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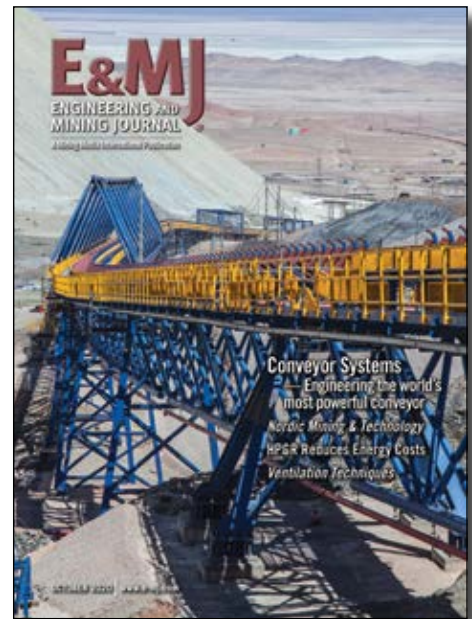
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This month, E&M reports on recent developments with conveyor systems. On the cover, an 11,000-mt/h capacity overland conveyor carries ore from the Chuquicamata Underground Project to a mineral processing facility 5 km away. It is a large, powerful conveyor, but not the most powerful conveyor on this project. (Photo: Codelco)

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

## Musk Charges Forward With Battery Development

Tesla's Battery Day event fell flat, according to the mainstream press. The truth is that Elon Musk unveiled new battery technology and discussed the hurdles the company's scientists face. Instead of wowing the audience with next-generation vehicles, the session was a science lesson about battery manufacturing and the mainstream press has a limited attention span when it comes to science, math and facts. Tesla is planning to improve battery design, reduce costs and produce a passenger car that would sell for \$25,000, but they offered little in the way of a timeline.

Musk described the company's plans for a tabless cell, which would be much larger than the current cell. It would increase the amount of energy storage by five times, reduce resistance and lower heat generation. Probably the biggest surprise was his announcement regarding the development of silicon anode technology. Saying that silicon stores nine times more lithium than graphite, Musk discussed silicon-oxide-based solutions and said he expected it to dominate the market for the next seven years. Tesla believes that silicon anodes could increase the vehicle's driving range by 20% and lower costs by 5%. Musk said it could take three years to fully realize large battery-cost reductions.

Several new initiatives from Tesla could bring battery chemicals production back to North America.

The first was the development of a North American cathode facility, which would give the company greater control over raw materials and allow it to reduce the carbon footprint of battery production.

Tesla also mentioned it may move upstream into mine production. The company has acquired a lithium deposit in Nevada and it claims to have developed a novel lithium extraction method. It also recently signed a deal with Piedmont Lithium (See Leading Developments, p. 5).

As *E&MJ* has mentioned in the past, the term lithium-ion is a bit of a misnomer. The actual amount of lithium in the cell is quite low. The cell should be called a nickel-graphite cell, and the more nickel, the higher the energy density of the battery. The Tesla Model 3 contains about 30 kg of nickel. Musk talked about his options for nickel and he has been quite vocal about his nickel needs this year.

Nickel is primarily used to produce stainless steel and nickel prices have not really recovered from a collapse in 2007. No new major mines have been developed since and, with the lead time for mine development standing at seven to 10 years, no new sources will likely be developed any time soon. This would be a great opportunity for Musk to roll up his sleeves and buy an idled nickel mine or a nickel mining company and lead the world with eco-friendly natural resource development.

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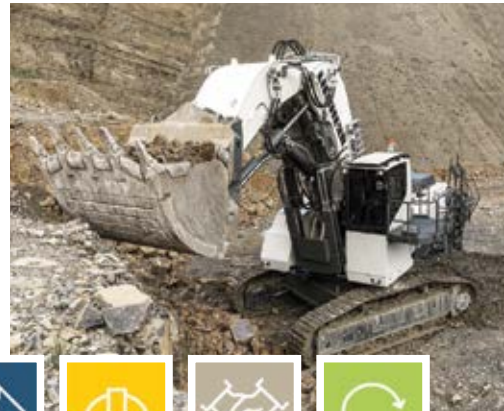
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# LIEBHERR

# Pebble Partnership CEO Resigns

By Jennifer Jensen, Associate Editor

The CEO of the Pebble Limited Partnership has stepped down after an environmental group released tapes that show him making comments about his close relationship with elected and regulatory officials in Alaska.

Tom Collier submitted a resignation letter to parent company, Northern Dynasty Minerals Ltd., which said his comments “embellished both his and Pebble Partnership’s relationships with elected officials and federal representatives in Alaska, including Gov. Dunleavy, Sens. [Lisa] Murkowski and [Dan] Sullivan and senior representatives of the U.S. Army Corps of Engineers.”

The videos, which were secretly recorded by individuals posing as investors, were released by the Environmental Investigation Agency and contain conversations with Collier and others with Northern Dynasty President and CEO Ron Thiessen.

In the videos, Collier described the governor as a friend and that he has had private dinners with him in his mansion in Juneau. “Like I said, we talk on a regular basis,” he said. He also said the governor’s chief of staff, Ben Stevens, served on the Pebble Advisory Committee prior to the governor taking office.

Thiessen also described easy access to the White House. “We can talk to the chief of staff of the White House any time we want,” he said.

Comments were also made describing relationships with Murkowski and Sullivan and what both men believed to be support from them regarding the project. Thiessen also discussed Murkowski’s father, a former governor, who accompanied him and others to meet with Rio Tinto, BHP and Anglo American to invite them in on the project.

Collier said Murkowski sits on the fence regarding the issue. “She threw a bone to those constituents that are against us in the committee report but when it really mattered she didn’t do anything,” he added.

Regarding Sullivan, Collier said Pebble Mines Corp. Chairman John Shively rents an apartment from Sullivan’s state director. “And the two of them have worked together for 20 years so John



Tom Collier, CEO of Pebble, and others are secretly recorded by individuals posing as investors. (Photo: Alaska Daily News)

knows her well and talks to her regularly,” he said. He added that Shively has been told Sullivan is “gonna try to ride out the election and remain quiet.”

Northern Dynasty said the comments were “clearly offensive” to the political leaders mentioned, as well as other political, business and community leaders in Alaska.

In addition to comments about their relationships with political and regulatory officials, several comments were made regarding the size of the Pebble project and possibility of expansion.

Thiessen said the two actors posing as foreign investors on behalf of the Environmental Investigation Agency were trying to entrap the two executives into stating there is a defined plan to expand Pebble beyond the 20-year mine life currently being permitted. In this objective, he said, they failed.

“The mine development proposal currently being evaluated by the USACE, and for which we expect a final record of decision this fall, provides for 20 years of mining at an average daily throughput of 180,000 tons, and processing of 1.3 billion tons of mineralized material,” Thiessen said. “What we have said consistently, and is reinforced in the ‘Pebble tapes’ released this week, is the operator of the Pebble mine may decide at some point in the future to propose additional phases of development, but there exists no formal plan to do so today.”

Thiessen added that any extension or expansion of the Pebble Project proposed in future would have to go through a comprehensive, multiyear federal and state permitting process.

“The unethical manner in which these tapes were acquired does not excuse the comments that were made or the crass way they were expressed,” Thiessen said. “On behalf of the company and our employees, I offer my unreserved apology to all those who were hurt or offended, and all Alaskans.”

The company named former Pebble Partnership CEO Shively, who most recently served as chairman of the Pebble Partnership’s general partner, Pebble Mines Corp., as interim CEO pending a leadership search.

“My priority is to advance our current plan through the regulatory process so we can prove to the state’s political leaders, regulatory officials and all Alaskans that we can meet the very high environmental standards expected of us,” Shively said.

In July, the U.S. Army Corps of Engineers issued a final Environmental Impact Statement for Alaska’s Pebble Project. Northern Dynasty said it expects to receive a final Record of Decision this fall.

## Barrick Accepts Closure of Pascua-Lama Project

Barrick Gold Corp. has accepted the Antofagasta Environmental Court’s decision to uphold the closure order and sanctions

Chile's environmental regulator imposed on Compañía Minera Nevada, the Barrick subsidiary that holds the Chilean portion (Pascua) of the Pascua-Lama project. The court said Barrick failed to implement certain measures to comply with its environmental license.

Barrick suspended construction at the project in 2013 due to environmental issues, opposition and development costs. Now, Pascua will be transitioned from care and maintenance to closure, in accordance with the Environmental Court's decision.

Barrick said it would not appeal the decision.

Following the ruling, Barrick Executive Director for Chile and Argentina Marcelo Álvarez said Pascua-Lama remained an important project and work is already under way to re-evaluate its potential. This involves a comprehensive internal review of its technical, economic and social aspects as well as different approaches to permitting and development should the ongoing studies deliver a project that meets Barrick's investment filters. He confirmed that any new project development would comply with current legislation in both Chile and Argentina.

"Barrick is a very different company since its merger with Randgold and we now have a strong focus on establishing good relations with the communities and authorities," he said.

He added that Barrick is committed to investment in Chile and Argentina.

While the project was suspended, Pascua-Lama continued to treat and monitor water quality in order to meet its environmental commitments, according to Barrick. In 2014, Chile environmental officials fined Barrick \$16 million over noncompliance regulatory requirements. The Environmental Court acknowledged that none of the earlier infringements that prompted the closure order had caused irreparable damage.

## Piedmont Signs Lithium Supply Agreement With Tesla

Piedmont Lithium Ltd. has entered into a binding agreement with Tesla Inc. for the supply of spodumene concentrate (SC<sub>6</sub>) from its North Carolina operations. The agreement is for an initial five-year term on a fixed-price binding purchase commitment from the delivery of the first product, and may be extended for a second five-year term.

## Rio Tinto Executives Step Down Over Destruction of Heritage Sites

Rio Tinto Executive Director and Chief Executive Jean-Sébastien Jacques will leave the company following backlash after the company's destruction of heritage sites, Juukan rock shelters in Western Australia, in May. Stakeholders expressed concern about holding those in charge accountable to be able to move forward with the Puutu Kunti Kurrama and Pinikura (PKKP) people.

"What happened at Juukan was wrong and we are determined to ensure that the destruction of a heritage site of such exceptional archaeological and cultural significance never occurs again at a Rio Tinto operation," Rio Tinto Chairman Simon Thompson said. "We are also determined to regain the trust of the Puutu Kunti Kurrama and Pinikura people and other traditional owners."

A process to identify Jacques' successor is under way. He will remain in his role until the appointment of his successor or March 31, 2021, whichever is earlier.

Jacques was not the only executive to step down. Iron Ore Chief Executive Chris Salisbury will leave the company on December 31. He will be replaced by Ivan Vella, managing director for rail, port and core services within Rio Tinto Iron Ore, on an interim basis. Corporate Relations Group Executive Simone Niven will also step down on December 31.

As previously announced, Rio Tinto said it is establishing a new social performance assurance function, reporting to Mark Davies, group executive, HSE, technical and projects, to strengthen oversight of communities and heritage practices and performance within the operations.

Simon McKeon, non-executive director, has been appointed senior independent director, Rio Tinto Ltd. This newly created role will complement the existing senior independent director role, which will continue to be performed by Sam Laidlaw for Rio Tinto plc.

"We are determined to learn the lessons from Juukan and to re-establish our reputation as a leader in communities and heritage management," Thompson said.

The Juukan 1 and Juukan 2 rock shelters, dated with evidence of human occupation over 46,000 years ago, were damaged during a blast on May 23 as part of the expansion of Rio Tinto's Brockman 4 iron ore mine. Rio Tinto said a formal request to cease mining activities at the rock shelters



Jean-Sébastien Jacques.

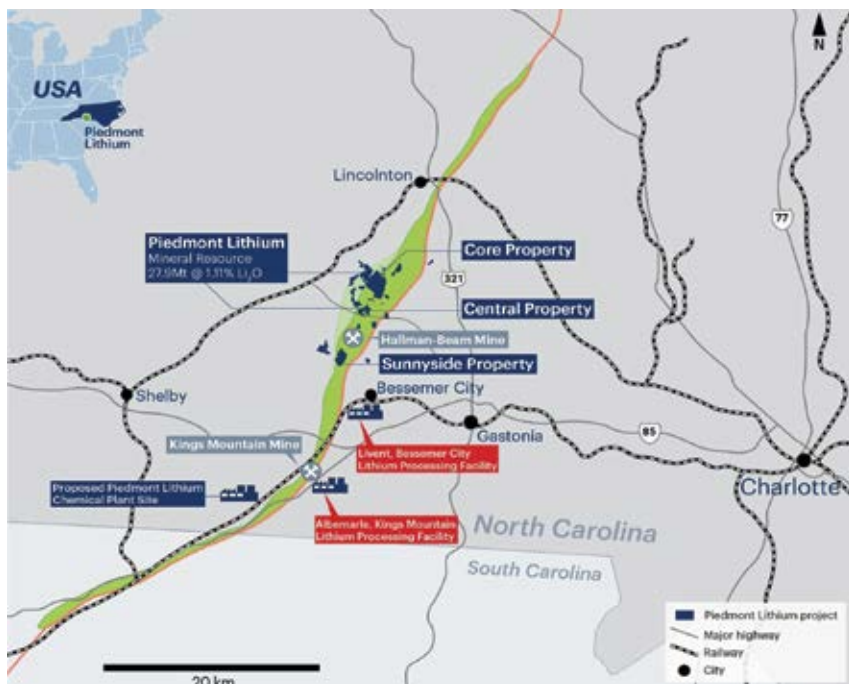
was received from the PKKP in May 2020, but it was too late. The company had drilled 382 blast holes and loaded them with explosives and an independent expert said the blast holes could not be safely unloaded.

During 2012 and 2013, Rio Tinto progressed its plans for Brockman 4, Pit 1 in the Juukan Gorge area and four pit options were considered. The option that impacted the rock shelters in order to access higher volumes of high-grade ore was the one chosen by Rio Tinto. In 2013, Rio Tinto said it received consent to impact the rock shelters and the PKKP were informed of this. A further ethnographic survey was conducted in 2013 and three excavations of the Juukan rock shelters were conducted in 2014 to ensure the salvage, analysis and ex situ preservation of the cultural heritage material contained within the rock shelters. As a result, new information on the significance of the Juukan rock shelters became available.

Puutu Kunti Kurrama Land Committee Chair John Ashburton said the 2014 excavation, staged in three short trips, uncovered artifacts of extreme importance and put the area among the most significant research sites in the Australia.

"There are less than a handful of known Aboriginal sites in Australia that are as old as this one and we know from archaeological studies that it is one of the earliest occupied locations not only on the western Hamersley Plateau, but also in the Pilbara and nationally," Ashburton said. "Its importance cannot be underestimated."

The company admitted that opportunities were missed to re-evaluate the mine plan in light of the new information and even more opportunities were missed to "pause and reflect" on whether the rock shelters should be preserved.



Piedmont controls a significant lithium deposit located in the Carolina tin-spodumene belt near modern infrastructure and Charlotte, North Carolina, USA.

Piedmont controls approximately 28 million metric tons (mt) grading 1.11% lithium oxide ( $\text{Li}_2\text{O}$ ) located in the Carolina tin-spodumene belt that hosted the Hallman Beam and Kings Mountain mines.

The Piedmont's commitment to Tesla represents approximately one-third of Piedmont's planned  $\text{SC}_6$  production of 160,000 mt per year (mt/y) for the initial five-year term. Sales are expected to generate between 10%-20% of Piedmont's total revenues from its proposed integrated mine-to-hydroxide project for the five-year term.

The agreement is conditional upon Tesla and Piedmont have agreed to a tentative start date for spodumene concentrate deliveries between July 2022 and July 2023 based on the development schedules of both parties.

"We are excited to be working with Tesla, which represents the start of the first U.S. domestic lithium supply chain and a disruption to the current value chain," Piedmont President and CEO Keith D. Phillips said. "The agreement highlights the strategic importance of Piedmont's unique American spodumene deposit and confirms the trend toward spodumene as the preferred feedstock for the lithium hydroxide required in high-nickel batteries."

Phillips said Piedmont will now accelerate its mine/concentrator development to support Tesla's plans, work to further ex-

panding its mineral resources, and potentially increase its planned annual spodumene concentrate production capacity.

"We will simultaneously advance our plans to produce lithium hydroxide in North Carolina, using a combination of internally produced spodumene concentrate as well as material sourced from other producers around the world," Phillips said.

## Newmont Sells Gold Royalty Portfolio for \$90M

Newmont Corp. has entered into an agreement with Maverix Metals Inc. to sell a portfolio of 11 royalties. Newmont will receive total consideration of approximately \$90 million from Maverix, consisting of \$15 million in cash, 12 million Maverix common shares, and up to \$15 million in contingent cash payments payable upon completion of certain milestones.

The royalties provide exposure to five flagship gold assets owned and operated by growth-oriented mining companies. The portfolio includes royalties on Camino Rojo and Ana Paula in Mexico, Cerro Blanco in Guatemala, and Mother Lode and Imperial in the United States.

Newmont's ownership interest in Maverix will increase from 26% to approximately 32% after the closing of the transaction, which is expected to close in the fourth quarter of 2020.

Maverix's diversified portfolio includes more than 100 royalties and streams across 18 countries, with assets predominately located in Australia the Americas and Mexico.

"This transaction further strengthens our strategic partnership with Maverix," Newmont President and CEO Tom Palmer said.

## Cleveland-Cliffs Acquire ArcelorMittal USA

Cleveland-Cliffs Inc. announced today that it will acquire substantially all of ArcelorMittal USA's operations and its subsidiaries for \$1.4 billion. Upon closing, Cleveland-Cliffs will be the largest flat-rolled steel producer in North America, with combined shipments of approximately 17 million net tons in 2019. The company will also be the largest iron ore pellet producer in North America, with 28 million long tons of annual capacity.

In 2018 and 2019, ArcelorMittal USA averaged annual revenues of approximately \$10.4 billion and annual adjusted EBITDA of approximately \$700 million. The assets acquired include six steelmaking facilities, eight finishing facilities, two iron ore mining and pelletizing operations, and three coal and coke making operations.

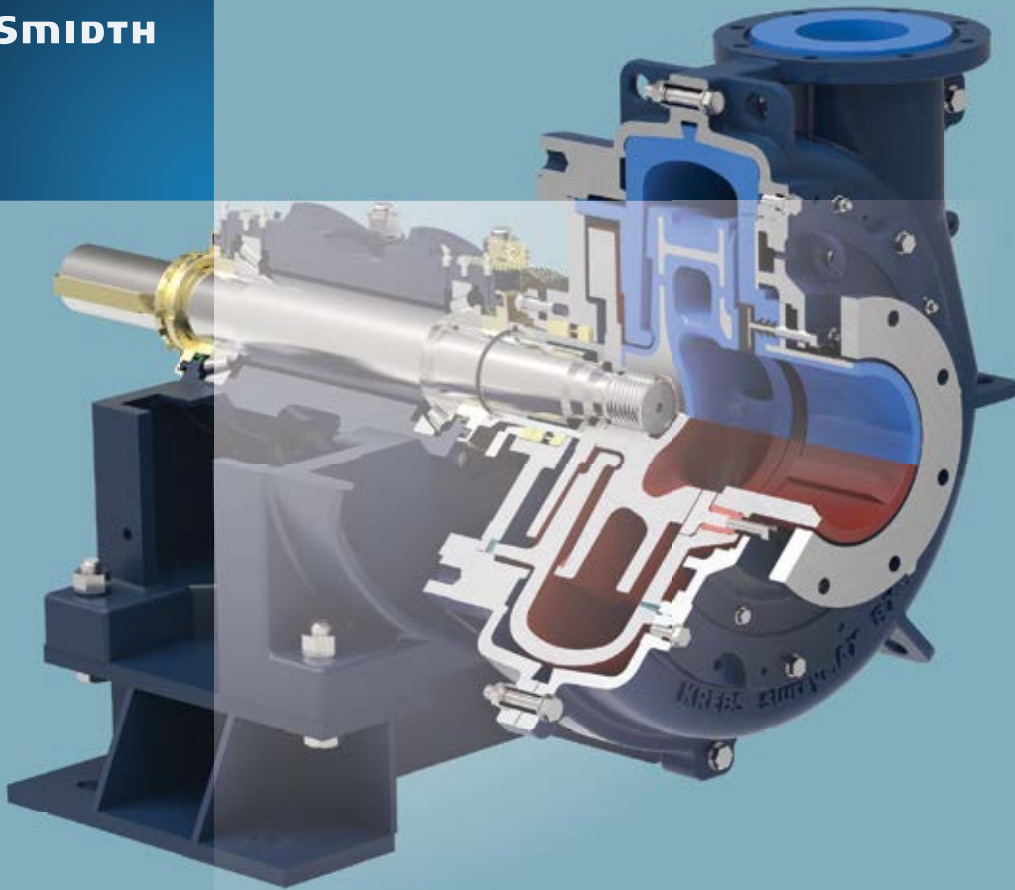
"Steelmaking is a business where production volume, operational diversification, dilution of fixed costs, and technical expertise matter above all else, and this transaction achieves all of these," said Lourenco Goncalves, chairman, president and CEO of Cleveland-Cliffs. "ArcelorMittal is a world class organization that we have long admired as our customer and our partner, and we know for a fact that they have taken good care of their US assets."

The six steel mill included in the transaction are: Indiana Harbor, Burns Harbor, Cleveland, Coatesville, Steelton, and Riverdale. The iron ore mining and pelletizing operations include: the Hibbing JV (ArcelorMittal USA's 62.3% interest) and Minorca. The metallurgical coal and coke making facilities include: Monessen, Princeton, and Warren.

Goncalves said he looks forward to welcoming the ArcelorMittal USA team into the Cliffs organization. "We are creating an exceptional company, based on great people and supported by our existing strong relationship with the Unit-

*(Continued on p. 22)*





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# Equinox Gold Completes Construction of Phase 1 Castle Mountain Mine

Equinox Gold Corp. reported that construction of the phase 1 mine at its Castle Mountain gold mine in California is complete, irrigation of the leach pad is under way and first gold pour is expected in the fourth quarter of 2020.

Equinox Gold commenced construction of the phase 1 mine at Castle Mountain on October 30, 2019. Construction was completed with no lost-time incidents. Pre-production mining began in early June and has stacked more than 1.4 million metric tons (mt) of ore on the leach pad to date.

Commissioning of the plant is in the final stages and irrigation of the leach pad commenced on September 16. Loaded carbon from Castle Mountain will be processed in the carbon stripping and smelting plant at the Mesquite mine, 200 miles south in California, resulting in increased operating efficiencies for both mines.

“Castle Mountain will be Equinox Gold’s seventh-producing gold mine in the Americas and our second operating mine in California,” CEO Christian Milau said. “We expect Castle Mountain to be a long-life flagship asset for Equinox Gold, bringing significant benefits to our workforce, shareholders, local communities and San Bernardino County.”

The 100% owned Castle Mountain Phase 1 mine is a fully permitted, run-of-mine heap leach operation processing around 12,700 ore mt per day. Phase 1 is expected to produce on average 45,000 ounces (oz) of gold annually. The company is completing a feasibility study for the potential Phase 2 expansion, which is expected to average 200,000 oz of gold annually. The phase 2 feasibility study is targeted for completion in fourth quarter 2020.

## Magellan Reopens Portals at Center Star Mine in Idaho

Magellan Gold Corp. has reopened the main and emergency access portals of the Center Star gold mine in Idaho. The company said it is now working on additional mine stabilization to ensure worker safety, and subsequently develop an exploration plan for drilling and sampling.



New barren and pregnant solution tanks sit in a containment area (foreground), while construction is completed on the carbon-in-leach plant (left).

Since acquiring the Center Star project, which hosts high-grade gold mineralization that was discovered in the early 1900s, in July 2020, Magellan has acquired additional unpatented mining claims adding 320 acres of land to increase its holding to 620 acres along the Center Star gold trend.

“Given its historical production, we strongly believe in the potential for this project,” Magellan President Mike Lavigne said. “As such, reopening the mine’s portals to understand its underground workings is an important milestone in our progression, and one that would define our future development and strategic direction.”

Gold mineralization at Center Star is hosted in multiple, parallel steeply dipping quartz veins in a banded gneiss. The gold occurs in high grade veins that trend north-easterly and dip steeply to the southeast. These veins are present in a 75- and 100-ft wide sheer zone hosting quartz veins and breccia. No exploration or development work has been conducted at Center Star for 35 years.

Magellan is focused on the exploration and development of precious metals in North America. In addition to the Center Star mine, it also currently controls the Silver District property in Arizona.

## Northern Vertex Hooks Moss Mine Up With Grid Power

Northern Vertex Mining Corp. has completed its 6.9-mile electrical powerline project. The system was energized on September 9 and the diesel generator bank shut down on September 10. The Moss gold and silver mine in Arizona is now linked to the Mojave Electric power grid, and the company said it is now beginning to realize numerous benefits, which include reducing electrical costs from approximately \$0.31 per kilowatt-hour (kwh) to a grid system cost \$0.08/kwh.

The move also eliminated the operational and maintenance cost of operating the diesel gensets, which attribute a savings of \$15 million to \$20 million over the life of mine. All of this translates into a \$50/oz all-in sustaining cost savings, the company said.

“The completion of the powerline and successful connection to the electrical grid further reduces our operating costs, improves reliability, and is a demonstration of Northern Vertex’s commitment to sustainability by reducing our carbon footprint,” Northern Vertex President and CEO Ken Berry said. “Furthermore, the company will continue with several cost savings initiatives

that include the successful transition to McCoy and Sons as our dedicated mining contractor; the completion of the Intermediate Leach System to accelerate gold recoveries; and our ongoing exploration success of recent drilling to establish the Moss mine as a highly profitable, long-life operation.”

## CK Gold Moves to Prefeasibility Stage

A prefeasibility study at U.S. Gold Corp.’s CK Gold project near Cheyenne, Wyoming, is under way with permits in place to conduct the follow-up drilling program. Drilling at the former Copper King project is aimed at gathering fresh mineral samples for metallurgical tests and convert previously reported inferred resources to measured and indicated and extend the resource to the southeast.

As previously reported, flotation concentrate from sulphide and mixed sulphide sample composites for the project contained 26% copper and 89 grams per ton (g/t) gold with little or no deleterious elements contained for later smelting. Fresh samples should allow flotation recoveries, already reported as averaging 72.5% gold and 81.5% copper across the resources, to be optimized, the company said.

Drilling is expected to conclude sometime in October, when a resource update is intended to be completed encompassing the new data and a complete re-evaluation of the existing core, which is now largely completed. The relogging exercise of the existing core under the supervision of geologic specialists reveals new textures to assist with assessing gold and copper deposition, and the presence of native copper, which could have impacted metallurgical recovery in prior test work, the company said.

George Bee, recently appointed president of U.S. Gold Corp., conducted his own due diligence exercise with specific focus on the CK Gold asset.

“Given the current market conditions with gold prices rising substantially and crossing the \$2,000 mark, our PEA and internal estimates published in March 2020 are now very conservative,” Bee said. “Furthermore, not only does potential development come at a time when the coal, uranium, and the oil and gas businesses in Wyoming are facing challenges from depressed prices, there ap-

pears to be many synergies and positive aspects for the project as a consequence of its location.”

Bee said the CK Gold project is a “rare opportunity whose time has come.”

