

# E&MJ

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A Mining Media International Publication

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*This month, E&M turns its attention to the diamond mining sector, noting many of the advancements taking place. On the cover, Alrosa's Udachny diamond mine in Russia. After the pit reached its final depth of 640 m, it transitioned to underground operations and produced more than 3 million carats in 2019. (Photo: Alrosa)*

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

## Nornickel Had a Bad Month

Russia's Nornickel is the world's largest palladium miner and one of the largest nickel miners. With palladium prices hovering around \$2,000/oz, one would think this mining company would be set, and they were until a fuel tank at a power plant near Norilsk ruptured. The spill quickly snow-balled into a full-blown environmental disaster. No one was injured, but this event has brought unwanted attention to a proud mining company. During June, the company decided to sell non-core assets in Australia (See News, p. 13) and, as this edition was going to press, it was defending itself from damages assessed by the federal environmental regulatory authority.

*E&MJ* doesn't normally report minor equipment mishaps and engineering fails. They happen every month. When the first press release from Nornickel arrived regarding the leak, it seemed like a formal acknowledgement of a minor incident. In a normal year, much like other mining companies, Nornickel would issue a dozen or so press releases. Soon, biweekly updates began to arrive with photos of the progress. It seemed the company was doing its best to be transparent, but no good deed goes unpunished.

On May 29, ground that had supported the tank for 30 years subsided causing the leak. By the end of the following day, Nornickel had pumped more than 100 metric tons of diesel fuel into a containment area, treated the contaminated ground with sorbents and began installing booms on a tributary to the Ambarbaya River. More people and equipment steadily arrived on-site to assist with the cleanup. By June 7, one week after the spill, more than 500 people had become involved in the cleanup (300 from Nornickel). They had removed 50,000 mt of contaminated soil, pumped 949 mt of fuel from the area around the power plant and skimmed more than 913 mt of a fuel/water mixture from 18 boom lines on the river. A week later, Nornickel COO Sergey Dyachenko announced that the first stage of the cleanup efforts had been completed. He thanked everyone involved in the effort including experts from LaFarge-Holcim and Norway who had experience and arrived on-site almost immediately to advise the company.

A week later, Russian President Vladimir Putin hosted a meeting to discuss the progress. The Minister of Emergency Control Evgeny Zinichev reported the second phase of the cleanup was almost complete, with a total of 32,000 m<sup>3</sup> of water-fuel mixture collected and 103,000 mt of contaminated soil removed. Nornickel President Vladimir Potanin emphasized that the company intended to fully fund the environment rehabilitation costs related to the accident and added that the company has already spent RUB5 billion (\$70 million). "Truly remarkable work has been accomplished," Putin said. "I know that the situation has been successfully reversed."

The next step will be the restoration of biodiversity. Nornickel said it would provide financing for the construction of a fish hatchery, but the government wants more. It launched an ethnological expert review on the Taimyr Peninsula to assess the damage caused to the indigenous minorities of the North. They have invited experts from the Federal Agency for Ethnic Affairs and several academic institutions. The commission is expected to assess the impact of the fuel spill on the lifestyle and traditional industries of the indigenous northern minorities by studying current and future influences of the incident on hunting and fishing, reindeer herding and preservation of cultural traditions.

As this edition was going to press, the Federal Service for Supervision of Natural Resources Management had estimated that the complete restoration will cost Nornickel approximately \$2 billion. While it reiterated its commitment to covering the costs of remediation, the company was vigorously disputing that figure.

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# Nevada Gold Mines Exceeds All Expectations in First Year

Nevada Gold Mines (NGM), established a year ago, has posted an exceptional performance in its first 12 months of operation, according to Mark Bristow, president and chief executive of Barrick Gold Corp. Barrick operates NGM, the world's largest gold mining complex, and owns 61.5%, with Newmont Corp. owning the remaining 38.5%. In its first year of combined operation, NGM met the production and cost targets set out at the start of the joint venture, even during the coronavirus pandemic.

Bristow said this was a significant achievement, considering the merger required the integration of multiple assets, including three tier one mines into a unified complex under a new leadership team. The company said it has been working with Nevada and its stakeholders to provide financial and logistical support to mitigate the impact of the pandemic.

The company started with a clean slate in a fit-for-purpose structure, Bristow added.

"By removing the fences that had previously separated geologically connected assets, mines and projects that clearly belonged together could be combined into larger and more efficient operations, with substantial savings as an immediate benefit," Bristow said. "Even more important, this merger has created a platform from where we can see a bright new future for NGM as the leader of its industry in every respect: truly a case of the best assets and the best people delivering the best returns."

The assets of Nevada Gold Mines include 10 underground and 12 open-pit mines, two autoclave facilities, two roasting facilities, four oxide mills, a flotation plant and five heap-leach facilities.

## Zijin Acquires Guyana Goldfields

The mystery buyer for Guyana Goldfields was revealed to be China-based Zijin Mining. The two companies announced the binding arrangement agreement on June 12, where Zijin will acquire Guyana Goldfields for C\$1.85 a share in cash.

"The all-cash offer from Zijin represents a significant premium to the amended Silvercorp offer price and is an excellent outcome for Guyana Goldfield's shareholders," Guyana Goldfields CEO Alan Pangbourne said. "Zijin is a highly regarded mining company with an impressive track record of successful international acquisitions and operations."

Chairman of Zijin said, "We believe that the Aurora mine is a high-quality gold asset with significant upside potential, which we believe will be highly complementary to Zijin's existing mining asset portfolio."

Zijin previously acquired Nevsun Resources in a takeover bid valued at US\$1.41 billion back in 2018.

Guyana Goldfields received the offer from Zijin to purchase all of its shares and was determined to be a "superior proposal" to the one made by Silvercorp Metals Inc. back in April. The offer valued Guyana Goldfields at C\$323 million. Silvercorp de-

clined not to exercise its "right to match" and will not increase the consideration payable to Guyana Goldfields shareholders.

Following its initial offer, Silvercorp had amended its agreement in May, which valued the company at C\$227 million.

Zijin has also agreed to provide Guyana Goldfields with a US\$30 million secured loan facility to finance ongoing operations of the Aurora gold mine and to fund other liquidity needs of the company.

Based on the closing price of the Silvercorp common shares on the Toronto Stock Exchange as of June 3, the new proposal represents a premium of approximately 35% to the implied value of Silvercorp's proposal.

If Guyana Goldfields terminates the arrangement agreement with Silvercorp, it will receive a termination fee of C\$9 million.

## Hudbay Appeals Stop-work Ruling for Rosemont

Hudbay Minerals Inc. filed an initial brief in federal appeals court to contest a district court ruling that halted construction on the company's Rosemont copper project in Arizona.

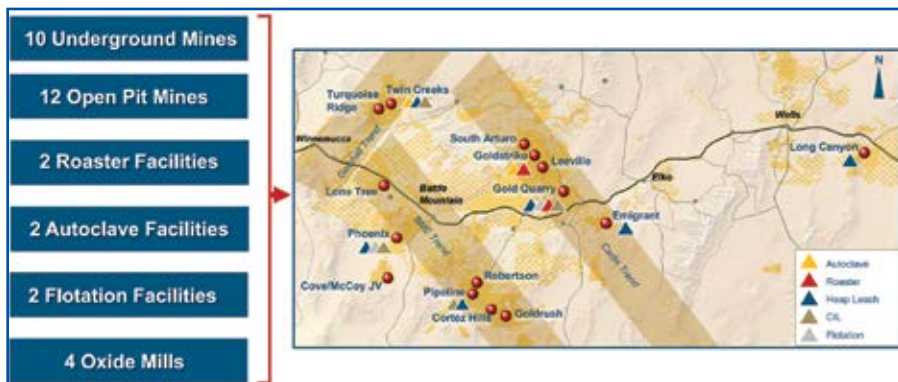
The brief, filed with the U.S. Court of Appeals for the Ninth Circuit, followed one filed by the federal government last week.

Both briefs argued against the District Court of Arizona decision of July 31, 2019, to revoke the U.S. Forest Service's Final Record of Decision for the project, issued in June 2017.

The district court ruled that Forest Service mining regulations apply only to mining activities on valid mining claims. The project involves mining activities that would occur on public lands and not on mining claims.

The ruling came after a host of environmental organizations, mining opponents and tribes sued to stop the project.

Both briefs held that the district court misinterpreted federal mining laws and Forest Service regulations. According to both briefs, the law and Forest Service regulations authorize mining-related activities on open Forest Service lands.



Nevada Gold Mines produces close to 2 million oz/y of gold, with targeted all-in sustaining costs below \$950/oz.



The briefs argued the Forest Service has authority over mining activities occurring on public lands, and, therefore, the Forest Service decision covers the project.

Hudbay's brief described the district court decision as unprecedented. "Prior to the District Court's decision, no court had ever held that a mining plan of operations may only be approved if all mining and mining-related operations will occur exclusively on valid mining claims," the company reported. "The district court imposed this novel requirement on the Forest Service after misreading both the relevant statutes, which authorize the Forest Service to approve those operations on or off of mining claims."

Hudbay said the court ignored more than 150 years of precedent. "This decision, if not reversed, will disrupt the long-standing policy of the federal government to promote mining on public lands, including within national forests," Hudbay Vice President of the Arizona Business Unit Andre Lauzon said.

The \$1.9 billion open-pit Rosemont project, sited in the Santa Rita Mountains, was fully permitted and had announced the launch of construction when the district court issued the stop-work order. It was planned to be the third-largest copper mine in the U.S.

The Forest Service environmental review and decision involved 17 cooperating agencies.

## Newmont Ranked Top Miner

Newmont Corp. was ranked 13<sup>th</sup> overall in 3BL Media's (formerly Corporate Responsibility Magazine's) 100 Best Corporate Citizens list for 2020, moving up from 20<sup>th</sup> on last year's list. Newmont was the sole mining company in the top 20 and one of only two miners to make the 21st annual list.

"Consistently strong environmental, social and governance performance is inextricably linked to delivering superior business results and is a key measure of how well our business is managed overall," President and CEO Tom Palmer said. "This recognition is yet another indicator of how deeply sustainability and strong, transparent governance is integrated into our culture."

3BL Media's 100 Best Corporate Citizens methodology ranks the 1,000 largest, publicly traded U.S. companies on environmental, social and governance (ESG) transparency and performance.

## Osisko PEA Supports Zinc-Lead Operations at Pine Point

Osisko Metals has reported results from an independent preliminary economic assessment (PEA) of its Pine Point zinc-lead project near the town of Hay River in the Northwest Territories, Canada. Osisko Executive Chairman and CEO Robert Ware said, "The proposed mine plan would produce more than 450 million lb of zinc in its peak year and an annual av-

erage of nearly 330 million lb of zinc and 145 million lb of lead over its estimated 10-year mine life.

"On a zinc-only basis, Pine Point could potentially, if it entered into production, become a low-cost zinc-lead producer ranking fourth largest in the Americas and ninth in the world, yielding an exceptional-ly clean and high-grade zinc concentrate.

"Furthermore, the concurrent release of an updated 2020 mineral resource estimate for Pine Point demonstrates that

## Fortescue Reaches Autonomous Milestone

Fortescue Metals Group celebrated an important milestone in the rollout of autonomous haulage at the Chichester Hub with the conversion of the 100<sup>th</sup> autonomous truck. The full conversion of 108 haul trucks at the Chichester Hub, which comprises the Christmas Creek and Cloud-break mines, is expected to be completed in September.

Since the introduction of its Autonomous Haulage System (AHS) technology at Fortescue in 2012, 168 trucks have been converted across the company's Solomon and Chichester hubs. Fortescue's autonomous haul fleet has moved around 1.4 billion metric tons (mt) of material and achieved a greater than 30% increase in productivity levels.

"Fortescue's AHS deployment represents the largest fleet conversion to autonomous haulage in the industry," said Fortescue CEO Elizabeth Gaines. "Our history of embracing leading edge technology has ensured Fortescue remains at the lowest end of the global cost curve and remains fundamental to driving sustained productivity and efficiency improvements across our business to ensure we continue to deliver enhanced returns for our shareholders and key stakeholders.

"Most importantly, the introduction of AHS technology has improved safety outcomes across our operations and we're very pleased that the Automated Mining Projects team has also achieved this important milestone in the truck conversion program with zero harm to any team members," Gaines said.

Workforce skills development has been a key aspect of Fortescue's automation project, with the company's training and redeployment program successfully transferring or upskilling team members to new roles across the business.

"Training is at the heart of everything we do at Fortescue and as we continue the integration of autonomous trucks across our sites, this ethos has guided our efforts to ensure no redundancies due to automation and to deliver significant benefits to employees from the opportunities offered by this project," Gaines said.

Fortescue claims to be the first company in the world to deploy CAT autonomous haulage on a commercial scale at the Solomon Hub and it said it was the first mining company to retrofit Cat's Command for hauling on Cat 789D and Komatsu 930E haul trucks.



Australian iron ore miner Fortescue recently converts its 100<sup>th</sup> haul truck to autonomous operations.

continued drilling will improve the classification of the resources and potentially yield further expansion of known deposits. With several deposits open, I am particularly excited to continue exploring and expanding the resource base across the project. We strongly believe in the Pine Point project, and Osisko Metals will continue developing this asset within the context of improving global zinc markets.”

Osisko President and COO Jeff Hussey added, “The current PEA concept is a large-scale, 11,250-metric-ton-per-day (mt/d) operation, where the mineral resource mined would be sourced mainly from small, near-surface open pits, with additional contributions from eight high-grade, shallow deposits mined by underground methods. The PEA considers historical data from the Cominco Ltd. era and incorporates significant technological improvements in the mining industry since the closure of the Pine Point operation in 1988.”

The open-pit mineral resource inventory used in the current life-of-mine plan is contained in 47 open pits over a strike length of 50 km and is mainly located above 125-meter (m) depth from surface. Most of the deposits are characterized by multiple shallow tabular panels dipping approximately 2° to 5° to the west.

The open-pit mining method incorporates 5-m benches in mineralized material, 10-m benches in waste, and an overall open-pit wall angle of 45°. Mineral resources will be extracted using a fleet of long-haul trucks with payloads of 90 mt. The production rate will vary between 8,000 mt/d and 11,250 mt/d. The strip ratio is expected to average 5.2:1.

Underground operations will use 45-mt haul trucks with ramp access to produce at a rate of 4,000 mt/d in the project’s West zone and 1,500 mt/d in its Central Zone. Mining methods will be a mixture of long-hole stoping (80%) and room-and-pillar (20%). All mineral resources will be transported to a central concentrator located adjacent to the existing electrical substation. Additional power will be supplied by LNG fueled generators.

The Pine Point processing flowsheet includes a three-stage crushing circuit incorporating an XRT-based mineral-sorting system that will reject 40% of waste material on average. The mineral sorter concentrate will be blended with the crushing circuit fines to feed 6,700 mt/d to a

ball mill, followed by conventional lead and zinc flotation circuits. The process plant will produce on average 168 mt/d of lead concentrate at 62% Pb and 687 mt/d of zinc concentrate at 58% Zn.

Overall zinc and lead recoveries, inclusive of sorting, are expected to be approximately 87% and 93%, respectively, over the life of the mine. The flotation concentrates will be filtered and trucked to Hay River for transloading into rail cars for shipment.

Concentrates will be sent by rail to North American smelters and further afield to Asian smelters by bulk sea freight.

Flotation tailings will be thickened and pumped for disposal within mined-out pits.

The Pine Point PEA was prepared by Osisko in collaboration with independent engineering firms BBA Inc., WSP Canada Inc., and Tetra Tech.

Going forward, value trade-off studies will be performed to determine the best overall processing and dewatering methods, mining schedules, and infrastructure to further optimize Pine Point operations, leading to increasingly attractive economics to be included in an eventual feasibility study.

This work will include resource expansion laterally along open-pit-constrained boundaries; 3D hydrogeological and groundwater modelling to optimize dewatering management plans; metallurgical testing and material-sorting efficiency options to further optimize recoveries and increase the sorted coarse material fraction; geotechnical testing to potentially reduce open-pit wall angles and strip ratios; and incorporation of automation to reduce camp and personnel requirements.

## Agreement is Reached for Long-term Power Supply for Oyu Tolgoi

Rio Tinto, Turquoise Hill and the Government of Mongolia have reached an agreement on the preferred domestic power solution for Oyu Tolgoi that paves the way for the government to fund and construct a state-owned power plant at Tavan Tolgoi.

The agreement, which is a revision of the Power Source Framework Agreement (PSFA) signed in 2018, said they would all will work toward finalizing a Power Purchase Agreement by the end of March 2021. In addition, the amended PSFA sets a proposed timetable for development, with construction of the coal-fired power plant set to begin no later than July

1, 2021, and commissioning within four years thereafter.

Oyu Tolgoi currently uses imported power.

“This agreement provides a potential pathway to securing a domestic power supply for the Oyu Tolgoi mine and underground project for the benefit of all shareholders and the wider community,” Copper and Diamonds Chief Executive Arnaud Soirat said. “We look forward to working with the Government of Mongolia to progress the solution.”

## Vale Canada Sells Stake in PT Vale Indonesia

Vale Canada Ltd. (VCL) together with Sumitomo Metal Mining Co. Ltd. (SMM) has signed definitive agreements for the sale of a 20% stake of PT Vale Indonesia Tbk (PT Vale) to PT Indonesia Asahan Aluminium (Persero) 1, also known as Inalum.

In October 2014, PT Vale signed an amendment to its 1996 Contract of Work with the Government of the Republic of Indonesia, which will expire in December 2025. For PT Vale to be entitled to an extension of its license to operate beyond 2025, requirements need to be fulfilled, which includes the divestment of 20% of PT Vale shares to Indonesian participants.

The company said the transaction represents an important development in PT Vale’s long presence in Indonesia and reinforces its commitment to keep investing in the region.

Inalum is the Indonesian state-owned entity for investments in the mining sector and its association with PT Vale contributes to the continuous development and operational expansion of its businesses in Indonesia.

The final terms and conditions include the secondary purchase of 20% of PT Vale shares by Inalum, and the maintenance of financial and operational control of PT Vale by VCL, as well as the financial and production consolidation in its financial statements.

After the closing of the transaction, Inalum will have acquired 20% of PT Vale shares, with 14.9% from VCL and 5.1% from SMM. Vale and SMM will then have a stake of 44.3% and 15% in PT Vale, totaling a 59.3% participation.

For its stake, VCL will receive approximately US\$290 million in cash upon closing of the transaction, which is expected to happen by the end of 2020.





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# Vale Will Resume Operations at Voisey's Bay



A fly-in, fly-out operation, the Voisey's Bay mill (above) processes 6,000 metric tons per day. (Photo: Vale)

Vale has moved from care and maintenance into a planned maintenance period at the Voisey's Bay Mine in Labrador, Canada, as a first step to resuming operations in early July. This includes restarting critical path activities related to the Voisey's Bay Mine Expansion Project, the company said.

The planned return to production follows three months of monitoring progress and events associated with the coronavirus (COVID-19) outbreak. Production is expected to resume in early July and reach full capacity by early August.

In line with World Health Organization (WHO) protocols to test, remove, track and treat positive or suspicious cases, Vale is partnering with a private testing lab in Newfoundland and Labrador to provide extensive PCR testing of all employees entering the site. The enhanced testing capacity enables the early identification, tracing and stopping of the spread of any potential COVID-19 cases. There have been no cases to date at site.

## Cliffs Plans to Restart Tilden Mine Early

Construction at Cleveland-Cliffs' Hot-Briquetted Iron (HBI) plant in Toledo, Ohio, will resume and the restart of its Tilden

mining operations in Michigan will be accelerated, according to the company. Construction of the Toledo HBI plant was temporarily shut down on March 20. The company has begun the process of remobilizing the workforce to complete the project. It is expected to be completed in the fourth quarter due to mandatory social distancing and other safety-related measures that have limited the number of workers allowed at the job site.

The Tilden mine, which primarily supplies the company's own AK Steel facilities in Middletown, Ohio, and Dearborn, Michigan, was idled in mid-April, with a restart previously expected in July. The company now plans to restart Tilden later this month. The earlier restart of Tilden comes in response to a faster improvement in steel demand from AK Steel's clients than initially anticipated, particularly in the automotive sector, according to the company.

"The demand for our steel, iron ore, and metallics products has recovered dramatically over the past month, and in light of this, we are restarting Toledo and Tilden sooner than we originally expected," Cliffs Chairman, President and Chief Executive Officer Lourenco Goncalves said. "We suspended these oper-

ations in a way that allowed us to restart as easily and efficiently as possible, and that is what we will do. Our footprint is well situated to capitalize on the rapidly increasing demand from the automotive sector, which is occurring faster than our most aggressive expectations."

The company has also already restarted numerous other previously idled facilities, including Precision Partners, AK Tube, Mansfield Works, and the Dearborn downstream facilities, as well as the PLTCM and the galvanizing line.

## PolyMet Appeals Air Permit

On Tuesday, June 16, the Minnesota Supreme Court agreed to review a Minnesota Court of Appeals' ruling regarding PolyMet Mining's NorthMet Project air permit. Back in March, the Court of Appeals remanded the permit to the Minnesota Pollution Control Agency (MPCA) to provide more information. PolyMet and the MPCA sought a review of the decision.

"We believe the MPCA in its permit appropriately accounted for the potential effects of the NorthMet Project on the airshed, and are pleased that the Supreme Court will hear the case," President and CEO Jon Cherry said. "The court of appeals' decision creates tremendous uncertainty for companies who want to invest in Minnesota and must seek permits from the state. This is an opportunity to remedy that situation."

This is the second case in which the Supreme Court has granted review of the lower court's ruling on Northmet Project permits. In April, the court granted the company's and Minnesota Department of Natural Resources' (DNR) requests to review the Court of Appeals' January 13 ruling, which remanded PolyMet's Permit to Mine and two dam safety permits to the DNR for a contested case hearing. The court is expected to hear that case later this year.

PolyMet has successfully defended itself in six of the 11 state and federal cases challenging the project. The remaining five cases — three state and two federal — are in various stages of litigation or appeal, including the two cases now pending before the state Supreme Court.



## New Gold Sells Blackwater to Artemis Gold

New Gold has entered into a definitive agreement with Artemis Gold to divest its Blackwater Project located in British Columbia, Canada. Under the terms of the agreement, New Gold will receive C\$190 million in cash, comprised of C\$140 million in cash upon closing and C\$50 million in cash payable 12 months following closing (second installment).

New Gold will also receive a gold stream of 8% gold produced from Blackwater, reducing to 4% production once approximately 280,000 ounces (oz) of gold have been delivered to New Gold. The stream is subject to a transfer price equal to 35% of the spot gold price. If agreed-upon production targets at Blackwater are not achieved by the seventh, eighth or ninth anniversary of closing, New Gold will be entitled to receive additional payments of C\$28 million on each of those dates.

New Gold will also acquire C\$20 million in Artemis shares upon closing, subject to New Gold not acquiring more than 9.9% of Artemis' common shares, in which case the difference between C\$20 million and the value of the shares issued to New Gold shall be added to the second installment.

"We believe that surfacing value for Blackwater today, while retaining exposure to the project through a retained gold stream and an equity position in Artemis, allows [New Gold] to transition to the next phase of our growth plan as we continue to reposition the company for shareholder value creation," New Gold CEO Renaud Adams said. "Artemis has clearly expressed its commitment to building and operating Blackwater that is supported by its management team's strong track record in the industry."

The Blackwater Project has gold and silver reserves of 8.2 million oz and 60.8 million oz, respectively. The project is in the development phase, having successfully achieved all necessary environmental assessment approvals. When the mine site is constructed, it will include an open pit, ore processing facilities, a tailings storage facility, waste rock dumps, water management facilities, offices, accommodation camps, warehouses and a truck shop. A 140-km transmission line will connect the mine site with an existing substation south of Endako, British Columbia.

The transaction is subject to customary closing conditions, including Artemis

shareholder approval and required regulatory approvals.

## Eldorado Gold Will Begin Decline at Lamaque

Eldorado Gold Corp. is commencing construction of a 3-kilometer (km) decline from the Sigma mill to the 405-meter (m) level of the Triangle mine. The company also provided an update on several positive developments in Greece.

"We are pleased to begin construction of the decline at Lamaque this summer," President and CEO George Burns said. "This is a project that we have been advancing for nearly a year and is another step toward further production growth and continued value creation at Lamaque."

The fully permitted decline project represents a relatively modest investment that is expected to provide multiple near-term and long-term benefits as the company continues to grow production at Lamaque. Detailed engineering and site preparations for the decline will commence in June and surface construction on the portal will begin in the third quarter of 2020. The decline is expected to be completed by the first half of 2022 at an estimated cost of US\$24 million.

The company said it is evaluating the possible addition of an underground crushing and conveying system as well as a potential mill expansion. An update outlining the path forward at Lamaque is expected in the fourth quarter of 2020.

## Development Plans Progress at Pumpkin Hollow Mine

While copper production has been temporarily suspended at Nevada Copper's Pumpkin Hollow mine due to the impact of the coronavirus (COVID-19), the company has made significant progress with its previously reported accelerated mine development plans.

As far as vertical development, multiple key milestones have been completed on final configuration of the East Main Shaft. The Main Haulage Shaft has been completed to a final depth of 2,131 ft. Miners have completed the shaft ramp. A loading pocket has been excavated and the form work is being installed for a concrete pour. A 25-person underground refuge chamber and an underground fuel delivery station have been installed. The reparations for final furnishing of the production shaft is on schedule.

Lateral development is advancing along with underground infrastructure. Orebody definition drilling continues to support mine planning. The ore stockpile ore now sits at more than 95,000 tons.

Nevada Copper said it intends to quickly complete its accelerated development plan and restart concentrate production in Q3 2020, subject to revision based on impacts of the COVID-19 pandemic and other factors.

"We are excited to be progressing rapidly with our accelerated critical path development program moving us closer towards recommencing copper deliveries with increasing reliability," CEO of Nevada Copper Evan Spencer said. "Completion of the main shaft to final depth is a key milestone for the project and allows us to commence the final phase of furnishing the shaft."

"The speed of our progress is a testament to the dedication of our team and the support of our key suppliers and stakeholders during the recent period of uncertainty."

## Intrepid Achieves Record Monthly Sales

Intrepid Potash, which was recognized as an essential business by New Mexico, announced it safely sold a record volume of its specialty fertilizer Trio to domestic customers during April. The company accomplished this safely and under mandated COVID-19 safety guidelines and procedures, according to Intrepid Vice President of Sales Mark McDonald.

"With cooperative weather for most of the spring, we saw customers move their purchases earlier into the season and our team was up to the challenge," McDonald said. "Achieving a record month takes daily cooperation and communication across all lines of our business, and we want to thank our customers, the transportation industry, production and load-out staff, and our sales and marketing team for their hard work and dedication to following the COVID-19 safety guidelines during this pandemic."

McDonald added that Intrepid was proud to serve the American farmer who is "working so hard through the COVID-19 pandemic to keep the agricultural food chain alive and well and feeding Americans."

Trio delivers three key nutrients, potassium, magnesium, and sulfate, in a

*(Continued on p. 20)*



Greg Gibson



Natasha Vaz



Jennifer Wagner



Duncan King

*Kirkland Lake Gold Ltd.* announced a number of management appointments. **Greg Gibson** joined the company as special advisor to the CEO, Business Process Improvement; **Natasha Vaz** is promoted to senior vice president, technical services and innovation, from her current position of vice president, technical services; **Jennifer Wagner** is promoted to senior vice president, corporate affairs, legal counsel and corporate secretary from vice president, legal; **Mark Utting** is promoted to senior vice president, investor relations from vice president, investor relations; **Mohammed Ali** is promoted to vice president, environment from director, environmental affairs, Canadian operations; **Duncan King** is appointed vice president, Canadian operations from his current role of vice president, Australian operations on an interim basis; **John Landmark** and **Brian Hagan** are appointed co-leads of Australian operations on an interim basis, from their current positions of vice president, human resources and vice president, Northern Territory operations, respectively; **David Londono** is appointed vice president, special projects from his current role of mine general manager, Detour Lake mine; and **Evan Pelletier** is promoted to vice president, mining (Kirkland Lake) from general manager, mining (Kirkland Lake).



