

SOLID

#2 2017

GROUND

A MAGAZINE FROM
SANDVIK MINING AND ROCK TECHNOLOGY

Finland:

**Hidden
depths**

Sandvik Reborn:

**In with
the new**

Big Picture:

**Life finds
a way**

**Sandvik 365 service in the
phosphate mines of China.**

FERTILE GROWTH

SANDVIK

Dear reader,

INNOVATION IS, BY its very nature, a never-ending process, one that is crucial to the continuing success of any organization and its customers. That's why we're able to bring you news of new, exciting developments in each and every issue of *Solid Ground* – and this one is no exception.

The technologies that we're developing aren't just designed to meet today's challenges – we're continually looking ahead to anticipate the requirements of the future. Mines are looking to increase their digital investment to meet their desire for increased safety, availability, productivity and overall equipment efficiency. We are setting out to be your preferred partner on that journey, through our digital offering framework:

- Autonomous equipment and features
- Connected equipment
- Analytics and process optimization

For example, our new generation of mining trucks (Sandvik TH551i and Sandvik TH663i) teams up with our industry-leading AutoMine and OptiMine automation and information management solutions to revolutionize haulage operations.

Our dedication and commitment runs right through the equipment life cycle – read about how we're supporting the Kailin Group with a Sandvik 365 maintenance agreement at their service yard in Jinzhong, China, where Sandvik engineers are working alongside Kailin's equipment teams (p.11).

Sandvik Reborn is yet another exciting part of the Sandvik 365 concept, a rebuild solution which replaces a complete crusher to upgrade its performance and restore availability rates close to those of a new unit, at a lower operating cost (p.16).

Our strong belief in our industry, and commitment to it, is driven from the very top, by Sandvik President and CEO Björn Rosengren, who himself has a long background within the industry. On p.6, Björn underlines our focus on innovation, new technology and performance.



LARS ENGSTRÖM
PRESIDENT, SANDVIK MINING
AND ROCK TECHNOLOGY

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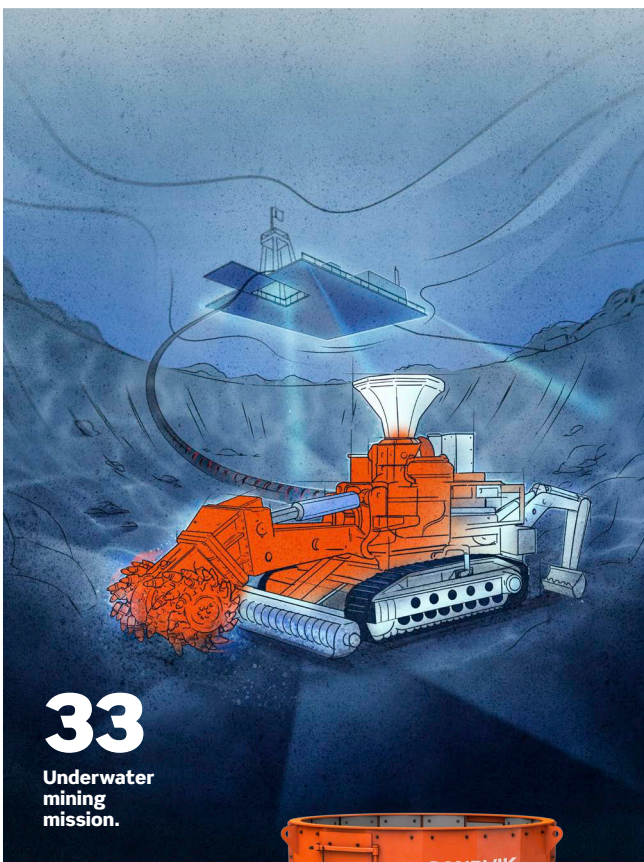
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Industry giant

▶ In March 2017, Sandvik Mining and Rock Technology delivered the world's largest-ever hybrid roll crusher. Sandvik CR810/18-40 was delivered to Vale at its Eliezer Batista S11D complex in Canaã dos Carajás, Brazil, in the state of Pará. In keeping with the size of the new machinery, this mining complex is also the largest in Vale's history.

In addition, 18 Sandvik Hydrocone crushers were delivered to the mine's complex processing plant. Sandvik CR810/18-40 integrates the structure responsible for primary crushing, while the others will perform secondary and tertiary crushing.



Sandvik DT912D showcases the latest in automated tunnelling technology.

Tunnel vision

▶ Sandvik DT912D was showcased at CONEXPO-CON/AGG 2017 in Las Vegas, where the most up-to-date construction innovations were on display. This latest advance in tunnelling technology allows customers to take an intelligent approach to rock excavation.

The full platinum package implements automatic boom movements and drill cycles, as well as full integration with Sandvik iSURE tunnel management tool for accurate drilling, charging and blasting plans.

A CRUSHING SUCCESS

▶ Sandvik QJ341+ is a new, improved version of Sandvik QJ341 mobile jaw crusher. This new model incorporates a double-deck pre-screen as well as a newly designed telescopic natural fines conveyor to complement this feature.