## Court Finds in Favor of PolyMet

A Ramsey County District Court judge found the Minnesota Pollution Control Agency (MPCA) did not engage in any procedural irregularities in connection with the processing of the National Pollutant Discharge Elimination System (NPDES) permit for the NorthMet copper-nickel-precious metals project, according to Poly Met Mining Inc., a subsidiary of PolyMet Mining Corp.

In his decision, Judge John H. Guthmann rejected the allegations that the MPCA engaged in a systematic effort to keep evidence out of the administrative record.

Guthmann found no evidence that the MPCA attempted to suppress the Environmental Protection Agency (EPA) comments.”

The court found that MPCA’s effort to reach an agreement with the EPA to delay making written comments on a draft NorthMet NPDES permit until sometime after the public notice period did not constitute a procedural irregularity. The court concluded the MPCA exceeded the requirements of the Memorandum of Agreement between the EPA and MPCA.

The district court’s conclusion that no procedural irregularities occurred in the processing of PolyMet’s permit will be incorporated into the broader challenge to that permit currently pending before the court of appeals, according to PolyMet.

## Midland Enters Nickel Exploration Funding Alliance With BHP in Quebec

Midland Exploration Inc. executed an alliance agreement between Midland, its wholly-owned subsidiary, Midland Base Metals Inc., and Rio Algom Ltd., a subsidiary of BHP. The alliance’s main objective is to identify, test and develop high-quality exploration targets to find new significant nickel deposits within the Nunavik territory, Quebec. The new alliance’s initial funding will be provided by BHP.

BHP and Midland are combining their efforts by forming a technical steering committee and pooling their large histor-

ical databases, including geological, geophysical and geochemical data.

During the first phase of the alliance, BHP will fund at 100%, up to C\$1.4 million on an annual basis for a minimum of two years. Midland will act as operator.

The main objective is to generate, identify and secure exploration projects to be advanced to a drill-ready stage through further exploration work. BHP may propose additional exploration work for up to C\$700,000 before advancing an identified project to the second phase.

Following the first phase, one or more specific exploration targets may be advanced to a second phase to be further developed as a separate designated project. Each designated project will have its own work program and budget to test and further develop the identified targets, mainly through drilling. Midland will act as operator during the testing phase, subject to BHP’s right to become the operator of any designated project.

For each designated project, the testing phase will last up to four years, with a total budget of up to C\$4 million with a minimum of C\$700,000 to be spent during the first year.

During this second phase, BHP and Midland will fund 75% and 25%, respectively, for approved work programs. For each designated project, BHP will pay Midland a designated project fee: C\$250,000 on or before the first anniversary, C\$250,000 on or before the second anniversary and C\$500,000 on or before the third anniversary, of the testing phase, for a maximum of C\$1 million per designated project.

BHP has the right to cease contributing its share of the funding of a designated project in which case Midland would have the right to retain a 100% interest of the designated project and BHP would receive a net smelter returns royalty interest.

BHP may decide to advance any designated project to the third phase as a (70/30, BHP: Midland) joint-venture project. Both parties would contribute to the expenses pro-rata to their participating interests. BHP would be the operator for all JV projects. For each JV project, BHP will pay to Midland a joint venture success fee of C\$200,000 after the formation of the JV. If a party’s participating interest in the JV is diluted below 10%, the interest would be converted into a net smelter returns royalty interest.



Alejandro Vázquez



Justine Fisher

*Teck Resources Ltd.* appointed **Alejandro Vázquez** as vice president, South America, following the retirement of **Chris Dechert**. Vázquez joins Teck from BHP, where he was asset president, Pampa Norte, with responsibility for its Spence and Cerro Colorado operations. **Justine Fisher** has been appointed vice president and treasurer, following the retirement of **Scott Wilson**. Fisher joins Teck from Goldman Sachs in New York, where she was a credit and commodities research analyst. **Amber Johnston-Billings** has been appointed vice president, communities, government affairs and HSEC Systems, effective October 12, following the retirement of



Amber Johnston-Billings



Jeff Hanman

**Mark Edwards**. Johnston-Billings joined Teck from Trevali Mining Corp., where she was the chief sustainability officer. **Jeff Hanman** has been appointed to the new position of vice president, office, of the CEO. Hanman joined Teck in April 2011, and most recently held the position of vice president, corporate affairs. **Doug Brown** has been appointed vice president, corporate affairs, following Hanman's role transition. Brown joined Teck in August 2011, and most recently held the position of director, public affairs.



Doug Brown

*Endeavour Silver Corp.* appointed **Donald "Don" Gray** as its new COO. **Godfrey Walton**, COO since the founding of the company, will retire at year-end and retains the role of president until then. Most recently, Gray was COO of Continental Gold Inc.



Donald "Don" Gray

*Alamos Gold Inc.* appointed **Scott R.G. Parsons** as its vice president, exploration. Parsons succeeds **Chris Rockingham** following his retirement on August 31. Parsons joined Alamos in January 2018, most recently serving as director of exploration, Canada, where he has helped oversee the exploration programs at Island Gold, Young-Davidson, and Lynn Lake.



Scott R.G. Parsons

*Trilogy Metals Inc.* appointed **Richard Gosse** as vice president of exploration, effective immediately. Previously, Gosse was the senior vice president of exploration at Dundee Precious Metals Inc.



Richard Gosse

*Compañía de Minas Buenaventura SAA* appointed **Daniel Dominguez** as CFO. Dominguez will succeed **Leandro Garcia**, who was appointed CEO on July 30, effective September 1. Most recently, Dominguez has been the supply chain manager since 2017.



Daniel Dominguez

**Lee-Anne de Bruin** has agreed to join *Perseus Mining Ltd.* as CFO. Most recently, de Bruin served as the CFO of Resolute Mining Ltd. She replaces **Elissa Brown** and will formally assume the CFO role by November 1.



Lee-Anne de Bruin

*Gold Royalty Corp.* announced **Ian Telfer** as chairman of its advisory board. Most recently, he was appointed chairman of the board for Goldcorp, a position that he held until 2019 when Goldcorp merged with Newmont Mining.



Ian Telfer

*Santa Fe Gold Corp.* appointed **Steve Antol** as CFO and corporate secretary. Antol served as the CFO of El Capitan Precious Metals Inc. from November 2004 to May 2007 and from April 2009 to March 2020. The company is currently inactive. Antol has been a consultant to Santa Fe Gold since mid-2005. Antol replaced **Frank Mueller** as CFO. Mueller became the manager of mining operations for Santa Fe Gold.

**Tom Dixon** was named the head of investor relations and media for *Newcrest*.

*KORE Mining Ltd.* appointed **Michael Tucker** as vice president of exploration. Tucker is the former exploration manager for Balmoral Resources, which was recently acquired by Wallbridge Mining Co. Two key recent additions to the team are **Frank Salazar**, manager of community and government affairs and **Betty Zataray**, manager of U.S. environmental and regulatory affairs.

*Magellan Gold Corp.* appointed **Deepak Malhotra** as director.



Thomas Anstots



Stefan Erdmann



Martti Sassi

As part of *Outo-kumpu's* strategy process, the company appointed new members to its leadership team, which include **Thomas Anstots**, executive



Niklas Wass



Tamara Weinert

vice president, commercial, business area Europe; **Stefan Erdmann**, chief technology officer; **Martti Sassi**, president, business area Ferrochrome; **Niklas Wass**, executive vice president, operations, business area Europe; and **Tamara Weinert**, acting president, business area Americas.

*Labrador Gold Corp.* appointed **Mathieu "Matt" Lapointe** as vice president of exploration, effective immediately. Most recently, Lapointe was chief geologist for TMAC Resources.



Christopher Richards

*Silver Bull Resources Inc.* appointed **Christopher Richards** as CFO, effective September 28, replacing **Sean Fallis** in that role. Prior to joining the company, Richards was the vice president of finance for Great Panther Mining Ltd.



Mitford Mundell

*Theta Gold Mines Ltd.* is pleased to advise that it has strengthened its management team with the appointment of **Mitford Mundell** as CEO, Africa, and **Jacques Du Triou** as COO, Africa.



Jesse Henson

*ABB's* Motors and Generators Division named **Jesse Henson** as president of their U.S. business. Henson, who has been with the company for 23 years, leads the team responsible for marketing, designing and manufacturing ABB and Baldor-Reliance industrial electric motors in the United States. Henson will also continue to be the global head of the NEMA motors product group. Henson started his career with Baldor Electric Co., at that time, in 1997 as part of the drives and motion control team.



Marc Cameron

*Caterpillar Inc.* appointed **Marc Cameron** a company vice president. Cameron will have responsibility for Caterpillar's Resource Industries Sales, Services and Technology Division. Most recently, he led the development and execution of the end-of-life strategy for Rio's North American legacy assets.



Jill McLeod

International law firm *Dorsey & Whitney LLP* named Corporate Partner **Jill McLeod** as head of the firm's Anchorage office effective August 24. McLeod succeeded **Mike Mills** as office head. Prior to joining Dorsey, she was in-house counsel for ConocoPhillips.

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# Capstone Considers Export Facilities



Puerto Santo Domingo, located 100 kilometers (km) from Capstone's Santo Domingo project, would become the second capesize vessel port in Chile's Region III.

Capstone Mining Corp.'s 70% owned subsidiary Minera Santo Domingo (MSD) has entered into a memorandum of understanding (MOU) with Puerto Abierto SA (PASA), a wholly owned subsidiary of Puerto Ventanas SA for Capstone's Santo Domingo project in Chile's Region III, near Copiapo. During a 90-day period, both MSD and PASA will explore mutual synergies and regional benefits for the proposed Puerto Santo Domingo, which is fully permitted and located 100 kilometers (km) from the Santo Domingo project. It would be one of only two capesize vessel ports in the region, making it an attractive site for bulk shipments and a key asset allowing for broad resource development in Region III of Chile.

MSD will allow PASA to study the project engineering and conduct a market study. PASA is looking to potentially acquire, construct, operate and maintain the deep-water port, including financing its development. Once in operation, Santo Domingo will receive preferred service as its volumes will represent a baseload of business for the port. The MOU also gives PASA 90 days to evaluate the replacement of the 110-km magnetite concentrate pipeline with a railway as part of its rail business, Ferrocarril del Pacifico SA (FEPASA). The Santo Domingo project infrastructure that is under consideration in this MOU represents approximately \$400 million of the CAPEX, including marine works and the pier; iron concentrate pipeline from Santo Domingo mine

to port; magnetite filter plant and stockpile building; copper storage building; and ship loading and support facilities.

"Over the past three months, we have seen a surge in interest in our fully permitted Santo Domingo project," Capstone President and CEO Darren Pylot said. "I believe this relationship with Puerto Ventanas will serve as a major catalyst for our Santo Domingo project."

The path forward includes the culmination of the strategic sales process, executing a gold stream agreement and arranging project debt financing, the company said.

"A partnership with PASA would simplify the Santo Domingo project as we would focus on construction and operational ramp-up of the mine site only, lowering our upfront capital requirements and allow each company to focus on their core business," Capstone Vice President of Projects Dr. Albert Garcia said.

## Gran Colombia Ramps Up Gold Production

Gran Colombia Gold produced a total of 20,644 ounces (oz) of gold in August, 14% more than the previous month.

Gran Colombia, which has several underground mines and two processing plants in operation at its Segovia and Marmato operations, reported total gold production during the first eight months of 2020 at 143,230 oz, compared to 155,359 oz in the first eight months of 2019. This reflects the impact of COVID-19 in mining operations, predom-

inantly in the second quarter of this year, the company said.

The company expects its 2020 annual production to range between 218,000 oz and 226,000 oz of gold.

## SolGold Receives \$100M From Franco-Nevada

SolGold recently completed a \$100 million royalty financing with Franco-Nevada Corp. for the Alpa copper-gold project and remainder of the Cascabel concession in northern Ecuador. The funds will be used to progress the project through to the final feasibility study and a development decision, according to the company.

In return, Franco-Nevada will receive a 1% royalty interest, calculated in reference to net smelter returns (NSR) from the Cascabel concession area. The NSR financing can be upsized by \$50 million at SolGold's election to a 1.5% NSR royalty interest on or before January 11, 2021.

The Alpa deposit is the main target in the Cascabel concession, located on the northern section of the Andean Copper Belt.

## Fortuna Irrigates Lindero Leach Pad

Fortuna Silver Mines reported that it has started irrigation of the ore placed on the heap leach pad at the Lindero gold project, located in Argentina's Salta province. The first gold pour is expected in early October.

The company also reported that construction and commissioning activities at Lindero are advancing according to plan. The ramp-up phase of the primary and secondary crushing circuits is under way. The operations team is engaged in addressing operational-related adjustments and fine tuning the process and equipment. Night shift operations started at Lindero in mid-August, ahead of schedule.

Irrigation of ore on the heap leach pad commenced on September 1. As of the end of August, a total of 277,000 metric tons (mt) have been placed on the leach pad averaging 0.87 g/mt gold, containing an estimated 7,750 ounces of gold.

Pre-commissioning of the ADR plant is progressing according to schedule. Testing of the plant circuits with water, carbon preparation, and commissioning of the main equipment is expected to begin soon.

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# Tropicana Attains Commercial Production

IGO Ltd., in conjunction with AngloGold Ashanti Australia, announced that commercial production has been declared at the Boston Shaker underground mine, the first underground mine at the Tropicana Operation (Tropicana).

The development and commissioning of the Boston Shaker underground mine has been completed on time, below budget and importantly, with no recordable safety incidents. The first production stope was fired in June, and the underground mining has now reached an annualized rate of 700,000 metric tons per year (mt/y). Ramp up to reach the design production rate of 1.1 million mt/y is expected to be achieved by March 2021. Commercial production was delivered in line with projections and below the A\$105 million capital cost estimated by the February 2019 feasibility study.

The Boston Shaker underground mine is designed to mine approximately 1.1 million mt/y of ore at an estimated grade of 3.5 g/mt gold and is expected to contribute approximately 100,000 ounces of gold production per year (oz/y) once fully ramped up.

Based on current understanding, the Boston Shaker Underground Mine life is

estimated to be seven years. The mineralized down-plunge depth extensions are planned for drill testing in fiscal year 2021 once underground drill platforms are established.

“Unlocking value at Tropicana has remained a key focus for the joint venture throughout Tropicana’s long and successful history,” IGO Managing Director and CEO Peter Bradford said. “We are confident that the success achieved at Boston Shaker will serve as a template for the potential development of additional underground mines at Tropicana over the coming years.”

The company said development of an underground drill drive from the Boston Shaker Decline is well advanced with a total of 240 meters completed to date. Underground diamond drilling is scheduled for the December quarter with a decision to mine expected during 2021.

## Construction Begins at Warrawoona Project

Calidus Resources Ltd. started construction ahead of schedule at its Warrawoona gold project in Western Australia’s Pilbara. This construction activity will provide the base infrastructure, including an access

road, accommodation village, communications and water supply in preparation for main project construction activities to commence in the first quarter of 2021.

The company has also issued preferred tenderer status to the mining and process plant EPC contractors to allow finalization of major contracts as part of the ongoing feasibility study, which should be completed this month.

The open-pit preferred tenderer is Macmahon and the EPC process plant preferred tenderer is GR Engineering. “Both of these companies have exceptional track records in the gold mining industry,” Calidus Managing Director Dave Reeves said.

The initial construction activities include a 7-kilometer (km)-long access road to a 240-room village and process plant, the installation of communications by Telstra and drilling dewatering wells. Awarding the preferred contractors also allows Calidus to facilitate Front End Engineering and Design (FEED) and place orders for the long lead items, the company said.

## Fenix Receives Key Mining Approvals

Fenix Resources is the latest iron ore explorer to move into the construction phase with its Iron Ridge direct shipping ore (DSO) project receiving Western Australia government approval.

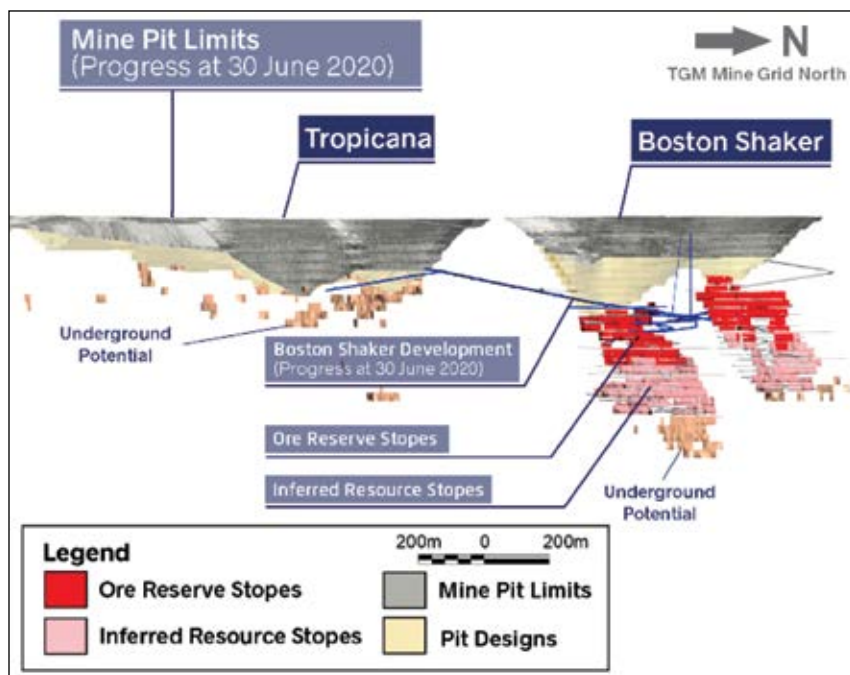
They were all set to commence works on site before the end of September, in line with the previously announced timeline to achieve first sales in early 2021, Fenix Managing Director Rob Briery said.

Fenix is proposing to ship 1.25 million metric tons per year (mt/y) of DSO iron ore from Western Australia’s Geraldton port, 490 kilometers (km) west of its Iron Ridge mine.

## New Century Will Not Proceed With Offer for Goro Mine

New Century Resources Ltd. has decided not to move forward with purchasing the 95% of issued shares in Vale Nouvelle-Calédonie SAS (VNC). VNC owns and operates the Goro nickel and cobalt mine in New Caledonia.

Back in May, the company entered into a 60-day exclusivity agreement with Vale Canada, to perform due diligence.



The Boston Shaker underground mine is designed to produce 1.1 million mt/y of ore.





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# AngloGold Ashanti Receives Approval for Sale of South African Mines

All conditions have been met regarding the sale of AngloGold Ashanti's remaining mines in South Africa to Harmony Gold Mining Co. Ltd. This includes approval by the Department of Mineral Resources and Energy (DMRE) for the transfer of the West Wits mineral rights from AngloGold Ashanti to Harmony. The transaction is expected to close on September 30, upon which Harmony will assume full ownership and operation of all assets and liabilities.

AngloGold Ashanti is well-positioned to safely deliver better returns as its focus narrows on growing free cash flow and shareholder dividends, while investing in its next generation of opportunities.

"While the decision to sell our South African assets was not an easy one, we are pleased that the assets are going to Harmony, a capable and responsible operator that will ensure their long-term sustainability," AngloGold Ashanti Interim CEO Christine Ramon said. "We can now sharpen our focus to pursue high return projects at several of our key assets, deliver new ounces from the world-class Obuasi mine in Ghana, and advance studies in Colombia, a new frontier for our business."

The transaction has expected proceeds of around \$300 million, subject to subsequent performance, and with additional proceeds if the West Wits are developed below current infrastructure. Harmony will pay US\$200 million in cash on comple-

tion of the transaction. Harmony has also agreed to pay a contingent compensation of US\$260 per ounce (oz) on underground gold production from the Mponeng, Savuka and TauTona mines that exceeds 250,000 oz per year for a period of six years commencing on January 1, 2021. This is valued at approximately US\$100 million based on AngloGold Ashanti's current production forecast; and a contingent compensation of US\$20 per oz in relation to underground production sourced within the West Wits mineral rights — comprising the Mponeng, Savuka and TauTona mines — below the current infrastructure if it is developed.

This, together with the company's pending sales of the company's assets in Mali, will result in a streamlined, high-margin business with quality assets and a robust pipeline for growth, the company said. Gross cash proceeds from the transaction will be applied to further debt reduction.

## Fekola Mill Expansion Commissioned Ahead of Schedule

B2Gold has successfully commissioned the mill expansion at the Fekola mine to 7.5 million metric tons per year (mt/y), one month ahead of schedule. The expansion, which included all major construction activities and execution of a process performance test, was scheduled to be completed on September 30.

Four days after startup, the five-day mill performance test was conducted from August 26 to August 30. The results of the performance test exceeded design throughput, gold recovery, grind and availability over the five-day day period, according to the company. Minor, outstanding construction work is expected to be completed by mid-September.

## Perseus Acquires Bagoé Gold Project

Perseus Mining recently acquired all of Exore Resources' assets including a portfolio of exploration properties situated in northern Côte d'Ivoire. This included PR 321 that hosts the Bagoé gold project, located approximately 70 kilometers (km) from Perseus' Sissingué gold mine.

During May, Exore announced an independently prepared maiden JORC 2012 compliant mineral resource estimate for Bagoé, based on mineralization associated with the Antoinette and Véronique prospects. During July, Exore published further drilling results, this time from the Juliette prospect that highlighted the potential for additional resources to be delineated along strike from Antoinette.

Perseus's pre-acquisition evaluation of Exore's exploration work at Bagoé indicated potential for the economic exploitation of Antoinette and Véronique by open-pit mining and either processing in-situ or transporting ore to Sissingué for processing. Perseus now intends to undertake a Definitive Feasibility Study (DFS) to confirm the technical and financial viability of a development concept for Bagoé.

Drilling at Bagoé was scheduled to start in the second week of October and finish in late December. The target date for completion of the DFS is June 2021.

Work will also be undertaken to prepare an Environmental and Social Impact Assessment (ESIA) for Bagoé. Local environmental consultants CECAF have been engaged to undertake this work. A field survey was due to commence during the first week of October 2020 and the fully documented application for the ESIA is scheduled to be filed during the March 2021 quarter.



B2Gold successfully increases Fekola's mill capacity to 7.5 million mt/y.

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# Zijin Mining Seeks Tier 1 Status

In September, Zijin Mining convened its Sixth Science and Technology Symposium where Chairman Chen Jinghe highlighted the company's global development over the past 20 years with scientific and technological innovation as a driving force. While uncertainty surrounding sociopolitical has increased, the mining industry, which is a fundamental one, remains stable, he added, and Zijin Mining plans to become a tier-one mining company through technological innovation and cooperation with other parties and sectors. Becoming a competitively global, tier-one metal mining company is Zijin Mining's main mission, Zinghe said.

To accomplish this, Zinghe said Zijin Mining will advance technological innovation with a global vision and new mindset. The company said it will strive for excellence above international standards.

Its project management model of "five ore treatment processes into one" will be applied and promoted more extensively. Efforts will be made to further uncover large deposits of significant market value, and achieve technological breakthroughs in the use of deep shafts for efficient, cost-saving and safe mining, the company said. In addition, research and application of eco-friendly processing and refining technology will be used to realize the goal of green development in the company's domestic and overseas projects.

The company also plans to "emphatically" develop a highly globalized mechanism for operation and management supported by science and technology. He

said Zijin will accelerate the use of data at its mines, and drive for reforms in quality and efficiency.

The company also plans to cooperate with other parties and join forces with various sectors to achieve these developments.

"To expeditiously build a new talent base with technical expertise, [Zijin] will reach out globally to explore for acquisition of, or cooperation with high-tech companies that have a strong talent powerhouse," Zinghe said.

## Russia Looking to Boost Rare Earth Minerals Production

By Vladislav Vorotnikov

By 2030, Russia plans to ramp up rare earth minerals production nearly tenfold, not only to meet the domestic demand but also to become the world's second-biggest rare earth minerals exporter, the Russian Industry and Trade Ministry recently announced.

The Russian government has detailed a roadmap of rare earth minerals production, Alexey Besprozvannikh, deputy industry and trade minister, told *Reuters*. In total, 11 new projects should be launched in the industry during the coming decade, with the overall investment value up to Rub110 billion (\$1.6 billion), he said.

Russian known reserves amount to 26.9 million metric tons (mt), which makes nearly 10% of the world's rare earth minerals reserves. The actual figure could be way bigger since vast territories in Siberia remain underexplored and

may contain deposits yet to be found. In 2019, the Russian state geological agency discovered 40 new mineral deposits in the country, of which a few were classified as rare earth mineral deposits.

The Russian Parliament has given strong incentives to the rare earth minerals industry development by cutting tax on mineral resources extraction from 8% to 4.8% starting from January 2020. The taxation of all new projects will qualify for a decreasing coefficient of 0.1% per year for 10 years since their launch, which should attract investors.

Under the state support program, investors are also eligible for soft loans with the subsidized interest rate under new projects in the rare earth mining industry. All in all, state support measures should push the Russian rare earth minerals production from 2,000 metric tons (mt) in 2019 to 17,000 mt or 20,000 mt, estimated Eugene Kiselev, director of the Russian state geological agency.

The upcoming projects will mostly focus on the global market, he added. The domestic demand for rare earth minerals remains relatively weak, which has been constraining the growth in production for several years, he said. The Industry and Trade Ministry anticipated an increase in demand on the domestic market thanks to the development of the domestic high-tech industry, according to Besprozvannikh.

On July 15, the national association of rare earth producers and consumers was established in Russia. So far, it involves six companies, each of which have projects in the area of rare earth mineral production at various stages of implementation.

In 2020, rare earth minerals have been recognized as reserves of strategical importance. On June 22, Russian President Vladimir Putin signed a decree prohibiting sharing information on the rare earth minerals reserves and production. All data relating to rare earth mineral production have been classified, except for the deposits developed by non-Russian investors.

For many years, Russian officials have been calling the government to embark on some steps to ensure the domestic market would not deplete its supply of rare earth minerals, which is crucial for the defense industry.



Tomtorskoye deposit is one of the biggest in the world.

Russia needs to produce rare earth minerals because tomorrow nobody would sell them to the country, Maxim Macharchyuk, general director of Neftekhimmash, told the Russian press a few years ago. Amid the ongoing sanctions war between Russia and several Western countries, some Russian companies faced problems with purchasing raw materials, he warned.

In Russia, rare earth minerals are used in the nuclear industry and defense industry, including producing nuclear missiles and tanks, Macharchyuk said.

The changing geopolitical situation should push Russia to avoid import dependence on rare earth minerals, said Alexander Kulikov, general director of the National Association of Strategic Materials Consumers. This step would be a logical response to the external challenges Russia is facing, he added.

As a first step, the Russian government could have resurrected the old projects abandoned with the fall of the Soviet Union, establishing a rare earth minerals cluster based on the Zabaykalsky Mining and Metallurgical Plant, and resume some joint projects with Kazakhstan, Kulikov said.

So far, there is no information on what projects have been included in the roadmap of rare earth minerals production, but some projects are already being developed.

In 2013, Russian state-owned corporation Rostec struck a US\$1 billion deal in 2013 to develop Tomtorskoye in a venture with Polymetal International. Despite several delays, the complex should be launched in 2022. The contained reserves are close to 19 million mt, which makes Tomtorskoye one of the world's biggest rare earth mineral deposits.

