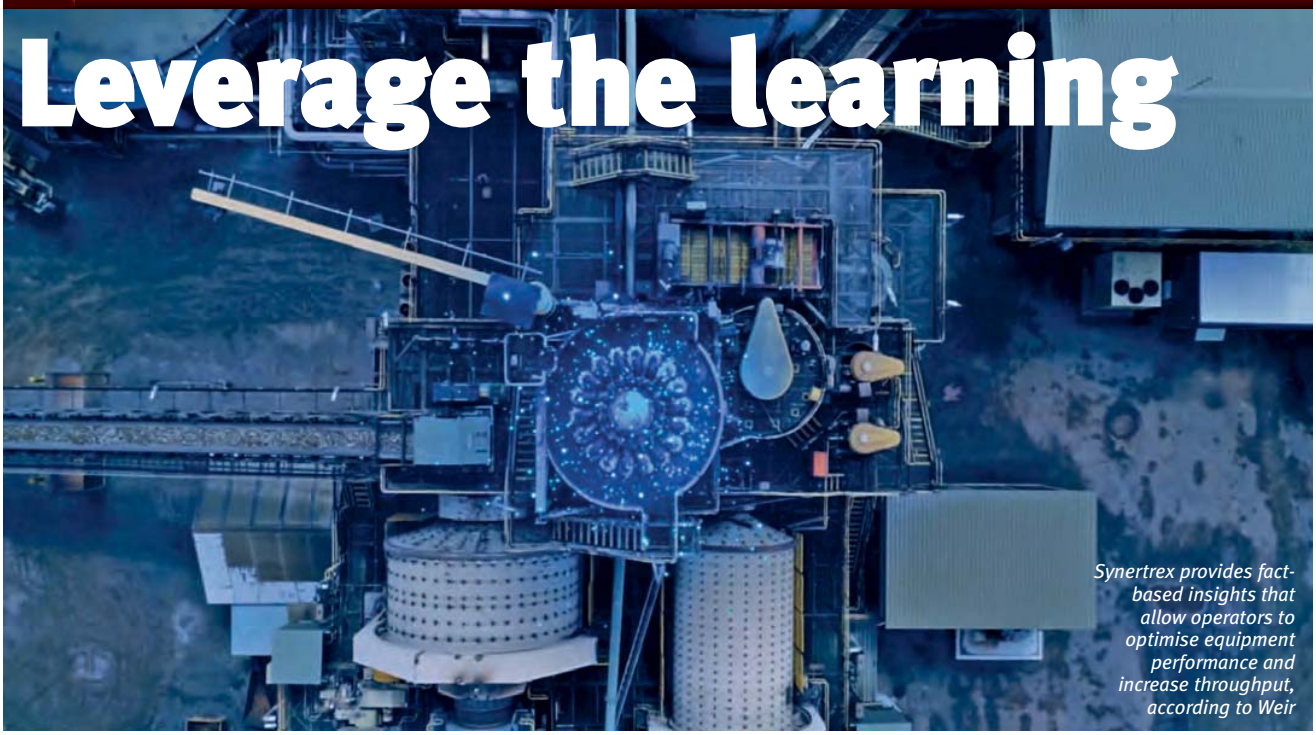
Leverage the learning



Synertrex provides fact-based insights that allow operators to optimise equipment performance and increase throughput, according to Weir

As the name suggests, big data is a vast and still-expanding sector that has been catching on in mining as companies look to squeeze more value out of existing assets. Dan Gleeson gets to the bottom of how those supplying these solutions are impacting the bottom line

Big data, digitalisation and machine learning have all become buzz words in their own right in the past five or so years.

Their presence in the mining zeitgeist has led to the largest companies installing nodes of various types on everything from haul trucks and drill bits to ventilation fans and flotation cells. The data generated from such equipment is certainly 'big', but whether it is all of economic value is less clear.

"The idea that data is intrinsically valuable is, in my opinion, not true," Penny Stewart, CEO of Australia-based **Petra Data Science**, told ***IM***.

"Some data hasn't got value as it is not relevant to a mining company's core business drivers."

Mining companies, arguably, need to treat big data investments like project development decisions where, if a proposed mine provides the necessary payback, the investment is greenlit. Any proposed project investment that doesn't reach the required threshold, conversely, is put on hold.

