optimum control and increased safety. The TA400 hauler's fully adaptable drivetrain is designed to maintain traction and speed on the toughest terrains, delivering outstanding productivity at all times.

"Given the rough terrain in the mine, articulated haulers are the only machines that can deal with these conditions," says Vyacheslav Zyryanov, General Director at SGT. "Our operators love working with the TA400 because it can handle any clay and dirt, even if it's very deep. Still, driving these big machines is always smooth and easy."

Comfort behind the wheel

Located in Khabarovsk Krai in the far-east of Russia, Malmyzh is one of the largest copper-gold projects in the world. Discovered in 2006, the deposit's commercial reserves are estimated at 5.156 million tons of copper and 278 tons of gold. Currently, a modern mining and processing plant is being built at the site, which will process up to 35 million tons of ore per year.

Adverse weather conditions make operating in the mine challenging at times: in winter, the temperature can drop to up to -25°C, whereas the summers are usually very hot with temperatures climbing to 30°C or higher. The TA400's spacious cab protects operators in the mine from any weather: its sealing elements have installed pressurised properties, which helps keep the in-cab temperature stable and minimizes particle ingress. The high performance and easily adjusted heating, ventilation, and air conditioning (HVAC) system ensures a stable temperature. Acoustic insulation helps to minimize noise levels inside the cab and its ergonomic design ensures operators are comfortable when behind the wheel.

Cost-efficient production

With a maximum payload of 38 tonnes (41.9 tons), the TA400 is the biggest articulated hauler Terex Trucks manufactures. This durable machine boasts a heaped capacity of 23.0 m^3 (30.3 yd^3) and is powered by a fuel-efficient Scania DC13 engine that develops gross power of 331 kW (444 hp) and a maximum torque of 2,255 Nm (1,663 lbf ft). The TA400 is designed to keep service time and costs to a minimum: its Allison HD4560 transmission boasts high performance oil and up to 6,000 hours between service intervals.

"We're operating in a tough business environment, so cost-effective production is crucial for us," says Vyacheslav. "That's the reason why we've been working with Terex Trucks haulers for the last ten years. For us, these machines have the lowest cost of ownership and operation and we know we can rely on their efficient performance."

Sovremenniye Gorniye Tekhnologii is one of the biggest mining contractors in Russia and the Commonwealth of Independent States (CIS). The company carries out a wide range of mining works including drilling, exploding, excavation, transportation and processing. Starting out in a couple of mines in 2009, SGT handles jobs in all types of mines across Russia and CIS today.

Dedicated support

Another benefit of the TA400 is that the machines are easy to service – the axle, gears and engine are all easy to access, so service and maintenance work is straightforward, without needing special diagnostic equipment. In Russia, Terex Trucks dealer Mining Eurasia offers dedicated on-site maintenance and support services.

"We've been working with Mining Eurasia since we purchased our first Terex Truck hauler," adds Vyacheslav. "If anything needs to be fixed, the team reacts immediately. It doesn't matter if they can handle it themselves or need support from the team in Motherwell, Scotland – any issue always gets resolved on time."

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Worldwide famous diamond manufacturer ALROSA relies on ABEL and orders six piston diaphragm pumps for filter press feeding

In spring 2021, ABEL received an order from the Russian company ALROSA for the delivery of six Piston Diaphragm Pumps (Type HM). ALROSA is one of the most famous diamond producers worldwide. The company is active in the exploration, mining, processing and distribution of rough diamonds.

ALROSA's share in diamond mining in Russia is 97%. Worldwide, the Russian company has a share of 27% in diamond mining.

The delivery of the six HM pumps is a follow-up order for the German pump manufacturer. This project is being implemented with the participation of the official distributor of Abel in Russia - the company SibComplectService.

The ABEL pumps will be used by the customer for filter press feeding. The first HM pump was already delivered to ALROSA in February 2020 as replacement for a centrifugal pump that was previously used for filter press feeding.

At the beginning of August 2020, the ABEL pump was commissioned at the Russian diamond producer's plant. The dewatering result (higher solids content, shorter filtration time) was so convincing that ALROSA decided to feed all filter presses in this plant with ABEL HM pumps.

The HM pumps are available as single- or double-acting versions. They impress with their high flow rate, reliable function and particularly low operating and maintenance costs.

In addition to filter press feeding, the hydraulic diaphragm pumps are also used for sludge transport, spray dryer feeding, rotary kiln feeding, autoclave feeding, and sealing/rinsing water supply, among other applications.

The ABEL HM pumps have proven successfully in their use worldwide.

www.abelpumps.com

Australian-first solution to electric mining

Western Australian mining services provider Murray Engineering has unveiled its new light electric vehicle (eLV) at the Austmine 2021 Conference, in partnership with Siemens.

After announcing the partnership last November, Murray and Siemens, a German multinational technology company, developed the eLV to not only reduce carbon emissions in mining, but to protect the health of workers who would otherwise be exposed to diesel fumes.

The eLV was unveiled at Austmine 2021 in Perth

In November, Siemens chief executive officer Jeff Connolly said the trial would be a first for the Australian mining industry.

"This partnership will continue our trajectory of bringing the best in the world to the region and helping provide safer, quicker, more cost effective and sustainable solutions," Connolly said.

"The partnership with Murray Engineering helps address a future need by trialling something that has never been done in one of Australia's most critical industries."

Siemens also provided its Sicharge UC high-power DC chargers which provide a flexible output range from 125-600 kilowatt, with five frontends on each station as well as pantograph charging.

The charging station was on display at Austmine, where Murray Engineering innovation and technology manager Max Ong displayed it to more than 1000 conference visitors.

In November, Ong said the technology would fill a great hole in the mining industry.

"Existing battery and charging solutions have fallen short of miners' expectations where it matters most," Ong said.

"Many existing electric vehicles designed for mining are matched to their own specific charging station, making the solution inefficient and expensive in the long run."

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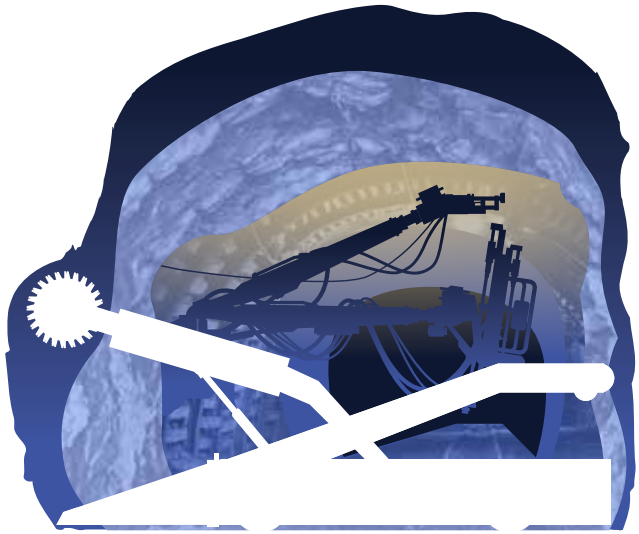


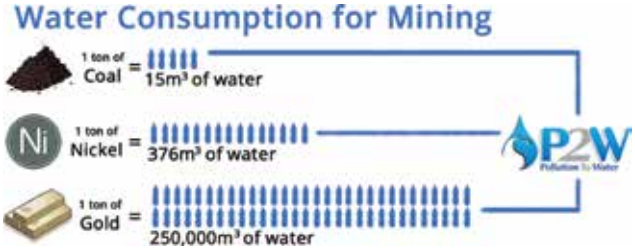
Water is an asset, not a liability

Water is a crucial input for any production system, and mining is no exception. A huge amount of water is being used in the various phases of mining activities. In the coming decades, the competition in using a sufficient amount of fresh water will become a major hurdle for the mining industry.

