Reach for the sky

Catalysed by the data revolution, investor interest and a strong commodity demand outlook, mining software vendors are thinking big. Dan Gleeson evaluates the sector's overriding trends

Optimising the NPV of the asset in the ground and optimising the activities associated with extraction are two key focus areas for Hexagon's Mining division

There is tangible excitement from those developing and producing software for the mining sector; they are riding a technology adoption wave they all predicted but has only now come to fruition.

IM attempts to look beyond the industry hype – buoyed by a raft of M&A in this segment in the last 24-36 months – to find out how some of the sector's leaders are making the most of this positive demand scenario.

Optimising on the way to net zero

There are few companies that can compete with **Hexagon** in the software and sensor stakes, with the Sweden-based company now having a suite of technologies sitting under Hexagon's Mining division that have proven transformational across the decades.

Some of its mine planning solutions have been in existence since the 1970s, evolving with the increase in computing power and learnings that have taken place over the past 50 years.

The founders of the Hexagon Fleet Management System (FMS) were key contributors to the very first mining FMS released in the mid-1980s.

Hexagon's Mining division also has one of the very first collision avoidance systems within its offering, a solution it added with the SAFEMine acquisition in 2014.

"Simply put, we have that pedigree," Dave Goddard, Chief Product Officer, Hexagon's Mining division, told *IM*. "That pedigree, context of operations and historical data can continuously be brought back into any modelling that involves a mine site's economics or net present value (NPV)."

Goddard, who is less than a year into his new role, is focused on leveraging this historical data – including millions of near-miss collision avoidance data points, hundreds of mine plans and oodles of optimised haul routes – to generate the industry's most powerful machine-learning algorithms.

Putting these algorithms in the hands of its clients is all part of the wider 'data-first' strategy Hexagon – with the Power of One ecosystem – is pursuing in all existing and new product development.

This focus is also reflective of the state of the mining market and need to build software with more context.

"When you start looking across the software ecosystem, much of the focus is on analytics around just one process step of the broader mining value chain," Goddard says. "There is a prevalent theory that if you provide all the data, operations will magically gain insight out of it, yet this is reliant on the person on the end of that data being able to integrate and contextualise everything they are receiving from the platform and action a process on the back of it.

"At Hexagon, we realise this is a big ask."

Not only is the mining industry losing experienced personnel closing in on retirement; it is also struggling to access new university-educated recruits due to a shortage of institutions offering such tertiary education and competition for talent from other industries.

Those who are coming through the industry's wide-open door are, because of the skills shortage, accelerating up the hierarchy at previously unimaginable speeds.

"This means the new recruits are getting less opportunities for mentorship and coaching, resulting in having people broadly educated in mining, but lacking the practical skills that engineers, geologists and other personnel had in the past," Goddard said.

This places even more onus on software providers like Hexagon, which Goddard says the company is prepared for.

"One of the challenges we are confronting is
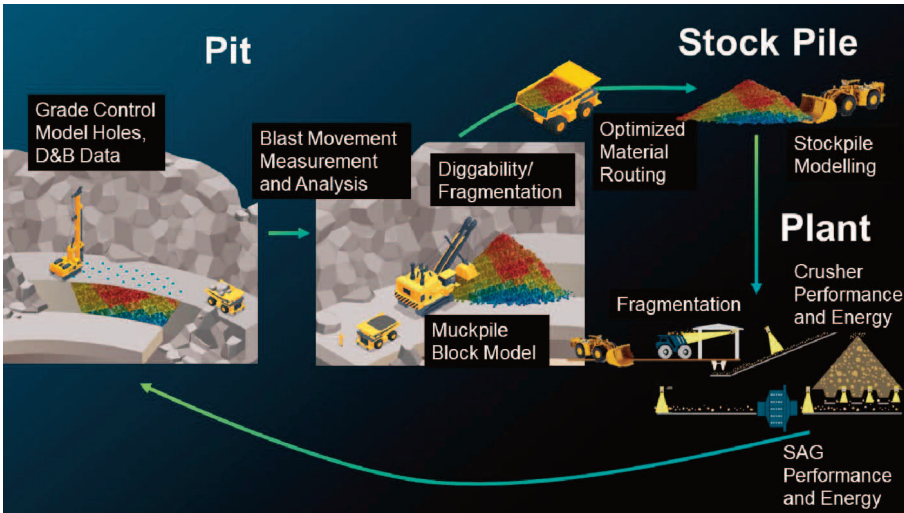
With fragmentation analysis and drill patterns, Hexagon's Mining division can review the results from the last several benches that came out a certain way using a similar geology and, if needed, change the timing or pattern spacing to get a measurable improvement in, for example, ANFO usage and energy consumption, according to Dave Goddard. This then trickles down to using less energy at the crusher and less energy during the comminution process, ensuring the value flows throughout the mining process
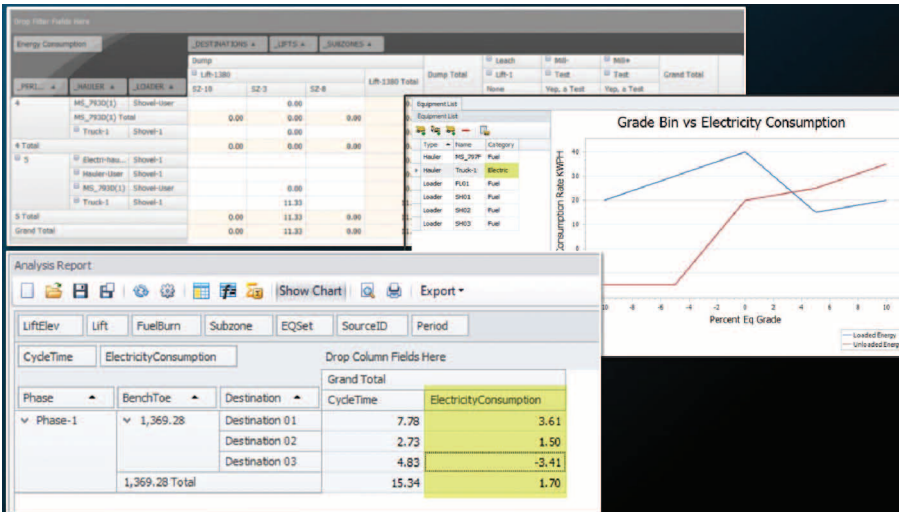
the need to embed within our algorithms and software those learnings, common sense and rules of thumb the industry has relied on for the past hundred years or more," he said. "We can do that with our portfolio of sensors – that provide the data fidelity one needs to have comfort in the readings – and software – which is broader than anything else out there in the industry."

