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# US oil firms unlikely to go 'drill, baby, drill' under Trump, says Exxon executive

US oil and gas producers are unlikely to radically increase production under president-elect Donald Trump as companies remain focused on capital discipline, a senior executive at Exxon Mobil said recently.

"We're not going to see anybody in 'drill, baby, drill' mode," Liam Mallon, head of Exxon's upstream division, told the Energy Intelligence Forum conference in London.

"A radical change (in production) is unlikely because the vast majority, if not everybody, is focused on the economics of what they're doing," he said.

"Maintaining the discipline, driving the quality, driving the information, will naturally limit that growth rate."

Trump, who takes office on Jan. 20, pledged during the election campaign to boost domestic oil and natural gas output.

Recent reports suggested that his transition team was preparing a wide-ranging

energy package to roll out in the first days of his presidency.

The United States has become the world's top oil producer following a surge in shale oil production, pumping over 13 million barrels per day earlier this year. It is also the world's leading natural gas producer.

Relaxing of land permitting processing could

provide a short-term boost to production, Mallon said.

BP CEO Murray Auchincloss told the conference that he looked forward to the Trump presidency, saying the Republican leader will help accelerate permitting time for energy projects.

Exxon earlier this year completed the \$60 billion acquisition of smaller US rival Pioneer Natural

Resources, consolidating its position as the largest shale producer.

Exxon expects to grow oil production in the Permian shale basin to over two-million barrels per day, Mallon said.

"We see growth beyond the two-million probably for a couple of years but not at that continuous same rate ... certainly up to 2030 we see it growing," he said.



## Bolivia says China's CBC to invest \$1bn in lithium plants

Bolivia's government and Chinese consortium CBC, which includes battery manufacturer CATL, have signed an agreement for CBC to build two direct lithium extraction plants for at least \$1-billion, government authorities said.

The government will take a 51% stake in the project, to be located in the Uyuni salt flat in southwest Bolivia, within the so-called lithium triangle shared with Chile

and Argentina.

The two plants together are intended to produce 35 000 metric tons of lithium a year, said Omar Alarcon, head of state-run lithium company YLB.

"This service contract will develop a final design for engineering, construction, operation and maintenance of a plant that will produce 10 000 t/y of lithium carbonate and another plant producing 25 000 t of battery-grade lithium carbonate per year," he told a press conference.

"CBC will build plants based on its technology at its own cost and risk," he added, saying the expected \$1-billion

investment represented initial construction.

Despite holding the world's largest resources of lithium, which is used to make electric-vehicle batteries, Bolivia has not managed any significant production and many investors are wary of its volatile political climate. The country is expected to hold a presidential election next year.

CATL supplies batteries for more than a third of electric or hybrid vehicles globally.

Direct lithium extraction is an innovative method to extract lithium more quickly than traditional methods that use massive evaporation pools.

Bolivia also signed a contract in September with

Russia's Uranium One Group for construction of a \$970-million plant to produce 14 000 t of lithium carbonate annually. However, the deal needs approval from Congress, where the ruling party is fractured and President Luis Arce lacks a congressional majority.

The agreement with CBC also requires lawmaker approval.

Arce said the government is scouting out more companies to invest in lithium, and has received interest from various countries.

"It's not just Russian and Chinese companies that are interested in investing in Bolivia," he said. "Our country isn't closed off to any company."





## Polymetals' next exploration Endeavor

Polymetals Resources will ramp up exploration at the Endeavor silver-lead-zinc mine near Cobar, New South Wales in 2025 by drilling the Carpark prospect.

The Carpark prospect is one of nine near-mine exploration targets Polymetals has identified at Endeavor, with the company describing Carpark as a "potential southern extension to the Endeavor orebody, from which 32 million tonnes has been mined over a 38-year operating period".

Polymetals has completed 12 reverse circulation (RC) core holes over Carpark over the past year, with all holes intercepting broad zones of anomalous lead and zinc mineralisation.

With downhole electromagnetic (EM) surveys having been undertaken and three 'off hole' EM conductor highs identified, Polymetals plans to commence the next phase of EM conductor plate drilling at Carpark in January 2025.

The drilling program will test whether the coincident induced polarisation (IP) chargeable and EM conductive high is a massive sulphide body at the southern extension of the Endeavor orebody.

It will also determine the potential supergene mineralisation located above the interpreted massive sulphide.

"The company has completed its compilation of the (approximate) 50 years of historic exploration data," Polymetals executive chairman Dave Sproule said.

"This is the first time a comprehensive database has been consolidated over the area and encompasses data from historic explorers including Metals Ex, Getty Oil, Electrolytic Zinc Australia, Newmont, Delta Gold, Pasminco, CBH Resources and Sandfire Resources.

"We are now able to begin testing the vast array of copper, gold and silver-lead-zinc targets across the portfolio. With cashflow imminent, Polymetals plans to ramp up its exploration activities over its entire Endeavor project tenure."

Before it begins drilling, Polymetals' initial works at Carpark will consist of 18km of IP survey lines and geological mapping programs across several prospects.

Endeavor's mine plan outlines a 10-year operation and production of 260,000 tonnes (t) of zinc, 10.6 million ounces of silver and 90,000t of lead.



## Denison inches closer to building Canada's next new uranium mine

Denison Mines has submitted the final environmental impact statement (EIS) for the Wheeler River uranium project with the Canadian Nuclear Safety Commission (CNSC).

The submission follows the completion of the technical review phase of the federal environmental assessment (EA) approval process.

Denison president and CEO David Cates noted that this development brings the company one step closer to building Canada's next new uranium mine, which would also be the country's first in-situ recovery (ISR) uranium mining project.

"Owing, in large part, to the use of the ISR mining method, the EIS evidences that the project can be constructed, operated, and decommissioned while achieving a superior standard of environmental sustainability when compared to conventional uranium mining operations," says Cates.

With the final EIS now filed, the CNSC staff will review the submission for acceptance and prepare recommendations for the commission members who will sit on the panel for the project's public hearing. The hearing will provide Denison with an opportunity to demonstrate the project's alignment with both regulatory requirements and

community expectations. While the exact date for the hearing has not yet been set by the CNSC, it is expected to be determined once the final EIS submission has been accepted.

In parallel with the federal EIS submission, Denison has also made progress in obtaining the necessary licences for the project. The company was recently informed that it had successfully met the requirements for a CNSC licence to prepare and construct a uranium mine and mill. This allows the CNSC to potentially make a licensing decision at the same time as the EA approval.

Last month, Denison also submitted a final EIS to the Saskatchewan Ministry of Environment (MoE), largely mirroring the document submitted to the CNSC. Although the technical review comment period was completed by the MoE in late 2023, Denison chose to delay finalising the provincial EA approval in order to incorporate the majority of modifications recommended during the federal technical review process.

This approach aims to streamline the provincial EA process, with the company expecting a single Ministerial decision following a public review period. This provincial review began in November 2024 and is expected to conclude in December.



## China eyes alternatives as seaborne coal imports lose market share

China, the world's largest importer of coal, has seen a sharp decline in the share of coal it imports by sea. According to a new report from Oceanbolt, a commodity market intelligence provider of Veson Nautical, the percentage of China's total coal imports transported by sea has dropped significantly, from 93% between 2015 and 2022 to just 76% in 2023/24.

This shift comes despite a 62% increase in total coal imports to China, which reached 473.4-million tonnes in 2023. The rise in imports, however, was not matched by an equivalent growth in seaborne coal shipments, which increased by only 45% over the same period.

The change reflects China's growing efforts to diversify its coal supply sources, moving away from traditional exporters and capitalising on geopolitical factors, such as the war in Ukraine, to secure discounted coal from alternative sources, including land-based transport routes.

### AUSTRALIA BEARING THE BRUNT

Australia, which has historically been a major supplier of coal to China, has seen its share of the Chinese coal market significantly decrease. From providing 26% of China's coal imports in 2019, Australia's share plummeted to just 11% in 2023, a direct result of an unofficial ban on Australian coal imports that was lifted only in 2023. Since all of Australia's coal exports to China are transported by sea, this decline in seaborne shipments largely explains the recent drop in seaborne coal volumes.

Mikkel Nordberg, senior maritime analyst at Veson Nautical, noted that Australia has been hit hardest by the shift to alternative supply



sources. "While there has been a recovery in imports of Australian steam coal to China after trade resumed in 2023, the coking coal trade has been heavily impacted," he said. In fact, Australia exported just 2.8-million tonnes of coking coal to China in 2023, a staggering 91% drop from pre-ban levels.

### CHEAP RUSSIAN COAL SEES IMPORTS SURGE

Russia has become a significant alternative supplier to China, with its share of Chinese coal imports growing substantially. From 11% in 2019, Russia's share nearly doubled to 22% by 2023. This shift can largely be attributed to the sanctions imposed on Russia by Western countries following the war in Ukraine, which effectively cut off Russian coal exports to the EU and other Western markets. As a result, China has taken advantage of discounted Russian coal, significantly increasing imports.

Nordberg highlighted the growth in Russian coal exports to China, noting that between 2022 and 2023, Russian coal exports surged by 50%, reaching 102-million tonnes.

"With reduced global demand and limited buyers, China has capitalised on the opportunity to purchase Russian coal at discounted prices," he said.

However, much of this

increase in Russian coal exports to China has been delivered by land. According to the report, while Russian coal exports to China increased by 34-million tonnes from 2022 to 2023, only 18.7-million tonnes of this growth was transported by sea, suggesting that the remaining 15.3-million tonnes were moved via land routes.

### MONGOLIA EMERGES AS A MAJOR PLAYER

Mongolia is also benefiting from China's diversification of its coal supply sources. The landlocked country saw a significant surge in its coal exports to China, with shipments increasing by 125% in 2023, reaching 70-million tonnes. Mongolia is now China's largest supplier of coking coal, accounting for 53% of China's total coking coal imports in 2023.

The Mongolian Coal Association has stated that the country has the potential to produce up to 100-million tonnes of coal annually, although its export capacity has been limited by infrastructure constraints. However, in 2023, Mongolia made significant strides in improving its coal export infrastructure, including the inauguration of a new railway line linking its coal mines to the Chinese border.

"In 2023, Mongolia accounted for 53% of China's total coking coal imports," Nordberg said. "As

a landlocked country, all of Mongolia's coal exports are transported overland, which means that it is effectively replacing the seaborne coking coal volumes previously sourced from Australia."

### IMPACT ON SEABORNE TRADE AND BULK CARRIERS

The report concludes that the shift towards alternative coal imports could have significant consequences for global shipping, particularly for bulk carriers. If the land-borne volumes were instead sourced from seaborne routes, the loss of trade could account for a 1% decrease in total ton-mile demand in 2023. This decline has been especially noticeable for larger bulk carriers, particularly Capesize and Panamax vessels, which are typically used to transport coal to China.

Nordberg pointed out that the decline in seaborne coal volumes has had a negative impact on freight rates for Panamax vessels. "This development has unquestionably hurt the Capesize and Panamax class vessels, which are the largest carriers of Chinese coal imports," he said. "It has been particularly evident in Panamax freight rates, which underperformed compared to Supramaxes in Q3, and the usual seasonal rebound in Q4 has not materialised."



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**WEIR**

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# Weir expands its range of ENDURON® screens

**F**or the last few years, Weir has been working to expand its range of ENDURON® vibrating screens. Its ENDURON® ORBITAL screen fills an important gap in the market for smaller, lower tonnage mining operations. Available in both circular (C-series) and elliptical (E-series) motion screens, the ENDURON® ORBITAL is well suited to crushing circuits in both secondary and tertiary screening duties

During the development phase, Weir consulted its customers and their feedback directly informed some of the most important design decisions it made.

Most notably, miners wanted screens that had a longer service life and a wider operating window, giving them greater flexibility to allow them to adapt when the operating conditions changed.

### LONGER SERVICE LIFE

The most significant design feature – and the thing that separates the ENDURON® ORBITAL screen from other comparably sized screens on the market – is its all-bolted construction. Weir has removed all welding from the main screen body.

The rationale for this design decision was straightforward: most screen failures are caused from high stress in welded joints, so eliminating these ensures a more reliable machine. The screens are manufactured to leading finite element analysis (FEA) and high cycle fatigue standards. ENDURON® ORBITAL screens are also manufactured

using automated computer numerical control (CNC) techniques, including laser profiling, bending, cutting and drilling to ensure the process is replicable.

The other benefit on the all-bolted design, which uses locking bolts in lieu of welding, is that it streamlines maintenance during the replacement of components.

### WIDE OPERATING WINDOW

Another important piece of feedback Weir received from its customers during the design phase of the ENDURON® ORBITAL screen was that they wanted a machine that could be easily adjusted without undermining or risking its structural integrity. When feed conditions or the application changes, screens are subject to harmonic resonance, which can lead to structural failure.

Crucially, adjustments to the throw-angle, speed and stroke can be made on the E-series screens, providing operators with more flexibility without compromising the equipment's structural integrity.

Indeed, providing customers with a high level of flexibility was prioritised and has informed other aspects of the screen's design.

### OPERATIONAL FLEXIBILITY

For instance, the ENDURON® ORBITAL screens can accommodate both modular flat decks and side-tension crown decks on the same deck structure.



Moreover, this modular screen construction extends to other parts of the screen; most of the components – decks, crossbeams, excitors, for example – are interchangeable within particular model sizes and, in some instances, across the C-series and E-series screens.

These components have been designed for easy replacement; the modular flat decks and side-tension crown decks can be fitted on the same deck structure through a simple adaptation polyurethane kit, for example. From an inventory management perspective, this means that customers can reduce the number of spares they need to hold.

Weir has also focused on streamlining maintenance requirements, so that downtime can be kept to a minimum and the safety of those working on the machine isn't compromised.

The ENDURON® ORBITAL range of screens comply with EN 1009, which is a set of standards that cover the safety of machines used in the mechanical processing of minerals and similar solid materials. What that means in practice is that operators can access screen media easily in multiple deck applications, while the modular all-bolted design means various parts can be individually replaced without needing to strip the entire screen.

Further streamlining monitoring and maintenance, the screens can be digitally enabled, providing the operator with greater visibility of equipment health and performance, as well as providing the opportunity for process optimisation. Data driven insights

Harnessing real-time insights makes it easier to maintain optimal performance and reliability for vibrating screens. Weir's NEXT Intelligent Solutions provides continuous data on key metrics, empowering operators to keep their screens running smoothly and allowing them to respond to issues before they lead to costly downtime or inefficient performance.

This solution utilises sensors to monitor vibration, stroke and throw angle; it then transforms this raw data into actionable insights to ensure that screens operate within their designed parameters. It allows operators to gain confidence in achieving their operational targets without compromising reliability.

NEXT Intelligent Solutions include a digital twin of the screen in which motion data is captured and presented in a user-friendly way, enabling fast and informed responses to deviations from design specifications.

There are a multitude of variables that influence how a screen operates; therefore, using motion data collected by NEXT Intelligent Solutions ensures maintenance planning can be based on the actual operating conditions, resulting in less unplanned downtime and improved reliability.

All ENDURON® products are fully supported by Weir's service network, offering unrivalled service, support and local expertise across the globe.

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## Anglo American to sell steelmaking coal mines to Peabody in \$3.8bn deal



Anglo American has agreed to divest its remaining steelmaking coal portfolio in Australia to Peabody Energy in an all-cash deal valued at up to \$3.77bn.

According to Anglo American, the transaction marks a significant step in its strategy to restructure its business through the sale and divestment of non-core assets.

Under the terms of the definitive agreement, Peabody Energy will pay an upfront cash payment of \$2.05bn at the closing of the deal.

The transaction also includes deferred payments totalling \$725m over four annual instalments, a potential price-linked earnout of up to \$550m, and \$450m contingent on the reopening of the Grosvenor mine.

In addition, Peabody Energy has committed to a \$75m deposit, which Anglo American may retain in certain circumstances if the deal falls through.

The steelmaking coal portfolio includes Anglo American's majority interests in several joint ventures (JV) across the Bowen Basin in Queensland. These include an 88% stake in the

Moranbah North JV, 70% of the Capcoal JV, 86.36% of the Roper Creek JV, and 50% of the Moranbah South JV.

Additionally, it encompasses a 51% stake in the Dawson JVs, including the Dawson South JV, Dawson South Exploration JV, and Theodore South JV.

These assets, which are spread across four metallurgical coal mines, namely Moranbah North, Grosvenor, Aquila, and Capcoal, are complementary to Peabody Energy's existing Australian platform, including the Centurion mine.

Anglo American's assets are projected to produce 11.3 million tonnes of steelmaking coal annually by 2026. Of this, around 80% is hard coking coal.

The mines have a combined marketable reserve of 306 million tonnes and an additional 1.7 billion tonnes of resources, with an average mine life exceeding 20 years.

Through the acquisition, Peabody Energy aims to enhance its metallurgical coal segment, increasing output from an estimated 7.4 million tonnes this year to 21–22 million tonnes by 2026.

Peabody Energy chief financial officer Mark Spurbeck said: "Subsequent to the transaction closing, we anticipate continuing our shareholder return program based on available free cash flow, while a portion of cash flows will be used to fund the transaction during the deferred payment period."

"Once we fully integrate the acquired metallurgical coal assets into our seaborne portfolio, we will have an even stronger platform to provide significant value upside to our shareholders."

In a related transaction, the Dawson mine is being sold to Bukit Makmur Mandiri Utama, generating an additional \$455m for Anglo American.