This type of investment rationale would ensure mining companies get the required returns on their big data packages and only spend money where they need to.

Stewart is not the only one that believes big data requires more than just the data itself to make a strong value proposition.

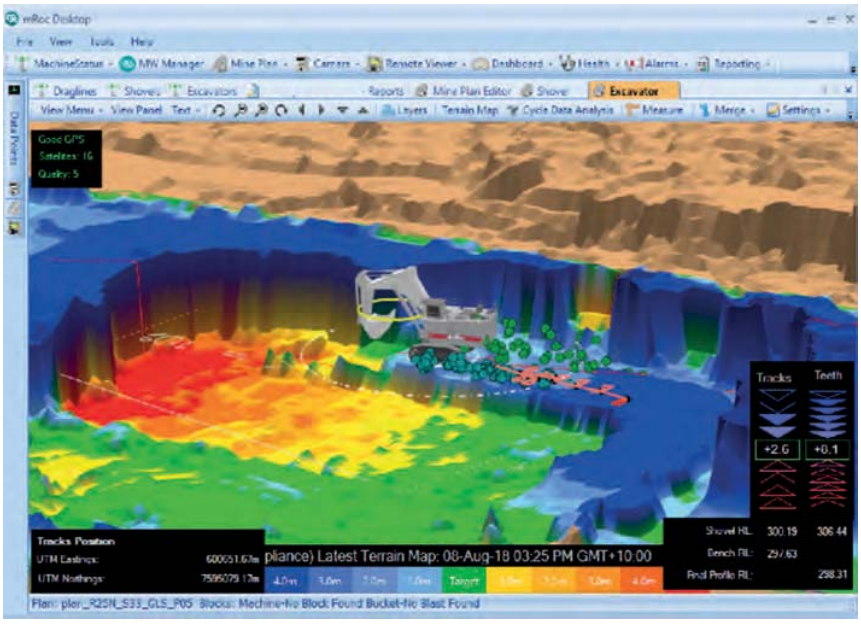
Andrew Jessett, CEO of monitoring and automation solutions provider **MineWare** (part of **Komatsu Mining**), told ***IM***: "Adopting new technologies to increase the use of big data is one thing...[But] to deliver real, sustainable performance improvement, the digitisation of mining must lead to joined-up process and equipment improvement across the whole value chain."

"Smart digitisation", as Jessett says, "means sharing data across the mining value chain and turning it into actionable, accessible information to improve operational performance".

With many operations suffering from 'silo syndrome' and the interoperability issues that come with this, providing an integrated operation where data and analysis flows freely is not as easy as one may expect.

Profit from the plant

Stewart says: "There is two parts to how you apply big data in mining, in my mind. One is around the process and getting maximum production and efficiency out of a process. In



Mineware is working with partners such as Komatsu Mining, Modular Mining and RPMGlobal to enable and deliver full integration between the companies' systems

that case, capturing all of the data from all of the equipment involved in the process efficiency and productivity is relevant.

"But, if you are talking about asset maintenance and how much value there is in applying big data analysis on non-critical assets, it might not be as important in mining, where you have a lot of backup equipment in existing circuits."

Where there is a case to be made for the former is the process plant, according to Stewart.

"This is an area where you can get a lot more value from integrating data and modelling a whole process," she said.

The type of data generated out of the processing plant – time-series data – is also suitable for the type of machine-learning algorithms starting to be applied in the mining industry.

"The other advantage with the process plant is you can deploy machine-learning algorithms using existing servers that are already supporting the process plant. You...[also] don't have to put everything in the cloud if you don't want to," Stewart said.

Petra recently collaborated with mining company PanAust to help predict tailings grade at the Ban Houayazai gold-silver mine in northern Laos using its MAXTA digital twin technology.

The machine-learning algorithm provided to PanAust integrated two years of 3D geological data with plant data to derive a formula to apply to block models, allowing both 'backward' reconciliation analysis and 'forward' predictions.

While similar digital twins could be developed without the geological information at the start of the process, Stewart admitted this would reduce the accuracy of the results. So, again, integration is key in this example (*you can read more about how Rio Tinto plans to use a digital twin at its Koodaideri project on page 60*).

OEMs are also catching onto these new big data analysis solutions in the process plant as they look to increase the availability of their products.