This is where the company's two areas of focus – optimising the NPV of the asset in the ground and optimising the activities associated with extraction – are bearing fruit.

"With fragmentation analysis and drill patterns, we can review the results from the last several benches that came out a certain way using a similar geology and, if needed, change the timing or pattern spacing to get a measurable improvement in, for example, ANFO usage and energy consumption," Goddard offers up. "This then trickles down to using less energy at the crusher and less energy during the comminution process, ensuring the value flows throughout the

mining process."

There are more examples of this.

Tying together learnings from Hexagon FMS and CAS solutions can, for instance, correlate incident hot spots with fatigue events and traffic analysis to leverage back in the mine planning module, potentially leading to the re-design of traffic intersections.

"You can then start to optimise safety and production flow simultaneously," Goddard said.

Should Goddard and his team be able to leverage the historical records Hexagon has at its disposal, the concept of a "single digital twin" to showcase such optimisation is achievable, he says.

"This will then act as a way to display these interactions across the site, and how optimising one area of the extraction process can lead to optimising the entire project NPV."

Beyond that, Hexagon's Mining division is actively developing battery-electric haulage vehicle support in its next software release, with enhanced functionality enabling clients to model

production rates, state of charge rates, battery swap/charge options, trolley infrastructure placement, etc slated for subsequent releases.

"More broadly, we are showcasing fuel optimisation opportunities across our software portfolio, which, again, is helping companies optimise on their way to achieving net zero," he said.

Goddard, excited by what lays ahead for the company and the opportunities Hexagon can present mine operations, says the ability to integrate sensors and operational software with the mine planning and modelling platforms will drive the continuous optimisation loop that mines require to achieve their net-zero goals.

"This will, in the future, be automated, with clients taking the full technology stack benefitting from a continuous improvement loop that lowers costs, increases productivity, improves metal recoveries, lowers energy and water consumption, and more."

Software for the mining value chain

Micromine continues to branch out of its geology-focused origins with a software offering that goes all the way to the run-of-mine (ROM) pad.

At the same time, it retains its founding intentions of creating solutions for specific roles in the mining value chain.

"What that means is that, instead of saying we have one tool to do everything – which has historically been the basis for many new innovations across industries – we are now providing specialist software solutions," Jeremy Hanrahan, Product Strategy Manager – Micromine Mining, told *IM*.

This sees the company implement solutions like Micromine Origin for early exploration through to resource evaluation, Micromine Alastri for open-pit hard-rock mine planning, and Micromine Pitram for real-time fleet management and mine control.

"This is the governing philosophy of how we provide solutions," Hanrahan says. A philosophy which, he adds, aligns closely with the industry's own needs.

"One of those key needs – reflective of the journey the mining sector is on – is that there is a skills shortage, but, more than that, there is an increase in the agency and mobility of professionals in the mining space," he explains.

The model of 'doing your time' across the mining value chain to reach mining engineer status no longer works in this resource-starved employee backdrop.

"Now, you could accelerate to become a senior mining engineer within only a few years of coming into the industry," Hanrahan says. "This is great for people accelerating their career, but it means there is less time for them to perfect the
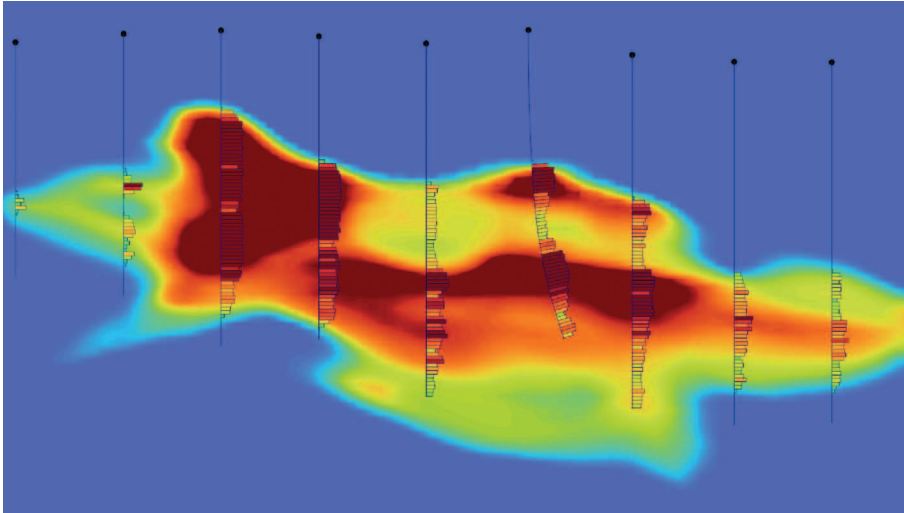
Micromine Origin Copilot is a cloud-based AI companion that, Micromine says, employs advanced machine-learning techniques to craft thorough and robust mining models autonomously

skills previously carried out shadowing experienced engineers in the past."

Micromine, as a group, has been addressing this need by working closely with universities and training institutes, providing software solutions and mentoring opportunities to those interested in mining careers.

On top of this, it aims to provide mining operations with improved confidence and efficiency in resource modelling, mine planning, mine scheduling and operations.

"We support the evolving needs of customers by identifying and simplifying the analysis and automation needed at every part of the mining lifecycle," Hanrahan says. "At a basic level, this means we don't put an underground tool in front of an open-pit engineer; we have specialised software dedicated to different commodities, mine approaches and lifecyle stages.

"We also remove the 'noise' associated with decision making by ensuring our tools are both intelligible and comprehendible, thus, improving the reliability of the outputs."

Such processes allow for optimisation across every part of the value chain, from drill hole to ROM pad.

This integration is best seen through the lens of Micromine's recently launched Nexus platform.

Micromine Nexus is designed to connect and orchestrate workflow tools, while providing data security across the entire ecosystem. Micromine says it offers unified data management and sharing capability across the product suite and, ultimately, a range of third-party integrations to make the sharing of data a real possibility.

Already available for geology customers with Micromine Origin, Micromine Nexus will soon be available with Micromine Geobank, Micromine Beyond and Micromine Alastri.

Micromine Nexus – available as both a cloud-based and on-premise solution – is key to providing the "compliance to plan" verification and analysis that allows continual process optimisation for clients, according to Hanrahan.

"When I started in the industry, the best available software was constrained by hardware limitations," Hanrahan reflected. "You were using approximations throughout that took hours or days to generate and could not accurately reflect, for example, the impact of using different sized equipment or changes in the ramp grade.

"Now there are no such hardware restrictions, and cloud-based platforms and AI use is allowing us to reflect the realities of what goes on underground or in the open pit within seconds.