Most people in the world realise that access to water is a human right and mining companies are now implementing strategies that hopefully will lead them to being environmentally sound and with no reputational damage based on perceived misuse of resources. The worlds mining industry is well aligned to the global pursuit of sustainable development. A commitment to leading practice sustainable development is critical for a mining company to gain and maintain its "social licence to operate" in the community. Water management is a very broad topic. Many practitioners are most familiar with the technical aspects of water management including pumps, pipes, storages, and slurries. However, it is important not to overlook the social and environmental issues which effect water management. Water must be managed at all stages of the life cycle of mining operations. The design and performance of the water management system at any given operation will be a function of the corporate, legislative, climatic, and local community environments in which they operate. Water management will only improve with the personal leadership and specific mandate of executive management and the proactive commitment of those directly responsible for managing water at the operation which is usually the site manager and his team.

As commodity demand continues to increase more than half of mining investment over the next decade will be in high to extreme water-scarce areas as water consumption continues to increase at 5%+ annually. Mining is a capital-intensive operation and thus the need to manage cost is vital, but increasingly the emphasis has extended to environmental concerns as well. Not only do mines need to operate under increasingly tight budgets, but they also need to be environmentally sound; sustainability is a key buzzword in the sector for more reasons than one. One way to ensure efficiency and long-term cost reduction is by implementing an effective water management strategy on-site. Water management, however, is routinely listed as one of the top global challenges facing mine development, production, and even closure. Successful mine water management can mean the difference between operating at a profit or loss – it is hard to get right.

It is therefore understandable that water in mining is a key concern for operators. As well as driving cost saving and efficiency, mine water management is also important considering emerging trends within the sector. Consider for example, as already mentioned that future mining investments will be located in geographical locations where water is scarce (water stressed areas). Furthermore, a decline in grade will increase the intensity of mineral processes and therefore increase the use of the water. Couple these factors with increased sustainability and regulations regarding the control and monitoring of water during the entire mine life cycle and it becomes clear that mining corporations need to sit up and listen when it comes to water management. In general water usage and the mining of minerals can be quantified as shown in the simple diagram



The water cycle in mining is complex, and needs to align with the entire mine life cycle. To create a successful water strategy, mining firms need to combine procedures and best practices with software and technology to enable successful management. Top level support and leadership is key to leading practice water management.

ENVIRONMENTAL MANAGEMENT STRATEGIES

Climate change is an issue that is now accepted as the responsibility of all worldwide. Water is connected with climate change due to alterations to amounts of rainfall, their timing and intensity, and the possible increases in evaporation. In many environments, leading mining operations are reconsidering their water system design specifications in light of potential changes. Climate change is definitely affecting the degree of uncertainty on hydrological and general operating conditions at all operations worldwide.

In recent decades there has been a greater emphasis put on the environment, resulting in more stringent regulations worldwide, which has in turn sparked a response from the international mining industry. “Environmentally responsible practices, especially relating to water, have become central to the viability and acceptance of a modern mining operation. For example, if other stakeholders believe a mine is using too much water, or polluting the water, it can lead to social conflict and discontent.

Major mining companies around the world are implementing water strategy key components that may include:

A comprehensive risk management approach.

A regional water management approach .

A focus on reducing, reusing, and recycling the water the operations need.

Investment in innovation to support long-term ambitions.

There remains a lot of consultant engineering companies offering water management expertise and, in this issue, MQW takes a look at how one of the leaders in worldwide water management expertise SRK shares one of its experiences from India.

MANAGING SURFACE WATER IN OPEN PIT MINES: AN EXPERIENCE FROM INDIA

Open pit mines often experience significant surface water inflow that adversely impacts the production profile. SRK India was recently engaged by a leading mining entity that experiences significant volumes of surface water inflow to its operating pits. The problem is further complicated by poor surface water disposal system that possibly promotes recycling of disposed water to the operating pits.

Considering the inadequacy of surface water management system, SRK explored the opportunities to (1) prevent surface water inflow to the operating pits, (2) to dispose pumped out water away from the pit and (3) to distribute additional water to nearby communities for agricultural purposes.

Unmanned Aerial Vehicle (UAV) were flown around the operating pits to collect photogrammetry, land use-land cover and topography data. Following this, a catchment rainfall-runoff model was developed to assess surface water flow pathways and likely runoff volumes using the SCS Curve Number and Weighted Runoff-coefficient methods. Different duration of extreme rainfall event and suitable return periods were considered based on the IDF graphs developed. This helped to quantify the likely volume of surface water inflow towards the pits and the probable pathways that may be used to divert water away from the operating pits. SRK undertook multiple walk over surveys to validate such derivations.

Utilising such site-specific knowledge, SRK developed the following:

1. A mine dewatering system including advisory on optimal pumping requirement, pumping arrangement and reticulation requirements.

2. Surface water diversion structures to prevent inflow to the operating pits. These structures were designed to carry intercepted runoff and pumped out water from the pit sumps. Engineering designs were developed using Manning’s formulation that helped to empirically compute velocity of flow in the channels and estimate normal depths in a uniform channel. The free board and side slope of the drains were designed following Indian and international guidelines. Peak flows were used to assess dimensions of each drain stretch. Fine adjustments in alignment were undertaken to minimize earthworks.

3. A water diversion plan to combine surface water flows to a treatment plant and finally to divert the treated water to designed disposal ponds. Ponded water is planned to meet the agricultural requirement of the nearby communities. This in turn will reduce the dependency on groundwater.

4. In addition, SRK also proposed a plan for integrated monitoring and database management using a Real Time Data Acquisition System (RTDAS) that will be useful in effective data recording, data sharing, visualisation, and sustainability. This will definitely help to reduce problems associated with inundation to the operating pits.

Sujit Roy is SRKs Principal Engineering Geologist Kolkata, India

Rockbreakers reach new levels

Rockbreakers are typically used in the mining and quarrying industry to remove oversize rocks that are too large or too hard to be reduced in size by a crusher. Rockbreakers consist of two major components, a hydraulic hammer (used to break rocks) and a boom (the arm). There are two major types of rock breakers, mobile and stationary – typically placed on a pedestal or slew frame.

In 2008, researchers from the CSIRO in Australia implemented remote-operation functionality for a Transmin rockbreaker located at Rio Tinto's West Angelas iron ore mine from Perth, over 1000 km away. Also in 2011, Transmin developed the first commercially available automation system for pedestal rockbreakers. The system was first installed at Newcrest's Ridgeway Deeps gold mine providing collision avoidance and remote operation functionality.

Removing personnel from hazardous environments has always been at the forefront of mining companies strategies and Rockbreaking operations are hazardous and demanding on operators. Tranmin have delivered the answer with the development of its RockLogic system.