One such company is **Weir**, which officially launched its Synertrex® industrial internet of things (IIoT) platform earlier this year to improve the uptime and performance of its portfolio of mining equipment.

Synertrex® provides fact-based insights that allow operators to optimise equipment performance and increase throughput, according to the company.

The platform has been developed by Weir with the help of leaders in IIoT, data science and edge computing. This includes the likes of Microsoft, Dell and Petra Data Science.

"Weir has developed the Synertrex® platform as a highly specific augmentation of their key products," the company said.

Alasdair Monk, Group IoT Product Management Director for Weir, told ***IM***: "The development of our Synertrex® platform is an evolution of Weir's equipment and services. It allows our customers to monitor their equipment in real time, enhancing the performance and reliability of their operations.

"Weir offers a series of service packages as standard. With the Synertrex® platform, we have redefined our service offering, advancing our reach, responsiveness and understanding to customer's critical issues and opportunities."

At the moment, monitoring of Warman® pumps, Cavex® hydrocyclones, GEHO® pumps and Enduron® HPGRs, screens and crushers can be enhanced with the technology.

While it is still early days for Synertrex®, a number of success stories have already emerged from several installations across the globe.

This includes ascertaining the causes and advising a mine site in Mexico on the required corrective actions for two GEHO® hydraulically-driven positive displacement pumps – all without sending a service technician to site.

At a mine site in South Africa, the Synertrex® platform detected a change in the operating performance of an Enduron® screen. This prompted a detailed inspection which found hidden cracks on a side panel and suspension springs, which was quickly addressed. On the same site, the Synertrex® platform detected an issue with an adjacent crusher which fed the screen.

"This demonstrates how Synertrex® technology can provide an advanced understanding of the entire process plant and identify anomalies impacting multiple pieces of equipment," the company told ***IM***.

According to Monk, this hat-trick of discoveries by the Synertex® platform saved the customer "millions of dollars in lost production".

Metso is also venturing into this space with the development of its own advanced analytics and AI-backed platform for comminution circuits (read more about Metso Metrics for Mining below).

More value from the fleet

There are plenty of other applications outside of the plant where analysis and interpretation of big data can be used to create value for mining companies.

Fleet management and maintenance is one area where numerous companies offer solutions.

The key to these is integration between mining operation systems, according to Mineware's Jessett.

"Traditionally, data has been very fragmented in the operations space. To reap the benefits of big data, mining companies and vendors need to break down these individual operating siloes," he said.

Jessett and Mineware are not just paying lip service to this; they are working with partners such as Komatsu Mining, **Modular Mining Systems** and **RPMGlobal** to enable and deliver full integration between such systems.

"Our comprehensive integration between RPM's short-term scheduling solution, Xecute, and our shovel and excavator monitoring system, Argus, is a world-class example," Jessett said.

This combines office-based planning and scheduling systems with in-pit loader technology to enable mine planners and equipment operators to compare planned production activities against what is happening on site in real-time.

"Together, Xecute and Argus create a living mine plan that continually evolves and closes the feedback loop between mine planning, scheduling and operations to maximise productivity through greater control, flexibility and predictability," he said.

Wenco Mine Systems' Business Intelligence Product Manager, Simran Walia thinks fleet management and maintenance data need to be factored into the same analysis package for complete solutions.

"Productivity per shift, loads per shift, equipment condition, payload analysis – they all involve several operational systems and they're all interrelated, so analytics tools need to show that relationship, the cause and effect," he told ***IM***.

Wenco thinks it has solved this with its Avoca Mining BI platform, which, according to Walia, takes all parts of the "mining process into consideration, so processing and mining teams, maintenance and geologists all get the value from big data".

Avoca digests this data and produces visualisations of it to highlight trends within the mining process that teams can act on.

Dingo believes integration of a different type is required to ensure these big data tools provide the value mining companies require.

"At Dingo, we know that technology alone is not the answer," the company told ***IM***. "It's integrating technology into the way people work and keeping the people who use the technology central to the process."

By sticking to these philosophies, Dingo has provided its customers, on average, a more than 4:1 return on investment in parts costs alone under its fleet maintenance solutions, according to the company.

"One example is a small surface mine in Nevada which had a target to reduce their maintenance budget by 15%. By partnering with Dingo, they achieved a 24% reduction in year one of their programme," Dingo said.