In testing, this has already shown increases in

productivity of up to 30 percent. In addition, there are improvements across the rest of the equipment, from the low-drag main conveyor to the self-locking hopper, so the benefits range from productivity boosts to better safety measures for the operator.



Sandvik QJ341+ is a state-of-the-art mobile jaw crusher.

A partnership built to last

▶ This year, Hindustan Zinc Limited (HZL) organized a Suppliers Meet for its major suppliers, including Sandvik Mining and Rock Technology. The company used the occasion to outline its growth plans and visions for the future, with a focus on safety, productivity, reliability and sustainability.

For the second year running, Sandvik was presented with HZL's Supplier of the Year Award - Operational Excellence - proof that after a 12-year partnership, the two companies continue to have a great relationship built on strong teamwork and an ongoing commitment to safe and productive operations.

Bringing down boundaries

▶ Travelling between Shenzhen in China and Hong Kong is a journey made by millions in the area, yet it often means congested roads leading to huge time delays. To solve the issue, a new Border Control Point (BCP) is being made, called the Liantang/Heung Yuen Wai BCP.

This major new development involves the construction of more than three kilometres of viaducts and 700 metres of tunnels. CRBC-CEC-Kaden JV, the company responsible, looked to Sandvik Mining and Rock Technology and its equipment for help. The contractor has invested in three Ranger DX800 surface drill rigs to supplement the Sandvik equipment already in use at the site, and the partnership is working well.

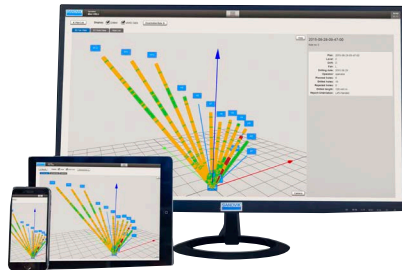
The evolution of automation

▶ In an effort to stay at the forefront of mining technology, Sandvik has introduced two new OptiMine modules: the 3D Mine Visualizer and the Drill Plan Visualizer.

The Sandvik 3D Mine Visualizer puts an accurate 3D model of your mine straight into your office. It streamlines the planning process, helps to identify problematic areas and assists in tracking a mine's development over time.

The Sandvik Drill Plan Visualizer displays both drill plans and drilling results in an easy-to-read, user-friendly way. Plans are easy to edit and can be transferred to the drills automatically. This allows customers to see real-time drilling data

immediately, and in turn they can optimize their processes constantly.



THE QUOTE

“It is a natural step for us to collaborate with a company like IBM – experts in advanced analytics, cognitive computing and modelling – to create even more value for our customers.”

Lars Engström, President of Sandvik Mining and Rock Technology, on the partnership between Sandvik and IBM, aimed at advancing technology in the mining industry.



This Sandvik LH514E mucked for more than 35,000 hours over eight years.

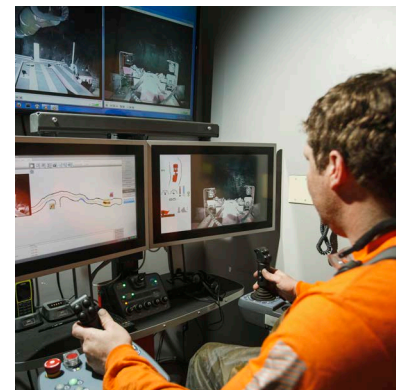
FAREWELL TO A MASTER

▶ A Sandvik LH514E loader amassed 35,516 hours of operation over eight years for Northparkes mine in Australia before its decommissioning at the beginning of 2017.

The electric loader is estimated to have moved more than eight million tonnes of ore – an impressive lifetime considering that the loader can carry 14 tonnes per trip.

The pioneers of Hecla Greens Creek

▶ Hecla Greens Creek in south-eastern Alaska is the first underground mine in the United States to use automated loading technology from Sandvik Mining and Rock Technology. The aim is to increase productivity, improve safety and achieve better cost control. In addition, by using AutoMine, operators can be moved from potentially hazardous situations to a control room at the surface.



Sensors save lives

▶ In South Africa, equipment operating in underground mines is required to be fitted with an active proximity detection system. This led Sandvik Mining and Rock Technology to design its own Third Party Proximity Detection Interface, allowing customers to install a proximity detection system for loading and hauling equipment.

The system lets equipment operators know when other personnel are in close proximity to the equipment, so it has a positive impact on the safety of the employees in the mines. All they need to do is wear the electronic tags that communicate with the sensors on the equipment.