The Tomtorskoye deposit is deemed to contain in terms of oxides more than 5% niobium, more than 7% rare earth minerals, around 5% titanium, and more than 1% vanadium. Russian geologists believe this factor places Tomtorskoye among the top 10 rare earth mineral deposits in the world.

At full designed production performance, Rostec plans to produce 16,000 mt of rare earth oxide per year (mt/y) from the deposit as well as 14,000 mt of ferroniobium.

However, the actual reserves of the Tomtorskoye deposit remain unknown.

According to Nikolai Pokhilenko, geologist of the Russian Academy of Science, only 40 km<sup>2</sup>, or 15% of the deposit's total territory, have been actually studied.

The second most promising rare-earth project is being developed by ZAO Technoinvest Alliance, partially owned by steel pipe maker ChelPipe PJSC. The goal is to extract tantalum and niobium and oxides of rare earth metals from the Zashikhinskoye deposit in the Irkutsk region. The project aims to process 1 million mt of ore per year.

In January 2020, the regional government said plant opening was delayed to 2023.

Russian fertilizers producer Uralchem has recently inked an agreement with Moscow-based SkyGrad Innovations to produce rare earth concentrates from waste dumps of phosphogypsum. SkyGrad plans to establish a processing plant near Uralchem dumps on the outskirts of the city of Voskresensk, in Moscow Oblast, with a designed production performance of about 100,000 mt. If all goes well, the investors plan to ramp up this figure to 700,000 mt. The first stage of the project was slated to be implemented by the end of 2020.

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# Court Upholds Decision Blocking Peabody, Arch Joint Venture

The U.S. District Court has concluded its review of the joint venture combining Peabody and Arch Resources' Power River Basin and Colorado assets and is supporting the Federal Trade Commission's (FTC) decision to block the formation of the joint venture.

"We are deeply disappointed with the court's decision as the intense all-fuels competition is clearly apparent to us," Peabody President and CEO Glenn Kellow said. "Our focus now is on continuing to be the low-cost PRB coal provider to best compete against natural gas and subsidized renewables."

The FTC said the transaction will eliminate competition between Peabody and Arch Coal, the two major competitors in the market for thermal coal in the Southern Powder River Basin, and the two largest coal-mining companies in the United States.

Following the court decision, Arch said while it disagrees with the verdict, it would terminate the proposed joint venture. Arch said aggressively driving forward with its strategic pivot toward steel and metallurgical markets and simultaneously intensifying its pursuit of strategic alternatives for its thermal assets is the best course of action for the company.

Arch and Peabody have agreed to discontinue legal efforts, given the significant investment of time, resources and expense that would be required to conduct an appeal.

"In the wake of today's decision, we will be intensifying our pursuit of strategic alternatives for our thermal assets, including, among other things, potential divestiture, while evaluating opportunities to shrink the operational footprint at those mines, reduce their asset retirement obligations, and establish self-funding mechanisms to address those long-term liabilities," Arch CEO Paul A. Lang said. "In the meantime, we will maintain our sharp focus on aligning our thermal production rates with declining domestic thermal coal demand; adjusting our thermal operating plans in order to minimize future cash requirements; and streamlin-

ing our entire organizational structure to reflect our long-term strategic direction."

The transaction was announced in June 2019 and would combine Peabody's North Antelope Rochelle Mine (NARM) and Arch's Black Thunder Mine, which share a property line of more than seven miles. Additional assets include the Caballo, Rawhide and Coal Creek mines in Wyoming along with the West Elk and Twentymile mines in Colorado. Ownership of the joint venture would have been structured with Peabody owning 66.5% and Arch owning 33.5%. The joint venture was expected to realize annual synergies of \$120 million over an initial 10-year period.

## Murray Emerges From Bankruptcy as ACNR

Murray Energy Holdings Co. and its subsidiaries' Chapter 11 bankruptcy plan was approved and went into effect on September 16, making way for a new entity. The company completed the sale of nearly all of its assets to a company owned by a group of its former creditors. American Consolidated Natural Resources (ACNR) was formed by the group and now owns and operates nine former Murray Energy mines in five regions in the United States. In addition, ACNR will manage and operate the Foresight Energy mines and the Murray Metallurgical mines through two separate management services agreements.

The restructuring transactions eliminated more than \$8 billion of Murray's debt and legacy liabilities and allowed ACNR to access new financing, providing ACNR with enhanced financial flexibility.

Robert D. Moore, who was took over as president and CEO of Murray Energy from Robert Murray following the company's bankruptcy announcement back in October 2019, will serve as ACNR's president and CEO.

"Through the efforts and sacrifice of our dedicated employees, the United Mine Workers of America, our secured lenders, and our trade partners and customers, we are a much stronger company today than we were when we sought Chapter 11 protection," Moore said.

He added that more than 4,000 people will remain working at ACNR.

ACNR entered into a new collective bargaining agreement with the United Mine Workers of America (UMWA), which was approved back in May during the bankruptcy process.

UMWA International President Cecil E. Roberts said, "As per the agreement ACNR signed and that was ratified by the UMWA membership in May, all active UMWA members who formerly worked for Murray Energy have been hired by the new company and are working."

ACNR is the largest privately owned coal company in the United States and said it will produce approximately 35 million tons of high-quality bituminous coal annually.



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**(News-Leading Developments - from p. 6)**

ed Steelworkers, the United Auto Workers and the Machinists unions," he said.

The transaction has been approved by the board of directors of both companies and is expected to close in the fourth quarter of 2020, subject to the receipt of regulatory approval and the satisfaction of other customary closing conditions.

**Boliden Will Expand Nickel Processing**

Boliden plans to invest EUR 40 million (US\$ 47.4 million) in an expansion of its nickel operations at the Harjavalta smelter. The investment will mainly be implemented in 2021. The expansion investment will increase the feed capacity from 310,000 metric tons per year (mt/y) to 370,000 mt/y of raw material. The expansion consists of a new concentrate dryer, increased capacity in the electric smelting furnace and granulation, as well as automated tapping of molten metal.

"We are now continuing on our nickel strategy that began in 2015," President of Business Area Smelters Daniel Peltonen said. "The investment strengthens our productivity and competitiveness while further improving our already very strong environmental performance."

Boliden also said the investment would decrease Harjavalta's carbon dioxide intensity by 15%-20% per ton of nickel produced. It is the largest nickel smelter in the European Union.

**NEWS - CALENDAR OF EVENTS**

**NOVEMBER 7-14, 2020: ALTA 2020 Conference, Online.** Contact: Web: [www.altamet.com.au/conferences/alta-2020/](http://www.altamet.com.au/conferences/alta-2020/).

**NOVEMBER 16-19, 2020: 2<sup>nd</sup> International Conference on High-Performance Mining (Virtual).** Contact: Web: [www.high-performance-mining.com](http://www.high-performance-mining.com).

**NOVEMBER 30-DECEMBER 4, 2020: The annual meeting of the American Exploration & Mining Association, Nugget Casino Resort, Sparks, Nevada, USA.** Contact: Web: [www.miningamerica.org](http://www.miningamerica.org).

**FEBRUARY 1-4, 2021: Investing in African Mining Indaba, Cape Town, South Africa.** Contact: Web: [www.miningindaba.com](http://www.miningindaba.com).

**MARCH 7-10, 2020: The annual meeting of the Prospectors & Developers Association of Canada, Toronto Convention Center, Toronto, Canada.** Contact: Web: [www.pdac.ca](http://www.pdac.ca).

**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: Longwall USA, Pittsburgh, Pennsylvania, USA.** Contact: Web: [www.longwallusa.com](http://www.longwallusa.com).

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

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



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# Building Resilience, the Boliden Way

*E&MJ looks at how innovation in energy supply and biodiversity are helping the Swedish powerhouse to futureproof its mining operations*

By Carly Leonida, European Editor

If the mining industry wants to use the land, then it's crucial it shows it can be managed in a good way, says Anders Forsgren from Boliden. (Photo: Boliden)

Incorporating measures to build resilience in the face of immediate threats such as COVID-19 has been a big focus for many Scandinavian miners this year. However, just as important is the work that these companies are doing to strengthen their businesses and operations against longer term challenges, such as climate change, waste management and social license to operate.

One name synonymous with sustainable mining is Swedish firm, Boliden. The company has a portfolio of metals spanning zinc, copper, nickel, gold and silver among others. This has not only helped to provide stability in the face of fluctuating commodity prices over the past 12 months, but also means it is well positioned to supply European producers of low-carbon energy and transport technologies going forward; a key part of the European Union's strategy on critical raw metals.

The 2019-2020 financial year was an important one for Boliden. The company invested 8.826 billion SEK (US\$971.8 million) in growth and improvement projects; it's highest number ever. And initiatives to cut energy supply from fossil fuels, minimize waste and rehabilitate mine sites were front and center.

To get a feel for some of these, *E&MJ* spoke to project managers in two varied yet equally important business areas...

## Working Toward Carbon-free Operations

Currently, electricity accounts for 70% of energy consumption at Boliden's mines and smelters. In April, the company announced it had signed an agreement with Agder Energi for the supply of renewable energy to its operations in Sweden and Finland totaling 1,000 GWh per year for 15 years from 2022.

Jonas Ranggård, manager for Boliden's Mine Energy Program, said, "We have such clean electricity in Scandinavia, especially in Sweden, that our carbon footprint from electrically powered equipment is now close to zero. The two main sources of CO<sub>2</sub> from our Swedish mines are propane for heating incoming ventilation air, and diesel for mining vehicles.

"We have worked intensely over the past few years with ventilation on demand. Boliden was the first company to have full Wi-Fi coverage in all our mines and we use that to position vehicles and control the ventilation systems to achieve maximize efficiency. We have very low ventilation inflow to start with, but now we have replaced some propane burners with electrical heaters and we also have heat exchangers heat the incoming air with the outcoming from the mines."

While this is a massive step toward achieving Boliden's goal of a 40% re-

duction in carbon dioxide intensity (CO<sub>2</sub> emissions per unit of metal produced) by 2030, it still leaves the question of what to do about diesel mining equipment?

November 2018 saw the startup of a pilot trolley-assist system with ABB and Caterpillar at the Aitik open-pit mine in Sweden and, following successful operation, Boliden has expanded this investment to its Kevitsa site as well. But there is more to come...

"So far, the Aitik installation has performed very well," Ranggård told *E&MJ*. "The original trolley line was built on a waste rock ramp where we could add a third lane. That allowed us to play around with the technology without harming production. We're now building the first in-pit trolley line that will really push the system capabilities.

"As soon as you start widening ramps in a steep open-pit mine such as Aitik, there are extra waste material handling costs, so we need to be able to fit this technology on a two-lane ramp and that is not that common.

"What we're doing now is building a 1 km trolley line down into the open-pit mine in very high-production pushback, so we will have high traffic intensity on that line. Then we'll convert 10 more trucks — equip them with pantographs — and extend or build more trolley lines in Aitik in

the next two or three years. We also have funding to build a couple of kilometers of trolley lines in Kevitsa in northern Finland as well and convert 16 trucks.”

The Kevitsa installation was scheduled to be commissioned in the fall of 2020. However, this has been postponed to spring 2021 due to COVID.

## Making Trolley Assist Fashionable Again

The Aitik installation sparked renewed interest in trolley-assist technology across the industry, and representatives from various mining companies have visited the site see the system working; the first to operate in Arctic conditions.

“I usually say that we are not the first to build a trolley line, we are just the first to brag about it,” Ranggård said with a chuckle.

“The reason the technology took off in South Africa during the 1980s was due to the apartheid oil embargos. Currently, in Sweden, we have a very similar cost ratio between diesel and electricity as they had in South Africa at that time. Especially since last year when the government took away the tax reduction for mining diesel...”

“But we see that this is profitable in Finland as well. And if it’s profitable in Finland, it’s profitable in Canada and South America since they have similar energy prices.”

To cope with the tough environment and the larger mining trucks, the poles and foundations for the trolley lines at Aitik are larger, and the pantographs from the OEM (in this case Caterpillar) are more sophisticated than their 80s predecessors. Otherwise, the systems are fairly similar.

“The long-term target is to have all our trucks running on trolley,” Ranggård explained. “At Kevitsa, we have 16 trucks converted for trolley at present and, in Aitik, we have 14 converted out of a fleet of 40. That is just the start.”

## Trolley is Just the Start...

While trolley technology will play a key role in meeting Boliden’s carbon reduction targets, Ranggård said tackling the CO<sub>2</sub> footprint of a mine as complex as Aitik requires a multi-pronged strategy.

“Even if we install trolley technology everywhere it’s feasible, we will still

only achieve diesel savings of 30%-50%,” he said. “That’s good, but it’s not good enough.

“Sweden aims to be fossil-neutral by 2045, so we need to act thereafter. Pretty much from day one, we concluded that we need to pair trolley technology with some kind of onboard energy storage for our trucks, such as batteries.

“We’ve been putting a lot of R&D into this and have done some simulations together with Chalmers University of Technology in Gothenburg where they simulated the combination of trolley and battery packs on a mining truck. The idea is to take out the diesel engine and fill that space with a really large battery pack.

“You use the battery pack to travel from the shovel up the ramp until you reach the trolley line. The truck then connects to the trolley line, travels up the ramp to the crusher or dump and starts to charge the battery as well. While traveling down into the pit again, the regenerative energy from braking also recharges the battery pack.

“We can definitely achieve the energy balance doing this and also make it profitable. It’s feasible based on the technology that’s available today, so that’s a top priority for us right now. Trolley is really interesting, but I see it just as a first step toward a completely diesel-free hauling cycle.”

Ranggård hopes to see battery-electric trucks in operation at Boliden’s open-pit mines within the next five years and, thereafter, at other mining operations across the globe.

“We really want others to use this technology as well to help push the costs down,” he said. “We have been sharing a lot of the trolley technology and learnings from Aitik with other mining companies and we will continue doing that for our battery initiatives as well.”

Why batteries? *E&MJ* asked. Why not use biodiesel or fuel cells to complement the trolley technology?

“Actually, we already have 20% HVO mixed into our diesel. That is partly our own initiative, but it’s also a consequence of the law in Sweden,” Ranggård explained. “There is an option of going all in on biodiesel as well, but you take a huge risk doing so.

“First, it will probably cost more, but it also carries political risk, because a

large part of the biodiesel imported into Europe today comes from palm oil or palm oil products.

“When it comes to fuel cells... we would need a really large hydrogen electrolysis production plant on-site. Today, producing hydrogen using electrolysis is only about 70% efficient. Then you have the fuel cells that only have an efficiency of roughly 50%. So, the overall efficiency of using fuel cells is much lower.

“When converting trucks to use hydrogen, you still need a battery pack to store regenerative energy, so we would rather make the battery packs larger and use them with trolley lines instead.

“From other mining companies’ perspectives, I can definitely see why they’re looking into hydrogen, but because we have really good, stable electric supply to our sites, battery plus trolley will be more efficient for us.”

## Electrifying the Underground

What about Boliden’s underground operations?

“We already have some electric-driven equipment,” Ranggård said. “We have some electrical pickups and drill rigs, and then we have some upcoming field trials that I can’t speak more about yet. We have been focusing mostly on open-pit mines because they are the largest diesel consumers, but also because mines in North America leading the way on underground electrification, mainly due to legislation and regulations on the working environment.

“We will, of course, try to be early adopters, but we aren’t pushing the OEMs as hard when it comes to underground electrification as we are for the open-pit mining.”

What’s your grand vision for energy efficiency at Boliden’s mines?

“By 2030, I hope that we will have our first underground fossil-neutral mine and that we will have at least a couple of diesel-free large open-pit mining trucks,” he said. “Since the large open-pit trucks have a long lifespan, I don’t think we will be able to replace all of them with battery ones before 2030... but at least some of them.

“And, if we open a new large open-pit mine by 2030, I am convinced that by then, we will have the technology to use diesel-free machinery.”

## Growing Interest in Biodiversity

Another important area that will contribute to increased operational resilience is biodiversity. Boliden is currently preparing a guideline to help the company achieve increased biodiversity in all regions where it operates by 2030.

Many of the tools it already uses, such as the mitigation hierarchy to minimize and compensate for potential biodiversity losses, are a key requirement of the International Council on Mining & Metals to which Boliden recently applied for membership.

Anders Forsgren, senior project manager for business development at Boliden, spoke to *E&MJ* about his team's work.

"At an international level, we are working through SVEMIN — the Swedish Mining Association," he said. "The environmental committee has a subgroup focused on biodiversity, and I'm the chairman of that. That group is feeding back to the Convention on Biological Diversity's (CBD) new framework, which envisages a net positive impact to biodiversity by 2050, and also the European Union's Biodiversity Strategy — part of

the Green Deal — that's ongoing. We are also currently producing a roadmap on biodiversity financed by STRIM, Boliden and LKAB for the Swedish mining industry as a whole.

"If we go to the next level — Boliden as a company — one of our aims for 2020 is to develop a guideline for biodiversity and land use. That will hopefully be published in October.

"Within Boliden, we have formed what we call the 'Green Group,' which drives most of our biodiversity projects. We share information, discuss biodiversity targets, develop benchmarks, share good examples, get inspiration, etc.

"We have meetings four times a year, and the group includes representatives from all our active and closed mine sites, a representative from our smelting business, Boliden's exploration group, and the group that manages our land and forests.

How do you choose those representatives? Is it based on people's personal interests or the role that they play at the sites?

"Both, I would say," replied Forsgren. "We have a lot of people with a biological background, so I would say

we have experts in each business unit. It's really interesting to see the growing concern for this. Even from the management level, there's a lot of interest in biodiversity, and understanding about its importance, the social benefits, access to land, stakeholders engagement, minimizing of risks...

"Our goal is to contribute to increased biodiversity by 2030, in all regions where we operate."

## Compensation Measures at Aitik

A key project the team has been working on is at the Tara underground zinc mine in Ireland.

"It's a really good example of a green mine," Forsgren explained. "If you visit Tara, you will never know that this is quite a big mine site.

"One of the most impressive projects when it comes to offsets or ecological compensation is at Aitik. It's a really large open-pit mine in quite an industrial area. A few years back, we had to take a new area of land into consideration to expand the tailings facility. It was around 167 ha of forest and the nature was of very high value, so we bought an additional 837 ha of land close to the mine site to compensate for that. We protected it for the future and made it possible for the authorities, county administration to make these nature reserves without cost.

"We moved different types of logs — around 700 just for this research project — different species, different standing dead wood and lying dead wood... We have initiated a research project together with the University of Agricultural Sciences. They are monitoring our progress in moving different species and settling them into the new habitat. We are also funding a Ph.D. project based on this."

Forsgren explained that collaboration with academia is an important part of Boliden's work in biodiversity.

"It's one way to build trust in what we do," he said. "To me, it's really important to involve universities and others. There is a big lack of knowledge in this area, and in how we succeed in moving species or creating habitats.

"If we [the mining industry] want to use land and get permits to open new mines or expand, then it's absolutely crucial that we show we can manage it in a good way."



2020 has been an uphill battle for many mining companies. Fortunately, Boliden is well prepared to weather the storm. (Photo: Boliden/Mats Hillblom)

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# 2020: A Show of Scandinavian Strength

*Nordic METS companies not only survive, but thrive through challenging conditions*

By Carly Leonida, European Editor



A Slepner E120 transports a Komatsu PC1250 on site. (Photo: Slepner)

The past 12 months have been almost unprecedented in the mining industry.

From a pandemic that saw production slowed, even suspended at certain operations, to soaring commodity prices and mines racing to keep pace with metals demand, 2019 into 2020 has been a period of great extremes. However, contrary to the tumbling sales figures seen in some industries, the challenges of the past year have actually highlighted the need to create operational resilience through the use of advanced mining technologies and remote support — things at which Scandinavian mining equipment, technology and service (METS) companies excel in providing.

Let's look at some key developments from the past year, with suppliers in alphabetical order...

## Devico Delivers Despite COVID

*E&MJ* began by asking Frank Finseth, Devico's operations manager for the Nordic region, how the company has fared through 2020.

"We have managed well despite the impact COVID-19 has had on the indus-

try," he said. "We have developed some promising new products and systems and have invested in the development of our global agent network. During April and May, we also had more time to focus on internal training for our employees and generally preparing for the upswing in the market, and we introduced and enhanced some of our remote training sessions for clients, which has been a real value add.

"April and May were slow with regard to overseas business, but we remained fairly active in the Nordic region and, surprisingly, our business increased. Overall business picked up from early June, with higher activity levels overseas.

"We have also noticed more interest in our directional core drilling (DCD) solution as clients are focusing on cost savings and placing higher emphasis on the level of experience of their subcontractors."

The DCD solution offers the potential for significant cost savings in deep-hole exploration projects. It provides deviation control and the possibility to drill branch holes and hit multiple targets from one initial hole.

"By branching off a drillhole from the middle of an existing hole, the meters

needed to drill to target are significantly reduced, saving both time and costs," said Finseth. "We've also been providing both directional drilling and borehole/collar surveying services all in one package using DCD, surveying and alignment products."

Before the pandemic, Devico launched the DeviGyro continuous survey tool, which has a wide range of applications.

"It provides continuous in-out surveying for exploration and production drilling," explained Finseth. "We've seen a lot of interest, both from mining and the civil construction market due to the small size and ease of operation.

"In April we also launched the DeviGyro Overshot Xpress (OX), an overshot surveying system for core drilling applications. This allows efficient surveying that is integrated into the drilling operation and causes no impact on drilling production."

The DeviGyro OX offers continuous gyro surveying up to 100m/min while retrieving the core tube and, since field testing was completed, more than 50 OX units have been implemented at mining operations around the world.

Of course, 2020 has brought challenges, too...

Finseth explained, "A key challenge we've seen is where clients have a willingness to change to a leading Devico product but, due to the restrictions in place, our ability to go to site and conduct product training has all but ceased. The introduction of our remote training system has answered this challenge, and we are now well equipped to provide our products directly, paired with remote training, resulting in a competent, confident clients."

Going forward, Finseth explained that the team will be focusing on further developing the DeviGyro product range and the DeviDrill directional drilling system.

"The DeviCloud online processing and reporting portal for Devico survey tools will soon be released as well," he said. "DeviCloud is a secure online portal offering instant and secure sharing of survey data within a private user group, along with an extensive range of processing, plotting, analysis and reporting functionalities.

“We are also focused on developing our global agent network, specifically in Australia, Canada, Russia, USA, Chile, Peru and Colombia to name a few, and have a number of projects under way in the Lapland area (northern Sweden and Finland).”

## Epiroc Advances Electrification and Automation Ambitions

Epiroc saw its 2019 revenues grow by 7% to 41 billion SEK, supported by interest in equipment and also aftermarket parts and services. Highlights for the company included progress on electrification, digitalization and automation of its product portfolio.

“We have established ourselves as an industry leader in battery-powered underground mining equipment, and landed many orders for equipment and solutions with automation features that help customers be more productive and safer,” Ann-Sofie Andersson, global manager of branding and communication, said. “Another highlight was in March 2020 when Helena Hedblom became our new president and CEO. With Helena as CEO we have, among other things, launched ambitious new sustainability goals for 2030, which include halving our CO<sub>2</sub> emissions and doubling the number of women in operative roles.”

How has COVID-19 impacted activities and orders? Have there been positive effects as well as negative?

“Initially, we were negatively affected,” Andersson said. “With many mining and construction companies halting equipment orders amid the global uncertainty and because many sites were closed down. The business started recovering in May and June, though it remains somewhat fragile. But there have definitely been some positive effects, too. It was a big priority for us to help customers keep their operations up and running during the pandemic. This has strengthened our relationship with them, and we have received lots of positive feedback.”

Like many, Epiroc’s mining customers are showing increasing interest in automation and remote-controlled equipment.

“The interest in automation has been increasing fast the past couple of years as mining companies are starting to realize the benefits it brings in terms of safer working environments and higher productivity,” Andersson said. “Now, with the

pandemic, the interest in automation is increasing even more.”

Epiroc currently sells to more than 150 countries globally and plans to continue developing that reach through 2021.

“Specifically, we will focus heavily on Africa and South America, as those are big mining markets with huge growth potential and an increasing interest for safety and higher productivity,” Andersson said.

In late 2019, Epiroc announced it has entered into a partnership with explosives provider Orica to jointly develop a semi-automated explosives delivery system, for safer and more productive blasting operations in underground mines.

The companies are leveraging their combined capabilities, including Epiroc’s face drilling and production drill rigs, and Orica’s charging systems and explosives know-how, to optimize the charging process for underground mining.

The aim is to design and deliver the first prototype during 2020, with the first commercially available systems to enter service in 2021.

In February, Epiroc, in partnership with ASI Mining, also scooped the contract to convert Roy Hill’s haul truck fleet from manned to autonomous use. The partners are delivering an interoperable solution to

the Australian mine site, with the ability to expand to other mining vehicle types and manufacturers, and the capability to integrate with existing Roy Hill systems. Epiroc and ASI Mining will also be working closely with Roy Hill and its partners Hitachi and Wenco on truck conversion and integration of the Wenco fleet management system.

The project will see a phased implementation, with testing and production verification of up to eight trucks undertaken in the initial phase prior to the second phase of full fleet expansion from mid-2021.

## FLSmidth Flexes Supply Chain

Manfred Schaffer, president of FLSmidth’s Mining division, said, while the mining industry has been affected by the pandemic, commodity prices have quickly rebounded, and the company expects activity to return to pre-pandemic levels relatively quickly.

“Around 96% of sites were in operation at the end of Q2 up from 90% in Q1, even though some were operating at reduced capacity,” he said. “This meant spare and wear parts demand was impacted due to reduced production rates. We also noticed less activity for technical services and project commissioning due to



Deviso operations manager, Frank Finseth, presents the company’s DeviDrill system to a client. (Photo: Deviso)



restricted access to sites. Customers are deferring non-critical investments. The largest impact was in South Africa and India with no significant mine closures in Australia and Europe due to COVID-19.”

For FLSmidth, managing the COVID-19 outbreak over the last two quarters began with securing the safety and well-being of employees and managing the impact to the company’s production and supply chain.

“We increased our efforts to help our customers maintain their operations through more remote services and adapting our on-site service and maintenance schedules to operational needs,” Schaffer said. “This first wave of initiatives was followed by a phase where we adjusted our activities and capacities to the new situation and the new activity levels.”

In mining, the post-COVID world will look increasingly digitized. Rather than slow down the pace of digital adoption, COVID-19 shone a spotlight on just how these solutions and data analytics are for mining.

“When logistics are severely challenged, when it becomes difficult or even impossible to be on site, suddenly all the value of digitalization becomes crystal clear,” Schaffer said. “Areas such as remote monitoring and diagnosis, predictive maintenance, and process optimization are center stage and the benefits — from increased uptime and improved throughput to safety, cost and environmental gains — are evident.

“During COVID-19 times, this range of benefits is becoming even more apparent. Some, like safety, might not be the primary driver for adoption right now (it is still a big factor, however), but the value

of digital in this area will still be seen. Given current priorities, it’s the advantages of remote-controlled operations and predictive maintenance that will be most recognized and appreciated.”

Overall, FLSmidth has experienced few disruptions to its supply chain, and on-time delivery has been equal to 2019 levels.

Asger Lauritsen, chief procurement officer, said the company has implemented what it calls a “nano management” approach using local service engineers and regional service centers to minimize disruption to the customer wherever possible.