Combined with the sale of its interest in the Jellinbah coal mine for \$1.1bn earlier this month, the total aggregate gross cash proceeds from these divestments are estimated at \$4.9bn.

Anglo American chief executive Duncan Wanblad said: "In steelmaking coal, through a combination of Transaction and our previously announced agreement to sell our interest in Jellinbah, we stand to unlock up to \$4.9bn of value, reflecting the high quality of the assets and adding to our balance sheet resilience."

"Peabody is a long-established and respected operator and we will work together and with our workforce, local communities, government, customers and partners to ensure a successful transition."

Subject to regulatory approvals and customary conditions, the transaction is expected to be completed by Q3 2025.



## Ecuador mineral exports could fall by some 20% this year

Ecuador's mineral exports could fall by some 20% year-on-year, mining vice-minister Rebeca Illescas told an industry conference recently, as power cuts and delays in giving export licenses hit output.

Ecuador's worst drought in over 60 years has plunged the hydropower-dependent country into an energy crisis as diminished reservoirs leave hydroelectric dams offline, pushing the government to impose power cuts.

"There will be a fall," Illescas said. "I expect it will be at least 20% compared to last year."

Output will recover next year, she said.

Mining exports were worth \$3.3-billion for Ecuador in 2023.

The Mirador copper mine is operating at about half of its capacity, Illescas said. Mirador's operator said in August they expect to invest about \$650 million into the second phase of the project over three years.

"Mirador has had energy problems for more than 30 days and since about 10 days ago they are at half capacity," Illescas said.

Mirador operator Ecuacorriente, a unit of Chinese consortium CRCC-Tongguan Investment, did not immediately respond to a request for comment.

Canadian miner Lumina Gold will develop a gold project in the coastal province of El Oro, Illescas added, with production set to begin in 2026.





## New diamond mine's shining start in 2025

Lucapa Diamond Company has released a key update on the restart of its Merlin diamond mine in the Northern Territory.

Lucapa first acquired Merlin in 2021 for \$8.5 million, marking the project as the second Australian prospect to join the company's portfolio of two existing diamond projects in Africa, joining the Brooking project in Western Australia.

Since it took the reins, Lucapa has completed a scoping study which estimated a 14 year mine life and a 4.4 million-carat resource.

This was followed up by a feasibility study completed in 2023 which determined market conditions to be unfavourable and temporarily put Lucapa's restart plans on hold – until now.

The company declared Merlin will officially restart in 2025 under a new two-step plan.

The first phase of the plan will take 18 months to complete and will use excavator dredging to mine to a depth of 15m from the base of five existing open pits.

The second phase is expected to take just over two

years and will see Lucapa use vertical pit mining to extract ore from the project's Gawain pit.

Lucapa is in the process of discussing funding options with a number of parties, which could involve offtake agreements, project level debt, project equity and government facilities.

In the meantime, the company is planning to continue increasing Merlin's



mineral resource through exploration at the site.

It is hoped there may be room to expand given the mine's proximity to the McArthur River mine, which is owned by Glencore and touted to be one of the world's largest deposits of zinc and lead.

## BHP Group expects a global copper deficit

BHP Group expects a global copper deficit of 10-million metric tons a decade from now, a shortfall that is driving its plans to spend at least \$11-billion at the world's biggest copper mine, Escondida, and other projects in Chile.

BHP detailed to investors this week plans to spend \$10.7-billion to \$14.7-billion within about 10 years to extract more copper from Escondida and the smaller Spence mine, and restart the Cerro Colorado mine.

The world's biggest listed miner's annual production is set to fall by around 300 000 t to 1.6-million tons by the end of the decade, largely driven by a slump at Escondida that is expected to peak in 2025.

Other top copper miners are facing similar

challenges to increase output at aging mines.

Those difficulties are hitting just as demand for copper, an essential metal for production of electric-vehicle batteries and construction of data centers, is expected to grow.

"We think the deficit is going to be around 10 million tons by 2035," BHP Americas President Brandon Craig said in an interview recently, estimating a \$250-billion cost to develop enough mines to match demand.

"That's quite a challenging task for mining companies."

The amount represents a little under half of current global production, with copper mine output at 22.4-million tons last year.

BHP is contending with

diminishing ore grades at Escondida, which it aims to offset through expanded and new processing facilities, plus leaching technologies to extract copper from sulphide, rather than oxide where copper is more commonly mined.

BHP's heaviest spending is anticipated around fiscal years 2030 and 2031, Craig said, referring to a schedule that outlines four Escondida projects and three at the Pampa Norte division, which includes Spence and Cerro Colorado.

The earliest projects are set for first production between 2027 and 2028, and the latest ones between 2031 and 2032.

BHP sought this year to boost its copper portfolio in a \$49-billion bid for Anglo American, but was rebuffed. BHP has not ruled out a renewed bid.

Asked about organic growth versus acquisitions, Craig said BHP is keen on maximising Escondida, Spence and Cerro Colorado.

"Our default is to take that resource and develop it ... We always have a set of investable growth options."

BHP aims to stagger the

timing of Chile projects to keep them from "becoming too intense to be able to execute effectively," he added.

BHP is also working with industry associations to press the Chilean government to finalise reforms for faster permitting, but for now anticipates the standard timeline.

"The legal time frames that they set out for how long it should take are often exceeded, so it creates a high degree of uncertainty," he said.

Although the company previously explored an underground expansion for Escondida, Craig said the idea was not feasible at current copper prices for at least another decade.

Three-month copper on the London Metal Exchange is down around 20% from its 2024 peak in May, at around \$8,995 per metric ton.

He also said the miner set aside past interest in selling Cerro Colorado, which was put into temporary care and maintenance late last year amid issues over water use. The miner is now looking for a leaching solution using seawater.



## Orica Digital Solutions and Kapeks sign collaboration agreement to equip turkey's mining industry with Advanced Digital Solutions

The collaboration agreement was formalised; signed by Hakan Kaya, Chairman and Özkan Düzgün Chief Executive Officer of KAPEKS, and Angus Melbourne, Chief Technology Officer of Orica, and Rajkumar Mathiravedu, Senior Vice President of Orica Digital Solutions. This agreement will see the deployment of cutting-edge digital solutions that provide enhanced data-driven insights and optimised decision-making across the entire value chain.

Commenting on the agreement, Özkan Düzgün, Chief Executive Officer of KAPEKS, stated, "This agreement with Orica Digital Solutions exemplifies KAPEKS' unwavering commitment to advancing industrial growth through the integration of digital innovative technologies. By adopting these advancements, we are poised to significantly enhance the mining sector. This agreement empowers us to deliver state-of-the-art mining solutions for Turkey, ensuring that we not only meet the industry's escalating demands while driving greater efficiency, safety, and sustainability across our operations."

Orica Digital Solutions technologies enable companies to extract resources more efficiently, manage environmental impact, and achieve greater operational predictability. By integrating physical and digital workflows, Orica's platforms assist mining companies in improving safety, reducing energy and water usage,

minimising emissions, and comply with regulatory requirements. These solutions also offer real-time insights, facilitating better decision-making, enhanced productivity, and sustainable outcomes.

Angus Melbourne, Chief Technology Officer Orica, expressed his enthusiasm regarding the collaboration agreement, stating, "Orica has accelerated the development of digital solutions from exploration to processing to address critical and emerging challenges. We look forward to setting new benchmarks in operational excellence and sustainability within the mining sector. Our commitment to innovation and safety is aimed at developing groundbreaking advancements benefiting both the industry and the broader community."

Rajkumar Mathiravedu, Senior Vice President Orica Digital Solutions added, "Our open, secure, and connected end-to-end ecosystem connects the digital world to real-world actions within the operation, providing customers timely insights. This allows for the translation of those insights into critical intelligence for better decisions and more predictable outcomes in near real-time and we are genuinely excited to bring these cutting-edge solutions to Turkey. Our technologies support the industry in its journey from the traditional disconnected silos to connected workflows to reduce risk, creating efficiencies and improving outcomes sustainably".



From left: Hakan Kaya Chairman KAPEKS and Angus Melbourne, Orica Chief Technology Officer sign collaboration agreement



From left seated: Hakan Kaya Chairman KAPEKS and Angus Melbourne Chief Technology Officer Orica. From left standing: Özkan Düzgün Chief Executive Officer KAPEKS, Rajkumar Mathiravedu Senior Vice President Orica Digital Solutions, Victor Morales Vice President Orica EMEA and Juan Miranda Senior Manager Commercial Orica EMEA.



From left: Özkan Düzgün Chief Executive Officer and Hakan Kaya Chairman KAPEKS with Angus Melbourne Chief Technology Officer Orica and Rajkumar Mathiravedu Senior Vice President Orica Digital Solutions





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# A high-fidelity modelling method for mine haul truck dumping process

Dumping is one of the main unit operations of mining. Notwithstanding a long history of using large rear dump trucks in mining, little knowledge exists on the cascading behavior of the run-of-mine material during and after dumping. In order to better investigate this behavior, a method for generating high fidelity models (HFMs) of dump profiles was devised and investigated. This method involved using unmanned aerial vehicles with mounted cameras to generate photogrammetric models of dumps. Twenty-eight dump profiles were created from twenty-three drone flights. Their characteristics were presented and summarised. Four types of dump profiles were observed to exist. Factors that influence the determination of these profiles include the location of the truck relative to the dump crest, the movement of the underlying dump material during the dumping process and the differences in the dump profile prior to dumping. The HFMs created in this study could possibly be used for calibrating computer simulations of dumps to better match reality.

## INTRODUCTION

Mine-to-mill optimisation is a longstanding goal of the mining industry<sup>1-4</sup>. This approach focuses on optimising the entire process around run-of-mine (ROM) material characteristics, rather than optimising the unit operations to material characteristics individually. The primary motivation for this approach is ensuring that the priority for optimisation is given to the most demanding and costly process (grinding)<sup>5</sup>. Despite its success, one difficulty in holistic mine-to-mill optimisation stems from a lack of understanding around material behavior during and between unit operations<sup>4</sup>.

Unit operations are defined within the context of mining as the basic steps used to produce mineral value from a deposit. They generally fall into either the category of rock fragmentation or materials handling<sup>6</sup>. Materials handling, for surface truck and shovel mines, comprises three steps, known as loading, hauling and dumping. Dumping commonly consists of the haul truck spotting itself into position and dropping ROM material from the back. This material forms a small heap if it is dumped on a flat surface, or cascades

along the edge of a dump face if dumped over a developing dump, stockpile or dump/heap leach<sup>7</sup>. While there are minor differences in each of these earthworks, for the simplification of this article, they are referred to as rock piles<sup>8</sup>.

Notwithstanding a long history of using large rear dump trucks in mining, little knowledge exists on the cascading behavior of ROM material during and after dumping. At least two schools of thought comprise the knowledge that does exist. The first school of thought studies ROM cascading behavior from an external perspective. The second seeks to understand the smorgasbord of characteristic properties that govern this behavior internally. Since this paper focuses primarily on the external viewpoint, only a sample of the literature pertaining to the internal philosophy is presented in order to call attention to some of its challenges. McLemore *et al.*<sup>8</sup> provide a robust review that includes a trove of references from each school of thought, should readers wish to dive deeper.

Work related to factors that influence ROM material behavior from an internal philosophy are numerous, and a



complete review of their literature is not within the scope of this paper. A plethora of material property variables relate to these factors, which include shear strength, bulk density, particle size and shape distribution, cohesive properties, friction angle, moisture content, etc.<sup>8,9</sup>. Several issues confound the ability to fully isolate and understand these variables. First, the size, shape and variability of the ROM material are greatly dependent on blasting, which is not yet a fully understood process<sup>10,11</sup>. Second, the successful testing of material property variables depends heavily on sampling and statistical estimation<sup>12</sup>. Furthermore, dump faces are hazardous, and observation of the dumping process is challenging<sup>13</sup>. Additionally, dozers and other equipment handle the material subsequent to dumping, which compound with the issues mentioned previously<sup>7</sup>. Moreover, some complex engineering issues, such as reclamation and slope stability, are commonly considered to be linked to factors involving these material property variables in ways not fully understood, which increases the debate related to them<sup>13-15</sup>. Mines may also be under the assumption that understanding these factors must originate from a first-principles approach, rather than a data-driven statistical and mathematical approach<sup>16</sup>.

Traditional viewpoints and operational strategies within the mining industry generally hinder innovation<sup>17,18</sup>. This might be particularly true for each of the three kinds of rock piles. Stockpiles have been seen as only useful to mines as a buffer against production variability<sup>19-21</sup>. Dump/heap leach design optimisation involves many meticulous considerations that take precedence over understanding the minutia of the dumping process, which may be considered to be optimised under simple guidelines<sup>22</sup>. Waste dumps have been reserved for material below the economic cut-off grade and, as a result, have historically been given little attention beyond safety and risk management<sup>23</sup>. While these traditional viewpoints would need to change in order for rock pile innovation to be successful, they need only be challenged in order for research in these areas to be justified.

Literature and news articles provide both cases and causes for some changing perspectives that motivate and support the endeavor of this paper. First, even though the primary function of stockpiles remains the same<sup>24</sup>, COVID-19 and global supply chain disruptions have placed increased demand on their use<sup>25-34</sup>. Increased knowledge of stockpile assets as the result of understanding the dumping process might afford mining companies a competitive edge in a post-pandemic world<sup>35-38</sup>. Second, while much of the seminal work in heap leach modelling involved small laboratory column studies operating at the particle scale<sup>39-41</sup>, there has been a recent shift towards modelling bulk scale phenomena (inter-/intra-particle diffusion, liquid holdup and hysteresis, gas flow, etc.<sup>42,43</sup>) as well as understanding the factors more closely correlated with the dumping process (stratification, segregation, breakage induced by ore stacking, etc.<sup>44-46</sup>). It is true that a better understanding of the dumping process will likely not lead to changes in the construction of heap leaches. However, it may yield an understanding of the gestalts about the bulk phenomena in existing heap leaches, and aid in the development of models that increase their profitability<sup>47</sup>. Third, what was once considered to be below cut-off grade may later become mineable ore<sup>48-52</sup>. Therefore, a deeper understanding of the dumping process as it relates to waste dumps may prove valuable for operations, where

old waste dumps become economically viable<sup>53-56</sup>. Finally, the perfunctory amount of documented work, aimed at capitalising on the opportunities hypothesised previously, may have less to do with the merit of such hypotheses, and more to do with the mining sector's lag in innovation<sup>17,18,57</sup>.

To improve the understanding of end-dumping and rock pile construction, we present a method for creating a high-fidelity model (HFM) of the dumping process through a digital transformation approach. Digital transformation<sup>57,58</sup>, employs an external philosophy for understanding ROM behavior, and is a process whereby real-world assets and processes are digitally transformed in ways that add value for decision makers. Innovation<sup>59</sup> and emerging technologies<sup>60</sup> make digital transformation possible. Unmanned aerial vehicles (UAVs), also known as drones, are an emerging technology<sup>61</sup> that allows for the digital transformation of the dumping process through data collection. Rock pile faces span large areas, and the nature of the material requires multiple vantage points for sensors or traditional surveys to be effective. By using photogrammetry, UAVs are capable of capturing multiple angles and covering large difficult areas, such as a dump face<sup>47,62</sup>. Thus, an investigation into whether photogrammetry can create the HFM of an individual truck end dump is of interest to the issue of better understanding the dumping process and rock pile construction.

HFM act as reference systems to reality<sup>63</sup>. These models are commonly used in engineering to calibrate simulation models<sup>64</sup> where there is a need to rapidly prototype many different design permutations<sup>65</sup>, or where measuring the real data being modelled is not practical<sup>66</sup>. HFMs are modular elements, and HFM integration is a modular framework that allows each aspect of the full model to be worked on independently<sup>67</sup>. This modularity means that simulations to match HFMs can be worked on independently from the work used to improve how HFMs match with reality.

Digital transformation techniques are fairly new, and little work has been conducted to digitally transform the process of rock pile construction via haul truck end-dumping. Zahl *et al.*<sup>9</sup> accurately assert that the formation and shape of mine rock piles are based mainly on topography. While this work is foundational to the engineering of rock pile construction, it offers little for the purposes of rock pile digital transformation. Mclemore *et al.*<sup>8</sup> provide an extensive review on the construction, the factors influencing the shear strength of soil, characterisation, the effects of weathering and the stability of rock piles throughout the world. Their review is more informative than that of Zahl *et al.*; however, it likewise does not consider a digital approach. Zhao<sup>68</sup> developed a real-time 3D modelling and mapping technique for the stockpiles formed by stacking/reclaiming machines for iron ore. Zhao's work is pioneering in the area of the digital transformation of small, intermediary stockpile construction, but does not consider the large rock fills made by haul truck end-dumping. The authors of this present paper previously illustrated a method for modelling and mapping large heap-filled stockpiles using fleet management system (FMS) data<sup>7</sup>. However, while these data were amicable to modelling, no external data were available for the validation of the model. Zhang and Liu<sup>47</sup> employed UAV aerial photography and performed image analysis to investigate particle size distribution along the face of a dump leach. However, while

**Table 1:** Camera and Flight Details.

Camera Details				Flight Details			
Sensor Type	Sensor Size (mm)	Focal Length (mm)	Image Size (Pixels)	Flight Height (m)	Average Flight Area (m <sup>2</sup> )	Average Photos Taken	Flight Style
M4/3 CMOS	12.8 × 8.6	8.6	5472 × 3648	60	74,500	65	Snaking Grid

they demonstrated the ability of UAV aerial photography to capture relevant data, they did not capture the volumes of individual dump profiles that could be used as a baseline to digitally transform the end-dumping rock pile construction process. Servin *et al.*<sup>4</sup> present a digital transformation technique for holistic mine-to-mill distributed particle simulation where the gaps between unit operations are simulated using data from control systems and sensors. While other frameworks for similar integration have been proposed in the past, the focus Servin *et al.* place on a unit operation-centered framework is consistent with the aims of this paper and the future direction of research in this area.