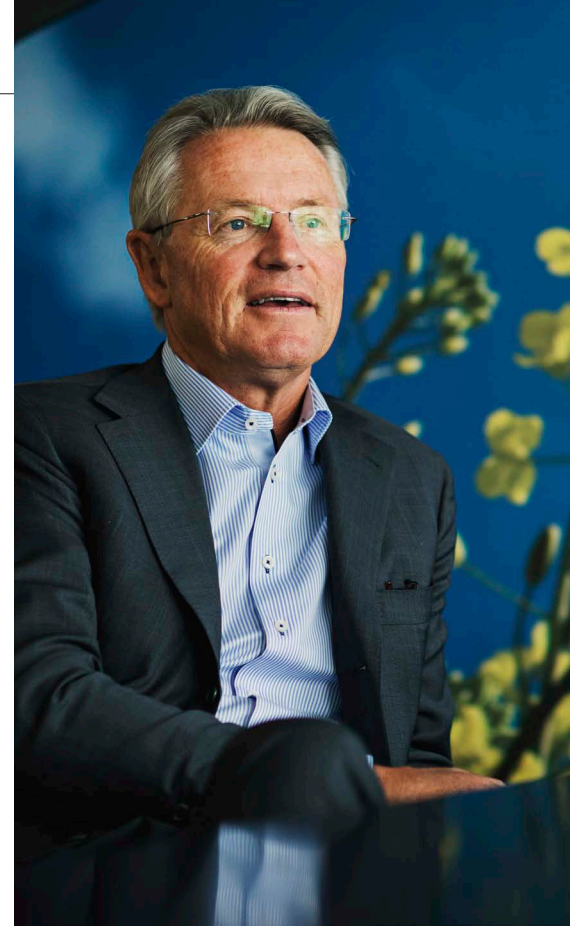


Q&A

INDUSTRIAL CAPTAINCY

■ Björn Rosengren, President and CEO of Sandvik Group, shares some of his extensive knowledge on the challenges facing the mining industry today, and how it could look in the future.

Text: JEAN-PAUL SMALL Photo: OSKAR OMNE



AS PRESIDENT AND CEO of Sandvik Group, Björn Rosengren has a lot on his plate. But with his extensive history at the helm of Swedish industrial multinationals, he is the ideal candidate to expound upon the current and future state of the mining world in general, and Sandvik Mining and Rock Technology specifically. He was kind enough to share some of his time and thoughts with *Solid Ground*.

Q You have a long background within the mining industry. How does your experience shape your views of the industry today?

A I'm pretty passionate about mining. I've been in the industry, more or less, since 1998. From my perspective, it's a good industry to work with, particularly when you're a world leader and well represented. I feel that for many of our customers, it's not just a company selling and another customer buying; mining is built on strong relationships.

Q The mining industry appears to be rebounding from a prolonged decline, particularly with regard to commodity prices. How does the recent rally affect Sandvik?

A Yes, it was quite a long downturn. The market coming back over the past year is actually a result of investments during that period. From my perspective, it's not a big expansion in the industry. If you look at the output coming from the mines, it actually goes up 1 or 2 percent every year, and it performed similarly during the downturn. So it's been consistent but because of low mineral prices, the mines didn't make as much revenue and that affected capital spending.

Q Based on your experience, how and where do you think the mining industry should evolve in the immediate future?

A Mineral prices will affect how mining companies behave. Speaking for Sandvik, we expected real expansion in autonomous mines since 2005. In fact, at the end of the '90s, we had a well-developed autonomous mining product offering. But with every downturn, cash flow becomes limited, which affects spending. Now that the mineral prices are performing well again, our technology has evolved. I'm 100 percent convinced that mines will quickly become more automated due to the available technology. The speed at which this happens may be determined by

commodity prices, but the direction is very clear. We are fortunate to be a market leader when it comes to technologically advanced offerings. We have off-the-shelf products that can immediately help productivity, and most mining investments are about getting the tonnage out of the mines safely for less cost.

Q In mining and rock excavation, there's always a big focus on sustainability. How do you think these industries can improve on this in the coming years and what is Sandvik doing to assist?

A When it comes to sustainability, mining companies are some of the most watched in the world, particularly the larger ones listed on exchanges. They follow regulations, locally and globally. This is important because regulations and demands on the mines will be tougher, not least when it comes to their environmental approach and how they treat their workforce. Safety, too, is of the utmost importance. I think the technology that we've introduced into our products is helping customers to become safer and more sustainable; these things go hand in hand. Automation, more fuel-efficient engines, battery technology, these all help environmental conditions. Our ambition and the basis of our strategy going forward is to help our customers be productive and safe.

Q What part of the mining industry excites you most, both now and looking to the future? Why?

A I like underground mining, particularly hard rock. That's the sweet spot where Sandvik can deliver the most value per tonne being excavated. It's also where you need the most advanced technology. When it comes to efficiency and productivity, this is where the focus will be. That's the exciting part of mechanical excavation. The dream of every miner is to leave blasting in the past, as the logistics are so challenging.

Q The demand for commodities changes over time, with the emergence of different technologies and manufacturing methods. Will the mining industry have to change what it focuses on going forward?

A Today gold and copper are the main two minerals driving most of our business. Silver, zinc and others are important too, of course. I think lithium is an area where we'll see a lot of mining, although the resources are quite

limited. Copper will continue, even though we've seen challenges in the prices. It'll still be excavated a lot in the future. When you look at the excavation of minerals, many of them will be more difficult to access. They're often deeper in the earth, so you have to be able to excavate more rock for the same amount of minerals. It's human nature to innovate and find ways to excavate the minerals, even if that means going underwater (see p.33 for more on the ¡VAMOS! project). If there are minerals, there will be mining. The key is to do it responsibly.