“As we saw COVID-19 continue to spread outside China, especially in Europe, and North and South America as well as in India, we imposed this ‘nano-management’ of all customer and supplier orders, with the intent to show that we are also responsible for keeping the mines open and operational,” he said. “We are an integrated part of the local and global society.”

“With 80% of our suppliers being external, we are exceptionally agile. We are running an asset-light model and have not invested in expensive production facilities, because we have a trusted network of suppliers in the right locations with the right capabilities. It is a blended mix of make/buy and insourcing and outsourcing, shifting between different suppliers in different parts of the world.

“Except for closedowns in India, and two weeks closure during the Chinese New Year in China, all our sites have been operating at 90%-100% capacity. Most people have been tested regularly and all local legislation and guidelines have been followed to make sure our employees and their families could stay safe.”

COVID-19 has also put even more emphasis on the need to extract more ore with fewer resources and lower costs, and one of FLSmidth’s core aims is to deliver sustainable productivity gains.

“Last November, we launched a new core strategy — MissionZero — which, in mining, aims to enable our customers to move toward zero water and energy waste, as well as zero-emissions processes by 2030,” Schaffer explained. “This has been well received by both mining customers globally and by investors. We definitely see environmentally sound practices and sustainability as key trends in mining, and we expect this to only gain in importance in the coming years.”

License to operate and geopolitical developments are also key challenges for mining companies at present, and the increase in trade tensions means that miners need to be even more careful with the selection of their suppliers so they can ensure supply chain security.

“We see this trend continuing and have adjusted our model accordingly,” Schaffer said. “With our regional setup, we have personnel and warehouses close to our key markets and, with our highly flexible supply chain, we can react quickly to any restrictions.”

Reflecting the market trend for investment in technologies that build operational resilience, FLSmidth recently commissioned an F-Series F3200-W high-pressure grinding roll (HPGR) at a gold project in Turkey. The model is equipped with ø2.2-m x 1.5-m wide rolls and 4,000-kW installed power making it the largest HPGR operating in gold heap leach in the world. The HPGR is a dry comminution tool, so there is no water involved that fits with the company’s sustainability ambitions.

Other key deliveries include a new gold processing plant to JSC Pavlik in Russia’s Magadan region, four production lines of grinding equipment with ancillaries to a copper mine in the Khabarovsk region of Russia, and the sale of three system packages to Gold Fields for the Salares Norte project in Chile.

## Fluid-Bag Builds Presence in Mining

Fluid-Bag’s business is steadily increasing in the mining industry. The company is not a direct supplier to mine sites, it provides packaging solutions to oil and



Epiroc’s second-generation battery fleet is tested as part of the SIMS project at Agnico Eagle’s Kittilä gold mine in Lapland. (Photo: Epiroc)





# DIGITAL TRAINER LOADER SIMULATOR

Targets in increased profitability, higher productivity and improved safety?  
The Digital Trainer - LH, training simulator for Sandvik loader operators offers an efficient and flexible tool for training. Equipped with authentic controls and simulating the mine working area in 3D, the Digital Trainer brings a real-life operating experience to the training room.

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grease suppliers that preserve and protect the quality of their product.

Henrik Kass, sales manager for Lubricants at Fluid-Bag, said, "What we see is an increasing number of mine sites that are receiving their lubricants in Fluid-Bags. It is mainly the cleanliness aspect and residue benefits that lie behind this steady increase. Fluid-Bag is a packaging alternative to bins and drums, which means that as mining and oil companies are learning more about the advantages, the conversion to Fluid-Bags is spreading."

The flexible Fluid-Bag provides a closed packaging system for the lubricant. It does not need to be opened on top to let air in when the lubricant is discharged and, because of this, the bag collapses. This means that no contamination ever reaches the lubricant, even during the emptying process. This is important for mining operations where downtime and engine failure can be crushingly expensive.

Another benefit is the low amount of lubricant residue after discharge. This can save a lot of money and makes waste disposal much easier.

"These features are important but, strangely, it's not that common that mining companies come to us and ask for it," said Kass. "But they could, or should, ask their lubricant supplier about how their packaging contributes to lubricant cleanliness and less waste, be it an oil company or a distributor."

Fluid-Bag will continue its focus on the mining and steel lubricants market in 2021.

"We have recently developed the Tau Xtractor for these industries, and we will focus on getting that marketed more extensively," Kass explained. "Tau Xtractor is a device for emptying Fluid-Bags, and it builds on the same cleanliness concept and further strengthens that."

The company also has ongoing projects concerning the emptying of its bags, including a new easy-to-use device for dis-

charging low-viscosity liquids, like oil. It is a spring-loaded winding device, which is placed on top of the bag, this makes sure all of the product is discharged.

More sustainability-focused projects are in the pipeline for late 2020.

### Metso Outotec: New Name, Wider Portfolio

The past 12 months have been exceptionally active for Metso Outotec. Aside from the merger of Metso and Outotec in July to create a unified face in mineral processing, other highlights include the company's 2020 Q2 financial results, which warranted issuing a positive profit warning.

Saso Kitanoski, president for the Europe market area, spoke about the company's performance highlights.

"It has been a very active 12 months and, under difficult conditions with COVID-19, we did perform exceptionally well," he said. "Additionally, and despite COVID, both companies have managed to

### Sandvik Pushes Boundaries for Mining Automation

Sandvik Mining and Rock Technology revealed their future vision and concept for autonomous mining equipment at the company's Innovation in Mining Virtual Event, which was held during late September. The company gave a glimpse of the next generation of intelligent technologies, which included the fully auto-

nous AutoMine Concept vehicle. Based on the latest technologies, it is equipped with completely new sensing capabilities and artificial intelligence to enhance mining operations.

The AutoMine Concept perceives its surroundings and environment in 3D and reacts to it in real time. These technologies

provide clear advantages by allowing vehicles to adapt and plan their own routes, and to find the most suitable paths even in continuously changing environments. The obstacle detection, collision avoidance, and 3D online mapping capabilities improve adaptability and increase flexibility.

"The AutoMine Concept is unique, because it has been designed ground-up for autonomous use. It is the world's first fully autonomous underground mining machine built specifically for automation," said Riku Pulli, vice president, automation at Sandvik Mining and Rock Technology. "This technology raises ease-of-use, effectiveness of asset utilization and adaptability to a new level, resulting in higher productivity. These technologies will truly change the face and pace of autonomous mining."

This game-changing platform is a foundation for using AutoMine technology in various equipment and can be applied to any vehicle. The AutoMine Concept vehicle also has a completely new industrial design without a cabin, and with built-in components for high reliability and productivity. This autonomy platform allows for equipment design that is optimized for its primary production tasks without compromises. Furthermore, being fully battery-electric, it generates no emissions.



The AutoMine Concept vehicle, which has no cab, uses sensing capabilities and artificial intelligence to enhance mining operations.

successfully launch a significant number of new products and solutions to the market, and customers have recognized those and invested in them.”

Kitanoski reported that the first few months of the company integration process has gone well.

“It’s been quite smooth so far,” he said. “We have a smaller number of market areas globally; we have only eight now. Whereas previously, both companies had more than 10 each. That gives a much better structure, much better efficiency, but also, it gives a stronger market presence for both companies. For the European market area, we are, in terms of organization and integration, quite well ahead.

“We have already established strong sales and service regions in Europe; Nordics being the biggest. Additionally, we have established an organization called ‘Technical Sales Support’ that is directly embedded in the sales and service market organization and which centralizes our technical knowledge and experience in this field. A large part of that organization is based out of the Nordics, very close to our customers in the region.

“Moving forward in the integration process, one of the most important points is that we are working on our strategy. I expect we’ll be able to share more details in Q4 this year.

“COVID-19 has brought different types of challenges to us. However, we have used our strong global footprint to answer the needs of our customers. Meaning that, if our supply chain in a certain area, for example, India, was challenged, we have the possibility to deliver solutions from Europe, China or from any other location where we have a stronghold. This has provided our customers with stability.

“We also have capabilities to predict maintenance needs, and to address those remotely with our customers and partners, wherever they are in the world. Again, the global footprint plays a critical role here, because all those solutions need to be adapted to the requirements of the particular customer that we are serving.”

Metso Outotec has also been using its digital platforms and online presence to present new solutions to the market during times of restricted travel and to train customers. The company has seen almost 15,000 participants join its webinars this year.

“We’re very happy with that and will continue in that direction,” Kitanoski said.

Topics that are informing these webinars, as well as R&D, include mid-term to long-term challenges that mines are addressing such as energy efficiency, water consumption and performance optimization of the mine value chain.

“For energy consumption, we are addressing the biggest consumer in minerals

processing which is grinding,” Kitanoski said. “We have new solutions coming to market soon which are well ahead of what we have today.”

“On the filtration side, which addresses water consumption, in 2021-2022, we will be launching new solutions which will again lift the level of quality and enable our clients to take a new step. Of course, all of that comes with the additional af-

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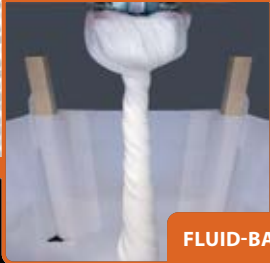
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Scania Mining establishes a permanent exhibition space at the company's Demo Centre in Södertälje, Sweden, to demonstrate its approach. (Photo: Scania)

termarket services. We are investing very seriously in that component.

“And we are planning to launch a different set of tools, going forward for consumables, like mill linings. Because, again, this is an important component in reducing wear costs, energy consumption and improving equipment availability.”

This ambition will be bolstered by the acquisition of [Australia-based fastener and wear monitoring technology provider] Davies Wear Plate Systems, which Metso Outotec announced in August.

In June, Metso launched the My Plant Planner on-line configurator for designing efficient crushing and screening plants. This free digital tool, now available on the Metso Outotec website, uses 3D simulation to allow mining and aggregates operations to design their own crushing and screening plants.

Other important product launches include the Outotec HIGmill plant — a modular solution for fine grinding — which also came to the market in June, the MesoTHERM BIOX process for treatment of refractory gold ores, and the Pretium Water Advisor for accurate site water balance monitoring.

## Normet Expands Service Reach, R&D

Normet CEO, Ed Santamaria, gave *E&MJ* a rundown on key developments for the company so far this year.

“The past 12 months have been quite eventful, and exciting in many ways,” he said. “For Normet, we have had multiple deliveries of our battery-electric vehicles and clearly see the demand. We have en-

tered new markets, such as the Democratic Republic of Congo. The financial results for 2019 were strong in all dimensions. We have also spent a lot of time developing our portfolio and offering in all our businesses; construction chemicals, rock reinforcement, equipment and services.”

How has COVID-19 impacted activities and orders?

“Our immediate response at the outset of the pandemic was to look after our people and to support our customer’s operations,” Santamaria explained. “We managed to keep everyone safe and healthy and attend to customer’s needs, be that in on-site support, delivery of new equipment and parts, tools and consumables.”

“Customers capital expenditure decision making has slowed down somewhat and, in places, has been deferred which has impacted the timing of new orders. But, on the positive side, we have seen people find new and effective ways to work and support each other remotely, to stay connected and functional in their roles whilst dealing with a great deal of uncertainty and insecurity.”

As for most companies in the industry, safety is the main priority for Normet.

“We’re also working to enable uninterrupted supply chains, availability of technical and application specialists and flexibility,” Santamaria said. “Productivity is critical and combining that with innovation is a strong foundation for Normet.”

Sustainability is also high on customer’s agenda, so Normet has expanded its SmartDrive battery electric vehicle (BEV) architecture to include the latest Li-ion battery technology with a fast charging ca-

pability. High-torque electric motors provide instant torque and efficient operation without any emissions. The fully reversible drive system ensures safe and sure movement in difficult underground conditions.

The company has also been working on complementary technologies to improve productivity, such as simulators to enhance operator skills, scanners for sprayed concrete and SmartScan for simplifying the operator’s work.

SmartScan combines sensor technology with sprayed concrete equipment. Using 3D laser scanning technology, it eliminates the need for manual calculations using probes and improves work site efficiency and safety. With SmartScan, the operator can automatically calculate and monitor applied sprayed concrete thickness and volumes for enhanced efficiency and less wastage. It uses advanced technology to remotely scan areas where repairs and concrete application may be needed, providing a perfect application.

To support customers in Chile, Normet opened a new service center in Santiago in late 2019. The facility offers equipment rebuilds as well as process training.

“Additionally, we opened a dynamic rock bolt manufacturing facility in Luleå to support our Nordic customers with rock reinforcement products,” Santamaria said. “And, in India, we have expanded service operations to support the business there.”

“For rebuilding and remanufacturing equipment, our service center in Lisalmi, Finland has been in full use to support our customers and recently we also opened a new modern testing and delivery facility in Lisalmi. This new facility supports many R&D and customer hand-over activities including functional testing and training.”

## New Products, Deliveries for Sandvik

Last year into 2020 has been busy for Sandvik despite COVID-19. As this issue went to press in late September, the company was preparing to present its latest solutions to customers and press at its Innovation in Mining virtual event. The lineup included the unveiling of the first Sandvik branded battery-electric loader, as well the DR410i rotary blast hole drill rig and a sneak peek of the forthcoming Top hammer XL system.

Earlier in the year, Sandvik teamed up with Exyn Technologies to create



solutions for mapping and visioning underground mines. Sandvik's OptiMine combined with data collected by Exyn's aerial robots creates progressive visualization of the mine environment to increase overall transparency of the mining process. The collaboration will entail research on how to apply and generate 3D views and perceptions of underground spaces autonomously, while leveraging the full potential of Sandvik's AutoMine system.

July also saw the re-launch of the Toro family name for Sandvik's underground hard-rock loaders and trucks, starting later this year. The Toro name has been recognized by Sandvik customers for decades and now Sandvik is bringing back the bull starting with the Toro LH517i and Toro LH621i intelligent loaders.

To pair with the loaders, Sandvik's 51- and 63-metric-ton (mt) underground trucks will also acquire the Toro name. Both models have recently received design upgrades, including a new transmission, heavy-duty cooler, AutoMine for Trucks with on-surface navigation possibility and an ongoing Stage V engine trial.

"Customer feedback on the i-series trucks indicates that overall maintenance costs have decreased compared to their predecessors, the Sandvik TH551 and Sandvik TH663. We have also received the same customer feedback on LH517i and LH621i loaders. Reducing costs in addition to the already-reported positive operator feedback clearly shows we are on the right track," said Wayne Scrivens, vice president for the load and haul product line.

Other noteworthy developments include the new DR410i, which joined the iSeries of rotary blast hole drills and, in March, Byrnegut and OZ Minerals successfully implemented an automation upgrade for a Sandvik DD422i development drill, despite the challenges of COVID-19.

With travel restrictions preventing Sandvik staff from attending site, Byrnegut, OZ Minerals and Sandvik experts collaborated via phone, teleconference and email to complete remote commissioning of the rig.

Byrnegut Australia became the first underground operator globally to successfully use the new automation and teleremote package for Sandvik development drills.

A little closer to home, in July, Nokia announced it was deploying a 5G stand-alone (SA) industrial-grade private wireless network for Sandvik's test mine in Tampere, Finland. Based on the Nokia Digital Automation Cloud (DAC), the 5G SA network will be used to enhance communications and connectivity at the facility where Sandvik Mining and Rock Technology tests, develops and prototypes mining solutions for its customers worldwide.

The network will enable fast, reliable and secure voice and video communications in a mining setting, which presents highly challenging conditions. Its 5G capability will also be used for automated mining processes, enabling remote machine operations of more than 4K video links between deep underground and the surface control center.

### Scania: Tough Trucks. Even Tougher People

2019 saw Scania team up with Navistar to provide vehicles and services for Canadian mining operations. The parties plan to bring a limited number of Scania heavy

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duty off-road trucks for trials by selected operators in late 2020.

In a separate announcement, Scania Mining also revealed it developed a portable site assessment kit to help determine the efficiency of customer's mine sites.

Scania Site Optimisation uses a lean approach to map the customer's business in order to help maximize value through increased revenue, risk management or cost reductions. Analysis of the data gathered reveals waste in the operation, low equipment utilization, queuing, inappropriate service planning and excess fuel consumption, all of which can adversely affect revenue. The data can also be used by the sales and services team to analyze the right specifications and services for the operations.

To support this, Scania Mining has established a permanent exhibition space at the company's Demo Centre in Södertälje, Sweden, to demonstrate this approach.

"The program is currently suspended until January 2021," Mai Auapinyakul, business development manager at Scania Mining, explained. "But it gives customers an insight into what Scania do."

"Driver Training and Coaching has also played an important role in the mining segment recently, especially for customers with large rolling fleets. Our tailored coaching and training programs not only focus on the operational aspect of the equipment, but also how the whole fleet



The Sleipner DB120PLUS offers more flexibility in daily production planning as drills and dozers can be delivered quickly to where they are working. (Photo: Sleipner)

plays the part in the bigger operation. This is part of how we help the customers adapt the lean mindset in their operation."

For Scania, 2020 thus far has been dominated by the COVID-19 outbreak and its consequences in the form of lower demand and decreased production.

"In the past 12 months, we had to deal with the temporary halt of our production, the reduction of staff hours, and the uncertainty and volatility of the market," Auapinyakul said.

"We have seen our team dedicate their time and effort to keep our service network open and customers' trucks running. We have seen our customer relationship evolve from supplier to reliable partner as we work closely to have open dialogues

and build trust to ensure the safety of the people and, at the same time, keep the operation running at an optimum."

Both sales and profitability were impacted negatively, but the company has taken necessary steps to mitigate this.

"It has definitely been challenging, as we had to prioritize our activities," Auapinyakul added. "Many of our hands-on activities, such as Scania Site Mapping of our customers' operations and our Mining Program at the Scania Demo Centre had to be postponed indefinitely due to travel restrictions."

"However, Eurasia and Asia saw an increase in order bookings, which is reassuring since our biggest mining markets are Russia and Indonesia. Our engines

## SIMS Project Comes to a Close... and Maybe a New Beginning

Collaborative innovation has been a big focus for the mining industry recently and April 2020 saw the completion of the Horizon 2020-funded Sustainable Intelligent Mining Systems (SIMS) project.

While the program had a European-wide focus and participant base, many of its work packages involved Scandinavian suppliers and a good deal of solutions testing also took place in the region.

Epiroc was the overall coordinator for SIMS and the company's Jan Gustafsson acted as project manager.

"It has been three fantastic years," Gustafsson said in his closing remarks, published on the SIMS website. "The vision for the project was to create a long-lasting impact on the way we test and demonstrate new technology and solutions for the mining industry, to be achieved with a consortium from mining companies, equipment and system suppliers and universities."

"We have fulfilled that vision and we can see great opportunities with this type of collaboration. The interest has also been very high and that is also proof that what the project has achieved is very important and taking us closer to an

even more sustainable industry. During this project, we have developed a great collaboration and 'team feeling' and that is something that very valuable for future collaborations, which we are looking into."

Among multiple achievements, SIMS successfully demonstrated the performance of fully electric mine production vehicles, a virtual reality environment for training and education of mine professionals, autonomous aerial mine inspections, the application of intelligent rock bolts, the 5G communication infrastructure, and overall control and process monitoring systems for the mining sector.

As part of the electrification work package, Epiroc's second-generation battery fleet, including the Boomer E2 Battery, Minetruck MT42 Battery and Scooptram ST14 Battery, was tested at Agnico Eagle's Kittilä gold mine in Lapland. Agnico Eagle subsequently purchased two second-generation Boltec E Battery rigs, which soon will go into production at the mine.

As Gustafsson hinted, the NEXGEN SIMS proposal has successfully passed the first application phase and the team is now working toward the next step in the application process.

also saw an increase in order bookings also globally due to increase in demand.”

Throughout this year, Scania has seen mining companies focusing heavily on parts, services and logistics in a bid to keep operations up and running.

“Our markets have been working hard in cooperation with customers to ensure parts availability and productivity,” Aua-pinyakul explained. “This has transformed the way we work with services, as we now have a more open dialogue with customers about their business, and how we can help them maximize and extend the life of their current rolling fleet as many customers are not buying new trucks.

“For example, in India, our field service teams managed to maintain 90% of uptime of 1,000+ Scania Heavy Tipper running throughout the country, by dispatching technicians to the sites. Their effort has been heartily appreciated by the customers.

“In Indonesia, our field team also met with logistical challenge that forced our technicians to think outside the box and come up with a new solution to manage spare parts for customer operations as or-

ders are now taking longer to arrive. Moreover, they have been discussing the business aspect of services with customers, like how using original parts could help ensure the life of the vehicle and how it will cost less over time.”

Sustainable transport solutions will be the main focus of Scania’s work from 2020-2025, harnessing electrification, automation, and connectivity solutions, as well as alternative fuels to answer demands.

### Sleipner Solves Transport Dilemmas

Transport solutions specialist Sleipner has been working to expand its market reach over the past 12 months.

CEO Jukka Koponen said, “We have now customers in over 50 countries. During the last 12 months Benin, New Caledonia and Portugal have been added as new user countries.

“We have recently added a new sales manager to our group to be responsible for sales in the U.K. and Ireland. Our DB series offering has recently been expanded too, and we are actively working on new developments for the future.”



The Tau Xtractor with a Fluid-Bag inside. (Photo: Fluid-Bag)

Koponen said COVID-19 has been a driver for the company to start utilizing remote tools more actively.

“We have started using a new tool to share our sales and technical mate-



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Normet's new testing and delivery facility in Lisalmi, Finland. (Photo: Normet)

rials internally and with our customers in remote meetings," he explained. "It is called Showell, which is from Finland. It's an easy-to-use, fast, and powerful sales enablement platform. With Showell, our sellers are always well-prepared to engage with customers in face-to-face meetings, virtual meetings, via email or in social media. The number of remote meetings has also increased. It has been possible to serve our customers despite the travel restrictions."

Product manager, Teijo Höylä, added, "COVID-19 has created challenges as well. Our customers have been forced to delay their investments, but there have been no cancellations so we strongly believe that we will be able to continue providing our solutions to our customers when the COVID situation starts to get better."

Sleipner is seeing increasing demand for safely relocating equipment for blasting and scheduled workshop maintenance, as well as reducing undercarriage maintenance costs.

"With the use of Sleipner, not only is there a potential for up to 50% savings on undercarriage maintenance costs, but also 85% travel time reduction and productivity increases of between 12% and 20%," said Conrad Caldwell, sales manager, U.K. and Ireland. "Sleipner aids in relocating equipment, for example, from the face to workshop. This can now be done safely, quickly and in the most cost-effective manner."

A recent highlight was the launch of the Sleipner DB120PLUS which improves the on-site mobility of tracked equipment. DB120PLUS offers more flexibility in daily production planning as drills and dozers can be picked-up and delivered quickly to where they are working.

Höylä explained: "With Sleipner DB-120PLUS, the drills' undercarriages last two to three times longer and the excessive undercarriage wear of bulldozers while traveling on tracks in third gear is diminished. Moreover, the ease of relocation from the pit enables maintenance to be performed preventively and in the better conditions, resulting in reductions in expensive and disruptive breakdowns."

The DB120PLUS bed can be hydraulically lowered for fast loading and once loaded, the bed is raised to a horizontal position for transport using hydraulics powered by the towing ADT.

"According to a customer above the Arctic circle, it used to take 12 hours to move a blasthole drill into another location," Höylä said. "Nowadays, it takes one hour with our DB120PLUS. You can drill lot more meters with the equipment than in the past. Used daily it opens new potential in mine planning."

## TOTAL Promotes Battery-electric Solutions

TOTAL's Nordic branches have not historically had a large presence in the mining sector. However, the last 12 months have opened up several business opportunities with major mining OEMs in Sweden, as well as at mines in Sweden and Finland.

"A significant development in the field of open-gear solutions has demonstrated our capability to reduce the total cost of operations for our customers," said Martin Steinkamp, industry lubricants sales manager for TOTAL Sweden. "And the launch of a new generation of renewable greases for the underground mining industry proves that sustainable products are part of our solution for the industry.

"The pandemic has of course had an effect on our business this year. However, because we market a very broad portfolio of products aimed at different customer segments, the negative effect in the Nordic countries has not been as large as we feared."

Steinkamp said there are two areas TOTAL is being asked to help with in the sector at present: reducing the environmental footprint of mines and optimizing productivity with non-stop operations.

"To reduce the environmental footprint, we at TOTAL are investing heavily in multiple solutions, working in close cooperation with our customers," he said. "We have a full range of fuel economy lubricants with proven field records (1% to 5% fuel economy) both for engine oils in the pit and gear oils in the plant. We also have bio-based products across our ranges from hydraulics to greases. Finally, on the digital side, our Optimizer software is an innovative solution, allowing site managers to monitor all their energy consumption and identify areas for savings."

Through 2021, TOTAL Nordics will be focusing on presenting its complete product range to miners and OEMs, particularly those for arctic conditions and electric vehicles.

"Indeed, TOTAL is the first company to launch a dedicated range for enhanced battery cooling that will ensure safe and reliable battery charging," Steinkamp said. "We will also focus on open gear applications. We have outstanding field inspection services as well as the only product in the world that can clean the gears in operation without having to stop the mills."

To further broaden its range of special greases for open gear mining applications, TOTAL is strengthening its ties with French lubricant company Lubrilog.

In the Nordics, TOTAL's range of Bio-adhesive Plus greases has been well received for underground equipment and the company is now ramping up production to supply the market worldwide.

"We are developing a dedicated offering to improve fire safety management," Steinkamp said. "HYDRANSafe HFC-E is a new-generation fire resistant, water-based hydraulic fluid. Compared with standard products, this fluid has improved anti-wear properties and optimal fire resistant. No compromises are needed anymore. It will be launched during 2020."



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# Considerations for a Mine Maintenance Program

*By making the best use of the available tools, decisions can be made quickly improving availability and keeping costs low*

By Steve Fiscor, Editor-in-Chief

Take care of the equipment and the equipment will work as it should for many years to come. To do this, the mine must develop and administer maintenance programs for stationary and mobile equipment. Many modern programs rely on data from monitoring systems, such as oil and vibration analysis, to keep tabs on the health and performance of various components. Even better tools are being developed and tested.

Training is one of the building blocks in the foundation of a modern maintenance program. Maintenance personnel need to know which lubricant is used where and why. This is especially true in the mining business where components encounter high pressures and stress daily. They also need to understand the importance of cleanliness and proper sampling.

Similarly, the engineers and executives overseeing these maintenance programs need to know the same things. They must also invest time in reading the reports and they must do so with a critical eye, not necessarily looking at the num-

bers, but looking at the trends. The era of the intelligent mine is here and the maintenance department of the future will use insight (or information) to improve its decision-making ability based on data.

## Getting the Full Benefits of Maintenance Program

Phillips 66 supplies about 70% of the lubricants used in the mines in the western U.S. by volume. When it comes to maintenance programs at a large mining operations, Steven Stollo, industrial lubricants engineer for Phillips 66, highlighted several steps to improving performance: identifying the correct oil for the application and using it consistently, understanding oil analysis and being able to interpret the data, and reinforcing the importance of cleanliness and understanding the errors associated with the automatic particle counting methods used by nearly all oil analysis labs.