The method presented in this work demonstrates how to create 3D HFMs of ROM end-dumping from photogrammetry. The method presented is very similar to that of Zhang and Liu<sup>47</sup>. The resulting HFMs are akin to the model developed by Zhao<sup>68</sup>, only they involve end-dumped rock piles as opposed to stacker-made intermediary stockpiles. These HFMs could be potentially suitable for the technique presented by Servin *et al.*<sup>4</sup> for holistic mine-to-mill optimisation, which includes large end-dumped rock piles. They may also be used as a modular test bed for the calibration of future simulations of mine haul truck dumping activity. The end goal of the HFMs this method creates is the parameterisation of dumping as a unit operation process. Essentially, while the foundational work of Zahl *et al.*<sup>9</sup> explains that topography is the main factor influencing rock pile shape, the method presented in this paper may be used to increase our understanding of the expected variability and parameters in such topography common to the end-dumping and rock pile construction process, thereby making these shapes more predictable and amicable to modelling.

## MATERIALS AND METHODS

### Material and Haulage Equipment

The material studied was low-grade run-of-mine (ROM) gold ore from a surface mining operation near Perth, WA. No additional characterisation of the material is required for presenting the concept of this method, although future simulation and modelling work will require more detailed characterisation in order to ensure that models are properly calibrated.

The ore was transported and dumped using CAT 793F haul trucks with a payload of approximately 231 metric tons, a struck capacity of 112.6-151 m<sup>3</sup> and an inside bed width of 7334 mm.

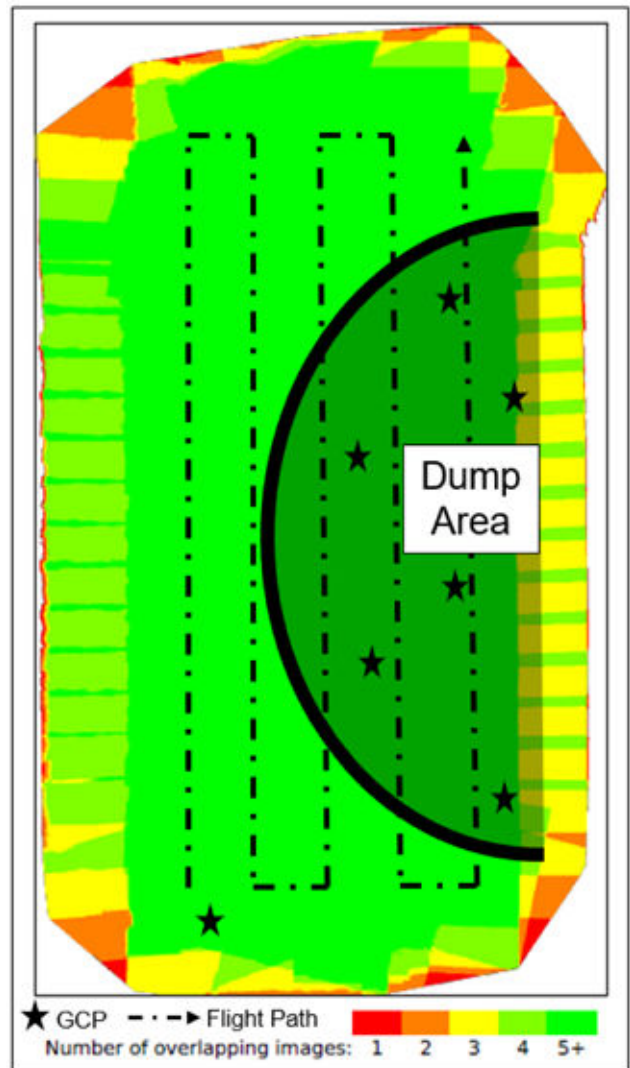
### UAV Flights and Photogrammetry Methodology

Field work and UAV flights were conducted in coordination with the mine's survey crew and through the use of their equipment. A total of 23 flights were recorded over the course of five day-shifts. These flights were performed using a DJI Matrice M200 drone with a Zenmuse X5S

camera (DJI-Innovations Company Limited, Shenzhen, China). **Table 1** shows details about the camera and flight settings used in these flights.

The methodology for the flights was as follows:

1. An initial flight was performed to create and update the local orthomosaic map (approximately 6 min);
2. Ground control points (GCPs) were marked and surveyed (3 to 7 GCPs were used for each flight);
3. A second flight was performed with an adjusted flight path to include ground control points (approximately 7 min);



**Figure 1:** Top (XY Plane) view of a typical flight plan. Stars represent locations of ground control points (GCPs). The dashed line shows the flight path of the UAV. The shaded area is an approximation of the dump area. The color represents the number of overlapping images in accordance with the scale shown.



**Table 2:** RMS Error Values by Coordinate Direction.

Coordinate Direction	Relative RMS Errors (m)				Absolute RMS Errors (m)			
	Minimum	Average	Maximum	Standard Deviation	Minimum	Average	Maximum	Standard Deviation
X	0.000565	0.011916	0.03008	0.008417	0.684995	2.410617	3.931733	0.790573
Y	0.000574	0.009329	0.032239	0.008137	1.128254	2.119136	3.641948	0.610887
Z	0.001044	0.017912	0.046895	0.011906	0.881072	7.083288	15.086508	4.262623

- A Quick Map was created from the second adjusted flight path so that the area of interest (dump area) could be readied, and the working flight path programmed;
- Once steps 1 through 4 were completed, flights were repeated using the site scan Quick Fly software function in the same area along the same flight path to capture the dump face during different time intervals and thereby capture before and after photos of the dumping process during regular operation (60 m flight height, 6 min flight times).

Once the flights were completed, pictures were uploaded to the 3DR cloud processing system, and photogrammetric point clouds were generated from the flight photos using Pix4D software (mapper 4.1 version, Pix4D SA, Lausanne, Switzerland). Absolute and relative accuracy were calculated for each GCP in the X, Y and Z coordinate directions. These calculations were performed automatically as part of the 3DR cloud processing.

**Figure 1** shows a top view (XY plane) of an example flight plan with GCP locations and the corresponding image overlap map generated from the flight. All flight plans were similar to Figure 1, with the only changes being the location of different GCPs. The thick black curved line in Figure 1 represents the upper crest of the dumping area, and it is a close approximation to the actual dump crest. As demonstrated by Figure 1, the dump crest area for each flight was photographed with 5 or more images of overlap.

**Point Cloud Analysis**

Maptek™ PointStudio (2021.1 version, Maptek/KRJA Systems Inc, Golden, Colorado, USA) was used to model and analyze the resulting point cloud data. These data were imported as individual files and converted into triangulation solids. Then, they were analyzed for overlapping areas where dumps had occurred. Polygons were created around the dump areas, and the two triangulations were processed into extracted solids. These extracted solids are considered to be 3D volumetric HFMs of individual haul truck dump profiles within the simulation and modelling context described in the introduction. The reason these software tools, as well as the drone equipment, were used is because they were what was available and provided by the mine. The results section details the HFMs created by this study. All HFM files are available at, [https://zenodo.org/record/5789951#\\_YgQiqJbMKUI](https://zenodo.org/record/5789951#_YgQiqJbMKUI).

**Classification Method**

Little taxonomic terminology yet exists for the information presented in this article. Classification involved qualitative analysis by the authors on the HFMs, with an emphasis on attributes hypothesised to be of interest to characterising the final position and geometry of the dump profile. From the qualitative analysis, the categories and characteristics of the dumps were created, and each dump was assigned to the matching category. Data on the resulting classification

are presented along with the statistical information of each category.

**RESULTS**

**UAV Flights and Field Work Results**

**Tables 2** and **3** show the root mean square (RMS) error values and the ground sampling distance (GSD) of the models computed from the drone flight data, respectively. Errors between the modelled coordinates of a GCP and its known survey coordinates are frequently used to represent the accuracy of a photogrammetry model<sup>69</sup>.

**Table 3:** GSD Values of the Photogrammetry Models.

GSD Values (cm/pixel)			
Minimum	Average	Maximum	Standard Deviation
1.72	2.2	2.52	0.26









RMS errors represent the quadratic means of these errors in the X, Y and Z coordinate directions. Both absolute and relative RMS error values are given. Absolute error represents the error in the coordinate location of the GCPs to their actual location on earth. Relative error represents the error in coordinate location of the GCPs as they relate to each other. Relative error is of more interest to this study, since the integrity of the HFMs is reliant on achieving a low relative error in the photogrammetry models.

Low ground sampling distance (GSD) values are required for accurate photogrammetry<sup>69</sup>. GSD is the physical distance represented between the centers of two adjacent pixels, and it can be estimated in advance of a flight based on the camera and flight details. With the drone flying at a 60 m height, a GSD of 1.64 cm/pixel is considered to be the lowest possible GSD value based on the camera specifications. Slight deviations due to perspective, the vibrations of the camera, blur, depth of field and other factors lead to variations in GSD at every point of a photogrammetric model. The GSD values calculated for the photogrammetry models of this study can be found in **Table 3**.

In **Tables 2** and **3**, the accuracy of the photogrammetry models is given. These accuracy values are important to consider, since they determine the granularity of the HFM models. The accuracy error of a given model will be at least the GSD value in each coordinate direction. Considering that the highest average GSD value of all flights was 2.52 cm/pixel, an accuracy error of at least 16 cm<sup>3</sup> (2.52 cm × 2.52 cm × 2.52 cm) to the volume of the HFM is expected to exist. Another way to confirm these accuracy errors is to multiply the RMS errors (**Table 2**) for each coordinate direction. The multiplication of the maximum relative errors for each coordinate direction, as shown in **Table 2**, gives 45.48 cm<sup>3</sup>, which is roughly 2.8 times the accuracy error

# HAUL TRUCKS

**Table 4:** Example front and side views of grayscale renderings of the HFM solids created in PointStudio for each of the four dump profile types.

Dump Profile Type	Front View (Direction of Dumping ↓)	Side View (Direction of Dumping ←)
Oval		
Comet		
Rectangular		
Sloughed Heap		

obtained by cubing the GSD. This discrepancy is consistent with other photogrammetry models that have been correctly scaled and reconstructed, which typically contain accuracy errors between one to three times that of the GSD value. In summary, the accuracy of the volumes generated from the photogrammetry models used in this study can generally be considered to be accurate to within 50 cm<sup>3</sup>.

### Point Cloud Analyses and Results

Of the 23 flights flown, 14 solids were extracted, from which 29 dump activities were identified and 28 were considered useable HFMs of the dumping process. Of these 28 HFMs, four types of dump profiles were determined to exist. The four dump types are named after their shape, as follows:

- A. Oval,
- B. Comet,
- C. Rectangular,
- D. Sloughed Heap.

Oval-type dump profiles are the most commonly occurring type of dump profile. These dump profiles are characterised

by their oval shape when viewed from a vantage point normal to the dump face. These dumps have narrow ends at the crest and toe of the dump face, and a maximum width midway through the dump face. Comet dump profiles are characterised by a large volume near the base of the dump and a narrow trail of material extending upwards along the dump face. Rectangular dump profiles cover the entire dump face (or a large portion of it) evenly to a uniform width. Sloughed heap profiles occur when a portion of the material is not dumped over the edge of the berm, but rather on the floor of the upper level of the dump. This causes a portion of the material to bunch near the dump berm, and a part of it to slough over the edge of the dump.

**Table 4** shows example grayscale renderings of what is observed in PointStudio for each of the four types of dumping profiles determined by a qualitative analysis of the dump HFMs. These example grayscale renderings are showcased via both front and side views. The front view shows the perspective facing the dump and in-line/parallel to the dump, with the dumping process proceeding from top to bottom. The side view represents the perspective perpendicular to



the front view, with the dumping direction proceeding from top right to bottom left. Measurements of these profiles were performed using software functions found within PointStudio.

The HFM solids created in PointStudio were classified using the following variables: volume (in cubic meters), maximum height, length, width and thickness (in meters) and angle (in degrees) from bottom left to top right. Volume was determined by querying the properties of the HFM solids after their creation. Maximum height and maximum length were considered to be the vertical and horizontal legs of the right triangle formed by connecting the bottom left and top right points of the HFM solid. Maximum width was considered to be the distance between the two farthest horizontal points of the HFM solid from the front-view perspective. Thickness was considered to be the distance between the two farthest horizontal points of the HFM solid from the side-view perspective. Angle was considered to be the inner angle of the right triangle formed by connecting the bottom-left and top-right points of the HFM solid. These measurements are tabulated in **Table 5**. An additional visualisation of the HFMs data containing all of the extracted solids is available in the data cache

associated with this article. The link accessed to this data can be found in the “Supplementary Materials” section.

In total, 28 dumps were profiled and classified via qualitative analysis. **Table 5** shows information from all of the dump profiles. With the exception of dumps 1, 2 and 3, all dumps were along the edge of a 30 m high dump crest. **Table 5** reveals that large volume does not always indicate large maximum width, height or length. High angles do not indicate large volume, but seem to increase the maximum width, height or length. In the case of sloughed heaps, the low angle is due to the fact that it is not measuring to the top of the berm, but to the extent of the dump profile, which occurs on the floor of the upper level of the dump area.

In order to investigate the statistical differences among the classification data of each type, box plots of their data for each variable are shown in **Figures 2-7**. In the box plots, the black dot represents the mean average value within the data, the line represents the median value, the box edges represent 50% of the data between the first and third quartiles and the lines above and below the box represent the maximum and minimum values of the data.

**Table 5:** Summary of Classification Data for All Dump Profiles.

Dump	Volume (m <sup>3</sup> )	Max. Width (m)	Max. Height (m)	Max. Length (m)	Angle (°)	Max. Thickness (m)	Shape
1 <sup>2</sup>	131	15	15	23	33	1.187	Oval
2 <sup>2</sup>	125 <sup>1</sup>	12	16	25	31	0.957	Rectangular
3 <sup>2</sup>	125 <sup>1</sup>	14	16	25	31	0.893	Rectangular
4	121 <sup>1</sup>	11	16	29	28	1.431	Sloughed Heap
5	121 <sup>1</sup>	14	30	44	36	0.368	Oval
6	121 <sup>1</sup>	13	31	43	36	1.207	Oval
7	155	20	20	32	33	1.016	Comet
8	119 <sup>1</sup>	22	26	39	34	1.123	Comet
9	119 <sup>1</sup>	17	18	26	35	1.256	Comet
10	119 <sup>1</sup>	11	32	46	34	1.006	Oval
11	134	20	28	40	35	0.887	Oval
12	125 <sup>1</sup>	15	21	35	31	1.675	Comet
13	125 <sup>1</sup>	19	19	29	33	2.011	Comet
14	137 <sup>1</sup>	16	19	27	29	1.053	Sloughed Heap
15	137 <sup>1</sup>	12	31	44	35	1.306	Oval
16	137 <sup>1</sup>	23	19	20	32	2.032	Comet
17	137 <sup>1</sup>	15	23	34	34	0.899	Oval
18	137 <sup>1</sup>	19	20	28	30	1.081	Sloughed Heap
19	128	20	21	30	36	0.953	Oval
20	138 <sup>1</sup>	16	28	39	31	1.000	Sloughed heap
21	138 <sup>1</sup>	16	25	36	35	1.202	Oval
22	117	11	7	16	12	2.062	Sloughed Heap
23	94	16	26	35	36	0.601	Oval
24	149 <sup>1</sup>	14	30	41	36	0.882	Rectangular
25	149 <sup>1</sup>	17	29	40	35	1.140	Oval
26	149 <sup>1</sup>	13	21	29	36	1.036	Rectangular
27	129 <sup>1</sup>	12	9	13	16	1.647	Sloughed Heap
28	129 <sup>1</sup>	17	26	37	35	1.033	Oval

<sup>1</sup> Volumes are averages from the total volume of the combined extracted solid containing the dump profiles.

<sup>2</sup> These had a 15 m dump height.

**Figure 2** shows that the comet and rectangular dump types have a slightly higher average volume compared with the oval and sloughed heap types. Volume is influenced by how much material was loaded into the truck before dumping, and also by how much material in the dump face moved at the time of dumping. This increase in the average volume of material for the comet and rectangular dumps may be due to the fact that both dump types seem to involve the movement of additional material contained in the dump face.