Q In your mind, what sets Sandvik apart from the other businesses you've been a part of?

A Our strengths are well known: Sandvik is a world leader with a broad equipment range, focusing on mechanical excavation and crushing, loading, hauling and drilling, both surface and underground. This is not so different from our main competitor. Over time, this changes. We will come up with innovative ideas and new products, but the great thing is when you have two such strong players, the focus on R&D makes each company better. It makes you unique, with a strong focus on new technology and performance. It provides quality for our customers, and miners are not prepared to compromise when it comes to quality. ■



Lithium looking positive

▶ Lithium is expected to be in great demand in the coming years, as more and more everyday devices are powered by batteries containing the metal. In response, the Australian government plans to invest in a lithium mine for the first time.

The long-term goal is to allow for the use of more renewable energy. Australia was the world's largest lithium producer in 2016, and with further investments it looks set to remain so.

**100
MILLION
EUROS**

The amount, in gold, that two new European vaults will be able to hold. CoinInvest, a European gold dealer, is looking to build one of these vaults, which will be 100 square metres in size.

Nuclear mining

▶ Any remote mining operation requires a huge amount of power to run at optimum levels for extended periods of time. Now, as more parts of the world are being explored, the need to be able to power mines efficiently has increased.

By using small, modular nuclear power plants, a 20-year supply of energy for a mining project can be provided by just 2.4 cubic metres of nuclear fuel. If a mine were to use diesel fuel instead, it would need 50 million litres per year, so nuclear power has benefits in terms of both cost and logistics. How long before the mining industry starts looking to embrace these new small nuclear power technologies?

Sustainable progress

▶ A report from the Mineral Products Association has shown that in the UK, the aggregates industry has taken major steps in its sustainability. The report said that the industry has a good record on recycling, emissions and environmental management, which will grow more important in the years to come.

Quarry restoration was highlighted as a major positive, with 469 hectares of land restored to priority habitat so far, and another 2,748 hectares planned to be restored to the same standards.

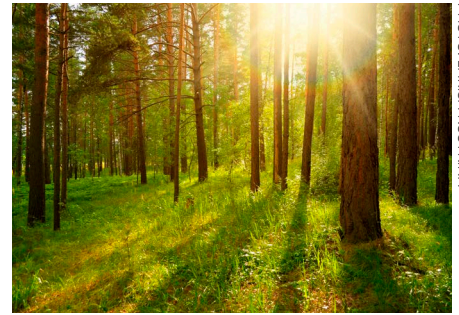


PHOTO: LARISA KOSTIKINA

PRODUCTION BY EXTRACTION



PHOTO: IGOR DMITRIEV

▶ As the demand for copper is constantly rising, scientists all over the world are looking for new ways to produce the conductive metal. Researchers at MIT have done just that, finding a novel way to selectively separate copper from sulphur-based minerals using molten electrolysis.

This new process is described as one-step, where all previous methods were multi-step. Fundamentally, this means cutting both the time and cost of extraction. If they continue to break ground, this new method could be important on an industrial level in the near future, leading to increased copper yields which will help meet demands worldwide.

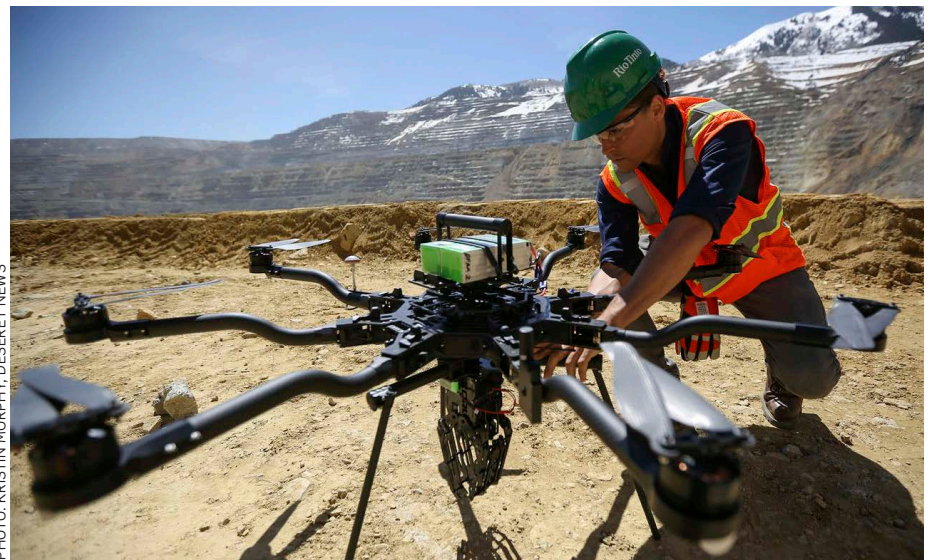


PHOTO: KRISTIN MURPHY, DESERET NEWS

Droning in

▶ More mines around the world are investing in drones and related technology, and it's easy to see why. At Bingham Canyon in the US state of Utah, managers used drones to map out the entire open pit mine, allowing them to identify potential hazards for employees and analyze the risks.