The demands placed upon a lubricant and the operating conditions vary greatly with different components. To protect the equipment and address the demands

placed upon the oil, lubricants have significantly different physical and chemical characteristics. Original equipment manufacturers (OEMs) stipulate the specifications for the lubricant, which are needed to minimize wear, maximize the performance and ensure the safe operation of their equipment. This information is normally found in the service manual. Mine operators need to review the service manuals for new equipment and work with his or her lubricant manufacturer to determine the appropriate oil. Quite likely, a lubricant meeting the OEM requirements may already exist on the property. This information needs to be conveyed to the maintenance staff to ensure its use in a component.

Stollo stressed the importance of consistently using the correct oil to maximize the life and performance of equipment and not topping off with an incorrect oil for convenience. Consistent use of the correct oil can be promoted by a variety of means including lubrication surveys, work orders identifying the proper lubricant, or permanent tags mounted near the filler port, which state the lubricant. He also stressed permanent, legible, and proper labeling of hose reels and oil storage and conveyance containers. Regardless of the method used, training should exist that reinforces the differences in lubricants and the need to use the appropriate oil.

Any maintenance program can be greatly enhanced through the use of condition monitoring tools. Oil analysis is one such tool, which, if properly implemented, provides multiple benefits. Some of the most powerful benefits include the detection of abnormal wear, projecting the time to failure, determine the suitability of the oil for further use, and detecting operating problems earlier in the failure cycle.

These benefits and others cannot be realized without a comprehensive oil analysis program, which addresses all as-



Maintenance programs should include training, procedures and equipment, which promotes proper oil handling and storage techniques to minimize the ingress of airborne dirt and water.

pects of the program from the shop floor collection of representative samples taken at an appropriate interval to the office interpretation of the laboratory report by a trained individual who understands the information and trends provided on an oil analysis report. “Too many customers do not have personnel with the time or training to make oil analysis maintenance decisions,” Strollo said. “Out of necessity, many customers depend exclusively upon the warnings and comments provided by their laboratory. This information is very important and should not be ignored, but full value of oil analysis is achieved by spotting subtle changes early and knowing which changes are important, knowing where and how a component is operating, understanding equipment, as well as an awareness of recent maintenance. This knowledge only exists at the mine level.”

To gain the full benefit of oil analysis, Strollo suggested that mine owners invest in software to assist with trending the laboratory data. This greatly simplifies and improves the accuracy of the maintenance decisions, which are derived from the oil analyses.

A maintenance program should include training, procedures and equipment, which promotes proper oil handling and storage practices to minimize the ingress of airborne dirt and water. These contaminants and others will shorten the life of equipment and hinder the efficient operation of equipment.

Most mining industry maintenance managers are aware of the ISO cleanliness levels, which are suggested by many OEMs for the oil used in their equipment, but many managers may not be aware of the various problems that are associated with the various automated methods used by nearly all of the laboratories to determine the cleanliness of new and in-service oils.

These problems very often lead to elevated particle counts, which do not accurately reflect upon the cleanliness of the oil. These problems include sample preparation errors, which do not remove air bubbles or moisture from the sample or oil additive interference. To eliminate them, the filter patch method should be used to accurately determine the cleanliness of a lubricant. “In this process, lab analysts draw a set volume of oil through a patch using a vacuum,” Strollo said. “Higher viscosity oils may need to be diluted with a clean solvent. The residue that accumulates on

the patch is examined under a microscope and analysts physically count the particles or they compare it to a template of photos of other patches that are representative of different cleanliness codes. It’s labor intensive and therefore seldomly used.”

Strollo said he has to often address inaccurate cleanliness analyses with a customer. The issue is normally resolved by the collection of additional samples, which are split and sent to both the customer’s normally used laboratory and a laboratory capable of performing the filter patch method. Nearly always, the results provided by the patch method will be lower. This is a problem not only for lubricant manufacturers, but also for filter companies. One of the large filtration suppliers, Donaldson, has a YouTube video discussing this topic in-depth.

### **Establish Baseline and Implement Training**

David Kupiec, mining manager for Total Lubrificants, agreed and believes that maintenance programs at mines should focus on contamination control. To be successful in its application, lubricants must be used properly and contamination degrades the product’s ability to perform, Kupiec explained. “Most lubricant suppliers have good products and the problems are not due to oxidation or performance related, it is usually related to contamination,” Kupiec said. He believes that a lot of the lubricant-related problems are connected to contamination.

For every new mining customer, Total conducts an audit and tracks the lubricant flow from the storage system to the warehouse and on to the machines, taking samples at different stages. A pinch of dirt could divide by two the life of components, Kupiec said.

Filtration also plays a vital role. The filtration system needs to be installed in the right location and maintenance crews need to make sure it works. “Oftentimes, mines will invest in an efficient and expensive system and, when it becomes clogged, the miners just bypass it,” Kupiec said. “That is why communications and setting a baseline correctly are so important.”

Kupiec agreed that oil analysis is important, especially for mining operations. In addition to looking at the reports page-by-page, Kupiec said maintenance planners should be looking at the fleet and the equipment from a macroscopic level.

Total operates a state-of-the-art oil analysis laboratory, ANAC, in Belgium. This ANAC laboratory ensures maximum efficiency and quality by operating a unique level of automation and the implementation of the most advanced oil testing techniques. This ANAC center also hosts a unique database with several million analysis samples on all types of equipment. It also hosts a customer website used by the company’s worldwide network of Weblink ANAC laboratories. This enables Total to give specialized diagnosis and miners to access its algorithms globally even in very remote locations.

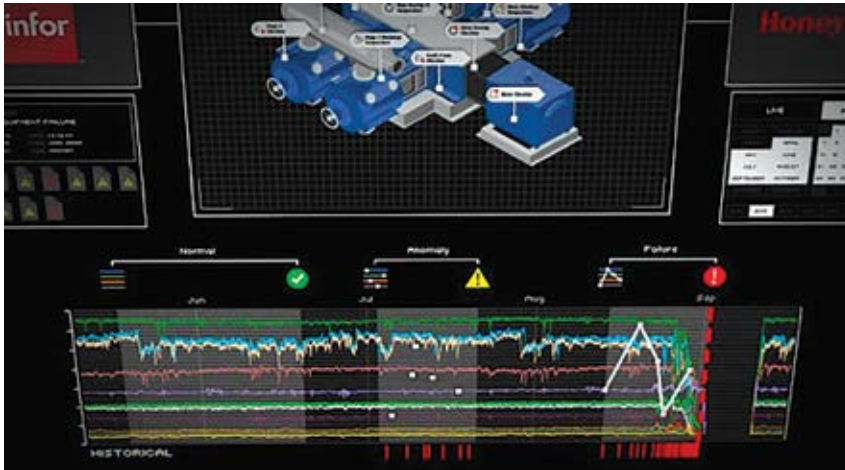
“Very regularly, we perform routine checks to make sure the values delivered from any ANAC Weblink lab in the world follow our standards and do not deviate,” Kupiec said. “It is more than being ISO certified. It’s making sure results are consistent from one year to the next and from one lab to another.

Total has a network of 20 oil analysis labs worldwide and mining customers simply send samples to the closest lab. For some of the larger mines, the company builds labs on-site. They recently installed and now operate a lab at a gold mine in Ghana and they are working on other projects around the globe.

Having Total people on-site also benefits the mine in other ways as they can readily assist with training and maintenance planning. “We have different levels of training based on the maturity level of the lubricant knowledge base,” Kupiec said. “As we move step-by-step from the baseline, we focus on best practices and experience sharing to build a reliable lubrication culture at the mine sites.”

Total also offers the TIG 6 maintenance software package, the sixth version of a digital tool that helps maintenance planners and mine engineers build programs matching oil analysis with machines and greasing schedules. Technicians can access it with devices, such as smart phones, and the system sends alerts automatically.

Total made two major product announcements recently. The first, with the recent acquisition of LUBRILOG, a leader in specialty lubricants such as open gears, the company now offers Lubriclean EP, which reduces downtime for continuously operating machines with open gears, like the ones found on grinding mills. “When it comes to open gears in the processing plant, there’s always incoming dust and



The Aspen Mtell software looks for multivariant signal patterns.

other pollutants with limited ways to prevent it from sticking to the gears,” Kupiec said. “Cleaning an open gear usually takes more than 48 hours. The plant stops the mill and operators manually remove the abrasive mixture of grease and particles, sludge, etc. from the open gear. We have created a new product that enables cleaning of the open gearing while its running. It’s a special solvent boosted with performance additives. Technicians spray the

gearing for an hour. It removes the build-up and they can inspect the gears. It shortens the inspection time to a fraction of the traditional method and eliminates all contaminants from the gear. We have already used it on more than 100 open gear units worldwide. This will be a game changer when you realize the costs involved in stopping these large mills for long periods of time.”

Total has also developed a water-based, biodegradable hydraulic oil. This hydrau-

lic oil has been designed specifically for large pieces of mining machinery with high hydraulic pressures. The benefits are twofold: it’s fire resistant and eco-friendly. When fires occur on mining equipment, it’s usually the hydraulic oil that fuels the fire as the hydraulic lines burst or burn. Kupiec said he is looking forward to introducing this to the mines.

### Predictive Analytics

What if a mine wanted to take the process one step further and predict failures even faster? Aspen Technology believes it has the answer. The company’s Aspen Mtell system is an analytical tool that makes decisions based on data and they said it is already helping mine operators predict and prevent failures faster and earlier than traditional systems.

Aspen Mtell represents a paradigm shift, when compared to traditional programs that are focused on monitoring equipment with oil or vibration analysis, which trigger alarms at certain thresholds, explained Eduardo Gonzalez, senior account engagement consultant for Aspen Technology’s APM Metals & Mining Group.

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“Aspen Mtell differs from other systems as it looks for multivariant signal patterns,” Gonzalez said. “Based on those patterns, we can identify pending failures well before the signals trigger an alarm from vibrations or changes in oil lab analysis. The system is easy to use. It’s meant to be used by personnel who are familiar with equipment, not data scientists. It’s equipment agnostic.”

More importantly, Gonzalez said it has a low time-to-value proposition. “Not long after it’s installed, it will begin to pay for itself,” Gonzalez said. “Many solutions require significant development work to identify the analytics to detect changes in behavior in the assets. In this case, all the data science work is done by the tool and it facilitates the creation of pattern recognition. We’re talking hours compared to other solutions that take days, weeks or even months.”

To reliably predict problems, Aspen Mtell uses data. “One of the barriers we see with mining is collecting data from geographically dispersed assets and large mobile assets,” Gonzalez said. “The system needs data. Data collection technology is readily available and many mines

are already collecting lots of data. Other mines will need to make an investment for data collection. Once the data is collected, the tool can be deployed and it will generate insight from that data.”

When Aspen Technology started deploying this at the mines, they started with fixed equipment, such as grinding mills, because the data is readily available through the plant’s control system. Those mines have now started using the tool on haul trucks and shovels.

A barrier to widespread use in mining is psychological or the perception of not being ready to use this type of tool. By perception, Gonzalez means a customer who feels they need to invest more money on sensors to collect more data. “We usually tell them they’re more ready than they think,” Gonzalez said. “They could leverage this tool on existing data and convert it to insight. This is a tool that can be deployed across the entire site.”

The various types of failures have different occurrence periods. “Our objective is not to predict lightning strikes,” Gonzalez said. “We are looking at degradation that occurs over time and we detect failures days, weeks and even months in

advance of the occurrence. The system that the mines are currently using detects the failure while it’s occurring. We aim to detect it before it starts.”

Aspen Mtell runs on a set of data that the mine provides. Using two types of agents, an anomaly and failure agent, the system uses machine learning to constantly improve. The anomaly agent is trained to recognize normal behavior. When behavior deviates from normal, it generates an alarm. If the deviation is confirmed, the software creates a failure agent to more precisely identify that action when it occurs again and it sounds the alarm earlier. If it’s a normal operation, the pattern is learned by the anomaly agent and it will no longer alert on this pattern.

“The anomaly agent learns not to report on false positives,” Gonzalez said. “The algorithms are already written and embedded in the software. The agents are trained on seasonal data by looking at a year’s worth of data at a time.”

Some mines have already saved significant sums of money in as little as 45 days, which pays for years of use of the software system. More than a dozen tier one mining sites are currently using the system.



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# HPGRs Grind Out Larger Role in Plant Productivity

*High-pressure grinding rolls offer potential energy, media-wear and extraction gains that producers find increasingly hard to resist*

By Russell A. Carter, Contributing Editor



Fortuna Silver Mines, which recently began commissioning and ramp-up at its \$320 million Lindero gold project in Argentina, included HPGRs in its tertiary ore crushing circuit, based on testwork that indicated HPGR-processed ore would provide higher extraction rates than that obtained using conventional cone crushers or a vertical shaft impactor (VSI).

On the evolutionary timeline of mineral processing technology, high-pressure grinding rolls (HPGRs) are neither a newcomer nor a relic of the past. Used commonly in cement production since the 1980s, HPGR technology was applied to iron ore and diamond processing in the following decade, and after the turn of the century established a firm foothold in nonferrous ore operations as well, with HPGR circuit installations in large concentrators at the Cerro Verde, Boddington and Morenci mines validating the technology for use in high-volume copper/moly and gold ore comminution.

The strong points of HPGR technology — lower specific energy consumption, reduced grinding media consumption, smaller machine footprint, higher availability — fit with current mineral producer initiatives to reduce overall comminution energy demand, accommodate harder and/or variable ore types, and streamline process circuit layout. A quick review of recent HPGR-related project announcements provides a yardstick for measuring the widening scope of interest and confidence process-plant operators have in regard to the technology.

For example, **Lumina Gold Corp.** recently completed two trade-off studies the company said will help form the basis of an updated Preliminary Economic Assessment for its Cangrejos gold-copper project in southwest Ecuador. One of the studies evaluated the addition of secondary crushing and HPGR to replace the SAG mills that were contemplated in the company's June 2018 PEA. The second study evaluated the addition of a Carbon-in-Leach circuit to enhance recoveries and allow for the production of doré on site.

Based on the latest study, comminution operating costs for the HPGR circuit are estimated to be \$3.75 per metric ton (mt) processed compared to \$5.62 per mt for the SAG milling circuit that was used in the 2018 PEA.

Lumina said FLSmidth tested a master composite made from four PQ drill holes to evaluate the viability of HPGR. Testing included JKTech Drop Weight tests, Unconfined Compressive Strength tests, Bond Low Energy Crusher Work Index tests, Bond Abrasion Index tests, Bond Rod Work Index tests, Bond Ball Work In-

dex tests and HPGR testing. The average Bond Ball Work Index for the 2019 master composite was 17.1 kWh per mt.

The study showed that on a per-ton basis, comminution circuit operating costs could be reduced by approximately 30%. Savings are driven by reduced costs for steel and lower power consumption. The study also showed that the HPGR circuit could be implemented for slightly less initial capital and equipment costs versus the conventional SAG mill circuit. The new circuit requires a lower connected power load, with an approximate 4-MW hour reduction at a 40,000-mt/d throughput.

Both studies, according to the company, showed potential for enhancements to recoveries and operating cost reductions. Lumina said it intends to integrate the addition of a CIL circuit and HPGR into its updated PEA, which it expects to release in the second quarter of 2020.

**NLMK Group**, a steelmaking company with operations in Russia, USA and the European Union, commissioned four additional HPGR units to boost productivity at its Stoilensky beneficiation plant in Russia by 800,000 mt of iron ore concentrate to 17.4 million mt/y. As a result, the plant can now cover 100% of the group's blast furnace needs for iron ore concentrate with Fe content higher than 65%.

NLMK began implementing HPGR technology in each of the plant's four process lines in 2016. The first four grinding rolls supplemented traditional cone crushers and ball mills, and enabled the plant to boost the productivity of the sections by 12.5% and to grow iron ore concentrate output by 1 million mt to 16.6 million mt/y. The plant also was able to significantly decrease the consumption of energy and grinding media required to process the ore.

Konstantin Lagutin, NLMK group vice president of investment projects, said, "Over 1.5 years of operation, the HPGR technology proved to be efficient and re-

liable. We have now launched HPGRs at Sections 2 and 3, completing the upgrade of the entire beneficiation plant. This will enable us to increase primary iron ore processing up to 37 million mt/y, up by 5 million mt/y in 2013, and become 100% self-sufficient in iron ore feedstock.”

Each HPGR unit replaced two conventional crushers. As explained by NMLK, because HPGR units not only crush the ore, but also break up its crystalline structure, the downstream stages at Stoilensky receive ore that is more ductile for further grinding, which delivers an increase in overall end-to-end productivity.

The company said its total cost to install HPGR technology at Sections 2 and 3 was 4.5 billion rubles (\$58.9 million).

**Eldorado Gold Corp.** recently predicted a 15-year mine life for its Kışladağ operation in Turkey, based on long-cycle heap-leach testwork and the replacement of the tertiary crushing circuit with a \$35.8 million HPGR circuit. The company said the addition of the circuit has increased expected recoveries to around 56%, and it believes there is potential for further increases in recovery with optimization of the HPGR circuit, which could lead to higher gold production.

**Los Andes Copper**, in an update on work conducted to progress a prefeasibility study on the company’s Vizcachitas project copper-molybdenum porphyry deposit in central Chile, said studies on the feasibility of using an HPGR circuit are progressing and show the potential for enhanced project economics, lower energy consumption, reduced maintenance and increased operational flexibility. HPGR technology has been identified as the most attractive grinding alternative, given the data obtained from the preliminary testwork conducted to date.

The **Weir Group** recently won a £100 million (\$128 million) order to provide process equipment to the Iron Bridge magnetite project, a joint venture between Fortescue Metals Group subsidiary FMG Magnetite and Taiwan-based Formosa Steel. The order includes Weir’s Enduron HPGRs and GEHO pumps. According to Weir, the equipment will allow the customer to reduce energy consumption by more than 30% compared to traditional mining technologies.

The \$2.6 billion project is located 145 km south of Port Hedland in the Pilbara region of Western Australia. When fully operational, annual production for the proj-

ect is targeted at 22 million wet mt/y. Delivery of the first ore is expected in 2022.

Ten thousand miles away in the Iron Range district of Minnesota, USA, Weir joined with the Natural Resources Research Institute of the University of Minnesota in a project to expand testing and knowledge of HPGR applicability to the taconite mining and processing sites in the region, where it’s not uncommon to see concentrators with as many as 18 rod mills — comprising the type of highly energy- and consumables-hungry operation that iron-ore companies would like to replace with more efficient processes. However, the scope of the project extends beyond the Iron Range as well.

“NRRI has done a lot of testing for many of our projects,” said Tim Lundquist, Weir HPGR manager for North America, speaking to June Breneman, a communications specialist at NRRI. “The proximity to the Iron Range is key, but we’ll also bring in material from all over the U.S., Canada, and elsewhere when it makes sense. Our preference is to work with NRRI whenever possible due to their flexibility, expediency and expertise.”

NRRI acquired the HPGR via Weir Minerals from the shuttered Magneta-tion iron ore tailings recovery operation in Grand Rapids, Minnesota. Both organizations are sharing the cost of maintenance.

## New in the Market

New-generation HPGR models are starting to enter the market, claiming to of-

fer performance improvements that will increase throughput and reduce energy and maintenance costs even further. The most recent new-gen version is thyssenkrupp’s HPGR Pro, which the company said draws upon operational knowledge gathered from 40 years of mineral-processing experience and more than 150 HPGR installations worldwide.

The new HPGR offers more throughput from the same-sized machine: according to the company, this results from using rotating side-plates on the fixed grinding roll. The rotating plates enable improved material feed and up to 20% more throughput compared with conventional HPGRs. At the same time, the specific energy consumption of the HPGR Pro is reduced by around 15%.

The uniform pressure profile in the milling gap results in better grinding and more even roller wear, improving the service life of the rolls by up to 30%. By reducing the so-called bathtub effect — accelerated wear in the center zone of the roll surface — the rolls can last longer before replacement is required.

Thyssenkrupp said a certain amount of roller skew, or uneven gap, is beneficial as it ensures uniform grinding, and the HPGR Pro provides a unique control feature that prevents excessive skew.

HPGR Pro rolls are lubricated with oil, not grease. This, according to thyssenkrupp, prevents excessive temperatures from developing during high machine usage and provides for easier cleaning.



thyssenkrupp’s new HPGR Pro model uses rotating sideplates on the fixed grinding roll — a design innovation claimed to enable improved material feed and up to 20% more throughput compared with conventional HPGR designs.

Optimized bearing seals, oil quality monitoring, and continual filtering also reduce contamination and environmental impact, while continual filtering allows the oil to be used longer.

The HPGR Pro also offers a stud detection system, automatically monitoring and measuring the condition of the studs and rolls by laser. The operator is kept constantly informed about the state of the studs and the rolls. “In this way, the stud detection system can predict the best possible time for roller replacement. Our customers no longer need to stop the machine as a precautionary measure, which saves them valuable time and money,” said HPGR Global Product Manager Frank Schroers. “As our specialists collect and process machine data, our customers can continually improve their HPGR’s operation and optimize throughput, energy consumption or machine availability in line with their specific targets.”

As mentioned in the September issue, Metso Outotec will introduce the next generation of its HRC HPGR technology, plus a retrofit kit that allows HRC technology to be applied to competitive HPGRs. Although details haven’t been released, major features anticipated for the new version include a smaller physical footprint and revised foundation requirements, lower machine height, a high level of component commonality with existing machines, and lower capex through elimination of items such as the transport cart and stabilizing hydraulic cylinder.

The company has strongly promoted the benefits of using larger HPGR models, such as its HRC3000, in high-capacity applications. Claimed advantages range from higher machine availability due to less ancillary equipment, such as conveyors, chutes, bins and transfer points, to reduced capex and opex resulting from the ability to buy, operate and maintain fewer HPGRs when a single machine can process 70,000 t/d or more of fresh feed.

Metso Outotec’s HRC machines were the first to offer flanged rolls in combination with an anti-skew system optimized for this type of roll design, with the objective to reduce “edge effect” comminution-performance falloff near the sides of the HPGR rolls, while protecting the rolls from uneven wear pattern and tramp metal damage.

Weir Minerals, noting that segregated feed problems can result in highly uneven particle sizes across the width of the

feed — and consequently, strong abrasive pressure on one side of the roll and insufficient pressure on the other — strongly endorses the concept of dynamic skewing for HPGRs. Weir claims its unique HPGR bearing design, in combination with effective edge guards, reduce wear and promote better grinding. In a white paper released in October 2019, the company explained that to accommodate uneven pressure conditions, its Enduron HPGRs use a unique spring-loaded lateral wall that reduces the edge effect (maintaining a gap of as little as 1 mm) and is specifically designed to facilitate roll skew.

Henning Knapp, HPGR process team leader for Weir Minerals, explained: “The degree to which the Enduron HPGRs skew is largely dependent on the width of the roll, with longer rolls skewing about 5 mm for every meter the roll is wide. However, the effect of even small changes can be significant on local pressure peaks.” Knapp also emphasized that skewing must be managed by an advanced control system that guides the rolls to meet desired output pressure. “This system also ensures the skew isn’t too great or maintained for too long, which both disrupt the compressive bed,” he added.

## Examining Energy Efficiency

As HPGRs continue to be applied more widely in mainstream process-circuit design, their economy of operation, reliability and ease-of-maintenance features will gain additional importance — along with closer scrutiny. For example, while HPGR energy efficiency when compared with conventional ball and rod mills has been a selling point, at least one industry expert recommends taking a wider look at potential energy-reduction benefits.

A paper\* presented by Grant Ballantyne, Ausenco’s director-technical solutions, at the 2019 SAG conference held in Vancouver, British Columbia, reported on studies that looked at not just the comminution energy intensity associated with grinding-mill motor power, but also at the power demands from ancillary equipment such as conveyors and pumps. According to the paper “...dry comminution circuits, such as those incorporating high pressure grinding rolls (HPGR), may have a power

*\*Quantifying the Additional Energy Consumed by Ancillary Equipment and Embodied in Grinding Media in Comminution Circuits, G. Ballantyne, and University of Queensland, Sustainable Minerals Institute, Julius Kruttschnitt Mineral Research Centre.*

advantage in rock breakage but use more power in material transport as they typically require an extensive conveyor system.”

One case study examined the trade-off between a SAG mill and HPGRs at a gold mine where HPGRs are operated dry and, therefore, the material is transported on conveyor belts, which can require additional power in comparison to SAG-based circuits. Additionally, HPGR circuits still require similar sized pumps to feed the hydrocyclones in the wet ball milling circuit. This ancillary power “...is not always considered in trade-off studies and has the potential to erode some of the energy benefit of HPGRs,” according to the author, who also noted that updated circuit design and other process-line innovations can preserve the comminution energy efficiency benefits of HPGRs even when ancillary energy is included.

Another approach for ensuring HPGR energy efficiency is recommended by lubricant supplier Klüber, which pointed out that when choosing the optimum gear oil for an HPGR application, determining the best balance of lubricant characteristics can be a challenge. Selecting a base oil with a high viscosity maintains thick oil films at higher temperatures. This lowers the coefficient of friction between metal-to-metal surfaces and enables high gear efficiency. On the other hand, selecting a highly viscous oil produces energy losses due to the hydrodynamics of moving mechanical components through a thick fluid.

To assist customers in making the right choice of lubricant for their HPGRs, Klüber Lubrication offers a free program called KlüberEnergy, a service that measures the energy efficiency contribution of lubricants in specific applications, with the purchase of oil. Using a detailed methodology to measure power consumption of a system before and after a lubricant “retrofit,” KlüberEnergy technicians measure baseline energy consumption and other critical parameters over a month’s period to determine the kWh per ton with the existing oil under typical loads. This measurement provides a key performance indicator (KPI). The gearbox is retrofitted with the recommended gear oil from Klüber, and the KlüberEnergy team then waits several weeks for the new oil to circulate and react to gear surfaces before performing post-retrofit measurements. Comparing the performance of the two lubricants provides positive proof of kWh, cost and greenhouse gas reductions.



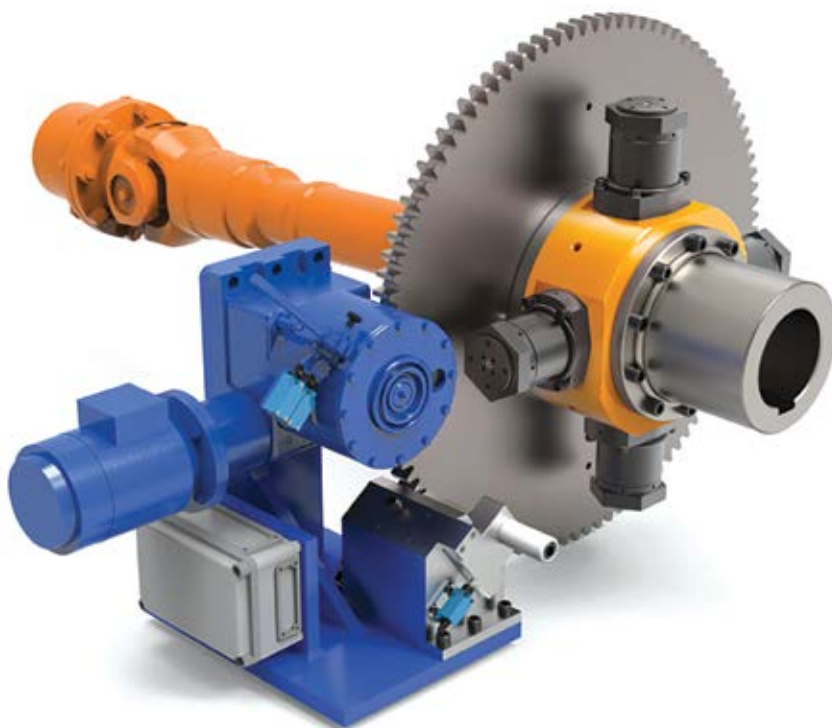
In one notable application, KlüberEnergy was called to monitor an HPGR installation at a South American iron ore producer. For both the baseline lubricant and the Klübersynth GH 6-320 that was recommended to replace it, KlüberEnergy recorded three variables every 10 minutes for over a month: power consumption, distance between rollers and in-feed rate. Once this vast volume of data was collected, KlüberEnergy experts calculated the pressure based on roller distance and in-feed rate measurements. They then analyzed the pressure in relation to power consumption.