Brad Moore



Jon Cherry

**Brad Moore**, executive vice president of environmental and governmental affairs, will retire from *PolyMet* effective July 12. He joined the company in 2011. Under his leadership, the company was the first project to navigate the permitting process to mine copper, nickel and precious metals from the mineral-rich Duluth Complex in northeastern Minnesota. The board has elected a new chairman and appointed two new board members. The board named **Jon Cherry** as chair to succeed **Ian Forrest**, who retired from the board after serving as its chairman since 2012.



Steve Douglas

*Hudbay Minerals Inc.* appointed **Steve Douglas** as senior vice president and CFO. From 2014 to 2017, he was senior vice president and CFO at *Agrium Inc.*, prior to its merger with *Potash Corp. of Saskatchewan Inc.*, and served as executive vice president and chief integration officer at *Nutrien Inc.* until January 2019. Eugene Lei, interim CFO, will continue in his role as senior vice president, corporate development and strategy, and as a key member of the executive team.

*Pretium Resources Inc.* accepted the resignation of **David Prins**, vice president, operations, who will depart the company on August 31. The company is initiating a search for a new leader. Prins will continue to assist in his current role until his departure in order to ensure an orderly transition. Prins was appointed vice president, operations, in 2018.



Olga Kalashnikova

*PAO Severstal* appointed **Olga Kalashnikova** as its new head of environment. Kalashnikova, who was previously responsible for Upstream environmental performance at *Shell Russia*, is now primarily focused on the development of a clear strategy and roadmap to decrease *Severstal's* carbon emissions. During more than 10 years at *Royal Dutch Shell*, she was responsible for ensuring best environmental practices were maintained at the group's joint ventures in Russia.

*Nova Minerals Ltd.* advised that Executive Chairman **Avi Kimelman** has resigned as a director. Kimelman will remain involved as a consulting general manager. The company also appointed **David Hershman** as non-executive chairman.

*American Lithium Corp.* appointed **Simon Clarke** as a director of the company and **G.A. Binninger** as special advisor to the board. Most recently, Clarke was founder, CEO, and director of *M2 Cobalt Corp.*, which sold to *Jervois Mining Ltd.* in June 2019. Binninger is a chemical engineer. Binninger has direct experience in lithium and related minerals having been CEO of *Potash Minerals* and a member of the advisory board of *Millennial Lithium*.

*Triumph Gold Corp.* announced that **Tony Barresi** has resigned as a director and president and **Joe Campbell** has resigned as a director of the company. Barresi will continue to act as a technical advisor. Barresi for his geological leadership over the past three years in discovering the *Blue Sky Porphyry* and advancing many of the other projects on the *Freegold Mountain Project* in the Yukon. **Brian Bower** has agreed to accept a position as lead director. Bower has more than 30 years of experience as an exploration and mine geologist.

*Horizon Minerals Ltd.* advised that **Peter Bilbe** will step down as chair of the company, but will remain an independent nonexecutive director of *Horizon*. Non-executive Director **Ashok Parekh** will assume the role of chair, serving alongside Bilbe and Managing Director **Jon Price**.



Ashok Parekh



Peter Vukanovich



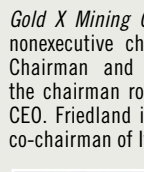
Paul Perrow

*Euro Sun Mining Inc.* has added **Peter Vukanovich** and **Paul Perrow** to its board of directors. Vukanovich currently leads *PMV Consulting Inc.* Perrow was senior vice president, director of sales and marketing with *CI Investments Inc.* until December 1996. He has held several other senior industry positions including managing partner of *Red Sky Capital*, co-head and managing director of *Merrill Lynch Investment Managers Canada*, co-founder and president of *Fairway Capital* and president and CEO of *BluMont Capital*.



Luther Nip

*Monument Mining Ltd.* appointed **Luther Nip** as interim CFO. Previously, he has worked for *Grant Thornton LLP* as senior manager, and *Ernst and Young LLP* as manager of assurance services.



Robert Friedland

*Gold X Mining Corp.* appointed **Robert Friedland** as nonexecutive chairman of *Gold X*. *Gold X's* current Chairman and CEO **Paul Matysek** will relinquish the chairman role, but will remain a director and its CEO. Friedland is the founder and currently executive co-chairman of *Ivanhoe Mines*.



Peter MacPhail

*Manitou Gold Inc.* appointed **Peter MacPhail** as a new director. MacPhail is the COO of *Alamos Gold Inc.*

**Mark Savit** has left his position as senior counsel at law firm *Husch Blackwell* to focus on his role as CEO at *Predictive Compliance*.



Mark Savit

**Rick Frantz**, of *Komatsu Mining Corp.*, formerly *Joy Mining Machinery*, has retired after serving the coal industry for 43 years. He was a principle engineer at *Komatsu* for 14 years and was responsible for many innovations that revolutionized underground mining, such as advanced shearer automation, continuous miner automation, and the *Faceboss Control System*.

**Carita Himberg** has been appointed senior vice president, human resources, and a member of the *Metso Outotec Executive Team*. She will start in her new role at the latest before the end of the year. Himberg joins *Metso Outotec* from *Stora Enso*, where she works as senior vice president of human resources in the *Packaging Materials Division*.



Carita Himberg





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# Lundin Reactivates Fruta del Norte



The mill is currently processing ore from stockpiles at a rate of 2,800 mt/d and is expected to ramp up to 3,500 mt/d over the next two months. (Photo: Lundin Gold)

Canada-based Lundin Gold is preparing to restart operations at the Fruta del Norte gold mine in Ecuador. Operations ceased when restrictions were put in place to limit the exposure of the coronavirus (COVID-19).

The company said its restarting and operating plan follows the guidelines of the Biosafety Prevention Protocols for the Mining Sector in the Face of the Pandemic COVID-19 presented by the Ministry of Energy and Non-Renewable Natural Resources and approved by the National Emergency Operations Committee on May 15. The plan includes the implementation of advanced and strict protocols for a safe and gradual restart of its activities for personnel, contractors and any person related to the mine.

Fruta del Norte is located in the Amazon province of Zamora Chinchipe and started to produce gold last year. It is one of two large-scale mining projects currently operating in Ecuador.

## PEA Supports Lumina's Cangrejos Project in Ecuador

Lumina Gold has reported positive results from a preliminary economic assessment (PEA) of its Cangrejos gold-copper project in El Oro province, southwest Ecuador. The current PEA demonstrates substantial improvements over a previously reported 2018 PEA, with the addition of the Gran Bestia deposit, increased min-

eral resource definition, and an improved process flow sheet.

Highlights of the Cangrejos PEA include life-of-mine (LOM) average annual payable production of 366,000 ounces (oz) of gold and 46 million lb of byproduct copper over a 25-year mine life. An initial 40,000-metric-ton-per-day (mt/d) processing facility would process ore during years one to five of operations, with an expansion to 80,000 mt/d planned for year six.

Average cash operating costs are estimated \$545/oz and all-in sustaining costs are estimated at \$604/oz for gold, net of byproduct credits. LOM processed grades are 0.56 g/mt for gold and 0.10% for copper. The LOM revenue mix is 78.9% gold, 19.4% copper and 1.7% molybdenum plus silver.

Initial capital costs, including working capital and refundable value added tax, are estimated at \$1 billion. Expansion capital to double throughput, including working capital, is estimated at \$454 million.

Lumina President and CEO Marshall Koval said, "I am extremely pleased that we increased the after-tax NPV of Cangrejos by more than \$600 million to \$1.6 billion, maintained average annual gold production of more than 360,000 oz per year (oz/y) for 25 years, and increased the after-tax IRR of the project to 16.2%.

"Cangrejos is an exceptional global gold deposit and one of the few of this scale that is 100%-controlled by an independent developer. After commissioning Fruta del Norte and Mirador, Ecuador will turn its attention to focus on the next generation of development projects."

The PEA contemplates large-scale open-pit mining using a 100% owner-operated equipment fleet. Five mining phases were designed for Cangrejos and two for Gran Bestia, both using a technique that optimizes present value by using a declining cut-off grade over the mine life.

Gran Bestia material begins to enter the mine production schedule in year five; however, the majority of the Gran Bestia economic mineralization (88%) is mined in the last nine years of the production schedule.

A 13-month preproduction stripping period is contemplated to expose sufficient material for initial operations. Haul road construction and clearing and grubbing of the pit area are expected to be performed primarily by contractors prior to the commencement of preproduction stripping.

The proposed Cangrejos processing plant is a conventional copper-gold flotation concentrator and carbon-in-leach (CIL) circuit. Near-surface saprolite and saprock materials have now been included in the mill feed since the material can be processed with the addition of the CIL plant. The saprolite and saprock account for 2% of the LOM processed material and contain 269,000 oz of gold. The CIL circuit throughput will be 4,000 mt/d during the first five years and 8,000 mt/d post expansion in year six.

The process flow sheet begins with a primary crusher adjacent to the pit and an overland conveyor to the plant. The plant consists of secondary crushing, HPGR and ball mills, copper and molybdenum concentration circuits, CIL treatment, and cyanide detox and thickening and filtering of the combined CIL and flotation tailings. The tailings are conveyed to a dry-stack tailings facility.

The plant is designed to produce gold and silver doré, a copper-gold flotation concentrate, and a molybdenum concentrate, which will be trucked approximately 40 km to Puerto Bolivar, Ecuador.



# BHP Acquiring Norilsk's Australian Nickel Assets



Honeymoon Well's resources are estimated at 173 million mt of ore grading 0.67% nickel. (Photo: Norilsk Nickel)

BHP has agreed to acquire the Honeymoon Well Nickel Project comprising the Honeymoon Well development project and a 50% interest in the Albion Downs North and Jericho exploration joint ventures from MPI Nickel Pty Ltd, which is a wholly owned subsidiary of Norilsk Nickel Australian Holdings BV. BHP Nickel West is currently a 50% shareholder in the Albion Downs North and Jericho joint ventures.

The combined tenement package is located in the northern Goldfields region of Western Australia, approximately 50 kilometers (km) from BHP's Mount Keith mine and 100 km from its Leinster concentrator. The package includes the Wedgetail deposit, which contains a high-grade nickel sulphide resource and a high-quality disseminated sulphide resource in the style of the Mount Keith and Yakabindie ore bodies.

"This is an exciting opportunity to enhance our world-class nickel resource base in Western Australia," BHP Nickel West Asset President Eddy Haegel said. "Proximity to our existing facilities makes us the natural owners of these deposits, and provides potential options to bring the undeveloped resources to market."

Haegel said this purchase is consistent with its strategy to invest in future-facing commodities and allows them to explore and develop these prospective nickel sulphide tenements.

BHP's Nickel West operations are a fully integrated mine-to-market business, with operations that include open-cut

and underground mines, concentrators, a smelter and a refinery. The majority of production is sold as high-quality nickel metal to overseas markets.

Three streams of nickel concentrates come together at the Kalgoorlie smelter, which uses a flash furnace to smelt concentrates and produce nickel matte. The Kwinana refinery then refines granulated nickel matte from the smelter into premium-grade nickel powder and briquettes containing 99.8% nickel.

A nickel sulphate plant is under construction and nearing completion at the Kwinana refinery. Nickel sulphate is a product used in the lithium-ion batteries that power electric vehicles.

## Browns Range Will Restart

Northern Minerals Ltd. has made the decision to partially restart operations at the company's Browns Range Heavy Rare Earths Pilot Plant Project as well as recommence exploration activities across its tenements in the East Kimberley region of Western Australia. The decision follows the lifting of the commonwealth's biosecurity restrictions that applied to the Kimberley region as part of the coronavirus (COVID-19) control measures, which was the catalyst for the company placing the project on care-and-maintenance at the end of March.

Northern Minerals has commenced planning and logistics to support the restart of operations at the pilot plant, which will

initially focus on testwork in the beneficiation circuit followed by tests in the hydro-metallurgical circuit. The company will also proceed with the mechanical construction and installation of ore-sorting equipment at the front-end of the pilot plant.

Exploration activity across the Browns Range tenement package will also be ramped-up, with a budget of \$4.5 million to \$5 million being allocated for greenfields exploration, further evaluation of identified mineralization and to boost confidence in resources, with the objective of increasing the overall life-of-mine potential of the project, the company said.

## NQ Minerals Acquires Beaconsfield Gold Mine

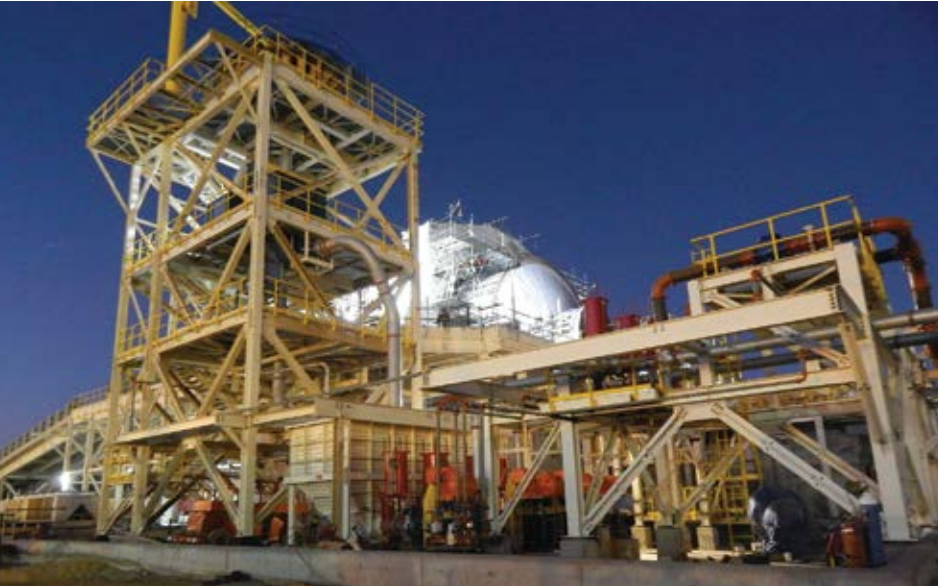
NQ Minerals Plc has now signed all necessary agreements and made the necessary payments to purchase and take immediate possession of the high-grade and historic Beaconsfield gold mine in Tasmania, Australia. The mine has historic recorded production of 1.8 million ounces (oz) of gold averaging 15 grams per metric ton (g/mt) and was closed in 2012 due to the low gold price at that time, the company said. The gold price has since increased by more than 100% and the company said it plans to reopen the mine as soon as practicably possible.

NQ plans to recommission the gold processing plant, which is currently under care and maintenance, and reopen the mine by developing a new modern mine decline access into the Beaconsfield mine from the surface to reconnect into the existing mine workings at the lower section of the orebody, which comprises all of the current stated gold resources.

NQ is currently increasing production at its flagship Hellyer gold mine in Tasmania, Australia.

NQ also recently announced a new JORC-compliant mineral resource estimate of the lower section of the Beaconsfield gold mine of 1.454 million mt grading 10.3 g/mt for 483,000 oz of gold. Significant additional gold potential is still to be assessed in the upper section of the old workings.

# Kinross Agrees to Terms With Mauritania Government



Kinross believes the agreement positions the Tasiast operation (above) for long-term success. (Photo: Kinross Gold)

Kinross Gold Corp. has reached an agreement with the Government of Mauritania to enhance their partnership, which the company said balances the interests of both parties. Under the agreement, the government will provide a 30-year exploitation license for Tasiast Sud, reinstatement of tax exemptions, and repayment of \$40 million in exchange for a \$10 million payment by Kinross when the agreement is completed and \$15 million once the license is received.

Kinross President and CEO J. Paul Rollinson said, "This balanced agreement will deliver increased stability, position Tasiast for long-term success, and provide enhanced benefits to Mauritania and its people."

The 30-year exploitation license for Tasiast Sud under the 2008 Mining Code and the 2012 Mining Convention will be granted with expedited permitting and the possibility of early mining. The tax exemption on fuel duties will be reinstated and the government will repay the \$40 million outstanding VAT refunds with an agreed payment schedule through 2025.

The \$10 million payment is related to fuel use and tax exemptions and the \$15 million payment was to resolve disputed

matters arising out of Kinross' prior application to convert the Tasiast Sud exploration license into an exploitation license.

At Tasiast, Kinross also volunteered to update its existing fixed 3% royalty payable under the 2006 Tasiast Mining Convention. Although it is still in effect, mining laws have evolved, so Kinross decided to pay an escalating royalty tied to the price of gold that aligns with the 2008 Mining Code and the 2012 Mining Convention. Kinross said this is comparable with other royalties in the region.

The government will receive a 15% free carried interest in Tasiast Sud with an option to purchase an additional 10% participating interest after additional feasibility work is completed, according to the company.

Mauritanian Minister of Petroleum, Mines and Energy Mohamed Abdel Vetah said, "This agreement is a result of positive efforts between the government of Mauritania and Kinross to amicably resolve our discussions. It also highlights our commitment to providing an attractive investment climate in the country and ensures that the Mauritanian people will receive the appropriate benefits from the Tasiast mine."

The parties have also agreed to enhanced exploration programs at Tasiast. It will focus on upgrading existing indicated resource estimates.

The government can nominate two observers to the board of directors of the Kinross subsidiary operating the Tasiast mine and will also have a right to nominate one representative and one observer to the Board of the Kinross subsidiary that will operate Tasiast Sud.

## Consolidated Gold Will Build 10 Plants in Zambia

Zambia has built 10 milling plants to process gold in a drive to formalize artisanal and small-scale miners and diversify from copper mining, state mining investment company ZCCM-IH said. The project is being undertaken by Consolidated Gold Co. Ltd. (CGCZ), a gold processing and trading joint venture between Karma Mining Services and Rural Development and ZCCM-IH. Zambia's efforts are part of a continent-wide push to tackle informal mining of gold, which is driven by poverty and unemployment, poses health and environmental risks and deprives states of revenue when the metal is smuggled across borders.

Africa's second-largest copper producer, Zambia aims to produce 40,000 kilograms (kg) of gold in 2020 from primary and secondary sources, including gold bought from artisanal and small-scale miners at government-controlled buying centers. The milling plants have a combined processing capacity of 30 metric tons (mt) of ore per day and a targeted average of 7.5 kg of gold production per month, ZCCM-IH said.

## Samapleu Project Targets Special Materials

Sama Resources has reported results from a preliminary economic assessment (PEA) of development of its Samapleu nickel-copper project in Côte d'Ivoire. The project will produce an estimated average 3,900 metric tons per year (mt/y) of carbonyl nickel powder, 8,400 mt/y of carbonyl iron powder, and 14,100 mt/y of copper concentrate over a 20-year mine life.



Nickel and iron powders produced by the CVMR carbonyl process are used a host of specialized applications.

Carbonyl nickel powder sells currently sell for \$25,483/mt, carbonyl iron powder (\$8,389/mt), and copper concentrate (\$966/mt).

Capital costs to develop the project are estimated at \$282 million, including a contingency of \$37 million. Operating costs are estimated at \$23.96/mt milled.

The Samapleu project is located approximately 650 road km northwest of Abidjan, Côte d'Ivoire and 25 km east of the nation's border with Guinea. The project would be mined as a conventional open pit, using off-highway haul trucks, hydraulic excavators, and wheel loaders.

Mineralized materials are contained in three pits. The average life-of-mine feed grade to the processing plant is estimated at 0.24% nickel, 0.18% copper, and 11.86% iron. An estimated 44.42 million mt would be mined over the life of the mine.

The plant flowsheet consists of crushing, grinding, and rougher and cleaner flotation. The back end of the concentrator includes concentrate and tailings thickening, concentrate filtration, and material handling.

Nickel and copper concentrates would be recovered by conventional flotation. Nickel concentrate would be sent to a carbonyl refining plant on site to extract nickel and iron. The concentrate would be roasted in a fluid bed roaster to convert sulphide minerals to oxides. If the concentrate is too fine, the feed may have to be pelletized prior to feeding the fluid bed roaster.

Calcined concentrate would then be reduced with hydrogen in a rotary kiln to convert the nickel and iron oxides to metallic nickel and iron. The nickel and iron would be extracted from reduced concentrate in the form of volatile metal carbonyls through the CVMR carbonyl process, then separated and decomposed to metal nickel and iron products.

## Ivanplats Completes Sinking of Shaft 1 at Platreef Project

Ivanhoe Mines' South African subsidiary, Ivanplats, has completed sinking of Shaft No. 1 to a final depth of 996 meters (m) below surface at its Platreef project on the Northern Limb of the Bushveld Complex in South Africa. The project is tar-

getting mineralization containing palladium, platinum, rhodium, gold, nickel, and copper in the thick, high-grade, flat-lying, underground Flatreef deposit.

Shaft No. 1 is located about 350 m from a high-grade area of the orebody that is planned for bulk-scale, mechanized mining. Underground mine development is currently focused on construction of the 996-m-level station at the bottom of the shaft, with final completion planned by the end of July. The shaft can then be equipped for rock, personnel and material hoisting.

A new auxiliary winder for the 7.25-m-dia shaft is scheduled to be delivered later this year.

Ivanhoe is also updating the Platreef project's 2017 definitive feasibility study to take into account development schedule progress, updated costs, and refreshed metal prices and foreign exchange assumptions. Ivanhoe is finalizing a preliminary economic assessment for the phased-development production plan for the project. This work targets significantly lower initial capital to accelerate first production by using Shaft No. 1 as the mine's initial production shaft.

"The pending study will assess phased-development options at Platreef, with substantially lower upfront capital," Ivanhoe Co-Chairman Robert Friedland said. "The goal is to prioritize near-term production while safeguarding our strong balance sheet. We are confident that the project will, in time, become one of the world's largest and lowest-cost primary producers of platinum-group metals and provide long-lasting and meaningful benefits to all of our stakeholders, including the 20 local

communities — comprising approximately 150,000 local Mokopane area residents — that are our equity partners."

Mining will be based on mechanized methods, including long-hole stoping and drift-and-fill mining. Each method will utilize cemented backfill for maximum ore extraction. The ore will be hauled from the stopes to a series of internal ore passes and fed to primary ore silos at the base of Shaft 2, where it will be crushed and hoisted to surface.

When completed, Shaft 2 is planned to provide primary access to the mining zones; with secondary access via Shaft 1. During mine production, both shafts will serve as ventilation intakes. Three additional ventilation exhaust raises are planned to achieve steady-state production.

The orebody at Shaft No. 1 is 29 m thick, with grades of platinum-group metals ranging up to 11 grams per metric ton (g/mt) platinum, palladium, and rhodium, plus gold and significant quantities of nickel and copper. The 29-m intersection by Shaft No. 1 yielded approximately 3,000 mt of ore, estimated to contain more than 400 ounces (oz) of platinum-group metals. The ore is stockpiled on surface and is being used for metallurgical test work.

The Platreef project is owned by Ivanplats Ltd., which is 64% owned by Ivanhoe Mines. A 26% interest is held by Ivanplats' historically-disadvantaged, broad-based, black economic empowerment partners, which include 20 local host communities. Itochu; Japan Oil, Gas and Metals National Corp.; and Japan Gas Corp. hold the remaining 10%.



Socially distanced masked miners celebrate the completion of the nearly 1-km-deep Platreef No. 1 shaft.

# Ongoing Drilling Is Enhancing Bellevue Gold's Western Australia Gold Project

Bellevue Gold has announced exceptional infill drilling results from its Bellevue gold project in central Western Australia. The drilling has intercepted the Deacon Shear at the predicted lode position and returned consistent high-grade mineralization.

The Deacon Lode is an analogue to the adjacent, previously mined Bellevue mine about 350 meters (m) west of Deacon, with a moderate westerly dip and gently plunging high-grade mineralized shoots associated with semi-massive pyrrhotite and quartz clasts.

Detailed results have been received from a total of 16 drill holes completed as infill at the Central Deacon discovery, where a maiden inferred resource of 410,000 ounces (oz) grading 12.3 grams per metric ton (g/mt) gold was recently reported. The recent drill holes close the drill spacing from the original 80-m centers to 40-m centers over a portion of the Central zone as a first pass assessment of how the lode will respond to infill drilling.

The recent drilling has also highlighted an important new high-grade shoot within the Deacon envelope containing a very high metal content. Intersections from this shoot are in excess of 250 g/m and appear similar to the Level 13 shoot at Bellevue, which produced high-grade gold mineralization from the historic mine.

Deacon remains open in all directions. The recent infill drilling points to the potential of further high-grade shoot definition within the Deacon Corridor with step-out exploration along strike and down dip.

The total inferred resource at the Bellevue project currently stands 2.2 million oz grading 11.3 g/mt gold.

Operational activity on site is ongoing, with dewatering of the existing underground mine proceeding to plan and initial inspections used to determine the refurbishment required to regain access for drilling and eventual development highly encouraging.

Geotechnical, metallurgical, and mining studies are also well under way. ([www.bellevuegold.com.au](http://www.bellevuegold.com.au))

## Exploration Briefs

**O3 Mining** has significantly expanded its current drill program in Val-d'Or, Quebec, to 150,000 meters (m), including work on its Malartic, Alpha and East Cadillac properties. O3 Mining has drilled approximately 26,000 m as part of a 50,000-m drill program originally announced in September 2019.

Exploration success in the initial campaign and a recently completed C\$35 million financing have provided the company with the confidence to triple the drilling program. The first drill was mobilized in early June, and more drills will continue to be mobilized in the near term.

The exploration budget for the expanded drill program is C\$24 million. Drilling will continue year-round, with three to five drill rigs expected this summer.

O3 Mining President and CEO Jose Vizquerra said, "We are very pleased to restart our drilling activities in Val-d'Or. Our recent financing will allow us to triple our exploration program for our Val-d'Or properties and add value for our shareholders. We remain vigilant of the current Covid situation and are continuously following all government protocols to ensure the safety of our employees and community." ([o3mining.ca](http://o3mining.ca))

**Sienna Resources** has initiated a drill program on its flagship Slättberg PGE-Ni-Cu project 25 kilometers (km) northwest of the historic mining city of Falun, Sweden. The PGE-Ni-Cu enriched mineralization remains open at depth and along strike. The abundance of sulphides, higher platinum group element values, and a swarm of mafic dikes suggest that Sienna is moving closer to a source area for the sulphide mineralization and associated mafic intrusions as it drills to progressively deeper levels.

The current 1,000-m drill program will test the continuation of the PGE-Ni-Cu massive sulphide mineralization in the western part of the project with two or three drill holes. Another drill hole will follow-up earlier drill results.

Slättberg is a historic mining camp hosting cobalt and PGE enriched nick-

el-copper sulphide mineralization along a 2-km belt of historic nickel-copper mines. The project contains drill defined zones of massive sulphide mineralization that extend to about 100 m in depth, which is also the approximate depth of historic mining in the area. At least 16 historic mines are located on the property, with historic operations dating back to the late 1800s.

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

**Libero Copper & Gold** has announced plans for its 2020 drill program on its Big Red property in the Golden Triangle of northwest British Columbia. The surface program was underway in mid-June, and drill camp construction began in early July. Drilling was scheduled to begin in July and continue through August.