"When we then incorporate artificial intelligence (AI) into the mix, the improvement opportunities for clients are close to endless," he said.

This ability is letting mining companies model increasingly autonomous and electrified operations, providing emission benchmarking of haulage options, for instance.

Micromine Alastri's Haul Infinity solution and Tactical Scheduler is being used for exactly this, with companies modelling haulage scenarios involving diesel-powered, battery-electric, hybrid and hydrogen fuel cell electric vehicle cycles, according to Hanrahan.

"As long as we know the specifics behind how the energy is provided, we can include such vehicles in the modelling," he said. "We can then provide an output to show the associated carbon footprint of each option alongside – for battery-electric equipment – a chosen battery charging or swapping cycle."

As the industry for renewable energy sources evolves, modelling will only get more powerful and accurate, helping mining companies achieve net-zero targets.

"There are so many changes coming with the decarbonisation movement, which will present new market opportunities for Micromine,"

Hanrahan says. "At this stage, we are giving clients the chance to ask questions through modelling scenarios that they can routinely run.

"We are providing the tools for the change we all know the industry needs to make."

Leveraging a Virtual Twin framework

The lifting of limiting technology factors mentioned by Hanrahan is opening a virtually limitless range of possibilities to enable leaps in productivity, according to Gustavo Pilger, WW GEOVIA R&D Strategy & Management Director, **Dassault Systèmes**, who compared the current innovation climate to that experienced during the first Industrial Revolution.

Pilger's insights are of interest given that Dassault Systèmes has been developing digital solutions spanning 11 industries and over 60 segments for the last 40 years.

"Our purpose has been to provide businesses and people with virtual universes to imagine sustainable innovations capable of harmonising product, nature and life," he told *IM*.

It is doing this through developing "Virtual Twin Experiences" that aim to break down silos to bring people, processes and technology together in the 3DEXPERIENCE platform.

He clarified: "A 'digital' twin is typically a mere digital representation or copy of a given process or set of processes, while a 'virtual' twin goes beyond by providing a live virtual replication of the real world in which processes (or systems) are interlinked and associated with one another with the underlying data that informs and describes these processes."

This distinction is important in the world of mining given operations are influenced by several external factors a static digital twin may struggle to comprehend. This virtual platform also allows Dassault Systèmes to, it says, provide the path for clients to realise business transformation.

Pilger elaborated on this: "We provide software tools that allow our clients to model and simulate processes and how they interact with adjacent (connected) processes before anything is actually built, in early project development phases, or to correct the train of action on projects already in production in order to keep chasing value while operating."

Since the underlying data used is federated, indexed, standardised and contextualised in a safe and secured single repository, and systems are connected with input and output associated through common data models, one can test multiple hypotheses or scenarios in this "virtual world" to then apply a given design or plan in the real world. This process, Pilger says, eliminates unnecessary waste, reducing risk, minimising material re-handling and maximising productivity.

Within a sustainability context, this allows mining companies to assess the impact of
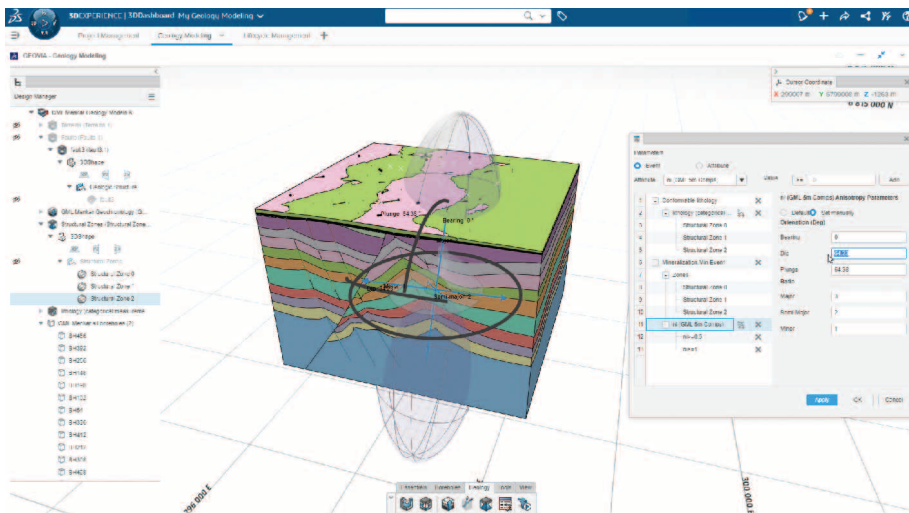
Geology Modeler is an established role in the 3DEXPERIENCE Platform, which counts with an original and proprietary engine for implicit modelling

decisions from conceptual design models through to operation and disposal, or mine rehabilitation.

In practicality, this could allow mining companies to use a single platform with full value chain visibility and advanced energy control to: optimise, capture and re-use energy, while reducing overall operating costs.

"So, the Virtual Twin can help with de-risking the electrification process too," Pilger said.

More than this, this platform acts as a sandbox for mining companies to test out scenarios related to extracting more metal, more efficiently and more sustainably, all while complying with environmental, social and governance (ESG) standards and associated targets, and with the ability to display such a model – that can include biodiversity, water, energy and emissions data and designs – to interested stakeholders.

"It allows managing permit status, asset agreements, asset licences and associated cost analysis, ensuring that everything goes according to plan and schedule," Pilger said. "It allows for creating digital continuity between the natural environment, claim boundaries and built infrastructure. It allows taking advantage of immersive visualisation with spatial contextualisation to gain a complete picture of data for actionable intelligence."

This platform is continuing to expand in line with customer requirements, including the addition of the Strategic Mine Planner and Underground Mine Designer 'Roles' in the established portfolio of Roles within the 3DEXPERIENCE platform. In 2024, the company is not only introducing new Roles to the portfolio but also enhancing those established Roles released in prior years, it says.

The Strategic Mine Planner role allows the user to develop a comprehensive strategic plan by conducting an evaluation of critical input parameters through multiple scenario analyses from development to closure, according to Pilger. "It allows simultaneous or sequential application of several advanced value-adding options for optimising capacity to create an optimised and robust mining schedule that prioritises value and ecological responsibility," he added.

The Underground Mine Designer role enables the user to rethink the design approach to underground mining through the evaluation of multiple options through generative parametric modelling. Pilger explained: "One will be able to generate and evaluate multiple development designs through an automated parametric process, offering optionality assessment of designs." This is all within a "safety by design" approach, considering safety standards related to underground excavations from physical constraints to geotechnical features.