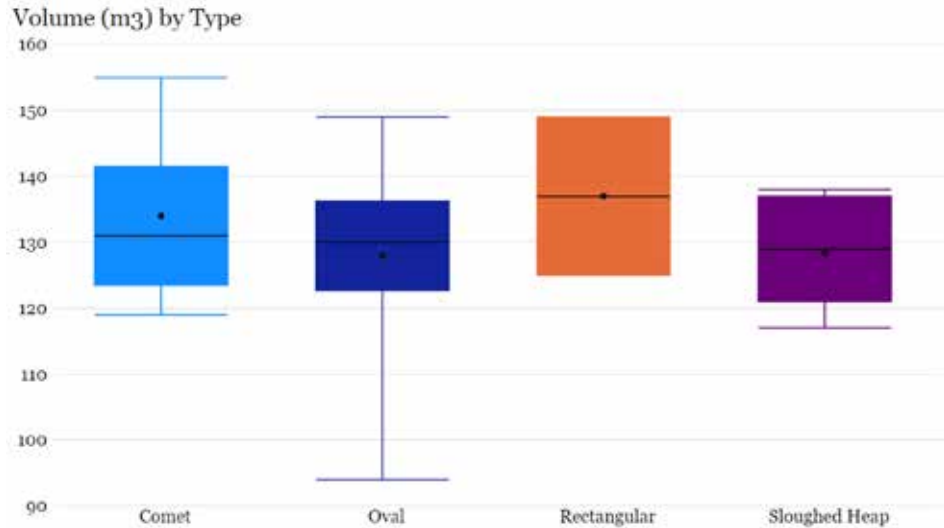
**Figure 3** shows a lot of similarity in the average angles of the comet, oval and rectangular dump types. Sloughed heap angles are lower because the material does not typically extend the full length of the dump face. Where the material of the sloughed heap extends along the dump face, the angle of the material matches the angles for the other dump types.

**Figure 4** shows that the oval and rectangular dumps have the highest dump height.

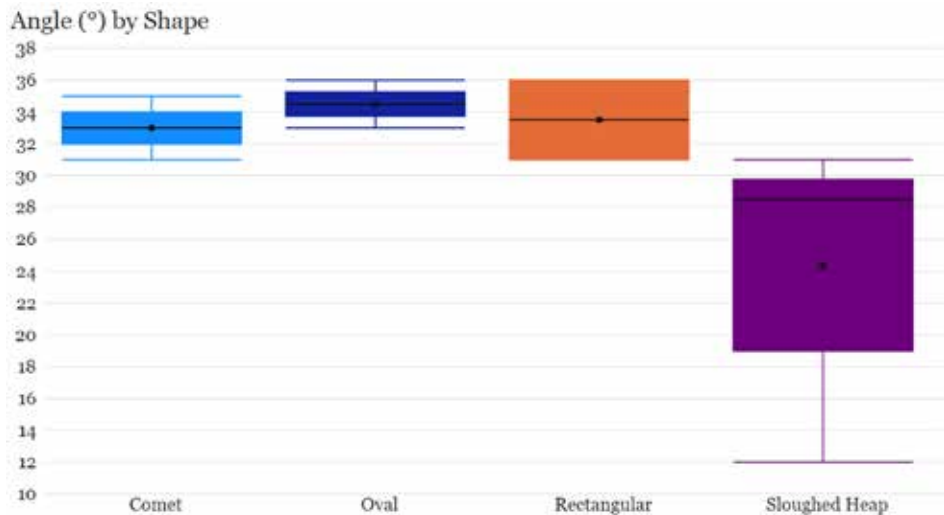
Dump height is a measurement of how much of the vertical dimension of the dump is covered by the dump profile. Sloughed heap and comet height values are lower because the material does not typically extend the full length of the dump face.

**Figure 5** shows the same general differences between dump types as Figure 4. This is likely due to the fact that length is a measurement of how much of the horizontal dimension of the dump is covered by the dump profile. Length values are lower for sloughed heap- and comet-type dump profiles compared to the other dump types. This may be related to the same reason why height values for these types are also lower.

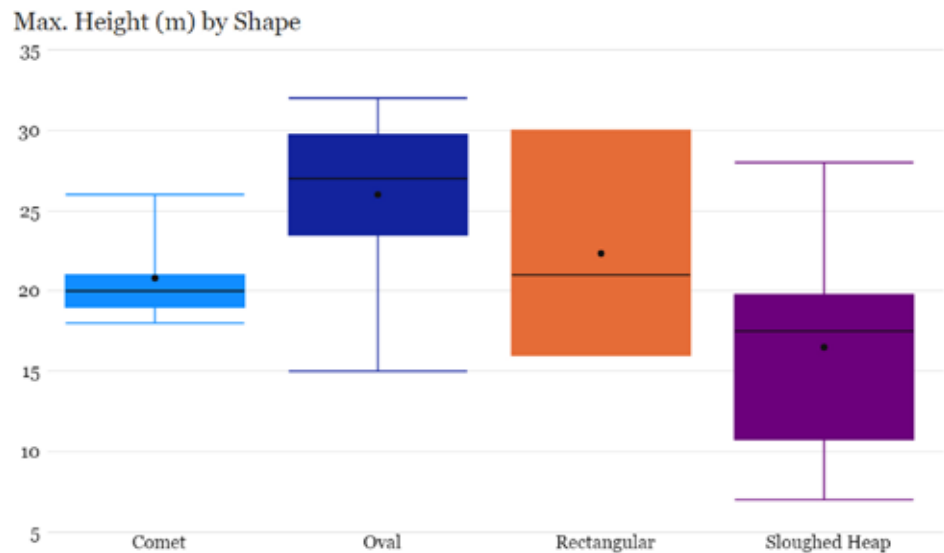
**Figure 6** shows that comet dump profiles tend to be the widest. This may be the result of additional material from



**Figure 2:** Box Charts of Volume (m<sup>3</sup>) by Dump Profile Shape.



**Figure 3:** Box Charts of Angle (°) by Dump Profile Shape.



**Figure 4:** Box Charts of Max. Height (m) by Dump Profile Shape.



Max. Length (m) by Shape

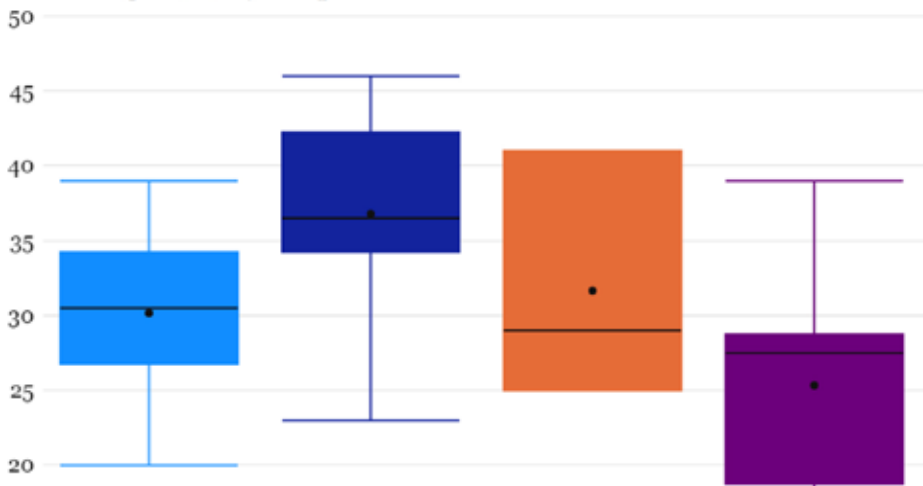


Figure 5: Box Charts of Max. Length (m) by Dump Profile Shape.

Max. Width (m) by Shape

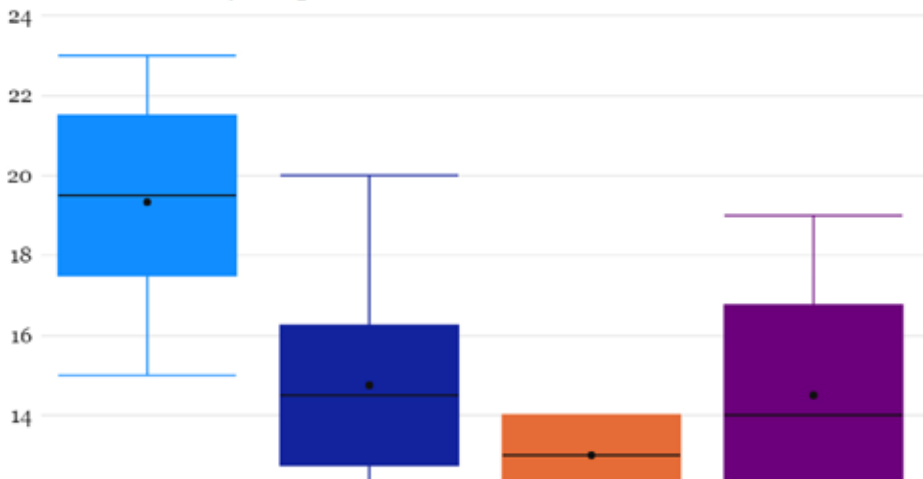


Figure 6: Box Charts of Max. Width (m) by Dump Profile Shape.

Max. Thickness (m) by Shape

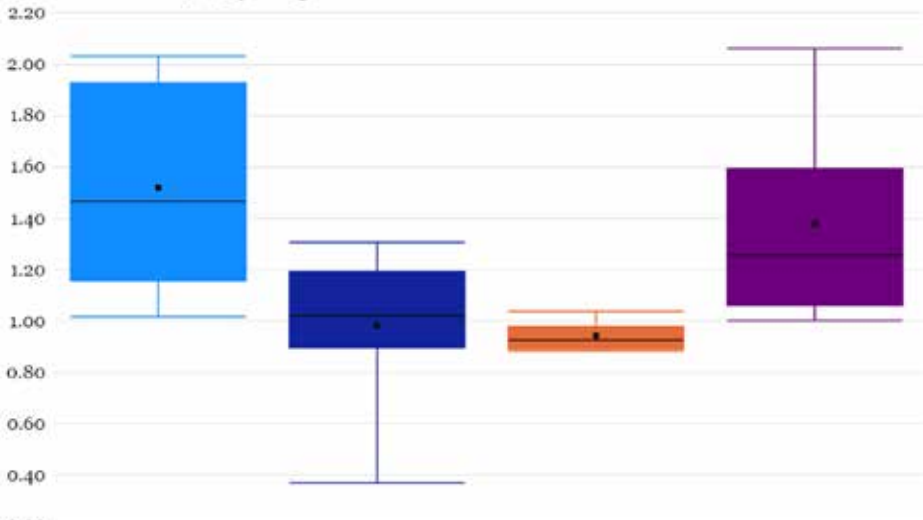


Figure 7: Box Charts of Max. Thickness (m) by Dump Profile Shape.

the dump face aggregating with the dump mass as it cascades, resulting in an increase in width. Rectangular dump profiles tend to have the lowest width values, which is interesting because they typically have the highest volume values, and this might be explained by a low amount of frictional resistance on the dump face compared to the cohesion of the dump mass.

As shown in **Figure 7**, the comet and sloughed heap dump profiles typically have a higher thickness than the oval and rectangular ones. Assuming that the dumps are of similar total volume, this is to be expected, since oval and rectangular dump profiles typically have higher height and length. Therefore, the dump material for oval and rectangular dumps is spread thinner across more surface area, which leads to less thickness. Comet dump profiles may also interact with loose material on the dump surface, and the resulting solid might include some of that material in the thickness, as it might with the total volume.

## DISCUSSION

### Modelling Discussion

The HFMs presented in this paper offer a novel look at individual dumps. These HFMs can be used as a basis to calibrate future simulation models of dumps via the V-model for calibration described by Quist<sup>63</sup>, Hofmann<sup>66</sup> and others. **Figure 8** illustrates the V-model for simulation calibration and validation, which occurs over three levels. At the bottom level, validation is carried out by calibrating the individual parameters of particles in a laboratory setting. The second level involves calibration based on the aggregated behavior of the particles through multiple flow regimes. The third level compares simulated outcomes with real industrial-scale operations.

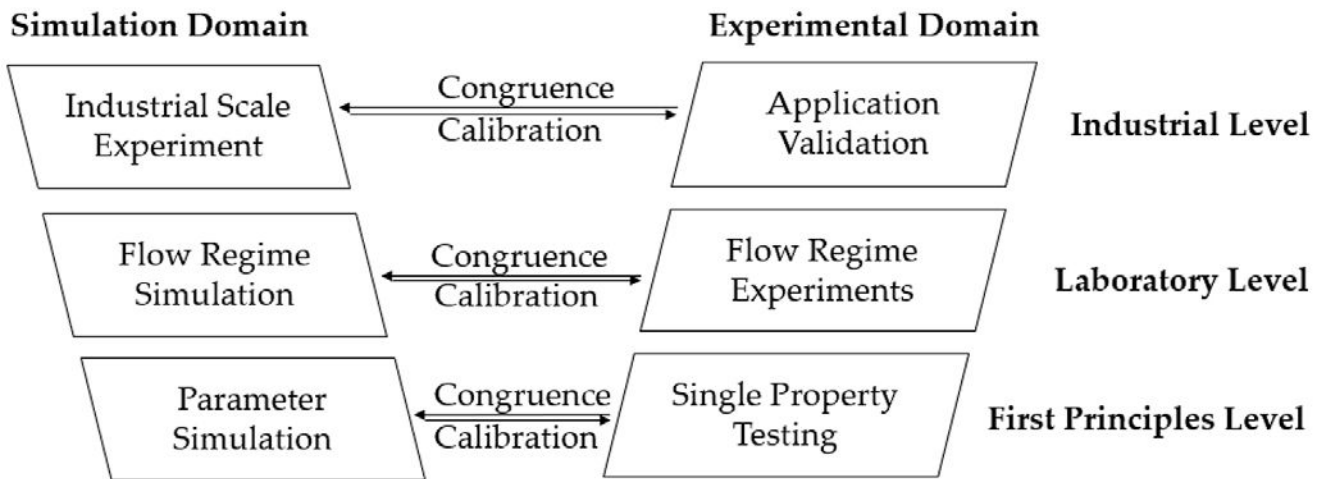


Figure 8: The V-model for DEM calibration and validation (adapted from<sup>63</sup>).

To the knowledge of the authors, no work has been conducted to validate dumping behavior at a real mine against simulated outcomes; however, much work has been performed to calibrate and validate ROM material simulations at lower levels of the V-model, particularly for mineral processing applications<sup>70</sup>. In instances such as dumping, where reality cannot be used to calibrate models, calibration involves adjusting parameters to fit HFMs instead. There is no mention of a method for creating HFMs of mine haul truck dumping activity in the literature. The method used for this study is easily achievable for any mine operation where UAVs and photogrammetry are presently in use.

### Dump Profile Discussion

Even though this study found only four types of dump profiles, there may exist additional types. The factors that determine which type a dump will be categorised into are many. These factors likely fall into several categories, including the way the material is loaded into the truck, how the truck dumps the material, how the pre-existing dump face interacts with the dumped load and how the material behaves on its own. None of these factors were investigated in this paper

How the truck is loaded directly influences the volume of the resulting dump profile. It may also influence the determination of the dump profile type, forming either comet, oval or rectangular profiles. For example, if the truck is unevenly loaded with more material in the back than towards the front, this may cause the resulting dump profile to favor a comet format. However, the exact interplay between how the trucks were loaded and the resulting dump profiles remains unclear, and no information on truck loading was gathered during this study.

How the truck dumps the material clearly influences whether or not the dump profile becomes a sloughed heap or one of the other types. This is because if the truck dumps far from the crest of the dump face, it will create a sloughed heap. When the truck dumps against the crest of the dump face, the type of the resulting dump profile is either comet, oval or rectangular; however, it is unclear which one it will become from this information alone.

### Terminology Discussion

The lack of terminology around dump profile behavior is one challenge to improving our understanding. The authors present new terminology here for the four types of dump shapes, but much more terminology is likely needed to fully describe and characterise dump profiles. This is made true by the fact that many dump profiles display characteristics of more than one type and, therefore, additional description may be required to fully classify them. For example, a sloughed heap may slough into a comet shape at the bottom of the dump, or an oval may have an extremely long rectangular section. There also needs to be reflection around how much effort should be spent creating terminology, since it is well known that the shape of mine rock piles is mainly based on topography<sup>9</sup>.

### Practicality Discussion

Admittedly, some findings in this study may not offer much practical applicability, especially considering the status quo of the mining industry. It is unknown whether the HFMs presented in this study represent the global characteristics of the dumping process across all mines, or whether they are limited to the mine used for the study. However, the method used for data capture was seamlessly incorporated into routine operation, and was practical from the standpoint of simplicity and ease of realisation. Many mines are capable of measuring their own dump characteristics and creating HFMs for themselves. It is entirely probable that many other shapes of fallow land exist, and their discovery and classification can increase our understanding of the cascading process of ROM material.

Additionally, as has been previously stated, the findings of this study are practical for the purpose of verifying the accuracy of the simulation modelling of individual truck end dumps. Without an HFM to verify simulations against, there would be less confidence in the accuracy and relevance of the simulation. It is computationally intensive to simulate an entire dump area. Simulating individual dumps may allow for larger areas to be simulated with less computational power through the use of pseudo-particles<sup>4</sup>.

Dumps generally conform to whatever shape the local topography provides, but knowledge of the common shapes provided via a routine dumping process for a particular ore at a given mine has historically been mostly speculative.



Speculation of this kind causes engineers and mine planners to place an unknown amount of dependance on operators that work with the material constantly to ensure the process is conforming to plan. In future autonomous mining scenarios, this dependance will not be allowed. Thus, digitally transforming the dumping process is hypothesised to support continuity in the transition towards autonomous mining. Without operators at the helm, there is little knowledge to ensure that dumping is occurring correctly. Additionally, without a basic reference, there would be no way to determine the performance quality of the autonomous equipment. The fact that autonomous equipment will be covered in sensors to map the work area continuously will mean very little, unless it is known what conformity should actually look like.

