

# E&MJ

ENGINEERING AND  
MINING JOURNAL

A Mining Media International Publication

**Copper Processing**  
— Finding optimization opportunities

*Utility Equipment Advances*

*Diesel Engine Developments*

*Predictive Biometrics*

*Autonomous Mining*

DECEMBER 2020 | [www.e-mj.com](http://www.e-mj.com)



## Explore the Future of Mining

When it comes to mining productivity nothing matches the pairing of the Komatsu PC8000 mining shovel and the Komatsu 830E dump truck. Hard production figures have shown the perfect pairing of these machines working together.

Machine availability, performance, operator comfort all combine for more production.

Komatsu Mining offers mining solutions for the world,  
Come Explore the Future of Mining.  
Komatsu; quality you can rely on.

Models shown may include optional equipment. Available models may vary by region or country. Materials and specifications are subject to change without notice.

**FEATURES**

**Copper Processing: The Quest for Efficiency at Scale**  
*Where do the greatest optimization opportunities lie? And what will future flowsheets look like? E&M sets out to answer some copper-based questions.*..... 30

**Autonomy Reloaded**  
*With the influx of open, interoperable autonomous mining solutions will come new possibilities... E&M presents some of the companies that are ushering in this change*..... 42

**Predicting the Way to Better Workplaces**  
*Alex Moss, CEO of Canaria Technologies, discusses how predictive biometrics could revolutionize mine workforce safety and productivity*..... 54

**Industry Trends Drive Diesel Development**  
*Diesel remains the heavyweight champion of high-volume haulage power, but BEVs, alternate fuels and other green-tech challengers are rapidly rising in the rankings*..... 62

**New Scalers, Carriers, Solutions Solve Specific Problems**  
*The latest releases were developed based on customer feedback, and offer better control, more options and improve job satisfaction*..... 71

**LEADING DEVELOPMENTS**

Barrick Posts Outstanding Quarterly Results ..... 6

ICMM Offers New Tool for Sustainable Mine Closure ..... 6

Lundin Family Donates \$2M to UArizona Mining Program ..... 7

Northern Vertex, Eclipse Gold to Merge ..... 7

Newmont Commits to Net Zero GHG Emissions by 2050 ..... 8

Vale Lowers Iron Ore Production Guidance ..... 8

Suncor Offers 2021 Production Outlook ..... 8

**AROUND THE WORLD**

**U.S. & Canada:** *Dominion Will Sell Ekati Mine*..... 10

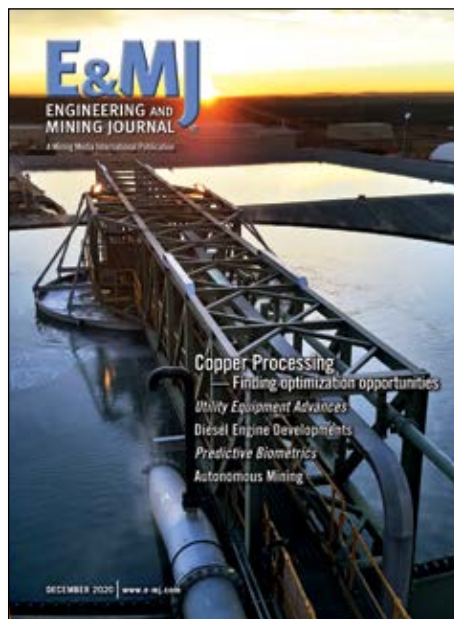
**Australia/Oceania:** *Dacian Gold Will Merge With NTM Gold* ..... 15

**Latin America:** *Lundin Mining Reaches New Collective Agreement With Candelaria Union* ..... 18

**Africa:** *West Africa May Be the New Frontier for Mineral Deposits*..... 20

**Asia:** *Pentwater Blames Rio Tinto for Oyu Tolgoi Mismanagement* ..... 22

**Europe:** *Protests Related to Political Turmoil Impact Mines, Suppliers in Belarus* ..... 27



*This month, E&MJ offers in-depth copper processing coverage. On the cover, a thickener decants water from tailings at a copper concentrator. (Photo: FLSmidth)*

**DEPARTMENTS**

Calendar ..... 27

Classified Advertisements..... 94

Equipment Gallery..... 90

From the Editor..... 2

Markets ..... 96

Operating Strategies ..... 82

People ..... 14

Processing Solutions ..... 88

Suppliers Report..... 84

This Month in Coal ..... 26





**Steve Fiscor**  
Publisher & Editor-in-Chief

## RCEP Establishes Major Trading Bloc

During mid-November, 15 nations representing about 30% of global gross domestic product signed the Regional Comprehensive Economic Partnership (RCEP). This culminated after eight years of negotiations, and the signing ceremony took place virtually, another sign of the COVID-19 times.

The group included the ASEAN nations together with Australia, China, Japan, New Zealand and South Korea. It does not include India, which dropped out of negotiations last year. Both Australia and China touted the agreement as a major step forward despite the recent tension that has been brewing between the two major trading partners.

The agreement is largely a tariff reduction deal. Exporters will only need one certificate of origin, which will simplify trade for multinational operators within the bloc. Bringing China into RECP was important as it is one of the largest trading economies, but it's also largely symbolic as the agreement has no teeth. The sections regarding dispute settlement and competition are weak and it includes nothing new related to labor or environmental policy.

From an iron ore, coal and steel perspective, Australia, Indonesia, Japan and South Korea would benefit the most. RCEP would likely have a negative effect on India and the U.S. As *E&MJ* documented last month in its Iron Ore Outlook, Australia exports 836 million metric tons per year (mt/y) of iron ore. Most of it goes to China and other steel producers like Japan and South Korea. Rio Tinto exports 270 million mt/y and BHP Billiton exports 240 million mt/y from mines located mostly in Western Australia.

"The opportunity ahead is to not only implement RCEP effectively but also to build on the momentum created by the agreement," BHP CEO Mike Henry said. "Overcoming and recovering from COVID-19 is going to require a collective and collaborative approach on a truly global basis. We must return the world to growth to help improve living standards and do it in a way that is sustainable and benefits all. For us to 'build back better,' we must 'build back better, together.'"

Henry acknowledged the tension that BHP and other Australian miners currently face, saying it is antithetical to prosperity and a challenge that needs to be resolved. Producing iron ore, copper and coal as well as oil and gas, BHP claims to be the world's largest multinational resources company and Chinese companies make up the lion's share of its customers.

With the obvious codependent relationships, it will be difficult for those within this bloc to apply pressure to China regarding other socioeconomic issues that concern some of the countries not included in this bloc. So, for the rest of the world, RCEP will place a larger burden on them for resolving issues like intellectual property rights and environmental policy.

With the obvious codependent relationships, it will be difficult for those within this bloc to apply pressure to China regarding other socioeconomic issues that concern some of the countries not included in this bloc. So, for the rest of the world, RCEP will place a larger burden on them for resolving issues like intellectual property rights and environmental policy.

Steve Fiscor, Publisher & Editor-in-Chief  
sfiscor@mining-media.com

p.s. — Enjoy this edition of *E&MJ*. Have a safe and festive Holiday Season!



### Mining Media International, Inc.

11655 Central Parkway, Suite 306; Jacksonville, Florida 32224 USA

Phone: +1.904.721.2925 / Fax: +1.904.721.2930

### Editorial

**Publisher & Editor-in-Chief**—Steve Fiscor, sfiscor@mining-media.com

**Associate Editor**—Jennifer Jensen, jjensen@mining-media.com

**Technical Writer**—Jesse Morton, jmorton@mining-media.com

**Contributing Editor**—Russ Carter, rcarter@mining-media.com

**European Editor**—Carly Leonida, cleonida@mining-media.com

**Latin American Editor**—Oscar Martinez, omartinez@mining-media.com

**South African Editor**—Gavin du Venage, gavinduvenage@gmail.com

**Graphic Designer**—Tad Seabrook, tseabrook@mining-media.com

### Sales

**Midwest/Eastern U.S. & Canada, Sales**—Craig Scharf,

cscharf@mining-media.com

**Western U.S., Canada & Australia, Sales**—Frank Strazzulla,

fstrazzulla@mining-media.com

**Scandinavia, UK & European Sales**—Colm Barry, colm.barry@womp-int.com

**Germany, Austria & Switzerland Sales**—Gerd Strasmann,

info@strasmann-media.de

**Japan Sales**—Masao Ishiguro, ma.ishiguro@w9.dion.ne.jp

**General Manager-Operations**—Dan Fitts, dfitts@mining-media.com

**Marketing Manager**—Misty Valverde, mvalverde@mining-media.com



## MININGMEDIA INTERNATIONAL

*Engineering & Mining Journal*, Volume 221, Issue 00, (ISSN 0095-8948) is published monthly by Mining Media International, Inc., 11655 Central Parkway, Suite 306, Jacksonville, FL 32224 (mining-media.com). Periodicals Postage paid at Jacksonville, FL, and additional mailing offices. Canada Post Publications Mail Agreement No. 41450540. Canada return address: PO Box 2600, Mississauga ON L4T 0A8, Email: subscriptions@mining-media.com. Current and back issues and additional resources, including subscription request forms and an editorial calendar, are available at [www.e-mj.com](http://www.e-mj.com).

**SUBSCRIPTION RATES:** Free and controlled circulation to qualified subscribers. Visit [www.e-mj.com](http://www.e-mj.com) to subscribe. Non-qualified persons may subscribe at the following rates: USA & Canada, 1 year, \$90. Outside the USA & Canada, 1 year, \$150. For subscriber services or to order single copies, contact *E&MJ*, c/o Stamats Data Management, 615 Fifth Street SE, Cedar Rapids IA 52401, 1-800-553-8878 ext. 5028 or email [subscriptions@e-mj.com](mailto:subscriptions@e-mj.com).

**ARCHIVES AND MICROFORM:** This magazine is available for research and retrieval of selected archived articles from leading electronic databases and online search services, including Factiva, LexisNexis, and Proquest. For microform availability, contact ProQuest at 800-521-0600 or +1.734.761.4700, or search the Serials in Microform listings at [www.proquest.com](http://www.proquest.com).

**POSTMASTER:** Send address changes to *E&MJ*, 11655 Central Parkway, Suite 306, Jacksonville, FL 32224-2659.

**REPRINTS:** MiningMediaInternational, Inc., 11655 Central Parkway, Suite 306, Jacksonville, FL 32224 USA; email: [subscriptions@e-mj.com](mailto:subscriptions@e-mj.com); phone: +1.904.721.2925, fax: +1.904.721.2930; [www.mining-media.com](http://www.mining-media.com).

**PHOTOCOPIES:** Authorization to photocopy articles for internal corporate, personal, or instructional use may be obtained from the Copyright Clearance Center (CCC) at +1.978.750.8400. Obtain further information at [copyright.com](http://copyright.com).

**EXECUTIVE OFFICE:** Mining Media International, Inc., 11655 Central Parkway, Suite 306, Jacksonville, FL 32224 USA phone: +1.904.721.2925, fax: +1.904.721.2930, [www.mining-media.com](http://www.mining-media.com).

**COPYRIGHT 2020:** Engineering & Mining Journal, incorporating World Mining Equipment, World Mining and Mining Equipment International. ALL RIGHTS RESERVED.



# Engineering & Mining Journal 2021 Editorial Calendar

Issue	Surface Mining	Underground Mining	Coal Processing	General Interest	Special Features
<b>January</b> Close: 12/23/20 Art: 12/30/20 Mail: 1/15	Drilling & Blasting	Battery-Powered Equipment	Process Control	Electric Motors & Drives	Mining in Arizona
<b>February</b> Close: 1/21 Art: 1/28 Mail: 2/15	Equip. Transport & Assembly	Maintenance Planning	Grinding Systems	Material Handling	Mining in Ontario
<b>March</b> Close: 2/18 Art: 2/25 Mail: 3/15	GET & Wear Protection	Ore Haulage	Hydrometallurgy	Communications & Networking	Legal Vein
<b>April</b> Close: 3/24 Art: 3/31 Mail: 4/16	Fleet Management	Shaft Sinking	Secondary Crushing	Pumps & Valves	Mining in Chile
<b>May</b> Close: 4/21 Art: 4/28 Mail: 5/14	Hydraulic Excavators	Production Drilling	Vibratory Screens	Oils & Lubricants	Mining in Nevada
<b>June</b> Close: 5/26 Art: 6/2 Mail: 6/18	Haul Road Design	Mine Rescue	Flotation	Gold Miners Roundup	Health & Safety
<b>July</b> Close: 6/23 Art: 6/30 Mail: 7/16	Blasthole Drilling	Ground Control	Slurry Pumps	MINExpo Preview	Mining in Brazil
<b>August</b> Close: 7/22 Art: 7/29 Mail: 8/16	Pit Dewatering	Narrow Vein Mining	Gold Recovery	Data Management/ Cyber Security	Mining in Peru
<b>September</b> Close: 8/23 Art: 8/31 Mail: 9/17	Haul Trucks	Mass Mining	Dewatering & Drying	Supply Chain Optimization	Alaska/Yukon Mining
<b>October</b> Close: 9/22 Art: 9/26 Mail: 10/15	Maintenance Programs	Ventilation Optimization	Tailings Storage	Conveyor Engineering	Nordic Mining Technology
<b>November</b> Close: 10/21 Art: 10/28 Mail: 11/15	Pit Slope Design	IT Systems	Next Gen Concentrators	Mine Power Products	Exploration & Permitting
<b>December</b> Close: 11/24 Art: 12/1 Mail: 12/17	Autonomous Mining	Utility Equipment	Copper Processing	AI/Machine Learning	Mining in Australia

## Bonus Distribution

Subject to change

March  
Haulage & Loading 2021  
Tucson, Arizona, USA

August  
MINExpo  
Las Vegas, Nevada, USA

March  
MiningWorld Russia  
Moscow, Russia

Perumin  
Arequipa, Peru

April  
Expomin  
Santiago, Chile

October  
IMARC  
Melbourne, Australia

May  
Elko Mining  
Elko, Nevada, USA

November  
AEMA  
Spokane, Washington, USA

## Marketing Extras

June & December  
Company Profiles

## Keeping the World Running Smoothly®

At Phillips 66® Lubricants, we pride ourselves on our history of innovation, which drives us toward the future of modern lubricant formulations. Phillips 66 understands the burden earth moving equipment bears. Extreme temperatures. Heavy loads. Rock, water and dirt that threaten your equipment. Earth moving is the ultimate heavy-duty environment, so the toughest working machinery deserves the toughest lubricants.

In the United States, 60% of mining operations trust Phillips 66 Lubricants to keep their equipment running smoothly. And when you look at the lab test results, it's clear why. Phillips 66 has put its heavy-duty engine oils like Guardol ECT® through thousands of hours of testing. In industry-standard scuffing, oxidation and corrosion tests, Guardol ECT outperformed its competitors and the OEM factory fill. Simply put, the results prove that Guardol ECT protects better than its competition.

Phillips 66 even protects beyond the engine block with high-quality transmission lubricants, hydraulic oils, gear oils and greases.

### Featured products:

#### Guardol ECT with Liquid Titanium® Protection Additive

Phillips 66 Guardol ECT (Emissions Compatible Technology) Diesel Engine Oil with Liquid Titanium protection additive is a premium-quality, part-synthetic API CK-4 engine oil specially formulated to reduce wear and enhance protection against corrosion and oxidation.

Applications:

- Off-highway construction, earthmoving and mining equipment;



- On-highway diesel trucks equipped with exhaust aftertreatment devices;
- Diesel engines equipped with exhaust gas recirculation (EGR) or other NOx-reduction technologies;
- Older diesel equipment with conventional, non-EGR engines;
- Mixed fleets with diesel- and gasoline-fueled vehicles.



#### Syncon® Final Drive

Phillips 66 Syncon Final Drive is a full-synthetic, high-performance lubricant specially designed for use in the final drives and axles of off-highway equipment. It is formulated with advanced additive technology to provide improved gear and bearing life in final drives and axles. It meets the performance requirements of the Caterpillar FD-1 specification.

Applications:

- Certain highly loaded Caterpillar final drives and axles that do not contain friction materials.

#### Multiplex® Grease

Phillips 66 Multiplex 600 is manufactured with high-quality base oils, a special polymer and a lithium complex soap thickener. It is fortified with extreme-pressure and anti-wear additives plus rust and oxidation inhibitors. It has excellent thermal stability at high temperatures, high load-carrying capacity for excellent wear protection, and protects metal parts against rust and corrosion. Its tackiness properties and heavy base oil provide a high level of adhesion to bearing surfaces, maintaining an effective seal to help minimize bearing contamination, improve retention, reduce leakage and provide excellent resistance to water washout.

Applications:

- Agricultural, construction, mining and industrial equipment operating under heavy or shock loads;
- Wheel bearings of passenger cars, trucks, high-performance vehicles, sport utility vehicles and motorcycles equipped with disc brakes;
- Conveyor bearings;
- Ball joints, universal joints, other chassis parts, and water pumps on passenger cars, trucks and other mobile equipment.

For more information on these and other heavy duty lubricants from Phillips 66, contact the technical hotline at 1.877.445.9198 or visit [www.Phillips66Lubricants.com](http://www.Phillips66Lubricants.com).



LUBRICANTS

**KEEPING THE  
WORLD  
RUNNING  
SMOOTHLY.**



**PROVEN MINING, CONSTRUCTION,  
AND EARTH MOVING EXPERTISE.**

**Kick up tons of dust. Just make sure your engine runs clean. The same oil trusted by 60% of mining equipment operators could and should be protecting your heavy duty construction engines. Help your machines run smoother with less downtime, for more years, on more jobs.**

**SEE DETAILS FOR ALL OUR HEAVY DUTY PRODUCTS AT [PHILLIPS66CONSTRUCTION.COM](http://PHILLIPS66CONSTRUCTION.COM)**

**HEAVY DUTY ENGINE OILS | TRANSMISSION LUBRICANTS | HYDRAULIC OILS | GEAR OILS | GREASES**



# Barrick Posts Outstanding Quarterly Results

Saying it had captured the benefit of higher gold prices through agile management and operational efficiency, Barrick Gold Corp. reported an increase of its operating cash flow by 80% quarter-on-quarter to \$1.9 billion and free cash flow by 151% to \$1.3 billion in the third quarter of 2020 — a record level of quarterly free cash flow for the company. Debt net of cash was reduced by a further 71% to \$417 million, compared to \$1.4 billion in the prior quarter.

Barrick President and CEO Mark Bristow said two quarters into the COVID-19 pandemic, it was clear how effectively the company was dealing with the impact of the virus on its business, its people and its communities.

“As today’s results show, in the face of unprecedented challenges, we have succeeded in beating our earnings consensus, reinforcing our 10-year plan and capitalizing on the gold price to maintain an industry-leading balance sheet,” he said. “Our year-to-date gold production of 3.6 million ounces (oz) keeps Barrick on track to achieve our guidance of between 4.6 and 5 million oz for the year.”

Of the capital projects for the assets the company operates, only Veladero’s cross-Andean powerline and phase 6 expansion were stalled as a result of Argentina’s COVID-19 response and further complicated by the onset of winter, with

these projects now restarted. The construction of the third shaft at Turquoise Ridge, the twin declines at Goldrush, and the underground mine at Goukoto, as well as Hemlo’s transition to contractor underground mining, the process plant and tailings expansion plan at Pueblo Viejo, the commissioning of the group’s first solar power plant at Loulo and the resumption of underground mining at Bulyanhulu were not interrupted.

In October, Twiga Minerals Corp., a joint venture between Barrick and the government of Tanzania, paid a maiden dividend of \$250 million. Bristow said the revived Tanzanian mines, North Mara and Bulyanhulu in combination, had the potential to become Barrick’s seventh tier one asset. A tier one mine is defined as one that can produce more than 500,000 oz of gold annually for at least 10 years in the lower half of the industry’s cost curve.

Subsequent to the third quarter results, Barrick and the government of Papua New Guinea announced they had agreed in principle to form a new partnership to operate the Porgera mine that is currently on care and maintenance. Under the conceptual agreement, which is still to be finalized, Barrick Niugini Ltd. will remain the operator, the government will acquire a major share of the equity, and the two sides will agree on an equitable sharing of economic benefits.

Bristow said Barrick’s restructuring and portfolio rationalization had made it a more streamlined business with a much-improved exploration strategy, particularly in its Latin American region, which should uncover new business opportunities. In the meantime, exploration around its tier one assets continued to deliver organic growth, and the company was expecting to grow mineral resources at most of its key assets.

“Barrick’s consistently strong performance since the merger has more than validated our belief that a combination of the best assets with the best people would deliver the best returns,” Bristow said. “It also shows that a business flourishes when it is driven by a clear strategy and not by the whims of the market.”

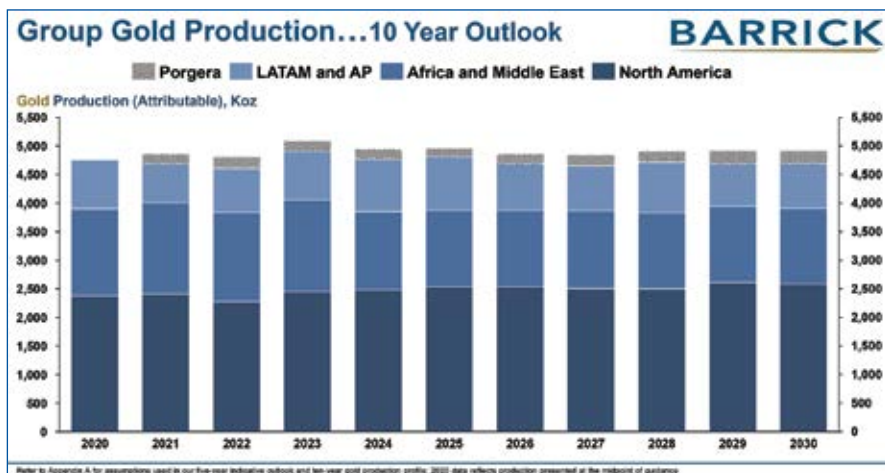
## ICMM Offers New Tool for Sustainable Mine Closure

The International Council on Mining and Metals (ICMM) has launched an interactive tool called the Closure Maturity Framework that will help mining and metals companies establish a clearer view of their asset’s current levels of maturity on the road to achieving sustainable mine closure. The tool will assist them in understanding what future work is needed to achieve their closure objectives with the goal of driving continuous improvement in closure performance.

The Closure Maturity Framework is designed to help companies map their current position, motivate improvement and measure the state of their operations’ progress toward sustainable closure. It outlines a pathway toward achieving desired post-closure land uses and closure vision while considering relevant aspects of mine design, operations and technology.

“To achieve sustainable outcomes that are beneficial to a company and its employees, the environment and host communities, mine closure must be considered as an integral part of an operations’ core business and effectively integrated across the mining life cycle,” ICMM COO Aidan Davy said.

The Closure Maturity Framework tool has two components: a user guide that



Barrick Gold projects consistent gold output for the next 10 years.



describes each of the maturity levels and helps companies categorize the status of their sites, and an interactive Excel tool that helps companies assess closure maturity at the site level.

ICMM said it can serve as a communication tool that drives conversation between different business units and levels of a company to converge thinking and align decision making. It can also facilitate the aggregation of results from multiple sites to enable companies to understand closure performance within a portfolio.

## Northern Vertex, Eclipse Gold to Merge

Northern Vertex Mining Corp. and Eclipse Gold Mining Corp. plan to merge in an all-share transaction, creating a new gold growth resource business focused on the western United States. Combined company will be comprised of 71% Northern Vertex shareholders, 18% Eclipse shareholders and 11% new shareholders. Northern Vertex will be the resulting company with offices in the US and Canada.

Northern Vertex owns and operates the Moss mine, currently the largest pure gold and silver mine in Arizona. Eclipse Gold Mining is exploring the Hercules gold property within Nevada's Walker Lane trend.

"The result of this transaction will be a combined company with a greatly strengthened balance sheet, and an enhanced team with extensive experience growing multi-asset gold companies," said Northern Vertex President, CEO and Director Kenneth Berry stated. "This represents a significant step toward our unwavering vision of building a top of the class mid-tier gold producer. We plan to use this new platform to accelerate organic growth opportunities by targeting significant resource expansion at the Moss mine and execute an aggressive roll-up strategy focused on the western United States."

"Shareholders of the new combined company will now own a platform including two Walker Lane gold projects with multi-million-ounce potential, a producing mine with untapped production and cash-flow growth opportunities, and an executive team with demonstrated success building multi-asset companies organically and through M&A," said Eclipse President, CEO and Director Michael G. Allen stated. "This combination aligns all the key elements required toward building America's next mid-tier gold growth story."

## Lundin Family Donates \$2M to UArizona Mining Program

The family of two University of Arizona alumni have donated \$2 million to help the university expand its highly ranked mining and geosciences programs and set the stage for an interdisciplinary school of mining engineering and mineral resources.

The Lundin family has made a \$2 million commitment and will provide up to \$2.5 million in addition in a challenge grant to match funds raised by December 2022.

The family leads the Lundin Group, which comprises 14 publicly traded companies in the natural resource sector that operate in more than 25 countries.

"We are very excited to be supporting such an important initiative alongside the University of Arizona. The drive toward a safer, more sustainable and efficient mining operation requires the very best talent across many disciplines, not just mining engineering and geology," said Jack Lundin, president and CEO of Bluestone Resources Inc., one of the group's companies.

Lundin earned a master's degree in mining, geological and geophysical engineering at the University of Arizona in 2016 and has served on the board of directors for the university's Lowell Institute for Mineral Resources since 2017.

"While most universities' mineral resources programs are shrinking or not keeping pace with change, the University of Arizona has demonstrated a vision and commitment to enhancing natural resources education. This gift is intended to catalyze the resources necessary and to attract industry support to make this vision of creating the best mineral resource program in the world into a reality," Lundin said. "We believe this partnership with the University of Arizona to create a new interdisciplinary school of mining and mineral resources will bring the kind of energy and excitement needed to attract the very best talent, and to prepare students to positively impact the future of mineral resources."

### Supplying the Best Possible Workforce

At the core of expansion initiatives is an unwavering commitment to keeping the industry pipeline filled with well-rounded, highly skilled professionals. Thus, the new school aims to prepare a new generation of professionals to enter the mining industry from a broader range of educational disciplines, including finance, law, computer science, environment and social sciences. The College of Engineering, the College of Science and the Lowell Institute are sharing the gift and working together to develop interdisciplinary curriculum and update research and teaching facilities, such as the San Xavier Underground Mining Laboratory.

"The generosity of the Lundin family will allow us to upgrade our facilities, build partnerships with industry and other universities, and strengthen the department's focus in areas such as data science and artificial intelligence," said David W. Hahn, Craig M. Berge dean of the College of Engineering.

The Lundins are based in Canada and Switzerland, but the family maintains strong ties in Arizona and at the university. Lundin and his brother, Harry, who earned a bachelor's degree in mining engineering in 2010, were both at UArizona when Professor Emerita Mary Poulton, co-director of the Lowell Institute, was head of the Department of Mining and Geological Engineering. "Our location amid some of the largest copper deposits on Earth, world-class faculty members and long-standing relationships with industry mean the University of Arizona has what it takes to lead," said Poulton, who co-directs the Lowell Institute with Mark Barton, professor of geosciences. This gift will help us take our efforts to the next level."

The gift will also fund the Lundin Family endowed chair in Economic Geology within the department of geosciences.



Located in Tucson, UArizona says it will use the gift to prepare a new generation of professionals for a career in mining.



The merger includes Northern Vertex's Moss mine, the largest pure gold and silver mine in Arizona. (Photo: Northern Vertex)

The management team will be comprised of President and CEO Kenneth Berry, CFO David Splett, EVP Corporate Development Michael G. Allen, and Dr. Warwick Board as Vice President of Exploration. Shareholders of Eclipse will receive 1.09 shares in Northern Vertex for each Eclipse share. The transaction has been unanimously approved by the board of directors of both Northern Vertex and Eclipse.

### Newmont Commits to Net Zero GHG Emissions by 2050

Newmont Corp. plans to implement industry-leading climate targets of a 30% reduction in greenhouse gas (GHG) emissions by 2030, with an ultimate goal of achieving net zero carbon emissions by 2050. The new 2030 target builds upon Newmont's existing GHG emissions reductions target of 16.5% over five years, concluding in 2020.

"At Newmont, we hold ourselves to high standards — from the way in which we govern our business, to how we manage relationships with our stakeholders, to our environmental stewardship and safety practices," President and CEO Tom Palmer said. "We fundamentally understand the human contribution to climate change and understand we reap what we sow.

"It is our responsibility to take care of the resources provided to us. We take these climate change commitments seriously and make them because our relationship with the planet is absolute. We want a world that is not just sustainable, but thriving for generations to come."

Using science-based criteria, Newmont has set climate targets for 2021-2030 for its operating sites, including a renewable energy target. The science-based

criteria align with Science-Based Targets Initiative (SBTi) criteria and assists Newmont in developing specific emissions reduction pathways and meeting the Paris agreement objective of being well below 2°C global temperature change.

### Vale Lowers Iron Ore Production Guidance

Hosting its Vale Day recently, Vale discussed its plans for the future, and ultimately lowered its 2020 iron ore production guidance to 300 million to 305 million metric tons (mt). Earlier this year, it lowered its guidance to 310 million mt. The company said it planned to grow production to 315 million to 335 million mt per year (mt/y) in 2021 and was targeting 400 million mt/y of capacity by the end of 2022.

The company acknowledged the Brumadinho incident, saying "We will never forget." They identified the \$2.6 billion that has been spent on reparations for people and the environment. They also talked about their plans for improving safety using a more proactive approach to risk management. The company also highlighted its commitment and the challenges associated with emissions reduction and net-zero mining.

In related news, Vale announced plans to begin the Sol do Cerrado project, a solar power generation project in Jaíba, Minas Gerais, Brazil. The project involves the construction of a photovoltaic plant, including 17 sub-parks that add an installed capacity of 766 peak megawatts (MWp). It has an estimated investment of \$500 million, which will be eligible for sustainable financing lines.

"The investment is a strategic alternative that, in addition to helping to

achieve the goals of sustainability and competitiveness, will provide a reduction of approximately \$70 million per year in electricity costs," the company said in a statement, highlighting that it is part of Vale's \$2 billion investment strategy to reduce carbon emissions.

The project, which is scheduled to begin operations in the fourth quarter of 2022, will produce approximately 193 average megawatts (MWm) of energy for Vale's operations annually, corresponding to 13% of the mining company's estimated demand in 2025.

### Suncor Offers 2021 Production Outlook

Suncor released its 2021 corporate guidance that includes an average upstream production of 740,000 to 780,000 barrels of oil equivalent per day (boe/d), which represents a year-over-year production increase of approximately 10% compared to the midpoint guidance range of 2020. Suncor's oil sands operations are expected to produce 410,000 to 445,000 barrels per day (bbls/d), followed by Syncrude at 170,000 to 185,000 bbls/d, Fort Hills at 65,000 to 85,000 bbls/d, and 80,000 to 95,000 bbls/d from E&P activity.

"The decisions we made this year give us the ability to strengthen the balance sheet, increase shareholder returns, and invest in our business to grow future free funds flow," President and CEO Mark Little said. "As we look to 2021, with a focus on the safe and reliable operation of our assets and disciplined cost management, we're well-positioned to make significant progress in all of these important areas."

The expected 2021 Fort Hills production represents a 20% increase when compared to the midpoint guidance range in 2020. The increased Fort Hills production is grounded in long-term value creation ensuring a disciplined focus on costs by maintaining the operating and capital costs savings achieved in 2020, the company said. Suncor will operate Fort Hills with structurally lower costs and continue to work with the joint venture partners on a plan to operate the asset at nameplate post 2021. Through the emphasis on cost reduction and maximizing cash flow of each barrel, Fort Hills cash operating costs per barrel are anticipated to be reduced by approximately 20% to \$25-\$29 when compared to the 2020 guidance midpoint.

# Welcome to a new way of working



**United. Inspired.**

Office TeleREMOTE is designed to control SmartROC DTH drill rigs\*, MK I from a remote location. The drill rigs are controlled safely from an office located on the same local area network as the quarry or mine. Office TeleREMOTE improves working conditions for the operator, ramps up efficiency and boosts productivity.

\*The SmartROC models currently compatible with Office TeleREMOTE work desk are: SmartROC D50 MKI, SmartROC D55 MKI, SmartROC D60 MKI and SmartROC D65 MKI.



[epiroc.com](https://www.epiroc.com)

# Dominion Will Sell Ekati Mine



Ekati, which means 'fat lake' in Tlicho, is Canada's first surface and underground diamond mine.

Dominion Diamond Mines ULC settled a purchase agreement with DDJ Capital Management LLC and Brigade Capital Management LP, both investment managers to holders of the company's second lien notes. Under the agreement, an entity controlled by the purchaser would acquire substantially all of Dominion's assets, excluding its joint venture agreement and liabilities relating to the Diavik mine, in consideration for the assumption by the purchaser of various liabilities and the provision of a \$70 million working capital facility. The capital will fund the post-closing satisfaction of certain assumed liabilities, operations at the Ekati mine and general working capital purposes.

Dominion filed for insolvency protection on April 22 under the Companies' Creditors Arrangement Act (CCAA) and obtained an order from the Alberta Court of Queen's Bench granting Dominion protection under the CCAA pursuant to an order from the CCAA Court.

Upon completion of the proposed transaction, Dominion expects the ongoing business to pay or otherwise satisfy, obligations to certain stakeholders, including Dominion's employees; pension obligations; reclamation obligations at Ekati; and Dominion's Impact Benefit Agreement partners and other Indigenous groups and Northern communities.

The company said it has agreed to take all action reasonably necessary or appropriate to restart operations at the Ekati mine as soon as possible, and no later than

January 29, 2021. Under the terms of the agreement, the proposed transaction must close no later than February 1, 2021.

Dominion filed for insolvency in April, a month after operations were suspended and more than 300 employees were furloughed at the Ekati mine due to the COVID-19 pandemic. Under an order from the Companies' Creditors Arrangement Act (CCAA) Court, Dominion is protected from its creditors until December 15.

Last month, a deal to sell its assets for approximately \$126 million in cash to an affiliate of The Washington Cos. fell through.

Dominion Diamond Mines ULC owns a controlling interest in the Ekati diamond mine, which it operates, and 40% of the Diavik diamond mine, with Rio Tinto holding the remaining 60%. The company also holds a controlling interest in the Lac de Gras diamond project.

## Full Production Restarts Hudbay's 777 Mine

Full production resumed at Hudbay Minerals' 777 mine in Flin Flon, Manitoba, on November 25 following the skip hoist incident in October. The shaft repair activities were completed well ahead of schedule and the total direct repair costs were under the estimated \$5 million, the company said.

While the shaft was under repair, the company temporarily reassigned equipment and personnel from the 777 mine to the Lalor mine in Snow Lake to partially

mitigate lost production. Although fourth quarter production and sales volumes will be impacted, the company said it expects the Manitoba business unit to achieve its full year production and unit cost guidance for 2020.

"The shaft incident was an unfortunate event, but the team responded quickly and was successful in bringing this important asset back into full production ahead of schedule," President and CEO Peter Kukielski said. "At the same time, the team used this as an opportunity to temporarily allocate additional resources to Lalor to test the mine's production potential and we are encouraged as to what this might mean for the future of our Snow Lake operations."

## Aquila Submits Dam Permit Application for Back Forty

Aquila Resources Inc. has applied to the Michigan Department of Environment, Great Lakes, and Energy (EGLE) for a dam safety permit for its Back Forty Project. The company has already been issued the four foundational state permits required for the commencement of construction and operations at Back Forty, with the mining permit, air permit, water discharge (NPDES) permit, and wetlands permit. The dam safety permit, which is required to build the proposed tailings management facility (TMF) and contact water basin, is the final state permit required to commence construction and operations.

"With input from globally recognized engineering firms including Golder Associates Inc., Aquila is designing an operation that will protect the environment while providing a significant economic opportunity for the counties surrounding the Back Forty Project," Aquila President and CEO Barry Hildred said. "We look forward to supporting EGLE with their review of our application and expect the dam safety permit to be issued in 2021. The design of the Back Forty TMF reflects best-in-class safety standards to manage precipitation at the mine site during operations and does not involve impounding or interfering with any water bodies."

In order to refine elements of the Back Forty Project design, including to reduce wetland impact, improve dust management, increase stormwater storage capac-

ity, and reduce the footprint of tailings facilities post-closure, the company revised its application for the wetlands permit and submitted updated applications for an amended mining permit and air permit to EGLE, both of which were approved in December 2019.

## Musselwhite Commissions Conveyor System

Newmont Corp. has completed two key projects at its Musselwhite mine at Lake Opapimiskan, Ontario, Canada, with the full commissioning of the mine's conveyor system and the material handling project. "I am extremely proud of the work that has been completed by the team at Musselwhite to safely deliver these two critical projects, while managing through the unprecedented challenges caused by COVID-19," Newmont President and CEO Tom Palmer said.

The commissioning of these projects puts Musselwhite in a position to contribute to Newmont's portfolio for many years, Palmer added.

The conveyor system and the material handling systems work in association to efficiently move material from deeper mine levels to the surface. Haul distances are reduced as the ore crushed at depth will be hoisted from the underground crushers to the conveyor system and brought to the surface for processing.

## Radial Stacker Returns to Service at Relief Canyon

Americas Gold and Silver Corp. reported that its large radial stacker has returned to operation on the Relief Canyon leach pad. This will allow ore placement to return to the targeted rate of approximately 14,500 metric tons per day (mt/d) from the current rate of approximately 7,250 mt/d. The stacker suffered a structural failure in late May, which required extensive repair work to be completed off-site. The repaired unit was tested prior to delivery for a period of several weeks by the fabricator, which included software upgrades aimed at improving operator efficiency. While this led to a slight delay in receiving the unit, the company expects this will benefit the operation in the longer term.

The company anticipates commercial production will be reached at the end of Q4 2020 with full production by the end of April 2021, setting the company up for a strong 2021.

The Relief Canyon mine in Nevada, USA, is the company's newest asset. It has poured first gold. Americas Gold and Silver Corp. also owns and operates mines in Mexico and manages the 60% owned Galena Complex in Idaho, USA.

## Bunker Hill Initiates PEA for Quick Restart at Mine

Bunker Hill Mining Corp. has launched a preliminary economic assessment (PEA) to assess the potential to quickly restart production for minimal capital expenditure at its Bunker Hill mine, located in Idaho's Silver Valley, USA. The company expects to have the PEA completed during the first quarter of 2021.

"We believe that there is strong potential to quickly restart production for minimal capital by focusing on the de-watered upper areas of the mine, utilizing existing infrastructure, and based on truck haulage and toll milling methods," CEO Sam Ash said. "The rapid restart would allow us to self-fund our ongoing high-grade silver exploration, immediately crystallize the value created through exploration, and demonstrate our ability to successfully operate the mine based on modern techniques."

Production ceased at the Bunker Hill mine in the early 1980s.

Consulting Engineers from MineTech International LLC have been engaged to deliver the PEA. It will focus on mining operations conducted above the current water level (Level 11). This will include a systematic study of existing infrastructure, capital cost estimates, operating cost

estimates, metallurgy, resource modeling, mine design and scheduling, ventilation, haulage and marketing. The analysis will compare truck haulage from the Russell Tunnel versus rail haulage from Kellogg Tunnel; toll-milling versus construction of various in-house processing options; sensitivities to production rates that vary from 400 tons per day (t/d) to 1,000 t/d; contract versus owner-operator mining; and grade versus tonnage trade-offs.

Bunker Hill said it continues to make steady progress on its ongoing high-grade silver-focused exploration campaign that commenced during September.

"In my short time on site, I have seen the outstanding mineral potential that exists at Bunker Hill," Vice President of Exploration James Stonehouse said. "As our geologic understanding continues to grow through modeling and drilling, I am confident in our ability to add to our already sizable resource through continued exploration success in both the upper and lower levels of the mine."