The company's Trakka® predictive maintenance software helps manage and correlate multiple condition monitoring technologies into one database to aid analysis and decision making.

On top of this, Dingo has a team of

The release of Dingo's Trakka 4.5.12 comes with improved drag and drop functionality, flexible CSV data import, a new interface for dozer tracker inspections and new ERP integration web service

maintenance experts, working under its Condition Intelligence® platform, who use Trakka to help filter through the massive amounts of data coming through from monitoring equipment.

This type of service is extremely valuable; in effect offering a human touch to the machine-heavy processing of data.

And, the company is offering "actionable information on the go" with the development of products such as the Trakka Field Inspection App and Asset Heath Management Dashboard and App.

The increased uptake and use of such apps has led to higher volumes of digital reports, images and other files; something the company addressed in the release of Trakka 4.5.12. This features drag and drop functionality, flexible CSV data import, a new interface to dozer tracker inspections and new ERP integration web service – all geared towards simplifying the user experience.

Simon Van Wegen, Product Manager, Maintenance Systems, Modular Mining Systems, says there are four main areas maintenance departments must focus on when it comes to the health of equipment components.

These are:

- The failing component;
- The root cause of the component's failure;
- Component health degradation for the failure type (is the failure detectable earlier on the P-F curve? (relationship between a potential failure and a functional failure)), and;
- Actions to take to prevent future failures, or a plan to replace the component before it fails.

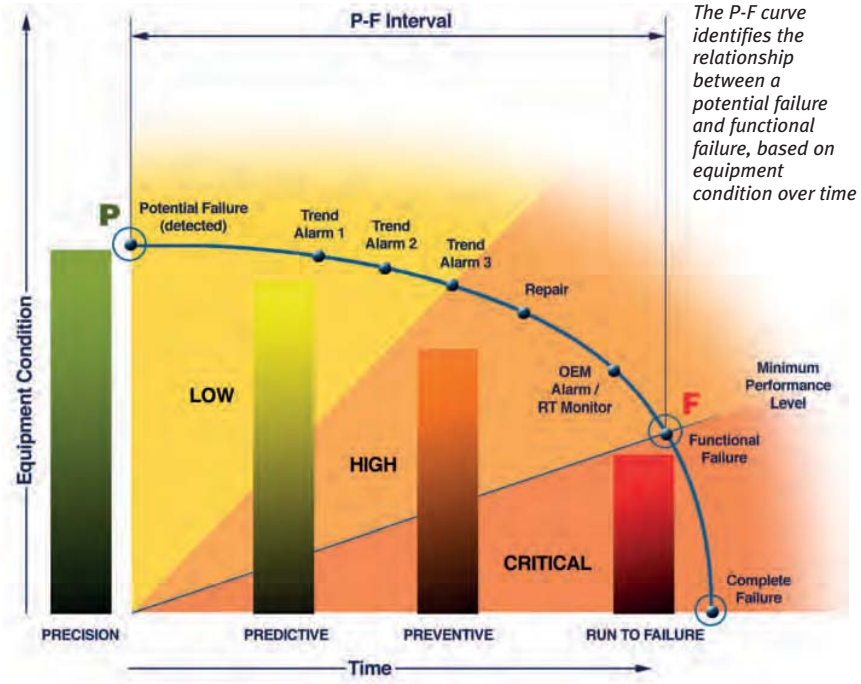
"An intelligent maintenance management system provides plenty of data to confidently identify the above and some systems can often process this data by two different technological means: edge computing and cloud computing," Van Wegen told ***IM***.

"The MineCare Maintenance Management system from Modular Mining Systems, for example, utilises both of these computing means to help increase equipment availability, minimise troubleshooting efforts, mitigate catastrophic failures, and provide analyses to identify component health degradation and predict when potential failure points will occur."

The MineCare system leverages edge computing's real-time capabilities to quickly notify operators and maintenance teams about critical, time-sensitive conditions while also enabling rapid data transmission for central processing, according to Van Wegen.

"For example, if a haul truck's engine oil levels are critically low, the MineCare system will immediately notify a maintenance technician. This real-time information drives technician action to stop the unit and address lubrication levels before major engine damage occurs," he said.