The drill camp has excellent infrastructure with a neighboring placer mine and both road access and a dedicated airstrip.

The surface program, which consists of additional geochemical sampling and mapping, will be used to guide a 3,000-m, 16-hole drill program. The surface program will advance the 19 multi-element geochemical anomalies identified in the company's 2019 field program and high-conductivity targets identified by a recent ZTEM geophysical survey in order to identify additional high-probability drill targets for the 2020 field season.

Initial planning calls for 1,000 m of track-mounted reverse circulation reconnaissance (RC) drilling in 10 shallow holes at the best targets. The RC work is intended to rapidly provide subsurface confirmation of the high soil and rock values.

Results will be used to better target an initial round of 2,000 m of core drilling in six holes. On-site XRF analysis will be utilized to analyze rock chip samples and drill core for pathfinder elements to focus exploration in real-time.

Core drilling is planned for August, leaving time for compilation and interpretation of results and implementation of a follow-up program in the early fall, should results warrant.

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





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# BMA Makes Major Investment for Daunia



BMA will introduce 34 autonomous haulers at Daunia over the next 18 months. (Photo: BMA)

The BHP Mitsubishi Alliance (BMA) recently announced it would introduce 34 autonomous trucks at the Daunia coal mine in Queensland, Australia, a \$100 million investment. This is a multigenerational investment in the industry and state at a time when it is needed, explained BMA Asset President James Palmer.

“This announcement is a vote of confidence in Central Queensland,” he said. “At least 10 regional and indigenous businesses will be employed to support the rollout, with contracts worth \$35 million. This will result in 150 additional project roles for BMA people and contractors. This is on top of 56 new permanent roles on site.”

Hastings Deering’s Central Queensland operations will see an additional 30 jobs required to assist with truck and ancillary fleet conversion. “This contract is a huge boost to our local business and the region,” Hastings Deering CEO Dean Mehmet said. “We will need 30 additional people to support the work that is required to convert the trucks and ancillary mining fleet.”

“We have engaged with our workforce at Daunia over the previous 18 months on the possible rollout of autonomous haulage,” Palmer said. “Our people have told us that they are eager for new job opportunities and skills. That is why we are confident this is the right decision for Daunia. It will further increase safety and performance and help the mine remain competitive over the long-term.”

To help prepare for Daunia’s autonomous future, it is estimated more than 30,000 hours of training will be delivered, from general awareness to extensive training for those operating equipment, interacting with the autonomous haul trucks, or taking on new roles. The first autonomous trucks will begin from February 2021, with the rollout expected to be completed by the end of 2021.

## Westmoreland to Suspend Coal Valley Operations

Westmoreland Mining and its subsidiary Prairie Mines & Royalty ULC decided to suspend operations at its Coal Valley mine due to the significant constraints and challenges imposed by the COVID-19 pandemic. Since the start of the outbreak, the company said it has steadfastly prioritized the health, safety and well-being of its employees, the local community and all other stakeholders in its coordinated response to the virus. Based on its latest assessment of the situation, they ultimately concluded that there was no other option than to place the Coal Valley on care and maintenance.

“This is a very difficult call for us to make, however, we know it’s the right decision in the circumstances and one that balances our duty of care to our workforce with the long-term interests of Coal Valley,” Westmoreland COO Joe Micheletti said. “These actions highlight the extent to which

the day-to-day activities at this unique mine have been compromised by COVID.”

All the equipment and infrastructure on site, including the processing plant, will be maintained to preserve a state of operational readiness. “We will be transitioning to a small number of employees remaining on site to maintain the property and equipment, as well as to oversee all environmental responsibilities and compliance,” said Stephen Love, Coal Valley’s general manager.

The transition to full care and maintenance activities expected to occur within the next quarter.

## Foresight Implements Reorganization Plan

Foresight Energy LP announced it has consummated its Chapter 11 plan of reorganization. The remaining Foresight assets were transferred to Foresight Energy Operating LLC, which is owned by Foresight Energy Resources LLC.

Pursuant to the plan, Foresight discharged more than \$1 billion of debt and eliminated \$94 million of anticipated annual cash interest payments, plus additional reductions in annual cash flow expenses through modified contractual terms with key logistics, mineral interest and vendor counterparties. Holders of the old Foresight limited partnership units received no recovery under the Plan. Foresight has emerged from Chapter 11 with only \$225 million in secured exit facility loans, \$75 million of which will convert to equity 60 days following the closing of the exit facility, and will have approximately \$65 million in cash liquidity.

“We are thankful to our many stakeholders. With their cooperation, we have been able to achieve confirmation within four months of entering Chapter 11. I count this as a tremendous accomplishment,” said Robert D. Moore, CEO, Foresight Energy. “We are working expeditiously to timely implement the plan, and we look forward to emerging from the Chapter 11 process.”

A large Illinois Basin coal operator, Foresight operates three longwall mining complexes with four longwall mining systems and the Sitran river terminal on the Ohio River.



# J-LOK P™

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The J-LOK P Pumpable Resin System has been successfully expanding and advancing into the hard rock mining industries. The most recent mine to successfully use the J-LOK P Pumpable Resin System to install cable bolts has been a copper mine. The mine installed the cable bolts with hangers or wedges to anchor the cable bolts in place preventing the bolt from exiting the drill hole while the pumpable resin was being installed. This full encapsulation system ensures great anchorage in the strata and keeps the cable bolt isolated from destructive environments. The system consists of a two-component, pumpable, polyester resin and a specialized pump that delivers the resin directly to the bolt hole.

Developed to improve the productivity, safety and reliability of ground support installations, J-LOK P can be used for a wide range of ground support products including solid steel rebar, hollow core bolts and cable tendons.

#### ENVIRONMENTAL ADVANTAGES:

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#### STRENGTH ADVANTAGES:

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For more information on the J-LOK P Pumpable Resin System please contact us at:  
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[WWW.JENNMAR.COM](http://WWW.JENNMAR.COM)

*(Regional News-U.S. & Canada - from p. 9)*

single particle. The company's mineral production comes from three solar solution potash facilities and one conventional underground mine.

## Minerals Permitting Bill is Introduced in US House

On May 28, U.S. Reps. Paul A. Gosar (AZ) and Michael Waltz (FL) introduced the American Critical Mineral Exploration and Innovation Act of 2020. They were joined by House Committee on Natural Resources Ranking Rep. Rob Bishop (UT), House Committee on Space, Science, and Technology Ranking Rep. Frank Lucas (OK), and House Rep. Leader Kevin McCarthy (CA). This bill is intended to facilitate the availability, development and environmentally responsible production of domestic resources to meet national material or critical mineral needs.

China continues to dominate the critical minerals market, controlling the vast majority of the global supply. Currently, 14 of the 35 critical minerals identified by the U.S. Geological Survey are imported to the U.S. at a rate of 100%.

"This dual-committee effort will make significant strides toward securing our nation a domestic supply chain of critical minerals from the United States for the United States," Rep. Gosar said. "Critical minerals are the building blocks of modern life, necessary for applications in defense systems, renewable technologies, healthcare and more."

The global pandemic has demonstrated the consequences of allowing America's overreliance on China to go unchecked, Gosar added, "and this legislation will be-

gin the complex process of unraveling our addiction and addressing this problem."

The bill will address current impediments to domestic critical mineral development, such as requiring federal agencies to streamline the permitting process. It will also promote technological advancements, such as minerals recycling.

Arizona Mining Association Executive Director Steve Trussell said proper measures must be taken to "protect, responsibly extract and utilize our resources so we are not reliant on foreign sources."

## Piedmont Studying Options for North Carolina Project

Piedmont Lithium has completed a pre-feasibility study for a proposed lithium hydroxide chemical plant in Kings Mountain, North Carolina. The company is now considering whether to operate the plant as a stand-alone merchant plant that would convert spodumene concentrate purchased on the global market to battery-grade lithium hydroxide (LiOH), or, alternatively, to develop an integrated project based on mining nearby, company-controlled deposits to produce spodumene concentrate feed for the plant.

The design basis for the chemical plant is identical in both the merchant and the integrated scenarios. Nameplate production capacity would be 22,720 metric tons per year (mt/y) of LiOH. Process equipment selection is based on conventional, proven technologies. Project life for both options is planned at 25 years.

Quartz, feldspar, and mica byproducts would provide credits to the cost of lithium production.

Both development options confirm that Piedmont would be a strategic and

low-cost producer of battery-grade LiOH, with the project benefitting from access to exceptional infrastructure, low operating costs, and low corporate taxes.

Both development options are at the low end of their respective industry cost curves. The average merchant project LiOH cash costs are estimated at \$6,689/mt. The average integrated project LiOH cash costs are estimated at \$3,716/mt.

Initial capital costs to develop the chemical plant are estimated at \$377 million for both project options. Capital costs to develop a mine and concentrator on Piedmont Lithium properties are estimated at \$168 million. The mine and concentrator would produce 160,000 mt/y of 6% Li<sub>2</sub>O spodumene concentrate.

Currently, 80% of the world's LiOH is produced in China. The Piedmont Lithium announcement makes note of the fact that its merchant project option would compete against the numerous merchant spodumene converters currently operating in China, providing United States and European automotive companies a secure and independent source of the LiOH required for their supply chains.

The merchant project would also provide the growing number of spodumene concentrate producers in Australia, North America, South America, Europe, and Africa with an alternative, non-Chinese processing route for their material for the first time. Piedmont is actively engaged with several such parties, discussing the securing of feed material for the plant.

Meanwhile, Piedmont Lithium is initiating a definitive feasibility study for the proposed integrated project.

## NEWS - CALENDAR OF EVENTS

**SEPTEMBER 8-11, 2020: UGOL & Russia, Novokuznetsk, Russia.** Contact: Web: [www.ugol-rossii.com](http://www.ugol-rossii.com).

**OCTOBER 20-22, 2020: MiningWorld Russia, Crocus Exhibition Center, Moscow.** Contact: Web: <https://miningworld.ru/>.

**NOVEMBER 7-14, 2020: ALTA 2020, Pan Pacific Hotel, Perth, Australia.** Contact: Web: [www.altamet.com.au/conferences/alta-2020/](http://www.altamet.com.au/conferences/alta-2020/).

**NOVEMBER 9-13, 2020: Expomin, Espacio Riesco, Santiago, Chile.** Contact: Web: [www.expomin.cl](http://www.expomin.cl).

**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).

**FEBRUARY 7-10, 2021: 47<sup>th</sup> Annual Conference on Explosives and Blast- ing Technique, Orlando, FL, USA.** Contact: Web: [www.ISEE.org](http://www.ISEE.org).

**FEBRUARY 28-MARCH 3, 2021: SME Annual Conference & Exposition, Colorado Convention Center, Denver, CO, USA.** Contact: Web: [www.smenet.org](http://www.smenet.org).

**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.** Contact: Web: [www.haulageandloading.com](http://www.haulageandloading.com).

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





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## KMEC and PICOR A Bulk Material Handling Manufacturer Who Understands Supply Chain

**KMEC, a division of Purvis Industries, is an international provider of bulk material handling equipment.** Located in Houston, TX, KMEC has been in the bulk material handling design, engineering, fabrication, and commissioning business for over forty years. They take on the toughest application challenges and solve them using their years of experience and expertise.

KMEC was acquired by Purvis Industries in 2017 and joins two other sister companies to provide turn-key solutions from start to finish: PICOR and Foresight Automation.

### KMEC – Bulk Material Handling

Some of the installations that KMEC has successfully designed and built include:

- Horizontal curved conveyors
- Long overland conveyors (up to 12 miles)
- Double-arm and radial stackers
- Complete ship loading systems

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### PICOR – Innovation, Quality, Value

PICOR has been in the bulk material handling business for over forty years. Their specialty is solving tough material handling challenges in product flow control, reclaim and loading of truck, train and barge.

- Walker Reclaimer – no touch, 100% reclaim of material.
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- Mass flow gates.
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- Precision Loading Systems (PLS) for road or rail – within 0.1% accuracy.



PICOR's unique, patented designs will save you time – loading up to 6,000 TPH. They'll also save you money in lost freight capacity with their Precision Loading System™ – a high-speed weighing system that is so simple you must see it to believe it.

### Foresight Automation – Automation & Control

Foresight Automation joined the Purvis family of companies in 2019 and is located in Fort Worth, TX. Foresight has been in the automation, custom machine building, and industrial control integration business since 2000.

Foresight's engineers add automation and control intelligence into the KMEC and PICOR designs. Automated loading and operation? Done it. Data acquisition and retention? Done it. Rail manifests? Done it. Foresight handles it all from the service entrance to the newest generation IoT sensors.

### Putting the “Smart” in Material Handling!

Nothing is really exciting about bulk material handling to the average person. If you're a mine engineer or mill manager, however, you need that product coming in consistently and reliably! KMEC does it with the newest generation of Industrial Internet of Things devices from ABB – the ABB SmartSensor!

Powered by ABB Ability, and available through your phone or tablet, ABB's intelligent bearing sensors, AC motor sensors, and connected VFDs provide constant feedback to your operations department about conveyor condition and uptime. Catch vibration and temperature alerts early or get real time fault information from a tripped VFD.

### Purvis Industries The One Call You Need to Make!

Purvis' 78 branch offices are located throughout the Western and Southwestern US. Every one of them is stocked with conveyor components and has experts available to coordinate all our services for you. Their eCommerce site provides up to the minute availability for your operational needs. Through their CAPCORP conveyor belt division they can also provide and install heavyweight conveyor belt, including track, train, splice, and repair. The Purvis Industries team has you covered for all your bulk material handling needs.

**Want to Learn More? Call, go online, or email to schedule your bulk material handling expert call! Their motto is “Purvis for Service”! (purvisindustries.com)**





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# New Tools for Back Support

*As more mines gravitate toward mechanized systems, operations consider roof support alternatives to improve safety and cycle times on lateral development*

By Steve Fiscor, Editor-in-Chief

Some underground mines are fortunate. They are blessed with consistent geology and a competent rock formation. Their roof control plan will remain consistent throughout the life of the mine. For most mines, however, that's not the case. While mines in certain districts must deal with really poor ground conditions, the geology at other mines changes over time and the miners must learn to adapt.

One of the bright spots for underground mining in the U.S. are the gold mining operations in the Carlin Trend. There has been considerable recent consolidation among the mines in this region with Barrick Gold and Newmont forming Nevada Gold Mines. Today, Elko has the highest concentration of underground miners in the U.S. It also has some of the worst ground conditions. Imagine for a

moment the frustration of trying to stab a resin cartridge in a hole with a cable bolt before it collapses in squeezing ground.

Most mines use some combination of rock bolts, chain mesh and shotcrete to support the heading. The popularity of rock bolts varies by region with some mines favoring resin bolts, while others prefer friction stabilizers or inflatable bolts. They have mixed feelings about shotcrete. Some see the advantages, especially with macro-synthetic reinforced fiber, while others see it as complicated.

The ground conditions at mines are site specific. Some of the older, deeper miners in Ontario, Canada, for example, are testing the limits of these new tools, while their younger counterparts in Australia are going a different direction with great success. All of them are looking at alternatives to turn around the cycle times associated with ground control.

## Mechanized Bolting Trends

During his presentation, Experience and Future of Mechanized Rock Bolting, at the annual conference for the Society for Mining, Metallurgy and Exploration, Ryan Lyle, senior geotechnical engineer for Cementation Canada, offered data confirming what many had already suspected. The evolution and adoption of mechanized bolting has improved safety.

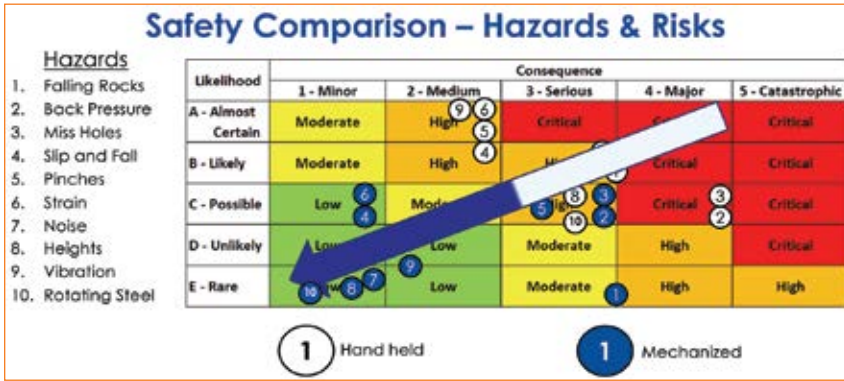
Cementation Americas is one of the largest North American underground mining contractors. Lyle and the Cementation team, which included Alex MacInnes, mining estimator, and Eric Smith, executive vice president, health and safety, compiled and analyzed data on bolting activities in lateral development from multiple projects carried out by the company.

They separated the different methods into three categories: handheld (jacklegs and stopers), semi-mechanized and fully mechanized. "Yes, we are still required to do a lot of handheld drilling, especially in areas that cannot be accessed with larger equipment, as well as working from scis-



Some American miners working on the Carlin Trend are installing the Nevada Bolt, slang for Jennmar's MPA and J-LOK P resin pumping system (above).





The use of mechanized bolters has reduced the severity of hazards miners encounter on the job.

sor lifts for rehab and construction work,” Lyle said. “Semi-mechanized bolting systems take the drill out of the miner’s hands, but they are still standing next to it and extending their hands into the drilling area. Fully mechanized systems further isolate miners from hazards.

Comparing the bolting hazards and risks with handheld and mechanized bolting, they identified a clear trend with mechanized bolting. “We wanted to see where the different methods fit in the risk matrix,” Lyle said. “Mechanized bolting eliminates a lot of hazards. But, is it actually better?”

During the last 10 years, at more than 50 mine sites in North America, Cementation has completed 134 km of lateral development with mechanized bolters, 60.5 km with semi-mechanized bolters and 32.5 km with handhelds.

Making a safety comparison between the three methods, medically treated injuries and incidents that required first aid were much lower for mechanized bolting. “This confirms what we suspected, that mechanized bolting is safer,” Lyle said. If mechanized bolting is the safest method, then why aren’t more mines using it, Lyle asked rhetorically.

Mechanized bolting has many strengths and challenges, Lyle explained. Cementation worked with the first fully mechanized cable bolter at a metal mine in Michigan. Fully mechanized bolters improve safety by separating the operator from the hazards. One machine scales and installs ground support. They install inflatable and friction bolts efficiently and they can be operated remotely.

On the other hand, standard mechanized bolters are large machines that have height requirements. The machines can encounter productivity issues if the operators and mechanics are not trained

properly. With a price tag of \$1 million-\$2 million, they are an expensive capital item.

Lyle said they also have high “perceived” operating costs. “Some miners believe these machines are just too expensive to operate,” Lyle said. “They have a lot of sophisticated systems. If something breaks, it’s expensive to fix and the machine is down until it’s repaired. Even when there is no serious injury, shutting down development for an incident can cost hundreds of thousands of dollars. You can buy a lot of spare parts with that much money.”

“There are some who see these machines as so expensive that they might as well send the miners out with jacklegs, which cost \$5,000 each,” Lyle said.

“Cementation sees this internally,” Lyle said. “If we have two miners on a scissor deck running stopers and putting bolts in the back, in certain conditions they might be more productive than a mechanized drill, but two miners and two drills are also in a potentially more compromising position.”

Mechanized bolters struggle with resin bolts and resin bolts are the bolts of choice

at most mines in the Canadian Shield, Lyle explained. “The mines may be able to overcome this issue in the future with hollow bolts and pumpable resin systems. Miners in the Sudbury Basin and elsewhere in Canada are currently testing such systems. We are hearing a lot of good things about the ‘Nevada Bolt,’ hollow bolts with self-drilling anchors and sacrificial bit. These hollow bolts may be connected together to do away with cable bolting.

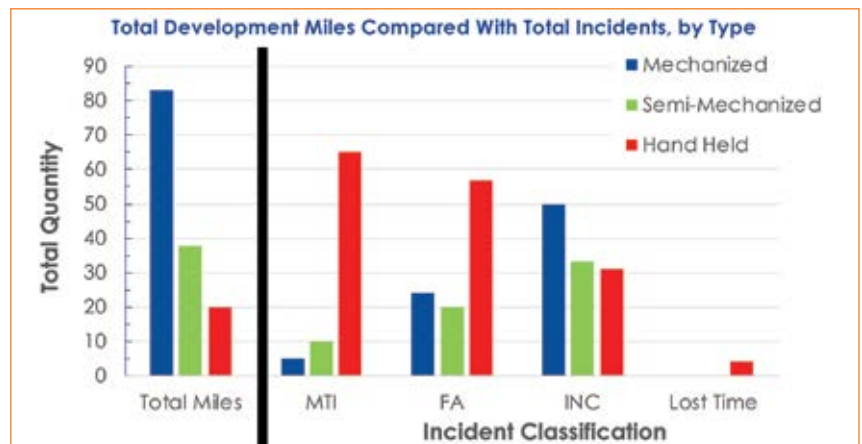
Recognizing the advantages, mining companies looking more closely at mechanized bolting and Lyle believes Canadian miners are on the cusp of making it work.

## The Nevada Bolt

When it comes to ground support products in the U.S., business has been brisk with gold miners, explained Todd Young, western hardrock manager for Jennmar. “The ground conditions encountered in northern Nevada, and the Carlin Trend in particular, are notoriously poor,” Young said. “Sometimes it appears to be as loose as gravel. The drill holes collapse before the miners can install ground support.”

That is why Jennmar introduced its multipoint anchor (MPA) technology for the region three years ago. The MPA is a hollow core self-drilling bolt. The system pumps resin through the bolt, encapsulating the bolt and filling the hole. The miners do not need to remove the bolt to install a resin cartridge, which would ordinarily allow the hole to collapse.

Previously, many of the mines in Nevada were using rolled-form, inflatable bolts, Young explained. Using a special head on the bolter, they would inject high-pressure water and hydraulically in-



This bar chart describes incidents over the course of 227 km of lateral development during the last 10 years. MTI=Medical Treatment, FA=First Aid, and INC=no harm, equipment damage only.

flate the bolts to 310 bar, creating a friction-type stabilizer.

"They would typically install 8-ft inflatable bolts, but the geology in this region often has a low pH and the acidic conditions corrode the metal over time," Young said. "We provided bolts with coatings, but that didn't work as well as we had hoped. Squeeze, ground movement and highly variable rock quality caused some mines to accelerate their rehab schedule in areas supported with inflatable bolts."

The use of the Jennmar MPA and the J-LOK P pumpable resin system, often referred to as the Nevada Bolt, has greatly reduced the cost and downtime associated with rehabbing areas that have already been bolted.

"They use the MPA's with chain mesh and shotcrete and the J-LOK P is the biggest improvement they have experienced lately," Young said. "They can couple these bolts and use 16- and 20-ft lengths."

"Three years ago, Jennmar began a partnership with customers to develop the MPA system. With assistance and input from those customers, we were able to develop technology that addresses their ground support needs, and it has really taken off," Young said. Mines operating in the Carlin trend are currently using six machines and they are considering a couple more. As they go deeper,

they believe ground conditions will continue to deteriorate.

The J-LOK P pumpable resin system can be mounted on any bolter and Jennmar has developed attachments that allow miners to quickly convert bolting rigs.

### Shotcreting Solutions

Shotcrete has several advantages, according to Sika, speed, ease of application, and how it performs over time compared to other existing systems under load. Sika is one of the world's largest suppliers of shotcrete consumables.

"With today's shotcrete mix, you can get very nice early strength development and significantly decrease the cycle times," said Fabian Erismann, market field manager, mining, Sika. "Some mining companies still shy away from it, thinking it's too complicated or they need advanced education on concrete technology. Some wrongly believe that it's difficult to maintain consistent quality of large volumes of batched concrete at the mines. It's true. It's not easy to maintain quality from both a production and application perspective, but once they get into a working routine, they see that its extremely versatile, flexible and fast. Shotcrete has a proven to be the go-to technology for underground construction globally."

When it comes to lateral development rates, Erismann believes that Australian

mines are more efficient than North American mines and he partially attributes that success to the use of shotcrete. "Many large North American mines install bolts and screen mesh only, while their peers in Australia, operating in similar geology at a similar depth, are using 100% shotcrete," Erismann said. "The Australian mines are used to yielding shotcrete. They put it up fast and efficiently. This reduces cycle times, increases development rates and lowers overall costs."

There are many other differences between Australian and Canadian mines that contribute to these differences in efficiencies, such as ramp vs. shaft access and the use of fully mechanized machines.

Last year, Sika acquired King Shotcrete Solutions, the leading shotcrete supplier for Canadian mines. "Canadian mines usually apply shotcrete for specific applications, such as ore passes, paste barricades or rehabilitation purposes, but rarely is it used in the mining cycle on a day-to-day basis, but it's coming," Erismann said. "Several large modern mining operations are considering full-scale wet and dry applications or have already implemented it, even for challenging projects in the Canadian Arctic."

Sika specializes in rapid setting, early strength concrete with a high-yield component, which makes it an active form of ground control. Chain or welded-wire mesh are passive supports, they deform until they take a load. Shotcrete prevents movement from the time it's applied.

Sika is also the leading producer of macro-synthetic, fiber-reinforced shotcrete. "These fibers are used in almost all the large underground development projects today," Erismann said. "These macro-synthetic fibers also have applications for mines where yielding underground support is critical due to destressing events or seismic events in general."

"Today, we can provide the same energy absorption per square meter of support with way less fibers per kilogram than we used 10 years ago," Erismann said. "Less kilos in the concrete mix is less money. The shift from steel fibers to synthetic fibers also avoids the corrosion risks in an acidic mine environment."

Under dynamic loading, when we talk about seismic shock or destressing events, you need a support system that can handle ultra-rapid rock mass movements," Erismann said. "These synthetic fibers have proven they can handle these rapid move-



Maintaining consistent quality of large volumes of batched concrete underground is possible and, once they get into a working routine, miners usually find that using shotcrete is extremely versatile, flexible and fast.



ments much better than traditional shotcrete systems. With the use of these synthetic fibers, we no longer see the spalling of shotcrete that has been sprayed over mesh. In many mines, we have a much more homogeneous buildup of the support system because we no longer have the mesh-concrete interferences.”

## Underground Construction Expertise

When it comes to poor ground conditions, there are several solutions that range from anchoring resins for rock bolts to ground-consolidating chemicals — a rock glue that fills the cracks when rock bolts can't get the job done, according to MAPEI. “MAPEI is the largest privately held chemicals and powders company in the world,” said Jim Pinkley, UTT country manager for MAPEI. “We also offer shotcrete accelerators and other shotcrete materials. MAPEI has 27 plants in North America and all of them have been deemed essential. Because of that, we have product readily available and we have recently picked up additional business.”

MAPEI has a large presence in the tunneling sector. Pinkley and his team are looking to share MAPEI's heavy underground construction experience with the hardrock mining sector in North America. Bill Cheatham, business development leader for MAPEI covering the western U.S., is very familiar with the region, especially the poor rock conditions in the Carlin Trend. “The rock mass rating in this region can drop to as low as 10 and it averages about 40,” Cheatham said. “They have a lot of faults, clays and silts.”

In addition to the ground-consolidating chemicals, Cheatham explained, MAPEI also markets void-filling foams, which expand four to 10 times their volume. “These products are really useful for mines that encounter large vugs,” Cheatham explained. “They have a surprisingly high compressive strength. They make bad, loose ground solid again.”

MAPEI produces its own powders and chemicals and it does not have a contracting arm. “We supply mining contractors; we do not compete with them,” Cheatham said. “We're engaging them to bring us to the table when they have encountered extraordinary conditions and we evaluate these situations as individual engineering projects.”