RockLogic remote operation removes the operator from the immediate vicinity of the rockbreaker to a remote location. This eliminates hazards to the operator, reduces travel time to and from site. RockLogic also provides a bypass mode allowing fall-back for maintenance operations. Remote operations could be as far away as a remote operation centre located thousands of kilometres away, or as close as an operation centre at site, or a combination of both including radio controller for site use. Why send the operators to the controls, when you can take the controls to the operators, Personnel can operate up to 4 controllers from the single desk using our slimline controller (based on one at a time) for sites with more than one rockbreaker. With the added “audio kit” the controller can support a headset giving the operator full audio feedback enhancing rockbreaking efficiency.

Transmin has been supplying rockbreakers and other services to the mining industry for over 30 years .

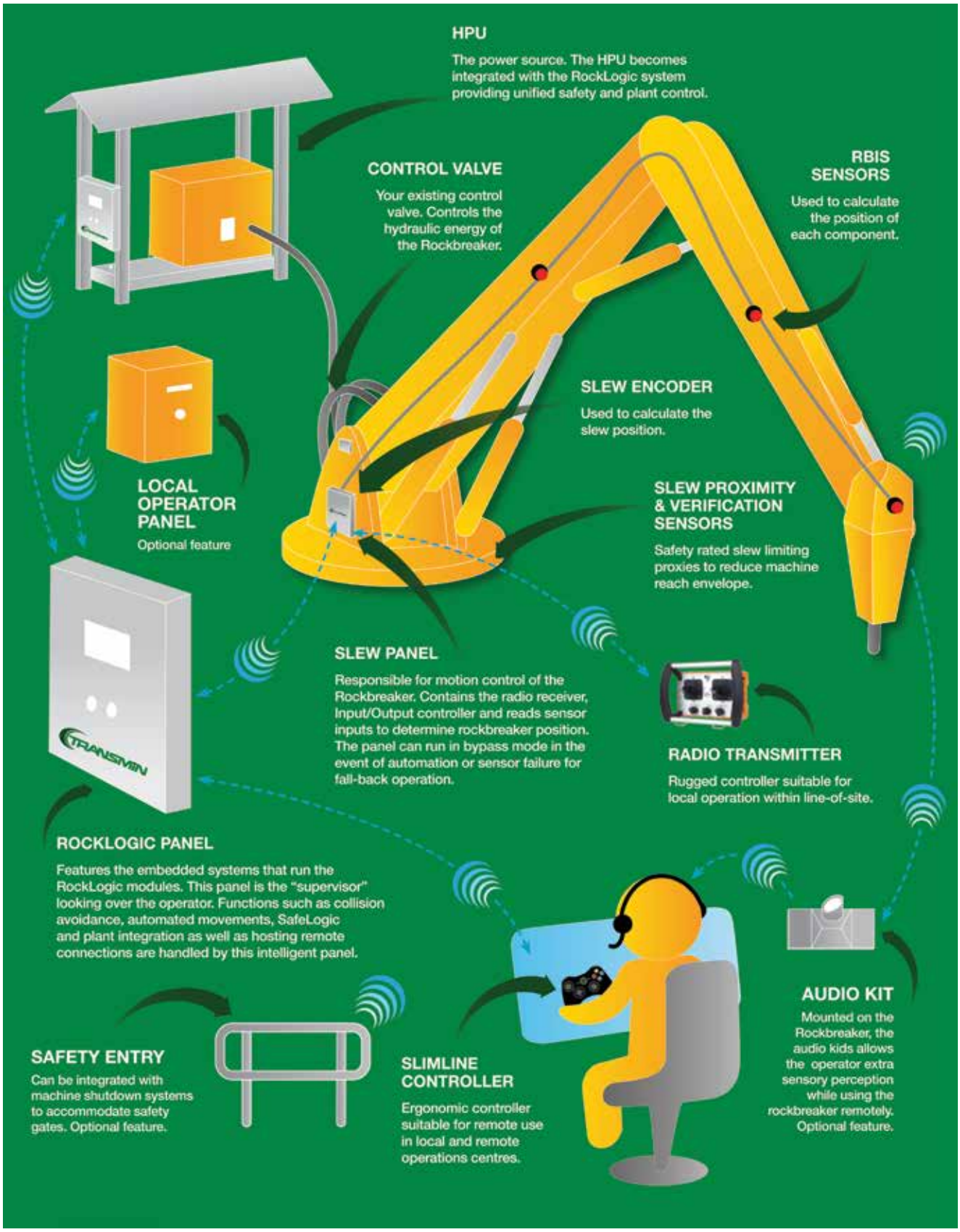
SO, WHAT IS ROCKLOGIC ?

RockLogic intelligent rockbreaker control system maximises the speed, safety, and efficiency of rockbreaking. In turn, it significantly increases plant productivity, whilst reducing

downtime and maintenance costs via the systems' advanced suite of control modules.

Together these modules make up the RockLogic Core package The Core package includes all of the hardware and engineering required to enable remote rockbreaker operation, whilst providing an upgrade path for advanced feature modules.

RockLogic has evolved over recent years to include features such as robust inertial position sensors (RBIS System) to replace the first generation electromechanical 'in cylinder' transducers for the award winning RockLogic Controls Technology; water cannon cleaning attachments; positive pressure systems to keep dust out of the internals and multiple quick hitch options for attachments such as grapples.



RockLogic™ Core Technology features the following benefits:

– Improve safety and productivity with Remote Operation. Reduce personnel fatigue and heat stress. Remove personnel from flyrock, dust, noise, and vibration hazards.

– Control multiple rock breakers from one centralised Remote Operation. For high output mines, multiple rock breakers at different crushing stations can be controlled efficiently from one control centre, improving staff utilisation.

– Improve rock breaker efficiency with Automated Movements. Go to park and deploy positions with the press of a button, minimising crushing delays.

Eliminate site damage with Collision Avoidance. Prevent unnecessary downtime by eliminating damage to rock breaker and surrounding plant equipment with customised collision avoidance software.

Increase throughput via improved communication between equipment with Plant & Process Integration. Signals to and from vehicles and plant equipment automatically retract the rock breaker for continuous crushing operation.

Reduce the rock breaker operating costs with Preventative Maintenance. Smoother rock breaker movements, data logging and collision avoidance minimises component wear and dramatically reduces on-site maintenance costs.

Integrate your safety procedures with SafeLogic. A tailored programmable Safety System with accommodation for isolation gates and E-Stop.

HOW DOES ROCKLOGIC™ WORK?

Robust inertial position sensors (RBIS Sensors) are used to calculate the position of each component.

- Improve safety by eliminating hazards.
- Improve production capacity/throughput.
- Increase rockbreaking efficiency.
- Improve staff utilisation and reduce reliance on fifo.
- Reduce downtime and maintenance costs.
- Achieve total integration with site operations
- Remove operators from the hazardous environment of site and placed into a safe office environment.
- Enhance situational awareness during remote operation with Human Machine Interface (HMI)
- Utilises Transmin's Remote Operation Centre slimline controller.

BESPOKE SIZING SOLUTIONS

MMD remains at the forefront of Sizer technology, developing tailored mobile and semi mobile sizing solutions for many types of applications from large open pit mines to small quarries.

The Twin Shaft MINERAL SIZER™, which sits at the heart of every system, is a high capacity, versatile and compact machine suited to mobile and semi-mobile systems. The Sizer's consistent product and minimal fines generation, together with the versatility to process any combination of wet sticky material and hard dry rock, has been a successful formula for over 3,000 installations worldwide.