For large quantities of real-time and batch data that could have any influence over a



The P-F curve identifies the relationship between a potential failure and functional failure, based on equipment condition over time

component's health, this is where cloud computing comes in.

"Cloud computing's massive storage capability also facilitates easier machine learning and analytics. Gone are the days that require an engineer to sift through huge raw data files; the MineCare solution feeds large datasets into intensive machine-learning algorithms that can identify trends, calculate predictions about components failures, identify components that are operating differently than other components with similar operating hours, and much more," he said.

This is a potent combination that has brought about some impressive results.

For example, a large mine in Australia reduced its unplanned events by about 25% in roughly one year after leveraging the MineCare system's intelligent algorithms to identify potentially-problematic trends before they resulted in component failure.

And, on top of this, Modular is offering a remote monitoring package, RemoteCare, where highly-trained specialists monitor and manage real-time telemetry data generated by a mine's entire fleet, providing valuable insight that can lead to valuable results.

"By collecting the right data at the right time and analysing it at the appropriate edge or cloud level, the MineCare system helps maintenance teams resolve the root cause of repeated failures to increase equipment uptime and decrease associated maintenance costs," Van Wegen concludes.

Teck Resources is using such big data analysis at its steelmaking coal operations in British Columbia, Canada, incorporating artificial intelligence into its data generation procedures.

"Through our partnership with **Google Cloud** and **Pythian**, we are unlocking new insights from the millions of data points generated by our mobile fleets," the company said.

"Issues that were previously unpredictable,

This month sees the launch of Metso Metrics for Mining, a cloud-based IoT solution designed to monitor and predict integral components of a mine's comminution circuit. Dan Gleeson received some more details on the new innovation from Metso Chief Digital Officer Jani Puroranta ahead of its official debut.

IM: ***How will Metso Metrics for Mining differ to Metso Metrics for Aggregates?***

Jani Puroranta: Metso Metrics for Aggregates is more akin to other fleet management solutions you can find for various kinds of mobile equipment. It uses satellite connection (or cellular internet, when available) to communicate with Metso's backend. Hence, it collects only small amounts of the most critical data such as operating hours, alarms, etc.

Metso Metrics for Mining, on the other hand, collects vast amounts of data from circa-100 sensors within the machines at one second resolution or even higher. Connectivity is typically fixed internet, which allows for much more data to be transferred to Metso's cloud. The aim is to monitor the current condition of the machine and its various sub-systems (hydraulics, lubrication, etc), and to predict critical component failures already in advance. With the help of advanced analytics and AI, we can automate some of these monitoring and prediction tasks.

Also, the data allows Metso experts to look for ways to improve the machine's operation such as how to reduce the specific energy consumption, or to find correct operating parameters for the application to maximise throughput and product quality.

Hence, in summary, Metso Metrics for Mining is a more technologically advanced solution combined with a 'hypercare' expert support model. Metso Metrics for Aggregates is more a self-help tool for the user.

IM: ***You have mentioned one of the major roadblocks for predictive maintenance and AI in fixed plant applications in mining has been the non-standardised nature of these plants. How is Metso getting around this problem?***

JP: Unfortunately, there is no easy way out of this since ultimately we need to work with heterogeneous fleets of all ages. Hence, prioritisation of development work has been key for us to move forward at good speed. We started the work with Metso's primary gyratory and cone crushers, as well as vibrating screens. Next in line will be other asset types such as mills and pumps. We always try to see where we can add most value to the customer's operations and where there is little or no relevant offering on the market today. What we do not want to do is repeat something that already exists (such as APC or GMD condition monitoring), but find blank areas within the processing plant. These are not hard to find – the tough part is how to solve them remotely.

IM: ***Can you give any more insight into the African, US, South American and Australian operations currently trialling Metso Metrics? How has it impacted the uptime of the crushers, for example?***

JP: We have been piloting Metso Metrics on five customer plants during the past year. On these sites, the biggest benefits have actually come from collaboration between Metso's and the customer's experts. In the past, both were operating blindly without really knowing what is causing maintenance issues, critical component failures or reduced throughput. Now, we have the data to get to the root causes quickly so that machine and circuit performance can be quickly improved.