Additionally, in 2024, Dassault Systèmes has planned four 3DEXPERIENCE releases to keep enhancing these new roles, as well as established 3DEXPERIENCE Mining Roles such as "Geology Modeler", "Geoscience Referential Manager", "Earth Engineering Coordinator", "Pit Optimizer" and "Surface Mine Designer".

This comes alongside eight planned releases for Dassault Systèmes' traditional desktop portfolio – Surpac, MineSched, Whittle, Minex and GEMS – focused on select enhancements, technology upgrades and defect fixes.

Such a plethora of updates reflects Dassault Systèmes' ability to leverage and adapt technologies and/or processes from sister brands within the group. An example of this comes from the pattern recognition algorithms originally developed for BIOVIA to identify chemical compounds in the medical and pharmaceutical industry now being used for mining and geology use cases.

Such algorithms are expected to play a role in future mining productivity leaps, according to Pilger, going some way to counter the expected

mining skills shortage caused by retirements and a dearth of new blood.

"The Virtual Twin framework can make this possible by opening career doors for this new generation of mining professionals while securing knowledge and know-how for the sustainable continuity of the industry," he said.

Pilger concluded: "In 2024, we will continue to enhance and support our traditional desktop portfolio; in parallel, we continue to build a new portfolio on a new and modern technology stack on 3DEXPERIENCE. And, finally, we will continue to seamlessly connect our traditional desktop portfolio to 3DEXPERIENCE via our POWER'BY approach for expanding workflows and business processes."

Solving old problems with new capabilities

Orica reported its first full year of results from its Digital Solutions division in November, with Sanjeev Gandhi, Managing Director and Chief Executive Officer, highlighting a doubling of earnings alongside a significant improvement in margins in its 2023 financial year.

"Customers are continuing to seek operational efficiencies across the mining value chain and unlocking the value of digitisation and automated workflows is key to achieving these efficiencies," he said during the FY23 results presentation.

With an abundance of solutions on the market, why would mining companies look to Orica's Digital Solutions to provide these efficiencies?

"Our software offering stands out from the competition by providing innovations underpinned by modern computing science," Matthew Craft, Orica's Senior Manager Technology, Blast Design and Execution, told *IM*. "The unique value provided by Orica Digital Solutions is the seamless integration of physical blasting operations with digital platforms. This enables our customers to readily understand and optimise their operations at every step of the value chain, with integrated workflows, access to real-time data and end-to-end predictability from mine to mill."

With mines going deeper and orebodies becoming more complex and remote, the demand for these solutions is only set to increase, according to Craft.

"Our solutions include categories spanning the resource value chain, including orebody intelligence, blast design and execution, measurement and monitoring, and mine simulation and optimisation," he said. "Whether operating individually or as a whole, our solutions ensure the right intelligence is delivered at the right time for better decision making and more predictable outcomes."

This improves transparency across the

FRAGTrack™ Geospatial, unlocks operational and technical insights by providing georeferenced samples to correlate blast design and orebody information to blasting performance, according to Orica

operation, allowing customers to adapt their operations to improve safety, boost productivity, rationalise energy use, produce fewer emissions, reduce environmental impact and cut costs, he said.

The new division launched 15 products in the 2023 financial year – including new variations of FRAGTrack™ technology to provide operations with increased scope to capture fragmentation insights and new AI-backed innovations and physics modelling with OREPro™ 3D Predict to model blast movement.

Its 2024 financial year has already got off to a fast start with the introduction of BlastIQ™ Underground, which marked its expansion into the underground blast control domain segment.

And, at the tail end of last year, the company enhanced its geotechnical offering as well as added an established stream of recurring software revenue with the binding agreement to acquire Terra Insights.

"For 2024 and beyond, Orica Digital Solutions is looking to leverage our modern platform to solve customer problems with big data management, automated design recommenders, and interoperability with customers and partners," Craft said. "Aside from the marque launches, we will continue to focus on the basics of assessing and organising industry data, which will enable more sophisticated solutions to evolve."

These digital solutions are having an impact on the process-driven goals Orica has and, in particular, its aims to automate the drilling and blasting process and minimise personnel exposure to harm.

"The core of this acceleration lies in our commitment to leveraging digital technologies," Craft said.

"Within our Orica Digital Solutions portfolio, products like SHOTPlus™, OREPro, LOADPlus™, Design for Outcome, FRAGTrack, and BlastIQ™ are instrumental in automating various facets of the drilling and blasting process. These solutions facilitate seamless data transfer, loading rule application, classifications, and image sampling and processing."

Such incremental steps collectively contribute to the broader objective of achieving comprehensive automation, reducing the need for human intervention in potentially hazardous tasks, according to Craft. They are also part of Orica's five-year technology roadmap and help guide Orica's "journey toward full automation", particularly in processes like explosives loading, both on surface and underground.

This technology roadmap also recognises the need for collaboration and modularity across the

mining sector, hence the reason Orica recently entered into an agreement with Caterpillar to supports its customer base in harnessing the power of merging data, sensors and intelligence to enhance workflows and enable real-time decision making.

"The initial focus will be on the integration between Orica's Rhino™, BlastIQ, FRAGTrack and Cat® MineStar™ Terrain technologies," Craft said. "This integrated workflow will provide customers with high-fidelity rock property information, enabling significant improvements to on-bench safety, drilling and blasting program accuracy and productivity, and higher-quality blast outcomes that generate enhanced mill performance."

This is all part of Orica's aim to support customers in sustainably mobilising the earth's resources with innovative technologies.

"With the ongoing advancements in software, old problems can be solved with new capabilities," he concluded.

Interest in integrated thinking

The Digital Mining Technology division within **Sandvik Mining and Rock Solutions** is also a recent entrant into the software space, yet the OEM's customers have been calling out for such an integrated offering for several years, according to Elen Toodu.

Included within this division is the Deswik, Newtrax, AutoMine and Polymathian businesses: an assortment of companies able to provide data feedback and automated end-to-end process optimisation.

Toodu, Director, Strategic Product Portfolio Management at the division, says the customer feedback on this offering has been strong, with requests continuing to come through about how the division and its solutions can improve mining operation efficiencies.