This technology can be used to maximize the

potential of any mine, while minimizing risk to employee health. Drones can go to places where people can't, see things the human eye can't see and give operators vital information about where they're working and where they should be focusing their efforts. As costs come down, the technology is more commonplace, and many mines have dedicated drone pilots.

The Expert

THE WORLD'S LARGEST

diamond producer has announced plans to operate a carbon-neutral mine within just a few years. De Beers, majority owned by Anglo American, intends to implement a carbon capture and storage (CCS) project by storing carbon dioxide in kimberlite rock, abundant at most diamond mines. *Solid Ground* spoke to Stuart Haszeldine, professor of carbon capture and storage at the University of Edinburgh's School of Geosciences, about CCS and what it may mean for mines in the future.

Q: Briefly explain the basic tenets of CCS for miners and mine sites.

A: CCS is the collective name for a group of technologies and actions that are trying to reduce the rate at which greenhouse gases such as CO₂ are added to the atmosphere by human activity. It is well established from basic physics that increasing CO₂ content acts as a thermal blanket around the Earth, increasing temperatures by a measurable 0.9 degrees Celsius.

The mining industry produces large quantities of CO₂ emissions from the fuels used by heavy equipment moving rock and earth, and also by the crushing, purification and separation processes used in many mining operations. In some places mines are sitting on a valuable asset - the excavated or crushed rock associated with ores or products. Some of these rocks types, particularly those associated with igneous bodies, are chemically reactive with CO₂. Over time, those minerals will naturally undergo weather-

ing by reaction with atmospheric CO₂ and combine that CO₂ into new minerals - carbonates, clays, serpentine or soluble salts. So the mining industry wastes - rubble, tailings and fines - can be ideal materials for reaction with rainwater or river water carrying atmospheric CO₂.

Q: So mine sites make good storage venues?

A: Yes, there is a huge resource of reactive rock, which has been crushed finely and so is ready to react. There is an industrial infrastructure that can divert water flow through the relevant rock debris where CO₂ can be absorbed. And there are monitoring and clean-up facilities which can catch pollution episodes with enough engagement, speed and understanding to ensure that a new method of operating more cleanly is promoted rapidly.

Q: De Beers plans to store carbon in kimberlite tailings. Why are kimberlite tailings a particularly good choice for carbon storage, and can other mines - not just diamond mines - find success using their tailings as well?

A: Kimberlites are rich in mafic reactive minerals that contain iron, calcium and magnesium, such as forsterite olivine or magnesian ilmenite. These are particularly suited to rapid reactions with CO₂ and may form serpentine, with methane as a by-product. Most igneous mines can produce minerals that have suitable reactions to absorb CO₂. For example, granites contain feldspars, which react with CO₂ to form clay minerals. ■

+ Stuart Haszeldine, professor of carbon capture and storage at the University of Edinburgh.

KAILIN ROCK PHOSPHATE MINES



A misty mountain landscape with a winding road and a small town in the valley. The scene is dominated by green, forested hills and mountains under a hazy sky. A road curves through the lower right, with a few vehicles visible. In the distance, a small town with blue-roofed buildings is nestled in the valley. The overall atmosphere is serene and somewhat somber due to the mist.

A CONTAINER FULL OF COMPETENCE

- Rock drill maintenance costs have plummeted at one of China's leading rock phosphate producers, which also makes fertilizer to help feed the world's growing population.

Text: DAVID NIKEL Photo: JUSTIN JIN

KAILIN ROCK PHOSPHATE MINES

Every year the planet's population grows by around 75 million people – more than the entire population of the United Kingdom. The United Nations states that the world produces enough food to feed the entire population of earth, yet close to 800 million are chronically hungry. There's little doubt that food production is one of the biggest challenges facing the world today.

Food production itself has risen significantly since the 1980s, thanks in

part to the increased use of fertilizer. Rock phosphate is the raw material used to manufacture most commercial phosphate fertilizers on the market. It's also available in abundance underneath China.

Worldwide demand for phosphorus is expected to grow as the world begins to run out of the naturally occurring element. There is a finite amount of phosphorus left underground. Although phosphorus can be recycled, it cannot be artificially produced. China and Morocco hold most of the world's remaining reserves.

The rapid growth of the Guizhou Kailin Group Co. Ltd (Kailin) in the Guizhou province of south-western China has mirrored the economic growth of the country. Since 2000, the Kailin Group has achieved an average annual growth of 33 percent. The large industrial group mines rock phosphate but also owns the chemical plants that produce the fertilizer and several other industrial interests.

KAILIN IS BLESSED with rich natural resources of rock phosphate, expected to last for 100 years at the current rate of production. Nearly 80 percent of China's rich phosphorus resource with P_2O_5 content above 33 percent is concentrated around the Kailin mining area.