However, it is still a bit too early to show statistically reliable numbers. And sometimes you cannot really quantify the benefit of a predicted failure that was avoided with preventive maintenance – how can you measure something that never happened?! But with the connected fleet expanding to dozens of machines of the same type, we should be able also to put numbers on the benefits over the coming 12-24 months.

such as potential electric failures, are now being identified before they happen by machine-learning algorithms. We are also modelling and predicting remaining life span of our trucks, determining wear, identifying abnormal failures and enhancing alarm and notification systems."

This type of machine learning is helping minimise unplanned maintenance, reduce overall maintenance costs and extend equipment life, according to Teck

"It is estimated that at one site alone there is potential for over C$1 million ($769,843) in annual savings from implementing this programme," the company said.

Interoperability

While there is no shortage of potential data points at most mines for machine-learning algorithms to study, there are still barriers holding back data integration in this space – the main one being interoperability.

The problem boils down to many of the machines involved in the mining processes speaking a different 'language'.

One solution to this problem is to come up with an industry standard that all machines use, which facilitates machine-to-machine interaction and allows for smooth transfer of data between mixed fleets.

IREDES and the Global Mining Guidelines Group are two organisations pushing for such a standard.

Chairman of the IREDES initiative, Christoph Mueller told ***IM***: "The reasons why standardisation is a hot topic now...is the fact that the operating mining companies realise if they join up with one manufacturer for their autonomous fleet, they are locked to this specific OEM, and there is no chance to include other equipment, even if 'their' OEM does not supply this kind of special equipment."

Mueller is aware there is a conflict between opening up data exchanges in this way – causing potential intellectual property issues – but says, for process information to be properly and quickly used, an industry standard data communication interface is required.

"Today, information processing capability is so big that, in my opinion, it makes much more sense to have the raw data turned into really usable information right on the machine and use this information for maintenance, operations and quality assurance.

"This way, the machine by itself can compute information like estimated time to next service, load integrals for all kinds of different components, etc in order to allow cost-effective maintenance and to optimise operational dispatch availability."

Mueller said the initiative has seen more interest in implementing the IREDES profiles on machinery in the last two years and it was in the process of carrying out a review of the standard – news of which is likely to be discussed at the upcoming APCOM conference in June.

Even without a standard machine-to-machine language, OEMs and data analysis providers are still integrating their own software and hardware with other system providers' systems.

Technology company **RCT** has found a way around proprietary systems to install its automation and teleremote solutions at many mines around the world.

Brendon Cullen, RCT's Automation & Control Product Manager, said the company likes to work with OEMs and dealerships to ensure they are comfortable with the programmes they provide mining customers, but when information is not forthcoming, they can go down another route.

"RCT has a skilled team that are able to reverse engineer a solution by interrogating the machine's data sources," he told ***IM***.

"Interoperability is key for RCT as our ability to fit similar systems to many makes and models of machinery on a site and integrate with their current fleet management, dispatch and information systems, is what sets us apart from our competition."

Cullen points out there is no OEM machine RCT has not been able to integrate with over the years – from a 1980's dozer to a 2018-built underground truck.

And, more OEMs are opening up data sources

to companies like RCT, according to Cullen.

Caterpillar is one of these OEMs, as was recently made clear on a project in the Pilbara of Western Australia. Here, the company is on course to complete a retrofit of Cat MineStar™ Command for hauling autonomous technology on 24 Komatsu 980E haul trucks by the end of the year.

Bill Dears, MineStar Solutions Commercial Manager, lays out a number of reasons why today's mining companies are demanding interoperability and, in turn, why Caterpillar is providing solutions to them:

- They have made significant investments in the machines they already own and are not interested in replacing whole fleets in order to leverage new technologies;
- They rely on a variety of manufacturers and vendors to provide their information technology/operational technology systems, production equipment and other support vehicles and need technologies that can work across all their machines, systems and processes, and;
- They want to optimise their operations and make them as lean as possible. The connectivity that pulls together all machines and systems, across the site and the enterprise, is what helps mines achieve that optimisation.

Petra's Stewart thinks APIs (application programming interfaces) and SDKs (software developer kits) can provide another route around the data language issue.

"Often when we integrate our MAXTA digital twin solution, for example, we integrate other companies' data into our product (through an API/SDK), but that one-off integration cost is relatively small when spread across machine-learning models of throughput, recovery and product quality," she said.