She explained: "A lot of the mines that are
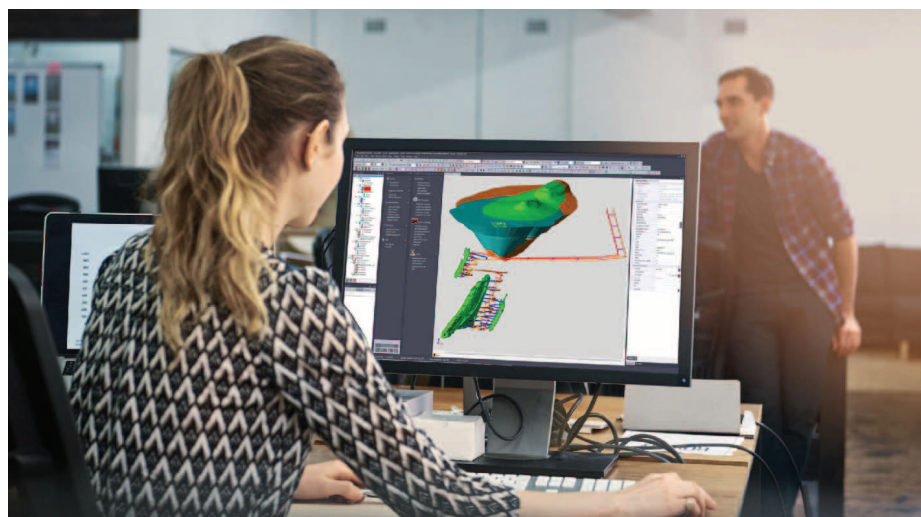
The addition of Deswik and its mine design, scheduling and planning portfolio has allowed Sandvik to reach upstream areas of the mine development stage

digitally advanced have different solutions from different providers and end up integrating them themselves. In some ways, they become the software developers, diverting their attention away from their primary mission: to mine the orebodies they have."

The addition of Deswik and its mine design, scheduling and planning portfolio is a standout here, allowing Sandvik to reach upstream areas of the mine development stage.

Mats Eriksson, President of Sandvik Mining and Rock Solutions, said as much during the recent Sandvik Capital Markets Day: "When you find a new orebody, you need to plan how to extract it and Deswik has this capability. So, already, when we see a greenfield project, Deswik is getting involved."

Toodu said Deswik OEM-agnostic solutions have provided the Sandvik Mining and Rock Solutions division with a "closed loop" from mine design, to operations, connected fleet and then autonomous execution, allowing data to be fed up- and down-stream into different time horizons, phases of planning and operations management.

Polymathian – which has a product offering for areas such as the extraction process, material flow, energy and fuel consumption, and maintenance efficiency – has provided end-to-end modelling optimisation opportunities within a platform that continuously evaluates the most efficient way of doing things in an ever-changing environment.

All four products and the opportunities they offer have allowed the division to engage with customers on their future digital roadmaps, according to Toodu.

"This is helping the customers as well as allowing us to focus and prioritise areas of software development in the near-, medium- and long-term," she said.

"Our vision is a fully integrated, OEM-agnostic solution for self-planning, self-optimising, autonomous operation," Toodu said.

Block caving – considered as close to an industrial operation as you get in underground mining and an area where Polymathian's solutions have already been adopted – is an area where this vision is closer to reality, yet there is potential to apply this vision in all types of dynamic environments.

"We are working on automating the data exchange between the various parts of the value chain to ensure that learnings downstream come into the upstream mine plan," Toodu added. "Ideally, we want to, for example, automatically notify the drill planner after we change a drill hole location to amend the charging plan, if needed."

Further advancements could see information from Newtrax collision avoidance and proximity detection systems fed back into upstream mine design to test out different mine plan scenarios that may alleviate downstream traffic interactions.

"Right now, this type of automation is one of our focus areas," Toodu said. "First, we want to make sure there is a smooth flow between the underground operation and the surface oversight, as well as ensuring there is an optimised data workflow and data governance plan in place."

It is easy to visualise just how powerful this proposition could be in a mine of the future, removing the inefficient layers of process associated with data entry, data handoff, short interval control and the like, replacing them with automated functions on automated equipment.

And, speaking of equipment, Toodu says her colleagues in the equipment business are starting to reap the benefits of this enlarged digital platform.

"A strong digital and automated offering is enabling us to sell more equipment, for sure, with the modelling capabilities showcasing how autonomous and electrified fleets can be easily implemented and provide significant value," Toodu said.

"The Digital Mining Technology division is a strong business on its own that has shown double digital growth, year-over-year. It also has a differentiated subscription-based revenue model that provides stability throughout the cycles.

"I expect the growth and the wider synergies we are already seeing in the early stages of this digital integration to continue into the future, with more mining operations realising the benefits of using such an integrated offering."

Secure and sustainable software

RPMGlobal noted a greater interest in integrating process-driven decision making from its clients of late, all with the aim of ensuring a "greater compliance to plan".

The Australia-based company has a suite of products that, it says, generates value at every level of a mining organisation, yet it says integrating features up- and down-stream of points in the value chain provide the most return for investment.

"With SOT (a strategic financial optimisation tool) and Enterprise Optimiser (mine scheduling), for example, organisations will look at optimising capital and strategic decisions, which are then passed to MinePlanner to determine the optimal mining schedule," the company told *IM*. "This is published by way of integration to both XECUTE and ShiftManager for the short-term scheduling and execution, which is only made possible with enterprise integrated solutions and solutions that ensure there is consistency at each level of the planning process."

Such functionality is being leveraged in sustainability and emission-related decision making by mining companies, according to RPM, with the company's scheduling, optimisation and financial products factoring in the emission profiles of one mine plan or scenario over alternatives at the same time as forecasting and optimising schedule and budgets.

"While mine planning has traditionally aimed to economically optimise mining processes, our solutions now offer the ability to simultaneously optimise for ecological and/or carbon reduction drivers," the company explained.

RPM's products are also able to optimise schedules using a user defined weighting or prioritisation of NPV versus emissions, allowing miners to balance both considerations in their decision-making process.

This is also displayed within the RPM simulation portfolio, which allows users to model, quantify and visualise the differences between diesel, hydrogen, hybrid diesel and electric vehicles within the mining fleet, as well as the emissions of each.

Through products such as MinePlanner, XECUTE, AMT Mobile (from left to right), RPMGlobal is offering integrated data exchange and learnings throughout the mining value chain

"We also offer products that are specifically designed to capture, store, manage and report on environmental data," RPM said, referencing EnviroDataVault to share environmental data anywhere throughout an operation, including with external stakeholders.

"This transparency has been a welcome change for many of those stakeholders who now have access to data from the operations," it added.

RPM ranks its most important development as a company in the last five years as the achievement of ISO270001 accreditation – a standard that, it says, ultimately provides an organisation with a framework for establishing, implementing, maintaining and continually improving an information security management system.

It explained: "With cyber threat and data breaches on the rise, mining organisations need to know that they are doing business with other companies that take security seriously and have implemented best practice approaches to information security."