As another hypothesis, there might be a relationship of practical synergy between predictive modelling and UAV surveys. UAV surveys have become increasingly ubiquitous at mines, and can accomplish tasks to a level of quality unachievable by traditional survey crews within a greatly reduced timeframe. They could be made to occur at such frequent intervals as to overwhelm mining engineers and long-range planners. The HFMs described in this article demonstrate the parameterisation of the dumping process, which could facilitate the training and validation of predictive models to help automate design conformity to UAV surveys of rock piles, thereby decreasing the cognitive load placed on the domain experts.

## CONCLUSIONS

HFMs of dump profiles for 28 dumps were created. These HFMs show characteristic behaviors classifiable into four types, named comet, oval, rectangular and sloughed heap. These classifications may make it easier to examine the dumping process as a whole. While more terminology and modelling will be required to gain a complete understanding of the dumping process, the HFMs examined here provide a basis to articulate new terminology and calibrate new modelling.

Since further investigation is required, some recommendations for future study in this area include:

- Investigate factors that determine the classification of a given dump profile;
- Isolate additional variables that influence the cascading behavior of ROM from haul trucks;
- Simulate and calibrate particle modelling using HFMs;
- Validate and test the ability to accurately simulate and predict the dump characteristics beforehand;
- Correct for the difference between GPS coordinates recorded as dump locations and the true centroid coordinates of the dumped material;
- Develop constraints and map FMS data to rock piles;
- Prove the accuracy of these mapping/modelling techniques through a robust sampling campaign;
- Adapt this or a similar method for dozers and other equipment that frequently handle material at dumps and stockpiles;

- Review and analyze correlated phenomena (bulk phenomena in heap leaches, stratification, slope stability, etc.);
- Incorporate simulated predictions into a larger mine-to-mill optimisation model.

Supplementary Materials: The dump geometries can be downloaded at: <https://zenodo.org/record/5789951#YgQiqJbMKUI>.

Author Contributions: Conceptualisation, A.Y.; Data curation, A.Y.; Formal analysis, A.Y.; Funding acquisition, W.P.R.; Investigation, A.Y.; Methodology, A.Y.; Project administration, W.P.R.; Resources, W.P.R.; Software, A.Y.; Supervision, W.P.R. All authors have read and agreed to the published version of the manuscript.

## REFERENCES

1. Erkayaoglu, M.; Dessureault, S. Improving mine-to-mill by data warehousing and data mining. *Int. J. Min. Reclam. Environ.* 2019, **33**, 409-424.
2. Adel, G.; Kojovic, T.; Thornton, D. *Mine-to-Mill Optimisation of Aggregate Production*; Virginia Polytechnic Inst. and State Univ. (Virginia Tech), Blacksburg: Virginia, VA, USA, 2006.
3. Valery, W.; Duffy, K.; Jankovic, A. Mine to Mill Optimisation. In *SME Mineral Processing and Extractive Metallurgy Handbook*; Kawatara, K., Young, C.A., Eds.; Society for Mining, Metallurgy, and Exploration (SME): Englewood, CO, USA, 2019; pp. 335-343.
4. Servin, M.; Vesterlund, F.; Wallin, E. Digital Twins with Distributed Particle Simulation for Mine-to-Mill Material Tracking. *Minerals* 2021, **11**, 524.
5. Holmberg, K.; Kivikytö-Reponen, P.; Härkisaari, P.; Valtonen, K.; Erdemir, A. Global energy consumption due to friction and wear in the mining industry. *Tribol. Int.* 2017, **115**, 116-139.
6. Hartman, H.L.; Mutmanský, J.M. *Introductory Mining Engineering*; John Wiley & Sons: Hoboken, NJ, USA, 2002.
7. Young, A.; Rogers, W.P. Modelling Large Heaped Fill Stockpiles Using FMS Data. *Minerals* 2021, **11**, 636.
8. McLemore, V.T.; Fakhimi, A.; van Zyl, D.; Ayakwah, G.F.; Anim, K.; Boakye, K.; Ennin, F.; Felli, P.; Fredlund, D.; Gutierrez, L.A.F.; et al. *Literature Review of Other Rock Piles: Characterisation, Weathering, and Stability*; Questa Rock Pile Weathering Stability Project; New Mexico Bureau of Geology and Mineral Resources: Socorro, NM, USA, 2009.
9. Zahl, E.G.; Biggs, F.; Boldt, C.M.K.; Connolly, R.E.; Gertsch, L.; Lambeth, R.H.; Stewart, B.M.; Vickery, J.D. Waste Disposal and Contaminant Control. In *SME Mining Engineering Handbook*; Darling, P., Ed.; Society for Mining, Metallurgy and Exploration Inc.: Littleton, CO, USA, 1992; pp. 1170-1180.
10. Siddiqui, F.; Shah, S.; Behan, M. Measurement of Size Distribution of Blasted Rock Using Digital Image Processing. *J. King Abdulaziz Univ. Eng. Sci.* 2009, **20**, 81-93.
11. Badroddin, M.; Bakhtavar, E.; Khoshrou, H.; Rezaei, B. Efficiency of standardised image processing in the fragmentation prediction in the case of Sungun open-pit mine. *Arab. J. Geosci.* 2013, **6**, 3319-3329.
12. Maerz, N.H. Online Fragmentation Analysis: Achievements in the Mining Industry. In Proceedings of the 7th Annual ICAR Symposium, Austin, TX, USA, 19-21 April 1999.

For further references please use the following:

<https://www.mdpi.com/2673-6489/2/1/6#:~:text=This%20method%20involved%20using%20unmanned,generate%20photogrammetric%20models%20of%20dumps>.

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# Remote monitoring: theory versus reality

The potential of remote monitoring and machine learning to enhance performance in the mining industry is exciting, with promises of impressive time and cost savings. However, practical implementation of such technology often reveals a more complex picture. While remote monitoring systems can address significant challenges for production managers and maintenance teams, they can also introduce new issues. Based on real-world experience, **Robert Whetstone** of Martin Engineering provides a candid exploration of the benefits and the unintended consequences of adopting advanced technologies in bulk materials handling.

As a global leader in bulk material handling solutions, Martin Engineering has been among the pioneers of technology solutions for mining and materials processing for decades. Over the past 10 years Martin's engineers have developed remote monitoring solutions that use sensors to provide data on the condition and performance of wear parts

without maintenance teams having to physically go to the equipment to inspect it in person.

Traditional inspection regimes not only introduce unnecessary operating costs but also needless exposure to safety risks. That's why remote monitoring is especially effective, particularly in cases when:

- Equipment is so far away that inspection time is a fraction of the time to get there.
- Inspection involves complex procedures and supervision to organise safe access.
- The operation needs to shut down just to inspect one area or piece of equipment.
- Inspecting every conveyor takes days but no maintenance is actually needed.

### THE CHALLENGE OF PREVENTIVE MAINTENANCE

The drive for production in the short-term makes it more likely that preventive maintenance inspections go to the bottom of the 'to do' list, and maintenance only becomes a priority when there's a problem that needs fixing. Short-term targets frequently mean that systems 'run to failure' rather than being run to maximise long-term, cost-effective productivity.

Components like belt cleaners, which may not be seen as critical to productivity compared with other parts of the operation, are among the first to be overlooked. Therefore, Martin® Service Technicians (MSTs) are often called upon to react to a problem rather than prevent one. Ignoring maintenance for too long results in higher costs and more downtime in the long-term.

Remote monitoring mechanisms not only reduce labor but curtail unsafe behaviors such as taking shortcuts to access





equipment to save time, ignoring inspection schedules and risk assessments, or engaging in quick fixes with inadequate tools rather than planning safe maintenance during designated downtime.

By using cloud-based technology, operators can do real-time, condition-based monitoring and preventive maintenance of components like belt cleaners or air cannons. The data collected from sensors can help to predict when servicing may be required, giving operators enough time to arrange an inspection, order the required parts and book contractors to carry out maintenance during scheduled downtime.

## THE DEVELOPMENT OF VIABLE REMOTE MONITORING

Martin Engineering's Center for Innovation, located at its headquarters in Neponset, Illinois, USA designed and developed the first N2<sup>®</sup> Position Indicator (PI) for monitoring polyurethane conveyor belt cleaners (the first of many sensors compatible in the Martin OnSite infrastructure or ecosystem or platform). With the goal of making the device affordable, accessible, reliable and easy to install, the conveyor belt cleaners' performance and condition information is transmitted via a central 'gateway' to the cloud. Data is then clearly presented and easily accessed via a dedicated mobile app or desktop platform.

Martin's N2<sup>®</sup> PI is the ideal solution for drastically cutting down on inspection time, and the more difficult and time-consuming the belt cleaners are to inspect, the greater the potential for time saving. Essentially, if you know the condition of the belt cleaner blade by using the app, there is no need to go and visually inspect it. Live installations show that PI can reduce inspection time by as much as 90%, which also means reduced exposure to the safety risks associated with accessing conveyors. Additionally, remote monitoring eliminates the guesswork around belt cleaner servicing – the condition of the blade is based on data-driven facts rather than human observation and perception. That opens up the prospect of true preventive maintenance and, over time, predictive maintenance.

As a result, since the introduction of the Position Indicator, there are now thousands of N2<sup>®</sup> PI devices installed at more than 40 mineral processing operations



Martin's N2 Position Indicator provides data on the condition and performance of each belt cleaner.



Martin's Center for Innovation at its headquarters in Neponset, Illinois, USA.

worldwide. While operators monitored the performance of equipment, Martin monitored the performance of the PI and discovered that it might not be the right fit for some operators. And just like the familiar personal tech we all use every day, remote monitoring of wear parts can also be the source of some frustrations. Working closely with customers, Martin engineers identified four key areas to consider with the implementation of a remote monitoring system:

### 1) Does it address your pain points?

Martin Engineering design engineers think a lot about pain points – the everyday problems that cause hassle, create risk, slow productivity, waste time and cost money. The company's core mission of "cleaner, safer and more productive" operations drives the design and engineering of its extensive catalog of products, including the N2<sup>®</sup> Position Indicator.

During Martin's initial research, it was clear that many technological solutions falter because they do not address real pain points. In other cases, developers fail to clearly explain to operators how their innovative solution addresses their problems. And perhaps worst of all are those examples where new technology introduces new pain points that have been overlooked during development and testing.

Critical for Martin's designers, therefore, was to ensure that the N2<sup>®</sup> PI supported the identification of Key Performance Indicators (KPIs) to ensure the right pain points were being addressed. Unique to each operation, these KPIs focus on production inefficiencies and the operational discrepancies between individual belt conveyors.

For example, the PI system is designed to show if there's a problem with a belt cleaner blade on each conveyor. For some maintenance managers that's useful for them to take urgent action. For others it's just *another* notification about *another* task on an already too-long list of jobs (and frankly one that they're not going to get round to anytime soon!) So remote monitoring is only useful if internal maintenance team has the bandwidth to keep up.

In other examples, such as a site where the production team continually conducts walk-rounds and visual inspections of the whole operation, remote monitoring is not valued to the same extent as sites where a walk-round is done infrequently. Data from the sensors is

# REMOTE MONITORING AND MACHINE LEARNING

telling them what they already know so having to consult the app is itself a pain point.

## 2) Does it deliver useful, actionable data?

In a major bulk handling operation, there's a risk that remote monitoring solutions may lead to data overload. All of us are already inundated with information coming from innumerable sources, and additional data coming from remote monitoring systems competes with emails, messages and endless other notifications. Yet it's easy to fall into the trap of thinking that having access to lots more information is the goal, rather than the decisions and actions we take based on that information.

No matter how impressive any technology may be, or how interesting remote monitoring metrics may be, data collection alone doesn't achieve better productivity. The information therefore needs to be helpful, accurate and presented in a way that helps decision-making. Equally, having the wrong KPIs can switch focus away from the desired outcome and skew decision making in a way that is ultimately detrimental to productivity.

The Martin OnSite mobile app and OnSite dashboard provides a series of clear charts with actionable information that's automatically analysed, interpreted and presented in a way which makes decisions straightforward.

## 3) Are you willing and able to change?

One of the biggest barriers to advancement is the inability or unwillingness to change. This comes in two main forms – business processes and people. Firstly, long-established business processes can be rigid, engendering ways of working that become ingrained over decades. Secondly, people are generally resistant to change in their daily routines, regardless of inefficiency or safety.

So, in reality, introducing any technology requires change management. The installation and integration of the system must ensure the benefits of the change are well-anticipated and understood by stakeholders, and the new workflows are less onerous than the current regime. For example, workers in mining operations often provide pushback believing that technology could make their jobs redundant. This is not wholly unfounded, after all, on a large-scale operation N2<sup>®</sup> Position Indicators could replace what a typical worker does for a up to a whole day each week.



Remote monitoring is only useful if users are provided with useable, actionable data.

In some cases, conveyor belt maintenance teams who aren't aware that sensors are fitted, or aren't trained how then function, have had negative impacts on monitoring systems because they have failed to reset them correctly. Elsewhere there has been deliberate tampering of monitoring devices, and in one case the workers believed the new tech installations would be used to 'spy' of their behaviour, damaging their morale.

So, like all new systems, those involved must be prepared and trained in the right way, including explaining the rationale for installing remote monitoring systems, as well as reassurance about motives. When people are required to learn something new, without understanding why they are being asked to change, resistance is likely, and failure is probable. Such resistance can also be diminished and overcome by ensuring any new technology is easy-to-use, intuitive and even preferable (and certainly not worse than whatever the current procedures are).

## 4) Does it integrate with existing systems?

The N2<sup>®</sup> Position Indicator is designed to be retrofitted to belt cleaners without any other upgrades to the system. And it's also scalable across operations of all sizes, types and ages without incurring additional cost. However, there may be numerous physical obstacles ranging from accessibility and available space to legacy steelwork that needs refabricating.

Once the central Gateway is installed and powered, each N2<sup>®</sup> PI can be fitted and paired in just a few minutes. More importantly, a single Gateway can handle 1000s of PI sensors so expanding the N2<sup>®</sup> network doesn't require further investment in the communication infrastructure.

If an operation already has centralised remote monitoring for other components, N2<sup>®</sup> data can integrate with existing systems although it may require additional work to ensure compatibility. To avoid data overload, it is recommended to begin with simple core actionable KPIs such as status and wear times, then expand from there as required.



Once the central Gateway is installed and powered, each N2<sup>®</sup> PI can be fitted and paired in just a few minutes.



## “LISTENING TO UNDERSTAND” IS THE KEY TO SUCCESS

After spending around five years developing its N2® PI for conveyor belt cleaners, Martin Engineering formally launched the technology just before the global covid pandemic in 2020. Working hand-in-glove with customers' production and maintenance teams, Martin® Service Technicians listened, resolved teething challenges and reported issues. As a result, Martin has gone on to develop two further N2 conveyor products sensors which work with the same Gateway and is expected to launch a game-changing new flow aid sensor in 2025.

As with all things, a balanced perspective is required when embracing technological advancement. Martin is dedicated to helping customers accomplish their safety and efficiency goals, so the consultation and inspection of operations for viability, followed by a proper introduction and phased integration of the OnSite system is recommended.

To achieve the desired productivity improvement, it is imperative to understand the potential pitfalls that accompany change. Most importantly, having the right conversations, listening to understand the true pain points, embracing the challenge and working together are critical to transforming this huge opportunity into action and delivering tangible results.

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## Robert Whetstone

Area Vice President, EMEAI Region, Martin Engineering

Robert Whetstone is responsible for Martin Engineering's Europe, Middle East, Africa & India region (EMEAI). He started his career in the British Army before taking up leadership roles first in retail and then business services. He joined multinational building materials group Lafarge in 1998 where he held a number of senior positions in the UK and USA. In 2013 he took up a role with engineering services firm Babcock International to lead their Mining & Construction Business in North America before setting up his own consultancy supporting business growth. He joined Martin Engineering in 2017. Robert is a Fellow of the Royal Society for Arts, Manufacturing and Commerce (FRSA) and a former Fellow of the Institute of Quarrying (FIQ). His passion is developing and growing businesses by harnessing people's potential and strongly believes that people and organisations must evolve to stay ahead of the game and realise their full potential.