Sharing his experience in Canada, Brent Zemoroz, MAPEI's business devel-

opment leader for that region, explained that ground conditions often change over the life of a mine. “Miners are always looking to gain an edge to improve cycle times without compromising on safety,” Zemoroz said. “Most mines use some combination of bolting, mesh and shotcrete and, as much as they would like to eliminate one of the processes, they usually can't. More recently, the engineers at the mines have been looking at new ground control strategies such as macro-synthetic, fiber-reinforced shotcrete and better blasting techniques.”

Zemoroz sees room for improvement with the use of macro-synthetic fibers. Synthetic fibers retain structural integrity under load, while exposed steel fibers have issues associated with oxidation. Steel fibers are heavy and sink in water. Synthetic fibers are lighter, cheaper and easier to handle. “But, because they float in water, they are getting into the ditch lines, then the sump and plugging the dewatering pumps,” Zemoroz said. “Someone needs to develop a synthetic fiber that sinks.”

One of the best ways to improve ground control in the headings starts with blast design. “We're seeing better blasting techniques that provide more rounded backs on stopes,” Zemoroz said. “The blasters today are more knowledgeable and some of the stopes we are seeing in Canada look like they may have been cut with a tunnel boring machine.”

## The Case for Friction Stabilizers

In the Australian Pacific region, the mines tend to use jumbo development rigs for both development and rock bolting applications and friction stabilizers are the more commonly used bolt for ground control in underground hardrock mines.

In the last two or three years, there has been a shift toward mechanically anchored friction stabilizers, such as DSI Underground's Kinloc rock bolt. In addition to standard frictional force, the Kinloc bolt also provides a tensionable point anchor by way of an internal solid bolt. Soon DSI will offer the next generation Kinloc and the Kinloc Indie, which has an independent connection that loads dynamically more effectively.

“These new products lend themselves to being more dynamically capable so they can handle more load,” said Derek Hird, APAC CEO for DSI. “They offer improved

safety along with better productivity and performance. The speed of installation is much quicker than a resin bolt. They bang the Kinloc in and they have a high-capacity support. It's a friction stabilizer so it has a higher loading capacity.”

DSI Australia has also established in-house testing facilities to validate products before they approach traditional third-party testing facilities.

Unlike the U.S. and Canada, the adoption rate for pumpable resin systems in Australia is low. “We are currently working with a mine in Western Australia and an OEM to install a pumping system on a rig and trial the hardware,” Hird said. “When it comes to fully mechanized systems, however, there are still a lot of questions that need to be answered.”

It can get warm in Western Australia and most mine sites have refrigerated containers for storing resin as ambient temperatures in the region can reach 40°C. “We have researched various ways to prolong the shelf life of resins and we have a fairly good understanding of the affect high temperatures have on resin,” Hird added.

DSI also has a few small product initiatives. One clever, cost-effective device is a resin mixer that attaches to the end of the bolt. In bad ground, the miners can use the device to improve resin mining in the hole.

The Posimix resin bolt, which forces resin to the back of the hole as the bolt spins, now has a version that has no tail, meaning no bolt protruding from the bearing plate. “It has a coupling arrangement that screws in on itself,” Hird said. “It's a bit like a forged-head bolt, but it can be tensioned.”

For the digital space, DSI is developing an app. In addition to product catalogs, it has a Knowledge Center where users can download conference papers, and view market-related news and events. They can also view pricing and request a quote. “We see this evolving into a customer engagement tool,” Hird said.

A consignment feature assists customers with common stock. Using digital tools to manage stock in real time, the system re-orders product when it moves from the warehouse underground.

DSI is also looking at the use of digital twins to demo the life cycle of the product from the factory to the mine and then the point of installation. Someday, geo-referencing tools may be able to show the position of all the bolts in a heading.

# Moving Ahead in the Material World

*Bulk material-handling equipment is the backbone of the industry, linking mines to plants and plants to terminals. Keep that link alive in the COVID-19 era by following the advice of OEMs and experts on safety, system integrity and spares availability.*

By Russell A. Carter, Contributing Editor



The pandemic has focused the mining industry's attention on the importance of protecting its workforce and planning for higher levels of remote operations. Although there are many mine-site tasks that don't allow off-site support, such as conveyor maintenance and repair, new digital and material-handling technology can help minimize employee presence and risk in the field.

Minus the means to move massive amounts of material, mining as it is known today would not exist. The ability to efficiently convey, stack, reclaim and feed materials ranging from rock to concentrates is intrinsic to the industry's success, and current trends are steering producers toward greater reliance on bulk handling systems and equipment to meet their needs. Foremost among these trends are the most obvious: Fewer high-grade orebodies are being discovered, the volume of higher-grade ore in deposits currently being mined is shrinking, and producers must mine and process increasingly larger amounts of material to maintain profitability. And, just in case that's not enough, occasionally the outside world intervenes in ways that can be unexpectedly disruptive. The current COVID-19 pandemic is a prime example.

The industry's two-steps-forward, one-step-back progress in restarting operations after shutting down mines to protect workers from coronavirus-borne illness has highlighted problems that few operators ever expected to experience *en masse*. However, these notional "what-if" scenarios, often buried in dusty business-contin-

uation plans, can become very real impediments to recovery. To name a few:

- What if we can't persuade skilled or key workers to return, because they're concerned about health risks or have gone elsewhere for work during the shutdown?
- What if we don't have the resources or time to fully train new hires before they're put to work?
- What if local contractors go out of business or can't provide usual services and products due to workforce and supply chain problems?
- What if major equipment suppliers can't fill our orders for new equipment or spare parts?
- What if OEMs won't allow technicians and factory experts to travel to sites for consultation and troubleshooting?

These are concerns that can affect an entire operation from pit to port, and as seen from recent news and company reports, no aspect of underground or surface mining, processing and product transport is immune — including the mostly mechanical domain of bulk material handling where these "what-ifs?" can be filtered down to about three principal "how can we?" issues:

- How can we best support and protect workers needed to maintain and repair material handling equipment?
- How can we identify and apply the best available technology and expertise for maintaining efficient material flow during periods of uncertain labor, supply and capex/opex availability?
- How can we assure that inventories of consumables, spare parts and tools are adequate for sustained operation during a period of sometimes unpredictable supply-chain delays and disruptions?

## Starting With Safety

Conveyor-related injuries are always high on the list of industrial accident reports from regulatory agencies, and for good reason: belts, rollers, pulleys and drums move quickly and any distraction or misstep by a worker while inspecting or servicing them can be dangerous. While there are plenty of both low- and high-tech products available to assist in keeping workers safe and productive when working on or around conveyors, the most essential element is simple: Ensure that workers remain aware that they're in close proximity to powerful, fast-moving machinery that's not under their direct control.

As explained by Philip Dirige, senior specialist-ground control at Workplace Safety North, a Canadian health and safety training provider, "The typical conveyor belt travels around 400 feet or 122 meters per minute," Dirige said. "That means the belt is moving about six feet per second — so tools, loose clothing, hands and arms can be pulled into a pinch point before there is time to react."

Even stopped belts can pose a hazard. "When a conveyor belt is moving, there will usually be more tension on the carrying side," observed Martin Engineering Process Engineer Dan Marshall. "If the conveyor is merely stopped and de-energized, that tension may remain in the belt in the form of stored energy."



Marshall said a system under tension will always try to approach equilibrium; that is, it will try to release the energy. This release will likely come in the form of a pulley slip, which occurs when the belt slides around the head pulley to equalize the tension. The distance the belt will move is proportional to the amount of tension stored and the belt's modulus (elasticity), possibly several feet. If a worker is on the belt or close enough to be pulled in during this sudden release of energy, injuries or death can occur.

"There's a simple rule of thumb regarding conveyors: If it's moving, don't touch it," Marshall continued. "The most common way to prevent inadvertent contact is with suitable guarding that renders the moving components inaccessible." For maintenance or repairs, procedures for lockout/tagout/blockout/test-out should always be followed when working on a stationary conveyor, and systems should be equipped with anti-rollback devices (backstops) on the head pulley.

### Making Use of Mixed Reality

The likelihood that operations might be short-handed during or after pandemic-related events such as quarantine measures or layoffs — or may have to hire new, inexperienced workers for whatever reason — has both mine owners and industry vendors looking more closely at technologies and products that can help train workers and support them in the field. One promising area is mixed reality technology, commonly referred to as Augmented Reality/Virtual Reality (AR/VR). Another is a new generation of conveyor monitoring systems that listen to and analyze equipment sounds and call attention to possible trouble spots.

AR/VR technology has the potential to enable companies to deploy fewer workers in the field — and when they are needed at a site to help train, prepare and assist them in performing a task. As industrial-automation solutions provider Rockwell Automation pointed out, instead of walking along miles of conveyor to locate a problem, an AR/VR user can virtually travel the length of the belt using a digital twin on a computer or mobile device. Without ever physically visiting the control cabinet, the user can review the details of an issue and access data such as motor current and temperature to troubleshoot and make a diagnosis. On the basis of this information, a qualified technician can be

dispatched to the exact location with the tools needed to fix the issue.

Rockwell also noted that the repair process itself presents another opportunity for mixed-reality technology. Using a mobile device or headset, technicians can use AR technology to see the device's current operating data overlaid on the physical device itself. They can also view digital work instructions to get step-by-step guidance for repairing the problem. And if they need help, a remote expert or partner can join them in the AR environment to talk them through the repair process. With both parties viewing the same thing, miscommunications that can have dangerous consequences during equipment servicing and repair can be avoided.

Additionally, the company said users can access existing 2D drawings and 3D models, or aerial photos of the mine to build the environments. Industrial IoT software can connect these AR or VR environments to data sources like control systems and ERP systems. And analytics software can combine and contextualize different raw data into relevant information for operators.

To help introduce mine operators to the technology, Rockwell said that, in partnership with AR/VR solutions provider PTC, it's offering free access to PTC's Vuforia Chalk, a collaborative remote assistance tool, through August 31.

Power transmission specialist Voith Turbo told *E&MJ* its current product and services portfolios are designed to complement the industry's growing demand for "connected" equipment that combines

reliability with increased flexibility and enhanced data awareness and analysis. Currently, Voith offers the VOCUS system, which allows customers to tap into Voith expertise without having to deploy additional service personnel to a site. The remote-service VOCUS data helmet is worn by a technician at the customer's site. With it, the technician records equipment conditions and then receives information from a centralized Voith specialist or team that can exchange details via pictures, data and sketches with other teams to create a full image of the situation. The Voith experts then guide the customer's team accordingly. VOCUS also can be used to assist with repairs, measurements and individual training (see *Compact, Connected and In Control*, p. 31 for additional information about Voith coupling technology.)

Even with high-tech support provided by AR/VR apps and IIoT systems, the actual act of repairing conveyor components can be strenuous and risky. Roller replacement is a typical maintenance task that can result in extended downtime for the operation and/or injury to the worker involved. This job commonly requires two people and may involve the use of improvisational tools and equipment such as crow bars, forklifts or hoists.

The French firm R. Brunone recently introduced Sparcric G — a solution designed to assist and de-risk replacement of rollers on any belt. Sparcric G uses an airbag to lift the belt away from the rollers, allowing workers to access three sets of rollers at a time. Brunone claimed the Sparcric G allows replacement to be safely



The pinch point between the belt and a carrying idler is one opportunity for an entrapment injury.



Voith says its VOCUS video collaboration equipment can be helpful for tasks ranging from general troubleshooting during commissioning and operation, to damage analysis, maintenance and assembly, installation of spare parts and component replacement, repairs, inspection and training.

performed by a single worker, using a hand pump to inflate the airbag and lift the conveyor belt off the rollers. Once the Sparcric G is installed and inflated, the worker has both hands free for work. According to the company, the device can reduce average time spent on replacement by 50%.

Repairs to underground conveyors often take place under cramped, dusty and dim conditions, in areas that may pose challenges for getting both workers and supplies to the trouble spot quickly and safely. In this kind of environment, time is of the essence — for the safety of the personnel involved and to minimize production downtime. That's where equipment such as Flender's self-aligning A-Series geared conveyor belt drive units find opportunities to prove their worth.

Flender, a Siemens company, pointed out that adequate space for complicated conveyor-drive measuring, alignment and installation work is not always available, so its A-Series conveyor drives are delivered fully assembled and don't require time-consuming alignment on site. A direct connection between motor and gear unit makes alignment unnecessary.

The A-Series' self-aligning system may be used as a right- or left-hand version without need for conversion, offering installers an unencumbered choice of

which side of the conveyor belt the system can be fitted to at the site.

Conveyor monitoring systems have evolved to span a wide range of functions that start with basic safety and extend up to complete conveyor command and automation. Many are modularly designed, allowing operations to configure systems for site-specific needs and scale-up, if necessary. The latest systems, such as the Aura IQ system developed jointly by Australian mining research organization Mining3 and AVA Risk Group, employ sophisticated audio analysis and data collection techniques facilitated by fiber-optic communications and cloud storage and access.

Aura IQ uses a fiber optic-based detection and sensing platform developed by an AVA subsidiary, combined with Mining3's advanced signal processing algorithms, predictive analytics, and identification tools to acoustically monitor and assess conveyor health. By transmitting a series of short, laser pulses along a single fiber optic cable retrofitted along the length of a conveyor, acoustic disturbances from the conveyor system cause microscopic changes in the backscattered laser light that is then categorized into known parameters. Data is simultaneously gathered from the entire length of the monitored conveyor and processed by Aura IQ to preemptively alert operators, ei-

ther on or off-site to potential failures before they happen, according to the developers.

Andrew Hames, AVA's head of innovation, extractives and energy, said, "A typical conveyor can have up to 7,000 bearings per kilometer, which means 7,000 potential points of failure. Aura IQ can monitor the condition of every conveyor roller, eliminating the need to walk the belt, and allowing a controlled and scheduled plan of roller maintenance and replacement to be put in place."

Dr. Paul Wilson, senior engineer at Mining3, explained the conceptual background and challenges encountered in adapting the technology for conveyor applications. Wilson said the technology was originally designed for oil and gas industry seismic and micro-seismic work and well inspections. Later applications broadened into pipeline monitoring, then to detecting oil theft from pipelines and general intrusion detection on perimeter fences.

An early problem was that the sensitive nature of the equipment allows it to pick up extraneous sounds — even that of single raindrops hitting the fiber. Because conveyors are acoustically noisy, the system's detector can register noise from sources such as steelwork resonances or loose bolts and even machinery parked nearby. Removing the noise and extracting useful signals required advanced statistical signal processing. Eventually, Wilson explained, as the signal processing technology was refined, it began to deliver diagnostically useful results, to the point where the commercial version of the technology now makes it possible to detect a broken ball or cracked cage in a ball race.

## Stocking the Spares Warehouse

The challenges of operating in remote areas, encountering unpredictable environmental events and withstanding the erratic winds of workforce, regulatory and economic changes keep most mining companies on the lookout for innovative solutions to basic business problems — one of which is the threat of reduced spare-parts availability due to supply chain disruptions caused by global events such as the COVID19 pandemic.

Almost a decade ago, accounting and professional-services provider Deloitte published a report calling attention to the mining industry's unique and somewhat vulnerable position in the supply chain.



## Compact, Connected and In Control

Couplings link a conveyor motor to a gear drive and depending on the type installed, provide critical operational functions ranging from soft starts and safe stops to torsional vibration damping and infinitely adjustable torque control. Voith Turbo has been a primary provider of hydrodynamic couplings to the mining industry for more than 60 years, and *E&MJ* recently spoke with Kyle Kluttz, Voith Turbo North America's vice president of new business sales, to discuss how the company is meeting its customers' needs for advanced coupling performance.

**E&MJ:** Producers are asking for bulk material handling systems to carry more material farther and faster than ever; consequently, drives and couplings are becoming more powerful and sophisticated to meet these demands. What are the principal design and feature objectives for Voith when developing couplings for mining applications?

**Kluttz:** At Voith, the modern design features of our products are focused on smart, connected innovations that exhibit efficiency and reliability. We want our customers to see fewer and shorter downtimes. We want to boost the lifetime of installed equipment by monitoring the operation and limiting the degradation of equipment over the long term.

For example, our TurboBelt TPXL coupling delivers optimized startup behavior, easy installation and increased conveyor belt productivity. Facilitating accurate torque control, the TurboBelt TPXL preserves and adds to conveyor belt life yet allows high operation levels. This is a compact, easy-to-install solution that can be used in an open pit or underground environment.

The TurboBelt DriveControl optimizes coupling and conveyor performance by achieving perfect conveyor startups in all conditions. To allow fast commissioning, this communication system is pre-parametrized and standard communication protocols are used, which ensures quick and easy driveline integration. It also allows remote access through a secure VPN.

The TurboBelt TT Linear Booster Drive is an intermediate drive for belt conveyors that is integrated into the actual belt via a friction lock. Equipped with a head and tension station, it improves conveying efficiency on medium, long or inclined belt conveyors by extending the service life of belts, saving belt costs in new conveyors, and boosting capacity in existing systems.

And, our SmartSet is a torque-limiting coupling providing overload protection while minimizing mechanical disconnection of the drive. The SmartSet coupling has the ability to slip up to 120° without releasing, which allows the system to safely bleed off short torque peaks. If the torque peak escalates to an overload situation, the coupling will fully release, saving the driveline from serious damage. The SmartSet device then resets at zero rpm and the full slip angle is regained.

**E&MJ:** How does Voith provide high performance equipment that is reliable as well as serviceable by customer technicians?

**Kluttz:** We work hard to understand our customers' needs and take a hard look at data to reduce inefficiencies that might not be immediately apparent. Our goal is to constantly deliver improvements to our customers' systems. We achieve that by coupling machine technology with state-of-the-art digital technology for improved performance, reliability and ongoing monitoring.

Training is an important part of this process. Voith provides on-site training for technicians because we want our customers'

team to be experts on the equipment and capable of performing proactive maintenance. However, we also provide 24/7 service when required, and we have teams and equipment dedicated to remote assistance, which is further enhanced by diagnostic monitoring opportunities and the cloud-sharing of operational data. This creates an incredible efficiency in analyzing information and troubleshooting solutions.

**E&MJ:** What sort of software and diagnostic tools and services can Voith offer its mining customers?

**Kluttz:** Voith has a number of software and diagnostic tools including Voith Dtect, which adds digital intelligence to torque-limiting couplings. With it, you can get real-time monitoring of driveline performance, productivity and status. The system is designed to communicate coupling status and support better decision-making to predict potential problems, protect the driveline and prevent costly downtime.

Today's open pit mines operate in ever-more remote locations under harsh conditions, and with that in mind, Voith created BeltGenius ERIC (Efficiency & Reliability Intelligence Control). It's designed to help operators manage increasing transport distances as they face volatile raw material prices and increasing energy costs. With ERIC's digital capabilities, our customers can monitor, benchmark and optimize all their belt conveyors and conveying systems to ultimately help reduce costs. Essentially, operators get an exact picture of system performance without having to manage any IT infrastructure.

TurboGuide is an online platform used to simplify management and operation of fluid couplings. Whether customers are looking for assembly instructions, information about nominal fill volumes, tutorials for fill level checks, or scheduling overviews for maintenance planning, TurboGuide is a very helpful tool. Utilizing a central database, all important coupling information and technical data can be accessed anywhere and anytime.

Lastly, we have OnCare service, which is extremely useful in asset management. With this service, we collect data, including through the use of acoustic monitoring, to help our customers manage their systems. It starts with setting a baseline of the performance of their system followed by periodic or ongoing monitoring. When some element of the data shows an anomaly compared to the baseline, we alert the customer, provide actionable suggestions, and help them troubleshoot solutions.



BeltGenius ERIC (Efficiency and Reliability Intelligent Control) from Voith is a software solution that analyzes a range of data to determine how efficiently the belt conveyor systems of a mine are operating.



The Sparcric G developed by R. Brunone enables one worker to safely lift the belt for roller replacement.

For example, the volume of the industry's spare-parts demand is not huge by comparison with other industrial sectors, its needs are somewhat specialized, and there aren't an infinite number of suppliers interested in tackling the challenge of shipping goods to remote sites.

The report pointed out that spare-parts shortages can affect a company in a number of ways — some apparent and others

not quite so clear-cut: Most obvious, given the high cost of unscheduled downtime in terms of lost production, would be the inability to immediately repair broken equipment and the ensuing impact on operations. Perhaps less obvious, the report said, is the possibility that companies failing to meet production targets and earnings expectations due to performance issues may see investors take their money elsewhere.

More recently, the Swiss Re Group, a leading provider of reinsurance, insurance and other forms of insurance-based risk transfer, released a set of suggested guidelines and measures that mines could follow to prepare for COVID19-related impacts on their operations. Included in the advice were recommendations pertaining to spare parts availability. They suggest, at a minimum:

- Ensuring a good spare parts and consumable stock to allow continuous operation for longer periods without external dependence.
  - Reassessing the availability and lead times of critical spares and supplies.
  - Considering the following:
    - Are all critical spare parts available on site?
    - Do the business continuity plans consider critical spares availability and alternative consumable suppliers?
    - How long will consumable stocks last?
    - Are delays expected in the importation of goods? If so, what would the impact be in terms of time?
- Traditionally, mining has been seen as lagging in supply chain management compared with other industry sectors, yet miner-

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als producers appear to have blunted most major impacts from pandemic-related parts shortages — in some cases by adopting innovative measures ranging from collective bargaining to online spares pooling. For example, in late April, the Minerals Council of Australia reported that more than 280 Australian resource companies had been authorized to cooperate in sourcing essential safety supplies and machinery spare parts to keep operating during the COVID-19 pandemic. The Australian Competition and Consumer Commission gave interim authorization to the MCA, the Australian Aluminum Council and state resources bodies to jointly source safety equipment and spare parts for mining equipment.

At the other end of the supply chain, manufacturers have taken steps to improve supply-chain performance by embracing digital technologies. Earlier this year, conveyor systems provider Beumer Group bought Sparrow Networks, a startup online marketplace that allows companies looking for specific parts to buy those parts from other companies that may have surplus quantities. Participants upload spare parts stock data from inhouse stock-management software or in Excel files. Sparrow reportedly formats the incoming data and enriches it by tapping into manufacturers' master parts data and then allows network members to search the data for needed spare parts. Sparrow, according to its founder Meir Veisberg, offers users "an almost unlimited pool of spare parts" and handles order fulfillment.

A recent announcement from Shell and IBM illustrates a somewhat different approach promising a variety of potential digital-marketplace benefits for miners. The two companies jointly launched Oren, a global B2B digital mining services marketplace platform aimed at helping mining companies find solutions related to safety, sustainability, mine planning and operational efficiency.

Shell said it engaged with more than 350 mining businesses and found that 80% of those surveyed mentioned with challenges in their operations including difficulty aggregating data to make actionable insights; lack of intelligent workflows due to siloed organizational working; improving sustainability; along with keeping employees safe while deploying autonomous technology. As a result, Oren is intended to help accelerate the adoption of digital services in the mining industry by facilitating tech-

nology transfer, innovation and integration from solution providers ranging from established enterprise companies to startups.


Although Oren's initial focus appears to be skewed toward mobile-equipment data collection and analysis or general lubrication concerns, among the functions offered is access to IBM's Maintenance, Repair and Operations Inventory Optimization Services, which are designed to allow users to

optimally manage spare parts inventory. The MRO solution, according to IBM, can assist customers in deploying a centralized operational model that is scalable across sites, establishing and embedding stock parts rules into the system, sharing critical spares within a geographical region, reducing obsolete and inconsequential inventory items, standardizing procurement functions and tracking supplier performance.

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# Changing the Rotary Drilling Narrative

*Is bigger really better? Either way, the latest rigs on the market reflect shifting paradigms.*

By Jesse Morton, Technical Writer

The new rotary drills on the market promise increased production, reduced cost and automation features. A couple differ from predecessor models and the competition in what they deliver for their size. What the suppliers will tell you is these benefits are the result of extensive R&D and, importantly, cus-

tomers feedback. This could mean that customers, as their needs shift due to declining grade and increasing regulations, are shifting their expectations. As the headlines reveal, the big suppliers are happy to oblige.

## Higher Torque, More Efficient Drilling

Komatsu reported that customer feedback on the P&H 77XR blasthole drill (200- to 270-mm-diameter holes), released in September, reveals the rig delivers increased drilling efficiency and ease of operation.

The company reported it has received positive operator feedback on the higher torque, enabling more efficient drilling.

“Other feedback has been on vibration mitigation, where things like the increased torsional stiffness of the mast puts more energy into the ground, and not the structure; and on the lower works, the lower center of gravity with increased positioning, tractive effort, and turn-ability, which enables a smoother ride,” Komatsu reported. “We have also found that our leveling system has resulted in quicker cycles by keeping the deck close to the ground, enabling effective straight holes.”

Sergio Li, product manager, rotary drills, Komatsu, said since its release, the unit has been adopted for deployment in several different applications and has been met with success.

“Most recent is coal mining in Australia. This is a dynamic application where multipass drilling at an angle calls for speed and precision. This is also a new market for Komatsu drills, which triggers things like change management for new products with new technology,” he said.

Some of the operator training was performed remotely, and similar training options are currently available for other customers, Li said. “Interestingly, we found that users said that the 77XR is ‘really easy to learn.’”

Ease of operation is in part attributed to “ergonomics, such as joystick

configuration with buttons in reach, using ISO symbols, screen placement, visibility and indicators,” Li said. These features “enable operators to become quickly proficient. That, combined with new features like the Auto Bit Changer and easy accessibility to service points, like the location of the machine’s hydraulic pumps, make for a nice design layout.”

With intelligent compressor control and auto-bit handling, the 77XR gives customers the option of either rotary drilling or down-the-hole (DTH) hammer drilling. It offers a maximum single-pass depth of 16.8 m, a maximum multipass depth of 85 m, and maximum bit loading of 35,000 kg. It offers a pull-down force of 302 kN. The rotary head, with a hydraulic motor, is rated at 160 kW and offers 14.9 kN/m torque.

Komatsu reported that the enclosed mast design increases structural reliability. “Ergonomics and system optimization improve operational safety and comfort,” the company reported. “An innovative rack-and-pinion system for pull-down, combined with a lightweight carriage, eliminates the requirement of constant maintenance to the pull-down system, and delivers a more consistent load. Higher maneuverability reduces the drill footprint.”

Other standout features include an “interface that offers intuitive prompts for operator awareness, such as what went right or wrong and telling them why,” Komatsu reported. “The machine is set up to be an ongoing lesson, continuously teaching the operator, while reducing the need to flip through many screens.”

The interface gives the operator the ability to create one-touch button control for a sequence of procedures to make “semiautonomous operational aides in performance optimization,” the company reported. The supervisory control system, known as LINCS, significantly reduces complex troubleshooting.



Field results suggest the P&H 77XR, released last fall, offers a reduction in maintenance costs of 5% to 10%, an increase in drilling time of as much as 12%, and an improved availability of 2% to 5%, Komatsu reports. (Photo: Komatsu)



“More importantly, the system logs all the data needed to optimize drilling performance, pointing you to the fundamental source of data and pre-sorting the key indicators,” Komatsu reported.

For sites with multiple operators running the drill, each with different operational preferences, the “data analytics, both onboard and off the drill, enables ‘operator scorecards’ to identify best practices to offer tools to increase performance of less-experienced drillers,” the company reported. “Examples include increasing rotational speed, or more pulldown, or setup time, or carriage speed, or too much water injection caving the hole, whatever is necessary to achieve best practices.”

Li said many of the innovations are, in part, the result of decades of research and experience. “We designed our new generation of drills based on our experience with structures on our legacy shovels and drills,” he said. “Improvements in structures, compared to what has been done in the drill market for more than 50 years, allowed us to reduce significantly the time required for maintaining the main structural components, which translates into more productive time drilling.”