A total of 5,000 ft of core has been drilled from surface with two drill rigs currently in operation. Assay results are expected by mid-December. All of the targeted silver deposits are positioned near existing infrastructure and have the potential to add high-grade resources to the upper level inventory and add greatly to the value of any restart plan, Stonehouse explained. The company said it will conduct approximately 4,000 ft of infill drilling designed to upgrade its highest-grade inferred resources.



Exploration drilling at Bunker Hill adds to a sizable resource.

## Red Valve: The First Choice for the Toughest Mining Challenges. Since 1953.



Since its inception in 1953, Red Valve has been the world's leading manufacturer of Pinch Valves for the Mining Industry. Today, Red Valve products are used in every type of mining operation worldwide.

A pioneer and innovator of valves specifically built for the toughest mining applications, Red Valve has enhanced the efficiency of the mining industry with a wide array of cost-effective flow control products and solutions. Red Valve products are ideal for floatation cells, dewatering service, cyclone separators and tailing applications.

### There's a Red Valve Product for Every Mining Application

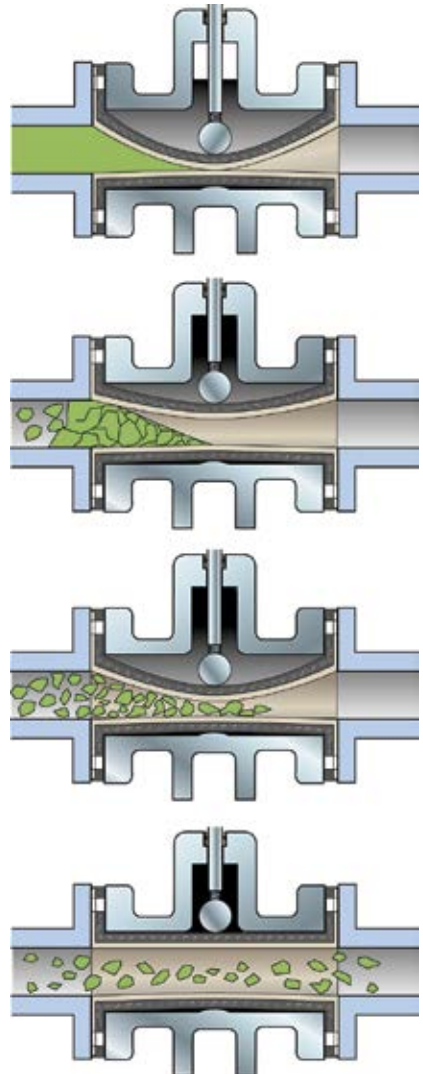
- Precious Metal Mines
- Iron Ore / Coal / Tar Sands
- Aluminum / Bauxite Mines
- Phosphate Mines
- Flotation Cells
- Thickener Underflow
- Lime Feed
- Sulfur / Phosphoric / Cyanide Acids
- Concentrators
- Leaching

### Red Valve Manual and Control Pinch Valves – the Industry Standard

Traditional ball, plug and gate valves used in mine slurry applications experience repeated difficulties and often break down or wear out quickly. The constant maintenance and replacement of these valves can result in high expenses and downtime. Red Valve Pinch Valves outlast these valves with state-of-the-art fabric re-enforced specialty elastomer sleeves that provide extremely dura-

ble structural support. Similar in construction to a heavy-duty truck tire, Red Valve's Pinch Valve Sleeves are actually much tougher than metal. Unlike the flow patterns of conventional valves, which create deflection that causes wear, the flow pattern of a Red Valve Pinch Valve is streamlined. The valve lining, flange gaskets and seating surface are combined into one unit, and expensive metal alloys are eliminated because the sleeve is the only wetted part of the valve.

For more than half a century, Red Valve's elastomer experience and know-how have become legendary, and truly unmatched in the industry. Red Valve offers a worldwide, world-class custom service network. With corporate offices in Pittsburgh, PA, manufacturing facilities in Gastonia, NC, and 114 sales representatives in 61 countries around the globe, Red Valve has the sales engineering team to help you select the best choice of valves and related products for your applications. "Rely on Red" to provide reliable solutions for your toughest mining challenges, day after day, year after year. Call 412-279-0044 or visit us at [www.redvalve.com](http://www.redvalve.com) to learn more.





# Red Valve®



TAILINGS

FLOTATION CELLS

THICKENER UNDERFLOW

CONCENTRATORS

CENTRIFUGE AND  
CYCLONE FEED

**The best choice for the toughest mining applications.** Since its inception in 1953, Red Valve has been the world's leading manufacturer of Pinch Valves for the Mining Industry. Today, Red Valve products are used in every type of mining operation worldwide. A pioneer and innovator of valves specifically built for the toughest mining applications, Red Valve has enhanced the efficiency of the mining industry with a wide array of cost-effective flow control products and solutions. Built to last, Red Valve products are the industry's first choice for isolation and modulating valves throughout a mining operation. Our global representative network is ready to work with you.

Control Valves



Knife Gate Valves



Manual Pinch Valves



Pressure Sensors



Tideflex®  
Check Valves





Gary Nagle

Glencore plc announced that **Ivan Glasenberg** will retire as CEO and as a member of the board during the first half of 2021. **Gary Nagle** will then become CEO and join the board. Nagle is currently global head of Glencore's coal industrial business based in Sydney, Australia. He joined Glencore in 2000 in Switzerland as part of the coal business development team.

**André Sougarret** returns to *Codelco* as vice president of north operations. After two and a half years out of the state company, the former general manager of the El Teniente Division will take over from January 2021 the operations of Chuquicamata, Radomiro Tomic, Ministro Hales and Gabriela Mistral. He was previously general manager of El Teniente.



André Sougarret



Guy Belleau

*ArcelorMittal Mining* appointed **Guy Belleau** as COO. Prior to joining the ArcelorMittal team, he was general manager of the Horne 5 mine at Falco Resources. Previously, he worked with companies such as Goldcorp and Xstrata, where he was involved in mining operations management, engineering and mine construction project management.

**Laurel Sayer** has been appointed president and CEO and a director of *Midas Gold Corp.* She is currently president of the company's subsidiary Midas Gold Idaho Inc. Sayer replaces Stephen Quin, who resigned as president, CEO and a director of Midas Gold.



Laurel Sayer



Theresa Redburn



Sherri Evers

*Imperial* announced that **Theresa Redburn**, senior vice president, commercial and corporate development, will retire on January 1, 2021, after 35 years of service. She began her career with Imperial in 1985. She began her tenure as senior vice president, commercial and corporate development in January 2017. The company also

announced **Sherri Evers** has been appointed as vice president, commercial and corporate development, effective January 1, 2021. Evers is currently fuels manager, Central and Eastern Canada.

*Centerra Gold Inc.* appointed **Tengiz A.U. Bolturuk** to its board of directors. Centerra also announced the resignation of **Askar Oskombaev** from its board of directors. Bolturuk has more than 30 years of experience in engineering and operations in the mining industry. Bolturuk was nominated by Kyrgyzalyn JSC, Centerra's largest shareholder.

**Simon Houle** is now the chief geologist for *Azimut Exploration* and **Francois Gagnon** has been promoted to the role of project manager.



Pierre-Philippe Dupont



Wendy Kaufman

*Canada Nickel* has announced senior management appointments and board nominations. **Pierre-Philippe Dupont** is now vice president of sustainability and **Wendy Kaufman** has been named CFO. The company has also nominated three independent, non-executive directors: **Kulvir Gill**, **Jen Morais** and **Francisca Quinn**.



Mike Struthers

As part of the transaction to acquire the interests of Empire Metals in the Bolnisi gold and copper project in the Republic of Georgia, *Candelaria Mining* appointed **Mike Struthers** as CEO and to the board. **Neil O'Brien** will also join the Candelaria board. The appointments are subject to the closing of the above transaction.



B.H. "Ben" Whiting

*Orex Minerals Inc.* announced that **Gary Cope** has resigned as president, CEO and director of the company in order to focus his efforts on Barsele Minerals Corp. The company also appointed **B.H. "Ben" Whiting** as president and CEO and as a director of Orex effective immediately. Whiting had served as the company's vice president, exploration, since August 2015.

*Torex Gold Resources Inc.* appointed **Andrew Snowden** as CFO, effective January 4, 2021. He will be replacing **Steven Thomas**, who will be stepping down from Torex. Snowden is currently senior vice president and CFO at Sherritt International Corp.



Andrew Snowden

*Maverix Metals Inc.* appointed **Tara Hassan** to the board of directors as an independent director. Hassan currently serves as vice president, corporate development, at SilverCrest Metals Inc.

*Temas Resources Corp.* welcomed **Michael Dehn** to the position of president and CEO. Dehn began his career as one of the most notable geologists at Goldcorp Inc.



Stephen Mullowney

*Tanzanian Gold Corp.* welcomed **Stephen Mullowney** as CEO and appointed him to the board of directors. Mullowney is a former partner and managing director of PricewaterhouseCoopers LLP (PwC) and PwC Canada's mining deal leader.



Nikhil Trivedi

The *Mineral Processing Division* and the *Coal & Energy Division Frank F. Aplan Award Committee* have selected **Nikhil Trivedi**, longtime member of the Society for Mining, Metallurgy & Exploration (SME), as the 2021 recipient of the prestigious Frank F. Aplan Award. The award recognizes engineering or scientific contributions that further the understanding of the technology of coal and/or mineral engineering.

*Gold Bull Resources Corp.* promoted **David Johnson** to vice president of exploration and welcomed **Randy Vance** as a key geology advisor.



Richard Lee Bullock

**Richard Lee Bullock** was born on July 24, 1929, in Independence Missouri and died on November 20, 2020, in North Richland Hills, Texas, after a long battle with congestive heart failure. After graduating from Houston High School in 1947, he attended the University of Missouri-Rolla and received a bachelor of science degree in mining engineering, a masters in mining engineering, and doctorate in engineering. He was the endowed Quenon Chair in Mining Engineering, University of Missouri-Rolla. After retiring from UM-Rolla, he continued to teach online courses for the university for an additional 13 years, while doing extensive consulting in the U.S. and around the world. He had more than 60 years of experience in the mining industry in managing: mineral property evaluations, mine developments, projects, ongoing operations, mining research and multi-disciplined engineering design groups, including nuclear studies facilities. During his career, he was asked to perform a variety of engineering studies, mineral property feasibility or evaluation studies on more than 250 prospective or operating properties. He received many awards, including the Society of Mining Engineer's (SME) Jackling Lecture, distinguished SME member and the distinguished M & E Division member, as well as numerous teaching awards from SME and MS&T. He was a registered engineer in Missouri, Tennessee and New York, and a qualified person in mining and reserves. He is co-editor of three mining books and author of approximately 50 published technical papers. Additionally, he published his two-volume memoir *From Hard Knocks to Hard Rocks: A Journey in My Shoes* in 2018/2019 and was featured in a two-part video interview for the American Institute of Mining, Metallurgical and Petroleum Engineers (AIME) Oral Heritage series in 2018. In lieu of flowers, donations may be made to the *Richard L. Bullock Endowment for Mining Engineering* at Missouri University of Science and Technology.



# Dacian Gold Will Merge With NTM Gold

Dacian Gold Ltd. and NTM Gold Ltd. have agreed to a merger, which will combine two complementary West Australian gold companies and leverage Dacian's operational expertise and processing infrastructure to unlock the development potential of the Redcliffe Gold Project through regional consolidation, according to the companies. Dacian Gold owns the Mount Morgans Gold Operation, while NTM Gold's main project is the Redcliffe Gold Project.

Under the agreement, each NTM shareholder will receive 1 Dacian share for every 2.7 NTM shares. Upon completion, Dacian will hold 68.4%, while NTM will hold 31.6% of the merged company.

The NTM Board unanimously recommended that shareholders vote in favor of the merger. NTM shareholders, including all NTM directors and the two largest shareholders, Empire Resources Group (13.7%) and DGO Gold Ltd. (13.6%), intend to vote all the shares that they hold in NTM in favor of the scheme.

"This merger will create value by delivering on our strategy of extending mine life, diversifying our production base and increasing operational flexibility at Mount Morgans," Dacian Managing Director Leigh Junk said. "This is a logical step for Dacian to expand operations in our region by unlocking resources within haulage distance of our substantial processing infrastructure, enabling

future resource and reserve additions to be brought quickly into production."

NTM Managing Director Andrew Muir said, "This is a compelling transaction for NTM and provides the financial, processing and operating strength to unlock the value of the Redcliffe Gold Project."

## FMG Celebrates First Ore at Eliwana Mine

Fortescue Metals Group Ltd. (FMG) achieved a significant milestone in the development of its iron ore operations in the Pilbara, celebrating first ore through the ore processing facility at the Eliwana mine and rail project in the Western Hub. Fortescue CEO Elizabeth Gaines, and Deputy Chairman Mark Barnaba celebrated the official event on site at Eliwana with the Hon. Bill Johnston, Western Australia minister for mines and petroleum, energy and industrial relations, and representatives of Fortescue's native title partners, the Puutu Kunti Kurrama and Pinikura People, members of the Fortescue Board of Directors and the Core Leadership team.

"Eliwana is the next important stage of development of Fortescue's world-class, integrated operations," Gaines said. "Exploration commenced in this area in 2006, and we have now delivered a new 30-million-metric-ton-per-year dry ore processing facility and infrastructure, along with 143 kilometers

of rail which is in the final stages of construction."

Construction of the mine, village and infrastructure was completed in 12 months, on time and one budget, she added.

"Fortescue has a vision to drive economic growth and contribute to thriving local communities, and our investment in the Eliwana mine and rail project will continue our strong track record of delivering against this goal," she said.

Minister for Mines and Petroleum Johnston said the project created 2,000 jobs during construction and will create 500 full-time site positions as the team move into operations.

"Fortescue's Eliwana mine will deliver a significant boost to Western Australia's economy, during the post-COVID-19 recovery phase, and contribute to the state's ongoing successful iron ore industry," he added.

Fortescue is one of the largest employers of Aboriginal people, including 14% of the Eliwana operations workforce, according to Gaines.

"The Eliwana project has delivered a significant boost to the state and industry, with contracts valued at A\$1.83 billion awarded to Australian businesses," Gaines said. "This includes contracts awarded to 290 West Australian businesses, with local procurement totaling 84% of the project spend."



Fortescue employees celebrate first ore at Eliwana, the company's newest iron ore mine in Western Australia.

## FLSmidth – Enhancing your productivity, sustainably

Driven by the changing demands and complexities you face in the modern mining industry, FLSmidth's focus is to deliver sustainable productivity, through innovative products, smart solutions and unmatched expertise. From in-pit crushing and conveying through to tailings management, you can access the full flowsheet of productivity-enhancing mineral processing and material handling technology and equipment through one provider.

Why does that matter? Well, we know your challenges include increasing production and output, while lowering your operating costs and environmental impact. So we built our unique combination of engineering, products and services to help you achieve just that. As your partner in mining, our staff in 80 offices around the world, brings over 135 years of FLSmidth experience, innovation and process know-how to you – whenever and wherever you need it. And we are focused on enabling all customers reduce their emissions and water waste by 2030 through our MissionZero programme.

### Your full flowsheet partner for premium products, innovative solutions and aftermarket service

FLSmidth is mostly active in material handling, comminution, materials testing and separation. We offer you a complete array of products, systems and services, ranging from single engineered or standardised equipment, such as crushers, ball mills, pumps, gravity concentrators, thickeners and flotation cells to bundled equipment, full production plants, wear parts, aftermarket service and maintenance solutions.

This wide coverage means we can increase your productivity by integrating upstream mining with downstream processing. It also means easier implementation of smart, digital solutions across the flowsheet.

### Tailings Management

When it comes to tailings, every mine site has unique considerations, such as water costs, permitting and stability issues. We work with you to determine what's best for your unique mining conditions and local regulations.

We are the only original equipment manufacturer with the ability to provide a comprehensive tailings solution to suit any mine site. We offer complete dewatering, material handling and co-mingling solutions, such as EcoTails®, in-house. Complete testing ensures the most economic tailings solution on a site-by-site basis. Our solutions include: sand dam tailings, thickened tailings, paste tailings, paste backfill for underground mines, filtered tailings or co-mingled tailings.

### Metallurgical Testing

We provide testing and ore characterisation services that include ore amenability, process development, flowsheet layout and plant



design to maximise operational efficiency. We have strengthened massively in this area through the purchase of the hydrometallurgical and mineral processing capabilities of AuTec, to bolster our capabilities in piloting, testing and the characterisation of simple to the most complex ores, including refractory gold.

We have also now fully integrated IMP Automation Group, meaning better data on your ore, helping to optimise your processing. With this acquisition, our flowsheet of laboratory solutions within mining and minerals processing is complete.

### Comminution and Material Handling

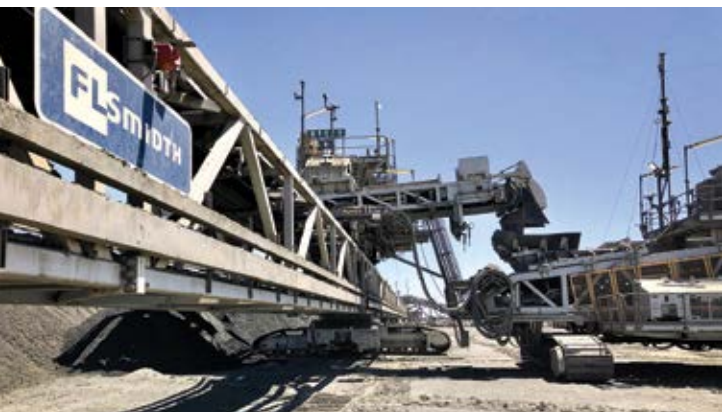
Our premium crushers employ the latest engineering expertise and technology, making them safer and easier to maintain. This robust crushing and milling equipment, combined with FLSmidth's vibrating screens and KREBS™ hydrocyclones and pumps, results in an efficient and reliable comminution circuit. We also provide the deepest range of In-Pit Crushing and Conveying (IPCC) options in the mining industry through one provider.

### Precious Metals Recovery

Specialised equipment for the processing of gold, silver and other precious metals includes complete Merrill Crowe plants, carbon ADR plants and precious metal refineries, as well as the Knelson Concentrator – the leader in gravity recovery. We have also developed Rapid Oxidative Leach process (ROL), which makes it possible to develop mineral deposits containing arsenic for recovery of copper, gold, and silver, while complying with stringent environmental regulations. ROL also allows for recovery from waste streams, and piles containing arsenic can be processed on site.

### Future Proofing Mining With MissionZero

Recently we launched *MissionZero*, a programme to enable customers and the mining industry to move towards zero water waste, zero emissions and zero energy waste. With new challenges, such as increasing costs and risk, tighter regulations and higher societal expectations, you need a partner that can ensure both business and environmental demands are met. We are openly inviting you to co-create new solutions with us and to ensure the adoption of innovations and technologies that will transform mining into a more sustainable industry.





## Overcome increased complexity through innovative solutions

**Knowing your ore characteristics from the mine and all the way through the processing plant is of increasing importance in mining as declining ore grades make it necessary to increase productivity through process optimisation.**

The demand for automated laboratories is growing due to a combination of high exploration activity and an increased focus on productivity, automation and digitalization. To respond to this need, we recently expanded our portfolio in mineral sampling and laboratory automation – something that will benefit customers globally.

Better data on your ore, reliable sampling and preparation, optimised processing and analytical solutions are ready to boost the productivity of your operations from grassroots exploration to final product.

[FLSmith.com](https://www.flsmith.com)

# Lundin Mining Reaches New Collective Agreement With Candelaria Union



The Candelaria open-pit mine moves 270,000 metric tons per day (mt/d) of which 43,700 mt/d is copper ore.

Lundin Mining Corp. and the Candelaria AOS Union, which represents approximately 550 workers at the company's Candelaria operations in Chile, has ratified a new 30-month collective agreement. The union accepted the last formal offer that was presented by Candelaria on November 12.

The safe resumption of partial operations is being assessed while the Candelaria Mine Workers Union, representing approximately 350 workers, continues with its labor action. In the meantime, the company said critical works continue to be executed to protect required on-site personnel, the operation and the environment.

As part of the collective bargaining cycle, Candelaria is in the legislated negotiation process with the two supervisor unions. An agreement was reached with the LMC AOS Union during advanced negotiations in May.

## Glencore Closes Minera Aguilar Plant

After 91 years of uninterrupted activity, Glencore has decided to close its Com-

pañía Minera Aguilar plant in the province of Jujuy, Argentina. The plant will go into maintenance because there is no more extractable mineral left, the company said.

Glencore, which operates Minera Alumbra, said the mine "has inexorably reached the end of its productive life." Guillermo Apraiz, president of Minera Aguilar, explained that the operation planned to run longer, but the current epidemiological situation has forced the company to close the plant ahead of schedule.

Minera Aguilar is a zinc, lead and silver deposit that reached the end of its production stage due to the natural depletion of its mineral resources, the company explained.

After the care and maintenance period, which will have an extension of 12 months, the company will implement a transition toward the environmental closure of the deposit.

Minera Aguilar was a pioneer in the mining business in Argentina. It is currently the oldest mining company in operation and also the main producer of met-

alliferous minerals such as lead and zinc. As of July 2005, it was fully incorporated into the Glencore Group, a world leader in the base metals trade.

## Capstone Reports Lowest Quarterly Costs for Cozamin

In its third-quarter 2020 earning report, Capstone said its copper production totaled 38.5 million pounds (lb) of copper, despite planned downtime at Pinto Valley to complete the majority of PV3 Optimization Phase 1 upgrades, at consolidated C1 cash costs of \$1.82 per payable pound produced.

"We are two months away from the start of a high growth phase for the company, enhanced by innovation that will see us delivering 40% more production at 20% lower costs by 2023," said Darren Pylot, president and CEO of Capstone. "I'm proud of the strong safety and operating results we delivered in Q3 2020, with Pinto Valley carrying out Phase 1 PV3 Optimization installations and Cozamin achieving the lowest quarterly unit costs it has ever realized in its history."

"We are seeing a pickup of interest in Santo Domingo since we announced the [memorandum of understanding (MoU)] for rail and port facilities last month. With an increasingly positive outlook for copper, iron and cobalt, it is not surprising to see momentum like this for a fully permitted, large-scale project in a mining-friendly jurisdiction," Pylot said.

Year-to-date consolidated production of 112.5 million lb and consolidated C1 cash cost of \$1.91/lb is on track with the company's full year guidance of 140-155 million lb, at C1 cash costs of \$1.85/lb-\$2/lb.

With improvements to copper markets during the quarter, full-year 2020 capital expenditures and exploration cost estimates have been returned to levels originally guided for 2020. Full-year capital and exploration costs are expected to be \$90 million and \$10 million, respectively, which positions the company for 20% production growth and 10% lower costs in 2021.

C1 cash costs of \$0.36/lb produced at Cozamin is the mine's lowest cost quarter in its operating history. During Q3 2020, the mine benefited from an optimized mine plan focused on higher copper grades (1.77%) and higher throughput (3,090 metric tons per day (mt/d)), resulting in higher production (10.6 million lb), higher byproduct credits on strong silver prices in addition to higher silver grades (46.5 g/mt) and recoveries (79%), as well as lower costs from reduced operating development meters.

### Codelco Refinances Debt

Chile's national copper mining company, Corporacion Nacional del Cobre (Codelco), will refinance its financial liabilities freeing up more cash, which it said it will invest in more capital projects. As part of the refinancing operation, Codelco has carried out a successful bond placement for \$500 million with a 31-year term and a yield of 3.173%. The rate obtained represents a differential of 148 basis points over the U.S. Treasury bond of a similar term, the company said.

This rate is the lowest the corporation has obtained in its history for a debt of 30 years or more. More than 230 orders were received with demand exceeding US\$4.5 billion, which shows the confidence investors have in the plans of the corporation and in the country.

This rate is the lowest the company has obtained in its history for a debt of 30 years or more. Codelco said it received more than 230 orders with demand exceeding \$4.5 billion, which shows the confidence investors have in its plans and in Chile in general.

### JX Nippon Buys Stake in Caserones Copper Mine

JX Nippon Mining & Metals recently signed an agreement to purchase the stake in the Caserones copper mine, owned by its partners Mitsui & Co. and Mitsui Mining and Smelting, for an undisclosed amount. Mitsui Kinzoku currently owns 25.87% of the mine, while Mitsui & Co. hold 22.63%. The mine is located in northern Chile, near the border of Argentina.

JX Nippon said its goal is to maintain and expand production volume, as well as extend mine life by investing in automation using Internet of Things technology.

"The copper concentrate from the Caserones copper mine is a valuable resource for the JX Nippon Mining & Metals Group smelting and refining facilities," the company said. "As the copper grade of ores worldwide declines and impurities are on the increase, the value of the high-quality and clean Caserones ores is rising.

"Obtaining such excellent copper concentrate is seen as of key importance for the company's copper smelting and refin-

ing business, the core of the metal supply chain from upstream raw material ores to the downstream advanced materials, including recycling."

### Regional Lockdown in Argentina Affects San Jose Mine

Hochschild Mining plc announced that a significant increase in COVID-19 infections in Argentina's Santa Cruz province has resulted in a temporary lockdown of various mines. The company's San Jose operation has been mandated to halt operations and is currently undertaking a deep clean of the site's facilities and equipment. Subject to permission from the authorities, Hochschild expected to restart limited operations in early December. The company said the production stoppage would not affect its revised full-year production guidance of between 280,000 to 290,000 gold equivalent ounces (oz) or 24 million to 25 million silver equivalent oz.

Located in the northwest corner of the Deseado Massif, the mine produces a high-grade ore that is processed at an on-site mill. Roughly half the concentrate is smelted into doré on-site and the balance is filtered and shipped as concentrate. In 2019, the San Jose mine produced 105,500 gold equivalent oz. The mine started production in 2007 and is expected to continue until at least 2024.



Located in Chile near the border with Argentina at an altitude of 4,600 m above sea level, Caserones produces 110,000 to 150,000 metric tons (mt) of copper concentrate, 30,000 mt of copper cathodes and 3,000 mt of moly concentrate.

# West Africa May Be the New Frontier for Mineral Deposits

## By Gavin du Venage

West Africa is fast becoming the global hotspot for exploration, as the last frontier for new mineral deposits of dazzling richness.

This is the view of the Junior Exploration Indaba, a Johannesburg-based conference, which is the sister event to the Jo'burg Indaba on which *E&MJ* reported last month.

As established mining jurisdictions such as Canada and Australia mature, explorers are venturing back to Africa to find undiscovered mineral deposits.

"Africa is still that sort of place you can find a rich mine," William Witham, CEO of the Australia-Africa Minerals and Energy Group, said via a Zoom call. "Australia doesn't deliver that sort of excitement any longer. It's lower grades that have been picked over."

Francophone Africa is particularly enticing. Recently, Australia-based Mali Lithium paid \$60 million to buy Morilla Gold from Canadian firm Barrick. Senegal and Guinea are also drawing the attention of major mining companies. While gold was still the focus of interest, other minerals such as iron ore are also drawing in companies.

The vast Simandou iron deposit in Guinea, which had some of the world's largest companies such as Rio Tinto circling, is now heading for development.

The outliers to West Africa are Nigeria and Ghana, both of whom risk losing exploration investment. Unfriendly legislation and, in the case of Nigeria, poor infrastructure and security troubles, make these less than ideal for exploration, Witham said.

"It's really up to countries such as Ghana and Nigeria to look at what these others are doing, because money is not going into these two countries at the moment."

Nigeria at least is aware of these concerns and moving to address them, Abdulrazaq Garba, the director general of the Nigerian Geological Survey Agency, said. The country has begun publishing research data to assist explorers, and initial surveys show large resources of gold, silver, lead, nickel and lithium, to name but a few.

"We are doing a lot of exploration in Nigeria," Garba said. "Government is encouraging a national exploration project. So, Nigeria is clearly open for business."

Gold meanwhile, remains the favorite for junior explorers. Analysts predict that the price of gold, which has hung on to the average price of \$1,800 for much of this year, will only go higher from here. This makes discovering fresh deposits a bankable option, said Bert Monro, CEO of U.K.-listed Cora Gold.

"I see a good gold boom happening in West Africa, particularly the Francophone countries such as Mali, Guinea and Senegal," Monro said. "When the gold price is north of \$1,800/oz, there'll be a lot more projects coming up in West Africa."

Mali and Senegal have most of the attention from explorers, and will continue to do so as these countries have created a good mining ecosystem.

"They are good countries to be operating in, they have good infrastructure and good mining laws," Monro said.

However, just because African countries are well endowed with minerals, it does not mean explorers will show up regardless of risk. Some countries such as South Africa and Tanzania, to name just a couple, are generally avoided by explorers because of the perception that they are too high risk.

Paul Miller, director of AmaranthCX, said too often African countries ignored the need to be competitive.

"Not only must African countries compete against each other, they also compete against world-class mining destinations like Canada and Australia," Miller said. "Both these countries together attract more exploration investment than all 54 African countries combined."

He noted it is unfortunate that governments tend to focus on existing mines, and try to squeeze as much revenue from them by tinkering with taxes and royalties. Already established mines have little choice other than to bend to the evolving rules, but juniors and other potential investors will simply go elsewhere.

The duty of the government is to drive down the country pay limit, Miller said.

This is the exact opposite of what is happening in South Africa, Zambia and Tanzania. These countries have a continually shifting legal landscape that deters fresh investment.

Even with its abundant infrastructure, South Africa is failing to attract fresh exploration, because it has become a tough place to make long-term decisions. Mines can work around the lack of electricity and roads. They cannot, however, plan for sudden shifts in legislation, Miller added.

"Existing mines have no choice — they own a hole in the ground. But new mines, these won't be built because the government makes the cost too high."

Perhaps few destinations demonstrate the risk-reward dichotomy of African mining more than the Democratic Republic of Congo. After decades of brutal civil war, the country has now been stable for almost 20 years. Yet, it remains the wild west of mining, said Louis Watum, president of the country's Chamber of Mines.

"There's a lack of infrastructure and power supply," Watum said. "There's also poor governance. This makes the cost of mining extremely high."

A result of this is that those companies working in the country only focus on the highest grade deposits. They know that building a mine will include laying on their own power, providing their own security, and flying in everything needed to keep their operations going. This means it does not pay to pursue mineral deposits that are not of the highest grade.

"The cost of mining means you focus on high value extraction, and this is a pity because it leaves a lot of value in the ground."

Of all the central and southern African countries, Botswana remains the favorite. The country has recently overhauled its mining legislation, a process normally fraught with tension for mining companies. However, Botswana Chamber of Mines CEO Charles Siwawa told the Indaba that the new law was crafted with mines very much part of the process.

"Government is willing to bend over backward to accommodate the industry, which is very encouraging," Siwawa said.

As such, it appears Botswana is on the cusp of a new wave of investment as exploration reveals new deposits, particularly along the western side the country. Up to now, most mining and exploration has focused on the east, Siwawa added.

“Copper is the main focus. Not as exciting as the Congo or Zambia, but interesting nonetheless. It is also the site of one of the greatest iron ore discoveries in the region — the value of the deposit is at least \$2 billion.”

## Amplats Completes ACP Phase A Rebuild

In early December, Anglo American Platinum (Amplats) safely and successfully completed the rebuild of the Anglo Converter Plant (ACP) Phase A unit. The unit was ramping up and on track to be operating at full capacity by the end of the year.

“The ACP operations and projects teams have done an extraordinary job in safely completing the rebuild and re-commissioning of the ACP Phase A unit,” said Natascha Viljoen, CEO, Amplats. “We were able to procure and deliver long lead-time items to site six months ahead of schedule, despite the impact of Covid-19 on supply chains, enabling us to bring forward the rebuild to the end of 2020, ahead of our initial expectations of Q2 2021. First converter matte is now ready to be dispatched, allowing us to re-establish the processing pipeline to finished metals. I am also pleased that our marketing team has worked tirelessly with our customers to mitigate the impact of the interruption and manage our contractual obligations during this period.”

As a result, the company has upgraded refined production guidance for 2020 to between 2.6 million to 2.7 million PGM ounces (previously 2.5 million PGM ounces). Sales volumes have also been upgraded to about 2.8 million PGM ounces, as minor metal refined inventories have been drawn down. The release of the work-in-progress inventory built up in 2020 is expected to take up to 24 months.

During November, the company decided to close the ACP Phase B unit after a comprehensive assessment discovered further water leaks. The company decided to close the unit and schedule a full rebuild for 2021.

“The ACP Phase B unit has been fragile and has unfortunately recently experienced a number of further instances of wa-



Early completion of the ACP Phase A rebuild (above) allows Amplats to upgrade its production guidance for platinum group metals (PGMs).

ter leaks,” Viljoen said at the time. “While the ACP management team has done extraordinary work to keep the unit operating safely over the past several months, we have taken this pre-emptive decision to now close the ACP Phase B unit to ensure we protect our employees, operating environment and the integrity of our assets.”

Viljoen also said at the time the company would continue with the rebuild of the main ACP Phase A unit, which was originally scheduled for completion during the second quarter of 2021.

## EGC Signs Offtake Agreement With Trafigura for DRC Cobalt

Entreprise Générale du Cobalt (EGC) recently signed an offtake agreement with Trafigura Pte Ltd. EGC is a Congolese mining company, owned by the state of the Democratic Republic of the Congo (DRC), which holds the monopoly for the purchase, treatment, transformation, sale and export of cobalt extracted by artisanal miners or artisanal mining companies in the DRC.

“For our country to benefit from the intrinsic value of cobalt, currently boosted by the development of carbon-free energies, it was essential that measures be taken to support the formalization of this industry,” said Jean-Dominique Takis Kumbo, EGC managing director. “By cleaning up this sector, which has been subject to recurring illegality and fraud for several years, and of which our artisanal miners are the first victims, society stands to benefit as a whole.”

Through the agreement, Trafigura will fund the creation of strictly controlled artisanal mining zones, the installation of ore purchasing stations and costs related to the transparent and traceable delivery of cobalt hydroxide to Trafigura on an export cleared basis. Under the supply terms, EGC will ensure that the ore marketed by Trafigura complies with OECD Due Diligence Guidance for Responsible Supply Chains of Minerals from Conflict-Affected and High-Risk Areas.

“Cobalt has a vital role to play in the world’s energy transition and electrification and artisanal mining provides an important livelihood in the DRC,” Trafigura Executive Chairman and CEO Jeremy Weir said. “Ultimately, the legitimacy of efforts to formalize and bring controls to the sector will depend on broad-based consultation and assurance that OECD standards will be upheld. We will continue to engage and collaborate with stakeholders to be part of the solution to supply cobalt responsibly.”

In support of this agreement, EGC will establish a technical committee through which Trafigura and the international nonprofit organization Pact, among others, will promote responsible sourcing diligence. The NGO Pact works alongside local communities in nearly 40 countries to eradicate poverty, notably by making artisanal and small-scale mining formal, safer and more productive. In 2018, Trafigura and Pact first piloted an approach to the responsible sourcing of cobalt from semi-mechanized operations at the Mutsho concession in the DRC.

# Pentwater Blames Rio Tinto for Oyu Tolgoi Mismanagement

Pentwater Capital Management LP, the largest minority shareholder of Turquoise Hill Resources Ltd., wrote a letter to the Rio Tinto plc Board of Directors, which manages and owns 51% of Turquoise Hill, describing Rio Tinto's "oppressive" actions taken against minority shareholders. It also threatened to file an action for oppression against Rio Tinto if its behavior is not corrected. Turquoise Hill Resources operates the Oyu Tolgoi copper mine in Mongolia.

A main concern from Pentwater was the delayed timeline for underground development at Oyu Tolgoi. It was originally supposed to reach first sustainable production in Q1 2021 with a \$5.3 billion budget. In July 2019, Rio Tinto said it expected a massive cost overrun and schedule delays.

According to Pentwater, a former Rio employee who turned whistleblower named Richard Bowley said the budget overrun and schedule delay were largely caused by Rio's negligent construction of shaft No. 2.

The letter said in July 2018, Bowley told executives the mine was \$300 million over budget and a year behind schedule. But in a presentation to U.S. investors on October 2, 2018, the head of Rio's copper business, Arnaud Soirat, said the project was "on budget and on schedule."

Pentwater said Bowley was scheduled to provide live testimony in open court last month, but the day before the hearing was scheduled to take place, Rio agreed to an undisclosed settlement with Bowley.

Pentwater also addressed the destruction of the aboriginal sites in Australia by Rio, as well as bribery investigations and financial disclosure investigations that have been brought against Rio.

A day before Rio Tinto decided to part ways with CEO Jean Jacques, Pentwater said Jacques "attempted to force Turquoise Hill to pay for the cost overruns caused by Rio's own mismanagement of the construction of the under-

ground mine through an equity rights offering instead of accessing cheaper, readily available financing."

Pentwater said Rio is preventing Turquoise Hill from seeking financing solutions that are most optimal for shareholders. "Rio is attempting to force Turquoise Hill to conduct an equity raise despite the fact that the current equity price severely undervalues the company and despite the fact that there are much cheaper and more advantageous financing options available to the company, such as streaming and bond financing," the letter said.

According to Pentwater, Rio has notified Turquoise Hill it will oppose any additional debt or hybrid financing options beyond the amount in the memorandum of understanding.

Turquoise Hill's current financing agreements are written to allow for \$1.6 billion of supplemental financing, according to Pentwater.

Pentwater believes Rio has prevented minority shareholders from serving on the Turquoise Hill board in an attempt to block any investigation into "Rio's reported misfeasance and malfeasance committed in construction of the underground mine."

According to Pentwater, U.S. corporate governance firm, Institutional Shareholder Services (ISS) supported minority shareholder representation on the Turquoise Hill Board. On July 15, ISS said, "the board's history of communication with minority shareholders is of particular concern" and noted that it "has not gone far enough" in ensuring "mitigation of conflicts of interest."

Pentwater said "enough is enough" and it is prepared to move forward with legal action if the "oppressive behavior" isn't resolved. Owners of the mine should be treated as business partners and "not as puppets or pawns."

It seems as though Pentwater isn't the only one with concerns. On November 25, the government of Mongolia asked Oyu Tolgoi LLC to seek an independent review into delays and costs

overruns in the underground expansion of the Oyu Tolgoi mine.

The board of directors of Oyu Tolgoi LLC approved a resolution establishing the special board committee to conduct the independent review.

The special committee is comprised of four members: two nominated by Turquoise Hill and two members nominated by Erdenes Oyu Tolgoi (EOT), a state-owned entity that owns the remaining 34% interest in Oyu Tolgoi LLC. The special committee will select and engage an independent and reputable firm of experts in the field of project management and mine planning to provide a report within six months of commencing the investigation. The resolution requests each shareholder of Oyu Tolgoi, as well as Rio Tinto, as manager, to cooperate fully with the special committee.

"TRQ fully supports our government partner, EOT, in securing an independent and objective review of the cost overruns and delays announced last year," Turquoise Hill CEO Ulf Quellmann said.

In addition to a formal review, Oyu Tolgoi has also initiated arbitration against Rio Tinto. It seeks clarification of certain agreements with Rio Tinto International Holdings Ltd. (RTIHL) and a related party associated with their role and obligations to support the company in seeking additional financing for the Oyu Tolgoi project.

The special committee said Rio Tinto's approach to the financing of the Oyu Tolgoi project is incompatible with the company's announced strategy to maximize debt and/or hybrid financing for the Oyu Tolgoi project so as to minimize the size and defer the timing of an equity rights offering, the company said. The special committee believes the arbitration will provide needed clarity from an independent third party. The arbitration process is confidential and is expected to take three to five months to reach a decision. The arbitrator's decision will be final and binding on the parties.



Details of the company's preferred funding options will be presented to Rio Tinto for consideration in accordance with the memorandum of understanding prior to December 31.

## Baru Gold Moves Forward With Sangihe Project

Baru Gold Corp. is hiring mining contractors and has commenced the sourcing of heap-leach operational equipment for its Sangihe gold-silver project in Indonesia.

"Baru Gold continues to move toward commencement of production and cash flow from gold production on the Sangihe project in the first half of 2021," Baru Gold CEO Terry Filbert said. "We have begun procuring equipment and additional land, and we expect the operation license to be signed off as soon as the Indonesian Mining Department (EDSM) reopens after its shutdown due to COVID-19." A second wave of the pandemic is currently sweeping through Jakarta.