The pressure and power consumption were then charted to compare the performance of the baseline lubricant and Klübersynth GH 6-320. KlüberEnergy used the median of all measurement values to calculate the company's savings percentage. When KlüberEnergy compared measurements between the two oils, Klübersynth GH 6-320 saved more than 68.4 MWh per month in electricity. This reduced costs by \$40,284 per year, yielding a simple payback in four months. When calculated over a full year, the oil saves 820.8 MWh in electricity use, which reduces greenhouse gas emissions by 580 mt, according to the company.

Meanwhile, other well-known industry suppliers have developed solutions designed to support HPGR power efficiency and minimize the duration of maintenance and repair shutdowns. For example, Siemens has extended its Simine digital-solutions portfolio for HPGRs to include a new controller with plug-and-play functionality which, the company said, makes the load share controller immediately useful.

According to Siemens, the new load share controller follows a proven control scheme: At HPGR startup the controller is inactive, but when a specific torque level is reached the unit assumes load-share control. If the controller is not available — such as in the event of an operational disruption — the drives do not start. Operation without load sharing is available, however; in that case, the drives take the speed reference from the mill automation.

Noting that load distribution between the rolls in an HPGR is generally 50-50, Siemens said the master follows the speed command and the slave follows the torque of the master. If an alternative load distribution is required, it is possible to change the load distribution between the drives using the load distribution factor. The ref-



This custom Turning and Locking (TL) system is designed by Twiflex to allow operators at a Turkish gold mine to slowly and safely turn and lock the twin grinding rolls of a large HPGR for repairs or maintenance shutdowns.

erence torque on the slave drive is then decreased or increased compared to the reference torque of the master drive. At the same time, the load share controller maintains the speed difference between the rolls within given limits. A process engineer can, via a web server-based operator interface, adjust the load share factor and limitation for speed difference at any time, even during the grinding operation.

In another example — a case history provided by Brunel Corp. — the company sought a reliable power transmission solution involving an HPGR custom gear Turning and Locking (TL) system for process equipment supplier FLSmidth.

It was needed for a new dual-drive, 2,000-kW HPGR going into service at a gold mine in Turkey. TL systems are designed to slowly turn and lock the twin grinding rolls, allowing for safe repair/replacement of worn tires during scheduled maintenance shutdowns. A chain/sprocket inching drive — slow to install and cumbersome to operate — was previously used to perform this task.

Based on prior successful project collaborations, Brunel contacted Twiflex, part of Altra Industrial Motion, for assistance. Twiflex supplied a TL system comprising a turning gear which engages with a 1,000-mm-diameter (39.3-in.) gear-

wheel mounted on the output flange of a Brunel torque limiter. The turning gear includes a 1.5-kW motor with a gearbox to produce breakaway torque of 3,760 Nm (2,773 lb-ft) and output torque (continuous turning, bidirectional) of 1,580 Nm (1,165 lb-ft) at a nominal turning speed of 5.2 rpm. A frequency converter was included to allow the turning speed to be controlled between 1.3 rpm and 5 rpm.

The bidirectional turning gear is designed to turn the grinding rolls clockwise or counter-clockwise and is rated for continuous operation. A hand-operated clutch mechanism is used to engage and disengage the drive with a limit switch fitted to indicate its position. The system includes a manually operated tooth-locking device with a rated torque of 52,000 Nm (38,353 lb-ft), that locks the gear-wheel in place. The status of the locking device is monitored using limit switches (i.e., lock on/lock off).

The Twiflex TL system also included an operation panel for local control of the turning gear. A plug-in handheld corded pendant was supplied for remote control of the turning gear close to the equipment. Brunel engineered and delivered a neatly packaged solution that incorporated all the components into a compact footprint assembly.

# Programming it to Succeed

*Recent ventilation projects show the importance of both airtight planning and innovating on the fly*

By Jesse Morton, Technical Writer



Above, the nose fairing of the axial fan system offered by CFE Technology GmbH. The system offers fully automatic operation, a smaller overall footprint, and significantly improved airflow control over competing centrifugal fan-based solutions. (Photo: CFE)

A couple of ventilation projects recently described to *E&MJ* showcase bold innovation meant to ensure the success of the solutions deployed. They also revealed how important it is to have plans in place to deal with the more predictable, inescapable challenges. Based on a couple other headlines from the space, it is apparently crucial for suppliers to strive to offer both.

## Turnstone Cools Hell

Turnstone Industrial Solutions, a joint venture between ABC Technology Group USA and Calandra Group LLC, completed a couple big projects in late 2019 and early 2020 that show the burgeoning capabilities of the new company.

While the company is best known for its HardLine ducting, the projects also demonstrated its engineering expertise, Bryon Cerklefskie, U.S. sales manager, Turnstone, reported.

For both jobs, Turnstone was brought in to assess and consult. It was then tasked with engineering the solutions. For both jobs, the results beat expectations and led to new contracts.

The first job was at a salt mine in New York and launched in September 2019. “We were contracted to assess the project, then tasked with developing an engineered solution,” Cerklefskie said.

The problem was the system, which used 30-in. fiberglass ducting, “had difficulty clearing out dust and fumes post blast.”

That created long re-entry times, which affected productivity.

“The mine shot on third shift, and was losing a lot of production time on day shift while the blast contaminants cleared,” Cerklefskie said.

Turnstone engineered a face ventilation system using 30-in. HardLine-MAX ducting.

“We switched to our product and then we did the engineering to calculate the optimal length of the runs and the type of transitions,” Cerklefskie said.

AirSTOP curtains were also installed. “The new configuration comes with double seams, grommet holes, extra height for muck, and zipper doors,” Turnstone reported. “All of these features allow for a better seal and lower leakage.”

When reality clashed with plans, “we had to innovate a bit,” Cerklefskie said. “The openings in there are so big, so different at times, that you’ve got to use a little bit of common sense mixed with very sound engineering, and then try it.”

Common sense told Turnstone to split the main line to the face, and to put in a damper system to “cut the air back and forth and push it different ways,” Cerklefskie said.

The result is effective evacuation of the air at the face. “It allows you to aim the air not just straight at the face, but actually to turn a corner so then you could manipulate that regulator for different times and different needs to accommodate whatever you need,” he said.

“That is something they didn’t have before. They weren’t sweeping the faces as effectively as they could have been,” Cerklefskie said. “Now the miners have control where, during these phases, if they see something a little bit different, they can adjust the system to manage it. Before they just had a start-stop button for the fan and that is it.”

After the project, an assessment followed. A hot-wire anemometer showed that the ducting in all five tunnels provided an airflow of a minimum of 15,000 cubic feet per minute (cfm).

“The logs show a drastic decrease in NO<sub>2</sub> and CO<sub>2</sub> concentrations using the new system, which means that the air is being circulated more effectively than before,” Turnstone reported. “On average, the new system has decreased re-entry time by two hours.”

Often, within a half hour of blasts, the area can be worked. “It went from can’t mine, can’t produce, can’t do anything until the air clears, to the miners are in there and mucking away,” Cerklefskie said. “They loved it.”

And they loved Turnstone. The salt mining company and Turnstone then moved to optimize tubing size. Next it “is going to roll out to their sister mines,” Cerklefskie said.

“We’ve gained that trust and we are going to spec out and do the full turnkey package for them,” he said. “It was a big win for us.”

It was the start of a streak. Turnstone partnered with a gold mine in Nevada late last year on a ventilation system optimization project that ultimately more than doubled the airflow to three faces.

Turnstone was brought in to first assess and then engineer the solution. The miner presented historical data that showed the predecessor system, on average, could only get less than half the air produced by the fans to the faces. Most of the fan fleet was more than 20 years old.

Cerklefskie said the old system’s performance was basically the sum of its parts. “They were using a flexible-type ducting that is very high resistance. It was a metal-spiral-wrapped fabric tubing,” he said. “That has got the highest resistance out there. That was a big part of it.”

In one section, the mine used 26-in. PVC hardline and 36-in. round ventbag.

PVC becomes brittle when used to conduct air, Cerklefskie said.

“This stuff is heavy and they were limited to a round profile,” he said. “It was a little less expensive and was popular back in the day.” What was saved in initial capex was later lost as opex, he said.

For example, the fan produced 24,000 cfm, and the tubing and ducting managed to deliver 9,900 cfm to the face. “Leakage and shock loss were 58.8%,” the miner reported. That translated to a pressure loss of 93%.

Turnstone and the miner upgraded the section with 48-in. oval HardLine-MAX



A gold mine in Washington state contracts Turnstone for more than 1,000 ft of 60-in. oval HardLine ducting. The HDPE-based polymer tubing maximizes airflow for the space available. (Photo: Turnstone)

tubing and 42-in. TwinDuct zipper ventbag. A new fan was installed.

The fan produced 41,400 cfm, and the tubing delivered 40,200 cfm to the face.

“Leakage and shock loss were 3%,” the miner reported. That translated to a pressure loss of 34.9%.

Airflow from the fan increased by 17,500 cfm or almost 73%. Airflow delivered to the face increased a whopping 30,300 cfm or 307%.

“That was achieved by combining resources with the mine. We shared data, combined expertise and then laid everything out properly,” Cerklefskie said. “We really dove in together to understand what they needed and understand it very clearly. We programmed it to succeed, rather than hoping for the best.”

The temperature at the face averaged 67°F after the upgrade, the miner reported. Which is of almost metaphysical significance, Cerklefskie said.

“It was the lowest working area in the mine and was called Hell,” he said. “At the time, it was well over 100°F.” With the humidity, few could take more than 15 minutes in the work area at a time.

“After that initial install, they brought the whole management group down and stood at the end of the tube,” Cerklefskie said, “and all of them were comfortable.”

Afterward, the miner and Turnstone upgraded another section with two faces. The section used a 2012 model, 42-in.,

100-hp Jetair fan, with 38-in. PVC and 36-in. round ventbag.

The fan produced 23,000 cfm. Of that, the tubing delivered 7,300 cfm to each face. That translates to an airflow loss of 68% and a pressure loss of 81%.

The mine installed a 2018 model, 44-in., 150-hp, two-stage Spendrup fan; and 48-in. oval HardLine-MAX and 42-in. TwinDuct zipper ventbag.

The new fan produced an airflow of 44,600 cfm, an increase of 21,600 cfm or 94%.

Airflow at one of the faces was 14,600 cfm, an increase of 7,300 cfm, or 100%. At the other face, it increased by 10,500 cfm, or 144%, to 17,800 cfm.

“The 48-in. HardLine-MAX and 42-in. TwinDuct zipper ventbag reduced airflow loss from 68% to 27%,” the miner reported.

Cerklefskie described such results as “pretty crazy.” At times, “they were losing like 90% of their pressure from leakage. We got the volume loss down to 5%,” he said. “That is huge.”

It proved to be a coup. “We gained a lot of trust,” Cerklefskie said. That trust brought new work. Turnstone now has product on 10 different levels at the mine.

“It paved the way for us to keep optimizing their system and implementing more, not only of our rigid tubing, but our flexible tubing, zipper couplings and other features that folks there have shied away from,” Cerklefskie said. “Now we’ve been



At a salt mine in New York, Turnstone Industrial Solutions installs 30-in. HardLine-MAX ducting. It conducted 15,000 cfm to the face and led to a ‘big win’ contract for a turnkey package. (Photo: Turnstone Industrial Solutions)

able to come out and prove that our stuff is reliable," he said. "They can trust us and ever since then they've never looked back."

### CFE's Axial Fan Reverses Fast

CFE Technology GmbH reported its axial fan system, with an electric motor, variable pitch control and push-button-reverse functionality, is capable of reducing the time needed to go from normal to reverse operation to less than 10 minutes.

Norbert Kuhn, general manager, CFE said, the system offers "significantly higher efficiency" and "decisively increases the operational safety of the mines, while at the same time reducing costs."

The system offers several advantages that include fully automatic operation, a smaller overall footprint, and significantly improved airflow control over competing centrifugal fan-based solutions. Heightened control comes from integrated blade adjustment, according to a report by CFE.

"This adjustment consists of a central planetary gear and bevel gears that are directly connected to the blades," CFE reported. "In the adjustment mode, the sun gear is moved by a hydraulically or electromechanically driven swivel drive. This movement is transmitted to the bevel gears of the blades via the planetary gear, which changes the angle of the blades."

A sensor on the rotary actuator monitors the change in angle.

"The value of the sensor is permanent compared with the proportional valve attached to the hydraulic unit and, if necessary, corrected," CFE reported. "With this technology, the blades can be adjusted to an angle of more than 220°. This ensures reversing operation with a flow rate significantly above 80% of normal operation."

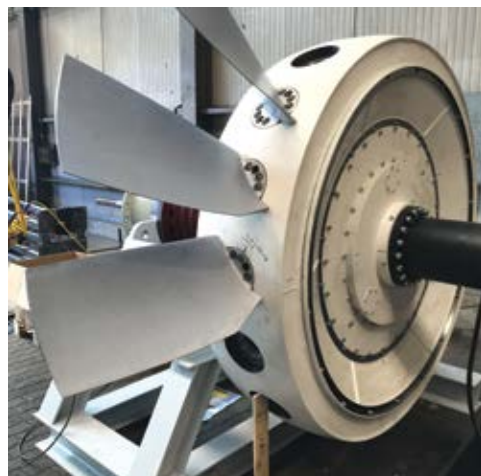
The design was first deployed roughly a decade ago at Janina coal mine in Poland, which was operating outdated centrifugal fans. The miner needed a system that could reverse airflow in an emergency. It was also looking to cut costs.

"Two centrifugal fans with lower efficiency were replaced by one axial fan for reversing operation and variable pitch control," Kuhn said. "This made it possible to significantly optimize the mine's ventilation while at the same time reducing energy costs."

The new fan motor was rated at 1.2 MW and offered a speed of 745 rpm. Auxiliary devices include the hydraulic systems for controlling the blades and brake.

The system features silencer baffles to absorb sound. Dedicated centrifugal fans in external arrangement cool the drive motors.

The system is designed for optimal operations in various contingencies. It has an emergency power supply, and an integrated emergency backup fan on standby. If the main power supply goes, the impeller blades return to a neutral position



Above, the rotor assembly for a CFE axial fan system to be deployed to an operation in Kazakhstan. (Photo: CFE)

and the damper-louvres close. While the system was designed for unmanned operation, it can also be operated from the main control room.

The system was commissioned in February 2012. "Results after commissioning exceeded the guaranteed values in both normal and reversing operation by more than 10%," Kuhn said. "Due to the higher efficiency and better reliability of the fans from CFE Technology GmbH, the ventilation of the mine is much more stable and the miners' work is also safer."

Those initial results were duplicated at later deployments, including one in China and one in Belarus, he said.

"Despite the higher capital and maintenance costs, total savings of more than 15% compared to a conventional design can be achieved, so the payback period is extremely short," Kuhn said. "This has been proven in several applications."

Currently CFE is installing an axial fan system at a plant in Kazakhstan.

The deployment at Janina illustrates the viability of the system as well as the company's expertise at applications engineering, Kuhn said. "CFE is able to solve almost all aerodynamic problems in the shortest time possible with programs developed in house," he said. "This significantly shortens the planning phases and makes them more cost effective for the customer."

### Zitrón Plants US Beachhead

In early 2020, Zitrón S.A., headquartered in Asturias, Spain, launched the subsidiary Zitrón USA.

Zitrón's stateside facility is located in Bluefield, West Virginia, and spans



For CFE's flagship axial fan system, with push-button reverse capability, the impeller assembly is mounted on a shaft end from the main motor. An actuator on the impeller hub then controls the blades in flight. (Photo: CFE)



In 2012, Zitrón S.A. installs the 630-kW ZVN 1-30-630/8 fan system at Pajingo gold mine in Queensland, Australia. (Photo: Zitrón S.A.)

70,000 ft<sup>2</sup>, with warehousing, manufacturing and service capabilities.

The development is part of the company's mission to expand its global presence, according to Encarna Quesada, marketing director, Zitrón S.A.

"The goal is to meet the growing demand from the North American market," she said. "There was a real demand from the U.S. market for us to be present in the country, and we also have found a reliable local partner."

The company, founded in 1963, is known for its custom fans. "Zitrón also provides complete solutions," Quesada said. "Zitrón provides optimized ventilation design, manufacturing fans with varying capabilities for diverse applications."

Joe Finn, a contracted U.S. representative of the company, described Zitrón as the world's largest axial fan engineering and manufacturing firm.

Zitrón reported it has installed 20,000 fans in a half-century. It boasts of having a mining fan operational in the most northerly inhabited place on earth, as well as of numerous more recent projects elsewhere around the world.

For example, the supplier installed three 1,300-kW vertical fans at Booyensdal platinum mine in South Africa; two 630-kW horizontal fans and switch rooms at Newmont's Tanami mine in Australia; a 2,800-hp fan as part of a turnkey project for Minera Saucito silver mine in Mexico; a 1,200-hp, 10-ft fan at the Kilyati mine in Finland; two 1,500-hp ATEX fans and switch rooms for Polyak mine in Turkey; and a 575-kW fan at Capstone Gold mine in Mexico.

As prolific as it is, and despite offering relatively short lead times, Zitrón focuses

on quality, tailored solutions made possible by its superior assets, Quesada said.

Zitrón reportedly has the world's largest testing facility of its kind. It is longer than a football field, is AMCA certified, and can test fans up to 3,300 hp and 19 ft in diameter.

The company reportedly also has "the world's largest database of factory performance tested fans."

The two superlatives give Zitrón the ability to custom design fans using empirical data followed by rigorous factory acceptance testing. "Fans from 15 hp to 12,500 hp, and with diameters from 30 in. to 17 ft, are designed, fabricated, tested and supplied all over the world," the company reported.

The KPIs from those fans prove their viability. An internal study of 4,700 fans, all larger than 48-in. in diameter, found that the mean time between impeller failures was 13,000 hours, and between motor failures was 16,600 hours. Availability was 99.9%.

Caleb Warden, sales director, Zitrón USA, said the company's superior quality solutions arise in part from a dedicated customer focus. "Customers choose Zitrón because we are a trusted partner who will work tirelessly to deliver the optimal ventilation solution for each project," he said. "Our passion in solving design challenges makes each project as unique as our clients."

Other than fans, Zitrón supplies diffusers, control panels, sound attenuators and winches. It also supplies safety solutions, such as dust extraction technology, which "provides safer, cost-effective control of combustible dust," Warden said.

Zitrón offers a machine health monitoring solution for managing ventilation systems for better efficiency. "Control and monitoring systems are based on continuous acquisition of data, and help increase productivity and safety in mines," he said. "It is a revolutionary approach that offers an efficient way of automating and optimizing mine ventilation, providing safer working conditions, productivity improvements and energy savings."

Beyond the launch and the new partnership, the company also recently increased factory floor space. Such routine investments in capacity, R&D, and in new materials and techniques "have positioned Zitrón as the industry benchmark," Quesada said.

Nonetheless, "our most valuable asset is the 462 professionals that make up the global Zitrón team," she said. "We should not forget that Zitrón was built on the shoulders of our employees and our success is driven by our people."

## M&RC Charges Ahead at Palabora

Murray & Roberts Cementation (M&RC) reported it completed the pre-sinking phase of a 1,200-m-deep ventilation shaft for Palabora Copper's new LIFT II underground block cave mining area.



In 2015, Zitrón S.A. installs the massive 5,600-kW ZVnV 1-36-1400/8 fan system at the Dugald River mine in Queensland, Australia. (Photo: Zitrón S.A.)



Above, during the pre-sink phase for a 1,200-m-deep ventilation shaft at Palabora Copper, in South Africa, water incursions occurred down to the 50-m level. To answer, Murray & Roberts Cementation use a quick-setting chemical compound, concrete lined the barrel, and resealed behind the lining. (Photo: M&RC)

Palabora Copper, located in South Africa's Limpopo Province, is described as the country's sole producer of refined copper.

The shaft sinking contractor started the 8.5-m-diameter shaft in early 2019. Pre-sinking went to a depth of roughly 50 m. M&RC expects the shaft to be complete in Q3 2022.

Graham Chamberlain, project executive, mine development, M&RC, said the main challenges thus far, aside from

those presented by COVID-19, were from unconsolidated rock and water.

"We had water intersections at various levels down to 50 m below surface," he said. "The type of water inflows we encountered were from various sources underground and easily found their way into the excavation around the fractured ground."

The company has a few solutions it deploys in such situations. "We made

use of a quick-setting chemical compound in close proximity to the shaft," Chamberlain said. "We then concrete lined the barrel and resealed behind the lining."

Going from the pre-sink phase to the main sink phase involves removing the temporary infrastructure and installing the permanent sinking infrastructure. "The main components are the winding plant for the kibbles and stage, the headgear and tipping arrangements, and all the services and controls systems required to operate the shaft," Chamberlain said. "We have a separate, highly skilled in-house team that does this."

The predicted challenges to the main sink piece relate to geology. "The other challenges are getting the teams functioning smoothly with all the new technology," he said.

"Our preparations and methodology is to cater for the worst known condition and be ready with a quick response plan for the unknown conditions," Chamberlain said. "From experience, we also have backup emergency plans and equipment on standby. In respect to the teams, we



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have chosen individuals with both a good safety and team player attitude.”

Advanced machinery in use includes high-penetration-rate hydraulic drills on robotic arms nested on the shaft-sinking stage. The arrangement allows drilling at any position in the shaft without worker contact with the drills.

“Our drilling equipment has been modified for efficiencies and noise reduction,” Chamberlain said.

Other newer solutions include the winding plant, which has been upgraded with state-of-the-art safety systems, he said. “Our explosive delivery and placement systems are also improved and apply the most modern information capturing systems.”

To deal with poor ground conditions, M&RC takes the shaft lining to the bottom of the shaft during sinking, as opposed to taking it to roughly 20 m from the bottom.

“Our lining approach is applied with the use of a modified version of the traditional shuttering and our specialized concrete mixes, which we design for this specific purpose,” Chamberlain said. “The mixes are prepared and delivered by our on-site batch plant.”

Despite the size of the shaft, Chamberlain said, ultimately more time is spent by management dealing with “outside influences” than is spent internally running the project.

“You cannot spend enough time educating and communicating to all interested and affected parties,” he said. “Being involved with the community and showing tangible benefits toward local employment and skills development, coupled with supporting the local businesses in the area, have been key factors for a smooth project thus far.”



Above, a crawler crane lowers the headgear assembly during the pre-sink phase for a ventilation shaft at Palabora Copper. M&RC reports the pre-sink phase is now complete. The shaft is expected to be completed in Q3 2022. (Photo: M&RC)

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# Mining Conveyors Make Transitions

*Modern conveyors systems can be engineered for greater capacities, low maintenance and high availability*

By Steve Fiscor, Editor-in-Chief



A construction photo shows the transfer building where Chuquicamata's 11,000-mt/h conveyor system, which travels a 6.4-km ramp from the underground ore storage bins, discharges on to another conveyor that transports the ore to a processing facility 5 km away.

For material handling, few systems can compete with conveyors, especially over long distances. Those long distances on grade or uphill, however, require more power and stronger belting. They also usually involve a transition such as a curve or a transfer point, which introduces another set of variables and more costs.

Conveyors also require a lot of moving parts, including motors, drives, pulleys, and idlers. These moving parts along with the chutes in the transfer points require maintenance. To keep the availability high on these systems, they must be designed with maintenance in mind.

When a mine makes this type of major capital investment, it expects high levels of availability. Usually, these conveyors are the primary means of ore transport and, when they go down, the entire operation goes down. To protect the investment and maintain production, they also must be designed with a relatively high safety factor.

Conveyor systems continue to evolve. Previous systems were a series of flights

with each flight traveling in a straight line. They were limited by elevation changes and the tensile strength of the belting. Over the years, the engineers that design these systems have learned how to install curves and increase the amount of power the drives can input into the system.

## Building the World's Most Powerful Conveyor

In 2019, Corporación Nacional del Cobre de Chile (Codelco) converted its Chuquicamata mine, one of the largest open-pit copper mines in the world, to an underground operation. The state-owned company selected TAKRAF to supply the principal ore transportation system that move crushed copper ore from underground storage bins to a mineral processing facility on the surface.

"The system called for no redundancies, which meant that for this project, high system availability, minimal system wear and easy maintenance of components were all decisive factors," said Mario Dilefeld, head of belt conveyor systems for TAKRAF GmbH, who has a doctor in engineering.

The scope of the Chuquicamata Underground Project (Chuqui UG) called for:

- Removal of crushed ore from 60 m high underground storage bins with a con-



Installed in a drift that extends 6,400 m to the surface, the inclined conveyors overcome an elevation of 950 m.



veying capacity of 11,000 metric tons per hour (mt/h);

- Transportation to the surface with a minimum number of transfer points;
- Conveying the ore from the underground tunnel exit to the processing plant; and
- Ensuring high-system availability, minimal system wear and easy maintenance of all components.

The conveying network begins at the underground ore storage discharge. Two ore storage bins measuring 6 m in diameter and 60 m in height control the flow of mined material onto the conveyors. Feeder conveyors move ore from the storage bins to the main conveyors. “As with any belt feeder, the contour of the material to be conveyed is specified by a shear gate and the flow of discharged material is defined by varying the conveying speed,” Dilefeld said.

Two conventional trough conveyors connect the feeder conveyors with the loading point of the inclined conveyor around 900 m away. Installed in a drift that extends 6,400 m to the surface, the

inclined conveyors overcome an elevation of 950 m. “Each underground transfer point along the tunnel required an underground chamber with a crane for maintenance work, power supply, transformers, and electrical and mechanical drive technologies, with adapted ventilation and suitable access paths,” Dilefeld said.

To minimize the number of transfer points, the inclined conveyor section was successfully developed employing just two flights. “To achieve this feat, it was necessary to use newly developed components that redefine the performance limits of belt conveyor technology,” Dilefeld said. “ST10,000 quality conveyor belts were used for the first time underground. Operating belt safety ratings of S=5 required belt connections with a reference fatigue strength of more than 50%. This value was proven on a belt test rig at the University of Hanover in Germany. Once again, new dimensions were achieved — this time in terms of installed drive power — with 10 megawatts (MW) of installed drive power per drive pulley and 20 MW per conveyor.”



To replace idlers, a specially designed maintenance vehicle travels along the conveyor path.

In cooperation with the drive motor manufacturer, ABB, TAKRAF engineers developed a drivetrain consisting of a 5-MW synchronous motor, a membrane coupling to connect the pulley shaft and rotor shaft and a drive pulley.