The big deliverable from that is increased output at a lower cost, Li said. “With our newest innovations, we expect to see a reduction in maintenance costs from 5% to 10%, an increase in drilling time of as much as 12%, and an improved availability of 2% to 5%.”

Those innovations were also, in part, based on customer feedback, Li said.

“We have redesigned drilling technology. We did this by basing our new designs in the voice of customer that we gathered over our years of drill experience,” he said. “We listened to our customers around the world and offered solutions based on their needs and the disadvantages they experienced by using the traditional equipment.”

The feedback suggested that “there was a big gap between what was required and what they were getting,” Li said. “This gap hasn’t been filled in many, many years.”

Being able to tap the global Komatsu network has helped P&H, formerly part of Joy Global, fill that gap and others. “Now that we have joined the broader Komatsu family, we can lever-

age their worldwide presence and the extended resources available to service our equipment,” Li said. “The foundations of our program now rely on our many years of drilling experience and the support and experience of the bigger Komatsu group.”

### Punches Above its Weight

Bigger is not always better. The DR410i rotary blasthole drill (152- to 251-mm-diameter holes) proves it by outperforming bigger units in field trials, Craig Hall, product manager, iSeries drills, rotary division, Sandvik, said.

“The most common misconception in mining, at the moment, is the need to have the biggest drill possible at your operation,” Hall said. “Sandvik challenges this misconception.”

Planned for release in Q3 2020, the DR410i, which offers both rotary and down-the-hole hammer drilling, was first deployed to a gold mine in Nevada. The results exceeded customer expectations. “Early tests and time studies of our prototype DR410i drill unit shows that it consistently drills faster than competitor solutions in the same class,” Hall said.

Such is par for the course for models in the Sandvik iSeries family. “We have seen our DR412i drill efficiently through some of the hardest ground around, iron ore,” Hall said. “We have seen our DR416i drill exceed expectations in South America in large-diameter

drilling,” he said. “The DR410i drill is no different.”

Following the path of the high-performing iSeries DR412i and DR416i drills, the Sandvik DR410i is pitched as a powerful and intelligent midsize blasthole drill.

The unit can be powered by a Cat C18 Tier-4 engine (with non-Tier-4 options available), which comes standard with Sandvik’s “advanced compressor management solution to help extend component life and also protect the en-



The compact size of the DR410i allows the mine to complete drill patterns with a smaller impact on the environment, Sandvik reported. (Photo: Sandvik)

vironment by reducing the carbon emissions,” Hall said.

The rig features simple, ergonomic controls that contribute to both efficiency and safety.

The drill has two mast options available. The standard mast arrangement gives hole depths to 46.6 m, achievable across all pipe sizes offered.

An extended mast option of 14-m (46 ft) first pass and a total depth of 32.3 m (106 ft) is available. It eliminates the need to change drill pipes.

Capable of a 258-kN bit load, and maximum pulldown force of 222 kN, the drill “punches above its weight,” Hall said.

“Its compact platform makes it nimble and easy to move on any mining pattern,” he said. “The size of the machine allows the mine to complete drill patterns with a smaller impact on the environment compared to some of the larger drills used to drill the same holes size.”

Lower total cost of ownership is achieved by coupling parameters, which match the drilling application with onboard technologies that increase drilling efficiency and productivity, Hall said.

That contributes to savings across the operation. “When combined with effective pattern and blasting design, fragmentation is improved allowing for cost savings and productivity improvements across the entire excavation chain,” Hall said.

“The DR410i assists in the process by drilling clean holes and offering the option of feeding measurement-while-drilling data into third-party systems to produce blasts tailored to ground conditions,” he said.

The rig features smart connectivity and comes automation ready, Demetre Harris, product manager, automation and technology, Sandvik, said.

“We design and develop our solutions to drill in any environment. This concept is not only for our drills, but the underlying technology as well,” he said. “Our solutions are developed through our unified Sandvik Intelligent Control System Architecture (SICA) and offer our customers technology-enhanced packages starting with onboard automation and graduating to remote fleet automation.”

The SICA Control system is common to all Sandvik mining solutions, both for

underground and surface. This makes the DR410i capable of incorporating innovative functionality that was developed across the entire Sandvik portfolio.

For example, on the DR410i, SICA supports maintenance specialist tools that cut the time spent troubleshooting concerns within the system by 30% to 40%, Harris said. “The solution provides maintenance and operators the ability to diagnose the alarms and parameters within the drill without the need to attach diagnostic laptops, making the system easy to support, maintain, and service.”

The DR410i can be equipped with the Sandvik TIM3D High Precision Navigation Solution and with scalable AutoMine Multi-Lite and Fleet solutions, Harris said.

“TIM3D provides our customers the ability to create high-precision patterns onboard the drill rig,” Harris said. “In addition, the solution has the capability of importing and exporting patterns and drilling data via USB for customers without network infrastructure.”

The AutoMine solution provides one operator the ability to remotely control and monitor one or more drills. It “was designed with the capability of direct connectivity to a line of sight or remote operating station,” Harris said. “The benefit is that we have a solution even if an existing network infrastructure does not exist.”

For customers with preexisting infrastructure, the DR410i can connect to an 802.11-capable network to transmit pattern progress and measurement-while-drilling data to a central hub. In addition, the drill closes the loop between plan and actual with optional third-party-integration capability. It can connect to other mining technologies to improve efficiency for the entire mining operation, the company reported.

“The DR410 is designed to fit into current mining operations in any region of the world,” Hall said. “No special requirements are needed to introduce the DR410 into any mining operation,” he said. “Offering scalable solutions has always been a key driver for Sandvik.”

Currently, interest in the drill is coming from the gold sector, but it “is equally suited for other applications including coal mines,” Hall said. “It is configured to suit any mining operation

as well as major contractors looking for a dependable, efficient and highly productive drilling solution.”

Efficient is the key word. It is the rig’s *raison d’être*. The series was originally developed to answer a notable industry-wide trend in inefficiency.

“We noticed that current solutions sold into the market included drilling parameters that were not aligned with application parameters,” Hall said. “There appeared to be a drive among the competition to ‘go big,’ resulting in the market being flooded with drills containing bigger engines, bigger compressors using more fuel, and requiring increased capital input to maintain and operate.”

The company launched the iSeries fleet to “build the right drill for the actual application, one which matches the key parameters of the application to specific drill capabilities,” Hall said, “thus increasing efficiency and lowering the total cost of ownership while maximizing productivity.”

To make sure the solution and others in the series deliver, Sandvik set up a system that has company experts coordinating with customers to regularly assess units in the field. “Sandvik has implemented a four-level support program and a newly created feedback system for our drilling solutions,” Hall said.

Feedback will better equip the company to continue “to change the game by offering solutions built to our customers’ applications, lowering costs while getting the job done,” Hall said. “As mentioned before, bigger is not always better. At Sandvik, we are pushing to change the narrative within the industry by developing sustainable solutions not just for today, but for the next five, 10, 15 years.”

## Single-pass Capability Cuts Costs

Epiroc released the DM30 II SP rotary blasthole drill (140- to 200-mm-diameter holes), which, the company reported, offers faster hole-to-hole drilling and contributes to lower costs per ton.

The release comes after 15 months of extensive field trials proving the unit’s single-pass capability, Heino Hammann, product line manager, blasthole drill rigs, Epiroc said. “Designed for longevity and with an 11-m sin-





The DM30 II SP features an 11-m single-pass tower option that, Epiroc reports, increases productivity for 29- to 36-ft drilling conditions by eliminating the need to add a second drill steel. (Photo: Epiroc)

gle-pass feature, it can only add value and success to any customer.”

The rig is ideal for medium to large quarrying and mining operations, Hammann said. “We at Epiroc take pride in offering our customers the best solution for their operational needs, and this is no exception with the DM30 II SP being the best fit for this application,” he said.

With both rotary and DTH drilling capability, the unit offers a hydraulic pulldown force of up to 30,000 lb (134 kN). The 11-m single-pass tower option increases productivity for 36-ft drilling conditions by eliminating the need to add a second drill steel.

That feature pays dividends “in applications where adding drill rods could be as timely as drilling half the hole,” Hammann said.

“SP also allows for lower consumable costs due to no coupling and uncoupling of drill rods,” he said. “In a very price-competitive mining environment, the DM30 II SP will contribute to a lower total cost per ton through safety, reliability, efficiency and productivity.”

Customers can choose a low- or high-pressure compressor.

The drill’s main structure has a design life of 45,000 hours.

The rig features a safe working environment for operators with a Falling Object Protective Structure cab that is pressurized, heated and cooled. The cab provides significantly reduced noise

levels and excellent visibility, the company reported.

“All operational functions are controlled from the driller’s console, and the ergonomic layout allows operators to instantly switch from drilling to tramming for increased productivity,” Epiroc reported. “In addition, the electric-over-hydraulic controls are common across the DM series, making operation easy for drillers with DM-series experience.”

A 300-gallon fuel tank provides 14 hours of operation.

The unit can adopt scalable automated features through the optional Epiroc Rig Control System (RCS) packages: RCS Lite Basic, Connected and Nav.

“Built on the RCS 5 platform that comes standard on the Pit Viper series, RCS Lite offers a number of safety and interlock features,” Epiroc reported.

The system allows for scalable automation options without any major rebuild. “RCS Lite allows all Epiroc rotary drills to have the same onboard display and system for consistent operator training and service,” Epiroc reported.

With a small footprint, the DM30 II SP maneuvers relatively easily on tight benches, and is simple to transport both in and between pits.

Reduced cost of ownership is one of the primary benefits offered, Hammann said.

“Designed off a proven platform and legacy products, the DM30 II SP

will provide a more profitable operation through its single-pass capability, low-cost maintenance, and ease of transportability to any customer,” he said. “It provides a lower total cost per ton through SP efficiency, productivity and scalable automated features. Easy and safer access to service points allows for less downtime and more time doing actual drilling.”

Hammann said the development of the DM30 II SP was based in part on customer feedback. “Epiroc has always worked closely with its customers and the market, identifying needs,” he said. The rig can “easily be integrated into any operation.”

“It is designed to allow for minimal to no impact on any process, workflow or routine,” Hammann said. “Further, we work closely with our customers on the supply of aftermarket support, ultimately contributing to the success of their operations.”

Hammann said the DM legacy products have been around for decades, valued and accepted by customers in various applications. “Through strong product offerings and industry-leading expertise, Epiroc will remain the leader in the blasthole drilling industry,” he said. “We will continue to develop solutions that benefit our customers.”

## Unmatched Maneuverability

In Q2, Caterpillar released the MD6380 Rotary Blasthole Drill, with 251- to 381-mm-diameter holes, a single-pass hole depth of 19.8 m, and multipass hole depth of 39.5 m. Automation-ready and designed to be rebuilt when needed, the drill is made for large-scale mining, Cat reported.

The rig offers reliable performance, high availability and more maneuverability, Lou McDuffy, marketing consultant, drills, Caterpillar, said.

“Caterpillar achieves this with the inclusion of Cat electronics, a matched powertrain, Cat technology, a new cab and operator station, all within a smaller footprint than competitive models,” he said. “The working envelope of the MD6380 gives it unmatched maneuverability, allowing quick and efficient navigation.”

The powertrain is designed to efficiently manage loads generated by the compressor and hydraulics, “delivering

superior fuel economy,” the company reported. “The compressor is configured with electronic regulation and variable volume air control, allowing the driller to perfectly match compressor output to drill tool and application needs. It also lowers standby pressures while the machine is in idle, further improving fuel efficiency.”

The undercarriage has grease lubricated track pins, positive pin retention and automatic track chain tensioning, Cat reported. These features help “the undercarriage deliver extended durability and optimal performance on grades and in tough operating conditions.”

The rig features a spacious cab and superior operator comfort, the company reported. “Intuitive multifunction

joystick controls and touchscreens promote efficient operation,” Cat reported. “Display screens are adjustable to suit the driller’s reach and line of sight.”

With a full-length driller window, large pane glass around the cab and four high-definition cameras, visibility is maximized.

The top tier benefits include an optimal mix of onboard air, feed force, rotary torque and machine mobility. The rig offers a best-in-class working envelope with a low center of gravity and ample approach angles, Cat reported. “These attributes give the machine superior maneuverability,” Cat said.

The rig comes “technology-ready to seamlessly interface with a mine’s digital, remote control and autonomous operations plan,” said Greg Scott, product and applications expert, drills, Cat.

“The drills in the series use a common computing platform and software, and share the same key design principles for large structures, powertrain and major components,” he said.

That platform and software is field proven, Cat reported. “Integrated machine protective features and interlocks help keep operators safe and the machine up and running by preventing potential failures or misuse,” the company reported. “With Cat Electronic Technician, troubleshooting is quick and easy. Drill electronics also provide a common platform for the integration of automation solutions.”

The machine features Drill Assist, which includes auto-level, auto-retract jacks, auto-raise and auto-lower mast, and auto drill functions. The drill depth monitoring system helps to reduce both over- and under-drilling.

The unit also uses Cat MineStar Terrain for drilling, which provides precise hole location, production reporting and strata reporting. “Terrain seamlessly connects to Cat Command, offering a path to remote operation and autonomous drilling,” Caterpillar reported.

The MD6380 is capable of a pull-down force of 49,895 kg and a rotation torque of as much as 20,880 Nm. The Cat 3512C diesel engine produces 960 kW and delivers emissions performance equivalent to U.S. EPA Tier 2 and EU Stage II.

The rig is the latest in the series, which debuted in 2017 with the launch

of the MD6250 (152- to 251-mm-diameter holes).

In April, Caterpillar reported Thies is trialing an MD6250 at the Mount Pleasant coal mine in Australia in a phased 12-month pilot project. The rig is equipped with Terrain and DrillAssist. The program has three phases: operator mission assist, semiautonomous drilling, and full autonomy. Currently, semiautonomous drilling is under way.

The MD6250 advancements were built into the next and larger model, the MD6310 (203- to 311-mm-diameter holes). “In late 2019, the new MD6200 (127- to 200-mm-diameter holes) was launched, designed for production drilling in quarry and mining applications,” McDuffy said. “In 2020, Cat launched this new ultra-class model, the MD6380.”

Since 2017, “the Cat Drill family has accumulated more than 100,000 hours of operation globally, working in coal, phosphate, aggregates, limestone, gold, copper, iron and magnetite,” Matt Jacobs, commercial manager, drills, Caterpillar, said.

The drills are relatively easy to adopt thanks to the Cat dealer network, he said.

“The new generation of Cat rotary blasthole drills use standard Cat components, systems, software and support networks,” Jacobs said. “The adoption of drills into a customer’s fleet is smooth and easy.”

The line enables Caterpillar to best serve customers “focused on safety, streamlined operations, improved production and lower total ownership costs,” Jacobs said. “Caterpillar is excited about today, and ready for our customers’ future needs.”

The culmination of a decade of deep investments in R&D for new product development, the line speaks to “the company’s ability to transition into the age of smart iron to meet customer needs,” McDuffy said.

“We paired robust mechanical designs with advanced technology resulting in a more productive, more reliable, more serviceable drill that can seamlessly accommodate multiple levels of technology and autonomy,” he said. “The new Cat Drill product line is an example of the success of that ongoing commitment to developing products that meet the critical requirements of customers.”



With a smaller working envelope, the MD638 offers unmatched maneuverability, allowing quick and efficient navigation, Caterpillar reported. (Photo: Caterpillar)



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# TLC for Primary Crushers

*A gyratory crusher is a significant investment for any mine. Take care of it and it will serve you well.*

By Carly Leonida, European

Primary gyratory crushers are easily the hardest working piece of fixed plant on a mine site. The gateway between extraction and processing, they bear the brunt of continuous operation, high feed volumes, and are subject to rock particles of extreme size variation and hardness.

It is therefore vital that they are kept in top condition, maintained regularly and their performance optimized in sync with the rest of the crushing and screening circuit. Poor maintenance

can result in unplanned shutdowns for repairs, premature failures and equipment damage all of which can be costly and can cause reduced throughput. A primary crusher that is underperforming will also impact upon every other piece of downstream equipment, quickly causing a bottleneck and, potentially, a source of lost revenue.

*E&MJ* asked three global OEMs and service providers how best to care for these machines.

## Preventative Maintenance

Assuming the correct gyratory model has been selected for the job, let's start with preventative maintenance, because prevention is always better (and less costly) than the cure.

The team at FLSmidth has been working with a number of customers recently to eliminate unexpected crusher shutdowns and to optimize equipment reliability. Manager of Life Cycle Services Charlie Madsen was happy to share this knowledge.

"Planned major maintenance predominantly means liner changeouts," he said. "But generally, the crusher will be shut down for two mantle changes and one concave change per year. Mantle changes can be done in approximately 24 hours and a concave with a mantle change in four to seven days depending on factors such as mine location and site specifics.

"Hydroset replacements are planned/recommended anywhere between one and five years, again depending on site-related variations. General maintenance is hard to time, but an educated estimate would be something along the lines of three to four days every half year. Maintenance schedules are planned through information, data, and trending of wear and components."

Rate of wear and wear characteristics are typically determined by the orebody type, work index, abrasiveness and fracture rate, as well as throughput.

"These are characteristics that can change over the lifespan of a pit or orebody, requiring constant attention to liner material choice and profiles. This ensures wear patterns and wear loss are kept at the optimum level and secures lowest cost per metric ton in operation," Madsen said. "FLSmidth mitigates wear rates by using different types of manganese in its liners, upgrading to chrome-moly where necessary. White iron can also be advantageous."

Combining this with the optimization of liner profiles, throat/chamber design and operations on-site for feed characteristics tends to give the most successful result, and changes in the above can



Safety is paramount when working on such large, heavy pieces of equipment. (Photo: Metso Outotec)



extend liner profiles and throughput over a lifetime by up to 500,000 mt in some cases. This is obviously welcomed by the customer as downtime is cut and maintenance costs reduced.

Madsen explained: “There are an abundance of checks that should be carried out fully and thoroughly in preventative maintenance inspections and with a computerized maintenance management system (CMMS). These, in combination with customer training, can reduce maintenance times and cut unplanned failures. It also enables more consistent scheduling of work activities, planned shutdowns and parts supply.”

Maintaining the open side setting (OSS) is typically done by operators with a control system that shows the main shaft position at all times. FLSmidth’s automation team has designed new software that can carry out optimization of the main shaft position based upon a number of instruments that maximize throughput, power/wear and final product.

“Calibration of the main shaft is an in-field exercise, as manual verification and measurements have to be conducted in order to calibrate and scale the electronic equipment,” said Madsen. “By optimizing the main shaft position, we create a more effective and constant wear profile, which allows the end user to get full wear out of liners.”

FLSmidth is in the early stages of developing a comprehensive maintenance management system for its Excel-Raptor cone and gyratory crusher lines.

“We also we have a self-aligning main shaft, which improves on installation times, and more importantly, safety and suspended loads,” Madsen added. “We are also the only OEM with a fully top service gyratory, which improves on maintenance downtime and saves on building and construction designs and sizes.”

The team has designed routable shell segments to reduce concave liner changeout times, and its spider removal jacks have also been redesigned to increase their size. These are threaded into the shell rather than being free standing to reduce manual handling requirements and improve ergonomic positioning for staff.

## Upgrades and Overhauls

Of course, there will come a time when certain parts need to be upgraded to take advantage of new designs and

safety features, or overhauled to maintain their performance.

“Really, any time can be a good time to upgrade a crusher,” Lucas Steiner, director of mining crusher products at Metso Outotec, told *E&MJ*. “Key things that customers should be looking for are: have their operations changed over time? Are there any performance issues that could be improved upon? Or are they anticipating a change in the future and need to start positioning themselves to avoid lost production?”

“Any type of change is a good chance to look at what upgrades could help the mine achieve its KPIs. It could be anything from ore grades decreasing, to the need to get maintenance budgets under control.”

“Another good time is if there’s a major repair coming, a larger shutdown, and the team is going to be looking at some areas of the machine anyway. It’s worth looking ahead and setting the operation up for the future.”

Major repairs or upgrades usually require a shutdown and this takes significant planning — sometimes upward of a year — to have the materials brought to site and the right teams assembled to ensure Formula 1 pit-stop style efficiency. This has meant that, despite the challenges of COVID-19 impacting mines across the globe, many have proceeded with the maintenance shutdowns they had planned; these kinds of activities are not easy to reschedule.

Steiner explained: “Upgrades can vary greatly in scope depending on what the customer wants to accomplish. Simpler upgrades might involve replacing just a few parts or an entire assembly. For example, in our portfolio, we have a shimable manganese spider bushing. It’s a direct drop-in to a current bushing spot, but it can bring up to three times the life. That’s a simple upgrade, which would require very little planning. The parts can

be positioned and readied while the machine is operating and implemented during a standard one to two-day shutdown period.

“On the other hand, a speed upgrade, which would allow the mine to get more tonnage out of their machine is far more complex. That might include lube changes, drive motors changes, drive system changes and possibly other internal components too. We can still ready the parts during operations, but it would require more planning and perhaps a three to four-day shutdown.”

Thorough planning is key to minimizing shutdown times.

“The best way to implement upgrades and minimize disruption to operations is to get our personnel involved from the start,” Steiner said. “If we build a good plan of how the activities should flow, get the proper parts ready... then shutdown times can be minimized. Customers can capitalize on Metso Outotec’s knowledge and resources, whether that’s physical labor or just advisory staff.

“We can help to preassemble components, reposition things and develop a timeline for implementation. And then we



Maintenance under way on the primary crusher at Anglo American’s Los Bronces operation in Chile. (Photo: Metso Outotec)

can help to tweak performance after an upgrade is implemented with process optimization. It's really dependent on what the customer wants, what their capabilities are and what they need help with."

Given the wide-ranging nature of upgrade activities, *E&MJ* asked: what separates everyday maintenance jobs from "upgrades?"

"When we look at upgrades, we're looking at things that make maintenance easier, make the machine more reliable or get more production out of the machine," explained Steiner. "Upgrades usually involve operational parts of the machine versus the wears parts. Replacing wear parts or adding custom liners would be more of an everyday maintenance activity."

### Safety and Efficiency

Metso Outotec recently released a new rotatable top shell for its Superior gyratory line and has formalized its upgrade and overhaul offering into a comprehensive program called MK nXt.

The Superior gyratory line was introduced in 1953 and, since then, the design has gone through several iterations, with each successive MK release incorporating design improvements to boost production and safety. The latest version, the MKIII gyratory was released in 2019, and that was when the former Metso decided to aggregate its upgrade offerings into a solution.

Steiner explained: "Every time a new MK number was launched, we had customers with an older version asking how they could modernize their machine. So, we decided to create a solution that pinpoints what upgrades the customer could actually benefit from rather than doing a blanket upgrade on everything.

"The MK nXt program breaks down available upgrades into three main categories: production, reliability and maintenance. The customer can use those categories to see which upgrades could best help them to meet their business goals; it gives them the best return on investment."

Currently, Metso Outotec doesn't have a similar program in place for its other crusher lines, but that may change if MK nXt proves to be a success. So far, the indicators are good. The team has performed spider upgrades and speed upgrades for mines in North America and Australia.

"We've applied our manganese shim-mable spider bushing multiple times at sites around the globe to help customers

looking for reliability enhancements," said Steiner proudly. "We've also implemented rotatable shell change-outs to improve maintenance efficiencies in Australia. And we have multiple opportunities for that on the horizon throughout North America, too."

The rotatable top shell is compatible with all the Superior gyratory crusher models and was originally developed at requests from Australian mine operators who wanted less downtime and safer liner change-outs.

"The concept started about five years ago, and it's been formally pursued since about 2017 after we saw the benefits and realized that it offers a really good ROI for a lot of customers," explained Steiner.

The rotatable shell package implements the use of a second top shell that can be out-fitted with new wear parts before a change-out takes place. In the past, a gyratory had its concaves inside the shell, and wear parts were relined without removing them. The work had to be done inside the machine using lifting equipment like cranes.

"We looked at that and said 'okay, why don't we do the same thing we do with cone crushers and change out the whole shell in one lift,'" said Steiner. "We've provided means to more easily install and remove that shell. We've made provision so that the concaves can be installed in the shells with them removed. We can actually take the existing top shells from the machine and convert them to be used in a rotatable program."

As part of the new solution, Metso Outotec offers OEM liners with custom optimization of the wear profile for both production and wear life, installation support, shutdown labor, and a multitude of different life cycle service options.

"We've also worked with customers looking at flexible financing programs and packages," Steiner said. "To go to a rotatable shell concept can be quite pricey because

it involves some very large pieces. But we've been able to, in quite a few cases, turn what would typically be a CAPEX requirement and bring it into OPEX budgets."

Faster, safer change-outs mean that extra time can be spent on other tasks during shutdowns.

Steiner explained: "Say, in the past it took you two days to do a concave change-out... If you get that down to one day, now you have an extra day to do other maintenance or you can get back to operating. It takes less manpower so you can have leaner maintenance crews. Or, if you have the same number of people, you can apply them to other maintenance projects.

"Then there's the safety aspect; the shells with used wear parts can be stripped down and realigned in a controlled environment. They can be moved away from the machine and worked on in a shop environment during off-peak times and while the equipment is running.

"They can be inspected and repaired properly, versus being repaired in the field under a high-stress timeline. There are some shells that never get repaired properly because the timeframe is too tight. They just get patched back into the machine to get it back up and operating."

Four customers already have the rotatable top shell in operation and Steiner



The new Metso rotatable top shell was developed at request from Australian mine operators who wanted a safer, easier to maintain design. (Photo: Metso Outotec)



said there has been strong interest across the board. Currently, it's only applicable to Superior gyratory models but Steiner hinted that retrofits for other gyratories might be in the pipeline, too.

## Education and Training

When selecting a crusher, it's worth choosing an OEM that will not only assist your team with maintenance planning and execution, but one that can also provide a holistic management program for the entire life of machine. All three of the companies interviewed for this feature do so, and there are many more.

Times are changing and, in light of COVID-19, automation and remote optimization and training tools are proving their worth many times over.

Mikael Lindberg, product manager for services and performance agreements in Sandvik Mining & Rock Technology's stationary crushing and screening line, spoke to *E&MJ* about this trend.

"Since COVID-19 hit, we're providing a lot more remote assistance," he said. "We still do go out to a site in many cases, but we have the ability to assist remotely with our digital framework.

"In terms of training, we also offer webinars — as do many of our competitors — and we have our Crushology web platform, which has been in place since 2015. That is key to customer knowledge transfer. Our main business isn't just providing service hours, it's about providing expertise."

Lindberg explained that lifecycle services have been a big focus for Sandvik over the past few years.

"Most of our customers today are keen on our service agreement offering," he said. "We have a standard service agreement that covers maintenance, and we can of course customize that. In some cases, we go in and handle the maintenance ourselves but, primarily, what we want is to improve the efficiency of these machines by empowering customers. Training is key to this and continued support, particularly around more complex tasks like process optimization and root cause analyses...

"We want to make sure that the customer can handle the machine in the best way possible with the current staff that they have. If a machine is down, that's bad for our brand as well as for the customer."

Proactive services are a crucial part of this. Like many OEMs, Sandvik offers



Beneath the surface, maintenance crews work to plan to ensure maximum efficiency and minimal downtime. (Photo: FLSmidth)

periodic inspections where its personnel come out to site to train and teach staff.

"That expert takes the whole staff through a practical training session, explaining what they need to look for in order to be proactive and predictive in their maintenance," said Lindberg. "We have a digital service platform that allows us to collect performance data and fill in any gaps with information that the automation system cannot collect. We can then use that information to visualize different trends and provide statistics for users to help them understand if something is heading in a destructive direction or if there is an unhealthy pattern in machine performance. These inspections are important in detecting issues that a customer might not otherwise notice.