With the environmental permit application (AMDAL) approval in October and the subsequent payment of the outstanding financial obligations in the fourth quarter of 2020, Baru Gold has ramped up operational activities by procuring the supplies necessary for the 100,000 metric ton (mt) heap-leach pad outlined in the company's business plan. The construction of the heap leach operation has begun and it is not contingent on receipt of the operational permit.

The company's engineering team recently completed a detailed survey of the areas required for mining operations. "We will soon be completing the land acquisition with the government and the local land users for the additional land needed for the project," Filbert said. "These additional hectares at Sangihe will provide Baru Gold with space for an operational base, warehouses, accommodations and production facilities required for proper operations."

The Sangihe gold-silver project is located on the island of Sangihe off the northern coast of Sulawesi and has an existing National Instrument 43-101 inferred mineral resource of 114,700 indicated and 105,000 inferred ounces (oz) of gold. Only 10% of the gold bearing area



Exploration drilling at the Sangihe gold-silver project further defines the orebody.

has been explored. The company's 70% interest in the Sangihe mineral tenement contract of work (CoW) is held through PT. Tambang Mas Sangihe (TMS). The remaining 30% interest in TMS is held by three Indonesian corporations. The term of the Sangihe CoW agreement is for 30 years upon commencement of the production phase of the project.

## China's GEM, Glencore Extend Cobalt Partnership

Glencore and GEM have extended their partnership for the supply of cobalt hydroxide by another five years and have formally embedded responsible sourcing and sustainability into the contractual relationship.

Under the terms of the agreement, Glencore will provide around 150,000 metric tons (mt) of cobalt contained in hydroxide for GEM between 2020 and 2029.

Glencore and GEM are committing each other to annual audits under OECD-aligned standards, specifically, the Cobalt Refiner Supply Chain Due Diligence Standard developed by the Responsible Minerals Initiative (RMI), Responsible Cobalt Initiative (RCI) and Chinese Chamber of Commerce of Metals, Minerals and Chemicals Importers and Exporters (CCCIMC). This shared commitment will help to demonstrate strong responsible sourcing practices and transparency across multiple points along the supply chain.

The Cobalt Institute, which counts Glencore as one of its members, has developed the Cobalt Industry Responsible Assessment Framework (CIRAF), an industry-wide risk management tool that helps cobalt supply chain players identify production and sourcing related risks. This long-term strategic cobalt partnership includes a commitment to use CIRAF when communicating publicly on environmental and social issues specific to the cobalt supply chain.

Xu, Kai Hua, chairman of GEM, said, "Despite the COVID-19 pandemic in 2020, the adoption of new energy vehicles is accelerating, and there is no doubt that they are revolutionizing the world's automobile industry. As a result, cobalt, as one of the key raw materials for EV batteries, will become a global strategic resource of extreme importance for the rapidly growing new energy vehicles market in China and the rest of the world.

"Glencore, the world's largest producer of responsible cobalt, has maintained strong cooperation with GEM for many years. This 10-year cobalt supply agreement reflects a deepening of the strategic cooperation between cobalt resources and the market in the face of the changing competitive landscape and the booming trend of new energy in the world and will fundamentally stabilize the development of GEM cobalt products."

## Demanding Conditions, Demand JENNMAR

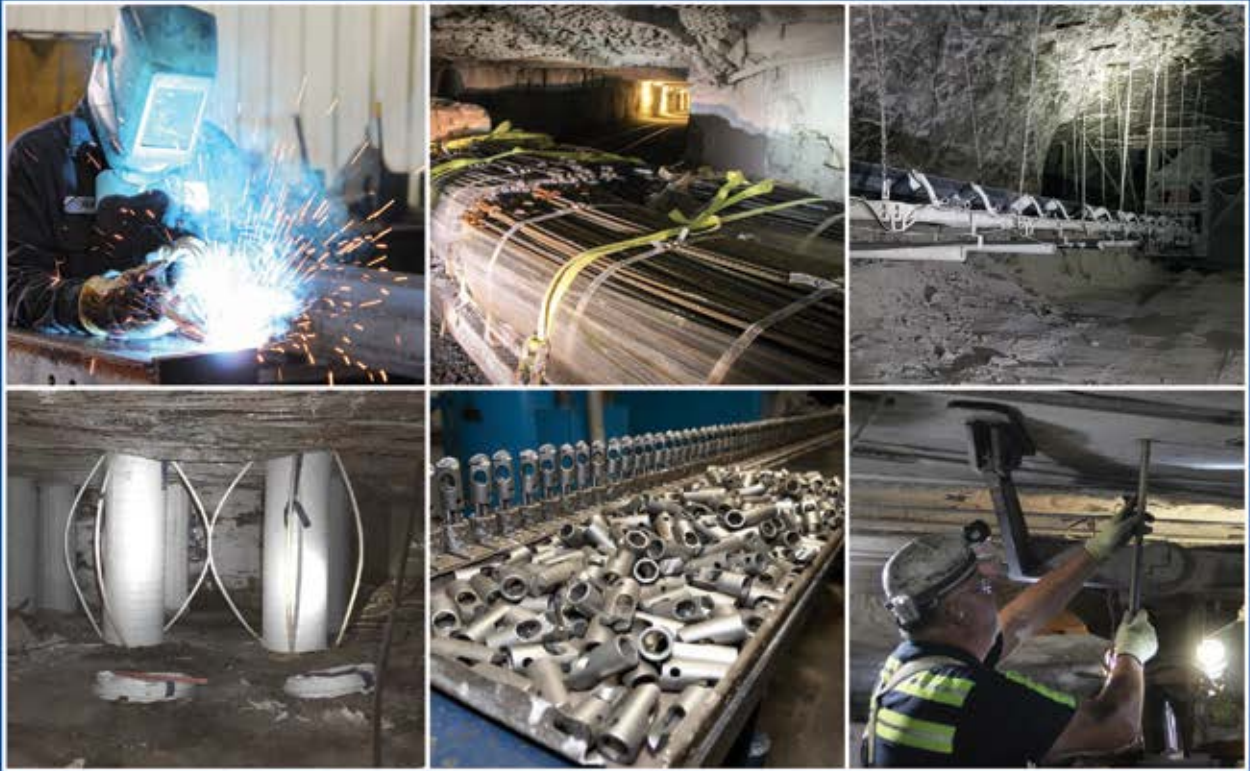
We are a diversified manufacturer and services provider for above and below ground infrastructure that sets standards in terms of quality and safety for our stakeholders. Our mission is total customer support and satisfaction.

Our portfolio of brands are rebuilding America's infrastructure. Because we understand the ever changing and demanding conditions above and below ground we have built the richest portfolio of diverse and complementary brands. From engineering to resin manufacturing, rolled-steel and drill-steel manufacturing, custom steel fabrication, precision wear parts, tools and bits, chemical roof support and sealing pro-

ducts, staffing solutions, transportation and more – we ensure the customer has the support at every stage of their projects. Visit our brands at [www.jennmar.com](http://www.jennmar.com), [www.xcaltools.com](http://www.xcaltools.com), or [www.xcalindustries.com](http://www.xcalindustries.com).

JENNMAR continues to grow, but our focus will always be on the customer. We feel it is essential to develop a close working relationship with every customer so we can understand their unique challenges and ensure superior customer service. Our commitment to the customer is guided by three words: SAFETY, SERVICE, and INNOVATION. It's these words that form the foundation of our business. It's who we are.





## SAFETY, SERVICE, AND INNOVATION

JENNMAR offers a wide range of products used in supporting, building and rebuilding our infrastructure from above and below ground. Our strength lies in our ability to offer our customers solutions in every phase of their projects. In addition to more than 20 strategically located manufacturing facilities, our affiliated brands of companies include engineering services, resin manufacturing, rolled-steel and drill-steel manufacturing, custom steel fabrication, precision wear parts, tools and bits made from tungsten carbide and steels, chemical roof support and sealing products, and even includes staffing solutions and our own trucking company. JENNMAR is backed by experienced engineers and technicians who are with you every step of the way, from initial consultation to qualified instruction and on-going technical support to make your project a success!

# China Buys More Met Coal From Teck

Teck Resources reported increased metallurgical coal sales to China for the fourth quarter of 2020. These sales have been at higher pricing levels compared to markets outside China. Estimated total fourth quarter sales remain within Teck's existing guidance of 5.8 million to 6.2 million metric tons (mt), with approximately 20% of these sales now to Chinese customers.

Pricing in China for Teck's met coal started to increase around the middle of the current quarter when a large portion of our overall sales were already concluded. Additional spot sales to China were concluded gradually as the price was rising and achieved an average premium in excess of \$35/mt above Australian FOB spot pricing at the time each sale was concluded.

The company explained its contract sales to Chinese customers are also priced on the basis of CFR China price assessments. The most recent three cargos were sold at prices between \$160/mt and US\$165/mt CFR China. In a declining coal price environment, Teck's realized coal price relative to benchmark would normally be lower than the long-term average of 92%. As a result of these recent sales at premium prices, however, the company is estimating that Q4 realized price will reflect that long term average of approximately 92% despite the price drop for markets outside China where the majority of Teck's met coal is sold.

The company also mentioned that it had detailed discussions with customers regarding 2021 sales and it's restructuring its sales book to target 2021 sales to Chi-

na of approximately 7.5 million mt. They also warned investors that these sales are subject to a range of risks including general market and economic conditions, general and specific port restrictions, Chinese regulation and policies, and normal production and operating risks. They are planning to sell those 2021 tons at CFR China pricing which currently reflects a premium to Australian FOB spot pricing of approximately \$50/mt.

## Aquila Investment Extends Life of Capcoal's UG Ops

Anglo American has invested more than A\$240 million (\$179 million) in its Aquila metallurgical coal project in Central Queensland, which it believes will be one of the world's most technologically advanced underground mines. Aquila forms part of the Capcoal Joint Venture between Anglo American (70%) and Mitsui & Co. Ltd. (30%).

The Aquila investment will extend the life of operation by six years, while it continues to use the associated infrastructure at the Capcoal complex as its nearby Grasstree mine approaches end of life.

Anglo American has awarded nearly \$200 million to six longwall equipment suppliers to deliver a walk-on, walk-off system using two complete longwalls, a \$20 million overland conveyor system and more than \$20 million in civil works.

Anglo American's Metallurgical Coal Business Chief Executive Officer Tyler Mitchelson said the project was on track for first longwall production of premium quality hard coking coal in early 2022.

"The mine will showcase our innovation-led approach to sustainable mining, with a remote operating center on the surface of the mine, proximity detection systems underground to alert machine operators to pedestrians and the continued digitization of our operations, using new technologies such as our Australian-first intrinsically safe underground electronic tablets," Mitchelson said.

## Carmichael Project Creates More Than 2,000 Jobs

Construction at Bravus Mining and Resources', formerly Adani Mining, Carmichael Project in Central Queensland is now at its peak level, with more than 2,000 people working at the site. Bravus CEO David Boshoff said the project has been able to deliver more jobs than previously expected.

"We have always said the Carmichael Project would be a major generator of jobs and now we are at peak construction levels employing more than 2,000 people on-site," he said. "The Stop Adani movement said our project would never go ahead and would never create a single job. We have again proved our opponents wrong."

Boshoff said the project's accommodation camps were full with workers from all corners of the state. "We have now awarded more than \$1.5 billion in contracts, and 90% of those are being delivered by Queensland-based contractors, from Rockhampton and Townsville, to Mackay, Clermont, Collinsville, Gladstone and Toowoomba," he said. "We have done our best to ensure Queensland businesses are reaping the economic rewards of the Carmichael Project."

The jobs announcement coincided with a project milestone for Bravus as the first controlled blast occurred on-site.

"The team has done an incredible job of moving more than 2.5 million cubic meters (m) of soil that sits on top of the coal seams, using excavators," Boshoff said.

Work has commenced on the coal handling and processing plant, and in the coming weeks, there will be progress on the rail project as well, with track laying to commence shortly.

The project will produce first coal in 2021.



Anglo American recently purchases new longwall mining equipment for the Aquila mine.

# Protests Related to Political Turmoil Impact Mines, Suppliers in Belarus

By **Valdislav Voronikov**

The continuing political demonstrations and protests against the Belarusian government and President Alexander Lukashenko have reportedly gripped the country's mining industry.

The largest potash producer in Belarus, BelarusKali, was forced to reduce capacity due to an ongoing strike at the company's production facilities, BelarusKali's strike committee said on November 6.

In October and November, the targeted production figures were reduced by nearly 15% compared to August, the committee said. In total, 60 company's employees are currently participating in the strike, with many more opting for a work-to-rule strike.

Belarus opposition announced a nationwide general strike on October 26. The strike has affected major state-owned companies, including oil company Belarusneft, fertilizer giant Belaruskali, automakers MAZ, MZKT, and Belkommunmash, tractor manufacturer MTZ and appliance maker Atlant, the National Strike Committee of Belarus said.

The strike has also affected the country's haul truck producer BelAZ, although it is not clear how many employees are involved.

The government officials, however, deny that the general strike has affected any industrial companies. "There is absolutely no damage. Production is manufactured and delivered as usual," Petr Parkhomchik, Belarus industry minister, said, speaking during his visit to BelAZ.

"They [protesters] gather in groups of 10, 15 or 20 men, take photos and post them on social networks, and claim that plants are not operating, protesting, not fulfilling its obligations. Our law is very strict — the man not executing his work duties will be subjected to certain penalties," Parkhomchik added.

However, other officials are not so optimistic. For instance, another major fertilizer company Grodno Azot is experiencing certain difficulties due to the strike.

"A group of a few dozens of men, encouraged from outside, calling itself a strike committee, is trying to kill the plant," Igor Bobyl, general director of Grodno Azot, said, adding that the protesters had been terrorizing the plant for nearly three months.

## Devaluation Cuts Profit

The Belarusian ruble's devaluation, however, proved to be a more significant

blow for the country's mining industry than the strike. Since the beginning of protests in May, the national currency lost nearly 50% in value, putting heavy pressure on almost all companies' financial performance.

During the first eight months of 2020, the country's mining industry's combined net profit decreased by a factor of 2.7 times to BYN 57.6 million (\$22.5 million). The share of loss-making companies in the industry doubled — from 8.3% to 16.7%, the Belarus State Statistical Service estimated.

As of September 1, Belarus mining companies accumulated a total debt of BYN 2.971 billion (\$1.1 billion). This figure jumped by 75.8% in national currency, as the Belarus ruble's downward rally made foreign currency loans and borrowings way more expensive.

Against this backdrop, Belarusian mining companies allocated BYN 1.542 billion (\$602 million) to repay loans, which is 90.7% more than in 2019. The Belarus ruble is likely to lose even more value, as the European External Action Service (EEAS), the EU's diplomatic body, announced on November 13 it will consider new sanctions against Belarus for violence against protesters, some of whom were killed during street clashes.

## NEWS - CALENDAR OF EVENTS

**MARCH 1-5, 2021: SME Annual Conference & EXPO, (Virtual).** Contact: Web: [www.smeannualconference.com](http://www.smeannualconference.com).

**MARCH 7-10, 2021:** The annual meeting of the **Prospectors & Developers Association of Canada, (Virtual).** Contact: Web: [www.pdac.ca/convention/attendee-info/pdac-2021-convention-goes-virtual](http://www.pdac.ca/convention/attendee-info/pdac-2021-convention-goes-virtual).

**MARCH 14-17, 2021: Haulage & Loading 2021, Hilton El Conquistador Resort, Tucson, Arizona, USA.** Contact: Web: [www.haulageandloading.com](http://www.haulageandloading.com).

**APRIL 19-23, 2021 Expomin, Espacio Riesco, Santiago, Chile.** Contact: Web: [www.expomin.cl](http://www.expomin.cl).

**MAY 4-6, 2021: Canadian Institute for Mining (CIM), Montreal, Quebec, Canada.** Contact: Web: [convention.cim.org](http://convention.cim.org).

**MAY 4-6, 2021: US Coal Show/Longwall Edition, Pittsburgh, Pennsylvania, USA.** Contact: Web: [www.longwallusa.com](http://www.longwallusa.com).

**MAY 11-13, 2021: 14<sup>th</sup> International Gold, Silver and Copper Symposium, Lima, Peru.** Contact: Web: [simposium-del-oro.pe](http://simposium-del-oro.pe).

**JUNE 1-3, 2021 Euro Mine Expo (Virtual), Kraft Center, Skelleftea, Sweden.** Contact: Web: [www.eurominexpo.com](http://www.eurominexpo.com).

**JUNE 7-11, 2021: Elko Mining, Elko, Nevada, USA.** Contact: Web: [www.ExploreElko.com](http://www.ExploreElko.com).

**SEPTEMBER 13-15, 2021: MINExpo INTERNATIONAL, Las Vegas, Nevada, USA.** Contact: Web: [www.minexpo.com](http://www.minexpo.com).

## Your new hard rock mining solutions provider



Hard rock mining operations require flexibility and machines that can evolve with your operation. As teams work in increasingly challenging environments on deeper deposits, you need ways to lower your costs, speed up production and mitigate the environmental challenges inherent in the work you do.

The mining industry is rapidly adopting new technologies, and Komatsu works to help customers stay on the cutting edge by delivering solutions that leverage artificial intelligence, augmented reality, automation, remote operation, robotics and more to help you reach your business goals. Our suite of forward-thinking hard rock products are designed for the challenges of tough mining environments and include jumbo drills, bolters, drifters, LHDs, trucks, and a full line of raisebor-ing tools and blasthole drilling tools.

Collaborating with customers and forging partnerships to advance beyond what was previously possible, Komatsu supports your operation by leveraging decades of experience and expertise, with a dedicated focus on safety, quality and reliability. Our new hard rock mining products are a direct result of invaluable customer feedback. Read on to see how customer needs have become industry solutions:

### Common platform lets you seamlessly convert from jumbo to bolter

What if you didn't have to invest in two different machines to cover your demands for drilling and bolting? To support customers' needs for flexible fleets there's now a common platform between bolter and jumbo offerings from Komatsu that lets you seamlessly convert from one to the other. The new Komatsu ZB21 underground bolter, and the Komatsu ZJ21 jumbo drilling machine have a platform with 100 percent design commonality from the rear skirt to the outer boom structure.

Beyond the industry-first common platform, the controls of the ZB21 bolter and ZJ21 jumbo are similar too. The hydraulic pilot control system with universal bolting and drilling controls, simplifies user training and adoption across both models. Platform universality offers advantages with job site efficiency, leveraging common parts, service and maintenance.

### Bring intelligence to your hard rock operation

Trying to make inroads into automation at your operation? The ZJ32Bi medium-class development drill has an "organical-

ly developed" computer control system. (The "i" stands for intelligent.) With semiautonomous functionality and built-in operator augmentation features when in manual drilling mode, the computerized, smart platform features two-joystick functions, onboard manuals, parts books and semiautonomous operation. Modular controls, a self-diagnostic system and ground monitoring are designed for precision. Features such as fixed bit and actuator roll around can augment the skills of even the most experienced operators.

To address the significant downtime chafed and damaged hoses on the boom can cause, we've created a hoseless boom that completes all fluid and communication transfer inside of the boom cylinder. The ZJ32Bi jumbo with hoseless booms eliminates the need to account for hoses in our automation algorithms. A hoseless boom also eliminates wear between the inner and outer boom tubes to improve drilling accuracy over time — offering a potential game-changer in terms of automation and productivity.

And since not every application may need a hoseless boom, Komatsu engineers have designed an unconventional "conventional" boom offering. Leveraging smart hydraulics, this solution reduces the number of hoses to only six per boom, helping improve visibility. All sensors and electronics are integrated into the design, protecting the six hoses, yet making them accessible for maintenance.

### Explore more

Want to learn more about these machines and other recent hard rock innovations from Komatsu? Check out the on-demand video from our recent virtual event "Explore beyond the surface: Innovations for hard rock mining." It can be viewed at <https://mining.komatsu>.

Our robust portfolio of products includes these innovative new additions as well as former Joy underground hard rock products now under the Komatsu brand; all connected to our vast global service and distribution network and supported by advanced technology to help optimize your hard rock mining operations.



**KOMATSU**

# Stay productive while inside

Modern mining means being able to complete the entire bolting cycle from the operator cabin. Stay productive, but further from the face, with the new Komatsu ZB21 hard rock bolter; featuring integrated screen handling and an all-new chemical injection system.

**See more at [mining.komatsu/hardrock](https://mining.komatsu/hardrock)**

# Copper Processing: The Quest for Efficiency at Scale

*Where do the greatest optimization opportunities lie? And what will future flowsheets look like? E&MJ sets out to answer some copper-based questions.*

By Carly Leonida, European Editor



CRC ORE recently completes an assessment of bulk ore sorting opportunities for BHP's Olympic Dam copper operation in Australia. (Photo: BHP)

Advances in copper processing technologies from the past 30 years nearly all fall into the category of “the bigger, the better” — higher volume flotation cells, massive high-pressure grinding rolls (HPGRs), super-sized concentrators. For some time now, we have been chasing economies of scale, which will soon cease to exist.

The trends that will characterize R&D to 2050 and beyond are quite different. Going forward, the lion's share of investment, for both vendors and miners, will lie in technologies and flowsheet designs that reduce energy consumption and greenhouse gas (GHG)

emissions, enable water reuse and handle tailings responsibly, all while maintaining high safety standards.

Copper processing operations are some of the most water and energy-intensive within the mining industry that, as a whole, is responsible for 11% of worldwide energy usage, according to the World Bank's 2020 Minerals for Climate Action report.

Today, the majority of copper is produced as a concentrate through conventional flotation, with a small portion produced as cathode through leaching followed by solvent extraction and electrowinning (SX-EW). Either way, a vast

amount of energy is required to liberate metal from waste.

In its report, Zero Emission Copper Mine of the Future, The Warren Centre at the University of Sydney, stated that 87% of electrical energy consumption in Chilean copper mining during 2015 occurred in mill plant concentrators, leaching and SX/EW circuits. To put that into perspective, in 2019, 23.6 TWh of electricity was used in Chile for copper mining. The country accounts for 28% of global copper output.

“The trend toward declining orebody grades and continued development of the



pursuit of existing operations to exploit lower grade deposits is likely to continue, in the absence of high-grade project discovery,” the report stated in its outlook for copper production to 2050.

“A decline in ore grade results in higher operating costs due primarily to the amount and depth of material required to be mined and processed to produce the same amount of copper product. It is no surprise that both GHG emission intensity and energy intensity increase as ore grade decreases. There is a point of inflection, where below an ore grade of around 0.5% copper, the intensity of both metrics rises sharply.”

Given that many mines are fast approaching, if not already tackling, similar grades, this is a pressing problem. In its fiscal year 2020 commodity outlook, BHP, the world’s third largest copper producer, estimated that grade decline could remove about 2 million metric tons per year (mt/y) of refined copper supply by 2030, with resource depletion potentially removing an additional 1.5 million to 2.25 million mt/y by this date.

It’s clear that the headwinds copper producers face are significant, but so are the strides being made in more efficient and economic processing.

## Growing Complexity

In copper, as with many other commodities, as ore grades have fallen, orebodies have become more complex, with higher levels of impurities, some of which mines are penalized for at the smelting stage if left unchecked.

“Arsenic is an example of an impurity that has increased in concentration. It has increased processing costs, and in some cases, made orebodies uneconomic,” Mark Mulligan, global head of process line management for mining at FLSmidth, explained. “In other cases, the orebodies are more polymetallic, also requiring higher processing costs to extract the copper.”

Orebody complexity can also pose challenges in the early phases of a project because, understandably, companies want to know exactly what they’re dealing with. Better knowledge of the orebody reduces uncertainty, but more testing requires more time and carries with it the chance of cost blowouts.

“If you’re a banker, you would look very closely at how well defined an orebody is,” said Alan Boylston, vice presi-

dent for process engineering and comminution at Metso Outotec. “Because you want to minimize risk and make sure that the plant you’re financing is going to be able to produce metal.”

In terms of the design of the plant, ore complexity also drives the approach to both comminution at the front end and separation at the back end.

“We’ve been looking at a copper plant recently where there’s sulphide, oxide and supergene mineralization zones in the orebody,” Boylston said. “The comminution characteristics are so vastly different between those three zones, that a traditional SAG ball mill circuit is likely going to struggle.

“The way that a SAG mill is going to behave with those different ores is very different. So, that can drive the front end of the process. And then, obviously, whether you’re dealing with an oxide or a sulphide-based ore, that’s going to drive what’s happening in the back end of the process.

“Complexity is a big issue these days. It’s one of the reasons that companies are trying to extend the life of their existing assets, because they’re often in a more stable part of the orebody. They know it much better and are prepared to deal with it.”

Ore complexity also reinforces the need for digital technologies like advanced process control. Higher variation in the plant feed means that constant measuring is required and subsequent adjustment in the operating parameters of separation technologies to maintain metal production through swings in the volume and head grade; process control systems are critical in achieving this.

Remote operation and support capabilities also allow mines to tap into domain expertise offered by their vendors, and machine learning and simulation open up new opportunities in performance optimization.

## Opportunity to Innovate

The past 20-30 years have been characterized by a gradual decline in the discovery and extraction of copper oxide orebodies, which can be treated through heap leaching flowsheets, and a shift toward sulphide ores, which are traditionally treated through flotation. Hence the increase in the number of concentrators built worldwide and particularly in South America.

While there are some new copper projects in the wings, most mining companies

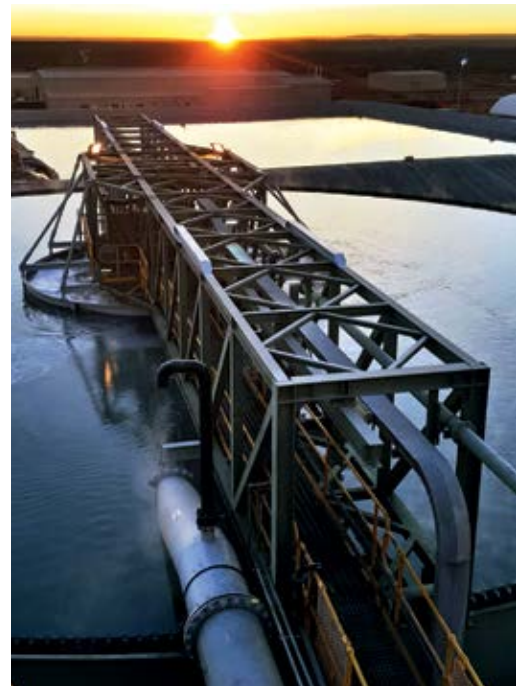
are looking to expand or optimize their existing operations rather than run the gauntlet of permitting a new development.

Boylston’s colleague, Matt Gallimore, senior manager for sustainability at Metso Outotec, also joined the discussion. “It’s getting really difficult to bring new operations online, for a range of reasons,” he explained. “Exploration costs are going up, the timeline for getting permits and designs finalized is much longer...”

“But a lot of mining companies are using that opportunity to think outside of the box. They’re more open to trying new things and that’s really encouraging.”

While mining companies may be keen to try new approaches when it comes to processing, convincing investors to back them is more tricky. It’s a frustration that every vendor interviewed for this article expressed.

“One of the differences between copper and gold, for example, is the scale,” Boylston explained. “Gold being a more volatile commodity, we tend to see a lot more smaller gold projects, with shorter mine lives and lower throughputs, because they can access financing easier. Whereas copper is more often tied to the state of the global economy and, in terms of construction, those projects tend to be much larger. Getting into new technolo-



Water reuse plays a crucial role in reducing risk and maintaining a social license to operate at copper mines across the globe. (Photo: FLSmidth)

gies therefore tends to be a riskier and more expensive proposition.

“We can do a small-scale proof of concept, but to put these technologies into an operation where you can validate that work is beyond the capabilities of a vendor,” Gallimore said. “Mining companies have to partner up with vendors, that’s the only way some technologies can be tested at a reasonable scale. For example, in copper, the design duty needed may be far beyond what you can validate at a normal pilot scale... The definition of pilot scale changes to requiring placement at an existing operation.”

This can present a challenge for vendors, as many existing operations are stretched for space and capacity. Fortunately, there are some opportunities though around water reuse.

“In the case of some tailings handling processes, it’s possible to put them into an existing operation,” Gallimore said. “But the challenge is that they might not fit with their tailings management system. It might require a really significant investment of capital if, for example, the mine is used to pumping its tailings to one place. To move to filtering would require a completely different material handling system.

“Having said that, you often have to do things at the brownfield level, because

how in the world is a mining company going to take a bench-level or small pilot-level validated technology and build a whole new facility around it? It compounds the risk. By necessity, companies have to take the risk somewhere, and it’s more logical for them to take it at a brownfield facility. But, again, the cost can be quite significant.”

Historically, risk has always been discussed in terms of finance. However, social license to operate now exceeds that in some areas; EY has named it the no. 1 risk to mining companies for two years in a row, and water use is a crucial aspect of that. It’s important to find a balance between priorities.

“Water usage can determine whether or not a mine can even run their plant,” Gallimore said. “We’ve seen mines that had to stop or reduce production because of a lack of water.”

### First, the Front End

Some of the most visible advances in process efficiency in recent years have been at the front end of copper flowsheets in comminution.

“There are two technologies that have been really strong over the last 20- to 30-year timeframe,” explained Boylston. “Firstly, stirred mills like the HIGMill, vertical mills or stirred media detritors (SMDs).

“With stirred mills, the big drivers are lower energy efficiency and media consumption. Then, in the finer size ranges, where something like a HIGmill or a SMD are used, it’s all about energy efficiency. It’s much more efficient to grind to very fine or ultra-fine levels using these technologies that have very small media than in a ball mill where a lot of the energy is wasted in lifting the media, as opposed to grinding.

“Second are HPGRs. These started out in aggregate and soft-rock applications and have moved into more hard-rock type applications. HPGRs are typically about 30% more efficient as a primary grinding device than a SAG mill would be.”

Boylston received the 2020 CEEC Medal along with Peter Lind and Kevin Murray at Newmont for their paper entitled, *Reducing Energy and Water Consumption through Alternative Comminution Circuits*.

E&MJ asked him about the impact of alternative comminution circuits in copper.

“It’s about finding better, more holistic ways to process the ore,” he ex-

plained. “Often, what we see is that plants are willing to take a small step in one particular technology; HPGRs are a perfect example, and also technologies like coarse floatation and ore sorting. But what we don’t see often is a design where all of these technologies are put together to leverage their collective benefits.

“The CEEC paper was based around an operation in South America. We had operational data from Newmont, the flowsheet was designed using equipment from Metso, and we were able to put together a comprehensive analysis of what would happen if we combined some of these technologies for a certain type of orebody, and the potential cost savings.”

The case has been made on paper, but Boylston said it’s now a matter of gauging how eager mining companies are to see what could be achieved if they implemented a similar setup at their own operations. Because it’s hard to answer some of these questions at a pilot scale, let alone on a laboratory scale.

His team has seen inquiries from mines referencing certain parts of the study, but interest in the more holistic view hasn’t come about quite yet.

“I would say that forward-looking companies like Newmont and Freeport that are used to dealing with new technologies and have the people who understand the risks and rewards... I think they are coming down the path,” he said.

“The next step is to develop some small-scale demonstration plants to look at the possibilities over a year’s worth of operation and to fine tune them before companies drop several billion dollars on a new 150,000-mt/d copper concentrator using the technology.”

### Sensor-based Ore Sorting

One of the best ways to reduce energy and water consumption in concentration or improve leaching is to remove as much gangue as possible as early as possible.

“I’m really optimistic on preconcentration and ore sorting,” Boylston said. “The technology has been used in many places, but it’s not mainstream yet. I think the biggest reasons for that are scaling and energy usage.”

Ore sorting is essentially a form of preconcentration and, while it does require a certain amount of energy to separate the material using blasts of air, the savings downstream in terms of energy, water and



HPGRs gain traction in copper thanks to their ability to significantly reduce energy consumption at the front end of flowsheets. (Photo: FLSmidth)

reagent consumption can be significant, as can the energy avoided; the amount saved by having ore or gangue bypass the concentrator altogether. It also translates into fewer tailings and coarser tailings, which are easier to handle.

There are two main types of sensor-based sorting: bulk ore sorting and particle sorting.

Particle sorting systems detect individual particles and accept or reject them depending upon their mineralogical composition. These systems are very effective at pinpointing minerals. However, they do have limitations in terms of throughput. While higher throughputs can be achieved by using multiple units, the complexity, size and cost of the installation can prohibit their use in very high throughput operations.

On the flip side, bulk sorting technologies scan the run-of-mine stream of material and accept or reject portions of the stream based on their average mineral content. This offers lower selectivity but a simpler, cheaper process capable of handling higher tonnages. Bulk sorting requires a certain amount of variation in the feed to justify deployment i.e., pockets of low-grade and waste material, mixed in with the valuable and more highly mineralized ore.

The decision of which technology to implement revolves around CAPEX and OPEX costs, the nature of the orebody, mining and processing costs, life of mine and the space available for sorting, particularly if the mine is already operational; neither is universally applicable. But, in copper, a good rule of thumb is that particle sorting offers excellent outcomes in lower throughput applications, and bulk sorting represents a straightforward and cost-effective way for larger mines to replicate those valuable results.

Through bulk sorting, it is possible to achieve a net increase in metal production despite having losses in the sorting plant, because mining recovery is improved and that eliminates the misassignment of trucks. The net impact across the whole system is that more metal is produced for the same amount of effort. So, in the processing plant, if you have a higher head grade going in but the same tonnage, then effectively on a unit cost basis, or per-metal-ton, there will be a reduction in costs, and the same is reflected in the mining operation due to increased recovery.



The GEOSCAN-M analyzer installed on an underground conveyor belt at the New Afton mine for bulk sorting of Cu-Au ore from the block cave. (Photo: Scantech International)

### Prompt Gamma Neutron Activation Analysis

PGNAA is one of the best known and widely proven techniques for multi-elemental measurement and sorting in bulk material. The advantage of PGNAA is that it measures through the full conveyed cross section continuously and provides representative element measurement without the need to constantly sample coarse conveyed flows.

“High specification PGNAA analyzers enable accurate measurement over time increments as short as thirty seconds,” explained Henry Kurth, chief marketing officer at Scantech International. “Elements such as copper can be measured to a precision of 0.02% copper over thirty seconds which is sufficient for high confidence in decisions for bulk flow diversion. Increments of 8 tons (from a 1,000-ton-per-hour flow) are diverted through a bulk ore sorting application to remove batches of waste from mill feed as well as divert material to different stockpiles based on ore quality.”

Longer measurement increments of two to five minutes are suitable for blending control of ores to reduce feed quality variability and to control average ore quality within a target range. Feed blends can be adjusted as frequently as required but, typically, multiple measurement increments are composited to produce a rolling average ore quality. Feed forward control is a growing application as process operators can see when ore type changes and adjust the process parameters to cater for that. Measuring the primary crushed con-

veyed ore quality provides all these capabilities simultaneously.

Scantech’s GEOSCAN analyzers have been successfully applied at numerous copper operations, including Chifeng Jilong Gold Mining Co.’s Sepon gold-copper mine in Laos, which uses the technology to manage feed variability and gangue acid consumption in its leaching circuit, New Gold’s New Afton copper-gold operation in British Columbia and Anglo American’s El Soldado copper operation in Chile, which use a GEOSCAN-M analyzer to upgrade mined and stockpiled ore prior to concentration.

### Magnetic Resonance

Although less well known, magnetic resonance (MR) — a type of radio frequency technology used by Australian equipment vendor NextOre — also holds promise in the bulk sorting of copper ore.

NextOre scooped the 2020 Australian Technology Competition Mining Technology award in October. The company’s technology comes from a background of collaborative work on behalf of CSIRO. The first full-scale MR unit was installed in 2014 at Newcrest’s Ridgeway mine in NSW and, following the project’s success, NextOre was established in 2017.

Since then, the company has delivered installations for mines in Australia, Chile, Mexico and Africa and, when *E&MJ* interviewed CEO, Chris Beal, in October, two analyzers were heading to a new crushing and sorting plant in the Philippines.

MR is a penetrative sensing technology that, unlike PGNAA or XRF, only tunes into one specific mineral. Initially that



Bulk sorting requires a certain amount of variation in the feed to justify deployment i.e., pockets of low-grade and waste material, mixed in with the valuable and more highly mineralized ore as demonstrated by this block of transition ore. (Photo: NextOre)

seems like a disadvantage. However, the trade-off of reduced selectivity is faster sensing times.

“Our best in-field measuring frequency is two seconds to get a measurement precision of  $\pm 0.023\%$  copper,” Beal said. “Also, we simply don’t have to recalibrate our equipment once it’s out in the field.”

What happens if you have a polymetallic deposit or if there are changing ore types?

“That’s the drawback,” Beal said honestly. “MR offers high accuracy and speed, but you have to make sure that the mineral you’re looking for is either the dominant economic mineral, or that it’s a proxy that indicates the absence of any economically viable material. Changing ore types can be managed with a well thought out sorting strategy, as demonstrated at Capstone Mining’s Cozamin mine in Mexico where MR bulk sorting was used specifically for the main copper dominant zone.”

The other option is to install two analyzers on the same conveyer belt and calibrate each to detect a different mineral or proxy, and the price point of the NextOre system is designed to allow that.

“We’re seeing a lot of interest at the moment from miners with satellite orebodies and mines that are looking at stockpile reprocessing,” Beal said. “And also, from large, mature copper operations that have depleted the high-grade portion of their orebody but still have a

significant amount of metal in the ground; if you can use the plant you’ve already got to increase metal recovery from the same number of tons, then that avoids having to go through environmental permitting for an expansion. Most of the really big mines in the world that are older than 10 years are having exactly the same problem.”

At the AusIMM Preconcentration conference in November, Beal presented the Cozamin case study mentioned above. The underground, polymetallic mine opted for a 200-mt/h bulk sorter from NextOre to upgrade the copper domain within its orebody.

“During the trial, we demonstrated a 30% grade increase and a 32% reduction in volume reduction with an overall net copper recovery improvement of 6%-8% despite having some losses in the bulk ore sorting stage itself,” Beal said.

“A lot of companies are looking to cut down on the capital cost of bulk sorting and we’ve gotten a lot of positive feedback on a new mobile solution which has a feed conveyer, analyzer and diverter gate all together in a mobile integrated system. All the mine has to do is deliver tons to the

#### COMPANY PROFILE-PAID ADVERTISEMENT

## IWT Solutions Enhance Safety, Productivity and Efficiency

Innovative Wireless Technologies, Inc. (IWT) is the leading supplier of wireless communications, tracking, and data systems for underground mining operations. IWT networks provide real-time tracking, crystal clear voice communication, text, sensor data, and mine analytics in one complete system. The result is a measurable improvement in day-to-day operational efficiency and miner safety. IWT offers a cohesive, integrated, mine operations solution that is optimized for increased productivity, enhanced safety, and low maintenance – making it the lowest total cost of ownership solution available.

IWT’s wireless solutions make equipment installation easy – even in the most challenging areas – to provide communications, gas sensor information and a seamlessly flow of production data to the surface. Access to real-time data allows mine operators to make decisions faster to enhance productivity.

Made in the U.S.A., IWT’s products are reliable and built tough to handle the harshest underground conditions. Unlike other solution providers who offer above ground technologies forced into service underground (often with limited success), IWT solutions have been designed by our own engineers for underground use from

inception. Thoroughly committed to the reliability of our customer’s systems, IWT provides world-class support services, including remote monitoring and troubleshooting, a technical support hotline, and a well-stocked repair and return facility to reduce repair time. IWT’s highly trained personnel manage the installation and repair of radios and systems with packages tailored to meet each customer’s individual needs. This approach ensures optimal system performance and protects the customer’s investment while minimizing lifecycle costs.

IWT’s team of forward-thinking engineers are obsessed with innovating solutions that simplify mine operation, reduce system maintenance, and reduce costs to the mine. What problem can we help you solve?

Always Thinking. Always Solving. Always Innovative.