MMD's global structure, technical expertise and service excellence will ensure your system always delivers optimum performance. Discover how we can deliver the complete portable sizing solution for your specific needs.

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Green Mining Solutions
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Mobile crushing and conveying in quarries – a chance for better and cheaper production

Nowadays cost reduction in every part of a production plant is a major key to surviving in global as well as in regional markets, the now established. IPCC systems in use at major open cut mining operations worldwide have earnt the reputation of cutting costs albeit if the mine plan lends itself to the implementation of the system and can reduce costs over the mines. life cycle. Some mines may not be suitable to adapt from the traditional truck and shovel method for many reasons, the main bone of contention being the initial cost of the IPCC and the forever changing costs of fuel. Careful considerations have to be made from the onset of mining; this is also no different for the quarrying industry which after all amounts to a surface mine operation. Therefore, for quarries it is also necessary to also review where money can be saved in order to increase profits and face challenging market prices. MQW presents this paper which in this context, considerations regard ing applications, case studies and the economic effects of fully mobile crushing and conveying systems are made.

INTRODUCTION

The major operation in quarries, up to and including primary crushing, can be split into drilling, blasting, loading, hauling and finally the primary crushing itself. Within these operations the blasted material is usually transported by dump trucks to the primary crushing stations, which traditionally are stationary plants. Looking back, it has become obvious that often companies have set up the plants at a more or less good starting position not thinking about the further development in the future. In a lot of cases the pit extended itself far away from the preparation plants and more and more haulage needs to be done. This is one of the most important points to be mentioned, because depending on the haulage distance and operational cost structures within the quarry, only the haulage costs themselves represent 30% to 60% of the whole operational costs. Therefore, in countries with high fuel prices the most interested companies for mobile technology can be found.

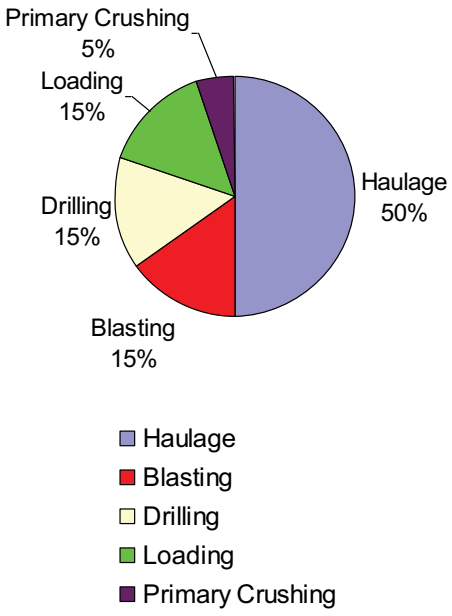

Figure 1: Cost structure for hard rock mining.

In order to lower the haulage costs, there are two ways to achieve this aim. The first solution is to buy bigger dump trucks and the second might be to implement conveyor belts. If you decide for the first solution you have to check if your excavation systems, haul roads, your feed hopper and, if the feed hopper is housed, if the housing fits to the bigger dump trucks. The benefit of this decision is quite simple. You can produce the same mass of raw materials with fewer employees, or on the other hand increase the production. If you decide for the second possibility then you have chosen lower operating costs for transportation and in addition to this, in pit crushing as well. In pit crushing is in fact linked to the conveying system because the blasted material, concerning block size, cannot be conveyed without preparation. The key to cost reduction is an in pit crushing system (IPCS), a combination of track mounted mobile crusher, with mobile and fixed conveyor belts. In the following the authors will just refer to the IPCS, due to the fact that this is the only continuous solution known for quarries. These solutions can work as well in other fields of application, e.g., civil engineering, recycling, tunnelling and many more.

APPLICATION

Quarry and Pit Design

One major restriction using the IPCS is the pit design, which looks like a cut in the surface. This means exceedingly small and narrow high walls in combination with more than 3 mining levels, which cannot operate at the same time. These are exceedingly difficult to handle, even if the mines are planned for IPCS. It might not be the best solution in any case, if you need to move all of the equipment around the pit in order to mine another level, but there are other viable solutions.

Compared to the restrictions, the fields of possible IPCS application are huge. One great advantage is the lower stripping ratio. Normal, main haul roads need to be a minimum width of the dump trucks. In addition to this they must be “shallow” with a maximum in- or decline of about 10%. As a result, the whole pit must be wider at the surface, in order to provide the trucks, the safety required to navigate down to the working site. Belt conveyors need fewer broad roads and therefore allow for steeper pit wall angels and are then furthermore able to offer lower stripping ratios. Lower stripping ratios mean that less money has to be spent on min ing overburden or waste material and transporting it around. This saves the capital of the investors at an early stage a mining operation and raises the mine profits. Furthermore, the minimization of the mine footprint will help to accelerate administrative decisions, or, in the worst case, it is the only possibility to get the required permission.

Mine Planning

The mine planner has to consider at the initial stages, the impacts of the preferred loading method, the needs of selective mining and the number of benches that have to be worked. Another important point is the influence of haulage. For example, dump truck operations need a ramp network. But the decisive and most challenging part in mining operations is to fit the mine plan to the restrictions of the mobile conveying system. The conveying system is less flexible but also has to serve the whole mine.

According to drilling and blasting you need to consider the maximum rock size that the mobile crusher will be fed with. Furthermore, you need to take a closer look on the allowed and required safety distance while blasting. Concerning the loading and crushing equipment, q.v. the next chapter, the loader/ crusher type and size need to be considered very carefully. These are basically the same considerations that need to be done if the equipment would be selected for normal/stationary operations. As mentioned previously, the new form of mine planning, in regard to IPCS is the most challenging part, while an existing pit is reorganized, or a new pit is set up.

Dump trucks offer one greatly significant benefit, their flexibility. They are able to haul material from any part of the quarry at any time to another location within the pit. In addition to this the breakdown of one dump truck will not affect the overall production too much, because normally there are still more trucks in the fleet, which can keep up production.

IPCS can work at its best, when the need to relocate, the system is reduced to an absolute minimum. This means that the mobile crusher and the linked conveying system should not be moved more often than necessary. This demand can only be satisfied if the whole operation is changed into long term planning. Furthermore, IPCS in general favors a more horizontally advancing excavation. In an optimum case you do not need to mine selectively, with more than two levels and operate on wide benches which are more than 100m wide. More complicated designs are deposits or quality restrictions where selective mining or multi-bench operations are required and furthermore the benches are narrow. But even those problems can be handled. If selective mining is required and you often have to change the production benches then, if you just take one IPCS it needs to be carefully considered because relocation on the same bench of about 0.5 km takes approximately half an hour. Relocation between two or more levels will take two hours, ore even more, depending on the distance that has to be moved. A better way to face the selective mining demands is to use multiple units of IPCS. On every bench the mobile crusher is linked to a moveable and extendable

Figure 2: Multi bench operation.

field conveyor by mobile conveyors. The material flows from the crusher onto the mobile conveyor and then onto the field conveyor. The field conveyor discharges onto an uphill or downhill conveyor, which is placed along the established high wall. If the field conveyor discharges onto a downhill conveyor it should be premeditated if energy from the belt drive could be gained. As shown in figure 2 the blending of the raw crushed material could be done with stock-piles. This is possible, if the different rock/ ore qualities are available at different parts of the working face or different levels. The different qualities can be assigned to different stockpiles at the end of the quarry conveyor belt chain. By extraction in special ratios the needed quality can be produced. Therefore, selective mining needs are not critical criteria for IPCS.