"The good thing about an API management architecture approach is that it enables companies to solve interoperability issues in months, and not years."

OEM-agnostic automation solutions provider **Autonomous Solutions Inc**, too, is making the most of API functionality in its bid to integrate with, mostly, proprietary interfaces.

Drew Larsen, Director of Business Development for ASI Mining, told ***IM***: "While we recognise ongoing efforts and initiatives around interoperability are having some effect, we anticipate universal standards and open interfaces will be slow coming from OEMs and other providers.

"ASI works around these proprietary interfaces through various means, but generally seeks cooperation from system providers through supported APIs or access to protocols where available. It also provides interface access to its own systems to partners and project participants to promote interoperability within an autonomous environment."

Whether it is an industry standard, an API, an SDK, or something else, there is a clear need for those providing data to the mining industry to enable more integration and create the platform for mining companies to leverage an ever-increasing number of solutions. IM

Resolute Mining, in partnership with **Sandvik**, is in the throes of an ambitious project to bring a fully autonomous underground gold mine into production at its Syama Underground asset in Mali. Dan Gleeson spoke with Resolute Chief Operating Officer Peter Beilby about why the company decided to go down this innovative route.

IM: ***What makes Syama Underground suitable for automation?***

Peter Beilby: It is a large orebody which will be operated as a sub-level cave. Sub-level caves, by their very nature, lend themselves to automation given the repetitive mining process. You continually go through a cycle of drilling, charging and firing the blastholes, then loaders extract the ore from drawpoints and, in our case, load into an ore pass.

These machines operate by laser scanning and learning the route they need to take. Once they have done that initial survey, they can repeat the route at speed – potentially at much higher overall speeds over time than a manual operation.

IM: ***How much of a role does big data and digitalisation play in Resolute's plans for an automated mine at Syama Underground?***

PB: Big data and digitalisation is a really important part of operating a fully-automated mine. What is particularly exciting is that we're just at the beginning of understanding how powerful these tools will be. Our automation team has been working with our partner, Sandvik, to help further develop what they already have in place in terms of data management and analytics for Syama. We will be generating a significant amount of data from the machinery underground and it is how we actually mine that data to come up with the information that will help us optimise performance.

IM: ***What facilities have you got in place to manage data at the Syama Underground project?***

PB: We are in a very remote place, which is one of the challenges. We rely on bandwidth associated with satellite connections.

We know we are going to need to transmit a large amount of data once in operation – it is not just the data we will be collecting from the machines, it is also the cameras we will have in place, ventilation controls, ground controls, etc. We decided to proof ourselves for the next five to 10 years by using 120 pair fibre-optic cables down each decline to ensure we don't lose functionality and have enough capacity for future operations.

One of the interesting aspects of our operation is that by linking in to Sandvik's OptiMine solution you can...instead of, say, looking at five LHDs on your mine site, compare your machines with Sandvik loaders all over the world. That means you are really starting to hone in on exactly what drives performance and identify areas for optimisation and cost savings within your maintenance programme.

IM: ***Aside from the AutoMine and OptiMine systems, what other information and production planning systems is the company using to help automate operations?***

PB: If we talk about the mine itself, we use **Deswik** for mine planning. The idea is that the database all feeds into this.

The hardware that is being put into the underground mine has the ability to carry significant amounts of data. As such, fans, pump stations, rockbreakers, geotechnical and other data-hungry usage such as video underground will also be monitored and controlled through the same system.

IM: ***Have you chosen to have a complete package from Sandvik in order to alleviate any potential interoperability problems?***

PB: When we started our Syama Underground journey two years ago, we went out like every miner and said: 'We want a yellow truck, an orange jumbo and a different coloured loader'. This was based on our own biases and preferences, and we envisaged a third party running them.

But, through that process, we looked at various partially-automated mines around the world (Finch and Northparkes, included). This ignited the fire in us to pursue automation further.

At that particular time, the only OEM that could automate the whole process was Sandvik. We realised we needed to align ourselves with Sandvik and leverage that relationship to deliver a fully automated solution.

IM: ***What's the latest timing on Syama?***

PB: We are firmly on track to deliver the world's first customised, fully automated underground gold mine. Sub-level caving will commence in December 2018 and we will then ramp-up to full automation and run-rate production by June 2019.