For more information on IWT products and services visit [www.iwtwireless.com](http://www.iwtwireless.com).



plant either, with a crusher in front of it or not. They could then collect the upgraded and rejected piles and pay for the system on a monthly basis. We're actively working on the design and will be rolling the system out in the next six months. The first unit is destined for the Magnetite Mines project in South Australia."

### From Front to Back...

While much work is being done to create efficiency in comminution, there's plenty of development in the back of flowsheets, too.

Lower head grades and higher impurity levels have, in some cases, led to a requirement for regrinding in the flotation circuits in order to achieve saleable grades, which have pushed energy consumption levels up.

"Previously the focus was always energy efficiency at the front end because it's so energy intensive in size reduction, but there's also been a refocus on the efficiency for the backend of the plant as well," explained Gallimore.

"Alongside that, there's more pump thickening, high density thickening and

filtration for dewatering now than 30 years ago. You tend not to see as many plants pumping their tailings directly out to a tailings pond.

"Filtration's a trend we'll see more of, because of the vast enhancement in safety for tailings impoundments. The permitting process should get easier too because long-term risks are reduced, and the ability to reuse water greatly increases so, new water consumption goes down. It's a lot cheaper to filter and recover process water than it is to desalinate and deliver new water."

Coarse flotation technologies hold much promise in delivering higher recoveries, and higher grind size requirements, which will help to reduce both energy and water consumption. Tailings with a lower proportion of fine and ultra-fine materials are also easier to handle and rehabilitate.

Mulligan added: "The implementation of different digital technologies will also allow higher plant recoveries and higher plant availabilities. Digital condition monitoring will allow a more proactive maintenance approach, leading not only to lower maintenance costs, but higher

plant availabilities. Data analytics and digital twins will allow for better reporting, and more accurate and specific predictions of the production, and allow for better allocation of resources."

### Heap and In-situ Leaching

Leaching bypasses the need for grinding and flotation, allowing mines to skip straight to the recovery of metal from a pregnant leach solution through SX/EW. Heap leaching and, in particular, in-situ leaching of orebodies is energy efficient and can be used to recover very low copper grades. However, traditional lixivants like sulphuric acid aren't effective on sulphide-heavy ores... i.e., the majority remaining worldwide.

U.K.-based startup, Argo Natural Resources, thinks it may have found a (forgive the pun) solution to this problem. The company has developed a leaching solution based on deep eutectic solvents (DES); a special group of ionic solvents that are liquid at low temperatures. These consist of chemical components that are widely available throughout the world at low cost.

**IWT**

## The Digital Mine

Are you harnessing your mine's potential?

- One Network for Compliance and Operations
- Time Studies, Short Session Intervals, Shift Reports
- Voice, Tracking, Sensors, Production Data
- Real-time Production Process Data Visibility
- Wireless Working Areas
- Electronic Data Capture

**Innovative Wireless Technologies, Inc.**  
1100 Main Street, Lynchburg, VA 24504 USA  
+ 1.434.316.5230 sales@iwtwireless.com

**MINE the DATA™**  
Learn more at [iwtwireless.com](http://iwtwireless.com)

In combinations they form non-aqueous solutions that allow for the oxidative dissolution of metals as part of the leaching process. Conventional recovery techniques and technologies can then be used to recover metal from the loaded DES. The barren DES can then be reused, unlike solvents in acid leaching systems.

Fred White, who handles business development at Argo, explained: “DES were discovered at the University of Leicester 20 years ago and a wide group of precious metals, base metals and rare earth elements have been proven amenable to DES. As the solvents are environmentally benign, biodegradable, recyclable and utilize an energy- and emission-light process, there is a major environmental advantage over conventional processing, which we believe has the potential for a sustainability revolution across multiple sectors. DES are also characterized by very high metal recoveries and fast leach kinetics, which also justify their advantage on a pure economic basis.”

There are two big opportunities for DES in copper processing: first, the processing of copper deposits in jurisdictions with water usage sensitives and, second, the processing via leaching of transition ores and copper sulphides.

“As the DES process requires minimal water usage, we only use it as an option for washing,” White said. “The technology is well suited to replace the water-intensive leaching operations that are causing a huge strain on the license to operate for mining companies, especially for projects in South America.

“There are a lot of large, low-grade copper oxide deposits moving into tran-

sition zone ores or sulphide ores. These are very difficult to process with the existing infrastructure built for copper oxide processing. The DES process can integrate into conventional processing operations and recovery from transition ores and oxides is something we are actively working on.”

Argo currently has testing contracts with a major mining company looking at several target metals and ores, along with contracts with a handful of juniors.

“We are currently designing and optimizing flowsheets and hope to establish our first DES plant in 2023,” White said. “Argo operates under a licensing and royalty business model in the mining industry and will look to implement DES processing with mining partners.”

### New Business Models

Argo is also looking to commercialize DES in the recycling of e-waste; something that is likely to become a part of more mining companies’ business models in the future — Boliden is a current example — as ore grades fall and pressure grows to close metal production loops.

“E-waste is the world’s fastest growing waste stream generating \$57 billion of contained metal waste in 2019. The future market potential is massive and a few of the world’s top mining and metals houses have already identified this trend, along with the increasing social and regulatory pressures to recycle more and create a circular economy,” White said.

“The future of the metals market is being driven by the electrification of the economy, which will require an ever-increasing metals consumption per capita.

The paradox is that it takes carbon-intensive processes to recover metals for use in low-carbon solutions. We believe that Argo’s process will benefit from significant environmental leverage.”

Argo is currently working with a FTSE 100 company testing DES on e-waste. Current e-waste processing routes use conventional smelting processes to recover high-value precious metals often at poor recoveries, circa 75%. Argo’s advantage is that DES has shown metal recoveries exceeding 95%.

“With the proportion of metals to come from recycling set to grow, we see the early movers building up a significant market advantage by investing in expertise and infrastructure to exploit recycled sources of metals,” White said. “New technologies will play a part in this, especially when the new technology can prove superior performance on both the economic and environmental levels. We believe that we need to rethink natural resources and that’s exactly what we are doing at Argo.”

### Bio-metallurgy

Advanced bioleaching is another area that holds much promise. Marny Reakes, vice president of mining BioTech at Cemvita Factory, said her company has seen a rise in interest recently from copper miners looking to optimize mineral processing and leaching circuits.

Even if sites don’t use bioleaching, there will be microbes throughout their processing circuits, and these may be helping or hindering recovery and efficiency. Synthetic biology and the latest biotechnology tools have the potential to allow us to better understand microbial actions within mineral processing facilities and harness greater control.

“One of the big problems at the moment is finding a large-scale commercial leaching method for the high recovery of chalcopyrite,” Reakes explained. “Chalcopyrite floats well but if ore grades drop then often it’s not economic to put it through a grinding and flotation route. It’s better to have coarser leaching instead.”

Around 70% of the world’s copper is currently found in the form of low-grade chalcopyrite; a copper-iron sulphide mineral. So, this is a key area that Cemvita has been working on with its mining clients.

“We’re looking at how to take the normal archaea and extremophiles that are



Capstone Mining’s Cozamin polymetallic mine in Mexico opts for a 200-mt/h bulk sorter from NextOre to upgrade the copper domain within its orebody. (Photo: NextOre)

used in bioleaching and modify them to speed up kinetics and increase the recovery of primary minerals like chalcopyrite that are usually recalcitrant in terms of their leaching ability,” Reakes said.

“What I’ve found when I talk to long-term miners about heap leaching, is that the culture that they use for bioleaching was probably borrowed from a neighbor 30-plus years ago. Each mining site or process will have a specific microbiome that is adapted to the local environmental conditions. For effective bioleaching, it’s critical to understand the genetic properties of the native microbiome. In turn, this provides key information to generate a bioleaching microbial consortium with high efficiency that is in balance with the native microbiome and is adaptable to the environment.

“When I talk to universities, companies or metallurgical labs that do leaching test work, quite often, they won’t have performed comprehensive analyses (genomics, transcriptomics, metabolomics or proteomics) on the culture to understand how it functions and can be augmented.



The bulk ore sorter at Anglo American's Mogalakwena platinum mine. The company also has a full-scale unit under construction at Los Bronces and a third planned for Barro Alto in the near future. (Photo: Anglo American)

“Understanding and optimizing bio-metallurgical consortia using synthetic biology could allow for much higher re-

coveries and less waste. Synthetic biology can also be used to develop grinding aids or soften ore.”

**PROVEN TO REDUCE DUST & ELIMINATE WATER BY 95%**

**NEW!**

## MineKleen® Underground Mine Dust Control System

A complete system of formulations, sprayer and support delivers extreme results for extreme conditions:

- > sprays roads, ribs, backs all at one time, or as needed
- > has fork pockets, easy-to-use with various types of underground equipment
- > inhibits the growth of mold
- > applies neat — waterless and odorless
- > eliminates dust and watering up to 95%
- > meets strict MSHA, Clean Air and Water Act requirements



**MIDWEST**  
 Visit [MineKleen.com](http://MineKleen.com)  
 or call (888) 762-3695.

© 2020 Midwest Industrial Supply, Inc.



# **LONGWALL USA Exhibition & Conference**

*Becomes the*

## **US COAL SHOW LONGWALL EDITION**

For nearly 25 years, Longwall USA has been the leading conference for longwall mining. While shearers, AFCs and shields do much of the work, longwalls also rely on a network of continuous miners and conveyors. It's time to broaden the discussion to include all aspects of underground coal mining.

### **We're Expanding the Scope**

In addition to longwall-related programming, the conference will include:

- Additional focus on room-and-pillar mining;
- More emphasis on coal handling and storage; and
- Better information for operations management

**Pittsburgh Is the Place to Be for US  
Coal Operators May 4-6, 2021**

[uscoalshow.com](http://uscoalshow.com)



## Anglo Puts Technology Into Practice

As in alternative comminution circuits, the real benefits will come when we start to piece together these new technologies and processes to create completely different flowsheets for copper extraction. That is when we will see step changes in energy efficiency and water savings.

One mining company that is already headed down that path is Anglo American.

"We believe that the copper flowsheets of the future will look completely different to those of 20 or 30 years ago," a spokesperson said. "From preconcentration and waste rejection up front, to energy efficient comminution, alternative separation technologies, and coarse particle recovery, all the way through to how we dispose of our discards.

"With the current digital transformation, plants will furthermore be extensively instrumented with real-time sensing of all aspects of an operation, leading to highly autonomous and virtualized operations.

"For us, some of the greatest opportunities going forward are the areas that our FutureSmart Mining program is focused on: energy efficient comminution, coarse particle recovery, sorting, dry processing, digital transformation and data analytics and a shift toward cathode production instead of the traditional concentrate to smelter route."

For Anglo American, bulk sorting is an important step towards dry separation.

"It's another of our step-change innovations and takes advantage of ore heterogeneity," the spokesperson explained. "It's cost effective in sorting material into low-value ore, which we reject, and high-value material, which we then send through the plant. This results in more mineral output."

Three demonstration plants have been successfully trialed in Brazil, Chile and South Africa.

"We are seeing a more than 5% uplift in feed grade and a 10% reduction in energy and water intensity. As a result, full-scale units are under construction at our Mogalakwena and Los Bronces mines and are due to go live this year with a third planned for Barro Alto in the near future," the spokesperson said.

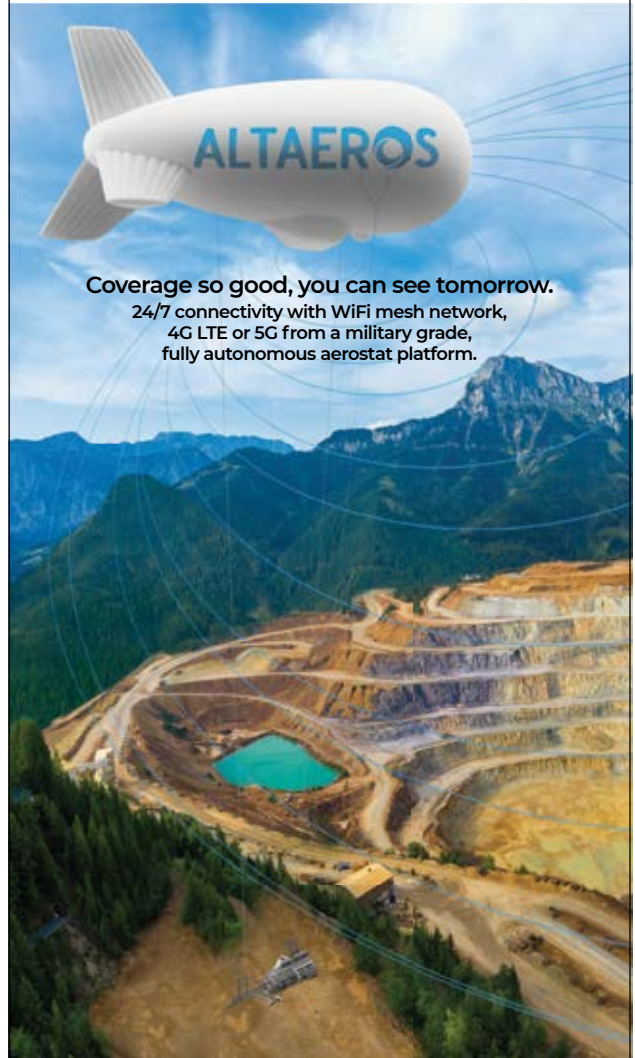
Anglo American was one of the first miners to voice its ambition for waterless processing plants, and work continues on this through FutureSmart.

"There are a number of steps to waterless processing," explained the spokesperson. "First, a reduction in water intensity i.e., using less water per unit of ore processed. Second, closing the loop by recycling the water that we do need; coarse particle recovery and hydraulic dry stacking take us to an 85% recycle opportunity; and, third, dry processing."

"Dry comminution is the first step to eliminating mass use of water in mineral processing. Subsequent separation and upgrade steps will deliver dry concentrates, which will further allow for new methods of refining. Today, our focus is on water recovery at the backend of the process recovering 85% of the water using hydraulic dry stacking in combination with coarse particle recovery. In the future, it will be on the safe stacking of dry waste, preventing dust and acid mine drainage.

"There are also many novel leach approaches being tested at the moment throughout the industry," they hinted. "Herein lies the next wave of step change efficiencies over and above those provided by coarse particle recovery and bulk ore sorting."

## Elevate Your Wireless with a 1000 ft. Super Tower



Coverage so good, you can see tomorrow.

24/7 connectivity with WiFi mesh network,  
4G LTE or 5G from a military grade,  
fully autonomous aerostat platform.

### ST-Flex Aerostat

Command simpler, easier, better coverage across your entire mine. The **ST-Flex** will improve and consolidate your wireless network with huge line-of-sight and range advantages over ground-based wireless equipment. Stay connected, night and day, to increase operational efficiency and safety.

# ALTAEROS.com

SALES@ALTAEROS.COM



## ASI Mining – Mining’s OEM Agnostic AHS Leader



### ASI: A World Leader in Vehicle Automation

Autonomous Solutions, Inc. (ASI) is a world leader in independent vehicle automation systems that develops solutions for mining, agriculture, automotive, construction, government, cleaning, and facility industries.

ASI has automated and tested over 90 different vehicle models at a campus located on a 100-acre proving ground in northern Utah.

ASI has helped automate over 1,000 vehicles in small and large fleets partnering with organizations such as Chrysler, Ford Motor Company, Danfoss, Hyundai, CNH Industrial, the U.S. Department of Defense, and many others.

ASI Mining is one of several business units of ASI. Being part of the ASI family of companies gives ASI Mining many benefits including access to resources, research, technology and automation expertise.



### ASI Mining: Mining’s Leader in OEM Agnostic Automation

ASI Mining began its first automation project in 2006. From the beginning, ASI’s mission has been to supply mines with safe automation solutions that give mines as much value as possible. For most mines, this means utilizing existing equipment and services. Integrating with legacy systems decreases downtime and replacement of established capabilities. It also means significant savings by retrofitting existing fleets compared to premature replacements.

### Mobius: Mining’s Interoperable Automation Platform

Mobius is an automation platform that enables true interoperability with multiple OEMs and legacy FMS. It’s designed to integrate with legacy dispatch systems and to function as a mine site’s FMS if needed.

Mobius provides robust support for haulage. It also provides traffic management applications for blasting, drilling, tele-op, and simulated operations.

Mobius supports multiple levels of automation to enhance all areas of a mine, including: driver assist, remote control, tele-op, semi-autonomous and full autonomous operations.

### Interoperability with Legacy FMS Simplifies Transitions

ASI allows participating OEMs to integrate their respective vehicles in haulage, drilling, blasting and other applications with the Mobius platform.

This level of interoperability allows these OEMs to supply autonomous-ready vehicles directly to the site for integration with Mobius.

### Legacy Vehicle Support via Retrofit Kits

Older vehicles with little or no drive by wire capability can be converted to autonomous control by ASI Mining. This allows virtually any vehicle to be automated on the Mobius platform, regardless of age. This allows mixed fleets and older vehicles to be automated together with newer vehicles, freeing mines from forced phase-outs.



### ASI Mining Projects

ASI Mining is currently automating a mixed fleet of 77 haul trucks in Western Australia comprised of CAT 793Fs, CAT 793F-CMDs, and Hitachi EH5000s for the Roy Hill Mine. ASI mining also recently automated 793D haul trucks for Ferrexpo in Ukraine and a fleet of Komatsu 930E-2 haul trucks for Barrick in Nevada.

ASI Mining has collaborated with Enaex, Epiroc, Liebherr and other OEMs to provide autonomous operations for their mining equipment on the Mobius platform.

### Supported by the Epiroc Global Dealer Network

In 2018 Epiroc acquired a minority ownership of ASI Mining. This partnership gives ASI Mining access to Epiroc’s global dealer support network for sales and service.



#### ASI MINING

Autonomous Solutions, Inc.  
990 North 8000 West  
Mendon, Utah 84325

To learn more about ASI Mining,  
visit [ASIAutomate.com](http://ASIAutomate.com)

## ASI Mining's Mobius Platform

**Mobius<sup>®</sup>**VEHICLE AUTONOMY PLATFORM  
TRAFFIC MANAGEMENT SYSTEM

### OEM Agnostic

Retro-fit your existing equipment, no matter what make or model.

### Interoperable

Compatible with Legacy FMS and participating OEMs.

### Scalable

Designed as a platform to manage automation for the entire mine.

### ASI has:

- ✓ Automated over 90 different vehicle models (and counting).
- ✓ Collaborated on mining automation projects on 5 continents with partners and customers since 2006.
- ✓ Worked with dozens of leading OEM partners.



Visit [ASIAutomate.com](https://www.asi-automate.com) for a free analysis and price quote for your automation plan.

# Autonomy Reloaded

*With the influx of open, interoperable autonomous mining solutions will come new possibilities... E&MJ presents some of the companies that are ushering in this change*

By Carly Leonida, European Editor

An autonomous drill rig at FMG's Christmas Creek mine in the Pilabara, Australia. (Photo: FMG)

Despite autonomous haulage systems (AHSs) having been commercially available for more than 20 years and some incredible results publicized in terms of utilization and cost reductions, the technology is still yet to achieve mainstream adoption. But that could be set to change thanks to a new wave of open, interoperable solutions.

E&MJ asked autonomy consultant Ben Miller, partner and principal at Autonomous Correct, to help it explore the market and its trajectory.

"Today, there are only three commercially available AHS options," he explained. "There are two from OEMs — Caterpillar and Komatsu — which both have a bunch of deployments, and one from a third-party provider — ASI — which has a few smaller deployments plus a major contract to convert trucks for Roy Hill in Australia. Both Hitachi and Liebherr have trials under way, but their systems are slightly different."

The latter OEMs have opted to produce trucks and/or systems that are ready to accept other companies' autonomous hardware and software. It's important because those two manufacturers generally only operate on mixed fleet sites; neither offer a large bulldozer, for instance, so their trucks and shovels need to be able to be "open" in order to participate in autonomous ecosystems.

"There are other companies that offer solutions for smaller machines like

Bobcats, but there's a very distinct difference between making one truck drive around and making many things drive around," Miller explained. "Volvo's approach is interesting; their autonomous technology is focused on trucks with less than 100 tons of capacity more often utilized in industrial mineral operations than large metallic mines.

"With traditional AHSs, the cost per conversion is so high that companies will have a hard time pushing into the 100-ton truck class with an autonomy layer. Currently, mines are limited on how small they can go with deployments."

How could the use of next-generation interoperable systems change that?

"The market is beginning to demand interoperability and, because of that, AHSs are becoming more of a commoditized product," Miller explained. "Now, because there are three companies offering these systems, mines can put their projects out to tender and see which bid they like best. Ten years ago, that wasn't an option, mines would have to create a strategic partnership with either Caterpillar or Komatsu. Today, the process is similar to buying equipment, and that means that mines have a little more sway in how things are done."

## Interoperable Hardware

This shift combined with the fact that the vast majority of mines worldwide run mixed fleets, means that things have to change.

"Most fleets aren't all the same shade of yellow and often their trucks aren't even the same model; for instance, a mix of Komatsu 930E-4s and 930E-5s," said Miller. "Often, you'll see Komatsu trucks with Komatsu shovels and then all the pushing gear is from Caterpillar. That's OK to deal with in the current AHS situation. However, if a mine had some Cat trucks and some Hitachi trucks then it's much harder to introduce an AHS. Caterpillar might encourage the mine to replace all of the trucks, or at least the Hitachi portion of the fleet, with newer Cat models, because their AHS kit wouldn't be compatible with the existing ones. That's just an example, but that limitation increases the cost of autonomy significantly for the mine."

The concern for many mines when considering autonomous haulage is that, if they pick one of the two-leading solutions, Caterpillar's Command for Hauling or Komatsu's FrontRunner, then, when it comes to the next iteration of truck purchases (which is constantly occurring) they won't be able to go to an open market if the autonomy layer won't support other OEM's trucks. Or that the AHS provider will support other trucks, but it could cost an extra million dollars to build special conversion kits.

"No mines want that situation," Miller said. "They don't want to be beholden to

the OEM that they've chosen for their dispatch or AHS system.”

Software obsolescence. We've all been there, usually with cell phones. You go to do a system update, but your phone model doesn't support the latest version, so you have to upgrade your handset. But all your music is on a certain platform and you use a certain computer for work, so it's easier

to stick with the same phone brand rather than move to another. The purchasing decision has essentially been made for you.

“It's exactly the same sensation,” Miller said. “And you don't want that sensation to occur over a \$5 million truck. Mines are paranoid that's how this is going to go, so that's why there's this pressure on interoperability.”

## Interoperable Software

The ability to put autonomous hardware on to any truck is just one piece of the interoperability puzzle, there is also the software to consider.

“With an AHS there needs to be interaction between the different layers of software,” Miller explained. “So, at the top of stack is probably the dispatch system — like DISPATCH from Modular

## Altaeros Takes Autonomy to the Sky

Another company with a novel solution for mine autonomy, albeit quite different to vehicle-based ones, is Altaeros.

Ben Glass, CEO and CTO, explained: “Our mission at Altaeros is to connect people, machines, and data no matter where in the world they are located. Four billion people and even entire regions still lack access to adequate connectivity services. This leaves many communities, businesses and industries without the critical communications services they need to thrive.

“The connectivity gap is mostly driven by traditional infrastructure that is expensive and difficult to build in rural and remote areas. We pioneered the SuperTower to provide a simple, affordable way to connect rural and remote areas.”

SuperTowers are autonomous, tethered aerostats that can lift heavy, wireless payloads up to 300 m into the air to provide wide-area coverage. A single SuperTower can replace about 15 ground-based cell towers, making remote networks simpler and cheaper to roll out and operate. They have a modular payload interface, which allows use with a variety of payloads, including LTE, 5G and Wi-Fi.

“We currently have two SuperTower configurations: a rapidly deployable, portable trailer-based SuperTower (ST-Flex) for flexible deployments and a larger fixed base SuperTower (ST-300) for permanent installations where maximum performance is key,” said Glass. “The ST-Flex is off-road and towable on-highway and can be set up in less than a day. One of the biggest distinctions between the SuperTower and other aerostats is Aerostat Autopilot, our autonomous control software. This capability allows SuperTowers to operate without any on-site crew, which reduces the cost by up to 90%. SuperTowers are the only aerostat in the world that can launch, operate and land without a large crew of operators.”

In addition to launching, landing and managing day-to-day flight operations autonomously, Aerostat Autopilot continuously monitors environmental and weather data, and responds instantly to maximize uptime, even in heavy wind, rain, snow or other adverse conditions. If winds near hurricane levels, Aerostat Autopilot will automatically land the SuperTower to keep the equipment safe and relaunch as soon as conditions allow.

Very interesting. But how do these apply to autonomous mining?

Well, AHSs rely on a strong, continuous wireless signal to function optimally. By elevating the wireless network equipment to 300 m above ground level, it's possible to eliminate the line-of-sight shortcomings of shorter, ground-based antennas. For example, site-wide coverage is often achieved by deploying mesh networks via Wi-Fi nodes on trailers spread around the mine

site. As the topography of the pit and haul roads change, the nodes must be relocated to ensure coverage reaches all corners of the mine. This process can be time consuming, costly, and a productivity killer.

Deploying one or two SuperTowers can provide consistent network coverage across an entire mine. The elevated vantage point ensures the signal reaches where it needs to, even as the mine topology evolves. No adjustments or relocations are needed. A well located SuperTower can provide coverage for the pit, the tailings area, the haul roads and even great distances beyond the gates.

“We were very excited to officially launch the ST-Flex in October,” Glass said. “The first unit ships to a customer in Asia early next year. The mobility, smaller scale and lower cost of the ST-Flex compared to our fixed-based models aligns with the connectivity needs of the mining industry. Even with the ST-Flex's smaller size, the reliable coverage range for LTE extends 25 miles (40 km) from the SuperTower, meeting any autonomous hauling connectivity requirement in terms of distance.

“As we roll out more SuperTowers around the world, we will introduce more prepackaged equipment integrations, making sure our customers get the most value possible from each deployment. Additionally, we are always improving the Aerostat Autopilot capabilities so every SuperTower will continue to get better even after it is deployed in the field.”



Altaeros' SuperTowers are autonomous, tethered aerostats that can lift wireless payloads up to 300 m into the air to provide wide-area coverage at mine sites. (Photo: Altaeros)

Mining or Wencomine from Wenco International Mining Systems — which tells the machines where they are supposed to go. Then the next layer is the traffic control or traffic management system, like ASI's Mobius, Cat Command or Komatsu's FrontRunner, then there's a machine health layer. There's an opportunity to add APIs between those soft-

ware layers in that stack so that they can talk to one another.”

Currently, there are supported APIs available that allow interoperability between Komatsu's FrontRunner and Modular's DISPATCH, and Modular released a public API in May to allow openness between third-party technologies and its suite of fleet management solutions.

It's also possible for mines to create unsupported APIs i.e., applications that pay attention to the data generated by the different layers and translate it for use in others. However, it takes a lot of time and effort to develop and maintain these APIs and, if the layer above the API receives an update, then the API might need to be rewritten. It's a work around as opposed to an optimized solution.

“Software interoperability is probably the most important piece,” Miller said. “Because it allows the mine to choose which dispatch system it uses alongside the AHS, rather than replace it for one that is selected by the AHS provider.”

It's worth bearing in mind that the physical conditions at some mine sites dictate the use of certain fleet management (FMS) or positioning systems. Currently, if those mines want to run an AHS, they must maintain their existing system alongside a new dispatch system that works with the AHS stack. This adds a further layer of complexity into an operation and poses significant challenges in terms of change management. If not managed properly, this could set the project up to fail before it's even started.

“The cost to replace or add a new dispatch system at an existing operation is massive,” said Miller. “And it usually has to happen in advance of the AHS implementation. We're talking maybe a year ahead and it could cost anywhere between \$10 million and \$100 million depending upon the size of the operation. If there

**COMPANY PROFILE-PAID ADVERTISEMENT**

**Count on GIW for Reliable Slurry Pumps and Parts Supply**

In this time of uncertainty GIW is more committed than ever to providing our partners with an uninterrupted supply of pumps and parts.

GIW is working tirelessly to get ahead of any future shortfalls in the market. Our factories are operating at normal capacity and we have increased the foundry output by 15%. We are continuing to produce parts in anticipation of customer demand. We also have a healthy inventory of non-white iron parts to cover your needs for the near future. Rest assured we are in constant communication with our sub-suppliers to ensure an uninterrupted supply.

In order to meet future market needs, GIW is forging ahead with the planned \$42.2 million expansion at their Grovetown, Georgia manufacturing complex. Construction of the additional 70,000 sq. ft. facility is progressing on schedule. The additional manufacturing space ensures we can continue to deliver just what our customers need: rugged, cost-effective slurry pumps.



**Solutions Designed With You in Mind**

**TBC-92** – The TBC-92 provides operators with longer run times, fewer outages, increased production, and a lower cost of ownership. This pump reaches up to 6,000 hours of operation before requiring maintenance.

**Ven-Bin Workflow Efficiency** – Inefficient workflow contributes to production losses. GIW has developed an intuitive hardware cart (Ven-Bin) to keep every tool and part in one place and standardize how millwrights work. The Ven-Bin is proof that even small modifications can help to minimize downtime, and boost efficiency.

From the development of new products to optimizing current working methods, GIW is by your side. When you choose GIW, you gain a partner that is dedicated to your success. You can count on us to support you through your simple and most complex challenges.



**GIW Is On Your Side**

We recognize that when times are hard, reliable tech support is critical. GIW products are designed to help you lower your total cost of ownership and reduce unplanned outages. But if a system breaks down unexpectedly, our customer service agents are available 24/7 to help you find the solution you need, when you need it. Our team can assist you with after-hours breakdown rush, technical services, and spare parts sales. You can get your questions answered easily with just one phone call to 1-888-832-4449.



An autonomous mine haul truck simulation using Oxbotica's autonomy platform. (Photo: Oxbotica)

were an API that allowed the mine to keep its dispatch system in place, whatever brand it might be, and just add an AHS... that would significantly reduce the cost and complexity of the conversion project.”

The overall impact of hardware and software interoperability is the same; they open up the market and drive down the overall cost of autonomy.

“I think it will be a win-win situation,” said Miller. “The industry leaders might be resistant initially because, right now, they have the ability to control the market if they wish. The push for autonomy will level the playing field a little and everyone will be back to selling trucks for the value of trucks. Because interoperability in autonomy removes the potential for a vendor to say, ‘That truck and shovel don’t match, we don’t know if we can support that.’”

The widespread introduction of interoperable technologies will probably see AHSs become more mainstream over the next 5-10 years, and not just at large mine sites, but smaller ones too.

Miller agreed: “Interoperability not only strips out a significant amount of cost from the front end of AHS projects, which reduces risk, it also brings down the overall cost of deployment. Together, those things are going to make it much easier to get the business case for the technology across the line.”

### From Truck to Shovel

The influx of small, agile technology providers into the mining autonomy market could also accelerate the development of solutions for loading equipment, too.

“Technologically, the autonomous control of trucks is not that difficult,” Miller said. “My hope is that some of the small, innovative companies that are coming through find novel solutions for the other equipment. There’s a reason why shovel operators are at the pinnacle of the operator level. It’s because they are doing a huge amount of visual processing while they’re looking at the face they are digging; they’re evaluating rocks, dig ability and safety. They’re gauging whether the ore markers are correct and making decisions based on that.”

How far away are we from fully autonomous shovels?

“There have been autonomous functions on excavators for some time, such as auto-grade control, which prevents the bucket from going beneath the bench

level without warning,” said Miller. “And there are teleop solutions available for excavators and dozers today, but the productivity is much lower on a teleop unit than a manned one.”

Part of the challenge is that good shovel operators need to “feel” the material they’re digging and how hard the machine is working.

“There’s haptic feedback, which allows remote operators to ‘feel’ the material they’re digging, but we also need to envision a way to provide enhanced feedback to the operator in a tele-situation and give them all of the feelings they would have if they were in the machine. Like perception of balance, vibration and how hard the hydraulics are working,” Miller said.

## COUNT ON GIW FOR RELIABLE PERFORMANCE.



GIW® pumps deliver reliable performance in the most aggressive slurries.

GIW Industries is built tough too. We’re more committed than ever to providing our partners with an uninterrupted supply of pumps and parts. We’ll stop at nothing to ensure the success of your operation.

Learn more at [www.giwminerals.com](http://www.giwminerals.com)

GIW® Minerals





SafeAI recently signs an agreement with Japanese firm Obayashi to automate a construction site. The pair are currently working on load-haul-dump cycles with an autonomous ADT. (Photo: SafeAI)

“One of the guys who works for me is a Ph.D. student at the Colorado School of Mines and he’s looking at hyperspectral analysis of geology at the face to provide real-time feedback to loading unit operators.”

Theoretically, by mounting a hyperspectral analyzer on a drone or on an excavator cab, processing the data and feeding it back to the operator in real time through a screen or even augmented reality glasses, then they could get a more

accurate idea of the ore grade and mineral content than if they were sat in the cab.

“Grade improvements delivered through functions like that could make up for the lower productivity that we see with teleop shovels and could potentially make the case to pull operators out of cabs,” Miller said.

“It’s a really interesting space, and I hope that some of these new players try to figure out the hard problems. Because

the agile sort of development that goes on underneath little nimble companies like that... that’s where we’re going to find solutions using new technology.”

Let’s meet some of these companies...

## ASI Mining

Although one of the three current big autonomy providers, ASI’s technology is fundamentally different to the other two. The company received an investment injection from Epiroc in 2018, with a view to expanding Epiroc’s scope of interoperable, autonomous solutions and the companies continue to work side-by-side today.

Drew Larsen is director of business development at ASI Mining, and he explained the company’s ethos.

“Our approach is to be OEM agnostic and customer-centric, above all else,” he said. “Because we don’t supply vehicles or FMSs ourselves, we have no business interest in replacing vehicles or legacy dispatch systems, nor in restricting future vehicle purchases to specific makes/models.

“Additionally, we want to help future-proof mine automation, so that when AHS operators desire to expand to addition-

## COMPANY PROFILE-PAID ADVERTISEMENT

### Paus – The Mining Experts who care

**Emsbüren, November 2020 - Always delivering the best solution for customers, no matter how demanding or individual the requirements may be, that is the core of “...the people who care”. The Hermann Paus Maschinenfabrik produces customized quality vehicle and machine solutions for elevator technology, construction machinery, industrial vehicles and especially for mining and tunnelling.**

Active dialogue is cultivated with industry experts and customers. This is the only way to achieve successful solutions for customers with professionalism, experience and innovative strength that meet the requirements of quality, environmental friendliness, compressive strength, safety and efficiency.

With the “**Made in Germany**” quality promise, Paus builds individual and tailor-made mining and tunnelling machines. With industrial production pro-

cesses, on the one hand the production of the basic assemblies is ensured in consistently high quality, on the other hand, suitable vehicle solutions for customer-defined tasks can be supplied from these basic modules.

The Universa 40/50 series and the MinCa series are designed as vehicle platforms. The quick-change system on Universa vehicles allows easy, safe configuration of various bodies on the base platform. Depending on the tasks required, whether concrete mixer, maintenance vehicle with workshop, scissor lift table or tyre changer, the Universa multi-purpose utility vehicles from Paus meet underground mining requirements **flexibly, efficiently and reliably.**

The MinCa 18A is also a multi-purpose utility vehicle offered by Paus with a range of different “superstructures”. The range extends from configuration as a transporter for personnel or material, as a fire brigade emergency vehicle to ambulance equipment and combinations of superstructures. More options are available on request!

The smaller MinCa 5.1 is very well adapted to the narrow conditions not only for applications in Narrow Vein Mining. It can be configured for five miners as an equipment variant “passenger transporter” and still has room for the equipment. With its all-wheel drive it is perfect for use on difficult roads. The MinCa 5.1 offers more stability, has a small turning circle with various wheel steering systems and low maintenance safety with oil-immersed multi-disc brakes.

The latest generation of the electrically driven MinCa 5.1 E with improved battery technology and proven NMC technology. In the standard ex works configuration, the battery capacity amounts to 50 kWh and is sufficient for up to 6 hours. The battery pack finds its place in the rear. The capacity “under the hood” can optionally be extended with a further 50 kWh, the unit can then easily operate for more than one shift!

**The Paus vehicle portfolio also includes LHD, dumper, scaler, grader and rock crusher solutions. Other special vehicles are available on request. All complemented by a worldwide, permanently professionally trained dealer and service network.**

Further information on the Paus product range can be found at [www.paus.de](http://www.paus.de).





al applications, such as autonomous drilling or blasting, they can leverage our autonomy platform — Mobius — to enable more seamless integration. Providing an open architecture that allows us to include the autonomy for all mobile equipment is our goal.”

ASI's solutions are scalable. The company offers remote operation and teleop solutions all the way up to full automation for single or multiple machines.

“For some operations, like haulage, full autonomy is already happening, and the payoffs are huge in terms of increased utilization, efficiency, and cost savings,” Larsen said. “In other areas, such as dozing, full autonomy isn't quite there yet. But we can auto-tram or provide basic navigation and situational awareness for the dozer. By applying semiautonomous functionality there is a seamless integration between teleop and autonomous control, enabling back and forth transition as needed based on the application. Over time, we anticipate more and more autonomous functionality in areas like dozers, wheel loaders, etc.”

Whereas most companies are focused on automating one or two aspects of an operation, such as drilling and hauling,

the end goal for the Mobius platform is to track, monitor and automate all aspects of mobile equipment operation in a mine. This allows better management of a mine's assets, as they are aware of each other. Also, by automating and tracking all aspects of a mine, operators can find new areas of improvement and optimization.

Larsen explained: “A big part of our effort is focused on establishing standard interfaces and connection points for OEMs and other technology providers. Examples of this include the integration of various FMS systems such as Wenco and Jigsaw into Mobius, and interfaces with truck OEMs such as Liebherr.”

The modular architecture of ASI's hardware and software allows integration points with Mobius as well as onboard systems that enable increasing participation opportunities for OEMs that don't offer a full autonomy stack. This benefits mining operators by eliminating the need for FMS replacement on brownfield sites or eliminating fleet replacements for unsupported models or OEMs.

“We continue to work with new OEMs and even other solution providers, such as

Enaex's blasting program to participate in the Mobius autonomy platform. We're excited to be able to announce new participants from time to time,” Larsen added.

In July, ASI announced a compatibility agreement with MS4M, a mine management and optimization solution provider, to ensure compatibility between Mobius and MS4M's ControlSense FMS for autonomous mine vehicles.

“As companies such as MineSense supply and maintain FMS to their customers, our agreement assures their MS4M system will leverage standard interfaces with Mobius to enable integration between their FMS and ASI's Mobius traffic management system,” Larsen said. “This assures MineSense customers the ability to implement autonomy under the MSF4M dispatch system having future compatibility with ASI's autonomous systems.”

As mentioned earlier, in March, ASI signed a subcontract with Epiroc for the supply of 77 autonomous vehicle conversions for the Roy Hill iron-ore mine in Western Australia. The companies are currently working on phase two of a three-stage deployment.

**PAUS**  
...the people who care

**Versatile Professionals**

Hermann Paus Maschinenfabrik GmbH  
Tel.: +49 (0) 5903 707-0  
E-Mail: [info@paus.de](mailto:info@paus.de)  
[www.paus.de](http://www.paus.de)

The basic platform of the MinCa 18 by Paus convinces with payloads from 1.5 to max. 3.0 t. Different superstructures can be mounted on it. As personnel or material transporter or for special operations. Always with best driving comfort and robust oscillating axles. You can count on them.



Oxbotica's autonomy platform offers a number of different software solutions that partners can mix and match as they choose or implement as a package. (Photo: Oxbotica)

"We have successfully automated both Cat 793F and Hitachi EH5000 haul trucks and completed integration of the Wenco dispatch system with Mobius," Larsen said. "Overall, the project calls for the automation of 77 haul trucks and situational awareness on all other manned vehicles operating at site."

What's next for Mobius?

"We continue to expand the value proposition of autonomy for our customers by continuously improving KPI per-

formance. We are also working to provide additional tolerance of suboptimal infrastructure including comms, and expansion into more applications and integration opportunities," Larsen explained.