Mobile Crushing

Loading and Mobility

The most effective way to load a mobile crushing unit can be chosen according to the site conditions, and local preferences. Due to the site mobility the mobile crusher is ideally suited for being loaded by a hydraulic excavator in backhoe operation. In the typical application of the excavator, the operator is able to control the crusher with a remote radio device from his cabin. The operator of the excavator is able to perform a relocation of excavator and IPCS during production normally in less than 5 minutes. Another advantage of this type of operation is that the operator is based on a higher level than the feed hopper. Therefore, he can control feed size and separate oversized material with the bucket. In addition, the operator, while digging, is able to check if the correct material level is reached in the crusher and bed height on the grizzly bars is sufficient. These major advantages, in contrast to other operations, lead to the point that by using a backhoe operation the correct feed rate can be maintained during the production and therefore ensure higher productivity.

The robust construction of mobile crusher also allows for the use of conventional loading machines e.g., wheel loaders. In applications where the mobile crusher is relocated frequently and the wheel loader is chosen for loading, building an access ramp to the feed hoper is time consuming and expensive in the long run. A better way to solve this problem of building ramps and “not visible” feed hopper for the wheel loader operator is a mobile apron feeder. With this piece of equipment, loading can be done directly from ground level and furthermore the driver can clearly see if the feed **Figure 2**. Multi bench operation hopper is over-loaded or not. This technique is used when short cycle times are necessary, and the blasted material is fine and homogeneous. The moving interval of this application lies in reference to the demands within 1-5 days.

Even loading methods, which are using a dump truck or excavator with face shovel, are not excluded from feeding a mobile crusher. The face shovel is not the dedicated excavator for feeding the mobile crusher, because most of the time the operator is not able to look into feed hopper. As a consequence, experienced operators, who take care of their work, are highly recommended. Another aspect of using face shovel excavators is that the machine itself is normally a bit oversized for the mobile crusher. This is because the loading cycles would otherwise be too long. If an excavator is used, which is just able to match the requirements of height and distance at highest extended point, the boom of the excavator has to always make an awfully long swing from the bottom to the top of the feed hopper.

Table 1 will give a short summary of the loading tools in relation to the mobile crushing unit.

As an alternative to self-propelled crushers, semi mobile units can also be used in pit crushing. These units are suitable in fields of application when the relocation interval varies from 0.5-2 years. In semi mobile applications the crushing unit is loaded with dump trucks. The dump trucks perform the short distance haulage, which enables selective mining. The long-distance haulage is after

Table 1: Loading Tools

	Backhoe Excavator	Face Shovel	Wheel Loader
Control of oversize	very good	good	mediocre
Feed consistency	very good	very good	mediocre
Size vs Capacity	size is selected according to the capacity requirement	oversize machine is needed to be able to reach the feed hopper	size is selected according to the capacity and the distance
Digability	very good	very good	good
Move interval	2-4 hrs	2-4 hrs	1-2 weeks
Reach	5- 10m	5-10m	50- 100m
General comment	in normal blast provides the los costs per tonne	can be considered with fine blast whre beigger capacity justifies machine	provides the possibiliy to mix feed from different parts of the face

primary crushing and is done with conveyor belts. That constellation reduces the haulage costs very efficiently. The relocation of the semi-mobile unit is assisted by a special carrier unit. The carrier unit is driven under the semi mobile crushing unit and lifts it up by help of hydraulic cylinders and carries it to the new location. Larger quarries or mines, which need several semi mobile crushing stations in different parts of the pit can use one carrier to move all units and fulfil the capacity requirements. A fully mobile crusher can also be converted into a semi mobile unit by using a skid mounted feed hopper. This feed hopper is exceptionally large, so that dump trucks can unload the raw material directly.

Equipment and Performance

Basically, there are three different types of primary crushing units to choose from. Mobile crushers are manufactured and delivered as jaw-, impact or gyratory crusher. The gyratory crusher at first was implemented for secondary crushing but will be soon available for primary crushing too. De pending on the pit demands the engine can be diesel powered and reach up to 645 KW or can also be electric powered. The travel speed of the track gear is approximately 1 km/h and the mobile crushing units are able to incline 20° or 35%. The through-put for jaw crushers can range up to 1800 Mg/h de pending on the feed material. The weight of mobile crushers varies from about 60 Mg to more than 200 Mg. Normally jaw crushers are equipped with a vibrating feeder, a bypass to keep small fractions away from the crushing process, the crusher itself, and a main conveyor. Depending on the manufacturer and the individual needs more equipment can be ordered. For example, screens to be placed in the bypass can be bought to scalp out waste material at an early stage of the process. Unnecessary haulage into further processes is thereby avoided. Using screens in the bypass only makes sense if there is a second discharge conveyor installed. In addition to this linking adapter for the mobile conveying system, money could be spent for such things as: dust encapsulating, magnetic separator, hydraulic hammer, driver cabin, several supporting stands, if needed. According to the needs of a mobile conveying system an electric generator must be bought too, because power supplied to the conveyor belts are normally comes from the mobile crusher units.

Mobil Conveying

One way to reduce the explosion of haulage costs is to use conveyor belts. The special need of a quarry operation, with a high frequency of relocating the mobile crusher, requires a mobile and flexible conveying system combined with a fixed conveying system. The mobile conveyors are assigned to haul the crushed material to the fixed system and equalize elongation between those two systems. These tracked mobile conveyors work over shorter distances than stationary ones, because they have to work as a flexible link between the track-mounted mobile crusher and the field conveying system.

The combination of mobile and fixed conveying can save up to 2/3 of the existing haulage costs. The use of dump trucks is in fact often very inefficient. Some of the largest dump trucks use over 50% of the energy to move themselves in spite of hauling blasted material. To make this clearer, a dump truck is empty for half of the operational cycle. A conveyor is also empty half of the time, but it is not hard to guess which one consumes more energy. In addition to this, the haulage distance limits the transport ratio of a dump truck. The further you need to transport the material, the less efficient it is to use a dump truck. The next figure shows a general overview of dump truck haulage capacity regarding the haulage distance.

Contrary to the reduction of the haulage capacity of dump trucks, the transport distance does not affect the capacity of conveyor belts. The capacity of conveyor