The drive pulley had the following specifications:

- Simple alignment and motor air gap adjustment during installation of the drive;

## Designing Chuqui UG's Drives

ABB provided the engineering design, gearless conveyor drives, electrical equipment for power supply, energy distribution and automation for the Chuqui UG conveyor systems. The three principal 11,000-mt/h conveyors feature gearless conveyor drives equipped with large ABB AC synchronous motors with a rated power of 5 MW each, resulting in a motor shaft torque of about 900 kNm. It is also the first transportation system in the world to employ the ST10000 steel cable belt technology on an uphill drift (ramp) conveyor.

“This mega project achieves a number of firsts, from the system’s installed drive power to the application of the ST10000 conveyor belt,” said Marc Hollinger, TAKRAF project manager. “This was a complex project of the highest magnitude demanding global cooperation between internal and external parties.”

“This is a new milestone in underground applications for continuous mining. It is the highest drive power ever installed on a conveyor and uses a wide range of features for data acquisition, equipment assessment and process optimization,” said Ulf Richter, global product manager for belt conveyor systems at ABB. “In piloting this gearless drive application with TAKRAF, we have overcome tremendous technical and logistical challenges due to underground situations, elevation change and capacity requirements.”

ABB liquid-cooled MV voltage-source frequency converters, together with large synchronous motors, deliver a decrease in active and reactive power consumption. This is highly energy efficient, and without additional network filters.

ABB’s Mining Conveyor Control Program (MCCP) ensures smooth belt operation and safe synchronization between high-power motors and high-power hydraulic brakes, necessary for secure operation of steep uphill conveyors. The drive systems also work without mechanical backstops.

A novel embedding concept, developed jointly by TAKRAF and ABB, enables straightforward installation and alignment of the gearless conveyor drive motors, saving installation time and longer deployment of maintenance teams. This was considered a major benefit compared to existing gearless conveyor drives in cantilevered construction. The concept also meant motors were 100% factory assembled and tested. They can also be mechanically disconnected from the drive pulley quickly so operations can continue if drive failure occurs. The total installed drive power for the entire system, including multiple feeder conveyors, totals 58 MW, of which there are 11 5-MW gearless synchronous motors. The new underground project is expected to extend operations at the Chuquicamata mine for the next 40 years.



The overland conveyor’s discharge at the mineral processing facility employs four 5-MW gearless drives (inset).

- Simple readjustment in the event of motor air gap deviations from the setpoint (e.g., after settling);
- Complete and fully assembled factory-tested motors on site (no motor assembly in a dusty environment); and
- Simple separation of the connection between the drive pulley and motor to ensure continued operation of the system for the short term with a reduced number of drive motors.

Maintaining the air gap between the rotor and stator was a crucial requirement for the operation of the motors, Dilefeld explained. The air gap, which is 14 mm, must only be allowed to deviate from the setpoint within small tolerances. “Deviations in the air gap reduce the efficiency of the motor, and if rotor and stator were to make contact with each other, this would result in damage to the motor,” Dilefeld said. “The air gap itself is continuously monitored during operation. If deformations and/or subsidence in the steel structure or in the motor foundations lead to a deviation in the air gap setpoint, the stator must be realigned. To simplify this process, the spacing between the rotor and stator at the non-driven end of the motor was fixed by a support bearing.”

The membrane coupling compensates for the deformation of the pulley

### PPI Supplies Hardware to Yukon

During June of 2018, PPI was awarded a contract to supply the pulleys and idlers for a mining project in Canada’s Yukon Territory. The heap-leach gold mine is the most advanced in the region and is developing toward becoming the largest gold mine in Yukon’s history. “Our customer supplied the material handling system to the mine owner,” said Nick Phillips, product sales manager, PPI. “The extent of the project included nine conveyors and three feeders, ranging in belt widths from 42- to 72-in. wide.”

This project required collaboration from various departments within the U.S. and Canada to make this opportunity a success. The contract scope included a large number of pulley assemblies produced at PPI Canada as well as a large number of idlers and structural components from PPI U.S. Over the course of several months, 63 pulleys with shafts, bearings and take-up frames were manufactured and shipped to the mine site. During this time period, approximately 20 truckloads of idlers and

shaft caused by belt tension, Dilefeld, explained. “The adjustable motor frame facilitates alignment of the motor during installation and ensures simple realignment if necessary,” Dilefeld said. “Eccentrics and spindles allow the stator to be



A Yukon gold mine recently installs this overland conveyor with PPI structure and hardware.

structures shipped from PPI Corning and PPI Lenox to the mine site.

For long, flat overland conveyors, PPI produces a stand that works well. “We can produce the C channel, rail sections and stands, and we can supply those at a competitive price,” Phillips said. “It’s great way to build an overland. When the material arrives at the mine site, the crews just bolt it together.” The mine is currently using the system to place ore on the leach pads.

adjusted in all directions. Should a motor fail, it can be quickly moved into a disabled position by opening the membrane coupling and adjusting the spindles. The system can then continue to operate only with reduced power.”

The conveyor from the underground tunnel discharges on to an overland at transfer station. That overland conveyor delivers ore to the mineral processing plant 5 km away.

The landscape surrounding the processing plant has been shaped by more than 100 years of mining at Chuquicamata. In addition to the various processing systems, waste heaps, railroad tracks, roads, pipelines and buildings scar the landscape. The challenge for the new conveyor system was to design a system that took into consideration this landscape for its entire length.

The overland was a continuous single-flight conveyor developed with the following parameters:

- Distance of 5,330 m between the material loading point and material discharge with a difference in height of 287 m;
- Horizontal curves with tight radii (1,600 m to 2,300 m) on more than 60% of the conveyor length; and
- Approximately 50% of the conveyor length on elevated structure with vari-



The overland conveyor passes over infrastructure that has accumulated over 100 years.

able lengths adapted to local conditions for foundations positioning and with support intervals of up to 96 m.

The conveyor design again revolved around ensuring high system availability, minimal system wear and easy maintenance of components. All loading points along the conveyor route were optimized in order to reduce conveyor belt wear. The arrangement of the rock boxes and grizzlies was verified with simulations using the Discrete Element Method (DEM).

Specially designed transfer chutes allow wear plates to be replaced quickly and easily. To replace idlers, a specially designed TAKRAF maintenance vehicle travels along the conveyor path, Dilefeld explained. "It can lift the conveyor and replace worn idlers to safely and efficiently," he said. "At the material discharge point, a bunker building performs a limited material storage function. Two feeder conveyors remove the material and feed it to the processing plants."

Three 5-MW direct-drive motors drive this conveyor, with a ST6,800 conveyor belt with a belt safety of  $S=5.1$  being

### A Transfer Unto Itself

RBL-REI has recently commissioned a belt deviation system for a Polish mining company, which allows one belt to change direction without motorization. Due to the narrow corridor available between the quarry and the plant, RBL-REI was asked to engineer the conveyor system. Ordinarily, that would include a transfer point and two separate overland conveyors between the origin and the destination. To optimize the project capital expends and coordinate starting and stopping times between the two overland conveyors, RBL-REI designed a single flight system — meaning the same belt is working upstream and downstream from the transfer point. A belt deviation

used, Dilefeld said. Vibration behavior of the belt during start up and braking was analyzed across all operating conditions using dynamic belt calculations.

System parameters such as a ST10,000 conveyor belt and 20-MW drive power per conveyor redefine the limits of belt conveyor technology, Dilefeld said. This made it possible to achieve the goal of reducing the number of under-



RBL-REI inserts a transfer point in one continuous conveyor. Traditionally one conveyor discharges on to another at a transfer point.

system without motorization was specially developed for this project to unify the two sections. In addition to eliminating the costs of the drives and a substation, the system also avoids the problems of chute clogging with sticky material.

ground transfer points, thereby justifying the use of these components.

High system availability, minimal system wear and easy maintenance of components were essential criteria when designing this system. Numerous innovations that were implemented for the first time. Six patents were awarded on this project, which resulted in a modern, powerful and environmentally friendly conveyor system.

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# Is Your Workforce Prepared for the Digital Mine?

*With digital advancement comes a need to make sure workers are equipped with the right skillsets*

By Rebekah Kowalski and Barry Elliott



As workers' roles continue to rapidly evolve in the industry's move toward digitalization, companies should focus efforts on modernizing their employment value proposition and developing a strong workforce strategy.

Today, companies find themselves in a unique global position. Mine operations may be paused or disrupted due to COVID-19, but it shouldn't stop them from looking to the future to determine how to address one of the industry's top challenges: the evolving workforce.

Digital technologies are changing the way mines operate and how they solve challenges like keeping up with growing demand while addressing declining ore grades. As this transformation continues, there will be a greater need for digital skills to use new tools that can help improve productivity and visibility in mines. And new workers with specialized skills will be needed to help mining companies get value from their data and from new technologies like machine learning.

Reshaping the workforce for a digital mine could prove difficult as they compete for hard-to-find skilled workers. Talent shortages, for example, are currently cited as a top risk for mining companies and are the most severe since 2006. And

95% of candidates that mining companies would like to hire are currently employed or engaged elsewhere.<sup>1</sup>

But by taking some critical steps to modernize the workforce, businesses can put themselves in the best position possible to attract and retain the employees needed in the digital era.

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**Talent shortages are currently cited as a top risk for mining companies and are the most severe since 2006.**

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## A Changing Workforce

Technology in today's mines is reshaping the work employees do and the skills they use to do it.

For starters, a mix of technical skills and soft skills like project management, communication and change management

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<sup>1</sup> ManpowerGroup analysis of Gartner & TalentNeuron findings.

are increasingly key to success. But roles are also drastically evolving as mining operations become more digitalized.

Drivers, for example, are becoming remote operators. And maintenance mechanics are transitioning into predictive maintenance specialists. Meanwhile, multi-skilled engineers are combining mechanical engineering, electrical engineering and computer engineering skills into one role.

Entirely new roles are emerging, a prime example is a vendor- or OEM-collaboration manager. This role handles integration efforts and works with the external resources to increase the success of new technology.

With the right development opportunities, a collaboration manager could be a career progression for drivers or machine operators, plant operators, engineers, or others with mining process aptitude and strong interpersonal skills.

Sourcing this role from internal candidates will be essential, as these employees must bring expertise in core operations and processing functions and often require deep machine or process knowledge. Internal candidates have existing relationships and organizational context to represent the interests and unique needs of the company.

Of course, with so much change in roles, modernizing a workforce might feel like an overwhelming task. So, consider focusing efforts on two things: modernizing the employment value proposition (EVP) and developing a strong workforce strategy.

## Modernize the EVP

It's inevitable that companies will find themselves competing with not only other mining companies, but also other industries for the best talent. To help secure the skilled workers needed, take steps to update an EVP.

An EVP is an exchange. The employer offers a work environment with pay, benefits, culture and opportunity, while the em-

ployee brings the valued skills, experience and work ethic that the employer needs.

An EVP is more than human resource hype. Organizations with attractive EVPs can reduce compensation premiums for attracting qualified candidates and reduce annual turnover by nearly 70%.<sup>2</sup>

The best way to do this is to look at the roles from the potential employee's perspective. Why should they work for you over another employer in the industry? What will make them stay at the company? What capabilities can they bring forward? What work environment will be provide to them?

The answers to these questions help lead companies to a modernized EVP.



#### Four Strategies for Success

Building the workforce requires more than updating hiring practices. A combination of workforce strategies — or the “four Bs” of workforce development — are needed to gain and groom the employees one needs in their digital mines.

**Build:** This is often the first strategy companies look at when navigating workforce changes and transformations. It involves investing in learning and development to grow your talent pipeline. Tactics such as identifying future potential, providing accelerated learning programs, and building a culture of learnability are key components of this strategy.

**Buy:** This involves looking outside of the company for talent. Many of the roles that mining companies seek are built on skills that are present in other industries. But companies will need to be cognizant of an EVP, because the candidates may see other industries as more appealing, at least on the surface.

**Borrow:** This strategy involves leveraging outside talent communities like freelancers, contract employees and

temporary workers. In some cases, these workers can bring skills that are especially valuable for digitalized operations. Freelancers and contract employees, for example, tend to have experience working remotely, which can help them support multiple mines at once.

**Bridge:** This requires creating a proactive and smooth relocation plan for individuals who aren't used to a new organizational strategy or its required competencies. Digital transformation and automation have created a skills revolution, where new skills emerge as fast as others become obsolete. It's crucial that you are able to not only optimize the skills you have in your

workforce, but also find alternate pathways for those whose skills are no longer a fit.

Consulting companies are a great resource for helping employers and employees with the process of finding another occupation that leverages the employee's skills and experience.

#### Get to Work

Technology is changing the industry quickly. As this transition occurs, companies must make sure the workforce evolves with it by having the right skillsets.

Companies can get ahead of workforce changes by understanding how roles and positions have changed, modernizing an EVP and developing a workforce strategy that takes a company from now to next.

*Rebekah Kowalski is vice president, Manpower Manufacturing, ManpowerGroup. Barry Elliott is vice president, Enterprise Accounts, Rockwell Automation.*

#### ESG Solution Promises Transparency, No Spreadsheets

IsoMetrix, a global EHS software provider, recently announced the launch of a new Environmental, Social and Governance (ESG) solution. Designed to help organiza-

tions effectively understand and manage their ESG performance, IsoMetrix claims the product allows companies to report more efficiently and in line with stakeholder and compliance requirements.

As ESG compliance and stakeholder requirements for reporting vary based on region, the siloed nature of data collection makes it difficult for companies to accurately track and report their ESG performance. IsoMetrix said its solution offers a transparent view of an organization's ESG performance by streamlining risk management data into a centralized platform to ensure it's meeting local and international reporting standards.

“We wanted to develop a solution that gauges alignment to whichever ESG-related standard an organization or investor would like to assess themselves against to help with the reporting burden associated with these standards,” said Robin Bolton, executive of sustainability at IsoMetrix. “In addition, the solution must help organizations understand their ESG risks, findings, incidents or grievances.”

As a centralized management system, the solution gives sustainability managers a true understanding of performance through a holistic view of their ESG data, according to IsoMetrix. Managers can identify the factors that affect their ESG profile by managing the complete ESG reporting ecosystem. Through a standardized dashboard that eliminates the use of spreadsheets, the solution removes companies' siloed reporting approach and eliminates the time-consuming task of collecting data. By providing a complete, transparent view of companies' ESG performance, the solution helps users determine the impact of their program to investors, stakeholders and regulatory bodies by gathering data and reporting against different standards, according to IsoMetrix.

“We are offering a solution that is purely agnostic and is not focused on a specific ESG standard or framework,” said Rigby Stott, senior executive of customer success at IsoMetrix. “Our solution allows you to gather different information and standards, and presents the results in a holistic way that shows a true reflection of the performance of the organization. In addition, it is also a management system that defines and manages all your ESG initiatives and displays them into potential action plans that enable you to meet objectives, and ultimately create long-term value for your organization.”

<sup>2</sup> Gartner says companies in the U.S. are overpaying to attract new talent, Gartner, 2019.

# ABB Will Modernize Nexa Plants



Nexa Resources appoints ABB to provide state-of-the-art industrial automation systems for existing and new operations in Brazil and Peru. (Photo: ABB)

Nexa Resources signed a five-year agreement with ABB on modernizing existing mining and smelting process installations in Brazil and Peru.

As part of the agreement, ABB will install ABB Ability System 800xA, a distributed control system automation platform.

The platform will serve as the basis for the digital transformation, and as a common operations platform to support all technology upgrades.

The platform will allow remote monitoring and control and will offer safety gains, ABB reported.

"The platform also increases productivity by applying modern control techniques and creating value for the company and local community," said Marcos Hillal, global product line manager, automation and digital, mining, ABB. "As part of the journey, we are providing Nexa with a thorough training and communications plan to support them through the transition."

ABB reported it is supporting Anglo American Technical Solutions, an analytical support center in Johannesburg, after the latter adopted ABB Ability System 800xA for use in continuous laboratory testwork.

There, the control system allows for expansion and application in mini-pilot plants for hydrometallurgical testwork.

The support provided by ABB consists of automation expertise and software solutions, licensing and training. It is part of an effort to expand the laboratory, modify experimental setups and maximize control.

ABB reported it will also deliver automation platforms at Aripuanã, a zinc-lead-copper mine in Mato Grosso, Brazil. The scope includes ABB Ability System 800xA equipped with MineOptimize solutions such as the Minerals Process Control Library, Power Control Library and camera connection. The plant at Aripuanã is a greenfield site.

Separately, ABB reported it signed a Memorandum of Understanding (MOU) with Hydrogen Optimized to explore development of large-scale sustainable hydrogen production systems. The companies plan to prove that Hydrogen Optimized's RuggedCell water electrolysis technology can be used to develop an

integrated solution based on a 100-MW single-module plant design.

## Teck Mine Taps AES for 72 MW

Compania Minera Teck signed AES Corp. for 100% renewable power for the Carmen de Andacollo (CdA) copper mine in Chile. The Chilean branch AES Gener will supply 72 megawatts (MW) of wind, solar and hydroelectric energy from September 1, 2020, through the end of 2031.

Teck said the move furthers the company's goal to become carbon neutral. "This agreement takes Teck a step closer to achieving our sustainability goals, while also ensuring a reliable, long-term clean power supply for CdA at a reduced cost to Teck," Teck Chief Executive Don Lindsay said.

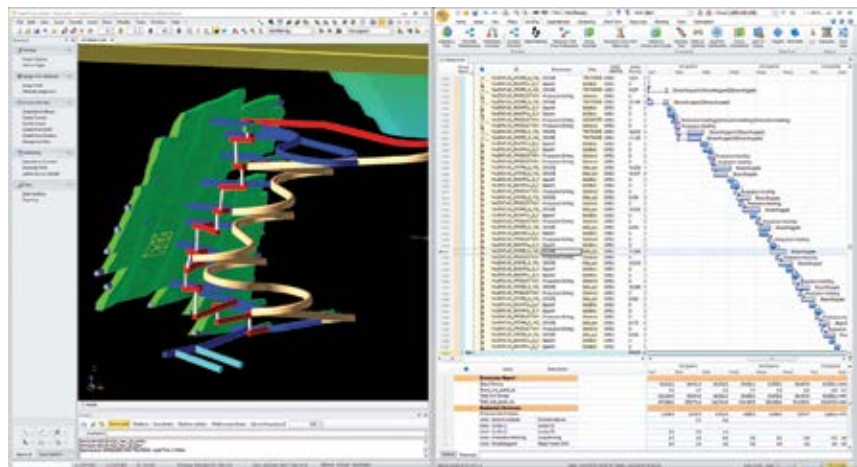
AES Gener said the development helps Chile build a more sustainable and reliable grid.

The mine is located in the Coquimbo Region. Teck owns a 90% interest in the mine.

## Nordgold Fully Adopts Deswik Software

Nordgold reported after a three-month trial, it hired Deswik to re-platform its mine planning IT systems. To date, Nordgold has implemented Deswik software and solutions for use in strategic mine planning, pit design, load and haul simulations, surveying, and drill hole optimization.

The software will be rolled out over three years.



Nordgold trials Deswik software and solutions for three months before adopting it enterprise-wide. Above, the scheduler module by Deswik. (Photo: Nordgold)

During the test period, Deswik software and solutions were adopted by the head office, the Gross and Tabornoe open-pit mines in Eastern Siberia, the Suzdal underground mine in Kazakhstan, and the Lefa mine in Guinea. Migration to the Deswik platform is expected to be completed at the Bissa and Bouly mines in Burkina Faso in 2021, with all remaining operations following shortly thereafter.

Nordgold described the Deswik platform as a perfect fit that caters to both underground and open-pit mines. "We have been particularly encouraged by the software's ability to circumvent our legacy systems' constraints, while still supporting older data formats for backward compatibility," Louw Smith, COO, Nordgold, said.

## MacLean Puts Plexus PowerNet in Test Mine

MacLean Engineering contracted Maestro Digital Mine for Plexus PowerNet at its test mine in Sudbury, Canada.

Plexus PowerNet, a gigabit network providing data and power over coaxial cable, offers high-speed, low-latency digital communication connectivity to access points, cameras and other devices. Easily installed, the Plexus PowerNet can be used in mines with or without a fiber optic network, and supports existing underground mine infrastructure.

MacLean said Plexus PowerNet was selected because of its capability to quickly and easily extend the mine's existing communications network to the face. "We're delighted to work with another company in Sudbury's mining ecosystem to get their top-of-the-line digital infrastructure installed at our Research and Demonstration



Korekiyo Yanagisawa, COO, Komatsu Mining; John Koetz, president, surface mining, Komatsu; Milwaukee Mayor Tom Barrett; and Jeff Dawes, CEO, Komatsu Mining, break ground for the South Harbor Campus.

Facility, where it will be the backbone of our automation product development," Stuart Lister, vice president, marketing and communications, MacLean, said.

Maestro Digital Mine said Plexus PowerNet is designed to reduce the time to connectivity for trialing new solutions.

"We strive to make the complex simple," Michael Gribbons, CEO, Maestro Digital Mine, said. "This underground R&D lab continues to build upon the strength and wealth of mining knowledge and expertise in Sudbury."

MacLean's underground Research and Demonstration Facility has a 300-m decline at a grade of 15% with multiple branches, headings and testing areas. It has a shop and office. The test mine allows the supplier to trial new equipment and technology.

## Komatsu Rebrands New P&H, Old Joy Equipment

Komatsu is rebranding some P&H and Joy Global equipment to reflect its unified focus on growth in the mining equipment space. All surface wheel loaders, new blast-hole drills, and all underground hard-rock equipment will be rebranded as Komatsu.

Komatsu said the development synchs with the company's 100<sup>th</sup> anniversary. "Building on the growth of our mining portfolio, we're excited to unite more products under the Komatsu brand, while respecting the history and value of the P&H and Joy brands," said Jeffrey Dawes, CEO, Komatsu Mining.

The first rebranded product, the Komatsu ZT44 track drill, debuted at CONEXPO in March.

Separately, Komatsu Mining Corp. broke ground on its new headquarters and manufacturing campus in Milwaukee's Harbor District. Komatsu is investing \$285 million in the campus, which spans 57 acres and includes purpose-built, modern manufacturing facilities; advanced technology, robotics, engineering and research and development labs; a large office complex; training facilities; data solutions center; and an experience center.

The state-of-the-art facility will help the company deliver innovative solutions, Komatsu said. "Our goal is to create a remarkable workplace for our employees that provides space to grow, will serve as a global center of excellence for Komatsu, and demonstrates a sincere commitment to sustainability and our community," Dawes said.

Preconstruction launched in late 2019. The new campus will be staffed in 2022.

## Plants in China, Bulgaria Get Outotec Shops

Metso Outotec reported it won two orders, at a combined value of \$11.8 million, for two Outotec Anode Casting Shops for delivery to production plants in China and Bulgaria.

One will go to Yangxin Hongsheng Copper's greenfield smelter in Huangshi, Hubei, China, which will be commissioned in 2021. The other will go to longtime customer Aurubis Bulgaria AD's copper production plant in Pirdop, Bulgaria.

The shops are expected to be commissioned in 2021.

Both shops will feature two casting wheels for high capacity and yield,



Plexus PowerNet delivers high-speed connectivity to the face at MacLean's test mine in Sudbury, Canada. (Photo: MacLean Engineering)



Metso Outotec sells its Anode Casting Shops, similar to this one (above), to a plant in China and a plant in Bulgaria. (Photo: Metso Outotec)

Metso Outotec said. “They will also be equipped with advanced automation to ensure high availability and high casting accuracy to produce high quality anodes,” Jari Algars, president, metals business, Metso Outotec, said.

Separately, Metso Outotec was recognized as the leading supplier for crushers, mills and maintenance in the Mining Suppliers’ Ranking by Phibrand in Chile. The supplier won Best Performing International Supplier, the highest possible ranking.

Metso Outotec said the winners are nominated by customers in a very competitive, high-end market. “We want to continue improving and delivering the best service to our customers by knowing their needs and innovating solutions,” Eduardo Nilo, president, South America market, Metso Outotec, said.

### Rolls-Royce Launches Microgrid Center

Rolls-Royce reported it expanded the recently acquired, Berlin-based Qinous GmbH into a Microgrid Competence Center. Previously, Rolls-Royce renamed the company Rolls-Royce Solutions Berlin GmbH.

As a center, it will see more group investment in its distributed energy systems business.

Rolls-Royce said the center is making a major contribution to decarbonizing energy systems. “It ranges from simple storage solutions to complex microgrids that intelligently combine battery storage with renewable energies, and with diesel or gas gensets,” Andreas Schell, CEO, power systems division, Rolls-Royce, said. “With Qinous, we are expanding our microgrid



Metso Outotec is named Best Performing International Supplier by Phibrand in Chile. (Photo: Metso Outotec)

expertise and combining the dynamics of a startup with the security and reliability of a large corporate group.”

### BME Breaks Blast Records

BME South Africa reported it initiated a single-detonation blast using its AXXIS electronic initiation system, 3,780 detonators and 461 metric tons (mt) of emulsion at a manganese mine near Hotazel. The blast moved 890,000 mt of overburden, and was a company record for largest blast using electronic detonators.

BME attributed the success in part to AXXIS, which facilitates larger, less frequent blasts. “BME’s ongoing product development has positioned us well to consistently produce quality blasts that deliver on customer requirements,” said Joe Keenan, BME managing director.

Previously, BME initiated a blast using 7,401 detonators at a copper mine in Africa. The company reported the blast was a world record.

### IAI, Bis Launch JV for Autonomous Systems

Israel Aerospace Industries (IAI) and Bis announced the joint venture Auto-mate, which will provide autonomous systems for mining operations.

With open architecture, Auto-mate can connect any asset to the fleet management system, regardless of type, brand, age or level of automation. The system offers scalable automation solutions specific to mine site requirements.

IAI described the system as the perfect union of cutting-edge technology and practical applications. “Auto-mate will deliver a flexible approach to automation, delivering usability for multiple levels of automation across all haulage assets and ancillary equipment, with one central command center,” IAI CEO Yoav Turgeman said.

Bis said the offering will be brought to market in Australian and elsewhere. “The flexible and scalable solution is designed to be the ultimate partner in mine site automation, with the ability to grow with the user’s operation,” Bis CEO Brad Rogers said.

Bis provides logistics, materials handling, and specialized equipment solutions to the mining sector. IAI has previously developed automation technology for heavy off-road vehicles in extreme environments.





Above, Epiroc's Minetruck and MT42 Battery at the Kittilä mine in Finland. (Photo: Epiroc)

### Epiroc Batteries Deliver Results in EU Program Trials

Epiroc reported successful field testing of the Boomer E2 Battery, Scooptram ST14 Battery and Minetruck MT42 Battery at Agnico Eagle's Kittilä mine in Northern Finland as part of the Sustainable Intelligent Mining Systems project.

The batteries dispelled any preconceived concerns regarding battery-electric equipment, Kittilä mine said.

They performed very well, delivering high reliability, increased performance and battery autonomy, Epiroc said.

"Our advances in zero-emission, battery-electric equipment, as well as automation and information management, have established us as a key driver behind the technology that is shaping the future of sustainable mining," said Sami Niiranen, president, underground division, Epiroc. "This project is aligned with our ambition to deliver the world's greenest machines and establishing ourselves as a leading provider of zero-emission battery-electric vehicles."

The project was part of Horizon 2020, an extensive European Union research and innovation program.