"Over the next 5-10 years, we see brownfield mines and smaller mines introducing automation to their sites at much higher rates than today. Larger mines that have already automated their haulage fleets will expand to other services such as blasting and drilling, even

ancillary activities like water trucks will be automated."

**Oxbotica**

Another company that made the mining headlines in June was U.K.-based autonomous software specialist Oxbotica, when it announced a partnership with mine FMS provider Wenco.

Co-Founder and CTO Paul Newman joined the discussion.

"Oxbotica was founded in 2014 by myself and Oxford University professor, Ingmar Posner," he said. "Since then, it has grown from a startup into one of the world's leading autonomous driving software companies."

The company is founded on the principle of universal autonomy — the idea that having machines know where they are, what is around them and what they should do are universally required competencies for autonomous vehicle's whether they're in mines, ports or cities.

"The universality point has some remarkable advantages," said Newman. "If the software can span domains then learning in one domain naturally transfers

**COMPANY PROFILE-PAID ADVERTISEMENT**

**A Proven leader in heavy-duty slurry pump manufacturing**



Schurco Slurry manufactures heavy duty slurry pumps for mining and other industries all over the world. Based in Jacksonville, Florida, Schurco Slurry operates a manufacturing plant with dedicated and highly trained machinists, mechanics, engineers, and a full customer support team to deliver their slurry pump products to a wide range of end users and applications in the mining industry and others.

Schurco Slurry pumps and replacement parts for various other manufacturers' slurry pumps are the industry's best source for supporting heavy duty centrifugal slurry pumps in industries like aggregate production, frac sand mining, industrial minerals, hard rock mining, mineral processing, power generation, or any type of slurry pumping application. Schurco's goal is to have the lowest total cost of ownership of any slurry

pump manufacturer on the market today by offering the greatest value on capital equipment, the highest quality spare and replacement slurry pump parts and providing unmatched engineering excellence from a company that only focuses on one product: slurry pumps!

With low lead times and attentive customer service, Schurco Slurry is one of the few remaining American ultra-heavy-duty slurry pump manufacturers delivering unmatched quality, engineering expertise and product value. Schurco is a recognized leader in slurry pump manufacturing, pump repairs, pump remanufacturing and quality replacement parts.

**Schurco's History**

The company has humble beginnings with its founding in 1975 by Frederick Schur. Today, mines and plants around the world use Schurco Slurry pumps and spare parts on every continent except Antarctica. Through their global distribution network Schurco supplies critical spares for their customers in a timely and expedited manner. Schurco's mission is to bring value to their customers through product availability and cost savings on the highest quality pumps and parts.



[www.schurcoslurry.com](http://www.schurcoslurry.com)

9410 Florida Mining Blvd E, Jacksonville, FL 32257 USA

to others bringing remarkable advantages. For example, the use of vision, radar and laser for obstacle detection and tracking on busy streets has transferred to the mining domain superbly. Similarly, with our partner Navtech, we have developed a system that uses radar as a replacement for GNSS in the mining industry, but it finds immediate application in ports and airports.”

Oxbotica’s product portfolio for the mining sector includes software that spans the entire technological spectrum, from low-level sensor managers, through calibration, four-modal localization (vision, laser radar and GNSS), mapping, perception (with vision, lidar or radar), 3D mapping and planning and control.

“It’s vertical integration even covers user interface and data export systems including cloud-based autonomy APIs,” said Newman. “What is unique about Oxbotica is we offer these pieces as parts or as a whole integrated system. Oxbotica has built an autonomy platform from a number of solutions, and partners can mix and match those solutions as they choose.

“A great example of this is our partnership with Wenco to develop an open auton-

omy solution for the industry. It will allow mining operators to deploy autonomy in a way that suits them, using hardware they already have and own and or operate.”

What makes your technology different to more traditional autonomous solutions?

“There are some obvious and immediate differences, as well as some subtle ones,” Newman explained. “Firstly, there is the modularity argument; our solutions (e.g., localization, obstacle detection, etc.) have open APIs. Then underpinning that are some fundamental technology differentiators. Examples include localization and obstacle detection with any combination of vision, radar and or cameras. And, of course, our complete stack is remarkably low power (circa 300 W) and agnostic to choices of vehicle, sensor and compute platforms.

“More subtly, our software-in-the-loop simulation and data synthesis tools allow us to rehearse and train and fake scenarios and sensor data across weather, lighting and scene types. This accelerates testing, secures safety cases and allows extremely rapid product iteration. This means we can react to customer needs in days.”

Oxbotica described its solutions as “universal.” In practice, this means the software can be installed on to any vehicle with a drive-by-wire interface, in any setting, to make it drive autonomously with a wide choice of sensors. The technology is able to work indoors, outdoors, underground, in any weather condition with zero dependence on external systems or reliance on GPS, third-party mapping or any single sensor modality or supplier.

Newman outlined the next steps for the technology. “There is a growing business case for open autonomy in mining and innovative new solutions are being introduced to the market,” he said. “We will service that market by providing optionality and high-performance autonomy solutions. From machine vision, through to planning and full site simulation. We will continue to add new functionality and make autonomy easier to use, easier to deploy and easier to add to.

“There are never going to be fewer autonomous vehicles in mining. We see the horizon of autonomous vehicles expanding in the sector far beyond current deployments. We see a world in which, if



### Slurry Pumps for Hard Rock Mining

Manufacturing pumps and parts to be installed wherever solids are pumped all over the world.



### Made in the USA

Serving global mining, processing, and general industry with reliable pumps, parts and service. Engineered, Built, and Tested in the USA.

Unmatched price, service, and attention to detail. Since 1975 Schurco has been a driving force in the pumping industry.



# SCHURCO SLURRY

**Satisfaction  
Guaranteed.**

9410 Florida Mining Boulevard East  
Jacksonville, Florida 32257

Call Us for more info  
**(904)356-6840**

[sales@schurcoslurry.com](mailto:sales@schurcoslurry.com)



SafeAI retrofits heavy equipment for autonomous applications in both mining and construction. It's platform currently supports trucks from 30-ton ADTs to 220t rigid-frame haul trucks, as well as dozers and skidsteers. (Photo: SafeAI)

there is an advantage to having a vehicle being autonomous, whatever its function, it can be. The advantages are, of course, diverse — economic, operational and safety — but they are all served by our single vision of universal autonomy.”

**SafeAI**

SafeAI founder and CEO, Bibhrajit Halder, was part of the Caterpillar-BHP

team that masterminded one of the first commercial AHS deployments back in 2008. Having taken his experience and software knowledge to Silicon Valley to work on self-driving cars, he came back to his roots in 2017, establishing SafeAI with a view to accelerating the transition to autonomous mining and construction.

“I have been working in autonomy for nearly 15 years,” he said. “Being part of

that massive Caterpillar-BHP project and helping to deliver the AHS system to site was a huge learning opportunity for me. In 2015, when I moved to Silicon Valley, autonomous self-driving cars were just starting to take off and, in the five years since, there has been an explosion in investment and technology development in that space. To give you an idea of the numbers, there's about \$20 billion invested in that ecosystem in the U.S. alone. Autonomous systems — the hardware, software and infrastructure — have all improved exponentially thanks to that.

“My team and I came from mining originally, and now we're bringing our knowledge and experience from Silicon Valley back to heavy industry. We know that the mining sector is looking to scale up deployments and use autonomy more widely and that's really where our vision is.”

SafeAI retrofits heavy equipment for autonomous applications in both mining and construction. It's full stack, task-specific autonomy platform currently supports trucks from 30-ton ADTs to 220-ton rigid-frame haul trucks, as well as dozers and skidsteers.

**COMPANY PROFILE-PAID ADVERTISEMENT**

**NORMET - DEFINING THE FUTURE UNDERGROUND**

Normet defines the future underground by leading the transformation into digitalised and sustainable underground mining and construction. We work with our customers and partners to continuously improve their processes, increase the safety and productivity of their underground activities, and improve the sustainability of their operations.

**SECURING A SAFE AND SUSTAINABLE FUTURE**

At Normet, a safe workplace is our first priority. We continuously develop new solutions that enable you to work more safely and sustainably and minimise your impact on the environment. We commit to exceeding industry standards.

**INNOVATING FOR PERFORMANCE**

We use leading-edge solutions and technologies to benefit our customers. In addition to innovations that improve our products and services, we also aim to improve our customers' processes continuously. Our commitment to innovation gives you clear results with improved performance and higher productivity.

**PARTNERING FOR LIFETIME VALUE**

We are committed to long-term partnerships and our whole team is dedicated to helping you reach your goals. Our expert cooperation, effective solutions and pro-active problem-solving

gives you superior lifetime value and lets you focus on your own business.

**Normet** is a fast growing and innovative company with a mission to lead the transformation into a safer and more sustainable tomorrow. We specialise in technology for underground mining, tunnelling and civil construction. We provide our customers with safe, high quality equipment, services, construction chemicals and rock reinforcement solutions for projects around the world.

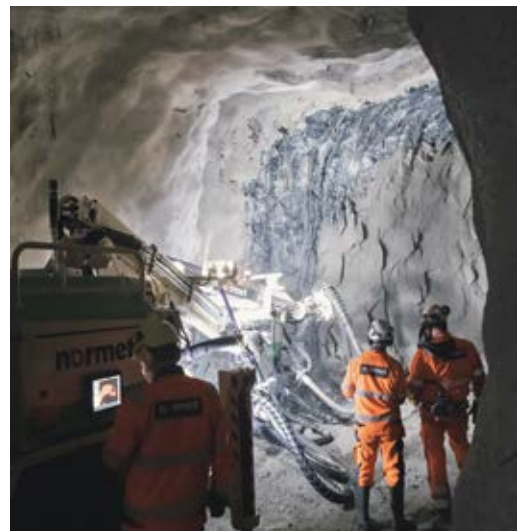
**Underground expertise**

We support our customers with process expertise gained from working on thousands of mining and tunnelling projects all over the world. To date, we have delivered more than 13,000 pieces of purpose-built underground equipment, while improving safety and productivity through our range of construction chemicals and rock reinforcement products. We also offer a range of services and support for our customers, and we employ over 1400 professionals globally, with more than 43 locations in 29 countries.

**Continuous development**

We constantly develop new equipment, technologies and construction chemicals to provide additional value for our customers' under-

ground processes. Our development teams consist of world-class experts who use the latest methods and tools. We use our own laboratories to develop our construction chemicals and perform field tests for the whole of our offering in real-world environments. In all our work, we aim to enhance safety and reduce environmental impact.



“In addition to the autonomous kit (hardware), which can be easily taken off of one machine and transferred to another, we also provide cloud-hosted, AI-based software that handles machine coordination, assignment and fleet management,” Halder explained. “Our APIs are open, and we provide customers with full access to their operational data. We believe that mining companies own their own data, and they should be able to use it in any way they see fit.”

This interoperable approach means that SafeAI can supply any or all elements of an AHS.

“Even though we have our own full stack AHS system, we have also integrated our hardware and software with other vendor’s systems,” Halder said. “For example, if a mine that already had Modular Mining’s DISPATCH FMS installed came to us and asked us to retrofit their Cat 777 trucks for autonomy which, by the way, Cat doesn’t currently offer, then we could do that and make our technology to work with DISPATCH too.”

In October, SafeAI announced it had partnered with Japanese construction

firm Obayashi Corp to create autonomous construction sites, beginning with a pilot program on a test site in California.

“We are currently working on automating a Cat 725 ADT,” Halder said. “It will debut in the U.S. first and we will expand the availability of that solution over the next six months.”

Where does Halder see the technology heading?

“We’ve got lots more work to do, but our goal is to work with mining companies, our end users, directly to deploy solutions that meet their needs exactly,” he said. “AHSs were originally developed by OEMs according to their vision of autonomy, but we’re doing things the other way around.

“We believe the key isn’t in just using technology to automate mine sites, it’s about giving mining companies what they really want. For example, if a mine wants to reduce its haul road lane widths because that will help them with costs, then we will tailor our technology to enable their trucks to navigate narrow road widths safely. If they want to implement autonomous haulage but

can’t afford to replace their network, then we will make our technology work with their current network. We work very closely with customers and that really makes for a better product.”

Halder hinted that SafeAI may expand its solutions in the coming years to incorporate automation for light vehicles and mine water trucks too.

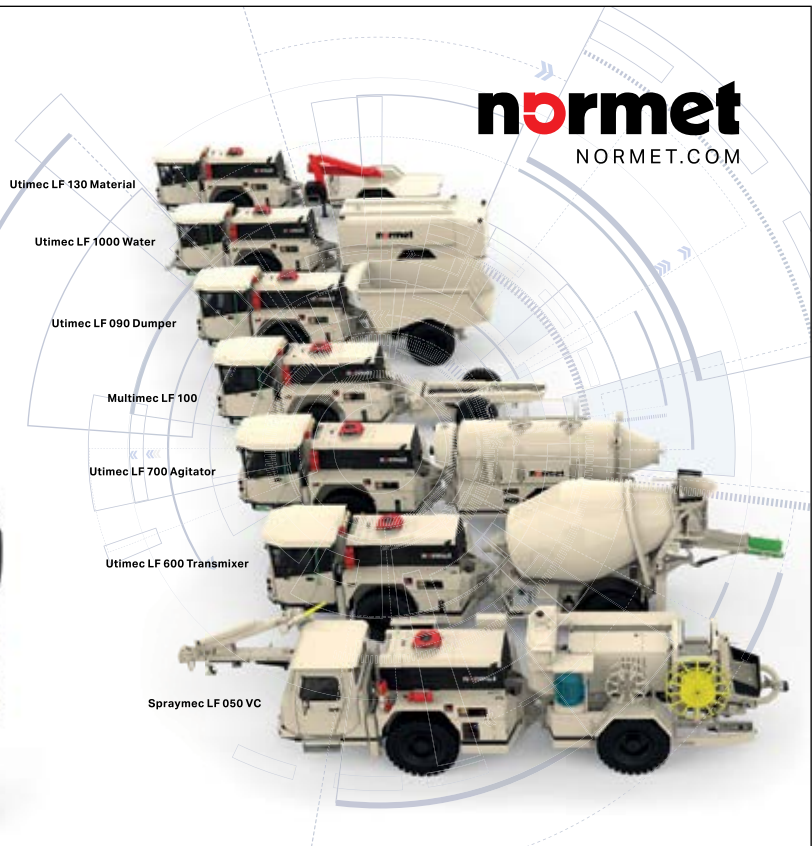
“The mining industry is at a tipping point with autonomous technology,” he said. “That tip may not happen for 2-3 years yet, but it’s coming. Autonomous technologies have improved exponentially. We can do things today that we never even thought of 10 years ago. There’s also a lot of venture backed capital flowing into the autonomy space, so we will see more players coming to the market with open and interoperable solutions.

“From the customer side, mining companies are getting access to better technology at reduced prices. Today, there are approximately 600 autonomous mining trucks across the globe, and I think we’re going to see that number accelerate very quickly. The drivers are all there from both outside and inside the industry.”

## INNOVATING FOR PERFORMANCE

Normet L-series Stage V offering meets the latest emission requirements and provides safe and efficient operation underground.

- > Reduced diesel particles and cleaner air
- > New cabin with superior visibility and ergonomics
- > Increased power for better performance



## The Hilliard Corporation: Made in America • Built for the World



The Hilliard Corporation has been a world leader in motion control, filtration technology, and braking systems since 1905. We are currently offering a line of caliper brakes under the trade name Hilliard Brake Systems. These brakes and braking systems broaden our product line offerings, which include a full line of mechanical clutches and electric brakes. As an established business for over 110 years with robust engineering and manufacturing strengths, this line of caliper brakes seamlessly integrates into our product mix. Hilliard will be offering complete custom turn-key systems as well as single components with the ability to replace all competitor products, while reducing length of lead times, and costs for our customers. This new venture opens global opportunities to sell braking products, as opposed to our current restriction to the U.S. marketplace only. This product mix for Hilliard translates into reduction of end-users' need to carry critical spares, reduce the costs of their inventory, as well as reduce downtime due to

braking components. We are committed to this investment for the future by expanding our manufacturing capacity and service to the industry with our ability to respond to our customers' needs.

#### Current Industry Experience:

- Mining
- Marine & Shipping
- Energy/Wind Power
- Lifts and Elevators
- Cranes and Hoists
- Steel/Metal
- Amusement/Theater

The Hilliard Corporation makes thousands of unique products, reaching markets globally and serving the needs of both small businesses and Fortune 500 companies. We offer a broad line of motion control products, oil-filtration and reclaiming equipment, and plate and frame filter presses used in the food industry. We also manufacture starters for industrial gas and diesel engines and gas turbines. Our filtration systems are sold under the trade names of HILCO\* and Star\* Filters.

Our products are designed, manufactured, and sold according to our customer's applications. As a result, we have a large portfolio of custom engineered products that can be modified to meet new applications. At Hilliard, we embrace the challenge of product development. With over 500,000 square feet and more than 500 highly skilled employees, we are able to meet desired requirements cost-competitively, even for short runs. Our experienced technical staff values craftsmanship, manufacturing efficiency, and responsiveness - all of which result in increased bottom line for our customers.



AS THE WORLD MOVES FASTER,  
OUR BRAKES WORK HARDER.



INDUSTRIAL BRAKES FOR A WORLD OF APPLICATIONS



HYDRO TURBINES | ELECTRIC GENERATORS | MARINE PROPULSION | WINCHES | DYNOMOMETERS | NUCLEAR COOLING PUMPS | FRICTION WELDERS | CRANE BRIDGE DRIVES  
THEATRICAL / STAGE EQUIPMENT | CRANE HOISTS | MINE HOISTS | ELEVATORS | ESCALATORS | MARINE PROPULSION | MINING CONVEYORS | GENERAL MACHINERY  
PAPER MILLS | TEXTILE MACHINERY | PACKAGING MACHINERY | POWER PLANT FANS | CONVEYORS | CAR SHREDDERS | GRINDING MILLS | KILNS | PAPER CONVERTING  
WIRE PAYOFFS | STEEL PROCESSING LINES | AMUSEMENT RIDES | MATERIAL HANDLING | DRAGLINES | SKIP HOISTS | MINING CONVEYORS | MARINE | RAIL/CONVEYORS  
MARINE/SHIPPING | WIND ENERGY | STEEL/METAL | BUCKET ELEVATORS | BARGE UNLOADERS | RAIL CAR DUMPERS | RAIL CAR POSITIONERS | PEOPLE MOVERS  
HYDRO TURBINES | ELECTRIC GENERATORS | MARINE PROPULSION | WINCHES | DYNOMOMETERS | NUCLEAR COOLING PUMPS | FRICTION WELDERS | CRANE BRIDGE DRIVES  
THEATRICAL / STAGE EQUIPMENT | CRANE HOISTS | MINE HOISTS | ELEVATORS | ESCALATORS | MARINE PROPULSION | MINING CONVEYORS | GENERAL MACHINERY  
PAPER MILLS | TEXTILE MACHINERY | PACKAGING MACHINERY | POWER PLANT FANS | CONVEYORS | CAR SHREDDERS | GRINDING MILLS | KILNS | PAPER CONVERTING  
WIRE PAYOFFS | STEEL PROCESSING LINES | AMUSEMENT RIDES | MATERIAL HANDLING | DRAGLINES | SKIP HOISTS | MINING CONVEYORS | MARINE | RAIL/CONVEYORS  
MARINE/SHIPPING | WIND ENERGY |

**MADE IN AMERICA, BUILT FOR THE WORLD**

**HilliardBrakeSystems.com**



Hilliard Products are  
Made in the USA

# Predicting the Way to Better Workplaces

*Alex Moss, CEO of Canaria Technologies, discusses how predictive biometrics could revolutionize mine workforce safety and productivity*

By Carly Leonida, European Editor

In September, Macarthur Minerals announced it had signed an agreement with Canaria Technologies to introduce and test the new Canaria-V predictive biometrics platform with a view to wider implementation at its Lake Giles iron ore project in the Yilgarn region of Western Australia during 2021.

Canaria's system is the first in heavy industry to utilize predictive biometric technology to identify and prevent potential safety-based incidents on-site, but it could, eventually, have wider applications.

"Predictive biometrics include any type of technology that uses historical biometric data from users to identify patterns in that data, then take a next step to make predictions about how that data will behave in the future," Alex Moss, CEO of Canaria Technologies, explained.

"It's hard to say exactly where the technology originated, it's an emerging field that builds upon biometric sciences and academia. We're one of the first companies to use it outside of laboratories and research institutes."

Leaders in the field of predictive biometrics include Professor David Clifton's work at the University of Oxford and various studies at MIT. Most leading universities today have a professor whose work touches upon the subject, even if they're not fully researching it.

"Interestingly, the techniques used to create time-series-based predictive biometric systems have been used in the financial sector for the past decade and are now being applied to the medical sciences," Moss added. "But, at Canaria, we find ourselves recruiting more full-stack developers and data scientists, because very few people have worked in predictive biometrics before."

"My company's technology originated from a project for NASA in 2016 for monitoring astronauts remotely, so I suppose it wouldn't be wrong to say that it came from space."

## What is 'Biometric' Data?

Any data that is gathered about the way the human body functions can be described as biometric.

The best known types are: fingerprint scans; iris scans; electroencephalography (EEG) readings, taken using skullcaps in hospitals; electrocardiogram (ECG) readings where pads are placed on the chest to measure electrical heart activity; and pulse plethysmography (PPG), which measures oxygen levels in the blood.

In early December, Canaria's work culminated in the launch of the Canaria-V platform, the successor to the Puck, which is currently in the process of being decommissioned. The technology is delivered via a multitiered subscription-based service that includes hardware (a wireless earpiece for each user and smart charging docks that can hold multiple devices) as well as software and cloud-based analytics to support operator safety in mines.

"At Canaria, we use a few different types of biometric data simultaneously to increase the accuracy of our systems and lay down foundations for future use cases," Moss explained. "We use a Linux-style of development for building our hardware. The sensor systems are, essentially, overengineered and some of the capabilities left dormant."



Alex Moss, Canaria Technologies' CEO.

When ready, these can be activated via a software update. For instance, today, the system can provide heat exhaustion predictions, cognitive fatigue predictions and man down alerts, but asphyxiation prediction may be added to that in the near future."

The Canaria-V Earpieces are themselves miniature computers with their own processing power.

"We lighten this processing load by off-setting segments of the data that our devices collect on to smart docks and then finally through our cloud-computing system," explained Moss. "The really heavy data analytics work is done on powerful computers by our data scientists and we present the data in a few ways, such as smart phones linked to our devices and on our desktop app, too. We're working on integrating this into our client's most used management software, so that users aren't overwhelmed with lots of different platforms."

Because the devices themselves have edge processing power, they can handle data and issue critical alerts both with and without an internet connection — a crucial feature at remote or underground sites — but having cloud power as well means that more complex sets of raw data can be computed and stored for future potential applications.

"For instance, we use PPG and heart rate variability measurements to predict cognitive fatigue today, but there could be parts of that data that we don't understand yet that in five-years' time could be a crucial building block for another application," Moss said. "It's important that we have that data, so we've built a few different layers of storage contingency on our devices. The earpiece itself is a microcomputer with on-device storage capabilities, the charging docks offer additional storage as contingency, and then we also have a backup cloud storage."

The team has found that, in practice, some mine sites can go for five days without a reliable internet connection, so the earpieces have been engineered to store





Canaria was established in 2016 and began by producing high-accuracy vital signs monitors for NASA.

data on-device to mitigate this data-transfer risk. Once on the charging dock, the data is automatically downloaded to clear the device and allow it to be pushed up to cloud via an ethernet connection. The previous generation's dock can store up to 10 days' worth of data from each device in case of poor connectivity.

"The idea is that the devices themselves are still functioning, still collecting data and importantly they are still sending out predictive alarms to all of our users while they are operating in the field or underground," added Moss.

### Predictive Capabilities

What makes biometric systems predictive is the ability to make the leap from recognizing a pattern in data, to being able to predict the next step in that pattern.

"Think of them as the high-tech equivalent of the 'work out the next number in the series' math problem we all did at high school," explained Moss. "The accuracy of the system completely depends upon the accuracy of the data. That's why we built our own medical-grade biometrics devices instead of just making the software."

I know exactly what you're thinking: "But, Apple Watch 'already does that.'"

Actually, if you've ever read the small print on the adverts, it clearly states that Apple Watches cannot be used for medical purposes. And the same goes for Fit Bit and Garmin devices.

Why?

"Garmin, Fit Bit and Apple Watches have around 27% inaccuracy in their biometric readings, which means they are

great for consumer use, but they can't be used as reliable biometric predictive systems, especially in life or death situations," Moss was clear. "By contrast, the Canaria-V and also its predecessor, the Puck, produce medical grade readings of less than 1% inaccuracy by using the same technique used in intensive care units for gathering up biometric data. And these systems are self-learning, so the more they are used, the more accurate they become."

There are two ways of obtaining PPG readings: the first method, reflective PPG, which is used in consumer devices, functions on the wrist. A green light is shone through on to skin and then it bounces off hemoglobin in the blood cells at a 90° angle and is picked up by photo sensors.

"The issue with this method is that there's room for light interference and, because the device is on the wrist, there's a lot of movement interference as well," Moss said. "Also, there's a limited amount of information in green light.

"Transmissive PPG, which is what we at Canaria use, has been used purely in medical settings and is usually based on floor-mounted devices with clips that fix on to an ear or finger. That method uses red, infrared and green light, which shine straight through a thin tissue sample and are picked up on the other side. Having the light pass straight through the tissue mitigates light interference, and the positioning of the device, especially on the ear — which is one of the big reasons we made Canaria devices for the ear — is that there's less movement interference.

"The other reason we chose to put them on the ear is that plethysmography works by measuring the rate at which light

reflects off the hemoglobin in the blood. In order for that to work, there needs to be a good amount of blood flow to the area that you're taking the readings from, which is normally fine except when somebody goes into shock, and the first areas that blood flow gets constricted from are the hands, arms and legs. The last areas are the brain and the internal organs. The ear lobe is on the same blood supply as the brain, and so is one of the last things to be shut off."

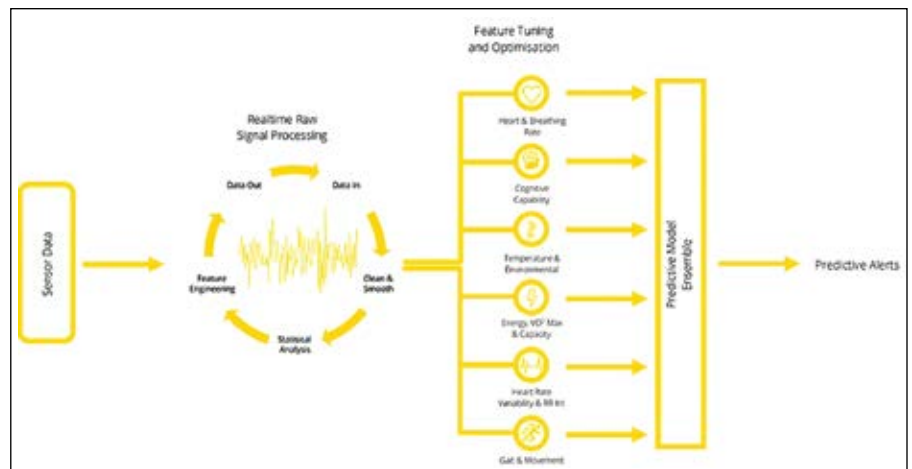
This is important because, if you took a reading from someone who was in shock — let's say they've been trapped in an underground mine collapse — even if you used the more accurate method of PPG but took the reading from someone's finger, it could tell you that they're dead or much closer to death than they actually are because blood flow to their extremities is being restricted. Whereas if you took those same readings from the ear, you would be able to tell if that person was alive and just in shock.

### Why Mining?

To date, predictive biometrics have mainly been used in medicine and in a somewhat experimental capacity. Medtronic recently introduced an interesting system for predicting insulin levels in diabetic patients (although users had to manually input their data), and a company called Natural Cycles has a system that predicts women's fertility cycles based on core body temperature.

Canaria has been working on proposals for companies in the aerospace and defense sectors, but Moss said mining is the first heavy industry opting to use predictive biometrics to solve problems.

"These systems are particularly useful in mining applications because the work-



The process flow of a predictive biometrics system.



The Canaria-V earpiece features a microcomputer with on-board storage capabilities.

ing environments are more extreme than, say, office-based work," she explained. "There's a much higher mortality rate, and higher asset damage costs if a worker passes out while operating machinery due

to fatigue or cognitive stroke... Sites are also more remote, so it's harder to access medical facilities when accidents do happen, meaning there's an extra incentive to make sure people never get past their physical limits in the first place.

"Predictive biometrics mean the difference between getting a phone call that your colleague has just had a microsleep or knowing that your colleague is 10 minutes away from having a microsleep. It also means that, although you can implement predictive biometrics based on group metrics, the alerts can be individualized for each user."

Most fatigue monitoring systems on the market focus only on the symptoms of cognitive fatigue and are limited to collecting one type of biometric data. This is where the Canaria-V differs; it collects multiple types of biometric data to produce different alerts.

"It's like the leap between an old Nokia cell phone and an iPhone," Moss said. "We're not just reading cognitive fatigue based on heart rate variability, we're doing heat exhaustion predictions based on the difference between skin tempera-

ture and ambient temperature, and we're cross referencing that with raw PPG signals, which denote general levels of physiological stress. Then we add to that a gyroscope and accelerometer readings so we can provide man down alerts as well by categorizing the type of movements our users are doing.

"We can also do software updates into pre-existing hardware, so users don't have to buy new devices every time an important alarm is added to the Canaria-V system. They'll get automatic software updates whenever we discover that our system can do something new."

To date, the subscription approach has been used successfully in consumer software, and it makes sense for companies in the mining space too, because it keeps both CAPEX and OPEX costs low.

"Our subscriptions are very affordable," Moss said. "For instance, Canaria Core, our entry level subscription, which isn't individualized, costs less than AU\$400 per person, per year. When you consider how many accidents occur in the mining industry each year and how much asset damage costs, it really should be a no brainer."

COMPANY PROFILE-PAID ADVERTISEMENT

Tsurumi Tandem Kit

Tsurumi Manufacturing Co., Ltd. was founded in Japan in 1924, and has since been manufacturing, purchasing and selling various pumps and related equipment, with a strong focus on submersible pumps. Herein introduced is Tsurumi's "Tandem Kit" that exhibits power in fields where high head is required, e.g., mines, and construction and tunnel work sites.

Generally, in applications that need draining at high head such as mines, it is necessary to prepare an expensive pump of a large size that provides high enough output to satisfy the required specifications by itself, or to make a sump pit as a relay point. Particularly, when it comes to draining water from mines, there is a limitation on installation space. Therefore, in such a case, a pump of compact and slim design is required.

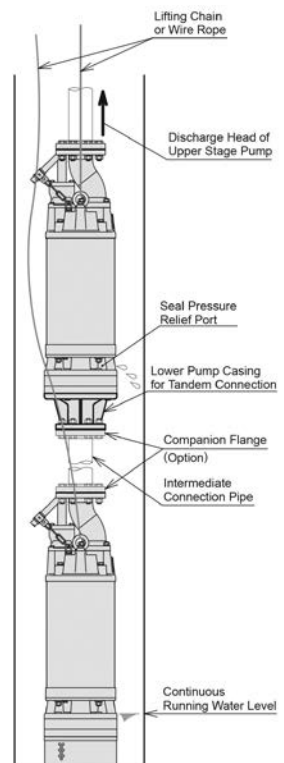
For this purpose, Tsurumi developed the dedicated "Tandem Kit," which is attached to the casing of the LH and LH-W series pumps that feature high head, high durability and slim design, and have been proven in mine drainage applications. With the "Tandem Kit," two pumps of the same model can be easily connected in series. Tandem operation that connects two pumps in series can provide twice the total head of a single pump at a fixed flow rate. The operating principle of this method is the same as that of a multi-stage pump.

Tsurumi has six 3-30 kW pumps that are applicable with the Tandem Kit. Most of these pumps have a dual impeller design. The Tandem Kit can be easily attached to the pumps at the work site. With this kit, an ultra-high head of a maximum 254 m can be obtained. A head of 400 m is possible with optional features.

Tsurumi offers a variety of heavy-duty, highly reliable pumps that enable continuous operation under the strenuous conditions found in mines, etc. Also available as options are submersible pumps for high-temperature liquids that can handle water of up to 90°C and "all stainless steel pumps," in which all liquid contact parts are made of stainless steel (316 stainless steel). To order any of these pumps, please contact us.



LH23.0W with Tandem Kit



Installation Diagram



Tsurumi Manufacturing Co., Ltd.  
 intsales@tsurumipump.co.jp  
 www.tsurumi-global.com

## Increasing Adoption

However, even with technology that seems a “no brainer,” there are usually barriers to adoption.

“If you’d asked me three years ago, I would have said those barriers were mainly cultural or data privacy concerns,” Moss said. “But, in practice, the barrier is high-speed internet connections on site. We’ve had to build our systems to work around sporadic connections, and to work with and without internet connections in users shifts, which is doable but has been a real challenge. The faster mine sites adopt new high-speed internet connections, the faster and better biometric predictive systems can be adopted on site.

So 5G could make a big difference in this case?

“As soon as 5G is used as standard on mine sites it opens up the door, not just for predictive biometric systems, but for predictive biometric systems to be integrated into vehicle collision avoidance systems and to have high-speed, real-time connections to control centers on the other side of the country for analytics... And then we can actually be industry 4.0 rath-



Transmissive PPG is usually used in medical settings and is based on floor-mounted devices with clips that fix on to an ear or finger.



**TSURUMI PUMP**  
www.tsurumi-global.com

# Extreme circumstances reveal true value.

With over 90 years of history,  
the Tsurumi Pump Brand continues to receive  
worldwide support with its superior quality,  
exceptional durability and solid reliability.



**TSURUMI MANUFACTURING CO., LTD.**  
4-16-40, Tsurumi, Tsurumi-ku, Osaka 538-8585, Japan  
Phone +81 6 6911 7271 Fax +81 6 6911 0100  
intsales@tsurumipump.co.jp  
www.youtube.com/user/amenics

er than just talking about it,” said Moss, with a wry smile.

Change management is of course, still an issue, although a lot of the work that mining companies have done over the past decade around mental health policies and procedures has paved the way for predictive biometrics.

“Canaria is the first company in the mining sector to use predictive biometrics and we’re extra careful, with the awareness that whatever we do will probably lay down the standards for the rest of the industry,” Moss said. “We’re at a point where our devices could become legally mandated — we’re already having discussions with federal ministers in Australia — but, on the flip side, if we misuse data or if training is not done properly then they could be banned. We’re doing everything we can to stay on the right side of that.”

To ensure data privacy, Canaria-V uses two tiers of anonymization and the data is stored in multiple siloes to adhere to EU Data Privacy best practice standards.

“We also have a strict company policy that we do not sell our user’s data to third parties,” said Moss firmly. “We’re just not interested in making money that way.”

When it comes to building a business case for the technology, Moss has created a simple equation to help mines get their numbers in order...

“Tally up all of the asset damage on site over the past five years and slash it by 30% for a conservative estimate in savings,” she said. “Bear in mind that work has already begun on using predictive biometric systems to reduce insurance premiums. So, on this horizon, build in an estimate for reductions in insurance costs, time off for workers affected by

medical incidents, and time taken for reports to be filled and external contractors to be brought in as a replacement.

“As a rule of thumb: 30% of asset damage on site for the past five years, plus a ~2% reduction in insurance premiums on the 10 year-horizon, plus the cost of incident reports equals the approximate conservative savings for adopting a predictive biometrics system.”

Which is huge.

“That’s why we’re in the mining industry,” Moss said. “Two thirds of all heavy industrial accidents are caused by microsleeps. If you can predict those accurately then, in a best-case scenario that’s a two-thirds reduction in accident costs.”

## Shaping the Future of Work

How do you see predictive biometrics fitting into the future of the mining industry?

“I see them becoming multifaceted as standard, fully integrated into mining operations, especially miniaturized devices mounted inside ear plugs that double as communication devices,” said Moss. “The live data from these systems should also update into mine management software and synchronize with emergency response off site such as hospitals. I see them optimizing workforces in a way that improves safety and productivity, while allowing workers more time off.

“As technologies become more remote over the next few decades, especially autonomous vehicles, predictive biometric systems will ensure that operators work in optimal physical conditions to prevent costly supply chain mistakes. This is particularly important in a post-drone landscape where operators are likely to work

in confined, dark conditions for long periods of time.”

Moss proceeded to give *E&MJ* a demonstration of the Canaria-V. She, and other members of the Canaria team, wear the device while going about their day-to-day lives. Using the readings to optimize individuals work patterns has significantly altered their work-life balance.

“I genuinely think these devices could revolutionize industries,” she said passionately. “Based on my team’s fatigue levels, we’re already trying to adopt a more streamlined work-week that prioritizes optimal performance over the standard 9-5 office work hours. Canaria team members often work 12-16 hours a day and during weekends and, using those readings, we know when it’s sensible to keep working or when people need to go have a nap.

“I was looking at the brochure for the Canaria-V the other day while wearing a Puck and my fatigue alarm went off. It went off five times in just one day. I was so tired, but it still felt awkward, as the CEO, to show my team the readings and say, ‘I’ve got to go take a nap, I’m not being productive right now.’”

Awkward though it might feel today, this is the first step in designing workplaces of the future. Predictive biometrics will eventually enable companies across every industry to redesign their processes and rosters to take advantage of how employees are feeling that day and make adjustments according to an individual’s needs.

In time, this information will allow us to design business models and team structures based around people and their capabilities rather than the other way around, which has been the norm up until now.

“I completely agree,” Moss said. “It could allow us to get rid of presenteeism and look at what value individuals really deliver to a company. For instance, if someone delivers four hours of focused work and makes the company enough revenue to not only fulfil their own paycheck, but hire another employee as well. Well then, that’s their work done. Why should they hang around the office for another three hours just for the sake of looking like they’re working while secretly browsing the internet?”

You’ve developed a very valuable technology, *E&MJ* noted. I’m surprised you haven’t been approached by a major tech company like Google.

“Not yet,” said Moss with a twinkle in her eye.



The Canaria analytics suite.



***e-mj.com***

Everything you love from the print edition  
in an easy-to-navigate format,  
and access to...

***Subscriptions***

***Newsletters***

***Digital Issues***

***Social Media***

***Marketing***

***Calendar of Events***

## AGUDIO: ROPE-HAULED SYSTEMS FOR MATERIAL TRANSPORTATION SINCE 1861

In the world of rope-hauled transport systems, few projects cannot be replicated because different material and working conditions require customized design and construction solutions.

In the Turin-based headquarters, a team of engineers work for the development of unconventional rope-hauled transport systems: ropeways, Flyingbelt, cable cranes, cableways and funicular for material transportation.

AGUDIO is now part of an international group together with companies such as LEITNER ropeways, POMA, PRINOTH, LEITWIND, DEMACLENKO and MiniMetro. Over 70 branches all over the world, more than 3,800 employees and an annual turnover amounting to over 1 bn euros.

Today, as result of the several projects successfully implemented, Agudio is a leading brand in the design and construction of ropeways and Flyingbelt for material transportation in difficult environmental conditions, the most cost-effective solution to reduce distances, overcome obstacles such as valleys and rivers, or fly over forests and protected areas with almost no environmental impact.