This development – alongside a commitment to migrate many of its solutions into cloud-based platforms – harks back to one of RPM's key differentiators: innovating on behalf of its clients.

"We spend a lot of time listening to our end users and then working with them to develop the next generation of digital solutions," RPM said. "This approach means we are always developing solutions to solve real and current business problems, rather than trying to find a buyer for a solution we thought the market needed."

Maptek on the path to value

Turning data into business insights is the primary goal of **Maptek** customer success strategies,, according to Eduardo Coloma, Maptek CEO, explaining that its customers are also looking for an integrated offering to deliver on this.
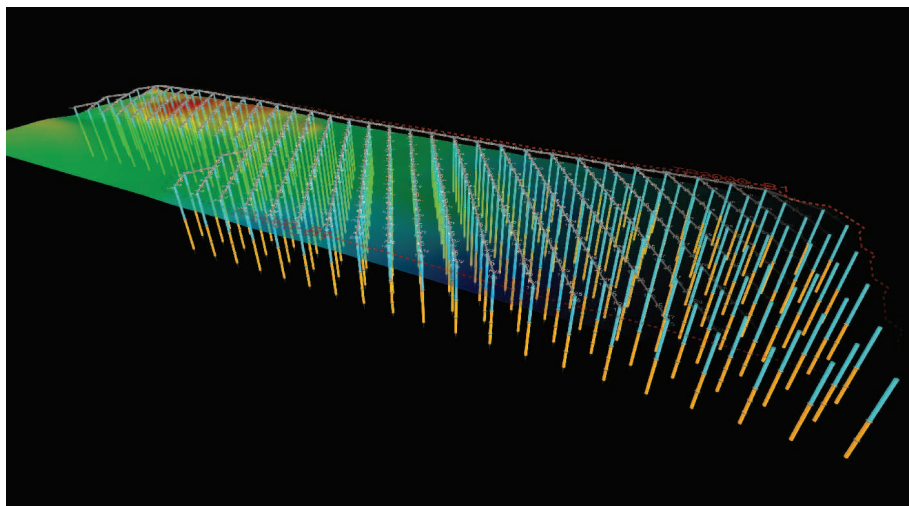
"Maptek recognises this and strives to deliver the shortest, easiest path to value," he told *IM*.

This path to value – which stretches across the mine value chain, from extraction to production and even reconciliation – is progressively being shortened through the addition of mechanisms for augmenting and automating the flow of information.

An example of this evolved out of the application of Maptek Vulcan for resource estimation at the Cerro Los Gatos polymetallic mine in Mexico.

The operation already used Maptek Vulcan for resource estimation, yet, with a significant volume of new channel sampling and drill hole data for monthly updates requiring integration, Los Gatos was eager to optimise the process without sacrificing quality of results.

Coloma explained: "The team was able to

With Maptek BlastLogic, an operations manager reviewing energy consumption over a specific period can recall blast metrics that correlate with the material being processed to explain spikes in usage, according to Eduardo Coloma

accurately define the mineralised zones, deploying Vulcan for exploratory data analysis to provide an overview perspective. Implementing the Maptek workflows tool, combined with Python scripting, automated the process, saving the operation 40% in turnaround time."

Resource estimations are now reconciled monthly against extracted material, with Power BI tools generating dashboards to allow Los Gatos to identify possible short- or long-term deviations from the resource model.

Such a process could be further improved with the help of AI and machine-learning algorithms if Maptek's success with its DomainMCF are anything to go by.

Maptek DomainMCF generates domain boundaries directly from geological sample data for rapid creation of resource models. This ensures mining companies incorporate the latest data to easily generate forecasts of project profitability within investment timelines, according to Coloma.

The AI embedded in DomainMCF allows the industry to use the skillsets of the experienced personnel more efficiently, embedding years of expertise into smart systems to help get the job done on time and under budget.

In Western Australia, a case study with IGO Limited followed geologists comparing machine learning and traditional approaches when preparing a resource update for the Nova-Bollinger underground mine. Faster processing with DomainMCF, in this example, meant senior staff had more time to focus on training less experienced colleagues and improving overall team productivity.

There are further layers of automation to be had here, too.

Coloma explained: "An automated continuous improvement loop was once a dream, as the time lag between acquiring data and utilising that data was prohibitive, and decisions were often needed before the new data was processed. The landscape is changing as products are intentionally developed to be integrated into the

data collection-storage-analysis-reporting processes that miners rely on for operational decision making."

Maptek is taking a holistic approach to this integration process, identifying where integration may provide the solution – through APIs or SDKs or scripting or a new interface with an OEM to promote data interoperability.

And more solutions are likely to come into this mix with the need to generate and analyse data related to sustainability metrics.

Products like Maptek Evolution are already being used to consider variables such as water consumption during the comminution process, or haulage evaluation comparing trucks versus in-pit crushing to minimise fuel consumption, as part of running strategic and tactical evaluations of mine schedule scenarios, according to Coloma.

One example of this involved evaluation of multiple alternatives in Evolution Strategy with respect to their impact in the processing plant with the introduction of bulk ore sorting and coarse particle recovery.

Mining operations can go further, considering the entire comminution process, including optimising the energy required to process material. Taking a strategic approach to blasting at a site that is analysed against processing outcomes via Maptek BlastLogic could offer potential.

Coloma explained: "With Maptek BlastLogic, an operations manager reviewing energy consumption over a specific period can recall blast metrics that correlate with the material being processed to explain spikes in usage. A searchable data repository ties drill design, as-drilled, dipping, backfill, charge plan, as-loaded and observed blast performance data with videos, third-party reports and laser surveys to

each blast."

By being able to identify inefficiencies due to drill setup errors, operations can reduce the incidence of oversize rock and poor blast digability, contributing to continuous improvement in material recovery and overall performance, he added.

Tapping into first-hand knowledge

Datamine claims to have the broadest range of software solutions on the market, with over 35 distinct product offerings across the mining value chain, from greenfield exploration through to material tracking and trading.

It leverages this position – and access to funds for new product development and acquisitions – to differentiate itself and address the complexities inherent in the world's most challenging mineral deposits.

"At Datamine, we understand that each mining company's needs are as distinct as the mineral deposits they own," Andy Lapworth, Chief Technology Officer at Datamine, told *IM*. "Datamine's network of more than 25 offices around the world allows it to provide tailored local support and offer flexible pricing options to suit individual regions."

Datamine says this scale, on top of the related consulting and support services, plus the collaborative nature of its product development teams, ensures clients generate value out of the company's offering.