As the phosphate mining operation expands, so does the pressure on the fleet of 65 Sandvik underground drill rigs. In 2016, Kailin approached Sandvik with a need for improved maintenance routines. The resulting Sandvik 365 service agreement has since

The hard rock means the drill and blast method is essential.





The price we pay is very small, considering the improvements we are seeing.

created the win-win situation of improved productivity and reduced costs.

“The rock phosphate here at Kaiyang is the best in the country,” says Zhongguo He, the general manager of Guizhou Kailin Mining Company.

So good is the material, and so great the demand, that the Kailin operation has expanded drastically over the past 10 years. The sub-level open stoping mines now totally dominate the town of Jinzhong, nestled in a remote valley in rural China. The once sleepy farming community is now a thriving industrial centre that is home to 50,000 people, of whom approximately 80 percent work for the Kailin Group in some capacity. Although currently one of China’s poorest regions, Guizhou province is investing heavily in infrastructure. It has built several of the world’s tallest bridges to reduce travel times in the mountainous terrain.

“Jinzhong was just a very small village before Kailin was founded,” says Zhongguo He. Although thousands of people now live and work in Jinzhong, it remains a tight-knit community. As he speaks on the town’s

central plaza, several people in the distinctive bright-orange overalls of the Kailin company stop to greet him. As a Sandvik drill is driven along the town’s main street, conversation shifts towards the importance of suppliers, not just for the phosphate mines but for the whole value chain.

“We extract the rock phosphate using mostly Sandvik machines,” he says. “It is transported via pipelines to the chemical plant, where it is processed and turned into fertilizer to be transported all over China via railroad and by ship to other countries. The whole operation is owned by various parts of the Kailin Group, so getting the equipment right in the mine has a direct impact on how much food our nation’s farmers can grow.

“THE BIGGEST CHALLENGE we face in technology terms is to stay safe when we mine underground,” says Zhongguo He. “Getting the right equipment and technology and keeping it operational is crucial. In the past, we purchased just the equipment, but increasingly we are focusing on an

integration of purchasing both equipment and ongoing service and maintenance agreements. Not only does it improve our productivity, it helps our suppliers to better understand our needs, which can only benefit us in the years to come.”

In total, the four mines of Kailin run under Jinzhong to a radius of nine kilometres. Ramps zigzag up from the main haulage level that runs below the ore body. From these trackless ramps, platforms are driven out into the ore



THE SANDVIK SOLUTION

Sandvik has supplied Kailin with underground drill equipment for more than 30 years. Currently, Kailin owns 65 units of Sandvik DD-series and DS-series drills across its four mines at Guizhou. A Sandvik 365 maintenance agreement has been in place since 2016. A Sandvik-branded container with maintenance equipment and a workstation is now based permanently at the Kailin service yard in Jinzhong. Sandvik engineers work on site together with the Kailin equipment teams.



ABOUT KAILIN

The Guizhou Kailin Group Co. Ltd (Kailin) is a large industrial group in the Guizhou province in south-western China. The rock phosphate mines around the remote town of Jinzhong are a major employer in Kaiyang county, with thousands of people working underground every day. The mines produce the highest grade of rock phosphate in China, and their reserves are expected to last 100 years.

body in two directions. Each mine consists of up to four simultaneous platforms at levels ranging between 100 and 400 metres below the surface, supported by roof bolts.

The drill-and-blast technique is necessary because of the hard nature of the phosphate ore, and Kailin's employees rely on a fleet of more than 60 Sandvik drill rigs to drill the blast holes. The mines operate two shifts per day with production blasts on a daily basis. To keep up such high productivity, the Sandvik rock drills mounted on the drill rigs need to be kept in good working order.

SHUGAO HE IS the deputy manager of Qingcaichong mine for the Kailin Mining Company at Guizhou. "Before we signed the service contract with Sandvik, we had to wait weeks for spare parts if they were needed," he says. "Sometimes we would need to dismantle rock drills and ship them elsewhere to be checked. It took a long time and had a major impact on our productivity."

The problem wasn't just on the rare occasions the rock drills needed repair. No regular maintenance schedules were adhered to, so the operating efficiency of the rock drills was sub-par. The local team didn't have the equipment or knowledge of what was required to keep the drills running at their optimum levels.

The relationship between Sandvik and Kailin stretches back 30 years, so once the phone call was made, Sandvik was eager to help.

THE SANDVIK 365 service agreement brings many benefits to the equipment teams and the overall mining operation. Sandvik engineers are on hand to perform regularly scheduled maintenance checks on the fleet of rock drills, and to make quick repairs should anything go wrong. The base of operations is a new Sandvik container at the Kailin service yard in the centre of Jinzhong.

Despite its small size, the converted shipping container has made a big impact on operations for Kailin. At just six metres in length, the container features a range of tools specifically designed to dismantle the rock drills, a suite of testing tools, a workbench and



The converted shipping container has a range of tools and a workbench.