"You can't just give customers a book and tell them to read it and trust what it says inside. Effective learning requires 10% classroom-based training, then 20% learning by doing with an expert to guide you, then 70% procedure. We try to work with that model."

For specific training sessions, Sandvik also uses augmented and virtual reality technologies to support learning, and Lindberg hinted that the company is developing a new digital tool or "ecosystem" for service interaction.

## Automate and Optimize

Optimization technologies are the final piece of the puzzle.

Combining automation and artificial intelligence with the correct sensors and hydraulic controls allows operators to adjust

power and crusher settings remotely and on-the-fly according to changes in feed characteristics, and even predict the need for alterations in advance. Digital twins are growing ever popular in this respect.

Technologies such as these can be a huge help in predicting and preventing unplanned downtime.

"It's also important to understand that you need to optimize a primary crusher in tandem with the downstream crushing and screening circuit to create system efficiency," said Lindberg. "It's not just about uptime on the gyratory. You need to look at the different system requirements and how you can put the system together to maximize efficiency, and make sure you hit your production targets or you will end up with bottlenecks."

It's true; anyone can put together a plant that will operate, but to maximize efficiency and throughput requires experience.

"You can easily find a 20% productivity improvement just by looking outside of the gyratory performance and taking a systems approach," added Lindberg. "If the primary, secondary and tertiary crushers and screens in between are not talking, then you will build silos and easily lose 20%-30% efficiency.

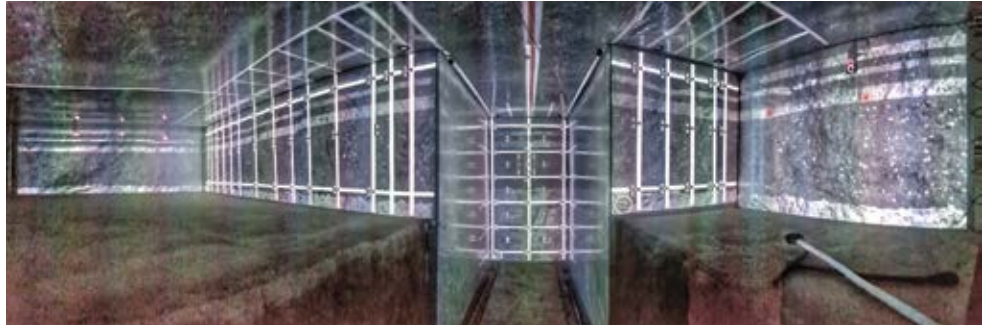
"When we make a process audit, we can usually find at least a 5% improvement in efficiency, no matter where we go. That is why we try to include these in our productivity services. We want to create a continuous way of thinking with the customer, to balance their expertise with ours, and to tackle challenges and find solutions together."

# Going Deeper Underground

*The role of virtual reality and serious gaming in STS3D's training for miners*

Miners constantly pursue technology that will improve safety and increase production efficiency in a challenging environment. Anglo American places the highest priority on safety when it comes to production. If the mining company can get its crews to mark off their blasting patterns accurately, drill straight and time the explosives in the correct sequence, the blast will advance deeper, straighter, with pinpoint precision and, more importantly, safer. This, however, is easier said than done.

The shift supervisors for Anglo Platinum in South Africa face significant challenges. Their job is to maximize the amount of platinum ore for every blast, every day, with as little waste rock as possible. If the crews make mistakes, it can be costly. Each poor blast could mean a shallow advance into the face, uneven faces, rock breaking well under or over the planned excavation, or even falling rock, all of which takes time to clean and make safe.



A panoramic view shows the faces at the Anglo's Amandelbult Virtual Reality Stope.

Mistakes could even lead to a missed blast during the next shift cycle, which could mean a production loss. With a target of 133 blocks of rock to be blasted every day, the pressure is on, and targets are easily missed.

## Training is Serious Business

Providing effective blast training is difficult on multiple fronts. Taking trainees 900, 1,500 or 3,000 feet underground

takes time. It's not only dark, dusty and damp in the mines, but also deafening and dangerous. This is not an environment to remain in for long. People rush the job to get out, and there is no time to look at better practices to advance the blast accurately.

Training crews on the surface, meanwhile, isn't much better. Communicating decades of practical experience and giving trainees a proper grasp of concepts like the scale, distances and measurements of a blast face (or stope panel) is extremely difficult in a classroom setting. Similarly, you can't build muscle memory in practical exercises on a scaled-down, 2D surface. Then, assessing for competency presents yet another round of challenges. Conventional techniques even include having trainees mark off the faces in 1:1 scale on the lawns, but that's a poor substitute for the real thing.

## Creating a Virtual Stope

To tackle this problem, Anglo approached Pretoria-based STS3D, with more than 15 years of experience in building safety training solutions for the mining industry.

The leading-edge virtual reality solution STS3D built is exponentially improving the process of training mine crews. This visionary approach has set the stage for Anglo American's custom-built solution: the Anglo American Amandelbult Training Complex Virtual Reality Stope, a world-first that recreates the situations miners encounter at



A shift supervisor marks the drill holes on a virtual face.



the face as they prepare to drill a round. With several Virtual Reality training programs, an immersive VR Cube, seven VR Blast Walls, and a VR Robotics Simula-

tor, STS3D planned the experience to meet Anglo's needs.

This facility is housed in a 2,300-ft<sup>3</sup> training space surrounded by an im-

mersive 800-ft<sup>2</sup> rear projection screen. Running the simulation is one powerful PC driving 12 digital projectors and another for the 20 state-of-the-art Vicon motion capture cameras.

Although designing and constructing the hardware, building the virtual stope, and coding the functions presented the STS3D team with a challenge, the key hurdle was how to track the users in real-time within this multidimensional virtual stope. This required breaking new ground, so STS3D, being new to motion capture, sought out the best in the industry for assistance.

### Virtual Solution for a Real-life Problem

One company stood out. With the depth of their response and their willingness to engage in an open conversation about how the system would work in the virtual mining environment, Vicon provided clarity and assurance.

Vicon quickly allayed concerns that cameras might not be able to track if markers were occluded by users. When Vicon convinced STS3D that their solution could track the subject accurately as long as a marker was visible to a single camera, it became apparent that this is the solution that would work. The simplicity of plugging the Vicon sample data into the Unity game engine increased the technology's appeal.

Anglo American trains 1,500 people per year and must be able to operate the system on site without constant external support. Since a single instructor — without any prior experience in motion capture or Virtual Reality — only needs a one-button start to run the blast simulation, the Vicon system more than met the criterion of simplicity.

Since the Vicon system can track up to five people at once it enables team learning and makes the training of large numbers of trainees possible — a must in the mining environment. This ability to track multiple objects through space provides very realistic training, preparing users for real conditions in the field.

### A Serious Solution for Serious Games

During entry examination, for example, miners must decide whether a zone is safe for operations. If they get it wrong, they get a realistic simulation of what



Using special cameras, gaming software and a few props, STS3D and Vicon Engineering create an immersive underground training center for platinum miners.



Miners discuss the results after detonating a virtual blast.

could happen. A big loud bang and sudden darkness simulate a potential rock fall on the spot where they are standing.

“Make no mistake, this gives the miners a real fright,” said Johan Boucher,

STS3D project lead. “They’ll remember their error. Since you are fully immersed in the virtual mine, there’s no room for distraction and the learning sticks. You’re on high alert all the time while marking

a pattern on the rock face for the drill operators. And when you detonate the blast, the rock flies — creating a very vivid, a very memorable experience.”

The VR Stope is a life-sized serious game. It has two modes: training and assessment. In training mode, users are instructed step-by-step how and where to mark off the panel using a special virtual paint brush. This builds muscle memory and motor skills, which will be recalled once the trainee is out in the actual environment. The system provides immediate visual feedback on correct or wrong actions. The added ability to undo and retry allows for fast, effective feedback and learning.

Once the user has completed marking and timing, they experience the full impact of VR’s immersiveness. When the detonation is set off right in front of them, they see the firing sequence and fragmentation of the rock, driving home the effect of what they’ve just done. It also enables them to inspect the quality of the blast first-hand again and again, in real time or in slow motion, forward



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or in reverse. The miners can now really understand how and why the correct blasting procedure works best.

After a blast, the cameras track the hard hat position of the trainee, adjusting the perspective of the projections. This creates an illusion of depth, showing that the face wall has in fact advanced. Trainees can then study the results of their blast and immediately see if they have had a good or bad advance, another completely novel experience.

In the assessment mode, trainees mark the blasting pattern and time the detonation sequence of explosives themselves. Once the marking pattern is submitted, the system takes a screenshot of the trainee's attempt. The image gets saved to their PDF report along with information on number of attempts, accuracy, the time taken and the number of times assistance was requested.

Trainees often compete for Top Score bragging rights, a level of gamification that goes beyond tricks like badges and achievements and that assists in making learning stick.




Trainees can inspect the detonation sequence just after the blast is initiated.


In the next phase of instructional design and deployment, STS3D will cover Safe Entry Examination, testing for ventilation and noxious gasses, support installation and rock strata control, simulating life-threatening experiences

without ever taking trainees away from the safety of the virtual stope.

*This article was adapted from a case study submitted by Vicon Engineering. For more details, visit [www.vicon.com/engineering](http://www.vicon.com/engineering).*

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# Out With the Old, in With the New

*Innovation is breathing new life into diamond mining. E&MJ investigates and interviews four mining companies, big and small.*

By Carly Leonida, European Editor



ALROSA's Jubilee open-pit diamond mine in Russia. (Photo: ALROSA)

In a part of the mining industry that has remained steadfastly traditional — institutional even — for the past 150 years, there is big change afoot.

It may not be immediately apparent, but the in-crawl of digital technology from new exploration techniques and sorting equipment, to digital selling platforms and blockchain for traceability, is slowly making over diamond supply from the ground up, disrupting age-old ways of doing business and occasionally ruffling a few feathers.

Many of these innovative tools and strategies are being introduced by mid-tier and junior miners; companies that are relatively agile and keen to differentiate themselves in a market consistently dominated by two or three big players.

That's not to say that the behemoths of this sector are standing still though. In a market where a single stone can fetch millions of dollars depending on its size and quality, the stakes are high, and many of the largest companies have internal divisions and R&D programs dedicated to advancing their operations technologically.

Aside from the discovery of new deposits to bolster dwindling reserves, preservation of value is the biggest innovation driver, and this is pushing every miner regardless of size or status to rethink their extraction and sorting processes.

## Lucara: Different by Design

Where better to start this exploration of the new than with Lucara Diamond Corp?

Lucara owns 100% of the Karowe diamond mine in Botswana, which has been in production since 2012 yielding three of 10 largest rough diamonds ever recovered: the 1,758-carat Sewelô, the 1,109-carat Lesedi La Rona and the 813-carat Constellation, which sold for a record US\$63.1 million.

Lucara was one of the first mining companies to successfully use X-ray transmission (XRT) sorting technology in its operations and recently launched Clara Diamond Solutions, an online matchmaking tool and marketplace for buyers that allows them to bypass traditional selling routes and purchase only the stones they want directly from the miner.

E&MJ caught up with President and CEO Eira Thomas in early June to talk through some of these initiatives. But first, a history lesson...

"Back in the early 90s, diamonds were completely unknown in Canada," she said. "Then there were discoveries from companies like BHP that ultimately led to a huge amount of investment and the creation of mines like Ekati, Diavik, Gahcho Kué, Snap Lake... and that completely changed the landscape. For the

first time, Canada was an important diamond supplier.

"Since that time, we've seen evolution through the Kimberley Process, new production coming out of Africa, and the emergence of synthetic diamonds in the jewelry trade. There has been quite a lot of change.

"But, fundamentally, over the last 25 years, since the discoveries in Canada, we've not really had any world-class discoveries globally. Diamond deposits are rare. They're getting rarer. Our long-term outlook remains positive for diamond prices, because supply is definitely going to be impacted by aging assets and the fact that we've got no new production on the horizon, just yet."

Lucara was founded 13 years ago to focus on diamond exploration in Africa.

"Catherine McLeod-Seltzer and I co-founded Stornoway Diamonds in 2001, and that company went on to develop Quebec's first diamond mine," Thomas said. "Throughout the evolution of that project and our work in Canada with Stornoway, we had pondered going to Africa, but our shareholders didn't like the idea of putting African and Canadian assets together.

"So, Catherine and I got together and convinced Lukas Lundin, who was a friend, to form a company with us. That's where the name came from — the combination of Lukas, Catherine and Eira became Lucara. We set about acquiring assets back in 2008-2009, and ultimately secured the AK6 deposit in Botswana, which was pretty transformative for the company."

## Karowe Heads Underground

Karowe is an unusual deposit, in that it has a preponderance of very large, high-value diamonds in its production profile; more than 70% of Lucara's revenue comes from stones in excess of 10.8 carats in size.

"Prior to the Sewelô being recovered, the Lesedi La Rona was the second largest diamond in history, next to the Cullinan," Thomas said. "We also recovered



the Constellation within days of recovering the Lesedi and we now believe they were potentially part of one very large stone, which, if it was put back together, would come pretty close to the weight of the Cullinan.”

The Cullinan — the largest rough diamond ever recovered — weighed in at 3,106 carats. It was discovered in South Africa in 1905 and its magnificence has never been surpassed. However, Thomas believes Karowe has the potential to produce a 5,000-carat stone.

“Karowe is the only mine that has ever produced two diamonds in excess of 1,000 carats,” she said. “That is a distinguishing feature of this deposit. Type-two diamonds originate from deep in the lithosphere-mantle boundary, as deep as 800 km.

“Within this deposit, there is a geological unit that we refer to as ENPKS, and that has been the source of all our highest value diamonds thus far. That unit only accounts for a small volume of production in the current open pit but, as we mine deeper, it dominates production. In fact, at 800 m down, 80% of the pipe volume is ENPKS.

“That’s a very important value driver for us because ENPKS has a coarser size frequency distribution, and the grade is also higher. ENPKS is 55% richer than what we’re currently mining in the south lobe, so that’s one of the reasons we’re keen to expand the mine underground. The goal is to drive a shaft to the base of the deposit and mine it from the bottom up, because that’s where the richest store is.”

Lucara completed a feasibility study for the Karowe underground mine in late 2018 and approved a US\$53 million expenditure this year funded out of cash flow.

“COVID-19 has obviously thrown a wrench into our plans,” Thomas told *E&MJ*. “But we’ve rescoped the underground to be more conservative for 2020, and the goal is to secure additional financing before the end of the year.

“Right now, we’re focused on early procurement. Our aim is to start sinking a shaft in 2021 and be delivering ore from the underground by 2026. We’re currently in discussions with banks, but the good thing is we started off the year strong with a healthy balance sheet and no debt.”

## Using XRT to Get Ahead

Karowe was the first diamond mine to incorporate XRT as its primary recovery method.

“XRT works with non-fluorescing diamonds, which is important because very few type twos fluoresce,” Thomas explained. “It’s also a bulk sorting technology, so it allows us to put our ore through an initial coarse crush, and then it immediately goes to what we call our ‘Mega-Diamond Recovery Circuit,’ which features an XRT unit. The idea is that if we have large, high-value diamonds, they will be liberated in that first coarse crush and recovered before the feed is subjected to successive stages of crushing, concentration and XRT sorting.”

The main purpose of the Mega-Diamond Recovery Circuit is to prevent very large, potentially high-value stones, from being broken.

“It’s critical because we know we broke the Lesedi,” Thomas said. “You think about the value of that stone. At 1,109 carats, we sold it for \$53 million. If we hadn’t have broken it, it could have been an order of magnitude more valuable. That’s why we put in the Mega-Diamond Recovery Circuit. We can now recover diamonds up to, potentially, 5,000 carats in size. Because we believe that Karowe has the potential to yield diamonds that large.

“XRT is very important for us and it has become our main recovery method. The rock at Karowe is high yielding and also extremely hard, unusually hard for kimberlite, and that became quite problematic for us. In the fine diamond recovery circuit, we found that there was a bottleneck with our DMS [dense medium separation] and introducing XRT in the middling circuit has helped us to deal with that issue. It means we can continue with the same production throughput as we had when we were dealing with weathered ore near the surface.”

Typically, XRT is set up to look for a specific element — in Karowe’s case it’s carbon — as opposed to traditional diamond recovery technologies that focus on the properties of diamonds, like fluorescence, density or hydrophobicity, to recover them. Those processes are not nearly as efficient as carbon detection and that is why, since Lucara’s success at Karowe, other miners, particularly those with a high percentage of type-two diamonds in their deposits, have opted to introduce XRT in their own operations.

## Expanding Exploration

“We are continuously looking at ways to make our overall recovery more efficient,”

said Thomas. “Diamond damage is something we’re extremely focused on because it’s a big value loss for us, and for every diamond mine. We’re currently tagging diamonds using tracers or RFID technology to look at different parts of our mill and where improvements can be made.

“We’re also looking at technologies to liberate embedded diamonds, and we’ve recently partnered with a Botswanan company called Sunbird to help advance our exploration efforts.

“Sunbird uses a UAV to fly very high-quality, airborne magnetic surveys for very low cost. The difference between Sunbird’s technology, and what you’d see in a traditional magnetic survey, is that the platform itself is completely silent so the equipment doesn’t interfere with the magnetic signal collection. It allows us to run surveys around the clock with multiple orientations. We collect the data and then we’ve got a portable drilling rig in the field that follows along, identifies targets and drills holes. We’re covering vast amounts of ground and reducing the time to evaluate a prospective piece of ground, using this technology.”

The low cost is particularly important because, as Thomas pointed out, there is very little investment going on in diamond exploration at present globally.

“It’s a tough market at the moment and it’s very hard to attract capital to the space,” she said. “There have been a



Diamond sorting by hand at Karowe. (Photo: Lucara Diamonds)

couple of announcements recently from a group out of Australia that is investing in two exploration projects and that's the first public money we've seen going into this space in quite a long time, other than very small projects in Australia and Canada.

"What we need to see is stabilization in diamond prices of the existing publicly traded producers. And that, in turn, will help generate more interest and hopefully attract more capital into exploration again."

### Clara Disrupts Diamond Trade

In keeping with its approach to innovation, Lucara also set about creating its own selling platform, ultimately acquiring and commercializing Clara Diamond Solutions in 2018.

Thomas explained why. "We've had one full year of sales through Clara. It was established in recognition that the current supply chain is antiquated and inefficient," she said. "We now have technology to completely disrupt the status quo and unlock significant value for all participants."

To understand Clara requires an understanding of how the current sales paradigm works. Many mining companies sell their run-of-the-mill diamonds in the same way; by building up an inventory of diamonds that are, by nature, heterogeneous, until they have enough product to divide up into broad classifications based on size, color and quality.

These assortments, or buckets of diamonds, are then sold as homogenous

parcels. Customers buy an assortment, which they then sort through, and the stones they don't want are sold on with some being re-traded up to 10 times before they reach a polishing wheel.

Of course, this does not apply to all companies or all stones. Some groups offer arrangements such as buybacks and bespoke options. And exceptional diamonds, which are of higher value, are frequently sold as individual items.

"With Clara, we use scanning technology, which has been around for almost a decade — we partnered with a company called Sarine Technologies, out of Israel, to develop it," said Thomas. "At the mine site, we recover and clean our rough diamonds, then scan them to see what can be made using them. This creates a 3D tomographic image that we upload to a secure web-based server in the cloud.

"Then, we ask our customers what it is that they want to make. They give us, essentially, a blueprint of the polished diamond that they want including the size, cut and color, facet angles... We upload that order to the platform and then Clara uses a matching algorithm to sort through our inventory and find the best stone to manufacture into that polished product."

This approach benefits everyone: manufacturers no longer have to carry unwanted inventory, or re-trade in secondary markets. The buyer can specify how much they wanted to pay when they upload the blueprint, and Clara also provides assurance on provenance using blockchain technology.

Once the platform matures, buyers will be able to filter diamonds from around the world and, even state which mine they want their stone to originate from.

A number of producers have started trading online in recent years. This has made the buying process more convenient, provenance easier to determine and has certainly helped with regard to recent travel restrictions, but many still sell the product in bulk.

Lucara has patented Clara's technology worldwide and the company has an exclusive arrangement with Sarine that restricts it from engaging with any other sales platforms of this nature, it is unlikely there will be similar platforms springing up in the future.

Thomas explained: "The goal is to open Clara up and have other producers sell their diamonds through the platform. Trials were set to begin in March, but those were delayed. Our aim now is to have third-party sales on the platform before the end of year. We're hoping that the market will open up sufficiently to allow that. I think it's a very clear business case in a post-COVID world. Our customer base has increased by 20% through the crisis."

Currently, only traders can make purchases through Clara, but Thomas would eventually like to open it up to everyone.

"Ultimately, that's where we're going," she said. "That will probably be version 7.0. But we envisage a day where you, as a customer, can log on to Clara and bid for a diamond from to create a bespoke piece of jewelry. The platform will also be able to help you select a manufacturer to polish the stone and a designer to set it according to your design ideas."

### Letšeng Leads on Technology

Another small company that is making big strides using technology is Gem Diamonds.

In 2006, Gem acquired a 70% share in the Letšeng mine in Lesotho, with the Government of the Kingdom of Lesotho owning the remaining 30%. Letšeng is famous for the production of large, exceptional white diamonds. It is the highest dollar per carat kimberlite mine in the world and has grown to be one of the largest open-pit diamond operations globally.

Since 2006, Letšeng has produced more than 60 white diamonds larger than 100 carats in size, including the 910-carat Lesotho Legend, the 603-carat Lesotho Promise, and the 550-carat Letšeng Star,



Birds-eye view of Gem Diamonds' Letšeng mine in Lesotho. (Photo: Gem Diamonds)



as well as multiple high-quality pink and blue diamonds. An exceptional 13.32-carat pink diamond achieved a Letšeng record price of US\$656,934 per carat in 2019.

Brandon de Bruin, operations and business transformation executive at Gem Diamonds, spoke to *E&MJ* about the company's approach to R&D.

"We regard technology and innovation as a critical means of improving operational performance and unlocking value," he said. "Letšeng unearths some of the highest quality and largest diamonds anywhere on the planet, and the potential for and impact of diamond damage during crushing and extraction often adversely affects the prices received for these diamonds.

"In 2019, we commissioned a pilot plant to further test new technology that, if successful, could significantly reduce diamond damage, improve yield and reduce operating costs. Letšeng has a unique diamond distribution within its orebody and a significant portion of its revenue is held in large, high-value, type-two diamonds, which can be more susceptible to damage in mining and treatment. Therefore, reducing diamond damage is a key focus of Gem Diamonds' strategy."

Following a successful proof-of-concept in factory and laboratory conditions,



The 1,758-carat Sewelō: the second largest rough diamond ever recovered. (Photo: Louis Vuitton/Lucara Diamonds)

the group's wholly owned subsidiary, Gem Diamonds Innovation Solutions, constructed a pilot plant at Letšeng to test the recovery system under challenging operating conditions. The pilot plant uses scanning technology in conjunction with proprietary imaging and sorting algorithms to detect diamonds within kimberlite. Once a diamond has been identified, the next step is to liberate it without causing damage. A non-mechanical lib-

eration unit was developed in-house, and this utilizes high-voltage pulse power for the selective non-mechanical fragmentation of composite materials to liberate the encapsulated diamonds.

"The pilot project is progressing well," de Bruin said. "The plant was completed and commissioned during 2019. Ramp-up and ongoing testing of the efficiency of the technology continues. Once proven, the next step will be to viably scale up the project for full production capacity."

Like Lucara, Gem Diamonds is also in the process of incorporating blockchain technology into its business to create greater transparency in the supply chain and to bring retail customers closer to the source of their diamonds.

"While the short-term outlook for the diamond market is unclear as we navigate through the global impact of COVID-19, we believe that in the medium to long-term, demand for the unique high-value diamonds produced at Letšeng will remain firm," said de Bruin. "The mine is a well-established operation. It has a strong relationship with the local communities and we're looking confidently to the future now that an agreement has been reached with the Government of Lesotho on the lease extension to 2039."

## ALROSA Homes in on Efficiency

ALROSA is looking to digital technology to boost the operational efficiency and productivity of its mines. The Russian firm is partially state-owned and boasts the title of the highest number of carats produced globally last year. Today, it operates 12 kimberlite pipes and 16 alluvial deposits, mostly in Yakutia, as well as in the Arkhangelsk region, where Europe's largest diamond deposit is located.

The group has recently succeeded in increasing the volume of ore mined by 11% and diamond output by 33% at its Nyurba mining and processing division. Part of this involved implementing and refining what ALROSA calls the "Perfect Shift" system aimed at reducing downtime in its mining fleet.

"Our specialists succeeded in creating a dynamic dispatching system and achieved a 7% increase in mining fleet daily capacity," Jane Kozenko, ALROSA head of communications, said. "Maintenance of dump trucks and excavators is performed in a Formula 1-like pit stop mode with simultaneous maintenance and refueling. All our dumpers stay in constant operation thanks to the Hot Seat mode — when one driver needs to leave the workplace for lunch, a substitute driver replaces him."

ALROSA has also improved its preventative maintenance activities and has reduced the yearly maintenance shutdown period for its Nyurba processing plant from 26 to 17 days.

"Additionally, we have built a model that allows us to predict grinding mill productivity depending on the characteristics of

the ore and, as a result, we succeeded in increasing the processing capacity from 220 to 245 tons of ore per hour," Kozenko said. "Moreover, we designed a specific burdening planner to calculate the processing plan depending on ore characteristics and to get the highest hourly capacity of the plant."

Today, 86% of the group's energy consumption is from renewable sources, and ALROSA is implementing a special program to improve the energy efficiency of its fleets, including switching some of its vehicles to run on natural gas.



ALROSA has applied various digital technologies to improve the efficiency and productivity of its fleets. (Photo: ALROSA)

## De Beers: Technology Titan

At the opposite end of the enterprise spectrum sits De Beers, the world's largest diamond mining company. Established in 1888, the group has operations that cover the full value chain from exploration and production to rough diamond sales and diamond jewelry retail.

"Whilst we are involved in almost every part of the pipeline, the majority of our workforce remains involved with our upstream operations," explained David Petrie, trade communications manager. "With our partners, we mine for rough diamonds in Botswana, Canada, South Africa and Namibia. In Botswana, we

mine via our 50/50 joint venture with the Government of the Republic of Botswana under the name Debswana. In Namibia, we work in a 50/50 joint venture with the Namibian Government called Namdeb Holdings — recovering rough diamonds offshore through Debmarine Namibia and on land through Namdeb."

Technology plays a key role in all aspects of De Beers' business and the group has dedicated facilities for innovation and technology development. Exploration has been a particular focus in recent years. The group is prioritizing greenfield areas in Canada, Botswana and South Africa, and interested parties can read more about the

group's application of full tensor magnetic super conductive quantum interference devices (SQUIDs) in *E&MJ's* February 2020 Exploration Game Changers feature.

The group is also working on developing new rough diamond sorting technology, synthetic diamond detection instruments, and technology for its offshore diamond recovery vessels used in Namibia.

Petrie said: "Technology will play an increasingly important role in mines of the future as they become more remote, more challenging to run and more costly. A good example is the Chidliak property we have on Canada's Baffin Island. This deposit would be extremely challenging to develop and run using conventional approaches. We are therefore looking at a range of technologies that will enable us to run it in a different way so that it is economically sustainable, safer and has a lower environmental footprint. With the remaining diamond deposits around the world being in such challenging locations, it's likely that we will see these kinds of technologies play a greater role in the sector's future."