One example is the resource modelling package Studio RM Pro, a single software solution that now comprises market-leading geological modelling and geostatistical software products Studio RM, Isatis and Supervisor®. Such a combination – borne out of M&A and internal developments – enables resource geologists to carry out complex resource estimation work.

"Each of these products is widely recognised as having superior functionality that is required to help our customers extract the maximum value from their assets," Lapworth said.

The addition of the Snowden Optiro consulting arm – which came into Datamine in 2021 – further strengthened this proposition.

"Having our own consultants engaged in feasibility and mine design studies provides us with first-hand knowledge of the challenges the industry is facing as well as unrestricted and quality feedback on our products," Lapworth said. "As providers of leading mining software like Supervisor and Reconcilor for decades, our Snowden consultancy arm contributes expertise that informs our software development."

This industry feedback has also led to the development of a new mining reconciliation program, which combines consulting services provided by industry leaders and top-tier

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software solutions to help mining companies achieve operational efficiency and unlock economic benefits by ensuring data transparency across the entire mine value chain, according to Lapworth.

Rodrigo Calle, Vice President of Sustainability Solutions, said this same focus is given to its sustainability-focused portfolio.

"Datamine has been at the forefront of this movement for several years, leading the way by incorporating a broad spectrum of solutions into our portfolio," he said. "These encompass operational safety, environmental management, occupational health and ESG reporting.

"Our commitment to sustainability underscores our dedication to not only meeting but exceeding the evolving demands of the mining industry, reinforcing our role as a trusted partner in its sustainable development."

Datamine's future software solutions will no doubt benefit from advances in AI-backed algorithms, however Lapworth cautioned these represented "tools" and not "panaceas".

"By integrating AI and machine-learning specialists across our multidisciplinary teams, we remain knowledgeable of the cutting edge and ensure the delivery of industry-tailored solutions

"At Datamine, we understand that each mining company's needs are as distinct as the mineral deposits they own," Andy Lapworth says

from a broad spectrum, without simply defaulting to the allure of novel but not necessarily superior technologies," he said.

Revolutionising data processing

Since its inception in 2017, **Eclipse Mining Technologies** has been dedicated to developing a comprehensive solution that addresses the most pressing data-related hurdles. This remit led to the development of the SourceOne® Enterprise Knowledge Performance System, built for mining companies to leverage all their data and transform it into information that can aid all levels of decision makers in all parts of the mining value chain.

Its latest focus is on the "transformative process" required for such data to be used effectively by AI tools and for knowledge generation, with a schema included in the latest release designed specifically to tackle this.

The company told *IM* that SourceOne is differentiated from the rest of the solutions on the market in its ability to work at "every data level", providing context to this data through the

Eclipse says Knowledge Graphs are able to support specific AI applications, such as using machine learning in predictive maintenance and modelling

identification of its interrelationships and characteristics. This helps transform data into actionable information and knowledge used in all domains of the mining industry.

"Specific applications like general mining packages, fleet management systems, or asset management systems can coexist with SourceOne, but only at the data level through their specific databases," the company explained.

In its current form, mining companies are unlikely to obtain the full value of AI without the inputted data going through a cleaning process in advance – something that SourceOne EKPS provides.

"Based on a domain ontology that describes how data coexists, concepts, categories, relationships and the rules governing these relationships, SourceOne provides a structured framework to model information, enabling machines to understand and interpret data," Eclipse said.

This could eventually enable the automated process improvement loop spoken about by many companies in this article, helping facilitate data interoperability, data sharing and knowledge extraction.

This is where a Knowledge Graph is required.

A Knowledge Graph is a type of data structure that stores information in the form of entities (nodes) and their interrelationships (edges). Widely used in new knowledge-based systems to enhance information retrieval, infer new knowledge and provide context-aware results, Eclipse views these graphs as being able to support specific AI applications, such as using machine learning in predictive maintenance and modelling.

Such tools are a prerequisite for effective use of these algorithms, according to Eclipse, with mining companies simply inundated with data that is not initially fit for the purpose of machine learning.

"By using knowledge systems that enable modelling and AI, mining companies now have the power to harness the wealth of all their data, leading to next-level informed decision making and operational efficiencies," it said.

The company concluded: "In a sector where no other vendor currently offers a solution of this caliber, SourceOne EKPS stands as a beacon of innovation. It's not just a product; it's an invitation to be part of an exclusive circle that 'gets it'.

"The current number of our clients in the mining industry is just at the beginning, but the potential and interest in SourceOne EKPS are significant. This isn't about where we are now; it's about where we're going. And for those who join us, the journey promises to be as rewarding as the destination."

Instilling confidence in decision making

acQuire has been providing software to tackle ESG issues across the mining space long before the acronym was considered industry parlance.

For Alison Atkins, CEO of acQuire, the value the company brings to the table has not changed over the more than 25 years it has been providing these solutions. "acQuire's value lies in providing strategic software solutions so when the right information is available to the right people, businesses can make confident decisions," she told *IM*.

The increase in data generation and higher regulatory hurdles placed in front of mining companies are likely to lead to further investments into "digital mining", according to Atkins: a change that will also require providers to be more open to the wider software ecosystem.

"Our customers expect solutions that are interoperable with other software used in a mining operation, from data collection and mine planning, through to land reclamation," she said.

For acQuire, this means monitoring the markets it operates in to identify new trends and emerging technologies, while engaging with customers to ensure its product roadmap continues to meet ongoing needs.

Atkins said the global drive towards ESG reporting requirements, as well as an increasing pressure from stakeholders to increase output, is providing the impetus for miners to leverage emerging technologies that not only meet these compliance issues, but further optimise their operations.

"At acQuire, this means delivering quality and sustainable software solutions that can give our customers the ability to assess 'are we compliant right now?', at any point in time, and be able to prove it," she said.

This is where tools designed to collect and

EnviroSys continues to be one of the best environmental data management systems on the market, according to acQuire

report on a range of geoscientific, environmental and social performance data, from a multitude of sources and in various formats, help businesses tackle complex compliance requirements and make confident business decisions.

"Our solutions will continue to evolve to help companies capture, monitor and report on their data in line with regulatory, social and global influences," Atkins said.

In South Africa, for instance, there is already great onus placed on mining companies to outline their support of the local economy and find solutions for effective management of their social licence to operate.

The company's recent acquisition of MTS and its Insite software is providing these companies with a "complete view" of their social compliance plans, according to Atkins. "A laser focus on analysing the direct impact of your entire mining operation identifies your risk and helps you make decisions with confidence. But the value extends beyond reporting; Insite becomes a management tool for companies to continuously improve their social performance impact."

Atkins expects to see demand for such solutions to grow – not just in South Africa, but globally – as ESG reporting becomes more stringent.