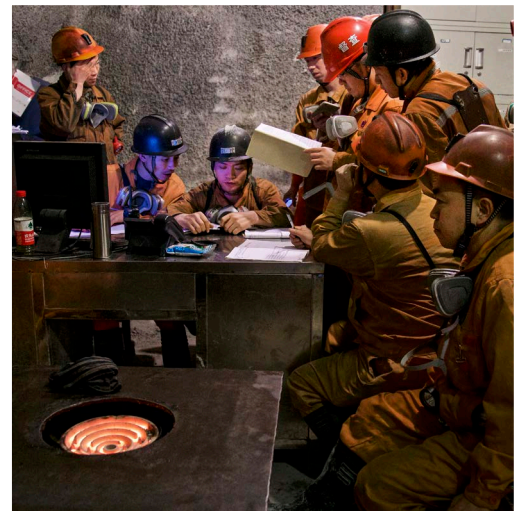
all necessary technical manuals and documented procedures. In less than 12 months, rock drills from 30 drill rigs have passed through its doors.

"THE CONTRACT WAS set up with this container designed to increase our ability to perform maintenance and repairs on site," says Ouyang Lin, deputy director of the Kailin Mining Company. "It helps us to reduce the likelihood of problems and fix the problems that do occur in a more efficient way.

"Before the regular maintenance was introduced, drilling a single blast hole could take up to 90 seconds. Now with the drills properly serviced, the average is down to 60 seconds. The price we pay for this service contract is very small considering the efficiency improvements we are seeing."

The benefits don't stop there. Kailin employees are also enjoying the use of professional tools and training in how to properly maintain and repair the Sandvik rock drills.

Jun Chen, Sandvik key account manager, explains that the Sandvik operational method has been altered to match the customer. "From the supply of parts to the operational methods to the aftermarket service, everything is aligned to Kailin's specific needs,"



30 seconds saved on drilling a single blast hole since using the Sandvik 365 service agreement.

Chen says. "Kailin management has become increasingly satisfied with the Sandvik service."

In addition to its annual production capacity of 7.36 million tonnes of rock phosphate (expected to hit up to 10 million tonnes in 2017), Kailin also produces more than 3.5 million tonnes of fertilizers and more than half a million tonnes of other phosphate products.

As the only pre-qualified phosphorus resource in China that can be directly used as the raw material of high-concentration phosphate compound fertilizer, Kailin is set to become ever more important. Sandvik is playing its part by reducing costs to allow every bit of phosphate ore to be extracted at as low a cost as possible. ■

SYSTEM REBOOT

Conventional wisdom in crusher maintenance involves two basic approaches: regular replacement investments in new crushers, or overhauls specified for the conditions at hand. It's not unlike buying a new car at regular intervals as opposed to making a continuous effort to keep an old car in a good state of repair.

Both approaches, naturally, have their merits and disadvantages. Investing in regular replacements increases capital spending, but helps to minimize maintenance costs. Extended ownership with regular overhauls can be financially more attractive, but the owner may have to accept longer downtimes.

Sandvik now offers a third way, called the Reborn rebuild solution, which could be compared with upgrading a used car with a new engine. Reborn combines a 100 percent new, factory-built Sandvik crusher with a systematic service package, where usable auxiliaries and surrounding process infrastructures are reutilized. A part of the Sandvik 365 service concept, the Reborn rebuild solution is combined with a three-year extended warranty that applies to all major components, including on-site service.

REBORN ESSENTIALLY STANDARDIZES the rebuild process into a systematic, six-stage service product: pre-feasibility assessment, budgetary quotation, crusher auxiliary audit, new crusher installation under Sandvik supervision, on-site training, and regular condition inspections.

■ Even as markets recover, the mining and aggregate industries are hard pressed after several years of sinking and volatile commodity prices. Innovation and rethinking are needed even in this area. Sandvik offers a new alternative for the conventional crusher overhaul with its Reborn rebuild solution.

Text: **TURKKA KULMALA** Illustration: **BORGS**

11
different Reborn packages available across the Sandvik range.

The exact scope of each Reborn package is defined during the pre-feasibility study depending on the specific crusher model. The standard scope in all cases includes a replaced crusher and hopper, a bottom shell liner upgrade with a hard, highly wear-resistant steel grade and a new off-line filter. The Hydroset cylinder protection is also included as a default for all models.

The most commonly usable auxiliaries and infrastructure surrounding the crusher include the main motor, drive system, lubrication and hydraulic systems, coolers, control, automation and electrical components, foundation, feeders and conveyors.

The pre-feasibility assessment reveals whether the auxiliaries can likely be reused with normal spare parts exchange and modifications. If so, this results in a quote at a fixed cost and scope. This can then be followed by a Reborn auxiliary audit, a full inspection of all auxiliaries to list the actions to be

taken prior to or in combination with the Reborn installation. The installation under Sandvik supervision is followed by on-site training to lay a solid foundation for effective operations and crew safety. Periodic condition inspections verify that the specifications and targets are met and that the preconditions for continuous improvement exist.