Potential solutions could include carbon capture and storage, renewable energy technologies and alternative fuel sources like hydrogen fuel cells for truck fleets, to mitigate, not just reduce carbon emissions.

## Advances in ESG

De Beers has also been rolling out technology to support its ESG efforts.

In 2018, the group launched GemFair, a pilot project that creates a secure and transparent route to market for ethically sourced artisanal and small-scale mined (ASM) diamonds. Artisanal miners at participating sites can use a digital toolkit to register the location in which their diamonds were discovered, providing a record of assurance regarding the responsible sourcing of the diamond. The group also uses apps on tablets to offer training on diamond valuation to ASM workers.

For the pilot run in Sierra Leone, GemFair is partnering with the Diamond Development Initiative (DDI) to ensure that participating mine sites abide by a set of audited ethical standards known as the Maendeleo Diamond Standards (MDS), as well as additional standards specific to the GemFair business model.

The aim is to support the ASM sector's drive for formalization and contribute to its development.





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Another exciting project involves the development of carbon capture technology that uses mine waste to absorb CO<sub>2</sub> from the atmosphere. Known as project “CarbonVault,” the technology uses kimberlite to naturally capture large amounts of carbon dioxide from the atmosphere through a process called mineral carbonation.

“Through CarbonVault, we are working in partnership with a team of leading experts from universities around the world to explore how this natural process can be accelerated, to soak up more carbon from the atmosphere, locking it away for millions of years,” Petrie said. “This is the first time such extensive research has been undertaken to assess the carbonation potential of kimberlite and the project has the potential to transform parts of the mining sector as a whole in terms of carbon emissions.”

### Traceability and Trading Post-COVID

De Beers pioneered the use of blockchain technology for diamond supply chain traceability through its Tracr platform, which was launched in 2018. This com-

binates blockchain technology, artificial intelligence, the Internet of Things, and state-of-the-art security and privacy to enable diamonds to be identified and traced from mine to retail.

“Tracr is designed to be an inclusive platform built by the industry, for the industry, to accommodate the full diamond value chain, from large producers to family-owned businesses,” Petrie said. “Tracr is making excellent progress, both in terms of platform development and industry adoption. A beta platform was launched in the fourth quarter of 2019, followed by an enhanced application interface that was launched earlier this year, working toward a full platform launch later in 2020.

“With COVID-19 having a significant impact on retail activities across a range of sectors, we envisage that more and more retail will be conducted online, and this will also be true for the diamond industry.

“Longer term, we see being able to demonstrate transparency and provenance growing in importance, and this is reflected by all the work we’re doing to be able to demonstrate this beyond doubt through platforms like Tracr.”



Gem Diamonds is piloting scanning technology in conjunction with proprietary imaging and sorting algorithms to detect diamonds within kimberlite. (Photo: Gem Diamonds)



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# Customizing Mining Practices Within Health and Safety Management Systems

*HSMS can be used to proactively improve the safety climate and miner performance*

By Emily J. Haas, Ph.D.

A health and safety management system (HSMS) is one of the most effective ways to proactively reduce workplace hazards and minimize the risk of injury or illness occurring on the job. As part of an HSMS process, mining companies are challenged to identify, assess and control risks in the workplace. Although trainings, audits, and individual knowledge and motivation aid in risk identification and mitigation processes, the safety climate, or perceived priority an organization places on safety, can impact worker and work crew awareness, attitudes, and decision making. To put it another way, even the best program can be fallible if a negative safety climate exists.

Specific to mining, the 2013 National Research Council (NRC) report argued that, when it comes to an effective HSMS, considering company safety climate is critical to adequately predict and prevent incidents. That is, if the safety climate improves, an effective execution of an HSMS is more likely. To that end, it is important to understand ways in which mine companies can assess and improve their safety climate.

The National Institute for Occupational Safety and Health (NIOSH) sought to better understand mine employee experiences at their respective operations by way of a safety climate survey that was disseminated between February 2016 and March 2018. The purpose, beyond assessing employee perceptions of safety climate, was to identify safety climate indicators that have a significant impact on employee proactivity and compliance to help tailor and implement an HSMS that can reduce and mitigate risks.

## NIOSH Survey Background

NIOSH developed a 58-question survey that used a six-point scale, with responses ranging from Strongly Disagree (1) to Strongly Agree (6). Each item related to one of a series of constructs, and responses were used to calculate an average score for each construct. The survey measured 10 constructs ranging from organizational and supervisor support to employees' assessments of their own tolerance for risk and thoroughness on

the job. Each construct was then used to determine significant influences on employee health and safety performance using proactivity and compliance constructs. Paper surveys were administered at mine sites that volunteered to participate, often during annual refresher training or pre-shift safety meetings, and took about 15 minutes for employees to complete.

In total, 2,683 workers — both salaried (22%) and hourly (78%) — at 39 mine sites throughout 17 states completed the survey. Among the 39 mines, the following subsectors were included:

- Coal—358 individuals, 13% of the sample;
- Industrial minerals—907 individuals, 34% of the sample; and
- Stone, sand and gravel—1,418 individuals, 53% of the sample.

Regarding experience in the mining industry, 9.3% of the sample had under one year; 18.2% had 1-5 years; 17.4% had 6-10 years; 15.4% had 11-15 years; 9.5% had 16-20 years; and 30.2% had more than 20 years.

## Survey Results

In a survey, initial averages are often calculated to establish a benchmark that can be used to measure improvement. Therefore, in this study, the average was calculated for each of the 10 safety climate constructs (Table 1). A score of 6 represented a higher perception of the construct. In general, most averages were between 4.5 and 5.5, indicating generally positive perceptions.

Next, NIOSH used relative weights regressions to determine which of the 10 safety climate constructs were the most influential on employee proactivity and compliant job performance. The analysis included the ranking of each factor based on its overall contribution to these two outcomes. All 10 safety climate constructs were statistically significant predictors of proactivity and compliance at the  $p \leq 0.05$  level of significance. For easier interpretation, the rescaled relative weights are presented for each predictor in Table 2, which sum to 100% for each outcome.

Safety Climate Construct	Average Score
Risk tolerance .....	5.28
Worker thoroughness.....	5.21
H&S training .....	5.15
Coworker communication.....	5.05
Supervisor support.....	4.85
Supervisor communication.....	4.76
Adaptability .....	4.69
Worker sense of control .....	4.64
Worker engagement.....	4.53
Organizational support/ priority toward safety.....	4.36

Table 1—Average perception of each safety climate construct (ordered from high to low).

## Improving Safety Climate Perceptions

By comparing the averages of each construct (Table 1) with the results of their relative contributions to worker performance (Table 2), it is possible to identify primary and secondary areas of focus and maintenance within companies' HSMS. Figure 1 depicts how the combination of these results map out in a quadrant modeled after former performance research.

**Safety Climate Constructs with Low Gain**  
Organizational support and adaptability had lower averages and demonstrated little support for employee performance. In response to this low impact, these two factors should be considered a lower priority; rather, organizations can first focus their attention on other areas.

**Safety Climate Constructs to Maintain**  
Supervisor support and safety training were perceived as strong constructs among employees but also had little influence over their performance. These two constructs can be monitored for changes in importance over time; however, directing additional attention to these constructs could be considered a waste of resources.

**Safety Climate Constructs to Leverage**  
Thoroughness and coworker communication demonstrated higher perceptions among employees and largely contributed to the proactivity and compliance models. It is important for companies to be consis-



Construct rank	Proactivity rescaled relative weights (%)	Compliance rescaled relative weights (%)
Worker thoroughness .....	20.76 .....	23.10 .....
Worker sense of control .....	17.06 .....	8.70 .....
Risk tolerance .....	13.16 .....	30.60 .....
Worker engagement.....	12.36 .....	5.40 .....
Coworker communication.....	8.88 .....	10.50 .....
Supervisor communication.....	7.36 .....	5.50 .....
Adaptability .....	7.14 .....	2.60 .....
Supervisor H&S support .....	6.07 .....	4.60 .....
H&S training.....	5.65 .....	5.30 .....
Organizational H&S support.....	1.57 .....	3.80 .....

Table 2—Weighted impact of safety climate constructs on mineworker proactivity and compliance.

tent within their HSMS practices to support the promotion of these constructs.

**Safety Climate Constructs to Address**

Supervisor communication, employee engagement, and sense of control revealed low perceptions among employees, but carried a high weight in employee performance and, as a result, should be priorities to address through organizational-level interventions. Additionally, although risk tolerance had a high average, this construct is an emergent state that can quickly change. As a result, it may be beneficial for organizations to continually monitor and improve risk assessment processes due to their high predictive utility for worker performance.

**Key Takeaways**

Results of this NIOSH study show intervention areas within an HSMS that, consequently, may improve safety climate perceptions and outcomes. When incorporating any of the suggested practices into an HSMS, it is important to keep in mind that workers' personal factors had a larger impact on performance. However, these personal factors can be influenced by organizational characteristics such as granting

decision-making authority, providing opportunities to use knowledge and skills, and promoting mechanisms to equally participate. Examples are discussed below.

**Improving Communication Practices**

Supervisor communication has been encouraged as an effective mechanism to enhance workers' awareness of safety and appropriate response to risks. Employees who participated tended to view the resources or tangible aspects of job support to be higher than supervisors' intangible contributions such as consistent, frequent and informative communication. These types of communication practices have been analyzed to show what types of information and resources mineworkers prefer on the job, including being visible and engaging in positive monitoring and feedback.

**Going Beyond Annual Refresher Training**

Perceptions toward training were high, but had minimal weight on workers' actual job performance. Other research has also shown that using training to address employee compliance is an ineffective use of resources. Therefore, rather than more training, improving the follow-up and communication that takes place when training commences can be considered. Also, mine

operations have been successful in improving micro-learning opportunities on the job that further develop soft skills.

**Finding Worker Engagement Opportunities**

The current results support that training is not an influential predictor of employee performance and that employee engagement is a critical construct to fix; therefore, identifying areas where employee involvement can be improved is important. For instance, seeking employee input before purchasing new or different models of personal protective equipment such as safety glasses or reflective vests, creating and involving hourly employees on different workgroup committees, and improving walkaround communication efforts throughout the day were methods identified by companies participating in the survey.

**Monitoring and Addressing Risk Tolerance**

Risk tolerance was a significant predictor of workers' compliance on the job. In general, most operations have mechanisms in place for hazard identification so, rather than build knowledge around hazard recognition and risk perception, more attention should be given to the decision-making process that is influenced based on tolerance for risk. In other words, mineworkers "should be empowered with knowledge, skills and abilities, rather than 'trained,' to recognize and mitigate hazards." An example of such processes has been undertaken by some operations.

The NIOSH survey results revealed a way to advance beyond the findings of previous studies, which have found that, in the absence of empirical data to lean on, HSMS resource allocations are often made based on feeling or intuition. By empirically exploring the ranked importance of safety climate constructs, NIOSH moved the pendulum in the right direction so that mine practitioners can make decisions based on science rather than on guessing or relying on former experience. Practitioners can use the current results to better prioritize actions as implemented via the HSMS to improve outcomes.

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**Disclaimer:** The findings and conclusions in this paper are those of the author and do not necessarily represent the views of NIOSH or CDC. Mention of any company or product does not constitute endorsement by NIOSH.

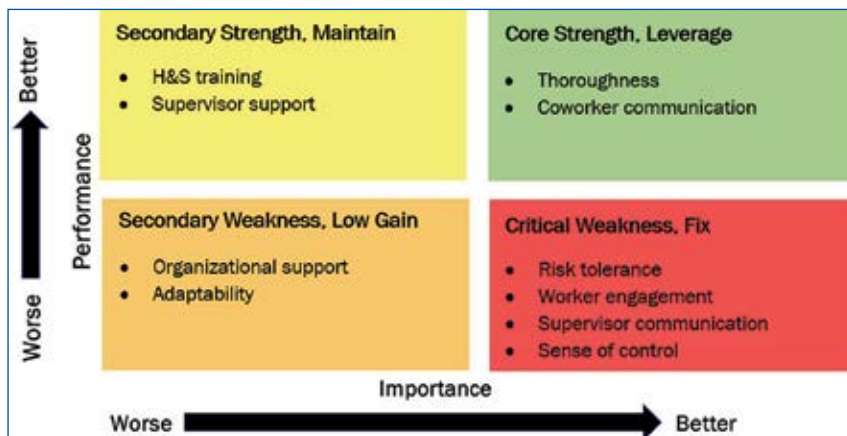


Figure 1—Prioritizing improvements in safety climate constructs.

# Coronavirus Sanitization Strategies, From Site-wide to Single User



The line of DustBoss atomized-mist dust-control cannons produced by BossTek can be conveniently converted for use to broadcast Surface Disinfectant Cleaners (SDCs) for large-area sanitation purposes, according to the company.

In the industrial world, unprecedented challenges often spawn innovative solutions, and recent reports from industry suppliers highlight interest in the growing need for effective microbe disinfection procedures for applications ranging from large public areas to individual personal hygiene. Two examples:

The need to find an effective means of achieving wide-area suppression of surface-borne microbes such as the novel coronavirus — also referred to as SARS-Cov-2 or COVID-19 — has been a growing concern for both private industry and public works. BossTek, an Illinois, USA-based dust-suppression systems supplier, recently announced its atomized mist technology is now being used for distribution of Surface Disinfectant Cleaners (SDCs) over worksites, busy foot traffic areas and communal spaces. The company's line of DustBoss industrial misting cannons — high-powered machines designed for large-area dust con-

trol — are playing a significant role in this effort, including the use of a DustBoss unit at a copper mine.

“The challenge is protecting workers and the public in outdoor spaces by the most effective means possible, using technology that requires the least amount of human contact,” BossTek Vice President of Sales Mike Lewis said. “Sending crews of people out on a regular basis to clean publicly accessed surfaces is inefficient, costly and exposes the workers to potential contamination. Studies have shown that the distribution of SDCs evenly across surfaces can effectively reduce the presence of viral and bacterial microbes to mitigate the spread of disease. Atomized mist has proven to be a very effective distribution method.”

Lewis said the company has also supplied equipment for large operations such as mines and material processing facilities that are sanitizing work surfaces before employees return to work. “We’re even

seeing some customers who aren’t back up and running yet, but they’re repurposing their machines to help out other businesses or municipalities, loaning out the equipment to help protect others,” he added.

The World Health Organization (WHO) differentiates cleaning from disinfecting by defining cleaning as “the removal of visible dirt or particles,” whereas disinfecting “refers to specific measures taken to control, deactivate or kill infectious agents, such as viruses and bacteria.”

A study testing the effects of SDCs on infectious viruses (Ebola) conducted by the School of Engineering at Tufts University found that “the use of just 0.5% chlorine solutions with a 15-minute exposure time is effective in reducing transmission risk.”

When distributing the proper mixture and dosage to an area during low traffic times, property owners can significantly mitigate the potential risk, according to BossTek, which explained that atomized mist technology disperses millions of tiny treated water droplets over a wide area to achieve effective coverage. Barrel-shaped DustBoss cannons force water through a circular brass manifold fitted with atomizing spray nozzles that fracture the water into tiny droplets 15 to 200 microns in size. The midsized model has a reach of up to 200 ft (60 m). Using a 25-hp fan that produces 30,000 cfm (849.50 cmm) of airflow, the droplets are propelled outward in a cone-shaped pattern. With the adjustable 0 to 50° angle and 359° oscillation settings, the largest model in the line can cover up to 280,000 ft<sup>2</sup> (31,000 m<sup>2</sup>) — nearly six football fields, according to the company.

The atomized misting cannons can be mounted on water trucks or configured in the company's Fusion configuration, which includes a trailer-mounted cannon and genset, an effective delivery system for large-scale disinfecting work that's portable by a pickup truck.

The company told *E&MJ* a South American mine has deployed a DustBoss for disinfecting purposes. The site, located in the Ica province in Peru and approx-





Hand-wash stations can be installed directly to a truck frame, chassis, box, or flatbed, allowing for nearly universal install on a variety of commercial vehicles, according to supplier National Fleet Products. Frame kits are also available for free-standing use.

imately 500 km from Lima, is close to the famous Nazca Lines (a group of large geoglyphs formed by depressions or shallow incisions in the soil of the Nazca Desert). The open-pit copper mine is currently using one DustBoss DB-100 cannon for large-scale sanitization on-site and within the local area. Six additional units (DB-60s and DB-100s) are also installed at the mine and used for dust control.

In collaboration with Americorp, the Latin American dealer for BossTek equipment, the mine was able to source two 275-gallon (1,000-l) tanks and a generator, which were mounted on a truck with the cannon to provide a completely mobile solution. The company said DustBoss units can be easily modified to disperse disinfectant, and any mine currently using DustBoss equipment that is interested in this type of application can contact BossTek for assistance.

**Mobile Sanitization Station**

Another U.S.-based supplier, National Fleet Products, called attention to the availability of portable, vehicle-mounted hand-washing stations. The company said its stations' purpose-built product design allows water and hand sanitizer to be dispensed virtually anywhere, and application-specific hardware enables units to be free-standing or mounted to a wide variety of vehicles.

The black or translucent-white water-dispensing tanks come in 6.5- and 10-gallon (25- and 38-l) sizes and are made of UV-resistant polypropylene. An integrated removable soap dispenser serves as the cap to the filling port, and a separate cap is also available. Spring-toggle water spigots automatically stop water flow when no longer depressed, thus eliminating a cause of recontamination because there is no need to touch them again once hands are clean. The spigots are recessed and side mounted to protect them from damage.

Portable units are available with powder-coated steel frame stands that can be outfitted with additional accessories such as paper towel dispensers, graphic signage and more. Vehicle-mounted units are available with frame- and body-mounting hardware that is compatible with virtually any type of truck, according to the company, which said the new units meet U.S. Occupational Safety and Health Administration (OSHA) requirements for hand-washing stations.

**Laser-based Warning Limits Portal Blockages**

Autonomous solutions specialist RCT, in response to requests from mining clients, said it has developed a unique warning system designed to prevent oversized equipment from getting stuck in underground mine portals.

Staff from RCT's branch in Kalgoorlie, Western Australia, were separately approached by two major gold-mining clients and asked to devise a solution to prevent portal blockages, which can severely disrupt regular mining operations. Branch technicians subsequently produced the Over Height Portal Warning System, which consists of a laser mounted at a particular height connected to a unit placed at the portal entrance. The unit produces an audible alarm and flashes stop to alert machine operators and nearby site personnel to a potential over-height hazard.

Site personnel are able to determine the system's field of view and isolate areas such as a corner or pole so the system will only activate when it senses new objects.

RCT Kalgoorlie Branch Manager Rick Radcliffe explained, "Occasionally, underground haul trucks try to re-enter the portal with their trays accidentally in a raised position and this causes the trucks to get wedged in the portal. The time needed to dislodge the haul truck from the portal is very costly to the mining operation. Therefore, the Over Height Portal Warning System is a cost effective and easy solution that will help keep mining operations running smoothly."

RCT said since its development, the Over Height Portal Warning System has been sold to 10 mine sites throughout Western Australia's Goldfields district.



This laser-based warning system developed by RCT warns drivers that the equipment they're operating may be too tall to enter the mine portal, a common problem encountered when drivers forget to lower the truck body on re-entry.

# Cadia Partners in Remote-Control Rock-Breaking Trial



Above, Cadia's secondary break trial using MacLean's Auto Explosive Loader enabled with Orica's WebGen wireless technology. (Photo: MacLean Engineering)



Above, the Auto Explosive Loader drilling a rock and pushing wireless explosives into the hole. (Photo: MacLean Engineering)

A "safety-driven initiative" was tested successfully at Newcrest Mining's Cadia Valley Operations site using remote drilling, loading and wireless blasting of oversized rocks.

The 30-day trial evaluated new technology from MacLean Engineering's secondary break drill-and-blast system (Automated Explosive Charger) and Orica's Wireless Blasting System (WebGen 100) in an isolated area.

Secondary break activities are used when oversized rocks block material from flowing through the draw points in caving operations or when they are deemed too large to pass through the jaws of the primary crusher underground. Many oversized rocks can be dealt with by preparation loaders or rock breakers; however, some of these situations require blasting, and workers need to access the area to wire the charge.

MacLean's secondary break drill-and-blast system removes workers from secondary break activities through the development of a prototype "bolt-on" piece of equipment, which is attached to existing secondary break drill rigs. This Auto Explosive Loader can drill a hole in a rock and push the wireless explosive inside the hole without the operator leaving the cab of the drill rig. The operator can then remove the drill rig, leave the area and remotely detonate the explosive, using a wireless device manufactured by Orica.

Cadia Acting General Manager Aaron Brannigan said the trial was successful and Cadia was able to meet the key objective of testing the machinery that eliminates human interactions on foot while working near an active draw point. "The trial has demonstrated the opportunity for significant safety benefits through eliminating human exposure to the major hazards associated with secondary break activities," Aaron said.

MacLean Vice President of Product Management Patrick Marshall said finding safe and efficient ways to introduce remote or autonomous fleet operations is a key area of technology development at

MacLean, and partnerships with customers and other manufacturers are a critical part of the success of this product development and commissioning process.

The next step will be a more comprehensive trial in a real-life production environment to further assess the safety aspects and productivity of the secondary break system.

## Epiroc Wins Chuqui Order

Epiroc was awarded a large equipment and service order from Codelco for use at Chuquicamata mine in northern Chile. Codelco ordered underground loaders, face drill rigs, rock bolting rigs and mine



Epiroc lands a large equipment and service order from Codelco's Chuquicamata underground project. Above, a Minetruck MT65. (Photo: Epiroc)



trucks, as well as several years of technical support and training, for use at the Chuquicamata underground mine project. The order is valued at more than \$20 million and was booked in April.

Codelco said Epiroc won the contract by complying with all technical, safety and performance requirements. It is “the supplier that provided the best economic proposal for all its equipment as a whole,” Codelco sourcing manager, Juan Mariscal, said.

The order includes multiple units of the Scooptram ST1030 and ST18 loader, the Boomer S2 face drilling rig, the Bolt-ec M bolting machine and the Minetruck MT65. The machines will be equipped with 6th Sense solutions for automation, connectivity and information management. Delivery of the equipment will take place later this year.

The order follows the signing last year of a large contract for service at Codelco's Andina mine, and a large order for equipment used at its El Teniente mine.

## Salares Norte Orders Outotec Mills

Outotec was awarded a contract by Gold Fields for the delivery of process equipment to their Salares Norte greenfield gold project in the Atacama region of northern Chile. The contract value is approximately \$15.9 million.

The scope of work includes the design and delivery of one 4-megawatt (MW) SAG mill and one 4-MW ball mill as well as five thickeners and one clarifier to be used in different process phases.

The mills are provided with Outotec's Polymer Hydrostatic Shoe Bearing system, which is fitted to all new Outotec grinding mills. The system is designed to maximize grinding mill availability and simplify maintenance. Both thickeners and clarifiers are Outotec's modular designs that enable minimized site installation time.

Outotec said it was “pleased to deliver our energy efficient and advanced process equipment to Gold Fields and support them in building profitable and sustainable operations in a challenging high-altitude location.”

Gold Fields is the 100% owner of the Salares Norte project. Once operational, the concentrator will have an average annual throughput of 2 million metric tons (mt) of ore. The equipment is planned to be delivered in Q2 2021.



Zijin Mining's Veliki Krivelj adopted ABB dual pinion mill drives and other solutions that offer frozen charge detection, controlled roll back, automatic positioning, variable speed and cascade monitoring functionalities. (Photo: ABB)

## Zijin Appoints ABB to Modernize Serbian Copper Mill

ABB reported it entered an agreement with Zijin Mining Group to install mill equipment control technology to Veliki Krivelj copper mine, a surface mining operation with an annual ore processing capacity of 2.5 million metric tons (mt).

ABB will provide ring-gear mill drives and intelligent control systems for one SAG mill (2 x 6.5-megawatt [MW]) and one ball mill (2 x 7.5 MW), including electric control systems, drives, motors, transformers and end-to-end services, which will increase productivity, reduce downtime and boost energy efficiency.

As part of a modernization project, the solutions will help optimize the performance of the mill, ABB said. “ABB's mill solutions reduce energy consumption, reduce mechanical stress, improve the service life of equipment and boost operational performance,” said Stephen Zhu, lead of ABB Mining, North Asia and China.

ABB has worked with Zijin Mining since 2018, the company reported.

Located in Borski, Serbia, Veliki Krivelj was acquired by Zijin Mining Group in 2018 as part of a deal with the Bor copper mine, which included three open-pit mines, an underground mine and a smelter. The \$350 million investment is one of China's largest investments in Serbia to date. Zijin Mining

Group expects to invest \$227 million to transform and expand the existing production capacity of Serbia's Bor copper mine and smelter.

## Metso, Outotec Receive Approvals for Merger

Metso reported it and Outotec have received all regulatory approvals for their merger, which was calendared for completion on June 30.

Upon completion, Metso will be renamed as Neles Corp. and it will be a separately listed entity focused on flow control.

Separately, Outotec reported it completed divestment of certain municipal and industrial sludge incineration technologies to Küttner Martin Technology GmbH, based in Germany. The transaction was first announced in December 2019, and both parties agreed not to list its value.

## Wenco Joins Oxbotica on Automation

On June 10, mine fleet management specialist, Wenco International Mining Systems, and U.K.-based autonomous technology provider Oxbotica, announced a Memorandum of Understanding to develop an open-autonomy solution for mining.

The companies said the open-autonomy solution will provide customers flexibility and efficiency in the deployment of autonomous mining equipment,



Wenco International and Oxbotica sign a MOU to develop an open-autonomy solution that will empower users to adopt autonomy technologies different from the OEM equipment to which they will be deployed. (Photo: Wenco)

allowing them to operate any open standard-based vehicle and integrate it into their existing fleet.

This approach avoids vendor lock-in and offers customers the freedom to choose preferred technologies, independent of their primary industrial systems.

Wenco is a wholly owned subsidiary company of Hitachi Construction Machinery (HCM), and the announcement builds upon the two companies' vision of an open autonomous ecosystem for mine sites that was first announced by HCM at the May 2019 CIM conference in Montreal, Canada.

Oxbotica was founded in 2014 at the University of Oxford to develop an autonomy software platform that enables faster deployment of industry-specific autonomy applications. Its mining solutions combine advanced robotics, artificial intelligence and computer vision to change the way vehicle fleets operate.

For more on this story, visit the *E&MJ* website: [e-mj.com](http://e-mj.com).

### Hitachi Offers Online Training

Hitachi reported it is offering Virtual Instructor-Led Training available to customers anywhere and via a laptop with internet.

From a training center in Davenport, Iowa, Hitachi mining product experts will run the online classes.

Hitachi said an expansion of global markets presented the need to reach more people and provide learning opportunities. "Our goal was to create an interactive training experience for customer and dealer technicians that meets and, in some cases, may exceed our current instructor-led training," Kendall Mattson, instructional team lead, Hitachi, said.

The classes use live-streaming video, interactive activities, poll questions and testing. Reduced training costs is a big

benefit, Patrick Hathaway, instructor, Hitachi, said.

"We're able to conduct training at a lower cost for the dealers and customers," he said. "There's a lower cost for the course and no one has to travel to a training even."

### Astec Closes Telsmith Plant

Astec Industries announced it will cease production at its Telsmith manufacturing facility in Mequon, Wisconsin in mid-August. The closure will occur in phases starting then and ending March 31, 2021.

Astec described the decision as difficult but necessary for optimized efficiency, flexibility and growth.

"We are incredibly proud of the strong brand and innovative products we have built with Telsmith, and I want to assure our customers that we will continue to grow the brand," Astec Industries President Barry Ruffalo said.