<b>MINIIZATION</b> The reduction of space required for rope-hauled systems allows 200 years of experience in the design and the construction of high-capacity systems in restricted installation conditions.	<b>LOW ENERGY CONSUMPTION</b> Rope-hauled systems for material transportation are highly suitable for long distances, especially by means of electric systems. Energy consumption is optimized only depending on the system, the site and the type of material, but always it is lower than road transport systems.	<b>LOW CO2 EMISSIONS</b> Rope-hauled systems for material transportation do not generate CO2 directly as these systems are powered by highly efficient electric systems where CO2 emissions generated are lower than the transport systems using directly fossil fuels, with savings up to 90%.
<b>LOW MAINTENANCE COSTS</b> The continuous use of a rope-hauled system for material transportation designed by Agudio are compatible with the use of standard components, but very reliable and of high quality, as well as implementation and maintenance plans which can be defined in advance for the system operating personnel.	<b>HIGH LEVEL OF AUTOMATION</b> Rope-hauled systems for material transportation are designed with a high level of automation to ensure the constant system control and operation and to synchronize the material loading and unloading systems with the line capacity.	<b>LONG SYSTEM WORKING LIFE</b> Rope-hauled systems for material transportation are designed according to the most advanced guidelines and the experience gained by Agudio in over 150 years of design, construction and maintenance of such systems which, moreover, last more up to over 40 years of working life due to the suitable programmed maintenance plans.
<b>SAFE AND RELIABLE SYSTEMS</b> As a result of the high automation level and the advanced quality, rope-hauled systems for material transportation are among the highest level of safety and reliability, thus offering a top performance and increasing the safe transport capacity rates.	<b>LOW DISPERSION OF DUST PARTICLES</b> Rope-hauled systems for material transportation can be designed with specific dust particle containment systems according to the type of transported material. In order to maximize dust dispersion on the air during loading and unloading operations, as well as during the line.	<b>SYSTEM OPERATION REGARDLESS OF WEATHER CONDITIONS</b> Rope-hauled systems for material transportation are designed according to the international standards in the range of operating conditions of the material to be transported and therefore capable to operate in various conditions which, moreover, last more up to over 40 years of working life due to the suitable programmed maintenance plans.

### AGUDIO FLYINGBELT

The Flyingbelt is a patented system combining the advantages of conveyor belts and rope-hauled systems into a unique product for its efficiency and reliability, ideal for the mining, extraction and cement fields, as well as big construction sites.

As it is not affected by the soil morphological conditions, the Flyingbelt can be used in any contexts, with a considerable reduction in the costs resulting from civil works, excavations and supporting structures usually required by conventional transport systems.



<b>CAPACITY UP TO</b> <b>10000</b> TONN	<b>GRAIN SIZE UP TO</b> <b>400</b> MM	<b>SPANS OVER</b> <b>1000</b> M	<b>BELT WIDTH UP TO</b> <b>1800</b> MM	<b>INCLINE UP TO</b> <b>25</b> DEGS
---	---	---------------------------------------	--	---

The adoption of standard components used also for traditional conveyor belts enables the Flyingbelt to be a highly innovative system, but at the same time, ordinary for its operating and maintenance methods and costs. Moreover, the Flyingbelt can be used for hybrid systems, where the same belt can run both hanging on ropes and on traditional supports laying on the ground.

### AGUDIO ROPEWAYS

Ropeways have always been the most cost-effective, rational and environmentally friendly solution to transport materials over long distances, steep slopes or poorly accessible areas.

Nowadays, Agudio ropeways represent the highest expression of this sector technology, with completely automated systems, which do not need personnel for material loading and unloading operations and can guarantee a high-level performance. A perfect solution for new installations or revamping of existing ones.



<b>CAPACITY UP TO</b> <b>800</b> TONN	<b>BUCKET VOLUME UP TO</b> <b>2</b> M <sup>3</sup>	<b>SPEED UP TO</b> <b>6</b> M/S	<b>INCLINE UP TO</b> <b>100</b> DEGS	<b>WORKING LIFE OVER</b> <b>40</b> YEARS
---	--	---------------------------------------	--	--

### AGUDIO CABLECRANES

Agudio cable cranes are designed with a double track rope having reduced diameter, easier and faster to be installed and more stable during operation, also in adverse climate conditions.

Agudio cable cranes, with loading capacity up to 50 ton, traverse speed up to 8 m/s and lifting speed up to 4 m/s, reflect the state of the art in this technological sector and make it possible to manage complex sites in a simple and advanced manner, with considerable advantages in terms of implementation costs and timing.



<b>HOOK LOWERING SPEED UP TO</b> <b>400</b> M	<b>PAYLOAD UP TO</b> <b>50</b> TON	<b>TRAVERSE SPEED UP TO</b> <b>8</b> M/S	<b>LIFTING SPEED UP TO</b> <b>4</b> M/S	<b>SPAN UP TO</b> <b>2000</b> M
---	--	--	---	---------------------------------------

# AGUDIO: INNOVATION THAT SHORTEN DISTANCES.



**FLYINGBELT, CABLE CRANES, MATERIAL ROPEWAYS, CUSTOMIZED CABLEWAYS.**  
Since 1861 reliability, performance and innovation are our values, Agudio a leading brand in engineering and construction of rope-hauled material transportation systems.

**Cable cranes**



**Material ropeways**



**Flyingbelt**



*Flying over obstacles, since 1861*

# Industry Trends Drive Diesel Development

*Diesel remains the heavyweight champion of high-volume haulage power, but BEVs, alternate fuels and other green-tech challengers are rapidly rising in the rankings*

By Russell A. Carter, Contributing Editor



According to the International Council on Mining & Metals, large mining mobile equipment currently produces roughly 30-50% and in some cases, up to 80% of Scope 1 emissions at a mine. (Scope 1 emissions are direct emissions from sources owned or operated by a company or organization.) ICMM's Innovation for Cleaner, Safer Vehicles (ICSV) initiative has brought together 27 of the industry's leading mineral producers and 19 major OEMs with the goal of introducing greenhouse gas emission-free surface mining vehicles by 2040.

For the better part of a century, diesel power has rumbled along a wide, uncrowded path to dominance in surface haulage of mined materials. In the underground world, the path hasn't been quite as smooth — at coal operations in certain countries, for example, where only approved diesel engines are permitted in mines — but even so, diesels have consistently prevailed over electric-drive equipment in underground metal mining.

However, the route ahead for both surface and underground diesel deployment is going to get tougher as competing technologies and evolving customer demands congest the traffic flow.

Nobody is predicting that diesel will lose its prime position anytime soon, but high-horsepower engine builders and OEM earthmover equipment sup-

pliers can be excused for having a lot on their minds as they piece together a product-line development strategy capable of solving issues ranging from basic power train configurations — diesel, hybrid or fuel cell, for example — to industry trends that will dictate how and to what extent diesel-powered haulage can be economically used, or eliminated.

For example, as mentioned in our September issue (see *Futuristic Decisions Threaten Status Quo*, pp. 60-69) Anglo American plc is moving ahead on a program that, if successful, could ultimately lead to conversion of more than 400 of its diesel-powered haulage trucks to use hydrogen fuel.

A pilot project starting next year at Anglo American Platinum Ltd.'s Mogalakwena operation in South Africa will

use a 3.5-megawatt electrolyzer to produce hydrogen on site. The company will convert a Komatsu 930E truck to run on a hydrogen fuel cell module paired with a scalable modular lithium-ion battery system from Williams Advanced Engineering. This arrangement, which replaces the existing vehicle's diesel engine and fuel tank, is controlled by a high-voltage power distribution unit delivering more than 1,000 kWh of energy storage.

Meanwhile, Nouveau Monde Graphite is publicizing plans to develop the first all-electric open-pit operation at its Matawinie project in the Canadian province of Quebec. The company said the mine will have an all-electric, zero-emission mine fleet comprising electric battery-driven 36-ton mining trucks, battery-driven front-end loaders, cable reel excavators and bulldozers, and battery-driven service vehicles. It also will have an electric in-pit mobile crusher and overland conveyor system to feed crushed material to the plant.

In the underground sector, activity and interest in battery-powered equipment is on the rise: Late last year, Epiroc announced that Agnico Eagle Mines had just ordered a Boltec E Battery rig for the Kittilä gold mine in Finland, and orders from several other companies had been booked in previous quarters for battery electric versions of the Boltec rig, Boomer face drilling rig, Scoop-tram loader and Minetruck hauler.

Agnico Eagle had previously been testing several Epiroc battery-powered machines at Kittilä as part of the Sustainable Intelligent Mining Systems (SIMS) project. SIMS, in which Epiroc serves as coordinator, is part of Horizon 2020, a large European Union research and innovation program. A Boomer E2 Battery had been operating for some months at Kittilä, and in midyear, a Minetruck MT42 Battery and a Scoop-tram ST14 Battery also arrived at the mine as part of the SIMS project.



In the U.S., Sandvik and Barrick signed a partnership agreement for trialing battery electric vehicles (BEVs) at the Turquoise Ridge gold mine, part of the Nevada Gold Mines joint venture (JV) in which Barrick serves as mine operator. During a three-year production trial, Sandvik will deploy four Artisan Z50 BEV trucks at the mine — the single-largest gold-producing complex in the world.

The 50-t-payload Z50 BEV haul trucks are equipped with AutoSwap, a self-swapping system for the Artisan battery pack that is claimed to only take about six minutes per swap and that can be accomplished in a passing bay or old re-muck bay without need of overhead cranes or external infrastructure, according to Sandvik.

Diesel-powered loading and haulage fleets aren't the only area of focus of electrification: Iron ore producer Fortescue Metals announced a A\$32 million renewable hydrogen mobility project that will deploy 10 hydrogen-powered buses to replace an existing fleet of diesel buses at its Christmas Creek mine in Western Australia starting in mid-2021. It will be supported by installation of a refueling station, which will harness renewable electricity from the Chichester solar gas hybrid project to generate renewable hydrogen onsite.

And in some cases, the stimulus for electrification comes from unexpected or nontraditional sources: In the U.S. in the state of Minnesota, for example, electric utility company Minnesota Power has asked state regulators to consider a pilot project involving site-specific analysis, replacement or retrofitting of a portion of existing diesel-electric haul truck fleets to trolley-assisted operation



MTU says Series 4000 diesels are its most successful product range, with more than 37,000 versions of the engine placed in service since its introduction.

at its Iron Range mining customers' mine sites. The utility said mines in the region, along with paper mills, currently use about two-thirds of its power production. It plans to file a formal plan with state regulators next year that may include financial support for retrofitting an existing haul truck fleet and installing trolley-assist infrastructure at a mine.

## Balancing the Benefits

There is no current effort under way to tighten emissions regulations applicable to high-horsepower off-highways diesels in North America, but the European Union's Stage V standards loom just over the horizon, now scheduled to take full effect in 2021 after a pandemic-related extension granted by the European Parliament. Logically, because the EPA and EU emissions-control standards in the regulatory tiers and stages have largely mirrored each other, there is an expectation that North American standards may be adjusted to reflect the more stringent standards of EU Stage V at some point in the future. However, most diesel engine suppliers would argue that due to the substantial reduction in emissions attained by recent engine-control strategies as well as improvements in fuel usage and power density, there's actually more benefit to be gained by taking earlier-tier or non-tier engines out of service and replacing them with Tier 4 models than there would be in achieving only incremental gains in emission control by imposing Stage V standards.

Recent reports indicate mining customers are indeed taking advantage of an opportunity to improve performance without investing in completely new equipment fleets. Rolls-Royce Power Systems, for example, said it will deliver 30 Series 4000 MTU engines this year to a large contract mining company in Brazil for a truck-repower program. The engines are going to U&M Mineração e Construção S/A, which will install the MTU 12V 4000 engines in its existing fleet of mining trucks and excavators. The engines to be delivered this year follow upon an earlier order by U&M for 20 of the same engines in 2019.

"We prefer to have the same engine powering both our load and haul machines," Mauricio Casara, U&M's commercial director, explained. "We tested the MTU 12V 4000 at a mine where we

had Komatsu 930s equipped with 16V engines so we could compare. We found that the cycle times for the 16V and the 12V were virtually the same."

U&M also has installed MTU 12V 4000 engines to repower its fleet of Hitachi EX5500-6 mining shovels. After working with an MTU support team to make necessary power calibrations, the company said shovel performance now exceeds previous levels obtained with the replaced engines.

Mindful of the industry's enthusiastic interest in autonomous operations, Rolls-Royce also noted it had joined with Autonomous Solutions Inc. (ASI Mining) to ensure compatibility of MTU diesel engines with ASI's Mobius command and control software for autonomous vehicles. The two companies signed a memorandum of understanding enabling Rolls-Royce to offer autonomous-compatible, Mobius-ready MTU engine solutions for equipment in a wide range of mining applications. The companies said they plan to apply their expertise to offer customers engine solutions that are compatible with ASI's vehicle automation software to help optimize vehicle power performance and efficiency.

A potential benefit to MTU and ASI Mining customers is the ability to retrofit power systems on existing haul trucks to convert them to autonomous operation. The companies said they are interested in exploring the value customers would receive by repowering trucks with higher-efficiency engines along with implementation of ASI's autonomous mining solutions.

Cummins reported last year that it had helped an Arizona mine obtain better performance from its fleet of seven Komatsu 930E-1 haulers by repowering them with Tier 2 QSK60 engines. After a trial engine changeover involving two of the trucks, the mine achieved significantly improved operating performance from them, including MTTF improvement of 43%, an availability increase of 3%-4%, and a 1-2 gal/h reduction in fuel burn, impressing mine management enough to proceed with repowering the rest of its Komatsu fleet.

## Looking at Options

Demand for conventional diesel engines remains healthy, but engine suppliers are hedging their bets, moving ahead

with engine design and performance tweaks as well as expanded emission-reduction options to meet the demands of regional regulations — while concurrently securing, through investments and partnerships, new expertise and market presence in emerging non-traditional power technologies such as batteries and battery management systems, hybrid systems, fuel cells and hydrogen production technologies.

Prospective diesel engine buyers now have access to a range of dual-certification (Tier 4F/Stage IV or V) options from most major suppliers that allow them to comply with differing regional emissions regulations as well as configurations for low- or non-regulated locales. These options cover the entire spectrum of engine ratings, from high to low. Caterpillar, for example, offers Tier 4 Final versions — standard (1,450) and high (1,600) horsepower — of the 3512E engine in the company's new Next Generation 785 mine truck, along with another version for sales in less-regulated markets. At the lower end of the size spectrum, Cat's new C3.6 in-line four-cylinder industrial diesel is offered in ratings up to 134 bhp at 2,200 rpm and provides a 5% increase in power density and a 12% increase in torque compared to earlier versions. It is dual-certified Tier 4 Final/Stage V with no changes to the engine or aftertreatment systems.

Cat's largest dual-certified diesel is the 78-liter V16 Cat 3516E industrial model introduced in late 2019, which uses dual SCR-only aftertreatment to meet EU Stage V and EPA Tier 4F standards. The 2,100-



Introduced at the 2019 bauma trade show, Cummins' Tier 4 Final/Stage V QSK60 engine offers up to 2,850 hp (2,125 kW) in mining applications, with simplified air handling, reduced complexity and improved serviceability, according to the company.

hp engine's aftertreatment system uses a diesel oxidation catalyst (DOC), diesel particulate filter and high-efficiency selective catalytic reduction (SCR) to eliminate the need for EGR. Fuel consumption, according to the company, is reduced up to 6% and the system is 63% lighter and 65% smaller than its current equivalent. It does require DEF, according to the company, but engine technology advances provide a lower rate of fluid consumption.

Diesel OEMs know that engine efficiency improvements can attract new customers, and some notable technological advances have come from diesel suppliers that aren't top-of-mind in brand recognition, but nevertheless are major players — China's Weichai Group, for example, which sold a million engines last year.

In September, Weichai officially launched what it claims to be the world's first commercially available diesel engine with a brake thermal efficiency (BTE) over 50%. Brake thermal efficiency is a measure of the fuel efficiency of internal combustion engines. The higher the BTE, the lower fuel consumption will be, along with reduced emissions.

Weichai's high-BTE six-cylinder engine has 13-L displacement, is rated at 560 hp at 1,900 rpm and features a Bosch 2,500-bar common rail fuel injection system. Increasing BTE from 46% to 50.26% reduces both fuel consumption and CO<sub>2</sub> emissions by 8%, according to the company.

Weichai said it has been involved in studying and designing internal combustion engines for more than 70 years and has invested 30 billion yuan (\$4.6 billion) in related R&D over the past 10 years. Its investigations into BTE improvement got a boost in 2015 when it assigned a special technical research team to conduct large-scale simulations and bench tests that produced a steady stream of incremental (0.1%) BTE improvements and finally led to its recent breakthrough. Weichai said it had developed several proprietary technologies that contribute to the improvement, including advanced fields synergy combustion technology, exhaust energy distribution technology, subzone lubrication technology and WISE ECU technology.

Belarussian truck builder BelAZ now offers Weichai diesels in its 90-ton 7558 series, as well as other options that in-

clude a gas-turbine engine using CNG fuel and another that uses a valve-inductor electric drive configuration. The truck maker said it plans to offer Weichai diesel options in future models of its 45-, 136- and 220-ton-payload haul trucks as well.

Elsewhere, underground mining and tunneling equipment supplier Normet is now installing Volvo Penta's Stage V solution in its new L-Series platform, encompassing 12 different products that include transmixers, agitators, fuel, water, multipurpose and material carriers, a sprayer, dumper and charging unit. This is the first time the company has used Volvo Penta engines and Normet reportedly is already planning to roll the engines out in other products, such as Stage IIIA versions of the L-Series machines.

"We started looking at updating the L-Series platform in 2018, when the Stage V emission regulations were on the horizon," explained Jarmo Husso, director, platform and module development, at Normet. "We decided to completely redesign and update the product platform with a new structure and features, as well as streamline our engine offer. Although we hadn't used Volvo Penta engines before, we'd heard good things about the company. Over the last couple of years, our two companies have been working together as one team on this project."

Volvo Penta's Stage V off-road lineup includes five engine models — D5, D8, D11, D13 and D16 — providing a power range from 105 to 585 kW (143–796 hp). A particular focus has been on maximizing equipment uptime by reducing active regeneration requirements. Andreas Viktorsson, the company's chief project manager for Stage V, recently explained how it managed to achieve its goal in the latest D series engines.

"The Stage V emissions legislation requires engines to have a diesel particulate filter (DPF), which captures and stores soot. This soot needs to be burned off periodically to regenerate the DPF and typically this is done while the machine is at a standstill — active regeneration. But who wants to keep having to put their machine aside for this process, where it is not working and earning?" Viktorsson commented.

"From a strict technical point of view there will always be a need for at least some active regeneration if the engine is not loaded. However, we challenged

ourselves to examine this and reduce it to an absolute minimum.

“For our Stage V off-road platform, we have developed the engine and after-treatment system hand in hand, and it has been an ongoing optimization project for all engines in the range, which share a common architecture. For example, we have implemented new water pumps, new oil coolers, new piston rings and new thermostats — relatively minor changes all over the engine but combined they have made significant improvements. Connected to this design philosophy, we have also achieved impressive fuel efficiency figures, helping customers to save costs and the environment.”

## Cleaner Combustion

Ongoing research into utilization of alternative fuels for off-highway diesels has provided fleet operators with potential options for cutting hydrocarbon-fuel emissions while keeping diesel engine infrastructure largely intact. For example, ClearFlame Engine Technologies, a U.S.-based startup specializing in development of clean engine technology for the off-highway and industrial markets, announced in mid-October it had successfully matched the torque and power of a commercial diesel engine using ethanol in place of diesel fuel, delivering more than 500 hp and over 1,850 ft-lb of torque while eliminating the need for additional aftertreatment such as selective catalytic reduction or diesel particulate filter systems.

ClearFlame said it achieved the results on a Cummins X15, a 500-hp, 15-liter-displacement engine by using a high-temperature stoichiometric combustion process, which employs higher temperatures to achieve diesel-style combustion of decarbonized fuel. Temperatures are achieved by optimizing existing engine thermodynamics and adding insulation on key engine components. The fuel injection system is also engineered to accommodate decarbonized fuels like ethanol.

ClearFlame claimed its engine technology enables low-carbon and carbon-negative fuels to be easily integrated into existing diesel engine platforms, while providing equal performance to that associated with diesel engines and eliminating the need for aftertreatment solutions.



L-Series underground equipment from Normet will be available with Volvo Penta Stage V engines starting in 2021. Normet says it also plans to offer Stage IIIA versions of Volvo Penta diesels in future L-Series machines.

dynaCERT, a Canadian company, reported in October 2019 that its HydraGEN technology had been approved for underground mining applications in Canada pursuant to a formal risk assessment commissioned by dynaCERT's dealer, Total Equipment Services, and one of TES's major underground mining customers in Northern Ontario.

The Workplace Risk Assessment and Control (WRAC) was undertaken to develop a better understanding of any occupational health and safety hazards that could arise from the use of a HydraGEN unit, in this case installed on a boom truck currently being used by the mine in underground applications. Risk assessment involves the assigning of a level of risk to each known health and safety hazard, followed by the ranking of those hazards. The next step, according to the company, is a user case study currently under way to analyze effectiveness of the HydraGEN technology underground by measuring changes in emissions and fuel economy.

dynaCERT said its patented technology uses distilled water to extract hydrogen and oxygen on demand through a unique electrolysis system and supply both through the engine air intake to enhance combustion, resulting in lower carbon emissions and greater fuel efficiency.

In October 2020, the company announced that Japanese conglomerate Marubeni Corp. had signed a distribution agreement with H2 Tek, a dynaCERT distributor, to market the HydraGEN system. Marubeni will sell HydraGEN primarily to mining equipment owners in Chile, Peru, Colombia, Mexico, Australia, Mongolia and Japan.

## Plotting a Path to Electrification

All available indicators point to a gradually declining role for diesel-powered equipment in underground mining, with BEVs increasingly taking larger bites of responsibility for production duties rather than being limited to utility and light-duty tasks. However, unless a mine is specifically designed from the outset to operate a fleet of battery-electric vehicles, the changeover from diesel to electric power can be a lengthy and costly process, particularly if the anticipated benefits don't accrue in a reasonable time frame.

In order to plot an effective course, mine operators can get help from initiatives such as the International Council on Mining & Metals' Innovation for Cleaner Safer Vehicles Program, an initiative launched in October 2018 designed to connect ICMM members with equipment OEMs and suppliers and accelerate innovative development of a new generation of cleaner mining vehicles. ICMM said its producer members represent approximately 30% of the global metals market with more than 650 assets.

The stated goals of the ICSV initiative are to introduce greenhouse gas emission-free surface mining vehicles by 2040, minimize the operational impact of diesel exhaust by 2025 and make vehicle collision avoidance technology available to mining companies by 2025. ICMM recently announced that eight new OEMs joined the initiative, raising the number of participating OEMs to 19. Diesel suppliers include Caterpillar, Cummins, Komatsu, Liebherr and MTU.



Cat's new 3.6L industrial diesel was designed to be physically smaller, with flexible aftertreatment mounting options and a simplified installation process, to provide equipment OEMs with more design and serviceability options.

In what seems to be a common first step in the process of reducing DPM exposure, hardrock mines often fit their largest items of mobile production equipment — trucks and scoops — with diesel particulate filters (DPFs). As a 2019 report\* from NIOSH indicated, operators primarily retrofit haulage trucks and LHD vehicles with DPF systems because they're perceived as the major contributors to exposure of workers to diesel aerosols and gases, and they operate over duty cycles that are characterized by higher DPM emissions and that favor passive regeneration of DPF systems.

These modifications generally produce favorable results. One instance provided by ICSV showed that Barrick, for example, has been able to significantly reduce harmful emissions from a fleet of Cat R1700G LHDs and AD30 underground trucks at its Hemlo mine in Canada by switching to biodiesel and installing DPFs on all units. The objective was to minimize the frequency of occurrences when measured DPM exceeded a company-mandated OEL of 0.16 mg/m<sup>3</sup> — significantly lower than the government standard OEL of 0.4 mg/m<sup>3</sup>.

Hannah Demers, an industrial hygienist at Barrick, reported at the Mine Diesel Emissions Council (MDEC) conference held in Toronto last year that

\* *Curtailment of Contribution of Light-Duty and Medium-Duty Diesel-Powered Vehicles to Exposure of Underground Miners to DPM: Burden, Challenges, and Opportunities*, Aleksandar D. Bugarski, National Institute for Occupational Safety and Health (NIOSH), Pittsburgh Mining Research Division (PMRD), 2019.

timely inspection and replacement of the filters has helped the mine reduce the number of excessive DPM occurrences in underground work areas, and it is moving forward with other supportive measures such as making continual ventilation upgrades — doubling flows in the lowest and busiest mining areas — and purchase of BEVs and cleaner diesel-powered equipment, including BEV jumbos and bolters as well as scoops and trucks fitted with Tier 4F-compliant engines.

In another example, workers at BHP's Broadmeadow underground metallurgical coal mine in Queensland benefitted from a company-wide emissions monitoring program. It promotes the use of real-time monitoring technology to assess worker exposure to DPM and coal dust.

According to BHP, the mine approached the goal of reducing worker exposure in four stages. The effort began by implementing a DPM awareness campaign among mine workers to help identify improvements and increase the general discussion on how we can eliminate the risk of exposure to DPM.

With the workforce engaged, the mine introduced an emissions-based maintenance project for the underground vehicle fleet. Maintenance activities relevant to DPM emissions were reviewed and exhaust DPM limits set that vehicles had to pass to be put back into service; failure to meet these limits triggered further maintenance. This led to a 40% reduction in DPM emissions from machinery used in the underground environment. Other options considered at this stage included the investigation of alternative fuels, a DPM health check and exhaust filtration.

After successfully reducing emissions through revised maintenance practices, the mine worked with a local company to develop a low-emissions engine for underground equipment. A new engine, from Japanese diesel builder Hino, was installed across the fleet and yielded a further 70% reduction in DPM emissions from each underground vehicle.

While the first and second stages of the program led to a significant reduction in DPM emissions, the team determined the only way to eliminate DPM emissions entirely was to move away from diesel power for underground vehicles. The team was unable to identify a lith-

ium-ion powered (LIP) electric mining vehicle supplier in Australia but found a manufacturer in Canada and worked with them to develop a tailored underground-approved electric vehicle for coal mining. The Broadmeadow team worked to enable the vehicle to be certified for use in most underground sections of the mine. Trials of the LIP electric vehicle in the underground environment were successful and Broadmeadow has acquired three more electric vehicles.

BHP said Broadmeadow was also one of the first BHP mines to pilot a new real-time mine emissions monitoring system. This technology has now been introduced at its Escondida operations in Chile and Whaleback iron-ore mine in Western Australia. It enables emissions such as DPM to be tracked in real time and allows additional controls to be implemented, where appropriate, to support those already in place for managing the risk of worker exposure to these emissions. The real-time data can be analyzed and accessed across a range of mobile devices and has the capability to issue automatic alerts and alarms to further protect workers.

BHP said it was in the process of extending this capability to another 11 mines.

And finally, the NIOSH report mentioned earlier called attention to the role that medium- and light-duty underground diesel equipment — shotcrete trucks, explosives carriers, graders, personnel carriers, side-by sides and pickup trucks — play in contributing to DPM exposure. In the U.S., for example, they're commonly perceived by mine operators as less-than-significant contributors to worker exposure to diesel emissions because they generally work in duty cycles that generate less DPM and are less favorable for passive regeneration of DPF systems. However, perceptions can be flawed: medium and light-duty vehicles also constitute an estimated 60% of the total number of units in underground fleets surveyed by NIOSH, and due to their numbers, generally higher attrition rate and difficulty in retrofitting with DPF systems, represent a prime target for replacement by battery-powered vehicles, or repowering with cleaner, contemporary engines instead of like-for-like original equipment, according to the report.

ONLINE  
**REGISTRATION**  
IS NOW OPEN



# 2021 HAULAGE & LOADING EXHIBITION AND CONFERENCE

MARCH 14-17, 2021



MARCH 14-17, 2021

## Tucson Hosts Haulage & Loading 2021

Join us for the three most productive days in open-pit mining. Held every two years, Haulage & Loading is the conference for surface mining professionals. The event, which brings mine operators and suppliers together in an informal Arizona resort setting, focuses on improving surface mining operations in general and truck-shovel loading in particular. The technical program offers continuing education for mining engineers and mine managers and the exhibit allows suppliers to interact with customers.

In 2019, nearly 150 mining professionals attended the event, including personnel from Agnico Eagle Mines, Asarco, Barrick Gold, Cleveland Cliffs, Colowyo Coal, Detour Gold, Freeport-McMoRan, Hudbay Resources, Kinross Gold, Peabody Energy, Syncrude Canada, Suncor Energy, Teck Resources and Usibelli Coal.

The venue, the Hilton El Conquistador Resort in Tucson, Arizona, and Mining Media International (MMI) are working to provide a clean and safe format to meet and conduct business. Adhering to CDC protocols for COVID-19, the ballroom and outdoor settings offer ample space for the proper social distancing of a group this size. Face masks and sanitary stations will be established throughout the venue. MMI is designing a touchless registration program to minimize the risk of the possible transmission of the virus. The Hilton El Conquistador Resort's COVID-19 policy is available at the bottom of the accommodations tab on the Haulage and Loading website.

We hope to see you at the El Conquistador for Haulage & Loading 2021.

Steve Fiscor, Publisher & Editor  
Mining Media International

### Registration Rates & Deadlines

	Advanced 10/16/20 - 12/31/20	Regular 1/1/21 - 3/14/21	Onsite Begins 3/15/21
<b>Full Conference Delegate</b> Includes engineers and management personnel from mining companies.	\$599	\$699	\$699
<b>Non-exhibiting Suppliers</b> Includes companies who wish to conduct business without purchasing a sponsorship.	\$3,200	\$3,400	\$3,400

# Tentative 2021 H&L & Technical Program

Monday, March 15, 2021

## Session 1: Operating Approaches

### Using Technology to Assess a Potential Fleet Improvement Strategy

By Brian M. Wright, Fort Knox MEM senior reliability engineer, Kinross Gold

### Optimum Economic Assignment of Trucks

By Benton T. Kelly, mining consultant (former mining engineer for Drummond Co.)

## Session 2: Emerging Technology

### Considerations for a Transition to Autonomous Mining

By Drew Larsen, director of business development, ASI Mining

### A Golden Opportunity: Gamification in Open-pit Management

By Phillip Hotzen, technical account manager, MineWare, and Nevada Gold Mines

### Full-scale Numerical Simulations to Optimize Rope Shovel Loading Performance

By Andreas Svanberg, industrial doctorate candidate, Boliden

Tuesday, March 16, 2021

## Session 3: Safety & Training

### Potential New MSHA Regulations for Surface Mobile Equipment and Powered Haulage Equipment

By Mark E. Heath, Spilman, Thomas & Battle PLLC, (co-chair firm MSHA and OSHA Practice Groups)

### Personnel Safety Around Fixed Equipment

By Mike Walling, general manager of safety electronics, Strata Worldwide

### Innovation in Mine Training Achieves Supervisor Proficiency at Faster Rates

By Richard Beesley, professional services manager, Immersive Technologies

## Session 4: Optimization Strategies

### An Integrated Approach to ROM Fragmentation, FMS and Impact of Primary Crusher Feed

By Tom BoBo, director of business development, split engineering, Hexagon

### Benefits of Using On-Board Scales on Underground and Above Ground Mining Vehicles

By Bill Zimmerman, R&D design engineer, VPG On-board Weighing, Vulcan On-board Scales

### Optimizing Payload Management

By Modular Mining

Wednesday, March 17, 2021

## Session 7: Workshop (Hybrid): Haulers & Haul Road Design

By Roger Thompson, principal, Specialized Consulting & Engineering Services and professor emeritus, Curtin University; and Tim Joseph, principal, JPI Canada and professor emeritus, University of Alberta

\*Preliminary, December 4, 2020 (subject to change)

[haulageandloading.com](http://haulageandloading.com)

## Safety Protocols

Now and going forward, your health and safety are paramount to this event, and we are making sure there is a comprehensive health and cleanliness program in place to ensure the safety and health of our attendees, while adhering to the CDC protocols for COVID-19.

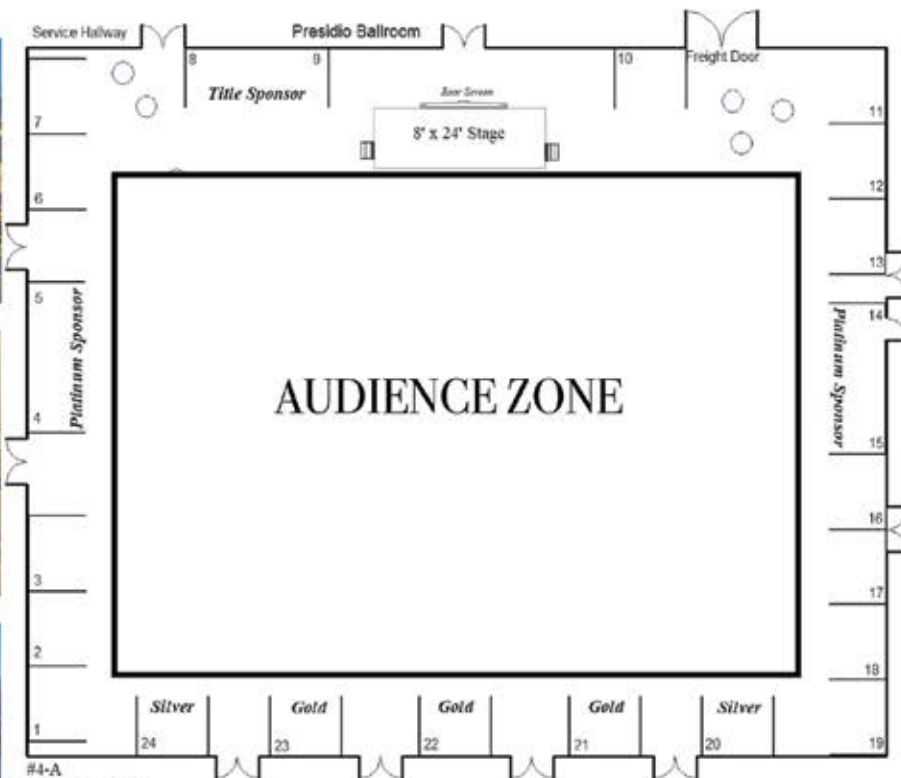
The following are some of the safety protocols that MMI and the Hilton El Conquistador have put into place. If you have any questions or concerns as it relates to safety protocols, reach out to Kristin Thompson at [kthompson@mining-media.com](mailto:kthompson@mining-media.com).

### MMI Safety Protocols

- Contactless on-site registration process
- Self-serve print stations at registration
- Physical barriers between registration staff and attendees
- Disposable face masks provided upon request
- Socially distanced general session & meal seating
- Visual indicators such as floor graphics & signage for one-way exit/entry
- Integration of boundaries and safety barriers as appropriate
- Safety greeter at entrance of space to ensure everyone is wearing masks and following guidelines
- Flexibility in registration and cancellation policies

### Hilton El Conquistador Safety Protocols

- Employee temperature checks upon arrival at work
- Proper cleaning and disinfecting of the public areas where people have direct and constant contact
- Staff fully trained in sanitization and food handling procedures
- Hand sanitizing stations throughout the venue, show floor and session space
- Seated dining
- Individually packaged meals
- Buffet served by hotel staff with personal protection equipment – not self serve
- Screens present at all food displays
- Signage suggesting limited number of passengers in elevators
- Plexiglass barriers at front desk



#4-A  
Revised 3.29.20  
24) 8' x 10' Booths





# New Scalers, Carriers, Solutions Solve Specific Problems

*The latest releases were developed based on customer feedback, and offer better control, more options and improve job satisfaction*

By Jesse Morton, Technical Writer

The latest news from utility equipment suppliers show what happens when OEMs co-develop solutions with miner partners. The resulting solutions deftly solve specific challenges, inexpensively, and with a nod to sustainability. They give operators more control, and operations more options. The typical list of benefits is topped by cost savings or improved safety. Field tests give clear wins.

The following stories also reveal that OEM-miner partnerships result in solutions that can simplify workflows and processes. They bestow upon the manager the chance to streamline. For operators, they offer not just improved KPIs, but improved job satisfaction. And, as one expert told *E&MJ*, a happy employee is a productive employee.

## Turning Scaling Into a Science

Hermann Paus Maschinenfabrik GmbH announced the PScale 8-T, a compact precision-scaler trialed and proven in high-altitude mines in Peru and Chile.

The model is the evolutionary successor of the Scaler 853. Paus said the PScale 8-T was developed to deliver surgical accuracy, and to operate in the tight confines and extreme conditions that define mines in the highlands of South America.

"The best scaler in the world has gotten even better," Franz-Josef Paus, executive manager, Paus, said. "It is a very successful, well-established machine, especially in South America. And if a machine is Peru-proven, it is ready for the rest of the world."

The new scaler was designed to give the operator a level of control that isn't offered by competitor machines. "The key for our machine is its size, the maneuverability, and the ability to really sensitively operate," Paus said. "The operator has the chance to incorpo-



The latest utility equipment releases give operators more control and operations more options. Above, MacLean's new pipe handler basket for the LR3 integrated carrier can be attached quickly, and can transport, lift and rotate pipes. (Photo: MacLean Engineering)

rate all of his skills in terms of judging where to work."

The ability to deliver only the needed energy and action to bring down loose rock separates the PScale 8-T from the competition, Oliver Wilke, sales manager, Paus, said.

"What the competition has is a machine with a scaling pick or a hydraulic hammer in the front of it," Wilke said. "With either, this can create problems."

Both can put too much energy into the walls and roof. "You will destroy the natural protection that is created when you build a gallery," he said.

In comparison, the PScale 8-T turns scaling into a science. "With our machine, you go to the point where you think that it is necessary to scale, and then you can do it on the point," Wilke said.

"You don't have to put so much energy into the sidewalls and into the roof," he said. "Most other machines cannot handle like that."

Most other machines are too big to maneuver easily, further limiting the options of the operator. "If you are in Phase A and you want to move to Phase B, with a competitor's machine it takes much more time than with our scaler because our scaler fits much better in smaller-sized galleries," Wilke said.

With a reach of 8 m, the PScale 8-T is 8 m long, 2 m wide and 2.5 m high. It has an internal turning radius of 2.5 m, and an external radius of 4.6 m and could be operated in galleries with a width of less than 3 m.

Compared to its predecessor, the scaler offers more power and improved safety.



The compact PScale 8-T precision scaler was designed to give operators more control over where and how to scale. Developed in Peru, it can handle heavy use in extreme environments. (Photo: Paus)

It has a 97-kW Caterpillar C4.4 engine. With increased air flow, engine cooling capacity is improved over that of the predecessor, company literature stated.

The PScale 8-T has a new boom design, with stronger geometry, that can handle up to 400 kg. Compared to the 853 Scaler, it has a more robust chassis, a stronger swiveling bearing, and optimized articulation, the company reported. The result is a power increase of up to 30%, and improved precision and production.

Compared to that of the 853 Scaler, the new cabin is better at cutting noise, heat and vibration. The cabin is tilted at 20°. It offers “excellent visibility, easy handling,” and a “relaxed atmosphere,” the company reported.

“It is more productive and safer than any machine in the market at the moment,” Wilke said.

Those superlatives are the fruits of two decades of research and development driven by feedback from both the Peruvian distributor Ferreyros and from customer mines. “We were looking for a small, maneuverable and quick machine,” Paus said.

“Especially in narrow vein and other applications, we were looking for a machine that was able to go into small, confined spaces, scale there, and then, when

the job is done, move quickly from one site to another,” he said. Ideal was a machine able “to use the operator’s skills in terms of knowing where to scale, to what extent, and to avoid any additional damage to the rock.”

The scaler will be offered with optional remote control or with a teleremote system, and in the near future with sensor packages, to include a loose rock detection system.

“We are scaling on a higher level,” Wilke said. “We were pioneers in mechanized scaling, and have the experience to help every customer with specific and dedicated solutions.”

Ironically, the scaler’s genealogy traces back to the 853 platform. The 853 is the progenitor of the multifunctional TSL 853 T7. Ingeniously undedicated, “it is the MacGyver of mining,” Hendrik Hörnschemeyer, sales manager, Paus, said.

The TSL 853 T7, in its most basic form, is a wheel loader; but with a swiveling boom and telescopic arm, it can also be equipped to function as a forklift, dozer, crane or sweeping machine.

That’s not all. It can operate a man basket, a 4-in-1 shovel, a hydraulic hammer or even a snowblower.

The backside can also be equipped with attachments, and can lift up to 500 kg. “Based on this, we can create new

solutions together with clients,” Hörnschemeyer said.