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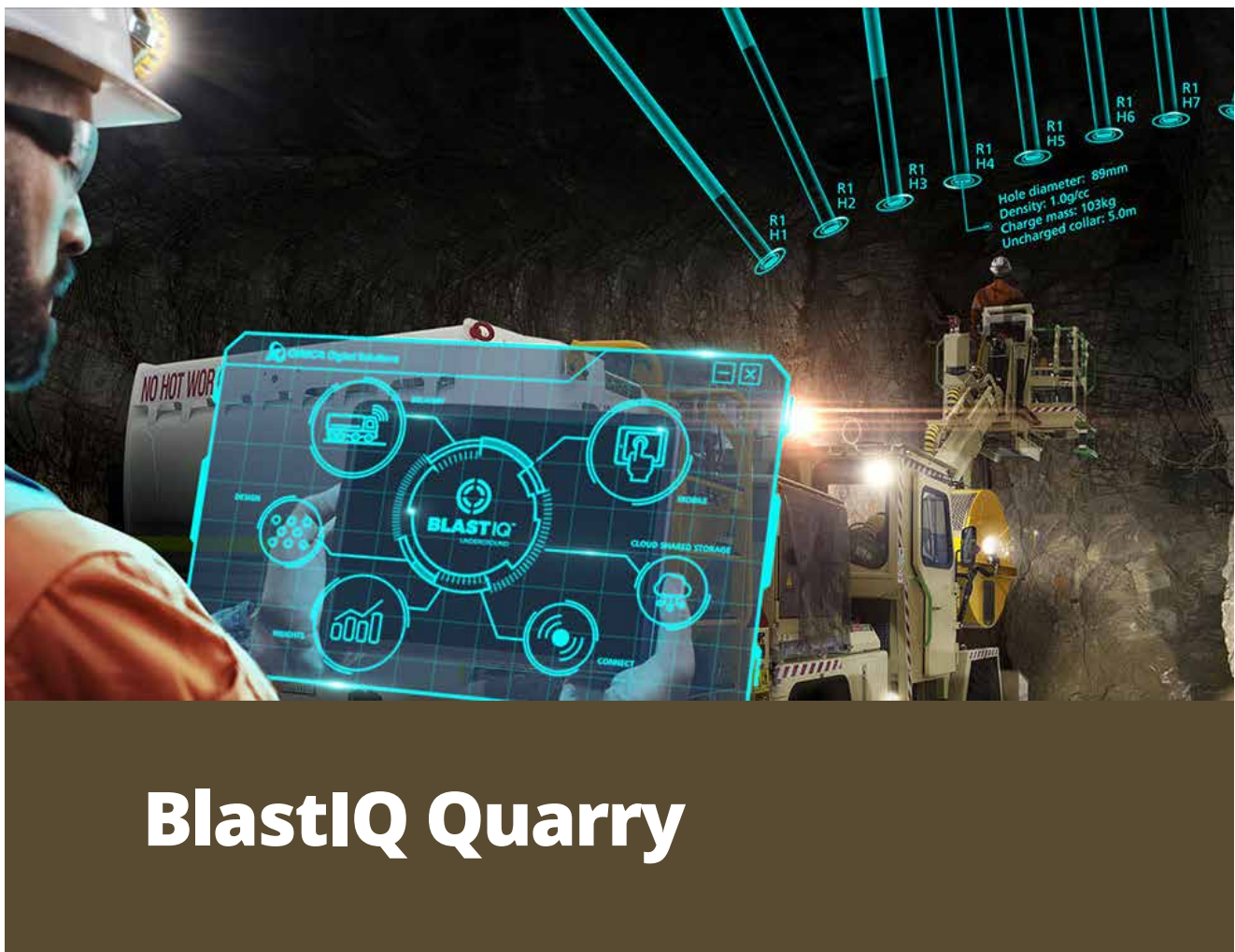
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# BlastIQ Quarry

Orica Digital Solutions combines Orica's 150 years of experience and know-how with powerful technologies to mobilise the earth's resources more precisely, efficiently, and sustainably. The ecosystem seamlessly connects the physical and digital worlds, giving customers the right intelligence at the right time across their operations for better decisions and more predictable outcomes at every step of the value chain, from exploration to processing.

Digital technologies are becoming increasingly vital to a quarry's daily operations, and Orica Digital Solutions has shared how customer feedback has shaped BlastIQ™ designed for the quarrying sector.

BlastIQ™ Quarry (**Figure 1**) delivers streamlined and improved blasting through smart and integrated solutions, offering quality control throughout the drill and blast process to deliver cost savings and superior blast outcomes. It allows quarry operators to design blasts according to performance objectives and presents drill and blast insights for continuous blast optimisation.

Orica Digital Solutions Senior Manager for Technology, Matthew Craft, details the key benefits of the blast control solution for the quarrying industry.

"BlastIQ™ Quarry guides an operation through better blasting by digitising drill and blast data while also implementing a best practice workflow. The technology tracks change by monitoring compliance to design and

blast performance. BlastIQ™ Quarry can provide further value by being augmented with natively integrated products such as AVM and FRAGTrack™ for a true continuous improvement loop."

Designed in collaboration with customers, BlastIQ™ Quarry is a user-friendly system that saves engineering and operations time across the drill and blast process, from planning to blast performance analysis.

Craft said the smart digital blast optimisation platform provides a single source of truth and delivers instant pre- and post-blast insights. Operators can collate their data digitally instead of manually handling paper-based information and derive insights to inform their drill and blast performance.

Complementary applications to enable a synergistic workflow include the SHOTPlus™ blast design and modelling software; BlastIQ™ Mobile, which places blast designs and hole conditions in the palm of field operators and engineers; and BlastIQ™ Insights, which enables the tracking of key performance indicators and comprehensive document storage.

"These technologies work together to offer customers improved productivity. The blast loading instructions and rules are instantly digitally communicated to field operations to ensure the right explosive product and quantity is used at the right place and initiated at the right time." Craft said.





**Figure 1:** BlastIQ™ Quarry offers extensive quality control throughout the drill and blast process to deliver cost savings and superior blast outcomes

Operations can achieve improved in-field blast quality control and assurance by using the BlastIQ™ Mobile application, which captures auditable data directly. Operations and engineering personnel can share the blasthole condition, which is captured in near real-time, allowing data to empower rapid decision-making and improved operational efficiencies.

With these features, BlastIQ™ Quarry can integrate easily into existing operational systems and processes.

“This allows quarries to improve blast quality control, eliminate rework, and reduce excess drilling and explosives consumption,” Craft said.

“It allows quarry operators to confidently optimise their drill and blast activities, reduce costs, improve productivity, and manage regulatory compliance, ensuring the long-term success of their quarry operations.”

BlastIQ™ Quarry is compatible with the public application programming interface and allows custom reporting and software integration in a single workflow. The electronic capture and transfer of field data to BlastIQ™ Insights eliminates manual entry and enables rapid reporting, intelligence, and audits with minimal transcription errors. Orica Digital Solutions designed the platform to eliminate

excess expenses and reduce the risk of poor environmental outcomes while enabling efficient documentation management.

“Smart and automated capabilities ensure the right explosive product with the right energy is loaded. Blast documentation and job pack functionality ensure relevant documentation is uploaded through the drill and blast execution process,” Craft said.

Craft said other key features include remote auditing, centralised collaboration, and market-leading blast design tools.

“With information securely and centrally stored, drill and blast information can be audited remotely. In addition, information can be shared collaboratively via cloud-hosted web portals,” he said.

“Exception reports can be generated to provide better visibility to manage blast quality control. Market-leading blast design tools are available for survey, profiling, loading and timing rules.

“BlastIQ Quarry undergoes continuous development and the team at Orica Digital Solutions continues to work with users to improve its value.”



# Kleemann | New compact crusher used for recycling



**The new mobile impact crusher MOBIREX MR 100i NEO from Kleemann is used in Nordhorn near the Dutch border. The new development is used for recycling concrete and rubble.**

**T**he MOBIREX MR 100i NEO is characterised by a robust design and flexibility. Thanks to the compact design, the mobile impact crusher can also be used in very tight spaces. The operator is convinced by the machine's sturdy design, technical innovations, performance and user-friendly handling.

### **USER-FRIENDLINESS AND SAFETY**

A new feature of the plant is "Lock & Turn Quick Access". The system enables the quick and tool-free opening of the crusher housing. Opening and closing only takes 30 seconds and works practically at the touch of a button. This simplifies access for maintenance work, when jams need to be cleared or impact bars replaced. The safety and efficiency during operation are also improved. In the hectic day-to-day life of recycling, this saves time, ensures smooth operation and increases the safety for the operators.

### **SAFE AND SIMPLE: GAP ADJUSTMENT AND DETECTION OF OVERLOADING**

Another highlight of the MR 100i NEO is the fully hydraulic

gap adjustment and overload system. The gap adjustment as well as the zero point determination are realised to the nearest millimetre at the touch of a button. This means that manual measurement, loosening screws and the ultimate positioning are not necessary.

The overload system ensures that the machine itself is protected against serious damage in the case of uncrushable material such as large iron parts. When it is triggered, the pressure plate breaks so that the rocker arm can get out of the way. This protects the rotor, the rocker arm and the crusher housing effectively. In such a case the pressure plate is replaced by the operator on the construction site, which works out much cheaper than damage to the rocker arm or in the crusher itself.

### **SIMPLE HANDLING WITH SPECTIVE CONNECT**

The operation of the plant is user-friendly thanks to SPECTIVE CONNECT. Important functions such as the crushing gap setting and troubleshooting of the belt weigher can be viewed comfortably from a distance, and in the future viewing of the production data will also be





available. This helps less experienced staff to familiarise themselves quickly and operate the plant safely. "The handling of the machine is really a major advantage for us. With our previous small impact crusher it was much harder for us to make settings, let alone have a digital solution which would give us such a comprehensive insight into machine data, etc. SPECTIVE CONNECT is therefore a real benefit here", adds Wouter Fahner, Managing Director of E+F Recycling GmbH.

**SATISFIED WITH THE COOPERATION**

In addition to the positive impressions on site at the factory in Kleemann Göppingen, the professional advice from the Kleemann experts of Wirtgen Germany was also crucial in the decision for the new compact crusher. The customer appreciates the proximity to the North German site of the German Wirtgen Group sales and service company because wear and spare parts can be easily ordered and a service technician is also always easy to reach in the event of problems.

In addition to the MR 100i NEO, the recycling company also

uses a mobile stockpile conveyor MOBIBELT MBT 24i to optimise construction site logistics. The fleet also includes the mobile coarse screening plant MOBISCREEN MSS 802i EVO and soon the smaller MOBISCREEN MSS 502i EVO – both are used for soil preparation, among other things.



# MINING & QUARRY WORLD

## Overview

*Mining & Quarry World* has expanded to become an international publication covering the surface and underground mining sectors. *Mining & Quarry World* will cover a wealth of technical articles, site visits, health and safety related issues alongside financial news, products and equipment in every issue.

We understand your need to get your marketing message out to the intended audience, *Mining & Quarry World* is regarded as one of the worlds leading publications serving the Mining Industry for equipment suppliers and service companies. With over 180,000 mining professional contacts on our database, this publication truly reaches a worldwide audience.

Further articles of interest will be added throughout the year. Should your company wish to contribute any articles or white papers of interest please note the copy deadlines.

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- Besides a wealth of feature and technical articles, site visits and industry news, *Mining & Quarry World* also covers health & safety, sustainability, technological innovation and financial news, alongside new products & equipment in every issue covering both underground and surface operations

## Mining and Quarry World topics to be covered throughout the year 2025

**Sustainable Mining Practices:** Case studies and innovations in reducing the environmental footprint of mining operations.

**Digital Transformation in Mining:** The impact of digital technologies, including AI and IoT, on mining efficiency and decision-making.

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**Critical Minerals and Rare Earth Elements:** The growing importance of these materials in technology and clean energy sectors.

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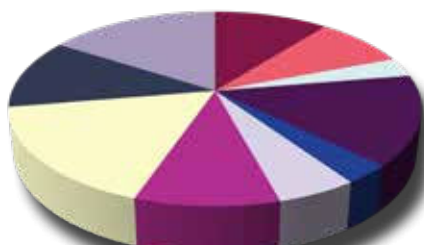
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Double page centre spread	£2,500	£12,500	Article placement in <i>Mining and Quarry World</i>	£1,200p/p	POA for multiple pages
Full page	£1,700	£8,500			

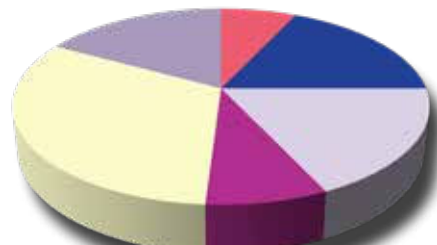
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### Circulation by commodity



12%	Coal	3%	Diamond
15%	Gold	6%	Nickel
8%	Silver	14%	Iron ore
3%	Uranium	10%	Potash
9%	Aggregates	15%	Copper
5%	Molybdenum		

### Circulation by business sector



13%	Exploration & drilling companies
36%	Mining operations
2%	OEMs & service providers
25%	Operating companies
6%	Major aggregate companies
18%	Processing & materials handling

Others include - smelters, steel processes and PR companies

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# MINING & QUARRY WORLD

## Proposed subjects for Mining & Quarry World

Every issue of *Mining & Quarry World* contains the latest news, new plant and equipment, health, safety and sustainability and digitisation issues affecting the industry. Site visits plus a one on one interview with top executives and engineers within the industry. All year round focused articles from exploration through to production.

### February

- Mining Trucks/Automation
- Slurry Pumps
- Underground Drilling and Blasting
- Mining and sustainability case studies and innovations
- Conveying underground
- Digital mining
- Signals and communications
- Hydraulic Breakers
- Blasthole drills
- Reducing your carbon footprint

**Copy date: 28th February 2025**

### August

- Wheel loaders and dozers
- Grinding mills
- Surface and underground conveying
- Electric rope shovels
- Crushers
- Sustainable mining
- Underground mining trucks
- Ventilation
- Fleet optimisation solutions
- Rock breaking and associated attachments

**Copy date: 30th August 2025**

### April

- Hydraulic mining shovels
- Dewatering pumps
- Rock drilling and rock reinforcement
- Mining automation
- Explosives technology
- Tyre technology
- Workforce transition
- Digital transformations and mining software solutions
- Lubrication
- Rock drilling tools

**Copy date: 30th April 2025**

### October

- Mining automation and information management
- Excavator and dragline attachments
- Underground crushing equipment
- Mineral comminution
- FLP Underground drives
- Scoop trams
- Gas monitoring
- Critical minerals and rare earth elements
- Transitioning mines to a sustainable future
- Fleet optimisation solutions

**Copy date: 30th October 2025**

### June

- Bulk material handling systems
- Sustainable mining practices
- Crushers
- Overland Conveying
- Data and software management tools
- Roof bolting and strata control
- Ventilation systems
- Pneumatic equipment in mining
- Wheel loaders
- Transitioning to an electric mine

**Copy date: 30th June 2025**

### December

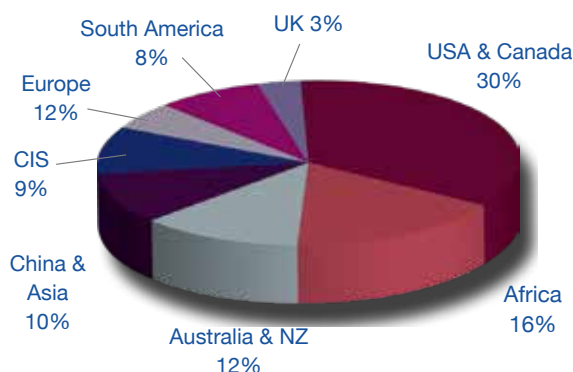
- Hybrid mining machines
- Mine planning and design software
- Autonomous mining and fleet optimisation
- Conveyor dust suppression
- Screening equipment
- Drilling rigs
- Off – highway trucks
- Community engagement and social responsibility
- Tailings Processing equipment

**Copy date: 30th December 2025**

Further articles of interest will be added throughout the year, if you would like to forward articles for consideration please contact [gordon.barratt@tradelinkpub.com](mailto:gordon.barratt@tradelinkpub.com)

**Mining and Quarry World will be attending major exhibitions around the world (as listed on page 4) ensuring your message reaches its intended audience through our bonus copy distribution.**

### Circulation by geographical area



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# MinExpo 2024..... The Good and the Great

**It is hard to believe that 4 years have passed since the last MINExpo show, however, with all pandemic restrictions and fears a thing of the past we now welcomed MINExpo 2024, as always we looked forward in anticipation to viewing a veritable mine-fest of innovation, gigantic machinery and the opportunity to collaborate, discuss, challenge, learn and engage current thinking, practices and the way forward for the industry, with like-minded individuals.**

**T**he National Mining Association (NMA) is the only national trade organisation that serves as the voice of the U.S. mining industry and the hundreds of thousands of American workers it employs before Congress, the federal agencies, the judiciary and the media, advocating for public policies that will help America fully and responsibly utilise its vast natural resources. *Gordon Barratt* representing both *Mining & Quarry World* and *Coal International* never fails to be impressed by the technological advances in mining showcased at this event and explores in person every level of mining, sourcing and investigating cutting-edge concepts and new-to-market equipment, however, an almost impossible task would be to try to cover all the “good and the great” who attended this show, so...here is an oversight of some of the key companies exhibiting this year.

## MONTABERT

During the MinExpo 2024 show it was a great pleasure to have a detailed discussion on Montabert breakers with Aaron Scarfia General Manager of Montabert USA, what Aaron and his team don't know about breakers, probably isn't worth knowing I was given a full tour of their products on display and at the end of it all I was a little wiser and more knowledgeable about these beasts of the mining and construction industry. Since 1921, Montabert products have been produced with a commitment to designing methods and solutions focused on productivity, reliability and safety.

Continuous investment in research and development has resulted in the delivery of technology products that revolutionise the construction and demolition industries. For almost 100 years, Montabert products have led these industries, with three to five patents a year.

Montabert products have been produced with a commitment to designing methods and solutions focused on productivity, reliability and safety.

Montabert drifters result from years of experience in hydraulic rock breakers and drifters design and manufacturing. In-depth knowledge of shock wave transmission and percussion mechanism theory has allowed engineers to be the first to develop new concepts such as hydraulic dampening and progressive blow energy.







**DRIFTERS**

Montabert drifters are the result of years of experience in hydraulic rock breakers and drifters design and manufacturing. In-depth knowledge of shock wave transmission and percussion mechanism theory has allowed engineers to be the first to develop new concepts such as hydraulic dampening and progressive blow energy.