### Motion Acquires AMMC

Motion Industries has completed the acquisition of Applied Machine and Motion Control Inc. (AMMC), a supplier of motion control and automation products and services.

Motion Industries said the move stemmed from its growth strategy. "In addition to broadening our offerings to customers, their go-to-market approach and line card" will complement Mi Automation Solutions Group offerings, said Randy Breaux, president, Motion Industries.

AMMC offers specialty services, including motion control, drives, HMI, PC and embedded control, automation control, mechanical, robotics, motors, and mechatronics-

### Total Acquires Lubrilog SAS

Total Lubrificants announced the acquisition of Lubrilog SAS, a high-performance synthetic lubricant producer.

Total Lubrificants said the acquisition broadens its high-end products portfolio. "Thanks to our international presence, our teams and engineers around the world will be able to leverage Lubrilog's high end technical solutions for the benefit of our clients," said Pierre Duhot, senior vice president, Total Lubrificants.

# Agile Approach to Process Optimization Pays Off for Copper Producer

Although new technologies offer an attractive avenue for achieving plant performance improvements, new ways of thinking can provide similar results. Such methods, however, can collide head-on with traditional industry custom and engineering practice. Copper producer Freeport-McMoRan is a case in point.

A case study provided earlier this year by McKinsey\* illustrates how Freeport-McMoRan adopted “agile principles” to its quest to get more production out of its Bagdad, Arizona, concentrator without heavily investing in capital improvements during a period of soft metal prices.

An Artificial Intelligence (AI) model built from years of operating data and agile-principle efforts predicted that the mine could increase production from its concentrator simply by speeding up the feed rate to the plant.

It was a gamble, but they tried it — and it worked. It couldn’t be classified as an overnight success, however. The mill’s improvement relied heavily on information from a “data warehouse” that the company had been compiling for about 10 years prior to the Bagdad project. The data warehousing initiative was aided by subsequent sensor deployment and network improvements.

In the words of the McKinsey report, during the years following the start of the data collection effort, “...maintenance teams lobbied for the installation of additional network equipment and performance sensors. The teams would manually download data from those sensors to the data warehouse so they could further sharpen their maintenance practices and improve the functioning of equipment. When wireless mesh networks became cost effective and reliable, Freeport-McMoRan installed them at all its sites. Now the company can capture and correlate second-by-second performance readings in the data warehouse, all in real time. With advanced analytics and AI techniques, Freeport-McMo-

\*Inside a mining company’s AI transformation. February 2020, [www.mckinsey.com/industries/metals\\_and\\_mining/how\\_we\\_help\\_clients/inside\\_a\\_mining\\_companys\\_AI\\_transformation](http://www.mckinsey.com/industries/metals_and_mining/how_we_help_clients/inside_a_mining_companys_AI_transformation).



Ran could scan the vast quantity of data it collected, identify even more operational changes that might raise performance, and put them to the test in the field.”

The McKinsey report explained that staff at Bagdad and Freeport-McMoRan’s central operations group originally believed all the ore entering the mill was of the same type. Consequently, they had defined a single “recipe” of lower and upper parameters for the mill’s 42 control settings: the mix of differently sized ore chunks being fed into the mill, the pH level in the flotation cells, etc.

But when the agile team at Bagdad ran the data from the mill’s performance sensors through its model, the members of the team discovered that, from the mill’s perspective, the mine was actually producing seven distinct types of ore — and the mill’s standard recipe for control settings didn’t match the properties of all those ore types. Ore containing more iron pyrite, for example, would yield more copper if the pH level in the flotation cells were set higher than the recipe prescribed.

“Thinking about ore clusters in terms of data from the mill’s instruments, rather than classifications from traditional geology, was a major mindset shift — and it opened up many new possibilities for improving performance,” said Sean Buckley, a McKinsey partner who led the analytics work. The team’s analysis suggested that adjusting the mill’s controls to suit each of the seven ore types could increase copper production by 10% or more.

The McKinsey report noted that by the time corporate management gave the

Bagdad improvement team the greenlight to incorporate production adjustments suggested by the AI model, the team had become proficient in “agile” thinking. Without going into deep detail, employing agile principles dictates making successive minor changes to reach an intended target, rather than intricately planning a single, comprehensive and hopefully, successful modification aimed at solving all perceived problems in a single step. For many traditional engineering-oriented companies and staffs, it’s a 180° change in approach. The McKinsey report quoted Justin Cross, the Bagdad site’s general manager. “Usually when we run operational projects, we over-engineer them,” he said. “We test every conceivable scenario, build in safeguards, and do everything we can to ensure that a process change will result in an improvement before we make it. It’s a dependable way to get good results. But it takes a huge amount of time, effort, and capital investment.”

“It took us a while to get comfortable with agile,” Cross said. “We had to let go of a lot of old habits.”

Harry M. “Red” Conger, former president and COO, Americas, at Freeport-McMoRan, summarized the company’s efforts to learn how to use agile methods and AI tools at its sites. Here are some of his observations and recommendations drawn from the Bagdad project:

- Don’t wait for the “perfect” product or solution to begin using it. Once it’s working well enough, implement it right away. Immediate action brings immediate results.
- Be willing to reconsider and discard long-standing assumptions and processes if better ways to do things are found. That means validating new ideas through data analysis and fieldwork.
- Empower frontline teams to take risks. That’s how testing and learning happens. Set clear boundaries on what teams can try. Make it clear they won’t be blamed if their experiments come up short or incur extra costs.
- Use data science to catalyze decision making. Human judgment and intuition

are hard to replace, but people can make better decisions when they're informed by analytical findings.

- Once value is created with agile and AI, spread the word about what was done and how it was done. Showcasing success will attract interest in these capabilities and motivate colleagues to adopt them.

## Process Equipment Exec Says Cooperation is Key For Ensuring Digital-tech Efficiency

Digital technology holds huge potential for equipment performance in the field of mineral processing, but equipment suppliers will make little progress if they work only on their own, according to Thomas Holtz, group chief executive officer of Multotec, a mineral processing equipment supplier based in Johannesburg, South Africa.

"The inclusion of today's technologies in mineral processing equipment demands collaboration on an unprecedented level," Holtz said. "To begin with, we need outside specialists to help build digital technology into our existing products. But we also need to cooperate with other process equipment suppliers to ensure that we feed into common systems that make customers' plants more efficient."

He highlighted the power of sensors, digital data communication and computer analytics to transform how mineral processes are monitored and optimized. Technology can make the plant a safer place and can run processes more efficiently. This includes monitoring wear life, helping mines plan for better maintenance and improve uptime.

"At Multotec, we have invested considerably in applying sensor technology — especially the use of accelerometers," Holtz said. "The real work, however, comes with the management and interpretation of the data these sensors generate."

For this reason, data analytics becomes the real value when applying this monitoring technology. He noted that this aspect of product development must generally be conducted with a specialist service provider over a long period of time. Even then, the process is usually arduous.

"Our technology journey to date shows how challenging it is to analyze the data we collect in a way that we can draw conclusions that are useful for our purposes," he said. "It is relatively easy to monitor vibration levels on a bearing and to generate a trend line on a graph. It is less \,



Data hoarding by equipment vendors, along with plant designs that make digital upgrades difficult and sometimes unrealistic expectations from customers, are hindering the progress of digital technologies in mineral processing.

simple, for example, to automate an operational response to that information."

Much progress has indeed been made, he said. Through collaboration with a technology partner, Multotec is developing a machine learning process to analyze vibration data from a cyclone. Based on this real-time data, an artificial intelligence server generates alerts related to predefined condition levels. He pointed out, though, that each equipment supplier can only monitor those functions within a process circuit in which their equipment performs.

"To fully leverage today's digital technology, a plant manager needs equivalent information from every item of equipment operating in the circuit," he said. "This full range of data — coming in from all the equipment — then needs to be synthesized to fully optimize the running of the plant."

One immediate challenge is that most existing process plants were not built to accommodate the latest technologies. Especially under current cost pressures, retrofitting entire plants is seldom an option. And, there are fewer greenfield operations being opened that could provide an opportunity to apply new ideas and equipment from scratch.

Prevailing mindsets are also an obstacle, Holtz said. Most suppliers jealously guard their intellectual property, frustrating any attempt at collaboration.

"We need to work toward a new approach, in which each player brings some input based on their area of expertise,"

he said. "Many small innovations, when combined, can produce significant progress and generate a meaningful advance for our mining customers."

He noted that all the equipment in a plant needs to talk to a central system



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that will drive the innovation that mines are looking for. Only in this way can mines gain efficiencies through technology and become more sustainable. This, in turn, provides the foundation of success on which their service providers can thrive.

In conclusion, Holtz emphasized the importance of gradual and sustained technological progress. Many new tech-

nology ideas are met with unrealistic expectations, and people are disillusioned when these are not immediately realized.

“Closer and ongoing collaboration with all stakeholders, including mines and design houses, will allow us to achieve the important long-term benefits that technology can and must deliver to our industry,” he concluded.

### BHP Tests MaxiFlox Chemistry at Olympic Dam

Australia-based SciDev Ltd. said it recently received a trial purchase order from Australia’s largest copper operation — BHP’s 172,000-metric-ton-per-year Olympic Dam complex — for the utilization of SciDev’s chemistries in the hydrometallurgical and concentrator sections of the Olympic Dam processing plant. SciDev, based in New South Wales, said staff will be on site to deliver associated professional services over the course of approximately six months after commencement of the trial in December. The order includes an initial A\$1 million purchase of SciDev’s MaxiFlox chemistry, reflecting approximately three months of consumption.

The company said its MaxiFlox products are supplied in both liquid and powder form across a range of molecular weights and charge densities. The product lineup includes organic liquid coagulants (based on synthetic organic monomers and naturally occurring polysaccharides), inorganic liquid coagulant blends, cationic and anionic flocculant emulsions, cationic and anionic flocculant powders, mud solidification polymers and antifoam products.

Commenting on the trial, SciDev Managing Director and CEO Lewis Utting said, “The order from BHP Group’s Olympic Dam operation is a significant opportunity for SciDev. The opportunity to transfer our chemistry and know-how from the waste processing side directly to the production side of a mining operation reflects the potential for the company’s bespoke chemistries. We look forward to working with the team at Olympic Dam and will continue to keep the market updated on developments.”

The company said another trial is under way at the Las Bambas copper mine in Peru, where site staff, along with SciDev technical experts, have developed trial protocols allowing effective remote support by SciDev staff from Australia. The results of the trial are being assessed and will be reported in the future. The commercial trial follows on from earlier successful technical evaluations that SciDev conducted during 2019. MaxiFlox chemistries are being used in the tailings thickener at Las Bambas, with the aim of improving water recovery and ultimately increasing the available volume in the mine’s tailings storage facility.

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# Small Loader Offers Fast Battery Change



Sandvik introduced the LH518B, an 18-metric-ton (mt) loader that features Artisan Vehicle powertrain and lithium battery technology.

The loader is equipped with three 2,000-Nm permanent magnet motors. It carries 18-mt loads, and is designed for 4.5 m by 4.5 m or larger tunnels. In addition to an innovative boom and bucket system, it features independent front and rear drivetrains, for a high payload capacity and a low overall height, Sandvik reported.

Battery changeouts use Artisan's 6-minute AutoSwap process, and require neither crane nor forklift. It can be done in a passing bay or old re-muck bay, Sandvik reported. The AutoConnect feature automatically connects and disconnects the battery pack to the machine.

Separately, Sandvik Mining and Rock Technology introduced simulator training on the DS422i, part of the new Digital Driller family. The low-weight, safe, portable family of simulators supports training on the DD422i/iE, DT922i, DL432i and DL421, and now the DS422i.

Digital Driller uses the same control system software as found on the Sandvik drills. It provides three levels of drill rig operator ability training, namely Drillmaster, Professional and Beginner. It comes with purpose-developed software that includes a range of specific operator exercises for recording and measuring operator behavior. Benefits include low-risk training and the reduction of the startup period.

Digital Driller comes in a wheeled carrying case and can be transported by a single person.

[www.rocktechnology.sandvik](http://www.rocktechnology.sandvik)

## Autonomous Blimps for Wi-Fi Grid

Altaeros reported its SuperTowers, tethered unmanned blimps, provide site-wide Wi-Fi coverage and universal line of sight access. For a large open-pit operation, one or two SuperTowers can provide a network comparable to that created by a series of small transmitter towers, the supplier reported.

The blimps can support private LTE networks with a range of up to 25 miles. They can be used to generate the connectivity needed to support autonomous mining equipment, Altaeros reported.

The SuperTowers are autonomous, with launch, operation and landing all executed without the need for a full-time ground crew. The base for the ST-Flex blimp can be towed by a standard pickup truck.

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



## Easy-to-use Electronic Detonators

Dyno Nobel released the EZshot EZDet series for surface blasting.

Units consist of a green shock tube with a surface detonator attached to one end and a high-strength in-hole electronic detonator on the other. The surface detonator is inside a color-coded plastic EZ Connector block for easy connections to shock tube leads, and can hold up to six shock tube leads. Easy-to-read, color-coded delay tags display the delay number and firing time prominently.

Units can be easily connected to one another to satisfy basic blast design requirements, the company reported. They can be used in combination with NONEL MS, NONEL EZTL and NONEL TD detonators for complex blast design requirements, and to minimize inventory of initiation system components.

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



## Military-grade Rugged Laptop

Durabook announced the Z14I rugged laptop can handle data-intensive tasks at speed in harsh environments.

Features include multiple PCIe interface connections for RAID cards, Wi-Fi cards or SSD add-on cards. It has an Intel Eighth generation CPU, which is qualified for military service commands in the field. It runs on Windows 10, and has Nvidia GeForce GTX1050 and GeForce GTX1050 Ti graphic chips. It can serve as an enterprise-class server, Durabook reported.

The Z14I comes with a high-definition multitouch screen.

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

## Automated Fault Detection, Recommendations

i-ALERT announced an automated machine health diagnostics offering supported by Symphony AzimaAI. It upgrades sensors to capture needed information on the severity of a fault, and makes recommendations to resolve it with the accuracy of a skilled analyst, the company reported.

The new diagnostics result from analysis of vibration signatures. Fault detection is provided by algorithms and an artificial intelligence solution from Symphony AzimaAI. The resulting machine health data and recommendations are accessed using a mobile device or computer.

[www.i-alert.com](http://www.i-alert.com)



## Design Optimizer Offers Guided Workflow

RPMGlobal launched the Strategic Design Optimizer (SDO) for UG metal mining. The tool is a design application that combines the complex tasks of strategic optimized slope and development design in a single, coherent automated process, the company reported.

SDO uses parametric design principles and optimization algorithms. It features an intelligent workflow that guides the user. It is offered as a standalone strategic design package and as a fully integrated end-to-end enterprise solution.

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

## Sensor Data Management Online

Canary Systems launched MLWebHardware, the Web interface for MultiLogger, sensor data management software that supports most makes and models of sensors. Over the web, users can monitor their assets in real time, as well as create programming with point-and-click forms, implement it, retrieve the resulting data, and import it to a database.

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

## Shroud System Ups Availability

Caterpillar unveiled the Cat Durilock Shroud System for Cat R1700 to R3000 loaders and most buckets of 5- to 10-m<sup>3</sup> capacity. It features hammerless installation and maintenance-free retention of GET with Cat Infinite elastomer compression retain-

ers. Shroud styles can be changed quickly to match an application without changing the base edge or retention system.

The Durilock system is offered in three styles. The D50S Standard is a traditional wedge shape. The D50A Abrasion has a contoured design. The D50P Penetration has less leading-edge material for better penetration.

Compared to that of predecessor competition: installation and removal of GET is 50% faster; maintenance time for GET is reduced by 50%; and internal corner guards extend bucket in-service time by 30%, Caterpillar reported. The integral corner design boosts corner life by 15% and improves penetration compared to systems with corner rounding.

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



## 2,500-kW Couplings for Conveyors

Voith presented TurboBelt 315 TPXL (315 kW) and TurboBelt 2500 TPXL (2,500 kW) fill-controlled couplings. TPXL technology, based on hydrodynamics and intelligent control technology, ensures wear-free power transmission without mechanical connection, the company reported.

The plug-and-play couplings are designed for easy integration into existing systems, and for use in challenging environments. The couplings can be used with TurboBelt DriveControl, a digital control system for seamless integration of drives, belt conveyors and system components.

TPXL couplings comply with EU Directive 2014/34/EU (ATEX). They are designed for applications in categories 2 and 3.

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



## Transmitter for Pressure Data

SignalFire Wireless Telemetry introduced the PRESSURE RANGER, an LTE-M Cellular Pressure Transmitter that provides plug-and-play instant connectivity of pressure sensor data to the cloud over cellular networks. As a component of the company's

cloud-based telemetry solution, the transmitter supports remote monitoring, control and alarming of assets from any web browser.

The transmitter uses MQTT/Sparkplug communications to integrate into third-party hosts. It features a built-in GPS receiver. Alarms can be sent by text or email.

The PRESSURE RANGER requires no programming or hardware, and connects to a 4G network without a gateway. It runs on a battery, and features weatherproof housing.

It is certified for use in Class 1, Division 2 environments.

[www.signal-fire.com](http://www.signal-fire.com)

## Submersible Explosion-proof Pumps

Tsurumi America released the AVANT Series of submersible explosion-proof pumps to the North American market. The line, certified to FM Global explosion-proof specifications, features IE3 premium efficiency motors and a closed-circuit cooling system.

The series has five different types of impellers: open channel, chopper, vortex, grinder and high head. It features 2- to 16-in. discharge bore diameters and 4- to 215-hp motor output. Options include Molib-tech coating, a more durable alternative to the conventional ceramic coating.

The pumps are available in wet or dry pit versions, and can be customized to customer needs. Benefits include cost savings, the company reported.

The series was released in Asia earlier this year.

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



## Solutions for Hybrid Wireless Architecture

Hitachi ABB Power Grids introduced the Tropos TRO600, a rugged router for hybrid wireless architecture. The router is part of a portfolio of solutions designed to integrate 2G, 3G and 4G LTE communication technologies, broadband mesh and sub-GHz technologies.

The portfolio provides a combination of interoperable technologies on a single communication network. It addresses operating challenges from disparate purpose-built communication networks, and it helps future-proof mission-critical operations in industrial and utility environments, the company reported.

Advanced security features include secure storage of keys and credentials, device certificates, and comprehensive options for encryption and authentication.

[www.hitachiabb-powergrids.com](http://www.hitachiabb-powergrids.com)

## Meter for Measuring Fastener Tension

Valley Forge & Bolt (VF&B) launched the SPC4 406A Electronic Meter for its SPC4 Load Verifying System. The meter is designed for accurate performance in demanding environments.

The meter measures tension within SPC4 fasteners, and adds to the line of meters compatible with the system. It has a rugged design, shock-resistant casing, and is IP54 rated for protection against dust and particles, VF&B reported. It features a large display and an ergonomic design, and offers one-touch gloved-hand operation. Bluetooth compatibility offers scalability for data management.


Precise tension readings help make both installation and maintenance faster and more accurate. Benefits include increased productivity, performance and safety, the company reported.

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



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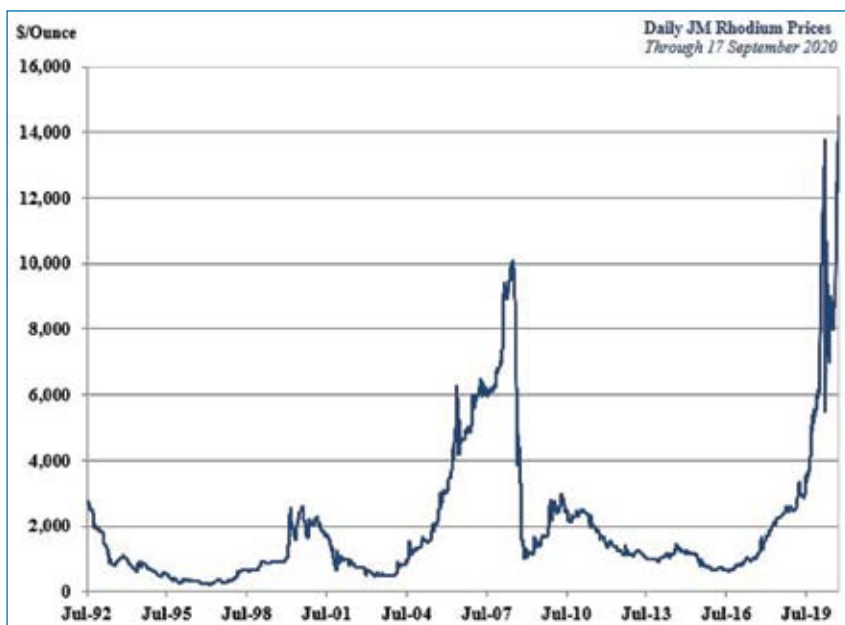
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# Rhodium's Meteoric Rise

Rhodium prices rose during August and into early September, reaching a record \$14,500 per ounce (oz) on September 15. The price cooled to \$14,000/oz, but the rhodium market remains tight. Supply from South Africa, which accounts for 80% of global rhodium mine supply, is still recovering from shutdowns earlier this year. There also seems to be some buying ahead of the seasonally strong period of demand that is typically observed over the fourth and first quarters of the year.

Passenger vehicle demand remains fairly weak in most parts of the world, which is expected to continue acting as a headwind at least in the near term. Auto makers have been buying concerned over long-term access to rhodium, using the current period of weaker auto production as a time to build rhodium inventories against anticipated shortages later. If and when the vaccine is approved for use, it will help to improve consumer sentiment, which coupled with an extremely low interest rate environment, could help demand in the coming year. The rhodium market seems to be positioning for this outcome. Price volatility should be expected in the coming months. On the downside, prices should not be expected to slip below \$9,000/oz.

Sharp increases in rhodium prices in the past have accelerated reduced usage and metal substitution. The glass manufacturing industry is a good example of where shifts are made in the amount of rhodium and platinum used to make the glass man-



ufacturing equipment, with reductions in rhodium use when prices have shot up the way they have in recent months. For many uses once ways are devised to reduce the amount of rhodium, it is unlikely that the amount of rhodium will increase back to levels before the reduction.

Scrap supply also is typically sensitive to the price of a metal. Two factors are expected to limit this typical sensitivity at this time. The first is the disruptions in scrap supply chains that have not fully allowed for scrap recovery to respond to the sharp increase in price. The other is the amount of rhodium being recovered is

faced with an ongoing headwind associated with technical issues that have tied up metal at refineries.

The mine supply side is typically the slowest to respond to the gains in metals prices. That said, the sharp increase in rhodium prices coupled with several years of increases in palladium prices is already seeing South African mining companies increase their focus on UG2 ore, which is rich in palladium and rhodium.

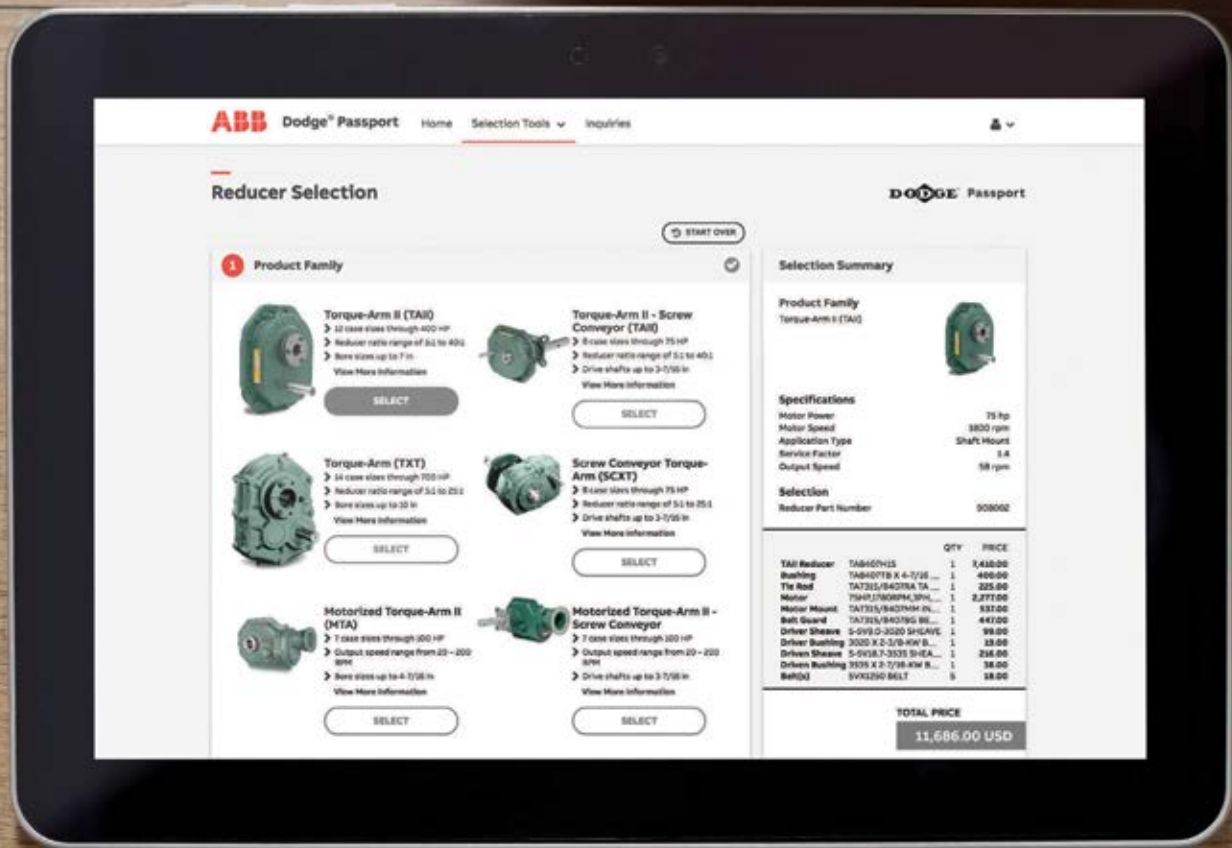
*This article was excerpted from CPM Group's monthly Precious Metals Advisory. www.CPMGroup.com*

## E&MJ PRICES INDEX

(October 1, 2020)

Precious Metals (\$/oz)		Base Metals (\$/mt)		Minor Metals (\$/mt)		Exchange Rates (U.S.\$ Equivalent)	
Gold	\$1,906.40	Aluminum	\$1,716.00	Molybdenum	\$18,000	Euro (€)	1.175
Silver	\$23.79	Copper	\$6,614.00	Cobalt	\$33,925	U.K. (£)	1.290
Platinum	\$902.00	Lead	\$1,809.50	Iron Ore (\$/dmt)		Canada (\$)	0.752
Palladium	\$2,346.00	Nickel	\$14,430.00			Australia (\$)	0.719
Rhodium	\$14,000.00	Tin	\$17,506.00	Fe CFR China	\$121.43	South Africa (Rand)	0.060
Ruthenium	\$270.00	Zinc	\$2,365.00			China (¥)	0.147

Gold and silver prices provided by KITCO Bullion dealers (www.kitco.com). Platinum group metals prices provided by Johnson Matthey (www.platinum.matthey.com). Non-ferrous base and minor metal prices provided by London Metal Exchange (www.lme.co.uk). Iron ore prices provided by Platts Iron Ore Index. Currency exchange rates were provided by www.xe.com.



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