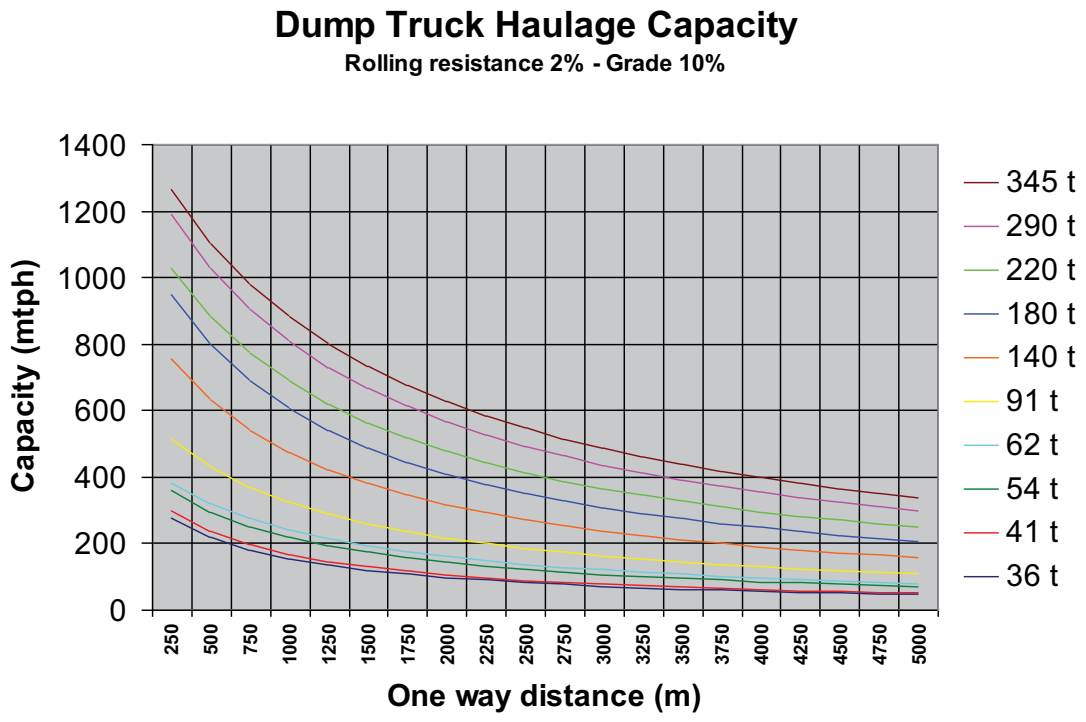

Figure 3: Dump truck haulage capacity.

belts is limited by the belt drive speed, belt width and form. As shown belt drives are much more economical than dump trucks and they are not limited by haulage distance. In opencast mines lengths of more than 30 km are not uncommon. The belt width of mobile conveyors varies up to 1600 mm and a maximum particle size of 1/3 of the belt width is suggested. Depending on the feed material and the mobile crushing unit haulage of 2000 Mg/h can be performed.

The transfer from the mobile crusher to the mobile conveyor belt is done with a direct linked system. The mobile conveying system is able to discharge onto the stationary field conveyor by a discharge hopper on rails or on a skid. The hopper is mostly equipped with a conical adapter for easier positioning and a vibrating feeder to protect the belt. The radial wheel set of the mobile belt, always mounted between two belts, is steered hydraulically by a remote device. The maximum number of mobile conveyor belts, which are linked to a mobile crushing unit and which can be controlled by a single operator is three. Moreover, there are conveying solutions with self-propelled-, track mounted transfer conveyors, stackers and truck loading hoppers available for each special demand.

Cost Savings

Belt conveyors save a lot of money in comparison to dump truck haulage. Belt conveyors are much cheaper to maintain because they contain far fewer parts and they also don't use as many spare parts, e.g., tires, as dump trucks. In addition, the excavator can be downsized to fit the capacity which is needed for the crusher. Usually, the amount of haulage affects the required size of dump trucks and the design of the truck itself directly influences the choice of the excavator. By using IPCS the excavator only needs to match the demands of the mobile crusher processing potential. As explained previously, the best way to feed the mobile crusher is an excavator in backhoe operation. Therefore, it is obvious that a smaller excavator in combination with IPCS can be as productive as an excavator with linked dump truck haulage. If the haulage is done by a conveying system, which is controlled by the excavator operator, there is no longer a demand for dump trucks and operators for them. Therefore, labor costs could be saved, and the quarry roads don't need to be built elaborately and kept well maintained, which could be expensive in the long term. In different internal studies it has been proved that the haulage energy costs could be 50% to 70% lower in comparison with dump truck transport.

Table 2: Comparison between Dump Truck and Conveyor

	Dump Truck	Belt Conveyor
Gradeability	10%	30%
Payload %	50 to 60	90 to 95
No of Operators	1	0
Power Draw	0.5-1.0 kW/ Mg*km	0.1-0.15 kW/ Mg*km
Cost/Mg	0.30-0.5 $/Mg*km	0.10-0.15$/Mg*km
Max particle size	no practical limit	30% con. width

Cost saving with IPCS in removing overburden or waste material is not excluded.

Further Advantages

Besides the cost savings, there are still other advantages of an IPCS that should be mentioned. By the use of conveyor haulage, the impact to the environment is also significantly reduced. The elimination of dump trucks reduces noise and emissions of exhaust gas. Moreover, fast driving dump trucks are always a risk for operators and the technical surrounding. Studies indicate that vehicle movement is one of the most dangerous operations in quarries. In 1997 almost 38% of all US mines and quarry fatalities were caused by powered haulage. Besides increased safety, less traffic also means that less dust is produced. Therefore, the watering of haul roads can also be reduced. As an example, a Texas based mining operator reports that his new 2-mile-long conveyor eliminates more than 140.000 cycles, which means 570.000 vehicle miles on an annual basis are no longer needed. As a matter of fact, this does not only reduce fuel consumption and labour costs but also reduces estimated production of PM- 10 emissions by mobile haulage from 95 kg/d to 3 kg /d. Under special conditions regarding dust emissions the whole conveying chain could be equipped with dust encapsulation. Furthermore, IPCS offers high resale values if mining activities are stopped at a site. Normally only some parts of a former primary stationary crushing plant can be sold and moved, e.g., crusher and feeder. But the concrete will remain, and the steel has only scrap value. By using IPCS everything could be moved easily to another mine or operation, because there is a growing world market for second hand mobile crushers. Even if mine prospecting went wrong and the primary crusher is set up on the best part of the deposit, there would be no need to worry, if an IPCS was chosen. A fast, easy, and cheap relocation will grant access to this part too.

Case Studies

Cost Comparison Example

In **Table 3**, a cost comparison example between Metso Minerals Lokotrack & Lokolink (LT) and a dump truck (DT) system are presented.

In addition to the data above the LT system requires a crane to do the maintenance for some hours per year and

Table 3: Key data cost comparison

	LT System	DT System
Annual Production	1.4 Mio. Mg/a	1.4 Mio. Mg/a
Excavator	4m^3	4m^3
Dump truck 55 Mg	0	3
Average crusher capacity	700 Mg/h	701 Mg/h
Field conveyor	1500 m	0 m
Mobil conveyor	LL 12	0
Annual working hours	2000	2000
Mine life	20 a	20 a
Interest rate	7%	7%
Depreciation time	5 a	5 a
Hourly wages + social	35 USD	35 USD
Fuel price	0.5 USD/1	0.5 USD/1
Electricity price	0.05 USD/kWh	0.05 USD/kWh

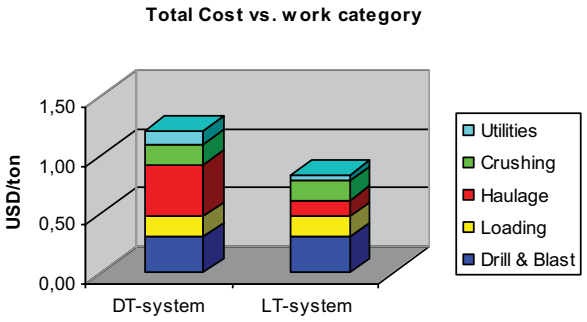

Figure 4: Cost comparison DT vs. LT system.

the DT system needs a grader for haul road maintenance. **Figure 4** shows a comparison between the total costs vs. work category.