The Telsmith product line will continue to be developed and manufactured at other Astec locations.

### Hexagon, Proudfoot Form Mining Partnership

Hexagon Mining and Proudfoot partnered on a safety-driven solution for mining companies seeking to attain zero-harm. By combining safety technology with a people-centric change methodology, the solution will help to de-risk mine operations, Hexagon reported.

Hexagon reported the solution would help miners find the optimal balance between safety and productivity. "There's nothing more powerful to me than knowing that our technology truly is saving lives," Hexagon Mining President Nick Hare said. "Together with Proudfoot, we can ensure our solutions are backed by a proven people-centric change methodology. Zero harm demands nothing less."

### Thompson Turns 50

Thompson Pump and Manufacturing Co. announced it is celebrating its 50<sup>th</sup> anniversary in business. The company started as a dewatering contractor founded by a NASA engineer and servicing the construction market in the Southeast region of the U.S. The company eventually jumped into pump manufacturing and sales.

One of the company's founders, Bill Thompson, said the company enabled him to live the American dream. "Reaching the milestone of 50 years is very gratifying for



From a training center in Iowa, Hitachi will run online training sessions. (Photo: Hitachi)



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Thompson Pump and Manufacturing Co. celebrates 50 years in business in 2020. (Photo: Thompson Pump and Manufacturing Co.)

me, the entire Thompson family, and the folks who stood side-by-side with us serving our customers and building our company.”

Thompson attributes the company's success to the family and the company's long-time employees. “Their contributions to our success cannot be overstated.”

### CR Renames Divisions

CR, formerly known as CQMS Razer, announced it relaunched its strategic direction and brand. In so doing, it renamed its product divisions to better align its portfolio to the needs of customers.

The divisions are: CR Mining, CR Digital and CR Contracts.

The acquisitions of Seattle-based Thunderbird Mining Systems, a developer of market-leading blasthole drill optimization technologies, and California-based Berkeley Forge & Tool's mining products business in part prompted the move, CR said.

“Our experience and passion for what we do, has seen us develop our business and become to a leader in our field, delivering outstanding results for our customers,” CEO John Barbagallo said. “This is a reputation we are keen to foster and build upon with our customers and markets worldwide under the new CR name.”



TECHNOLOGY DEFINING PRODUCTIVITY

### ERIKS, Fenner Partner on Conveyor Solutions

ERIKS North America and Fenner Dunlop partnered to provide conveyor belting products and services to industrial customers in northern California and Nevada.

Leadership at the former said the latter are producers of the industry's longest-lasting conveyor belting products.

“Now, through this partnership, customers in California and Nevada can gain the benefit of uniting their industry-leading materials with our high-quality conveyor components, all with the comfort of knowing that both are backed by our world-class installation and repair services,” Scott Holquist, vice president, conveying systems products, ERIKS North America, said.

ERIKS North America's local service crews deliver an array of installation, troubleshooting, preventative maintenance and downtime services.

### Puck Enterprises Acquires Competitor

Puck Enterprises announced the acquisition of U.S. Coupling & Accessories, Inc.

Puck Enterprises is a liquid-transfer equipment manufacturer. U.S. Coupling & Accessories is a hose connection and fittings manufacturer. Leadership and the team of the latter will remain unchanged at their headquarters in Dothan, Alabama.

The acquisition will give Puck Enterprises and subsidiary Bulldog Hose Co. better control over their respective product lines, the company said. “We have been longstanding customers of U.S. Coupling and our businesses really complement each other,” Puck Enterprises CEO Jeremy Puck said. “U.S. Coupling doesn't just bring the best couplings and fittings, they bring time savings, unrivaled machining

capabilities, and they bring brilliant talent that will allow us all to continue advancing the markets we both already serve.”

### Partnership Advances Battery Research

NOVONIX and Professor Mark Obrovac of the Research Group at Dalhousie University announced it can manufacture single-crystal NMC cathode material using its patented Dry Particle Microgranulation technique.

Single-crystal cathode materials are reportedly able to outperform traditional polycrystalline cathode particles and, therefore, are in demand by the lithium-ion battery industry, NOVONIX reported.

NOVONIX said the single-crystal NMC cathode material could aid in the development of lower-cost, higher-performance battery materials. “The single-crystal cathode development complements NOVONIX's PUREgraphite anode product, both addressing the ultra-long-life battery performance requirements critical to the achieving the million-mile battery life being sought by leading EV automakers,” NOVONIX Managing Director Phil St. Baker said.

### Stellar Turns 30

Stellar Industries, based in Iowa, U.S., announced it celebrated its 30<sup>th</sup> anniversary in early May. Stellar began as the first U.S. corporation to design and manufacture a hydraulic hooklift hoist. Since its inception, Stellar has added the design and manufacture of numerous products, including mechanics trucks, service cranes, mobile drawer systems, commercial tire service trucks, lube systems and fuel trailers.

Although they may not have been able to gather in celebration this year, Stellar Industries employees spent the week celebrating with their team and community through videos, photos, and trivia on their social media channels.



Before the coronavirus pandemic, the Stellar crew toasts 30 years in business. (Photo: Stellar Industries)





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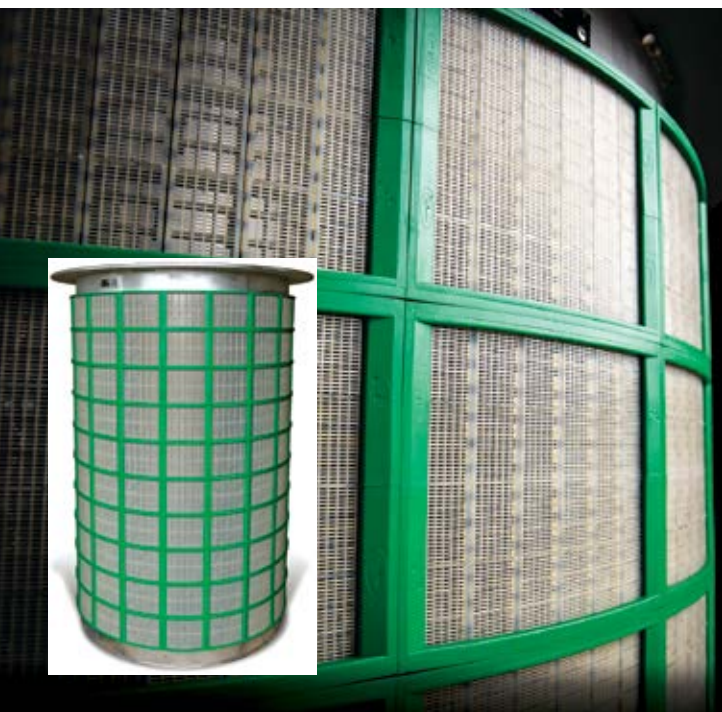
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# Derrick Introduces G-Vault



G-Vault screens are available in various sizes with screen apertures up to 1,200 microns, and are designed to be bolt-in replacements for wedge-wire units.

Derrick Corp. recently introduced the G-Vault polyurethane interstage screen for carbon in pulp/carbon in leach (CIP/CIL) and resin in leach/resin in pulp (RIL/RIP) processes at gold recovery plants. Due to the abrasion and blind resistance of the polyurethane material, the new interstage screen reduces maintenance by eliminating the frequent washing and unblinding procedure required for stainless-steel wedge-wire screens. G-Vault screens are available in a variety of sizes, with screen apertures ranging from 500 to 1,200 microns.

The G-Vault Interstage screen is a direct bolt-in replacement for the existing wedge-wire screens but allows reuse of the operating mechanism. The retrofit involves replacing the wedge-wire screen with the G-Vault screen and then lowering the module back into the tank. Derrick said the G-Vault offers higher open area than wedge-wire screens — in some cases, more than 20%. Combining the wear resistance and non-blinding characteristics of Derrick's polyurethane, the G-Vault screen produces the same micron consistency as wedge-wire screens with reduced process interruptions and extended intervals between cleaning cycles.

The G-Vault is composed of several independent screen sections retained in a 304 stainless steel cage. Derrick explained that the use of replaceable screen sections reduces maintenance costs by permitting replacement of only the heavily worn sections, rather than an entire screen.

Field testing conducted in six countries in North and South America, as well as Asia, has demonstrated that G-Vault screens can reduce maintenance and attendant costs,

while increasing throughput. In some applications, run times without periodic cleaning cycles have extended beyond 18 months, according to Derrick. And, while initial cost is higher than wedge wire due to its significantly lower maintenance costs, the G-Vault has been shown to produce a favorable return on investment (ROI) for mine management.

Jeremy Rozelle, senior metallurgist at OceanaGold's Haile gold mine, offered his experience with the Derrick G-Vault screens. "After the first checkup at six weeks, the determination was made to replace all interstage screens at our operation with the Derrick G-Vault baskets," Rozelle said. "This decision was based mainly on performance. During the first six weeks of the trial, neither basket had to be pulled by operations for any reason. Performance in the circuit went up, while also allowing operators to focus on other tasks. The wear on the screen panels tested was minimal to none over the trial."

## Critical Metals Recovered From Low-grade Material

Critical and economically significant metals such as cobalt and nickel can be recovered profitably from metal refining wastes as well as ores with lower than usual concentrations, according to the results of an European Union study coordinated by VTT Technical Research Centre of Finland.

VTT reported that the recently completed European METGROW+ project identified methods to increase Europe's self-sufficiency in critical commodities, including cobalt, nickel and zinc, by 10%-20% using only the material streams studied in the project. The developed methods can additionally be used to recover metals from other material streams, according to VTT, which noted that various stakeholders interested in using low-grade ores and waste can evaluate the valorization of raw-material streams with a web tool developed in the project.



European research organization VITO, a METGROW+ participant, reports it validated heap leaching of a Cr/Ni-rich sludge in a 1-m<sup>3</sup> fully automated setup with recirculation of the leaching solution and continuous pH and redox adjustment.



The METGROW Calculator web tool is intended to support decision-making by European mines, mining technology developers and others. The user can enter, for example, local laterite ore or jarosite from the zinc industry as a raw material and assess the options for utilizing the raw material stream in relation to local waste and energy prices.

“We developed and compared different methods for recovering metals from metal refining waste sludges as well as from low-grade ores whose metal concentrations have been considered too low for profitable recovery. We paid particular attention to the profitability and environmental impact of the methods. By developing new and combining old methods, we found new ways to increase the recovery of cobalt, nickel and zinc, among others,” VTT Päivi Kinnunen said.

“The potential of low-grade ores, wastes and side streams is now easier to discern as we know the kind of metal concentrations they have, and which methods are suitable for recovering those metals. Even a smaller side stream from a large mine or metallurgical plant can prove to be a significant business for another company,” Kinnunen explained.

According to VTT, some 19 companies, research organizations and universities from nine EU countries joined in the four-year €7.9 million (\$8.8-million) project, with R&D activity divided among the participants according to expertise in methods and materials. The research also considered local waste costs and energy sources — factors that can influence profitability and environmental impact of the methods in each country.

## Metso Unveils Plant Configurator Tool, Expands Wear-parts Production Capacity

Metso has introduced a drag-and-drop 3D crushing and screening plant configurator that it claims will enable mining customers to design more productive and efficient plants through real-time insights. The design and simulation tool, called My Plant Planner, is available on metso.com and is free to use.

Guillaume Lambert, vice president of crushing systems at Metso, said, “Our aim is to help our customers easily test different configurations and operating conditions to see how they affect process performance. The tool allows you to either design and simulate a new crushing and screening plant in 3D or test how upgrading your current equipment can improve performance.”

Metso said users of the tool, which is based on the company’s proprietary VPS and Bruno software, can design and simulate an ideal crushing and screening circuit in 3D and download a detailed report of the designed plant. The configurator, according to the company, helps users predict power consumption by the system and check the circuit’s footprint.

Users can choose among various crushers, screens and conveyors to design a balanced system and identify bottlenecks. System capacity, load, and power draw are revised in real time as the circuit is designed and the parameters updated. At any point, users can download a report that compiles detailed information about the selected crushers, screens, conveyors and their parameters, including power consumption.

Metso also reported that as part of an initiative to enhance its wear-consumables product range and production capacity, especially in larger part sizes, it recently installed a mega-sized compress press at its Trelleborg factory in Sweden. Due to the COVID-19 outbreak and related travel and site visit restrictions, a dedicated team at the Trelleborg factory performed the installation with the help of online remote support from the supplier’s experts in Australia and China.

Metso said along with increased production capacity, the modular press will expand the range, sizes and types of products manufactured, including items such as mill-lining wear parts that weigh up to 8 tons. Production from the press was scheduled to start in May and is the first in a series of three similar machines with a total value of €10 million.

Metso said travel restrictions and employee safety measures created a need to find a workable and safe way to install the new press. The installation was monitored remotely by the supplier with dedicated installation support hubs in Australia and China. The team in Trelleborg used headsets and wearable video cameras, and the installation area was equipped with video cameras, enabling continuous online guidance and instructions.

The Trelleborg unit produces rubber and poly-met wear parts used in the mining industry. Metso operates 11 factories manufacturing synthetic solutions globally, and said it plans to open a new factory for mining consumables wear parts in Lithuania in 2020.



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# Stage V LHD Offers 285 kW and 9-m<sup>3</sup> Bucket



GHH launched the LF-14 LHD with a Stage V engine. Previously released in 2018 with Stage IIIA and IV engines, the unit now comes with a Volvo TAD1381VE engine option. It offers 285-kilowatt (kW) power, with SCR and DPF exhaust systems.

The LHD carries a 14-ton payload in an up to 9-m<sup>3</sup> bucket. It is 11 m long, 3 m wide and 2.4 m high. It can be used in both hard rock and soft rock applications. The company reported it has the best power-to-weight ratio in its class.

For three-pass loading, the LF-14 is ideally paired with the company's MK-42

dump truck, which comes standard with a Stage-V, 460-kW Mercedes OM473 engine.

The company offers consulting, after-market support, parts sales and technical training.

[www.ghh-fahrzeuge.de](http://www.ghh-fahrzeuge.de)

## Test Shows Spiral Increases Recoveries

Multotec reported it developed and successfully tested the Multotec SC25 spiral concentrator, which eliminates beaching and enhances recoveries in the 1-mm to 3-mm fractions of high density materi-

al. The company described the spiral as a “game changer” in the recovery of the minus-1-mm fraction in ferrochrome slag.

In testing, the spiral, which features steeper angles that facilitate the flow of material and increase separation efficiency, enabled extraordinarily higher metal recoveries, Multotec reported.

The spiral uses no electricity and is easy to maintain, the company reported.

The SC25 is an alternative to jigs in the minus 3- to plus 1-mm range. Benefits include increased efficiency and recoveries.

The first commercialized order has already been placed, Multotec reported.

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

## Lithium Demand Ups Demand for Filters

Eriez reported strong demand for its Dry Vibrating Magnetic Filters (DVMFs) due to an uptick in worldwide lithium production for batteries. The filters are designed to remove very fine iron-bearing contaminants from hard-to-flow powders, such as lithium, the company reported.

Lithium producers usually pulverize lithium and it goes to the users as a fine powder. Producers typically position DVMF units prior to and after mill processing. Some users apply a filter to the product received.

The standard DVMF consists of a solenoid electromagnet, which generates





a magnetic field into the bore of the separation zone. A filter element in the separation zone concentrates the magnetic flux of the field. This produces collection zones, which capture magnetic contaminants as feed material filters through the element.

Eriez said DVMF sales are climbing in Argentina, Australia, Canada, Chile, China and the U.S.

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

## Modular Crushing Stations

Metso introduced FIT stations and Foresight stations, modularized crushing stations that focus on CAPEX reduction and shorter lead times.

FIT stations are designed with the focus on speed and flexibility. The two FIT stations, the Recrushing and the Jaw station, both fit into containers and require relatively limited welding to set up. Container delivery reduces delivery time by up to 25%, the company reported.

The Foresight stations are equipped with smart automation technology, including Metso Metrics, VisioRock, level sensors and a variable frequency drive. Foresight stations offer optimized speeds, preventative maintenance capabilities, and optimized production, the company reported. The MP cone crusher station

features a scalping MF screen and an MP Series cone crusher.

FIT and Foresight stations come with proven Metso equipment and technology to deliver maximum productivity for even the most demanding mining applications, Metso reported.

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

## Valve Redesign Offers Safety, Less Leaks

Flowrox announced a new design for the Slurry Knife Gate that eliminates the valve's cylinder tower and instead puts two actuator cylinders on each side of the valve. With the new design, the valve's body is now cast in one piece.

Without the tower, which can have a high center of gravity, the valve is easier to handle, more stable during assembly, easier to access for maintenance, and safer, the company reported.

With the actuator cylinders, all maintenance access points are less than 2 m from the ground, making them more easily accessible. Compare that to 3 m to 4 m above the ground, as was the case with the old design.

With the new valve body, there are less chances for leaking, and there is reduced bolting during maintenance, Flowrox reported.



The DN 900 to 1500 valves can handle pressures from 10 and down to 4 bar, depending on size. There are flange drilling options.

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

## Reliable 6-in DTH Hammer, Bits

Varel introduced the Warrior DTH product line, starting with a 6-in. hammer the company described as a reliable workhorse, and a range of QL60 shank bits for it.

The hammer features a robust piston, an optimized air cycle, simple design and premium quality, the company reported. The bits offer an optimized design, a wear-resistant steel body, exacting manufacturing, and are constructed of premium tungsten carbide for longer life, Varel reported.

The hammer is 150 mm in diameter, 1.2 m in length, weighs 92 kg, and accepts bits in the 152- to 203-mm range.

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



## Conveyor Bearings for High Peak Loads

SKF announced the UC 300 ball bearing units, which the company reported feature superior sealing and stronger locking, and are interchangeable with all Japanese-Industrial-Standards-compliant housings.

The UC 300 is ideal for use in highly contaminated industrial environments, the company reported. Designed for applications with



higher peak loads and lower rotation speeds, each unit features a grub screw locking system set at an angle of 62°, which gives optimal holding power.

The units are available with bores ranging up to 100 mm. Typical applications include conveyors, belt-pulley and chain transmissions, and cranes.

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

## Oil Property Sensor for Machinery

TE Connectivity released the FPS2800 oil property sensor for monitoring industrial machinery and off-road vehicles. Installed directly on the equipment, the FPS2800 helps determine the correct time to change the oil and detects system issues that could lead to higher damages. It measures dynamic viscosity, density, dielectric constant and temperature, the company reported. Standard port connection and CAN protocol makes installation simple, TE Connectivity reported.

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



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## Composites for Belt, Chute Repair

Belzona spotlighted the 2311 elastomer and other similar solutions for repairing rubber for use on, among other things, conveyor belts, chutes and hoppers. Typically, they applied in situ and without specialist tools, eliminating the need for hot work. Rapid cure times mean that emergency repairs can be carried out with minimal downtime, the company reported. Once cured, the composite provides pressure, impact and vibration resistance.

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

## Dynamic IoT Monitoring Solution

ClearBlade and MultiTech announced their joint out-of-the-box Industrial IoT smart monitoring solution, which they described as configurable, scalable, secure and affordable.

The solution leverages MultiTech's gateway and Clearblade's software platform and is managed by a single dashboard or streamed into existing systems.

Benefits include multiple profiles, an industry-leading battery life, extreme configurability, enterprise integrations,

easy data sharing, simple rule configuration, and remote configurability, ClearBlade reported.

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

## Mapping, Data Collection Software

Juniper Systems introduced Uinta Mapping and Data Collection software, described as a powerful, hassle-free data collection software.

Uinta's data collection tools include detailed mapping with points, lines, areas, as well as form-based notes for digital recordkeeping. Top benefits include efficient data capture, professional mapping, ease of use, and live support, the company reported.

Customization options allow organizations to create templates based on data type and which can be shared.

The software is designed for a Mesa 3 Rugged Tablet running Windows 10 and a Geode Sub-meter GPS Receiver.

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



## Dead Bed Nuts Increase Wear Life

CMS Cepercor introduced Dead Bed Tear-drop Nuts. The style-cast manganese steel nuts suit Symons Nordberg cone crushers.

The nuts offer improved weight distribution over the OEM design, and ensure safer maneuvering and handling, the company reported. They also offer increased wear life.



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Red Valve's Series DX Slurry Knife Gate Valve is the most durable and user-friendly valve for difficult slurry applications. The fully elastomer-lined DX prevents slurry build-up or dewatering by eliminating the seat cavity. Reinforced elastomer sleeves seal against each other, providing a 100% full-port opening, minimizing turbulence and wear when valve is open. Seats isolate and protect metal parts from contacting process. When closed, sleeve provides drop-tight seal in both directions. For more information, visit [www.redvalve.com](http://www.redvalve.com).



The Dead Bed Teardrop Nuts are currently available for the Symons Nordberg 4.25-ft, 5.5-ft and 7-ft models.  
[www.cmscepcor.com](http://www.cmscepcor.com)

### Sturdy LED Floodlight for Equipment

Phoenix Lighting introduced the Sturdlite Master Series, an impact-resistant, long-lasting, low-voltage LED floodlight for mining equipment. The series is IK10 rated and features a super heavy-duty harp to withstand significant and continuous shock and vibration, the company reported.

The high-temp polycarbonate lens is dirt, dust and debris resistant. The circuit board is conformal coated for ruggedness.



The series has three beam patterns: spot, flood and elliptical.

Two voltages are offered: 12-48 V and 24-48 V; and two versions, 24 W and 48 W, that produce up to 2,500 and 5,000 lumens, respectively.

The fixture can perform the -40°C to 65°C range, has a 50,000-hour rated life, and comes with a three-year warranty.  
[www.phoenixlighting.com](http://www.phoenixlighting.com)

### Pick-proof Padlocks for Explosives

ABLOY USA reported the Bureau of Alcohol, Tobacco, Firearms and Explosives recognized the PL340 padlock for meeting regulations as a locking device for securing explosives magazines.

The company reported the bureau tested and validated that the lock is pick-proof, which is due to PROTEC<sup>2</sup> CLIQ technology. ABLOY described the technology as a hybrid system that combines industry-leading mechanical discs with electronic components.

BATF regulations stipulate that padlocks must have at least five disc tum-



blers and a case-hardened shackle with a diameter of at least 3/8 in.

ABLOY stated the lock is the only available on the market that the ATF has inspected and verified. The PL340, PL342, PL350 and PL362 can be used to secure various explosives, the company reported.  
[www.abloyusa.com](http://www.abloyusa.com)

### Online Solutions Center Launched

Axora launched the online Smart Mining resource center, which, the company stated, is meant to help mining companies rebound and thrive after the pandemic. The center provides the latest industry insights and access to digital solutions and technologies that mining companies can adopt to accelerate growth, reduce wasted investment, and avoid duplication, Axora reported.

Axora uses blockchain technology to host more than 120 innovative solutions by a range of suppliers, from sector leaders to startups, universities and consultancies, the company reported. Digital solutions include smart devices, smart connected devices and IoT solutions.

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

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MINING media EUROPE

# Diamond Sales Poised for Recovery

By Gavin du Venage, African Editor

In May, De Beers reported sales of just \$35 million, compared to the \$416 million it sold the same time last year. Worldwide, the five biggest mining companies are probably sitting on excess inventories worth about \$3.5 billion, according to analytics firm Gemdex. This could reach \$4.5 billion of unsold stock by the end of the year, or about one-third of annual rough-diamond production.

With retailers now reopening, dealers in trading centers such as Dubai, Antwerp and Mumbai are once again looking for stock. "The diamond supply chain has been gradually opening back up in recent weeks," said Paul Zimnisky, an independent diamond industry analyst based in New York. "But the industry was pretty much closed from March through May."

The industry was already struggling with oversupply before COVID-19 hit, Zimnisky said. "It's my opinion that the diamond industry has been dealing with an oversupplied market since production hit a multiyear high in 2017 and as the midstream segment de-levered inventory over the last couple of years," he said.

Due to the saturated market, production had trended down over the past two years, and would continue to do so, Zimnisky said. For instance, the prolific Argyle mine in Australia is set to close this year, removing a substantial source of world diamond supply. Rio Tinto's Argyle mine has been something of a headache for the industry, as a major source of

gems of varying quality. Now, it's reached the end of its life to the relief of many in the industry.

In the short term, producers will look to the reopening of stores, especially in China. Zimnisky said early reports suggest Chinese buyers are returning to the market.

An illustration of this is LVMH, the world's largest luxury conglomerate, which said it is seeing significant improvement in sales growth in mainland China since stores reopened, adding that sales figures became positive in mid-March and have continued into April, and in some cases, sales growth has been more than 50% year-over-year. "Tiffany & Co. showed similarly impressive results out of China in April and May," Zimnisky added.

For diamond producing countries, this is welcomed news. Namibia, for instance, derives 10% of its GDP from diamonds, in a joint venture with De Beers — Namdeb. The latter operates the world's largest fleet of undersea mining vessels, representing a significant investment from both De Beers and the Namibian taxpayer.

Lesotho, Angola and South Africa are also significant diamond producers. In Zimbabwe, stones from the vast Marange field are one of its largest sources of foreign exchange.

Angola said it would open its own diamond exchange, and a local hub for traders. Peter Meeus, a doyen of diamond dealing with roots in Antwerp and who helped develop the Dubai Diamond

Exchange into a significant global player, will head the project.

"The wide range of services and infrastructure that the government of Angola plans to develop and offer to support the diamond trade will see completion over the next two years," Mining Minister Diamantino Pedro Azevedo said in a statement. "Angola's success in developing the industry has been evident over the past few years."

Some even predict the diamond industry will lead other resource sectors in returning to full business. James Campbell, CEO of junior explorer Botswana Diamonds, said consumers would quickly return to the stores as economies reopened.

"Historically, diamonds are among the first to experience a price crash during a 'black swan' event. But they are also among the first to recover."

Rather, he said, the long-term threat to diamond extraction wasn't the pandemic, but lack of exploration. Right now, Campbell's firm is one of just two explorers operating in Botswana, a country whose diamond reserves are predicted to run out within a generation.

Lack of tax breaks and other incentives, such as those offered by Australia and Canada, left the southern Africa region unattractive to explorers. Typically, exploration involved burning up to \$10 million a year, until a suitable deposit was discovered. For investors, this was a high risk, high reward venture and incentives were needed to draw in capital.

## E&MJ PRICES INDEX

(July 1, 2020)

Precious Metals (\$/oz)		Base Metals (\$/mt)		Minor Metals (\$/mt)		Exchange Rates (U.S.\$ Equivalent)	
Gold	\$1,770.30	Aluminum	\$1,593.50	Molybdenum	\$16,350	Euro (€)	1.124
Silver	\$18.00	Copper	\$6,016.50	Cobalt	\$28,500	U.K. (£)	1.247
Platinum	\$822.00	Lead	\$1,761.00	Iron Ore (\$/dmt)		Canada (\$)	0.736
Palladium	\$1,930.00	Nickel	\$12,555.00			Australia (\$)	0.692
Rhodium	\$8,000.00	Tin	\$16,920.00	Fe CFR China	\$98.01	South Africa (Rand)	0.059
Ruthenium	\$270.00	Zinc	\$2,007.50			China (¥)	0.141

Gold and silver prices provided by KITCO Bullion dealers ([www.kitco.com](http://www.kitco.com)). Platinum group metals prices provided by Johnson Matthey ([www.platinum.matthey.com](http://www.platinum.matthey.com)). Non-ferrous base and minor metal prices provided by London Metal Exchange ([www.lme.co.uk](http://www.lme.co.uk)). Iron ore prices provided by Platts Iron Ore Index. Currency exchange rates were provided by [www.xe.com](http://www.xe.com).



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