**CPA DRILLING ATTACHMENTS**

With Montabert CPA drilling attachments, your hydraulic excavator becomes a multi-purpose tool for loading, trenching and blasting.

The use of innovative high-performance technology in product design and manufacturing makes Montabert equipment the most efficient and reliable choice for customers around the globe.

With a network of 150 dealers around the world, you will always find a Montabert-certified partner close to you to provide the best service and solutions as they have a comprehensive support team that can provide help in any aspect.





The ZJ32 drill and ZB31 bolter expand product offerings to meet customer demands

## KOMATSU LAUNCHES A NEW LINE OF MEDIUM-SIZE CLASS FACE DRILLING RIGS AND BOLTERS

Underground hard rock mining operations looking for versatile solutions now have two more options. Komatsu is excited to introduce the new Z3 series of medium-size class development jumbo drills and bolters to its lineup, further broadening Komatsu's selection of offerings for the underground mining industry.

The Z3 machines are built on a universal platform and designed with a focus on modularity and efficiency. This focus offers improved productivity that can help reduce service and maintenance costs across operations. The Z3 also boasts universal operator controls, simplifying user adoption and increasing training efficiency. The new series expands Komatsu's current underground hard rock offerings by adding the ZJ32 and ZB31 medium-size class drill and bolter.

Key features include innovative technology, such as a newly designed ground support installation system developed in collaboration with JENNMAR that utilises their J-LOK P pumpable resin. In addition, the machines' drilling attachments have limited moving mechanical parts and offer a simple design for smooth operability, resulting in reduced cycle times and increased drifter uptime compared to competitors in the same size class.

"Our Z3 product line was designed to meet the evolving demands of our underground hard rock mining customers," said Johan Kempe, Product Director, Underground Drills, Komatsu. "The common platform on which both machines are built enables the interchangeability of parts and service, boosting operational productivity for customer operations."

In the near future, additional battery and intelligent machine control models of the Z3 series will be added to the lineup to provide customers with a comprehensive range of offerings to meet their demands. This product family of diesel and battery-powered machines will offer innovative solutions to support underground mining operations with a pathway toward autonomous operations.

For a firsthand look at the new Z3 series of products and other advanced mining solutions, visit Komatsu at booth 7132 in Central Hall at the Las Vegas Convention Center from September 24 to 26.

## KOMATSU EXPANDS HARD ROCK CRUSHING LINEUP WITH THE INTRODUCTION OF THE HRX800

Komatsu is proud to announce the expansion of its hard rock crushing equipment portfolio with the introduction of the HRX800 sizer, an innovative solution designed to enhance efficiency and productivity while reducing waste. This product line extension underscores Komatsu's commitment to providing customers with robust, high-performing machines that drive production growth and add value to their mining operations.

Komatsu's comprehensive crushing lineup includes feeder breakers, reclaim feeders, mobile crushers and sizers, all engineered to meet the demanding needs of modern mining operations.



A Komatsu ZJ32 designed for underground mining applications.





sizers can be successfully applied, delivering the power and performance our customers expect from Komatsu while offering the flexibility needed in today's dynamic mining environments



The HRX1000, a standout in Komatsu's crushing lineup, will be on display at the upcoming MINExpo 2024 in Las Vegas. This primary crusher is designed to accept run-of-mine materials and crush them to a size suitable for conveyor transport, making it a crucial component in mining operations that demand high production capacity. The HRX1000's innovative pick technology efficiently breaks down minerals in tension, reducing the need for multiple crushers and lowering operating costs. Its versatility makes it an invaluable asset in a wide range of mining applications.

The HRX800, launching at MINExpo 2024, represents the next step in Komatsu's evolution of crushing technology. Designed for hard rock applications, the HRX800 is a smaller-scale alternative to the HRX1000, providing the same high capacity and efficiency in a more compact form. This sizer is ideal for both underground and surface installations, offering the benefits of fines reduction in demanding applications of hard abrasive minerals or wet and sticky material.

"We are excited to introduce the HRX800 to our customers," said Brandon Phillips, Global Product Manager of Sizers and Feeder Breakers at Komatsu. "The HRX800 is designed to push the envelope on where

For a firsthand look at the HRX1000 and to learn more about the launch of the HRX800, visit Komatsu at booth 7132 in Central Hall at the Las Vegas Convention Center from September 24 to 26.

**KOMATSU SHOWCASES COMMITMENT TO THE COAL INDUSTRY**

Komatsu reaffirms its dedication to supporting coal customers and remains steadfast in its long-term commitment to the industry. With over 100 years of experience and a robust roadmap for the future, Komatsu continues investing in cutting-edge automation, innovative products and service solutions to help its customers achieve peak performance, safety and sustainability.





Investments in automation and innovation provide customers with products and services to meet their needs

Komatsu's continued evolution of automation solutions bolsters its dedication to the coal industry's future. Using advanced, web-based controls, Komatsu's Longwall Command and Control is removing operators from hazardous environments and enabling remote management of equipment. This solution allows for centralised management of mining equipment and brings consistency, productivity and safety to a new level. In step with advancements in longwall, Komatsu is driving innovation in room and pillar mining with industry-leading continuous miner automation.

Highlighting its latest advancements in longwall mining product solutions, Komatsu is featuring the next-generation Joy J7500 shearer ranging arm. The J7500

ranging arm offers greater productivity, power and reliability over its J525 predecessor. A longer arm enables an improved tailgate cut past, up to a 50% increase in motor power and increased geartrain life. Notable maintenance improvements, such as gob-side water seal access and a modular planetary subassembly, enhance efficiency.

Additional longwall mining features, including the latest in AFC pan lines, Powered Roof Support (PRS) Design Services and Electrohydraulic Control Systems, reinforce Komatsu's investment in coal mining solutions.

Further enhancing its customer commitment, Komatsu is investing in and expanding its service offerings. Through Komatsu's Application Engineering Services offering, its experienced mining engineers are positioned to assist customers in optimising equipment use, finding efficiencies and elevating mine productivity. The full-service support suite also includes quality parts and rebuilds, effective training solutions, responsive field service and insightful machine analytics to meet and exceed customer expectations.

"Komatsu remains fully committed to the coal business, and we will continue to invest in the technologies that help our customers operate safely, productively, and sustainably," said Dan Spears, Soft Rock AMNO Vice President at





Komatsu. "From our latest machines to advancements in automation, we are dedicated to providing innovative products and services that meet the evolving demands of the industry." With a focus on long-term partnerships, Komatsu remains a trusted name in coal mining and is dedicated to advancing the industry through products, services and technological innovation.

Komatsu reaffirms its dedication to supporting coal customers and remains steadfast in its long-term commitment to the industry. With over 100 years of experience and a robust roadmap for the future, Komatsu continues investing in cutting-edge automation, innovative products and service solutions to help its customers achieve peak performance, safety and sustainability.

Cat® wheel loaders are some of the most productive machines in your operation – working wherever you want, whenever you want them. Built for efficiency, they give you the mobility and flexibility you need to optimise your loading and hauling operation and lower your overall costs. You count on them to boost your productivity – and your profitability.

That's why we make sure Cat wheel loaders not only help you meet your productivity targets but exceed them. When they're not loading material, their versatility and mobility makes Cat wheel loaders valuable support machines. And with industry-leading service life and uptime, they'll keep your operation productive for years to come.

Cat large wheel loaders deliver optimised power for fast cycle times and continuously high bucket fill factors on every dig cycle. No matter the size, they have the capability to quickly dig through material and the power to lift full buckets. They're proven to deliver industry-leading availability, working around the clock to keep production moving. And they come with a variety of ground engaging tools to help you make the most effective use of your machine, no matter the conditions on your site.

Whether you're ready to integrate your first basic technology product or well down the path toward autonomous mining, there's a Cat® MineStar™ Solution for you. MineStar has the ability to track, monitor, automate and manage all types of assets — from people to production machines to light vehicles on site. Whether you deploy a single technology or a multi-purpose solution, you can expect a safer, more productive and more efficient operation.

## Haver & Boecker Niagara

Haver & Boecker Niagara is a leader in screening and pelletizing and has a mission to deliver the best of these technologies to customers in the mining, minerals, aggregates, cement, construction materials, fertilisers and salt industries. With deep roots and years of experience in these industries, they use innovative and shared technologies to effectively meet the needs of customers around the world.

Washington Samuel Tyler founded The W.S. Tyler Company in Cleveland, Ohio in 1872 with the basic operating principle, "our products are not an end in themselves, but a means by which our customer can accomplish something useful and profitable."



In 2019, Haver & Boecker Niagara launched a new, global brand for mineral processing technology, representing three manufacturing companies in Germany, Brazil, and Canada, but also their mineral processing expertise throughout the world.

It combines the long-term success of Haver & Boecker and W.S. Tyler with worldwide engineering and application expertise to help customers address their screening challenges more efficiently and more profitably than ever before. Their goal is to offer a complete portfolio of innovative mineral processing technologies to better meet the needs of customers.

Haver & Boecker Niagara is more than merely a name, it represents their heritage and our legacy, both in the past and future.

The Niagara F-Class vibrating screen offers the ideal solution for challenging screening applications requiring consistent performance, load independence and minimal vibration transmission into the structure.

### FEATURES & BENEFITS

- Dynamically balanced design eliminates dynamic loads transferred into the structure to allow for multiple machine installations.
- During overloading, surging and starting and stopping under load, the mounting system, drive and base frame maintain process reliability.
- Double eccentric, four-bearing shaft assembly enhances positive circular motion, ensuring the most effective screening action while minimising blinding and pegging.



Niagara F-Class Eccentric Inclined Screen

- Customised with cambered or flat decks to accommodate virtually any combination of side-tensioned or modular screen media.
- Side-tensioned deck set-ups incorporate the Ty-Rail™ quick-tensioning system, which cuts screen change-out times in half.
- Every side-tensioned deck is engineered with Ty-Rail, a patented quick-tensioning system designed to reduce change-out time by half.
- Side-tensioned deck set-ups incorporate the Ty-Rail™ quick-tensioning system, which cuts screen change-out times in half.



Niagara XL-Class High-Capacity Linear Screen

The Niagara XL-Class vibrating screen combines advanced exciter drive technology with a wide body to offer producers high-capacity screening action up to 15,000 tons per hour. It is intended for high tonnage production rates, yet designed for low maintenance, easy operation and unmatched reliability.

Each machine is custom-designed to its specific application using Finite Element Analysis to predict the high-stress areas and natural frequencies of the vibrating screen.

### BODY DESIGN

- Optimised to customer requirements with application-specific body design – supported by Finite Element Analysis.

### DECK OPTIONS

- Large deck sizes maximise feed rates.
- Available with flat deck for modular screen media panels, including pin & sleeve, snap-in, groove or bolt-

### SIDE PLATES

- Fully-bolted side plates without welding eliminate cracking and extend machine life.

### MOTOR SUPPORT

- Overhead, bridge-mounted drive system does not interfere with the material flow path maximising reliability and extending maintenance intervals.

### NEGATIVE SLOPE

- A slope from -3 to 10 degrees allows the force of gravity to keep the water back while the linear action moves material down the deck allowing for more efficient separation of fines from the coarse material and maximising production.

J.H. Fletcher & Co. is one of the top global producers of custom underground mining equipment. The company has engineered and manufactured solutions since 1937, creating a diverse product line. Fletcher roof bolters are world renowned and accompanied by an entire product line of technological machinery focused on worker safety and productivity in underground mining. At the core of Fletcher, is the value in what their customers say. Since opening for business, Fletcher has been answering some of underground mining's toughest questions. Fletcher provides an atmosphere for an open dialogue with customers to ensure their operations are reaching.

“Our goal is to manufacture equipment for underground mining that increases safety and production through engineering innovation, quality control, experienced service and ownership stability.” J. Robert Fletcher

The Fletcher PAN-DR model bolter is specially designed to control inby roof and face while preparing for longwall moves. Can mount on shield mover and use as a utility bolter between moves. This machine can reach seam heights as high as 16'.





**JENNMAR** has been an innovative leader in ground control for the mining industry for more than forty years. Their brand of affiliates provides the ability to offer a complete range of complementary ground control products and services ensuring quality, efficiency and availability, resulting in reduced costs, reduced lead times and increased customer satisfaction. Their contribution to the mining and tunnelling industries is second to none providing customers with a range of products and services

**JENNCHEM** is the world's largest installer of underground standing support and ventilation control devices, pumped from the surface of mines and tunnels. JENNCHEM designs, delivers, and provides on-site services and support for chemical roof support, rock stabilisation, and ventilation sealing products to the mining and underground construction industries.

**IMMERSIVE TECHNOLOGIES LAUNCHES “WORLD FIRST” UNDERGROUND MINING SIMULATOR TECHNOLOGY AT MINEXPO 2024**

The Immersive Technologies IM360+ was unveiled for the first time publicly at MINExpo, along with never before seen visual system innovations to drive value for underground miners. This solution is designed for underground miners, who often face unique challenges in equipment operator training.



J-CRIB®, a pumpable standing support, provides significant strength and logistical advantages over traditional coal mine standing support.

Equipped with a best-in-class visual system, the IM360+ is the first underground mining simulator to combine stereoscopic 3D, photo-realistic graphics and RealView™ head tracking technology. The IM360+ delivers realism and training value at a level not previously seen by the underground mining industry. The platform builds on the huge success of previous Immersive Technologies platforms that have become the global standard in the mining industry over the past 30 years, training over 250,000+ mining equipment operators across 51 countries.



Ultra-X Foam is a two-component grout that is intended for, strata consolidation, coal face reinforcement, and large or small cavity filling.

The IM360+ offers:

- **High Fidelity** – Class-defining 3D stereoscopic display system with true to life graphics delivers depth perception and sensory immersion at the highest levels possible.
- **Reliability & Asset Life** – Designed to operate continuously in harsh mining environments, the IM360+ utilises professional grade components with extremely



J-SEAL is a specialised foaming cement which can be used for backfilling behind steel sets or other general backfilling applications in coal or hard rock mining.

JENNCHEM's 120 psi. Mainline J-SEAL is MSHA approved and can be used with a variety of form designs including wood, concrete block, props and mesh.





high uptime. The platform is based on the most durable design in mining simulation that has a proven asset life of 10+ years.

- **Training Value** – Providing best-in-class training value and continuous improvement capability. The IM360+ incorporates new technologies designed to increase training retention and trainer efficiency. You can expect the highest level of skills transfer to the job in the shortest time possible, creating real operational value.
- **Safety & Comfort** – The IM360+ incorporates best-in-class safety and comfort with air conditioning and heating capacity for the most extreme environments, zero trip ultra-low profile motion platform, and positive pressure airflow system to prevent dust entering from the mining environment.

"Our close collaboration with mining companies paired with our extensive mining technology experience is a catalyst for innovation to solve real mining challenges. At MINExpo 2021 we launched the PRO5 for surface mining and the uptake has been massive due to the training value of stereoscopic 3D and true to life graphics. We knew that underground miners needed a similar capability, so we launched the IM360+ at MINExpo 2024. This is another big step towards our mission to make resource companies measurably safer and more profitable."

Immersive Technologies' Advanced Equipment Simulators are the mining industry's benchmark solution for operator training and workforce optimisation. These platforms have an unparalleled track record in the delivery of quantified safety, productivity and unscheduled maintenance improvements, including verified real results by **BHP**

**Billiton, Rio Tinto, Vale, Glencore, Barrick, Newmont, Freeport-McMoRan and Anglo American.**

This track record of innovation and customer success has led to Immersive Technologies being the industry's leader in innovation and the preferred partner with a dominant market share across simulation of all major mining OEM equipment.

- 90% of the World's top 10 mining companies
- 80% of the World's top 20 mining companies
- 360+ Global Mining Operations supported

## Caterpillar: Showcasing Solutions for the Mines of the Future

The Caterpillar MINExpo 2024 experience immersed visitors into the mine site of the future—showcasing industry-leading technologies, advancements in the energy transition and customised solutions designed to increase efficiency, safety and profitability.

The planned 2024 exhibition reinforced Caterpillar's position as a leader in mining technology with proven results in autonomy and automation and demonstrated progress in greenhouse gas reduction technologies.

"Caterpillar's legacy is to deliver an exceptional experience at every job site through customer focused solutions and services," says Denise Johnson, Caterpillar Resource Industries' group president. "As our exhibit shows, together with our customers, we are mining better, smarter and safer. And this is just the beginning of our closer-than-ever before collaborations with customers."

## SUPPORTING THE ENERGY TRANSITION

The company's latest innovations to support the energy transition – like the 372-tonne (410-ton) Cat® 798 AC Mining Truck configured for autonomous haulage with Cat MineStar™ Command for hauling.

“We believe systems, such as Command for hauling, are essential to optimise mine site performance, both with our current product line and as we introduce new offerings like our battery electric solutions,” comments Marc Cameron, senior vice president, Caterpillar Resource Industries. “Autonomous technology will help monitor and orchestrate the complex balance of onboard energy, available charging assets and production targets to achieve the lowest operating costs.”

Two Cat underground load-haul-dump (LHD) loaders on the show floor offer reduced emissions. The Cat R1700 XE Underground Loader features battery-electric propulsion that produces zero exhaust emissions and generates less heat than a reciprocating engine powered model. And the Cat R2900 XE Underground provides a high efficiency switch reluctance electric drive system that meets the mining industry's needs for bigger payloads, faster loading and lower emissions.