As shown in **Figure 4** the main part in cost saving structures are the haulage and utility costs. The special costs of drilling & blasting, as well as the loading costs are not affected by changing the operation system. Even the crushing costs remain nearly the same. As a result, it could be stated, that the LT system, in this simple example, saves 0.37 USD/ Mg. To underline this fact 0.37 USD/ Mg means that approximately 525.000 USD/ a or 10.5 Mio. USD in 20 years could be saved, by changing the operating system. With the yearly rising fuel prices, it is not exaggerated that cost savings could very well be much bigger in future.

Case Study Canada

The quarry in question produces 1.2 Mio.Mg/ year, of very hard granite. The work index (BOND) is at maximum at 26.5 kWh/Mg and at the average is 14.5 kWh/ Mg. The abrasiveness of the granite is medium. Until 2001 a dump truck fleet and an old Nordberg stationary primary gyratory crusher were installed. The dump truck fleet was aging, and the gyratory crusher had high maintenance costs. In addition to this labor costs should be reduced, and the working safety should be improved. Beside these technical and economic problems, the company got more and more pressure by a suburban neighborhood to reduce noise and dust emissions. The main goal of the mine was to significantly save money in total operating costs and fulfil the other demands. Within this area of conflict, the only solu tion to be considered was to switch from discontinuous to continuous mining by using IPCS. The IPCS consists of:

- Excavator CAT 365L
- Primary crusher on tracks, Nordberg LT 140
- Moveable conveyor system, Nordberg LL 12
- 4 conveyors, approximately 55 m long and 1,2 m wide
- two operators

The IPCS had to replace the following existing technical equipment:

- 3x 50 Mg dump trucks International
- Wheel loader, Komatsu WA 700
- Primary gyratory crusher, Nordberg and Five operators

The indicative capital value of the new equipment, which the quarry needed to reduce cost rising, is shown in **Table 4**.

Table 4 shows that there is not a great difference regarding investment between dump truck operation and an IPCS.

The reorganization of the quarry reduced the costs from 870.000 USD per year to now 388.000 USD per year. This is a significant decrease of more than 50% in operating costs.

The excavator is equipped with a high cabin. This offers the opportunity to watch the feed hopper from an elevated point while operating, which makes the operation safer and steadies the material flow. In addition to the IPCS three stationary conveyors had to be installed. They transport the crushed material to a stockpile with a tunnel feeder, which is in turn feeding the stationary preparation plant. With further developments of the working face more conveyor sections will be added. Regarding the cost categories; maintenance, labour and energy incur the most saving.

Advanced Quarry Operation

Within the most advanced quarry operations transport between the crushing and screening stages could be eliminated completely, by installing a fully mobile crushing plant. These plants consist of different stages of crushing and screening, each on a mobile unit. With this constellation the end products can be directly sold from stockpiles inside the quarry. With the crushing and preparation units placed in the quarry, it also means that there are no visible buildings disturbing the environment. If the production routines should be changed in order to produce other products, the whole assembly could be easily reorganized and new processing could be started within some hours. This is a great advantage if the raw material qualities are changing from time to time and therefore the demands of products can not be fulfilled. A change in the processing chain can improve the end product qualities, even if bad raw materials are being fed. In regard to the quality restrictions of the end products; one, two or three step mobile preparation plants can be installed. Every reasonable combination of mobile crushing and mobile screening units can be combined. As an example, a three-step preparation plant is described. At first a mobile crusher should be used, whereas different crusher types could be chosen. The mobile crusher feeds a secondary crushing unit, in which a first screening and secondary crushing are carried out. This generates a first product and material to be further processed in a tertiary crushing unit. This unit is only used,

Table 4: Indicative Value of new Equipment

Before	Costs	Now	Costs
3 Dump Trucks	1.590.000	Excavator	750.000
Wheel Loader	900.000	Nordberg LT 140	1.240.000
Primary Gyratory	1.000.000	Nordberg LL 12	505.000
		Conveyors	800.000
	3.490.000		**3.295.000**

Figure 5: Quarry overview.

if there are high quality demands to be matched. After the tertiary unit the output material is fed onto a mobile screening unit, which defines the end product qualities.

The fully mobile preparation plant offers assets and drawbacks at the same time. One of he biggest advantages is that no housing for the preparation plants is needed. This might be the biggest disadvantage, because products for asphalt and concrete application require special moisture contents, which within a region with high precipitation cannot always be ensured. A wet stockpile can be an elimination criterion for the application of the stockpiled products. Therefore silos have to be built, which are not easy to feed with wheel loaders. As a matter of fact, wheel loaders are the most suitable machines for mobile plants. They are able to feed the crusher as well as load the products quickly onto trucks. Another necessity is that the products must be removed at several different points at the plant. The high mobility of the wheel loader makes it possible, that trucks are loaded, material is stockpiled, and the conveyors of the mobile units get not in touch with the discharged products. In total one excavator feeding the crusher, one wheel loader loading trucks, two operators and, depending on the quality demands, up to four mobile units can completely substitute a stationary preparation plant, within some defined restrictions.

CONCLUSION

The application of IPCS has gained wide popularity in aggregate operations. In mining applications, the reduction of operational costs plays a major role in today's mine planning. Adapting the IPCS to a mining operation provides considerable advantages. The reduction of Labour costs, Haulage costs, Fuel Consumption and Pollution (Dust and Noise), is mirrored by an increase of health and safety. Nowadays the application of IPCS is only avoided through special quarry design. And even for the most challenging conditions, such as a small and tiny working face, solutions may be found and considered. In several case solutions the manufacturers of IPCS have proved their competence and knowledge in planning and construction. In the future, an offer of higher productivity and lower costs per Mg product will more and more convincing to companies in order to change the operating system from dump truck to mobile crushing and conveying, or mobile plants.

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Work hard, play hard

The mining industry faces continuous challenges in terms of increased global competition, demand for productivity, skills shortages, loss of scarce technical skills, strikes and high turnover rates. Hence, the lack of engineering skills (technical and management skills) may seriously hamper the capacity of the mining industry to ensure that productivity and safety standards are maintained. Mining and Quarry World looks at one of the roles performed by Ulf Gyllander: Global Product Manager/ Tophammer Cab Machines who has been in and around the mining industry for many years, witnessing many changes in both the development of mining machinery and the skills needed to be successful in this great industry of ours.

Responding to today's skills shortages with short-term fixes is not enough. The more critical challenge is to address skills gaps in ways that contribute to long-term organizational success. Engineers ensure that new processes and technologies are introduced and that current businesses are optimized and utilised. This can only be done by innovative ideas to ensure a quantum leap in performance and competitiveness. Business leaders often report deficiencies in both hard and soft skills and shortages in four key areas:

- Basic skills (which include communications and basic business acumen skills).
- Technical and professionals' skills (technology skills).
- Management and leadership skills (covering areas such as supervision, team building, planning, decision making and ethical judgment).
- Emotional intelligence skills (such as self-awareness, self-discipline, persistence, and empathy).

Ulf Gyllander has a variety of working experiences, including time in the military, from 1991 onwards Ulf needed to utilise his experiences and concentrate his efforts to achieve a more stable position within a company.

Experiences gained in the earlier years would lead Ulf to take a position with a company called Atlas Copco where opportunities to develop and progress would be more prevalent.