As such, the company is exploring the opportunity to develop a global solution based on Insite, in keeping with its international focus on ESG issues.

ThreeDify ready to leverage GeoMine's new capabilities

ThreeDify looks to its GeoMine platform for its key software market differentiators.
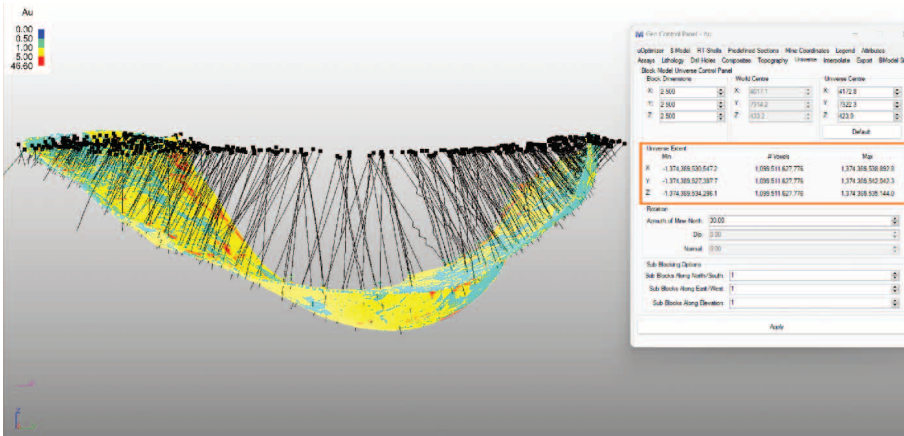
ThreeDify's recent advance in block modelling in GeoMine v6.5 has increased the block model universe to $2^40 \times 2^40 \times 2^40$, from $2^19 \times 2^19 \times 2^19$

GeoMine consists of 18 independently licensed modules, ranging from 3D geological and block modelling, 2D gridded seam modelling (for stratified deposits), infill drilling plan optimisation, pit optimisation, stope and cave optimisation, fleet budgeting and haulage analysis, mine planning, mine design, mine scheduling for both open-pit and underground mines, as well as total mine optimisation through cutoff grade optimisation and open-pit to underground transition optimisation.

The platform continues to evolve, as Nancy Liu, VP of Operations at ThreeDify, highlighted with a few recent updates looking to solve some of the critical issues mining companies are facing.

"Our recent advance in block modelling in ThreeDify GeoMine v6.5 now allows a block model universe with an astronomical size never heard before," she told *IM*. "We have increased the block model universe to $2^40 \times 2^40 \times 2^40$, from $2^19 \times 2^19 \times 2^19$ in the previous version. Such an astronomical size greatly simplifies model positioning and allows satellite deposits to be easily modelled and consolidated in a single GeoMine session."

The latest version of GeoMine adds DigiSIM, an integrated simulation and decarbonisation study tool.

Liu expanded on this: "Until now, mine haulage simulation for decarbonisation study has always been an external process that is disjointed from the traditional mine planning and modelling processes. GeoMine v6.5 changed that with modelling, mine planning and simulation now integrated into a single package to natively support the continuous improvement loop that is part of the modern mine planning process." Such integration allows companies to easily quantify the environmental/emission variables and their impact on mine planning within such studies, according to Liu. "This starkly differs from the traditional mine planning, modelling and simulation processes," she added.

Like others consulted in this article, ThreeDify

ABB's smart hoisting software

ABB has launched a new digital suite of applications for hoist monitoring and optimisation, now rebranded to ABB Ability™ Smart Hoisting.

This new suite, ABB says, potentially offers further integration to other cloud solutions and extended offerings that significantly increase the operational performance and reliability of mine hoists.

The new digital suite is an important milestone in the company's ambition to transform predictive maintenance for mine hoists. With new features such as ABB Drive System Monitoring and new key performance indicators (KPIs), ABB is opening the door to an entirely new level of mine hoist optimisation services for customers.

The traditional predictive maintenance approach relies on manual data collection and analysis over a short period of time. Intermittent issues can stay hidden or only be identified later, giving subject matter experts (SMEs) little time to program interventions exactly when needed. Additionally, manual collection and data analysis consume a significant amount of time for SMEs, preventing them from focusing on strategic performance management tasks.

ABB Ability Smart Hoisting is designed to significantly improve the uptime, availability, reliability, performance and productivity of hoists. By incorporating advanced monitoring features, the system provides actionable information on critical KPIs, ensuring better decision making and optimisation of hoisting operations. The automatic collection, monitoring and analysis of data will enable mining companies to increase production performance, identify potential functional safety hazards and optimise maintenance scheduling, ABB says.

The combination of innovative features and improved cyber security makes this solution a unique and valuable tool in the underground mining industry, the company claims.

Its predictive maintenance capabilities help increase standards and drive innovation, leading to more sustainable and profitable mining operations.

"The new and enhanced Smart Hoisting solution offers a step change in the operational performance of mine hoists," Charles Bennett, Global

The ABB Ability Smart Hoisting system incorporates advanced monitoring features to provide actionable information, ABB says

Service Manager, Hoisting at ABB, said. "From improved uptime, reduced environmental footprint and increased monitoring services, this new solution brings enormous benefits to the industry at an important time.

"Through the integration of predictive maintenance and advanced monitoring, the evolved ABB Ability Smart Hoisting solution marks a pivotal milestone in redefining the performance benchmarks for mine hoists. This transformative solution addresses industry challenges comprehensively, fostering heightened uptime, sustainability and operational resilience."

ABB says it has been a leader in developing world-class hoisting solutions for over 130 years. Powered by electricity with the possibility to run off renewable energy sources, hoists are very much a future forward solution for enabling the sustainable transformation.

To date, ABB has delivered over 1,000 hoisting solutions globally. As a supplier of complete mine hoist systems, customers can benefit from low life cycle cost, high reliability and system availability, short project execution time, and a single source of supply for complete systems, including service and spare parts.

sees fully automated decision making playing a major part in modern-day mine planning, with Liu saying ThreeDify is at the forefront of this wave. "Our GeoMine-DigiSIM module can already directly ingress the planning input/output data from other modules in GeoMine and egress its output back to the optimisation and scheduling modules within GeoMine," she said. "The basic process is already there, although the automation part has some way to go. We anticipate that AI and machine learning will be the enabling technology.

This year, ThreeDify also significantly advances two other GeoMine modules: OreChaser, an integrated drill hole planner and infill drilling plan optimiser using machine learning, and OreController, an integrated grade controller using 3D blast movement modelling and blast model scheduling. **IM**