For example, a miner in the U.K adopted it for ANFO charging applications. “They previously needed one machine for lifting up the people, and another machine for carrying the ANFO unit,” he said. “This we now combine into one machine where the operator is in front of the basket, loading holes, and from there controls the unit attached to the rear power lift and operates it as an ANFO charging unit.”

It could also be configured to be a concrete pump, Paus said. “A concrete pump can be added to the rear part and have the nozzle and the operator in the basket. The machine can be controlled from the cabin, from the basket or remotely.

The standard tool change takes 10 minutes or less. An optional hydraulic hose quick-change device drops that to less than a minute. The optional speed-lock system automatically connects power lines.

“Ordinary power-consuming attachments can be changed out in seconds,” Paus said.

The machine is available with a Tier 4F/ Stage V-certified engine. Customized solutions are available, the company reported.

“This machine is what we are,” Paus said. “It can do basically everything. For its versatility, its capability, and what it makes possible, it is a very affordable machine.”

## On-site Remans During Lockdown

In early 2020, Normet globally launched its new remanufacturing program. The of-



Tilted at up to 20°, the cabin for the PScale 8-T cuts noise, vibration and heat, and offers excellent visibility. (Photo: Paus)



Normet's reman program offers on-site rebuilds, and can help isolated mines maintain the needed equipment availability even when under tight travel and transportation restrictions. (Photo: Normet)



fering, which was trialed by a customer in China in 2019, includes the option of having Normet equipment rebuilt at the mine site.

The trial tested the concept in "harsh and isolated mining environments, where extending the lifetime of an existing fleet is an extremely viable solution," Mika Nevalainen, global product manager, remanufacturing, Normet, said.

For the trial, the rebuilds were done at a Normet hub, but they can also be done on site in partnership with the customer.

If a site is located where transporting equipment is difficult, expensive or even prohibited, Normet can bring in the tools and personnel to a dedicated work area at the mine. "Remanufacturing at the customer site both simplifies and minimizes logistics," Nevalainen said.

One option would be for the supplier to create a workshop in a space provided by the customer.

"Normet has a solution available where we could setup a full movable workshop," Nevalainen said. "Obviously, this is quite a large operation, and not feasible with smaller scale programs. A movable workshop requires cooperation with local authorities."

A bigger mine might provide a bay in a service center that is already capable of supporting a reman.

The average reman spans 16 weeks. During that time, Normet Rental can provide a temporary replacement machine to help prevent any disruption to production. "That provides an opportunity for the customer to test the latest technology available," Nevalainen said.

A reman, whether done at the customer site or at a Normet facility involves several steps. First, the supplier will disassemble and inspect the ma-

chine. The core is then sandblasted and repainted. Hydraulics and electronics are replaced. Upgrades are recommended. Testing follows. Lastly, the machine is certified, the process documented, and the data compiled.

"We pay attention to every detail," Nevalainen said.

The performance testing and documentation process is the same as for new equipment. The rebuild is certified to perform like new.

"We grant a full warranty on the complete machine," Nevalainen said. "Additionally, by adding the latest technology to the core, the productivity, performance, and operations experience can be raised while reducing operating expenses."

Compared to buying new, remanufacturing costs roughly 30% less and offers a 60% reduction in lead time. "By using an existing core, changes to site operations are minimized," Nevalainen said. "Operators already know the equipment," he said. "No major changes for spare part demand planning and stocking are required."

Since the global release of the offering, the pandemic and the ensuing restrictions and shutdowns fueled demand.

For many customers, buying new has simply not been a viable option for months. "COVID has brought a lot of uncertainty to all the markets," Nevalainen said. "This uncertainty has meant that many customers have delayed their capital investment decisions, including also orders for new machines."

For customers that were considering a new-buy when the pandemic hit, the restrictions and shutdowns further complicated already challenging logistics for importing and transporting equipment. Customers in remote locations

effectively became even more isolated, he said.

"A few of our teams have needed to spend extra months on customer sites as there has been no flights in and out of remote sites," Nevalainen said.

Simultaneously, in most countries, mining and tunnel construction were labeled essential business. "A majority of operations have run continuously," Nevalainen said. "Hence, machines have continued to operate normally."

Market uncertainty, complex logistics, and the need to operate uninterrupted made on-site rebuilds that much more attractive.

"Normet OEM remanufacturing at the customer site or from the nearest hub has become the solution in hand to get maximum performance out of the customer's existing fleet and to help mitigate future risks of breakdowns and lost production," Nevalainen said. Specifically, "Normet China and our Latin American teams have successfully, during COVID, completed remanufacturing programs to support customer needs and help them to overcome challenges with aging fleets."

Other Normet teams elsewhere, such as in the U.S. and Australia, are currently ramping up to offer the program. "Normet Finland, Chile and India are leading the way in building the capabilities," he said.

The new program fits well into the company's history of servicing machines throughout the entire lifecycle through to recycling. "Remanufacturing aligns well with all three targets of the Normet value proposition: Securing a safe and sustainable future, innovating for productivity and partnering for lifetime value," Nevalainen said.

On the first, “Normet is leading the way in sustainable and more environmentally friendly solutions for customers who are searching to improve productivity and extend the lifetime of equipment,” he said. “With remanufacturing, our customers can support circular economy, responsible manufacturing, recycling and minimizing carbon footprints. All of these are key drivers to customer satisfaction.”

## Versatile Carrier Adds Capabilities

MacLean Engineering released three attachments for the LR3, making the integrated tool carrier that much more versatile.

“With several basket and attachment options available and the ability to work on both flat ground and inclined surfaces, the LR3 is truly the Swiss Army knife of underground machines,” Bryson Lehman, product analyst, utility vehicles, MacLean, said.



The new pipe handler basket for the LR3 integrated tool carrier has adjustable claws, a tilting grapple feature, 240° basket rotation, dual control stations and the ability to store pipes. (Photo: MacLean)

The company released a fork attachment, a jib boom attachment and a pipe handler basket.

The fork attachment has a frame design that gives a clear sightline when loading and unloading, MacLean reported. “The adjustable forks can be positioned to evenly distribute the load for safe maneuvering.”

It has a 6,350-kg load capacity and 60-in. tines, and offers hands-free connection.

“The fork attachment can be used for loading and unloading pallets from deck trucks, loading ventilation fans into cradles, and just about anything requiring forks,” Lehman said. “One of the biggest benefits of the fork attachment is the high payload capacity as well the ability to make the LR3 a self-sufficient machine, eliminating the need for additional machines.”

The jib boom attachment is specifically designed to assist in retrieving pumps, loading fans on to cranes, and handling large, bulky loads, the company reported.

It has a 7,000-kg load capacity, a 60-in. boom extension, and also offers hands-free connection.

When used with the LR3’s boom swing, lift and extension, it has a large range of motion, Lehman said. With “a maximum reach of 4 m, the jib boom is ideal for getting into those hard-to-reach places, such as sumps for retrieving pumps,” he said. “The simple design of the jib boom is what makes it the perfect attachment for underground mining.”

The pipe handler basket “is the ultimate basket to safely and productively install pipes,” MacLean reported. It has adjustable claws, a tilting grapple feature, 240° basket rotation, dual control stations and the ability to store pipes.

The deck is 7 ft by 12 ft, has a 1,590-kg payload capacity, and has safety posts and gates. It features quick-connect hydraulics and electrical cabling. A camera is mounted on the front of the basket.

The basket is “designed specifically for retrieving, lifting, and positioning pipes of several sizes and lengths, ranging from 4 in. to 10 in. in diameter and 4 ft to 20 ft long, in headings as high as 8 m,” Lehman said.

“The basket rotates to install pipe on either side of the machine while allowing for personnel to be situated in the bas-



The fork attachment for the LR3 has a 6,350-kg load capacity and can be used to load ventilation fans into cradles. (Photo: MacLean)

ket for quick and precise installation,” he said. “All from one setup.”

The basket is a certified elevated work platform, he said.

It is can haul pipes. “An operator can load up several pipes into the basket and drive them to the installation point,” Lehman said. “This reduces the need for an additional truck to deliver pipes.”

The clawed manipulator “can grab pipes at ground level and lift them into position in one smooth motion,” he said.

The basket delivers safety and efficiency. “It is the final piece of the puzzle for making the LR3 the ultimate mine services and maintenance truck,” he said.

The LR3 was announced in 2016 and released in 2017. It was developed after a study in Australia on dangers linked to generic integrated tool carriers used as elevated work platforms showed the need for a dedicated solution. The carrier was originally designed for use in Australia, for the high-reach, heavy-load task of installing ventilation fans.

Quickly it was adapted with tools and attachments and deployed for a range of applications. It can raise to 20 ft an 8-by-12-ft work platform that can support up to 5,400 kg.

The rig is 11 m long, 2.5 m wide, 2.5 m high, and has an inside turning radius of 2.2 m, and an outside turning radius of 8.2 m. The LR3 comes with the company’s Remote Drive system, and is described by the company as ideal for large-heading mines.

Since its initial release in Australia, the demand for the machine exceeded original expectations, Lehman said. “What we did not know is how much traction the LR3 would gain worldwide,” he said. “With machines currently working in



The jib boom attachment for the LR3 has a 7,000-kg load capacity and can be used to pull pumps from sumps. (Photo: MacLean)

three continents and soon to be five, the safety features and versatility built into the LR3 are a real game changer.”

Because it “can do it all, mines can eliminate the need to purchase and upkeep several machines, reducing overall capital and ownership costs,” he said.

For that same reason, MacLean is driven to further develop and improve it, Lehman said. “With the LR3 being as versatile as it is, it gives us the perfect product to develop our ideas, with additional tools and baskets already in the pipeline.”

## Shearing Scaler Reaches 11 M

GHH reported it has sold three of the hefty, long-reaching LF-20HB shearing scalers since the model was released a year ago. Since the launch of the LF series in 1996, roughly 120 units have been deployed to potash and salt mines around the world. Almost 90 are in use in soft rock mines today.

The scalers are popular because they straight-up outwork competitor models, Guido Wolters, sales director, Europe, GHH, said.

“One of our scalers replaces three to four Oldenburgs and has a better performance at the end of the shift,” he said. In U.S. and Canadian mines, LF scrapers can sometimes double the daily production of competitor models, he said.

“High productivity at low costs and excellent ergonomics result in satisfied operators,” Wolters said. “Satisfied miners are good miners.”

The line launched with the LF-7.4B, co-developed with K+S Potash Canada.

“We built more than 40 LF-7.4B scalers,” Wolters said. “In 2012, we delivered the first LF-7.6HB to our customers.”

The LF-7.6HB offered lower maintenance costs in comparison to the predecessor model. “The drive train of the LF-7.4B was cost intensive due to the hydrodynamic drive system,” Wolters said. “Especially the standard design of the drive train using a typical gearbox was less than optimal.”

The LF-7.6HB featured a new hydrostatic drive system and greater stability, he said. “The customer is really happy with it.”

Besides lower costs, it offered several advantages over its predecessor. “For example, the soft change of the scaling direction, or the much quieter vehicle operation,” Wolters said. “The oil temperatures are very low, and this allows us to do much more hours between the maintenance intervals.”

More than 80 have sold.

The first LF-20HB was deployed in 2019 to a customer requesting a shearing scaler that could reach heights of up to 11 m. “All other standard scalers are for a maximum height of 8 m or less,” Wolters said.

With a massive boom and offering stability on inclines of almost 30%, the rig weighs 58 mt and is based on the chassis of a newly released GHH LHD. In comparison, the LF-7.6HB weighs 34 mt.

The LF-20HB features a more comfortable driving position, with joystick steering and dedicated seats for comfortable scaling. The cabin is described as ergonomic, and offers optimal visibility and safety. “The overview for the driver is very good,” Wolters said. “Also the system is ready for GHH inSite.”

An intelligent safety system protects the operator and machine, the company reported. Other optional assistance sys-



The LF-20HB shearing scaler was designed for a North American soft rock mining customer that wanted a LF scaler that could reach up to 11 m. (Photo: GHH)



The A64 HD Water Cannon made short work of clearing drawpoints and previously backfilled ore passes at a block caving operation. (Photo: Getman Corp.)

tems, such as collision avoidance, help deliver optimal safety outcomes.

The big scaler also features the “absolutely unbeatable” hydrostatic drive, he said.

The drive “enables quick reversing as well as sensitive roof and side wall scaling,” the company reported. The shearing principle it supports substantially “increases scaling performance” in soft rock.

“All competitor scalers and scrapers are equipped with a shift gearbox,” Wolters said. “Our scaler has just two accelerators,” he said. “One for forward and one for reverse, without any shifting of gears.”

The LF-20HB has a Tier 4-Final engine. The LF-7.6HB has an EU Stage V engine.

The new scaler offers the reliability and robustness intrinsic to the line. “Availabilities of 90% and more are standard,” Wolters said.

The line also differs from the competition in that LF series scalers were specifically designed for soft rock applications.

“A typical scaler has a percussion hammer to hit the loose material from the roof and the walls,” he said. “Our scalers are, in fact, scraping and not scaling.”

The LF line is also more mobile than the competition, Wolters said.

“A typical scaler gets lifted on hydro props and works in an area of just a few m<sup>2</sup>,” he said. “Our scaler is much more mobile because it is scraping the loose material while driving slow.”

The LF-20HB is billed as a safety vehicle and is designed for room-and-pillar soft rock mines in North America. “It would be ok for rock hardness of up to 80 to 100 MPa, as long as it’s not a constant process of scaling solid rock of that strength,” Wolters said.

Without a Stage V engine, it is not available in Europe.

The smaller units are available in Europe, and have helped GHH jockey for market share there and in North America, Wolters said.

“GHH is a specialist in soft rock mining due to the long-standing relationship with our salt and potash customers here in Germany and Europe,” he said. “We are experts in soft rock scaling and have deep experience in this field.”

## Water Cannon Clears Drawpoints

Getman Corp. announced a global version of their successful A64 HD Water Cannon, developed to help a customer who was losing time clearing blocked drawpoints. “With thousands of drawpoints, blockages were causing expensive delays and losses in productivity,” said Janne Ojala, director, design and engineering, Getman.

Unlike similar products, the A64HD Water Cannon is “specifically and purposely designed to clear drawpoints, working directly to aid mine efficiency,” Ojala said. “And in this instance, the customer’s method of clearing was time-consuming and unpredictable.”

The A64 HD Water Cannon proved to “make short work of a challenging situation and tackled their drawpoint blockage issue,” he said.

The customer also used the cannon to reopen previously backfilled ore passes. “They were able to reopen the ore pass without using explosives, clearing over 20 m of wet muck in two days,” Ojala said.

“Our water cannon is optimized to focus on the critical role of clearing rather than compromising the design by serving secondary functions such as dust suppression or washdown,” he said.

Using a 6-m boom, the unit clears muck by shooting water to 2,800 liters/min. With it, drawpoint clearance time can be reduced from days to hours. “First attempt success rates can be as high as 85%,” he said.

The topmost benefit offered is the safety of the teleremote operation. “Distanting the operator from the blockage area and providing them with an efficient, effective solution to clear the blockage keeps the operation moving smoothly without compromising safety,” Ojala said.

“Our radio remote control allows the operator to be underground with options

for either line-of-sight or at a further distance using teleremote operations,” he said. “The remote-control system is intuitive, and operators can refine their feel for the controls as they use them.”

The cannon’s design led to several unit orders in recent years.

The A64 HD Water Cannon is ideal for block-caving operations. “This product is dedicated specifically to this application and is uniquely suited in the market to be a safe and efficient alternative to other clearing techniques,” Ojala said.

The water cannon exemplifies Getman’s mission: helping miners work safe, Ojala said. “While we offer a broad range of standard production and production support products, we are adept at developing novel solutions for the challenges our customers face in this dynamic industry.”

## Scout Speeds Techs to Worksites

J.H. Fletcher & Co. announced the U.S. debut of the Mine Scout Supervision Vehicle. The company said the unit is a rapid-deployment supervision vehicle for transporting two people between underground and surface operations.

“It is equipped with ample storage space for tools, spare parts and testing equipment,” Francois Meintjes, associate



The Small Boss Buggy features a Tier 4-Final engine with streamlined electronics. To facilitate maintenance and cut costs, it has neither a diesel particulate filter nor diesel exhaust fluid. (Photo: Genco)

director, international sales, J.H. Fletcher, said. “It was designed with maintenance in mind, with easy-to-access service points.”

The unit offers speed and peace of mind. With industry-leading safety features, “the vehicle is a comfortable ride, and conserves operator energy when compared to walking or carrying tools by hand,” Meintjes said. “This enables the

service technician to do a top-quality repair job in a shorter amount of time.”

The Mine Scout features a robust chassis and world class components, the company reported. It can run for “up to 10,000 hours before an overhaul is required,” Meintjes said.

“When overhauled by J.H. Fletcher, the vehicle can achieve an additional 6,000 engine hours,” he said. “The longevity of the Mine Scout and ability to have a second service life sets it apart from its competitors and promises the customer the lowest running cost.”

The unit was co-developed with manufacturer UV Botswana to help African miners do more with fewer technicians and tools. “It was developed after observing, at a customer site in Zimbabwe, that a service technician wastes up to 26% of a 10-hour shift on walking,” Meintjes said.

“To make matters worse, the only rapid-deployment vehicles commercially available are ATVs, side-by-sides and light-duty trucks,” he said. “These commercial vehicles are not purpose-built for mining and lack the required durability and operator protection one might expect from a mine compliant vehicle.”

The Mine Scout “gets you to the workplace faster and safer than ever before,” he said.

J.H. Fletcher reported seeing interest in the vehicle from customers in Africa. UV Botswana “has successfully secured



Genco Mine Service co-develops a Cummins Tier 4-Final engine that uses exhaust gas recirculation and diesel oxidation catalyst technologies. The engine is simple and easy to maintain. (Photo: Genco Mine Service)

two orders for a platinum mining customer in central Zimbabwe, with another two orders lined up for early 2021," Meintjes said.

The vehicle demonstrates how J.H. Fletcher solutions add value by improving efficiency, job satisfaction and more, he said. "With the addition of the Mine Scout, Fletcher expands its priority of safety to general transportation in the underground mining industry," he said.

J.H. Fletcher will be showcasing the Mine Scout at exhibits throughout the western U.S. in 2021.

### Simple Engine for Easy Maintenance

Genco Mine Service (Genco) reported its Heavy Duty 12-Passenger Truck has a Tier 4-Final engine that is simple and easy to maintain. Featuring streamlined electronics, it doesn't have a diesel particulate filter (DPF) and doesn't require diesel exhaust fluid (DEF).

Instead, the engine uses exhaust gas recirculation and diesel oxidation catalyst technologies.

With exhaust gas recirculation, exhaust is fed into the air intake, cutting the incoming oxygen and making for lower-temperature combustion, which can reduce the creation of nitrous oxides (NO<sub>x</sub>) by much as 70%.

Diesel oxidation catalyst technology moves exhaust through a honeycomb of reactive metals that oxidize carbon mon-



The Mine Scout is developed to safely speed technicians from underground to surface worksites at mines in Africa. (Photo: J.H. Fletcher)

oxide, gaseous hydrocarbons, and any unburned fuel and oil. Basically a catalytic converter, it can cut emitted particulate volumes in half.

The engine electronics are all built in-house by Genco and allow for rapid troubleshooting, the company said.

"This should be a big help for the hard rock miners: Having a simple piece of equipment," David Sebring, president, Genco, said.

The company determined in 2016 it would offer a Tier 4-Final engine as an option in all of its underground equipment. "At the time, Tier 4-Final was on the horizon, so we decided as a company to get ahead of the game," Sebring said.

Genco determined that, from a maintenance technician perspective, ideal

would be a solution with no DPF and no DEF.

Typically, a DPF pipes exhaust through a ceramic sponge, which traps carbon and converts NO<sub>x</sub> to NO<sub>2</sub>. DEF converts NO<sub>2</sub> to ammonia. Lastly, a catalyst converts the ammonia into nitrogen and water.

A DPF is a complex serviceable, requires specific expertise to maintain, and, when malfunctioning, can damage an engine. DEF is a consumable and, thus, an expense. Genco sought alternative technologies.

"Working with Cummins we found that the QSF 2.8L didn't require DEF or a DPF and it would still meet Tier 4-Final requirements by using diesel oxidation catalyst technology only," Sebring said. "We started development in March 2016."

The process took several months and presented challenges, he said. "We first had to apply for the application, and once it was approved we had to work with Cummins Engineers to design the truck," he said. "Lastly we had to build the truck, and spend a week testing it."

The result is a 74-hp (55-kW) engine, offering 221 lb-ft (or 300 N-m) torque, that is easier and cheaper to maintain. Genco showcased it at MINExpo.

"Our solution is distinguished by its simplicity and standardization," Sebring said.

Standardized parts are readily available. "We have many different models that all use the same components and this becomes a competitive advantage for the mines when it comes to downtime and warehouse stocking," he said.

Further, the engine is "easy to work on," Sebring said. "The result is a more dependable machine."

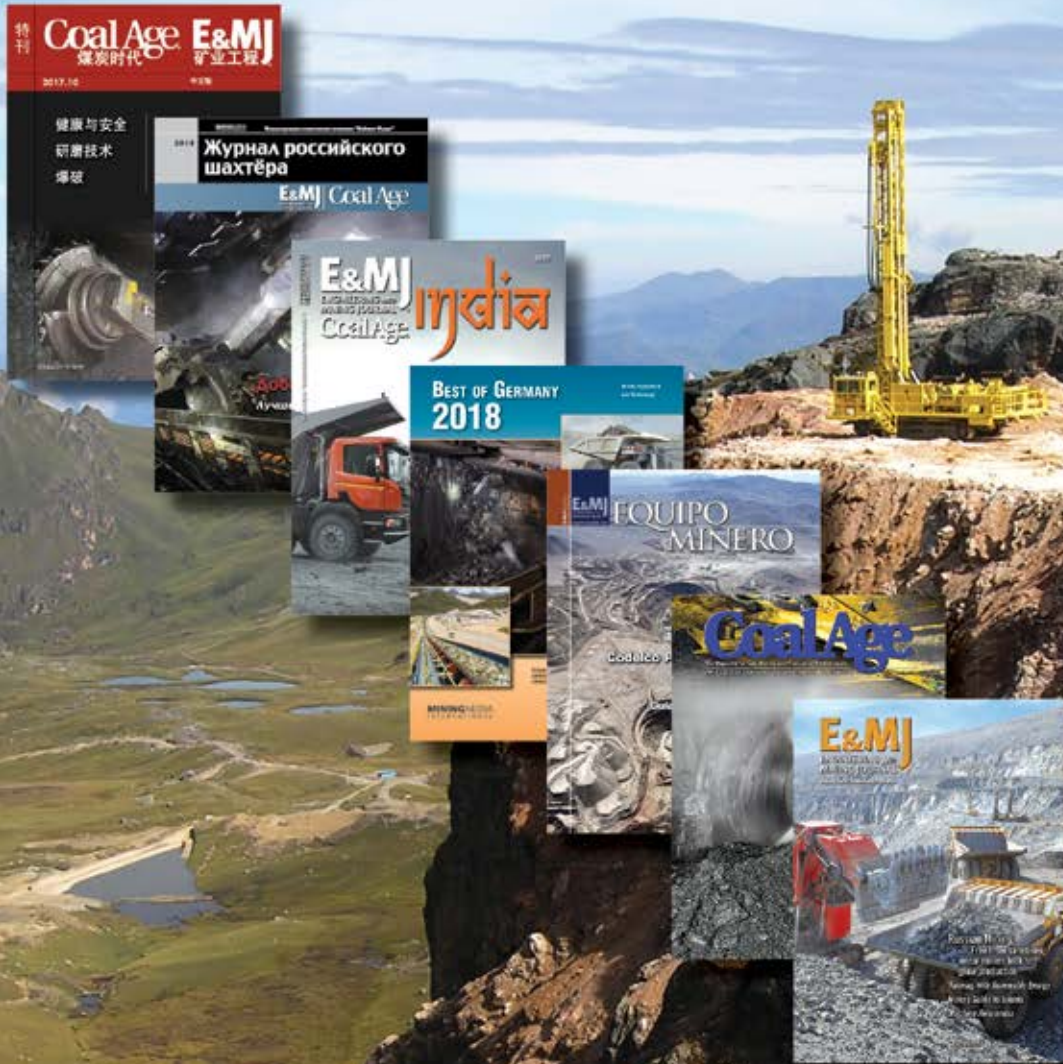


With a Tier 4-Final Engine, the HD Series Lube Truck has four wheel drive, straight tube axles and dual-piston hydraulic steering. (Photo: Genco)



# EXPERIENCE THE WORLD'S BEST-READ MINING MAGAZINES

Mining Media International Inc.'s Magazines Help You Reach the World of Mining



Leading other industry publications with extensive show distribution and an engaged editorial staff, Mining Media International Inc. brings dedication and unmatched industry knowledge to the magazines.

Find out how Mining Media International Inc.'s wide range of publications can help you reach the global mining industry.

**MININGMEDIA**  
INTERNATIONAL

VISIT ONLINE AT [WWW.MINING-MEDIA.COM](http://WWW.MINING-MEDIA.COM)

**E&M** ENGINEERING AND  
MINING JOURNAL

**Coal Age**

**EQUIPO  
MINERO**

## Superior Continues to Grow Mining Product Portfolio



In 2017, after several acquisitions and internal development projects, Superior debuted a new group of crushing, screening and washing equipment. These products joined an existing conveyor and custom plant portfolio to form a complete offering from Rock Face to Load Out®.

### Material Handling

- Mobile Heap Leach Conveyor System
  - Automated mobile package that optimizes material transfer for greater volume per move and more uptime in heap leach applications.
- TeleStacker® Conveyor
  - Combination of automated raise/lower and extend/retract features, plus quick



- transitions from radial to inline travel means high volume stockpiles with less human involvement.
- Other Stacking Conveyors
  - Dozens of options combined with custom-engineered structures for a resilient, made-to-order stacker.
- Trailblazer® Conveyor
  - Pre-assembled, portable overland conveyor is quick to deploy and reduces number of transfer points and electrical connections.
- Engineered Overland Conveyors
  - Eliminate unpredictable haul truck costs while providing an environmentally-friendly means to transfer material.
- Grasshopper Conveyors
  - Custom-engineered conveyor truss extends conveyor life in rugged mining applications.
- Conveyor Pulleys
  - Dedicated engineers create industrial strength products using certified American steel backed by in-house nondestructive testing.
- Core Systems® Design
  - Conveyor drive package consultation, engineering, manufacturing and assembly power-matched to your workload.
- Conveyor Idlers
  - Bearing sizes up to 60mm in single or double tube construction. Proven success within the highest capacity mines on the planet.
- Exterra® Belt Scrapers
  - Patented set for life technology means tension is maintained automatically through the life of the blade.

### Crushing & Screening

- Liberty® Jaw Crusher
  - An aggressive slant allows for consistent material grabbing and processing through the life of the liner.
- Patriot® Cone Crusher
  - Modern tramp relief system designed with fewer accumulators and inverted cylinders, which protect the hydraulic seals from contamination during operation.

- Guardian® Horizontal Screen
  - Conveniently integrated torsion arm tensioning system is easy to access for drive belt tensioning.
- Anthem® Inclined Screen
  - Bottle jack lifting points require no cranes or loaders which improves safety during spring maintenance or replacement.



### About Superior Industries

Superior engineers and manufactures groundbreaking bulk material processing and handling equipment and cutting-edge machinery components. From its headquarters in Morris, Minnesota, the manufacturing firm supplies mining customers with bulk crushing, screening and conveying systems. In addition to its home plant in Minnesota, the 48-year-old Superior operates from additional U.S. facilities in Arizona, Georgia and Nebraska, plus internationally-based operations in Canada, Brazil and China.





# MOBILE MINING



TELESTACKER® CONVEYOR PILES MORE MATERIAL PER MOVE



TRANSFER CONVEYORS EASILY SHIFT IN AND OUT

Superior Industries was founded and built on the premise of making conveyors mobile and minimizing the need for costly loader, dozer and haul truck use. For heap leach mining applications, our mobile material handling package maintains constant motion, piles more material per move and transitions quickly to move in all directions.

**SUPERIOR-IND.COM**

# Favorable PEA? Investors Warn It's Only the First Step In the Process

Preliminary economic assessments (PEAs) are no foundation for production decisions in mining projects, and serve little basis for detailed value-creation forecasts, according to a veteran mining consultant.

"The dire state of the global economy may be prompting the considerable number of PEAs being published," said Roger Dixon, corporate consultant at SRK Consulting. "Investors should be reminded that there is not much value in the detailed value projections that often accompany these assessments."

Dixon has more than 48 years of experience in the South African mining sector, and currently specializes in reserve and resource reporting to stock exchanges. His resume includes work at Anglo American, Anglovaal and base-metals mining group Metorex.

He noted that many PEAs include calculations on envisaged production levels, capital costs, operational costs and even net present values (NPVs) and internal rates of return (IRRs). "Setting out these indicators in exact dollars and cents tends

to belie the many assumptions that must be made at this stage in a project," he said.

"At best, it is a somewhat fruitless exercise to attach such exact numbers to a PEA — while at worst it could be highly misleading. There are just so many assumptions that are being made at this stage in a development, which have yet to be tested scientifically by technical studies."

He acknowledged that stock exchange regulators do make special provisions for PEAs, and that they do have a role in the project planning pipeline. Canada's National Instrument 43-101, developed after the 1997 Bre-X scandal, recognizes PEAs as one type of economic analysis of a mineral resource's potential viability.

"Regulators highlight, however, that PEAs have severe limitations," he said. "For instance, they tend to be overly reliant on converting Inferred Resources to Indicated Resources; they may also be misleading if they treat Inferred Resources as Mineral Reserves." Inferred Resources represent the lowest level of confidence in geological estimation.

Reading media reports of mining project PEAs brings home this risk, he said, with some projects showing that a third or more of the mineralized material they employ in their models is in the Inferred Resource category. The NI 43-101 requires that a PEA, which includes Inferred Resources in its modelling, must have a qualifying statement to clarify that these are too speculative geologically to have economic considerations applied to them.

"PEAs also tend to underestimate the costs and complexities of a project, and create expectations for indicators like NPV and IRR that may not be achieved in later studies, such as prefeasibility and feasibility studies," said Dixon. "They also often use overly optimistic metal recoveries and metal price assumptions."

He warned that PEAs were not intended to be the basis for production or investment decisions, but rather to be stepping stones in a much longer and more focused scientific and engineering process.

"The way that PEAs are reported in the media — where there is seldom space for all the necessary disclaimers — can also make a project appear more attractive than it should," he said. "In reality, a PEA does little to demonstrate economic viability, and projects at this stage of development typically have a high risk of economic or technical failure."

He highlighted that there is a wide range of modifying factors — including increasingly important social and environmental impacts — that mining projects had to explore and mitigate before a mine's viability could be fully assessed.

## 3 Ways LED Lighting Reduces Mine Hazards

Mining, although admittedly safer today than it was decades ago, has always been a high safety-risk business in which accidents and fatalities can have a devastating social and economic impact on families and be a major financial burden in an industry where margins are already thin. In addition, mining accidents often make national headlines, putting companies and their safety practices in the spotlight



Preliminary Economic Assessments '...tend to underestimate the costs and complexities of a project, and create expectations for indicators like NPV and IRR that may not be achieved in later studies such as Prefeasibility and Feasibility studies,' says mining consultant Roger Dixon. 'There are just so many assumptions that are being made at this stage, which have yet to be tested scientifically by technical studies.'



Better illumination has proven to decrease workplace accident rates by as much as 60%, according to lighting supplier Dialight.

and influencing public perception and recruiting efforts.

Luis Ramirez, chief operations officer of industrial LED lighting supplier Dialight, offered a case for implementing improved worker safety through better lighting. “According to U.S. government health and safety regulatory agencies, powered haulage, machinery and electrical accidents are among the leading causes of death in both underground and surface operations, accounting for around 90% of fatalities. In all three of these cases, poor lighting can be a primary contributor: the risk of slips, falls and contact with moving objects, constant noise that forces workers to rely on visual cues, and an inability to distinguish colors on warning placards and electrical wiring due to poor lighting all factor into these risks.”

Better illumination has proven to decrease workplace accident rates by as much as 60%. In fact, upgrading mine-site lighting to LED fixtures substantially reduces the risk of these preventable accidents, said Ramirez, who goes on to explain how modern LED lighting can improve mine safety to lower the risk and

cost of accidents, injuries and fatalities in mining facilities:

**Brighter environment** – High-quality LED lighting provides crisp, clear light that’s the nearest artificial source to natural daylight. This uniform and bright light reduces shadows, improves visibility and even enhances workers’ alertness, especially in dark areas such as underground facilities and at night in 24/7 surface operations. Enhanced visual acuity has been shown to improve trip-hazard detection by 94% and peripheral-motion detection by 79%, which could go a long way toward reducing powered haulage and machinery-related accidents.

**Improved color rendering** – Conventional lighting such as high-pressure sodium (HPS) is known for its dingy, orange hue that makes colors difficult to distinguish. This can lead to safety issues when workers must interpret warning signs and wiring colors and puts them at risk of misunderstandings that can lead to serious accidents. LEDs, on the other hand, have the highest CRI (color rendering index) of any artificial light source — in the range of 80-90 CRI, with natural daylight at

100. This means that colors are easier to distinguish. It also gives the overall facility a more natural, daylight appearance, rather than a dark, orange glow.

**Reduced maintenance** – HPS and fluorescent bulbs and fixtures fail frequently in the high-vibration environment of mining operations, and are easily damaged by contact with debris and machinery. This demands frequent replacement, which puts workers at risk of an accident. LED fixtures are much more tolerant of vibration and shock, greatly reducing the risk of fixture failure and the need for replacement. Less maintenance means less risk of an accident, which protects employees and the company.

Ramirez summarized by noting that upgrading to industrial LED lighting for mining operations can substantially reduce the risk of injury and improve worker safety on the job. When replacing failed or inefficient fixtures, choosing high-performance, long-life industrial LED fixtures is a worthwhile investment in both more efficient operations and in the safety and well-being of staff, as well as in improving the public perception of the industry.

# Glencore Taps Orica for Blasting Technology at Oz Ops



Orica's wireless initiating system technology, WebGen, in use at Glencore's Ernest Henry mine. (Photo: Orica)

Orica won a five-year contract for explosives technology and services for Glencore's Australian copper and zinc operations.

The supplier will deliver the full suite of explosives technology and blasting services, including WebGen, BlastIQ and Bulkmaster 7.

The contract expands Orica's longstanding relationship with Glencore, Orica said. "This deal shows Glencore's confidence in our technology roadmap as well as aligning with their strategic vision for technology to deliver added value to their operations," said Alberto Calderon, chief executive, Orica.

Glencore's Australian copper and zinc operations are McArthur River mine, Lady Loretta mine, Mount Isa mines, Ernest Henry mine and CSA mine.

## Fortescue Converts to Autonomous Haulage Fleet

Fortescue Metals Group completed its Chichester Hub autonomous haulage project. The fleet conversion project expanded the Fortescue autonomous haulage fleet to 183 haul trucks operat-

ing at Fortescue's Solomon and Chichester hubs.

The multi-class fleet includes Cat 793F, 789D and Komatsu 930E haul trucks, and has safely traveled more than 52 million km and moved 1.5 billion metric tons (mt) of material since 2013, the miner reported. An additional 900 assets, such as excavators, wheel loaders and light vehicles, are integrated and operated from the Fortescue Hive, the company's integrated operations center in Perth, Western Australia.

The company said the fleet will deliver productivity and efficiency benefits. "The introduction of AHS technology has improved safety outcomes across our operations and we're very pleased that the team achieved this important milestone in the truck conversion program to the highest safety standards," Fortescue CEO Elizabeth Gaines said.

## Epiroc Sells Bolting Rigs to Norilsk

Epiroc won an \$11 million contract from Norilsk Nickel for underground mining equipment. The miner ordered Boltec M

and Cabletec M rigs for use in the Oktyabrskiy, Mayak and Komsomolskiy mines in Russia.

Several of the Boltec machines will be equipped with the new automated pumpable resin system. The system, when combined with self-drilling anchors, is particularly effective in unstable ground conditions, Epiroc reported.

The miner is a longtime customer and the purchase broadens the relationship, Epiroc said. "We are proud to play a key role as this forward-looking mining company now takes the next step in its commitment to safety and productivity with our latest technology," Epiroc CEO Helena Hedblom said.

## Turquoise Ridge to Trial AVS Truck

Sandvik and Barrick partnered on a three-year production trial of battery-electric vehicles (BEVs) underground. During the trial, Sandvik will deploy four Artisan Z50 trucks at Turquoise Ridge gold mine.

The 50-metric-ton haul truck, with a battery-electric powertrain, is equipped with AutoSwap, the battery-swapping system by Artisan. Changing a battery can be completed in 6 minutes, and can be done in a passing bay or an old re-muck bay with no cranes or other infrastructure needed.

In previous trials, the truck achieved 1,400 hours of production. It proved it could operate 18 hours per day.

The miner reported the development reflects its desire to improve performance, sustainability and efficiency. "This partnership with Sandvik is exciting and will give us first-hand experience in BEV technology in our own production environment," Barrick CEO Mark Bristow said. "It is a significant step to furthering our BEV strategy across the group."

## Metso Outotec Tech Deployed to Iron Ore Plant

Beijing Shougang International Engineering Technology Co. Ltd. contracted Metso Outotec for delivery of new environmentally sound technology for Zenith's iron



Above, a Metso Outotec indurating machine. The supplier has logged five orders for pelletizing plant technologies from operations in China. (Photo: Metso Outotec)

ore pelletizing plant to be built in Nantong, China.

The contract covers the engineering and design of the indurating system, engineering of the process gas fan system, supply of proprietary equipment, instrumentation and control systems, as well as supervisory services and technical training. The core of the plant is Metso Outotec's traveling grate pellet indurating furnace, which has a grate area of 432 m<sup>2</sup>.

Metso Outotec said it is the fifth such plant delivered to China. "It is based on our environmentally sound traveling grate technology," said Tobias Stefan, vice president, ferrous and heat transfer business line, Metso Outotec.

The traveling grate technology produces uniform pellets and ensures high performance and quality with low investment and operating costs, as well as decreased energy consumption and emissions, the company reported.

Pellet production at the Zhong Tian plant is estimated to start by the end of 2021.

Metso Outotec announced plans to sell its fabrication, machining and assembly operations and to close or rearrange the rest of its operations in Vereeniging, South Africa. The production of

mill linings, as well as pump assembly operations, will be transferred to other Metso Outotec manufacturing units with flexible global service capability.

Metso Outotec also announced it was restructuring its consumables operations in North America. The company has decided to discontinue its factory operations in North Bay, Canada. The production will be ramped down by the end of the first half of 2021.

### FLSmidth, Consortium Get Grant to Upscale RFC

FLSmidth reported it and a consortium will upscale and commercialize the REFLUX Flotation Cell (RFC) after receiving an annual grant from EIT RawMaterials. The three-year project will involve pilot and full-scale testing, leading to sales to the copper and iron ore industries, FLSmidth reported.

The grant totaled \$6.4 million, of which \$3.3 million went to the supplier.

FLSmidth said the money will fund efforts to prove RFC can operate successfully outside the limitation of traditional open tank flotation systems.

"The opportunity presented by the work packages included in this grant will accelerate the commercialization of the technology," Manfred Schaffer, president,

mining, FLSmidth, said. "It will also allow for continued development and optimization of the RFC that will hopefully further increase resource efficiency in mining."

RFC has a higher throughput and improved separation efficiency compared to traditional flotation methods. It speaks to the supplier's MissionZero program to move toward zero water and energy waste by 2030.

The consortium includes KGHM Polska Miedz Spółka Akcyjna in Poland and Luossavaara-Kiirunavaara AB in Sweden, Norwegian University of Science and Technology, Helmholtz Helmholtz-Zentrum Dresden-Rossendorf University, the University of Newcastle in Australia, the Swedish Environmental Research Institute, and several external advisors.