Also on display will be a 12.2-m-long (40-ft-long) PGS 1260 HD Energy Storage System (ESS) module, which offers energy storage for charging battery electric machines, and the Cat MEC500, which provides mobile equipment charging for the underground mining industry.

“Since MINExpo 2021, our teams have made incredible progress with the development of our electric technology and supporting solutions,” comments Brian Weller, vice president of electrification, Caterpillar Resource Industries. “We have been working side-by-side with select customers to accelerate the deployment of Caterpillar's first battery-electric haul trucks. These machines will soon be operating at our customers' sites where they will be tested and validated across a variety of applications.”

## SHOWCASING MINING TECHNOLOGY

From fleet management to fully autonomous machine operation, Cat MineStar™ technology has helped transform the mining industry. Caterpillar provides building block technology packages that are scalable to meet the mining operation's needs as it moves along the technology integration journey. Special conversation stations are set up to allow visitors to engage with technology experts and view demonstrations of solutions for surface and underground operations

Every piece of equipment on the show floor will be infused with various levels of technology. In addition to the ultra-class 798 AC featuring Command for hauling, the R2900 XE LHD will be equipped with Cat MineStar Command for underground, which enables remote machine operation. The diesel-electric LHD will also feature MineStar solutions that safeguard against unintended interactions between personnel and assets and enhance operator alertness, both enhancing operating safety.







Optional onboard technologies available for the Cat 995 Wheel Loader include Payload Overload Prevention, Operator Assist and Operator Coaching.

Caterpillar is set to launch two new technology offerings to the MineStar ecosystem at the show:

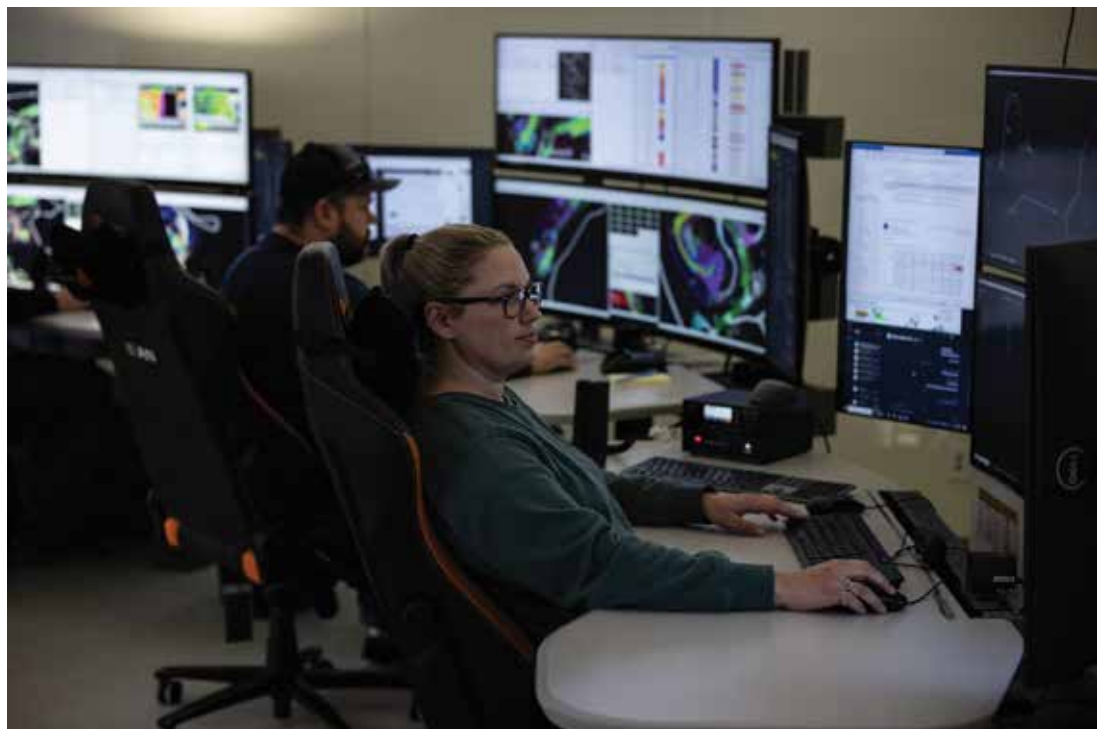
- Delivering the next layer of safety, the Collision Awareness System (CAS) is a site-wide solution that uses the latest in technology advancements to enhance situational awareness by warning operators of potential machine interactions before they have a chance to happen. CAS will be highlighted on the 995 and 798.
- A new office application for Payload Management expands the payload tracking technology to Cat Electric Rope Shovels and Draglines.

Showcasing the capabilities of MineStar Command technology, two remote operating stations will give visitors the chance to operate a dozer or rotary blasthole drill located hundreds of miles away from the Caterpillar exhibit. A third station will

offer simulations of Cat Command for underground, demonstrating the technology's versatility and ease of use.

Virtual reality experiences will allow attendees to experience the Cat 7495 Electric Rope Shovel and 6060 Hydraulic Mining Shovel.

"Customers will experience our latest technology innovations and autonomous developments throughout the Caterpillar show floor at MINExpo," says Sean McGinnis,



vice president and general manager of technology and global sales support for Caterpillar. "Mine site automation makes significant impacts in operations and not just with autonomous haulage. Today, we have customers around the world utilising our autonomous solutions for drilling, loading, dozing, hauling and underground, and we are working with many customers to develop the autonomous sites of tomorrow."

### CATERPILLAR DEMONSTRATES NEW AUTOMATED ENERGY TRANSFER SOLUTION FOR BATTERY ELECTRIC LARGE MINING TRUCKS

Caterpillar Inc. is reinforcing its commitment to deliver product design choices in alignment with customers' operational, sustainability and productivity goals that increase the value of a machine throughout its lifetime. These designs align with Caterpillar's strategy to deliver integrated site solutions to support customers today and through the energy transition.

As the industry looks to the future, Caterpillar is purposefully designing a modular Cat® 793 large mining truck platform with powertrain flexibility. This platform will include diesel mechanical, diesel electric and battery electric options.

Additionally, Caterpillar is leveraging the knowledge and validation acquired through its Early Learner battery electric large mining truck program to drive common platform benefits for its ultra class trucks, including diesel electric and battery electric offerings for the Cat 794, 796 and 798 models.

Caterpillar has a legacy of designing products with customers' current and future needs in mind. For decades, Caterpillar and the Cat dealer network have provided flexible solutions to extend the life of mining trucks, including retrofit kits, update and upgrade programs and full machine rebuilds. These options can extend a customer's equipment to align with current products and technologies while reducing total cost of ownership.

Caterpillar Group President Denise Johnson says, "No matter the powertrain you desire, we will have a solution. Designing and supporting machine platforms that drive commonality, modularity and a seamless experience across our product lines is not new to us. Our large mining trucks are engineered to integrate with the technologies of today and of the future."

All current diesel electric and battery electric large mining truck platforms are also compatible with the recently announced Cat Dynamic Energy Transfer system, providing immediate benefit to mine sites that want to lower their operating costs and greenhouse gas emissions while providing flexibility for the future.

Caterpillar Senior Vice President Greg Hepler said, "Caterpillar recognises every mine site requires a unique plan to meet their sustainability objectives, which is why we are delivering a suite of integrated energy transition solutions, including machines with powertrain flexibility, energy transfer systems, energy storage and management capabilities, autonomy and fleet management systems. Together with our Cat dealers, we are committed to







supporting customers through every step of their energy transition journeys.”

Caterpillar showcased a new solution to support battery electric truck charging – the Cat® Automated Energy Transfer System (Cat AETS). The company successfully demonstrated this new technology for customers at its Tucson Proving Ground in Green Valley, Arizona.

Cat AETS utilises robotics, robust vision systems and controls to fully automate the connection between a battery electric machine and a two- to six-megawatt stationary charger. The system replaces the manual process of mine site personnel connecting and disconnecting a charger from a battery electric machine.

Cat AETS enhances mine site safety by removing site personnel directly from the machine charging process, facilitating a more fully autonomous site operation. Automating the charging process

can also reduce downtime and improve consistency and reliability of the machine charging process.

Caterpillar Senior Vice President Greg Hepler explains, “When it comes to meeting production goals, every second matters on our customers’ mine sites. Through our advancements in mining technology and automation, our repeatable processes enhance machine reliability and ultimately reduce downtime. Caterpillar is proud to offer the solutions that create benefits for the battery electric machine charging process.”





Weir's ESCO® NEXSYS™ GET Lip System for rope shovel dippers

Visiting MINExpo always offers a variety of experiences, none more so than the stand for Weir where an array of technologies and solutions were encompassing the transition to a low carbon economy.

Weir is an innovative, end-to-end solutions provider focused on accelerating sustainable mining. Weir showcased its marketing-leading brands and unveiled a range of new innovative technologies and solutions. Weir launched its ESCO® NEXSYS™ GET Lip System for rope shovel dippers, which lowers lip maintenance requirements, extends tooth and adapter life and, ultimately, provides miners with longer uninterrupted shovel operation.

Also unveiled was the new high-capacity ENDURON® ELITE screen. It's a double-deck banana screen, available in a range of sizes, the largest of which has a deck measuring 4.3m x 8.5m and weighs nearly 50 tonnes. It's driven by two exciters, whereas competitor machines of comparable size require three.

It will form an integral part of Weir's commitment to deliver transformational flowsheet solutions in which traditional tumbling mills are replaced by HPGRs and vertical stirred mills, potentially reducing energy consumption by up to 40%.

Another area of the display showcased Weir's Digital Hub, which highlighted Weir's digital offering – MOTION METRICS® and Weir's new digital brand, NEXT Intelligent Solutions.



Weir's new high-capacity ENDURON® ELITE screen

The new MOTION METRICS® ShovelMetrics™ Gen 3 Payload monitoring solution is designed to optimise truck loading and improve haulage efficiency by reducing both underloading and overloading. And as part of Weir's commitment to service its customers even in the most remote locations, MOTION METRICS® systems now support connectivity via Starlink, enabling reliable data transmission anywhere in the world.

NEXT Intelligent Solutions extend and expand Weir's current capabilities and transforms its process optimisation services into real-time digital solutions. Weir has developed digital packages for all of its market-leading solutions – pumps, cyclones, HPGRs, screens and hoses and spools – based around key customer needs: Insight, Uptime and Production.

The Digital Hub will use monitors to create a remote operation centre, allowing attendees to experience the same digital platforms and interfaces that Weir utilises to support its customers.

Attendees also had an opportunity to experience an interactive scale P&H 41000XPC shovel model demonstration of MOTION METRICS® ShovelMetrics™ Gen 3, as well as a ShovelMetrics™ model control station, featuring the same touch screen monitor and controller used by operators.

Weir experts from its digital, extraction, processing, comminution, tailings, and flowsheet solutions teams were available at the booth to continue conversations about how Weir is partnering with customers to accelerate sustainable mining.



The new MOTION METRICS® ShovelMetrics™ Gen 3 Payload monitoring solution



Weir's new digital brand, NEXT Intelligent Solutions.



## BHP showcases Jansen's future

BHP celebrated its inaugural sponsorship and participation in the Canadian Western Agribition, one of Canada's premier livestock and agribusiness events held in Regina, Saskatchewan.

The six-day event took place from November 25–30, drawing a crowd of over 143,000 people, blending livestock showcases, rodeos, education, Indigenous agriculture, and business networking.

Potash's critical role in sustainable agriculture was a key theme, with BHP highlighting its contributions to global food security.

At the Agri-Insights: Breakfast in the Barns, BHP asset president potash Karina Gistelink delivered a keynote speech emphasizing the broader impact of the Big Australian's Jansen potash project.

"Jansen isn't just about mining – it's about empowering farmers with

the tools they need to sustainably feed the world," she said.

BHP executives, including Gistelink and president minerals Americas Brandon Craig, visited the Regina Food Bank's innovative community food hub on November 27.

This visit followed BHP's \$350,000 investment in August to support the food sovereignty program and a mural by Indigenous artist Chanel Yuzicappi from Standing Buffalo First Nation.

BHP also sponsored the Indigenous Agricultural Summit, themed 'Nourishing nations and empowering generations'.

BHP Indigenous engagement manager Courage Bear highlighted the company's Jansen project contributions, including \$850 million in Indigenous business contracts since 2021 and a commitment to a 20 per cent Indigenous workforce by the mine's 2026 start.

As the presenting partner of the Maple Leaf finals rodeo, BHP celebrated resilience and athleticism while engaging with the local community.

"Agribition highlighted that Saskatchewan agriculture is not just essential to our province – it's a cornerstone of global food security," Craig said.

"With Jansen now over halfway to completion, BHP remains deeply committed to supporting farmers, strengthening communities, and ensuring Saskatchewan's leadership in sustainable agriculture continues to thrive."

In other news at BHP, the company has appointed Mark Bendall as group investor relations officer and will jump into the role from April 1 2025.



Bendall is currently the vice president transaction analysis and special projects in BHP's portfolio, strategy and development team.

He brings 25 years of experience in the global mining sector to the role, including natural resources investment banking across equity, debt and private capital markets, transactions, and corporate advisory across many regions.

Bendall replaces Tristan Lovegrove, who has recently relocated to London, and has been appointed group treasurer from October 1 2025.

## Barrick said to seek buyer for Tongon mine as bullion soars

Barrick Gold Corp. is seeking buyers for its Tongon gold mine in Côte d'Ivoire in an effort to sell the aging operation when bullion prices are surging.

The world's No. 2 gold miner started working with Toronto-Dominion Bank to identify buyers and solicit bids for the mine in late November, according to

people familiar with the matter, who asked not to be named discussing confidential matters.

Barrick and TD both declined to comment.

Barrick plans to stop production at the 24-year-old open-pit mine by 2027 given its depleting resources, according to company filings. The mine

produced 204 000 oz last year – about 5% of Barrick's overall gold output for the year. Barrick has a nearly 90% stake in Tongon, with the Côte d'Ivoire government and local investors holding the rest of the operation, 682 km north of the port city Abidjan.

### Price rally

Gold producers have seen higher valuations for mines this year as bullion prices hit successive record highs bolstered by central-bank buying, geopolitical uncertainty and interest-rate cuts. Barrick's rival, Newmont, has brought in \$3.9-billion from selling mines in 2024 – almost double its initial divestment target. Newmont's Akyem mine in Africa drew interest

from several Chinese firms and was ultimately sold to Zijin Mining Group for \$1-billion.

Barrick previously considered selling Tongon in 2019, without avail. The company had signaled it was weighing options for the mature operation during an investor event in November.

"Although we have continued extending Tongon's life, it has become increasingly non-core to Barrick, and therefore we are currently looking at strategic options for this asset," Sebastiaan Bock, Barrick's COO for Africa and the Middle East, said during the event. Disposing of the asset "will increase the quality of the portfolio and it will reduce the cost profile by more than \$50 per ounce."





# Modified ToughFlex® Belt for Overband Magnets

**B**unting has joined forces with Smiley Monroe to modify a ToughFlex® belt for Overband Magnets. The new belt is more resistant to excessive wear in arduous working conditions.

Overband Magnets have a permanent or electromagnetic block mounted between two pulleys over which continuously runs a cleaning belt. In operation, the Overband Magnet is suspended over a conveyor transporting material such as waste, both industrial and household, and quarried rock. The magnetic field of the centrally located

magnet block attracts ferrous metals and other magnetic materials up and out of the conveyed material. Between the magnet box face and the separated metal is a moving cleaning belt with upstands, which transfers the captured material away from the conveyor and out of the magnetic field into a separate collection area.

The separated metal is often angular with sharp edges, which can damage the rubber cleaning belt. In certain applications, such as when handling industrial and commercial waste, there is a high content of metal in a form that commonly causes belt damage.

In particular, customers using the ultra-strong but lightweight ElectroMax Overband Magnet are achieving high levels of metal separation which has resulted in

a higher rate of belt wear. The lower magnetic power of permanent Overband Magnets separated less metal and, subsequently, had less belt wear.

Whilst assessing methods to extend belt life in difficult applications, Bunting approached Smiley Monroe, a leading producer of endless conveyor belts, cut rubber

and plastic parts for the materials processing equipment manufacturing sector. Smiley Monroe routinely test the abrasion resistance, tensile strength and adhesion levels of both the cover rubber and fabric plies of our raw materials and finished products in their well-equipped labs, to ensure conformity to DIN, ISO and company standards.

After considering several options, Smiley Monroe recommended the 'ToughFlex® Belt'. ToughFlex® conveyor belts are designed to handle the toughest conveying applications, from bulk handling to mobile crushing. The belts are constructed with a special weave of two fabric plies and an additional binder warp. The plies are reinforced to resist puncturing and are protected with heavy duty, wear resistant top and bottom covers.

The belt material and design met the criteria for less damage from ferrous metal piercing and tearing the belt, even when extremely angular with multiple sharp edges. This meant less maintenance and extended production hours between replacing belts.

Once the belt material was selected, the engineering design teams of Bunting and Smiley Monroe worked together to modify the belt for use on an Overband Magnet, adding integrally moulded cleats for the transfer of captured ferrous metal.

"We [Bunting] are continually looking make improvements that help our customers," explained Adrian Coleman, Bunting's Technical Director. "An increasing number of our customers are turning to the ElectroMax Overband Magnet because of the increased magnetic power but compact design. However, for certain applications we identified a benefit of using a belt with better wear characteristics and contacted Smiley Monroe."







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