Ulf Gyllander (when not working for Epiroc) also coaches ice hockey. His role as ice hockey coach is a combination of teacher, motivator, organizer and listener, in addition, there are many other responsibilities that a hockey coach will fulfil and can include: facilitator, demonstrator, evaluator, supporter, and planner. Somewhere… throughout Ulf's career, all these characteristics have been developed, but most importantly these characteristics are and have been transferrable.

In the case of coaching hockey, while strategy and tactical skills are required, there would be the added responsibility of teaching participants the fundamental skills and rules of the game; providing a fun and safe environment; developing character; teaching physical fitness; and having the ability to

Ulf Gyllander: Global Product Manager/ Tophammer Cab Machines.

communicate in a positive manner. Does all this sound familiar in terms of forging a career in the worldwide mining industry?

Ulf's passion for ice hockey resonates throughout his working life, when, Ulf is committed to something he see's it through with passion and vigour and I am convinced that Ulf sees every product development and release via Epiroc as a challenge in terms of maintaining worldwide interest for the company's products.

As a coach and mentor strategies and tactical awareness are always needed, no matter what industry or profession you are in. For any team to become successful they need to be developed, through this development every team member becomes a primary importance thus being able to advance in the competitive world of mining equipment and business.

MINING AND QUARRY WORLD INTERVIEW:
Ulf Gyllander: Global Product Manager/ Tophammer Cab Machines/Epiroc

MQW: To stay in the mining business for a long time clearly shows passion and commitment…. briefly explain your early signs of where you thought your career was heading.
Ulf has a background in mechanical engineering, it was this bias towards engineering that focused Ulf into achieving long term goals and stability for himself and family.

MQW: Qualifications and experience can be used as a worldwide currency, what qualifications and experiences do you have?
Ulf achieved several technical qualifications of which some related directly to the mining industry while others would dovetail into its associated supporting industries. However, Ulf does have experiences which he believes are a major asset, coupled with administering technical training around the world for approximately 11 years also enhances his qualifications/experiences.

Globetrotting around the world, meeting people, engaging in technical conversations, and listening to mining people and their opinions allowed Ulf to broaden his knowledge, to this end Ulf always thought that this type of work made him feel comfortable and at ease with his role.

MQW: In the earlier years who were your mining hero's?
"I think it is comfortable to say that all the teams and people I worked with were possibly mentors that I could look up to or call upon when needed".

MQW: What do you think are your main qualities…as a person…as a manager and as a leader of people?
"From my perspective I think that the ability to communicate and listen to other people are paramount in terms of working with and leading teams, my experiences of training people around the world as operators, technicians or to raise awareness of health and safety issues gave me a good understanding of the way people react in certain situations".

MQW: Do these qualities cross over into your social/free time…if so where and how?
"There are some similarities when you cross over into the coaching side of hockey, and I would say that communication and talking as well as listening are most important. Another key aspect is to be able to talk and listen on different levels. All people irrespective of their age, gender and ethnicity should be spoken to with professionalism and respect, being mindful of their background, capabilities, and characteristics".

MQW: Who do you think encouraged you the most?
"I do not think there was any one person who did this, however, my first recollection of this would come from the marketing side of the business and the technical engineers I worked with."

In many cases a career in the mining industry presents opportunities for global travel initiating discussions and debates with "like-minded people". Epiroc is a world leader in the field of mining and promotes its partnerships and support programmes worldwide.

MQW: What has been your proudest achievement so far working with Epiroc?
"One of my first recollections is the contribution towards the development of a navigation system which enables very precise positioning of drill rigs for operators, this was most satisfying and a very proud moment."

MQW: As a coach what do you think is the most important quality to possess?
"The main challenge when coaching hockey is they all love the game, so there is an expectation that we are going to be successful. One of the main challenges is the varying levels of ability, enthusiasm, and potential, listening to your 'team players' is imperative, working within teams at Epiroc resonates the same thoughts."

MQW: What do you see as the real difference between coaching a male/female team?
"With reference to ice hockey, all team members fight for the same cause and there is not much difference but historically the mining industry has been male dominated, however, I do believe that this is changing but in my opinion this change is happening at a slow rate."

MQW: How do you see the integration of women in mining being addressed within your company?
"We do have a high focus on diversity and inclusion within our company, and we are definitely moving in the right direction. Personally, I think more emphasis should be placed on promoting the mining community as a great place to work offering, challenge, fun, excitement, and good career paths."

With new technological opportunities and advancement becoming readily available many of the inherent physical obstacles are now being removed".

Photo credit: Rasmus Ohlsson.

The values of a diverse workforce are there for all to see, mining is a great business to be in, promoting employment, retention, and advancement of women in the mining sector to progress professional goals and career aspirations, this is key for this industry.

Epiroc has set the goal of doubling the number of women in operational positions by 2030.

To achieve this goal Epiroc focus in 3 strategic pillars.

- Increase awareness.
- Measure, identify and follow up.
- Top management commitment.

MQW: What benefits does diversity in mining give companies?
"One of the obvious benefits is that there is a different viewpoint that comes over, this can be in designing, training or problem solving to name a few but some of the best decisions are born from teams that have a good blend and mix of personalities and characteristics."

Epiroc acknowledges that embracing diversity and inclusion is imperative if the industry is to achieve and exceed future targets.

MQW: How do you think the mining industry is perceived by women and how does the industry encourage more women into mining?
"Indeed; there are fewer women on the boards of major mining companies, however, this is changing and increasing on an annual basis, it is refreshing to see the change happening.

Most women are probably less encouraged due to the working conditions but to counteract this we must have a greater presence in schools, colleges and universities and work with these establishments to promote mining and careers in mining for all".

MQW: What key projects are you currently working on?
"I am currently working on a large project, but I am unable to share the details of this project publicly, however, just like the car industry our drilling rigs constantly need upgrading and "tweaking" to ensure that our customers get the best out of them".

MQW: In relation to the most recent project can you explain any improved safety features that you have been part of developing?
"As always some of the most updated aspects on the drilling rigs are related to moving parts, ensuring that these are not in conflict with the personnel operating in and around the machine. One of the key safety features is that we are now getting further and further away from the actual drill site via remote operation.

Improving the operator cab experience and environment is also an area that has been developed".

MQW: The mining industry is often littered with claims of improved efficiency on most pieces of equipment…to give our readers a more convincing view of your product can you explain how efficiency has improved in your products?
"This is undoubtedly on the pollution aspects from the fuel consumption, recently a typical engine would consume 32/33 litres per hour now modern machines use as little as 21/22 litres per hour and can drill even faster. As well as this we improved electrical and mechanical systems making the drilling rig more efficient than its predecessors".

MQW: Discounting fuel consumption and exhaust emissions what makes your latest drilling rigs better than your nearest competitors?
"In my opinion the key things to take away as a customer is that our drill rigs have a better service life, they drill faster and have less maintenance on the rock drills".

MQW: Where do you think mining is heading?
"Remote operations and automation are becoming a leading technology in our industry and is a keyway to move forward".

Epiroc offer many solutions for the development and implementation of remote operations as can be evidenced by the partnering with mining companies around the world.

Understanding the challenges within a worldwide mining community is paramount, and a vital part of a sustainable society and global productivity partner for mining.

Battery technology and electrification are now well established within the company, Epiroc continues to spearhead the development and advancement of this technology.

Mining & Quarry World would like to thank the staff of Epiroc for their co-operation in providing images and information during this interview.

China Coal & Mining Expo 2021

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