### Cadia Deploys Teleoperated Water Cannon

Newcrest Mining reported it integrated a MacLean water cannon with Epiroc's traffic management system and safety hardware at Cadia Valley mine. The cannon can be safely teleoperated from the surface, and works alongside semiautomated loaders.

Commissioned in Q3 2020, the cannon is in use at Cadia East.

Newcrest said the cannon has improved efficiency in production and increased safety. "We are constantly pushing the envelope of change in the innovation and technology space," Aaron Brannigan, general manager, Cadia, said. "Automated machinery allows for shift in technical capabilities of our workforce, while ensuring we continue to eliminate safety risks from our operation."



At Cadia Valley, a MacLean water cannon is integrated with Epiroc's traffic management system so the unit could be teleoperated from the surface. (Photo: Newcrest Mining)

## RPMGlobal Acquires IMAFS

RPMGlobal has entered into a share purchase agreement to acquire Canada-headquartered, inventory optimization management software company, IMAFS.

The IMAFS solution is designed for optimizing the inventory holdings of large-asset-intensive companies. It is a cloud-delivered, inventory management and forecasting software solution that connects to an enterprise resource planning system and utilizes artificial intelligence to greatly improve inventory management, RPMGlobal reported.

RPMGlobal described the solution as a great fit. "It further builds on our cloud and optimization offerings," said Richard Matthews, CEO and managing director, RPMGlobal.

## Modular Plants for On-site HDPE Production

Tubi USA Inc. launched a Mobile Modular Extrusion system, which reduces logistics, installation, and handling costs for the manufacture and installation of high-density polyethylene (HDPE) pipe.

The breakthrough modularized production units operate at Tubi's sites or each client's site, directly reducing the cost of pipe transportation, and ensuring supply. The plants can be packed on to flatbed trucks and hauled to project sites in 72 hours.

Company leadership reported the modular plants cut the risk of handling large pipe lengths while delivering



A lab in Randburg, South Africa, will qualify operations for Albion Process. The process is a combination of ultrafine grinding and oxidative leaching. (Photo: Liebherr)

sustainability advantages by reducing truck traffic.

"Our game-changing modular technologies address the needs of an ever-increasing and far-spanning global community," Tubi CEO Marcello Russo said. "With our geographies widening, there is a real demand to utilize more efficient, flexible and sustainable methods of operation."

## Randburg Lab Offers Albion Process Testwork

SGS Minerals will offer Albion Process testwork at a lab in Randburg in South Africa, Glencore Technology's reported. The testwork has also been conducted at the SGS Lakefield lab.

The testwork seeks to qualify an operation for the process.

Glencore Technology said the development is part of a wider focus on the African continent. "The extension has been under discussion for quite some time," said Paul Voigt, technology manager, hydrometallurgy and pyrometallurgy, Glencore Technology.

SGS is the third certified provider of the testwork. Core Resources in Australia and Toms Institute in Russia offer the service.

Albion Process is a combination of ultrafine grinding and oxidative leaching at atmospheric pressure. It tolerates a more variable feed and lower grade, making some projects feasible.

Currently, at several plants, the process consistently delivers high recoveries in refractory gold and base metal concentrates, Glencore Technology reported.

## Cat to Offer Seeing Machines' Guardian

Caterpillar entered an agreement with Seeing Machines Pty Ltd. to deliver and support light vehicle and on-highway driver fatigue and distraction monitoring technology through Cat dealers.

Seeing Machines' Guardian 2 system is a non-intrusive system that senses operator movements and analyzes them for symptoms of fatigue or distraction. Seat vibration and audio alarms alert operators when a microsleep or distraction event is detected.

Guardian 2 replaces the Driver Safety System in the Cat MineStar Detect port-



Tubi USA modular plants manufacture HDPE pipe on-site. (Photo: Tubi USA Inc.)



folio, Caterpillar reported. Among other capabilities, the system provides reports and analytics for tracking patterns and determining if operators are having repeated fatigue or distraction events.

Since its introduction, Guardian has logged more than 4 billion km traveled and has detected more than 6.4 million distraction events.

## Alpha Quantix to Distribute Ironhand

Bioservo Technologies AB contracted Alpha Quantix to distribute Ironhand in the western U.S. Ironhand is an active soft exoskeleton for the hand.

Alpha Quantix, an engineering and consulting firm, said the development will allow the company to meet increasing demand from customers. Bioservo said it expects Alpha Quantix to easily integrate Ironhand into customer projects.

“Alpha Quantix has a wide experience in helping businesses improve their operations by providing analytics, metrics and training,” Bioservo CEO Petter Bäckgren said. “Their data-driven approach to technology implementations match our belief that it is important to base improvements in ergonomics and productivity on thorough analyses and measurements.”

## Norgold’s Lefa Gets ThoroughTec Simulator

Norgold equipped its new West African Training Center at the Lefa mine in Guinea with a CYBERMINE Full-Mission Simulator by ThoroughTec Simulation.

The simulator is a high-fidelity system that creates the sensation of operating equipment in a mine. The simulator cab

uses OEM controls and the simulated vehicle dynamics are based on detailed mathematical models that use vehicle manufacturer specifications.

The center is located in a key region, and the development is part of a wider training program, Norgold said. “They will enhance the skills of our people, and

in turn will enable us to run safer, more efficient operations,” Yulia Sklar, human resources director, Norgold, said. “The West Africa Training Center in Guinea is an important element of our strategic Employee Development Program.”

The miner reported the center is valued at roughly \$800,000.

**LinkedIn**

**facebook**

**twitter**

**JOIN THE CONVERSATION**

Join us on Facebook, Twitter and LinkedIn to stay up-to-date with industry news extras, live tweets and up-to-the-minute updates at industry trade shows, monthly photos, exclusive videos, and much more.

t f in RSS



Norgold deployed a ThoroughTech Simulation simulator to the training center at the Lefa mine in Guinea. (Photo: Norgold)

# Preventing Accumulation Problems in Hoppers and Chutes



Air cannons can be useful in preventing troublesome material accumulation in process equipment, minimizing the need for downtime and manual labor.

Efficient material flow is a critical element of wet mining processes. Accumulation or blockages in storage systems and build-up in process vessels can impede material movement, causing bottlenecks that interfere with equipment performance, reduce process efficiency and put a choke hold on an operation's profitability. Poor material flow also raises maintenance expenses, diverting manpower from core activities and in some cases introducing safety risks for personnel.

"Most systems suffer from some amount of accumulation on vessel walls, which can rob plant owners of the storage systems in which they've invested," observed Brad Pronschinske, global director of Air Cannons Business Group for Martin Engineering.

Although many plants still use manual techniques to remove build-up, the cost of labor and periodic shutdowns has led some producers to investigate more effective methods for dealing with this common production issue.

## Buildup vs. Throughput

Even well-designed processes can experience accumulations, which have a significant impact on output and profitability. Changes in process conditions, raw materials or weather can all have an effect on material flow, and even small amounts of accumulation can grow into a serious blockage.

Lost production is probably the most conspicuous cost of these flow problems, but the expense can become apparent

in a variety of other ways. Shutdowns to clear the restricted flow cost valuable process time and maintenance hours, while wasting energy during restart. Refractory walls can be worn or damaged by tools or cleaning techniques. When access is difficult, removing material blockages may also introduce safety risks for personnel.

Many of the most common problem areas for accumulation are classified as confined spaces, requiring a special permit for workers to enter and perform work. The consequences of untrained or inexperienced staff entering a silo or hopper can be disastrous, including physical injury, burial and asphyxiation. Material adhered to the sides of the vessel can suddenly break loose and fall on a worker. If the discharge door is in the open position, cargo can suddenly evacuate, causing unsecured workers to get caught in the flow. Cleaning vessels containing combustible dust — without proper testing, ventilation and safety measures — could even result in a deadly explosion.

## Getting Professional Help

"While some large facilities choose to make the capital investment to purchase their own cleaning gear to clear process equipment and storage vessels — as well as train personnel — others are finding it more sensible to schedule regular cleanings by specially-trained contractors," said Pronschinske. "Given the costs of labor, lost time and potential risk to employees, this can often be accomplished for less than the total investment of in-house cleanouts."

At one location, for example, the blockage was so severe in one silo that it had been out of use literally for years. While it took a contractor almost two weeks to fully evacuate the vessel, the process restored 3,500 tons of storage capacity. At another facility, the crew was able to remove enough "lost" product that the value of the recovered material actually paid for the cost of the cleaning. In short, regular cleaning of storage vessels can quickly turn into an economic benefit — not an expense, but rather an investment with a measurable ROI.

## The Costs of Cleaning

There are a few types of equipment used for this purpose. One operates like an industrial-strength "weed whip," rotating a set of flails against the material in the vessel. This approach eliminates the need for confined space entry and hazardous cleaning techniques, typically allowing the material to be recaptured and returned to the process stream.

The whip can be set up quickly outside the vessel, and it's portable enough to move easily around various bin sizes and shapes. Typically lowered into the vessel from the top and then working from the bottom up to safely dislodge accumulation, the pneumatic cutting head delivers powerful cleaning action to remove buildup from walls and chutes without damaging the refractory. Technicians lower the device all the way down through the topside opening, then start at the bottom of the buildup and work their way up, undercutting the wall accumulation as it falls by its own weight. In extreme cases, a "bin drill" can be used to clear a 12-in. (30.5-cm) pathway as deep as 150 ft (45 m) to start the process.

## Flow Aids

Regular cleaning is one approach to keeping materials flowing freely by removing buildups from silo walls, but there are other flow aids that may reduce the need for cleaning or even eliminate it. One method is through industrial vibrators designed for bin and chute applications. Electric vibrators are generally the most efficient, delivering the longest life, low



Safe, effective silo cleaning requires tools that work inside the silo from the top, controlled by personnel outside.

maintenance and low noise. The initial cost for an electric vibrator is higher than for pneumatic designs, but the operating cost is lower. Turbine vibrators are the most efficient and quietest of the pneumatic designs, making them well suited to applications in which low noise, high efficiency and low initial cost are desired.

Air cannons are another approach to maintaining good material flow, particularly in larger vessels. Also known as an air blaster, the air cannon is a flow aid device that can be found in mining, coal handling and many other industries. Applications vary widely, from emptying bulk material storage vessels to purging boiler ash to cleaning high-temperature gas ducts.

In the mining industry, air cannons are frequently specified to eliminate build-ups in hoppers, storage vessels, transfer chutes, bins and other production bottlenecks. They can also be found in mineral processing plants where metals are extracted using processes creating slurries and other wet, tacky tailings.

Air cannon technology has been used in mining and material processing for many years, helping to improve flow and reduce maintenance. The timed discharge of a directed air blast can prevent accu-

mulation or blockages that reduce process efficiency and raise maintenance expenses. In underground mines with potentially explosive dust, manual firing of cannons without the use of electrical solenoids is an option. By facilitating flow and minimizing buildup, air cannons help bulk material handlers minimize the need for process interruptions and manual labor.

The two basic components of an air cannon are a fast-acting, high-flow valve and a pressure vessel (tank). The device performs work when compressed air or inert gas in the tank is suddenly released by the valve and directed through a nozzle, which is strategically positioned in the tower, duct, chute or other location. Often installed in a series and precisely sequenced for maximum effect, the network can be timed to best suit individual process conditions or material characteristics.

“The core message for mines and material processors is that they don’t have to put up with accumulation problems and the additional expenses they can cause,” Pronschinske concluded. “There are a number of approaches that can help resolve those issues before they turn into expensive downtime, lost material and safety hazards.”

## FLSmidth: Dialed-in to Digital Solutions

FLSmidth recently called attention to the industry’s accelerated move toward digital solutions since the COVID-19 pandemic and pointed out that the company stands ready to support the trend by applying its decades of research and development activity.

Terence Osborn, FLSmidth’s director of product and account management for sub-Saharan Africa and the Middle East, said R&D is the lifeblood of the company’s new technologies. In fact, it has some 80 projects under way to improve its mining-related offerings.

“The power of digital technology is certainly a key element of these efforts,” said Osborn. “Together with our Blue Box digital concept, based on our ECS/ControlCenter, which is a cybersecure interface between our equipment and cloud data storage, we use our SiteConnect mobile app to monitor the performance of equipment and process plants in real time. The ECS/ControlCenter V8 process control platform sits at the heart of our digital vision, a key component in our

growing portfolio of digital solutions and services that we call ENABLR.”

An example is an FLSmidth REFLUX Classifier modular plant operating on a South African mine. Using SiteConnect, operations managers have real-time access to more than one hundred operational parameters for the plant. Data analytics linked to the cloud data can also generate time-based trends for instant viewing on the app.

“We have also developed SmartCyclone technology for our hydrocyclones,” Osborn noted. “This innovation uses sensors to detect wear and roping, a condition that reduces separation efficiency. By sending an alert when certain operating parameters are breached, the system ensures optimal efficiency is maintained, even as slurry conditions in the circuit vary.”

He said the company’s machine-level solutions are offered as part of plant and process packages. At both plant and process level, there is also FLSmidth’s advanced ECS/ProcessExpert solutions, which facilitate not just monitoring and control, but advanced optimization enabled by state-of-the-art AI technologies.

“It is important to remember that control systems need to be flexible, so that they adapt to customers’ needs and to their existing systems,” he said.

The company claimed its R&D pushes the boundaries of performance in a range of mineral processing fields. These include advancing its lamella plate technology in mineral separation applications, adapting its vertical roller mill for dry grinding in mining, and extending wear life of pumps with new polymers.



FLSmidth says its expertise in software engineering and machine control ensures that its machine-level systems can connect with all commonly used control systems to seamlessly deliver the data users need for effective decision-making.

# Komatsu Jumbo, Bolter Have Common Carrier, Controls



Komatsu introduced the ZJ21 jumbo drill and the ZB21 bolter for underground hard rock mining. Both use a groundbreaking common carrier and control system, and offer improved productivity and lower capital costs over predecessor competition.

The common carrier and controls allow conversion from the jumbo to the bolter, or the reverse. Conversion requires a kit from Komatsu, up to three shifts, a dedicated space for the entire timeframe, and an overhead crane.

An operation with both machines can benefit from efficiency gains and reduced costs, Komatsu reported. Maintenance can be streamlined and seamless. Inventory is reduced and inventory management is simplified. The units are designed for ground-level maintenance of all major functions. The common controls allow for an operator to easily transition from operating one to operating the other.

The rig has a conventional mechanical powertrain. Not including the boom, it is 1.7 m wide, 6.1 m long, and 2.8 m high. It

is designed to tram in a 3-m by 3-m heading, while capable of stability on a 90° turn.

The ZJ21 is the longest machine in its size class, but can still make a 90° turn in a 3-m by 3-m heading. It delivers up to 66 m<sup>2</sup> of face coverage, and is capable of drilling ramps, crosscuts, and truck loading bays. In a main development drift, it could back up a two-boom jumbo that was down for maintenance, Komatsu reported.

The drifter is manufactured by Montabert and offers best-in-class consumable life and operating costs.

The ZB21 allows operators to bolt in any direction, and can handle up to an 2.4-m bolting head. The entire bolting cycle can be performed from inside the enclosure using an integrated screen handler and the chemical injection system.

The bolter has a vertical reach of 7 m, a horizontal reach of 7.5 m, face coverage of 50 m<sup>2</sup>, and a boom weight of 2,200 kg. It is designed for use in smaller mine sections, and is capable of face bolting using mechanical, frictional,

chemical and Swellex bolting technology, Komatsu reported.

The feed has comparatively few moving parts and therefore low maintenance requirements.

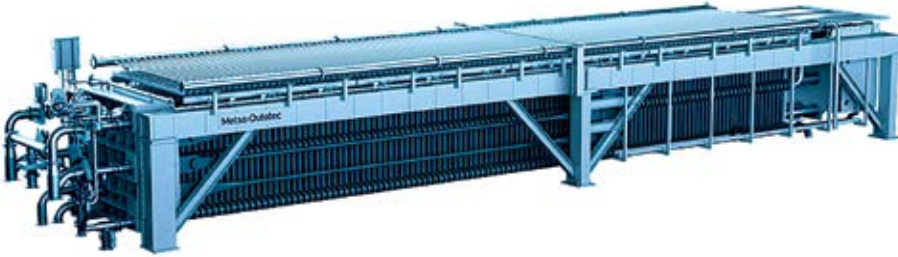
The units are the first two of 14 planned new models.

*mining.komatsu*

## Filter Press Offers More Capacity

Metso Outotec introduced the Larox FFP3716, a new FFP-series high-capacity filter for demanding tailings applications. With compact plate pack design and smart automation, it redefines the overall standard in reliability, capacity and safety in tailings filtration, the supplier reported.

An optimum plate pack design reduces wear on plate pack and cloth components. The new design of the closing and sealing mechanism with individual controlled sealing cylinders ensures squared plate pack at any time, resulting in long lifetime of the pack, Metso Outotec reported.



Features include a 2,000-m<sup>2</sup> filtration area, a 44-m<sup>3</sup> chamber volume, up to 16 bars operating pressure, a smart hydraulic system, and readiness for remote production application support.

The company also introduced the Filter Optimizer to boost the performance of Larox PF filters. It stabilizes the effect of upstream process variations, and gives more control over the solid/liquid separation process, the supplier reported.

Key benefits include maximized productivity, optimized energy consumption, consistent residual cake moisture and improved process visibility.

[www.mogroup.com](http://www.mogroup.com)

### Crusher Offers Lowest OPEX, CAPEX

FLSmidth reported its new TSUV Mark 5 Top Service Gyratory Crusher offers more power and higher throughputs and is ideal for lower-grade operations. It is the world's most OPEX- and CAPEX-efficient gyratory crusher, the supplier reported.



The crusher is digitally enabled, allowing operators to make fine adjustments, to track trends, and to instantly detect obstructions. The control system gives operators a 24/7 view of performance metrics.

The unit features a top-service design for safety, ease of maintenance and efficient crushing performance. The 100-metric-ton (mt) fully dressed main shaft aligns automatically, reducing risk.

The features combined offer the lowest cost per mt, the lowest cost of ownership, and reduced environmental impact, FLSmidth reported.

[www.flsmidth.com](http://www.flsmidth.com)

### Server Captures Data for Monitoring

Maestro Digital Mine launched the MaestroLink Server, an on-premise-based monitoring platform that enables control room operators and maintenance teams to monitor and manage devices via smartphone, tablet or computer in real-time.

The platform provides a secure multi-instance web-based interface to monitor and record the health of any Vigilante AQS or Zephyr AQS air quality monitoring station, DustMon PM particulate monitor,

and the Plexus PowerNet last-mile underground communication network. Every Maestro digital device provides multi-variable data, but also a complete suite of diagnostic data, the company reported.

Once installed, MaestroLink Server reaches out on the network to find and self-populate the devices and network nodes, and begins to monitor both the data and advanced diagnostics of the devices. The data allows the server to provide in-depth information regarding the device right down to the sensor.

The platform can be either a software solution, or a preconfigured and combined hardware and software solution.

[www.maestrodigitalmine.com](http://www.maestrodigitalmine.com)

### Glasses Support Remote Troubleshooting

BEUMER Group released Smart Glasses, which allow the supplier's technicians to see what on-site technicians see. The glasses support live contact with BEUMER service experts anywhere, the supplier reported.

To use, the on-site technician dons the glasses and launches the BEUMER Support app with a voice command. The service is password activated. The BEUMER technician then can see whatever the on-site technician sees. Advice appears in the field of vision. Use of the glasses requires no hands.

The main benefit offered is expedited problem solving, the supplier reported. BEUMER experts are available 24/7.

[www.beumer.com](http://www.beumer.com)





### Updated RCS Offers Improved Tracking

Epiroc introduced an update to its Rig Control System (RCS). The new version, RCS 4.20, includes a range of general improvements and features such as Time Usage Model, Real Time Data and AutoDrill optimizations, the company reported.

Time Usage Model allows for improved tracking of asset utilization against targets, which will help drive continuous improvement. Upgrades to AutoDrill bring advanced opportunities for automation. Real Time Data enables unprecedented data capture abilities to gather insights and help mines make quicker decisions.

Epiroc reported the routine software release raises the ceiling on operational excellence.

[Epiroc.com](http://www.epiroc.com)

### Oil Shear Brakes Last Longer

Force Control Industries reported MagnaShear Oil Shear Brakes mounted on heavy-duty Baldor cast iron motors are ideal for severe-duty, high-cycle environments, such as mining plants. Models range in size from 1 to 50 HP. The brakes, which are totally enclosed and sealed, last 5 to 10 times longer than traditional dry type brakes, with virtually no regular maintenance and no adjustment, the supplier reported.

[www.forcecontrol.com](http://www.forcecontrol.com)

### Dilution System for Thickeners

International technology Group ANDRITZ has developed the EvoLute NT dilution system, a new solution for diluting thickener feed that uses the overflow liquid from the thickener to dilute incoming slurries or suspensions to the optimum solid-liquid ratio.

This new, patented system is designed for flow rates between 600 and 9,000 m<sup>3</sup>/h. The dilution system does not interfere with the thickener settling process and can also accommodate slurries with low pH values. With the different flow rate

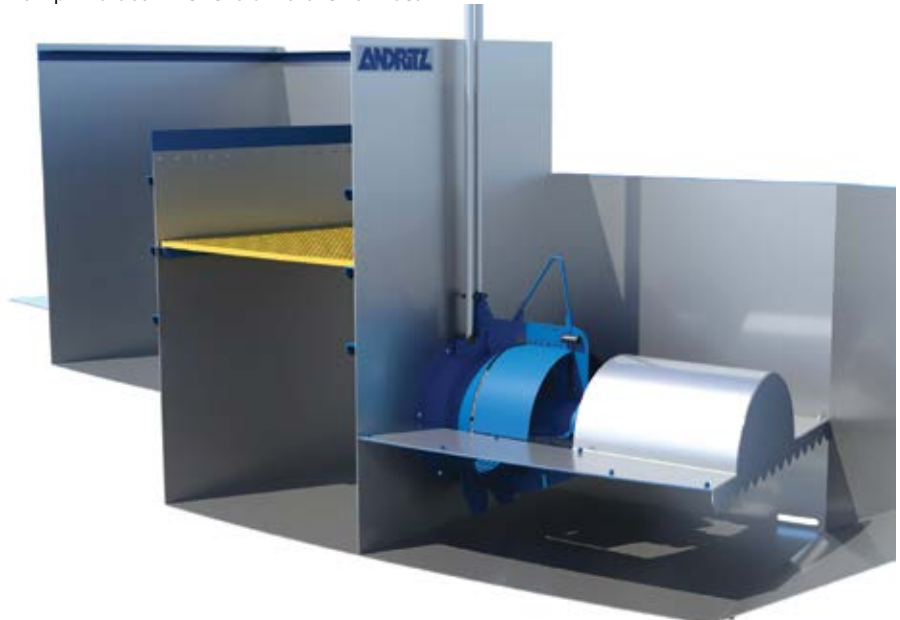
configurations available, each system can be adjusted to customer's needs.

The high dilution flow rates the ANDRITZ EvoLute NT dilution system achieves translate into cost savings through lower power consumption. Maintenance has been optimized thanks to easily interchangeable parts that do not require the thickener to be shut down. The system can also be integrated into the thickener automation processes.

In the most challenging applications, reliable clarification and thickening are critical to maintaining continuous production. That is why ANDRITZ has invested decades of expertise with thickening and clarification systems to develop an efficient and cost-effective solid/liquid separation system with a crystal-clear overflow.

The dilution process, where liquid is added to the incoming material and the solids concentration is reduced by adding more solvent, is a critical step. Dilution guarantees a perfect solid-liquid ratio in the thickener feed, which in turn enhances the settling rate of particles in the suspension when flocculants are added.

ANDRITZ offers many dilutions systems covering flow rates of up to 15,000 m<sup>3</sup>/h for a wide variety of applications. With their unique design features, ANDRITZ thickeners, including the ANDRITZ EvoLute NT dilution system, are considered the most effective and technologically viable systems on the market. [www.andritz.com](http://www.andritz.com)



## Optimum Pre-commissioning at TECBERG Park

*Assessable quality and time advantages for shaft operators due to unique level of system integration and pre-commissioning of shaft hoisting machines at the manufacturing plant*

**SIEMAG  
TECBERG**

For a company, strategies, concepts, partnerships and innovations sometimes condense into a single term. For the SIEMAG TECBERG group, a globally recognized manufacturer of innovative vertical shaft hoisting and horizontal material handling technology, "TECBERG park" is that term.

### Investments in New Product Assemblies at TECBERG Park

With the recently completed two new product assembly halls and an automated logistic center at SIEMAG TECBERG's headquarters in Haiger, Germany, the company has reached another milestone in its strategic development.

The optimum coordination of the individual components already accomplished at the OEM plant enables a significantly faster, fault-optimized start-up phase on the construction site and guarantees an increase in subsequent plant availability.

The new halls accommodate two heavy-duty test fields equipped with the latest diagnostic technology for comprehensive system tests of the mechanics, hydraulics, automation and drive technology of shaft hoisting machines and winches.

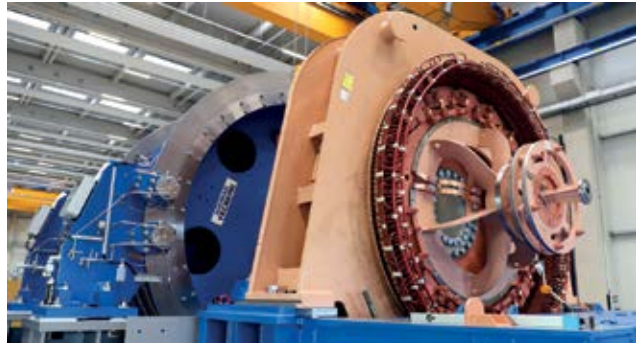
Before shipping a shaft hoist to the customer site, the complete product assembly comprising all components and disciplines of the system is realized. The subsequent system tests are supplemented in the field of automation technology by project-specific customer adaptations such as parameterization and simulation of sequence controls.



The TECBERG park complex, located at SIEMAG TECBERG's headquarters in Haiger, Germany, is equipped with new automatic warehouse and the new halls 2 and 3 with heavy load test fields and corresponding crane equipment.

### Test Field Diagnostics for Mechanics and Hydraulics

The test of a completely assembled shaft hoisting machine or winch in product assembly under virtually realistic conditions - i.e. the drive can rotate the rope carrier and the brake is ready for operation - provides extensive possibilities for quality assurance and inspection in the assembly plant. The examinations aim to concentricity measurements, inspection of dimensional accuracy of functionally relevant system dimensions, detection of geometrical unbalance or eccentricity in the overall system, on the verification of axial and radial forces as well as spindle and shaft torsion, on the recognition of dynamically impermissible vibrations or noise development; on the inspection of operating temperatures in plain and roller bearings; on the determination of the operating behavior (temperature, pressure, etc.) of aggregates; on the inspection of the operating behavior of gearboxes and clutches as well as the



A Koepe winder on the test field in hall 3 at TECBERG park.

adjustment of the complete brake system including the analysis of brake curves.

### Test Field Diagnostics for Automation and Drive Technology

The diagnostics of the automation and drive components such as cabling, motor, frequency converters and control cabinets are realized in a similarly comprehensive manner. The tests are used for early detection of possible errors and interface verification between mechanics, hydraulics and automation, converter system and other auxiliary controls.

Furthermore, these tests serve the parameterization of the controllers. The behavior at different starting torques, load jumps and load cycles is being tested. An analysis of motor characteristics, e.g. insulation and resistance measurements, no-load characteristics at nominal voltage takes place. Heating under load is being tested and an optimization of motor and control behavior at standstill torque (speed  $n = 0$ ) takes place. There is a simulation of processes for the testing of sequence controls, control of different operating modes of the overall system.

This is the basis for stable plant operation after installation on the construction site. The optimum coordination of the individual components already carried out in the assembly plant enables a significantly faster, fault-optimized start-up phase on the construction site and guarantees an increase in subsequent plant availability. Applying a system-integrating product assembly at the beginning of the product life cycle and its combination with TECBERG digital - the digital asset management offered by SIEMAG TECBERG - offers the shaft operators and shaft owners valuable information and support throughout the life span of the shaft hoist: the services of TECBERG digital offer the customer a comprehensive instrument for plant diagnosis and efficient maintenance management.

Since March 2020, SIEMAG TECBERG is official Solution Partner of Siemens especially for Large Drives LV. The possibilities already available at TECBERG park have convinced Siemens, that SIEMAG TECBERG company with its existing know-how and expertise is the right partner in the field of "Medium-voltage drives." With these optimized test possibilities for its shaft hoisting systems, SIEMAG TECBERG is now taking on a pioneering role worldwide. No other manufacturer of systems of this magnitude currently undertakes such extensive product assembly and testing with system tests, carried out on test benches for the system integration of complete hoisting machines.

Product safety at SIL3 level, comprehensive system integration and advanced digitalization are no longer a future topic at SIEMAG TECBERG - they are already part of our everyday practice!

**QUICK**  
*Usually Ships In 1/2 The Lead Time*  
 Horizontal and Vertical Pumps



Free Pump Selection  
 Software On-line  
**513-530-0888**

**41 YEARS**  
 1979  
 2020

**VERTIFLO PUMP COMPANY**  
 The Industrial Pump Specialists  
[www.vertiflopump.com](http://www.vertiflopump.com)

**FREELANCE WRITERS**

Engineering and Mining Journal is looking for remote freelance writers who can create quality content for the magazine. Knowledge of mining and mineral processing industries is preferred. We are especially interested in writers residing in Indonesia, Australia and China, but are open to writers in other parts of the world as well. You will be contributing news and feature articles to the magazine.


If interested, please send your resume and at least two writing samples to Jennifer Jensen, associate editor, at [jjensen@mining-media.com](mailto:jjensen@mining-media.com).



**YOUR CLASSIFIED AD HERE**

**1 column x 3" space**  
**Color: \$510**  
**Black & White: \$360**

**CONTACT YOUR SALES REP TO BOOK A SPACE TODAY**




**Delta Pump & Systems, Inc.**

**Process Pumps For Mineral Preparation**


Polymer, Flotation, pH Control  
 FCA, Belt Delcers, Latex  
 FMC Gland Water Pumps

Phone: 724-225-1995  
 Email: [deltaps@earthlink.net](mailto:deltaps@earthlink.net)



HOW SIMPLE THREAD CAN BECOME THE FABRIC OF A NATION.

CELEBRATING MORE THAN 125 YEARS.



1-800-RED CROSS  
[WWW.REDCROSS.ORG](http://WWW.REDCROSS.ORG)

**FOR ADVERTISING, CONTACT YOUR INTERNATIONAL SALES REPRESENTATIVE:**

**Midwest/Eastern U.S. & Canada**  
 Craig Scharf  
 Tel: +1 904-721-2925 ext. 106  
[cscharf@mining-media.com](mailto:cscharf@mining-media.com)

**Western U.S., Canada & Australia**  
 Frank Strazzulla  
 Tel: +1 949-459-1767  
[fstrazzulla@mining-media.com](mailto:fstrazzulla@mining-media.com)

**Germany, Austria & Switzerland**  
 Gerd D. Strasmann  
 Tel: +49 202 28 14 64 83  
[info@strasmann-media.de](mailto:info@strasmann-media.de)

**Scandinavia, U.K. & European**  
 Colm Barry  
 Tel: +46 (0) 736 334670  
[colm.barry@womp-int.com](mailto:colm.barry@womp-int.com)

**Japan**  
 Masao Ishiguro  
 Tel: +81 (3) 3719-0775  
[ma.ishiguro@w9.dion.ne.jp](mailto:ma.ishiguro@w9.dion.ne.jp)

**MININGMEDIA INTERNATIONAL**



Consulting services from exploration through to mine closure

**Engineering Expertise for Potash Projects Worldwide**

Schlumpberger Inc offers productivity solutions, project and outage management, and feasibility study reviews of evaporite deposits.

Contact: [michael@schlumpberger.com](mailto:michael@schlumpberger.com)



**YOUR CLASSIFIED AD HERE**

**1 column x 2" space**  
**Color: \$340**  
**Black & White: \$240**

**CONTACT YOUR SALES REP TO BOOK A SPACE TODAY**



Altaeros.....	39	Leitner S.p.A.....	61
Autonomous Solutions Inc (ASI).....	41	Midwest Industrial Supply Inc.....	37
<i>E&amp;MJ</i> 2021 Editorial Calendar.....	3	Mining Media Int'l - Mining Magazines.....	79
<i>E&amp;MJ</i> Website.....	59	Mining Media Int'l - Social Media.....	87
Epiroc.....	9	Normet.....	51
FLSmidth.....	17	Phillips 66.....	5
GIW Industries Inc.....	45	Red Valve Co Inc.....	13
Haulage & Loading 2021.....	67-70	Schurco Slurry.....	49
Hermann Paus Maschinenfabrik GmbH.....	47	SIEMAG TECBERG.....	93
Hilliard Corp.....	53	Superior Industries Inc.....	81
Hitachi Construction Machinery Co Ltd.....	BC	Terelion LLC.....	IBC
Innovative Wireless Technologies (IWT).....	35	Tsurumi Manufacturing Co Ltd.....	57
Jennmar Corp.....	25	US Coal Show/Longwall Edition 2021.....	38
Komatsu – Japan.....	IFC	World Mining Equipment (WME).....	95
Komatsu Mining Corp USA.....	29		

## World Mining Equipment

The online directory of equipment, products and services for the global mining industry



### The World Mining Equipment Directory:

- ✓ Search by product.
- ✓ Search by company.
- ✓ Cross reference with country.
- ✓ Live links to suppliers.

Have you seen the mining industry's  
**VIDEO HUB?**

**wme.com**

MINING media EUROPE

# Metal Prices Finish Strong

By Steve Fiscor, Editor-in-Chief

As the world says good riddance to 2020, it's worth noting that metal prices were looking like they would finish the year on a high note. With the exception of gold and cobalt, which were down 2.2% and 1.6%, respectively, all of the other metals tracked in the *E&MJ* Price Index increased during November. Gold has declined from its August highs of more than \$2,000 per ounce (oz) to \$1,838.10/oz on December 4, but the yellow metal started the year at \$1,538.50/oz.

Of the precious metals, platinum made the largest gain in November, climbing more than 25% to \$1,075/oz. Platinum has not sold above \$1,000 for a while. Palladium prices are steadily heading back toward the heady March highs of \$2,500/oz. Increased demand and the converter repair issues with Amplats in South Africa are having a pronounced impact on prices for platinum group metals.

Prices for base metals were also higher across the board. Copper, lead and aluminum were up 15.8%, 13.6% and 10.8%, respectively, on a month-to-month basis.

Year-to-date (YTD) Metal Prices (Dec. 4, 2020)	YTD Metal Prices		Monthly Difference		YTD		
	Dec-20	Nov-20			Jan-20	Difference	
Gold (\$/oz)	\$1,838.10	\$1,878.60	-\$40.50	-2.2%	\$1,538.30	\$299.80	19.5%
Silver (\$/oz)	\$24.16	\$23.64	\$0.52	2.2%	\$18.09	\$6.07	33.6%
Platinum (\$/oz)	\$1,075.00	\$858.00	\$217.00	25.3%	\$987.00	\$88.00	8.9%
Palladium (\$/oz)	\$2,391.00	\$2,240.00	\$151.00	6.7%	\$1,949.00	\$442.00	22.7%
Rhodium (\$/oz)	\$16,200.00	\$13,400.00	\$2,800.00	20.9%	\$6,075.00	\$10,125.00	166.7%
Ruthenium (\$/oz)	\$270.00	\$270.00	\$0.00	0.0%	\$250.00	\$20.00	8.0%
Aluminum (\$/lb)	\$0.92	\$0.83	\$0.09	10.8%	\$0.81	\$0.11	13.6%
Copper (\$/lb)	\$3.52	\$3.04	\$0.48	15.8%	\$2.80	\$0.72	25.7%
Lead (\$/lb)	\$0.92	\$0.81	\$0.11	13.6%	\$0.87	\$0.05	5.7%
Nickel (\$/lb)	\$7.28	\$6.93	\$0.35	5.1%	\$6.40	\$0.88	13.8%
Tin (\$/lb)	\$8.66	\$8.02	\$0.64	8.0%	\$7.80	\$0.86	11.0%
Zinc (\$/lb)	\$1.25	\$1.15	\$0.10	8.7%	\$1.05	\$0.20	19.0%
Molybdenum (\$/lb)	\$9.13	\$7.84	\$1.29	16.5%	\$9.20	-\$0.07	-0.8%
Cobalt (\$/lb)	\$14.54	\$14.77	-\$0.23	-1.6%	\$14.77	-\$0.23	-1.6%
Iron ore (\$/dmt)	\$141.53	\$120.19	\$21.34	17.8%	\$93.17	\$48.36	51.9%

The prices for several metals made considerable gains in 2020.

Copper prices are up \$0.72/lb for the year and most of that increase (nearly \$0.50/lb) came during November. Lead basically recovered ground it had lost throughout the year, while aluminum is up 13.6% for the year or \$0.11/lb. The year-to-date comparison also shows that zinc, nickel and tin are up 19%, 13.8% and 11%, respectively. As far as commodity markets are concerned, these metals, especially copper, are considered leading indicators and these prices are indicating a global recovery.

Iron ore prices were also on the move during November. When Vale lowered its guidance for 2020, spot prices for iron ore moved higher immediately. During November, iron ore prices climbed more than \$21 per dry metric ton (dmt) to \$141.53/dmt. Iron ore started the year at \$93.17/dmt and has increased by nearly \$50/dmt (51.9%). While some will say that these prices are unsustainable, Port Hedland, Western Australia's iron ore export hub, was preparing for a hurricane as this edition was going to press.

## E&MJ PRICES INDEX

(December 4, 2020)

Precious Metals (\$/oz)		Base Metals (\$/mt)		Minor Metals (\$/mt)		Exchange Rates (U.S.\$ Equivalent)	
Gold	\$1,838.10	Aluminum	\$2,027.50	Molybdenum	\$20,090	Euro (€)	1.214
Silver	\$24.16	Copper	\$7,741.50	Cobalt	\$31,980	U.K. (£)	1.348
Platinum	\$1,075.00	Lead	\$2,026.50	Iron Ore (\$/dmt)		Canada (\$)	0.781
Palladium	\$2,391.00	Nickel	\$16,020.00			Australia (\$)	0.744
Rhodium	\$16,200.00	Tin	\$19,060.00	Fe CFR China	\$141.53	South Africa (Rand)	0.066
Ruthenium	\$270.00	Zinc	\$2,748.50			China (¥)	0.153

Gold and silver prices provided by KITCO Bullion dealers ([www.kitco.com](http://www.kitco.com)). Platinum group metals prices provided by Johnson Matthey ([www.platinum.matthey.com](http://www.platinum.matthey.com)). Non-ferrous base and minor metal prices provided by London Metal Exchange ([www.lme.co.uk](http://www.lme.co.uk)). Iron ore prices provided by Platts Iron Ore Index. Currency exchange rates were provided by [www.xe.com](http://www.xe.com).



# SAME HIGH- QUALITY DRILL BITS. NEW NAME.

Since October 23, 2020, Varel Mining & Industrial is re-named to Terelion. Our rotary drill bits remain unchanged, with the same high quality. New name, new logotype for Varel's mining and industrial business, that's all.

Find out more at [www.terelion.com](http://www.terelion.com)



**HITACHI**

Reliable solutions

# HARNESS THE POWER OF AN UNRIVALLED PARTNERSHIP



Notes: Models shown may include optional equipment. Available models may vary by region or country. Materials and specifications are subject to change without notice. Photo situation is promotional style.

## THE HITACHI EH5000AC-3 MINING TRUCK AND EX8000-6 BACKHOE EXCAVATOR

Setting the highest standard of mining excellence with Hitachi's ultra-class hydraulic excavators and electric drive mining trucks engineered to maximise the productivity of mining operations. The latest low emission engines with both Cummins and MTU engine options in trucks, matched to the excavators more efficient hydraulic system performance.

Our flagship duo delivers mine sites with the best load and haul fleet performance for the lowest cost on the market, the most powerful combination yet.

 **Hitachi Construction Machinery Co., Ltd.**