Reborn replaces the complete crusher to upgrade its performance and restore availability rates close to those of a new unit at a lower operating cost, yet with significantly lower capital expense compared with purchasing an entirely new crusher system.

A KEY FEATURE of the Reborn solution is a pronounced and integrated lifecycle aspect, leveraging the expertise advantage of the original equipment manufacturer (OEM) compared with third-party overhaul firms. The extended three-year



TECH SPECS

Compatibility of the Sandvik Reborn rebuild package with the various Sandvik crusher models

Sandvik Reborn package

CH420:03
CH430:04
CH440:03
CH660:04
CH870:01
CH890:01*
CH895:01*

Compatible with

H2000, H2800, CH420
H3000, H3800, CH430
H4000, H4800, CH440
H6000, H6800, CH660
H7800, CH870
H8000, H8800, CH880, CH890
H8000, H8800, CH880, CH895

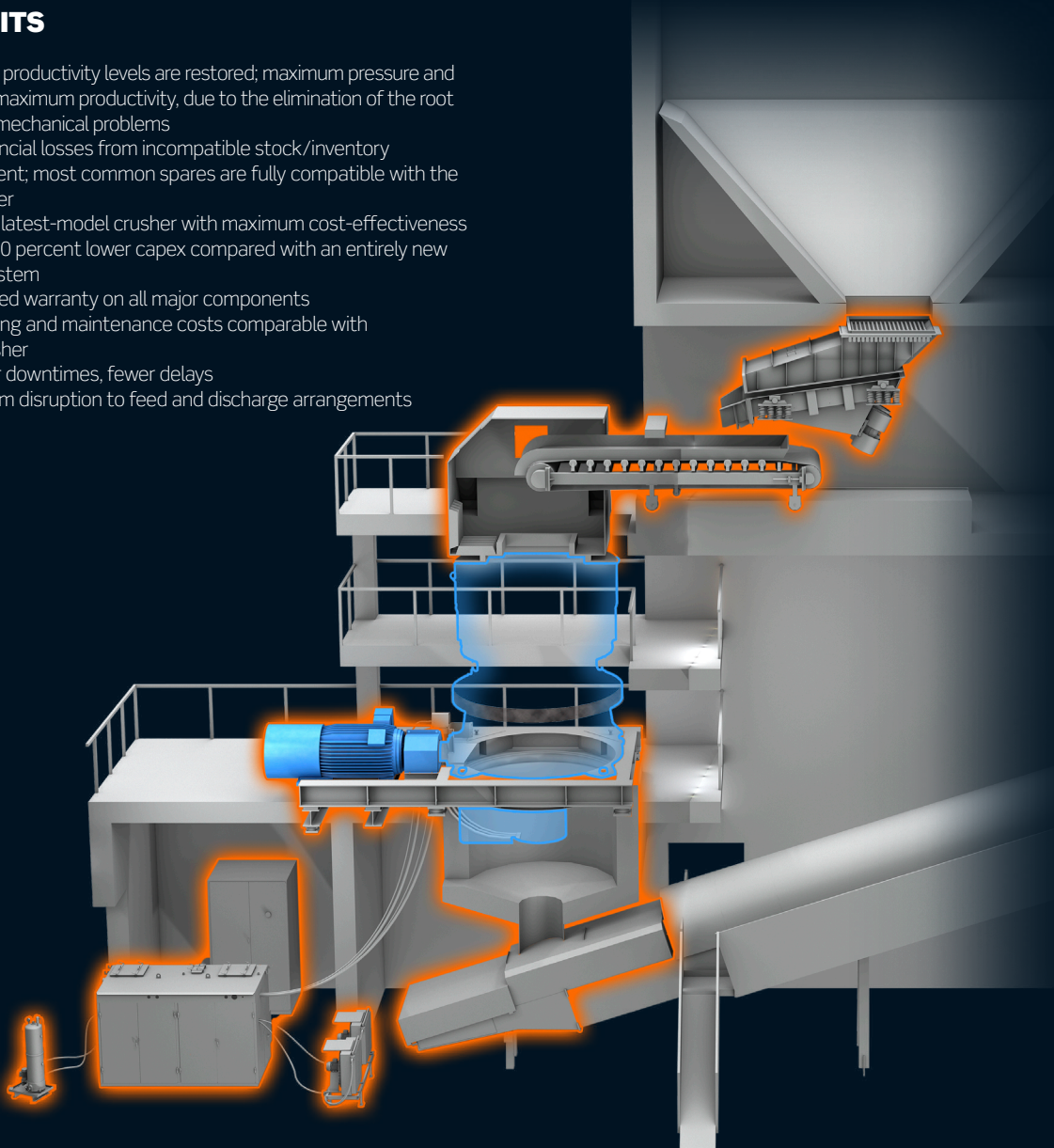
CS420:03
CS430:05
CS440:04
CS660:05

S2000, S2800, CS420
S3000, S3800, CS430
S4000, S4800, CS440
S6000, S6800, CS660

*Available on demand

BENEFITS

- Original productivity levels are restored; maximum pressure and power for maximum productivity, due to the elimination of the root causes of mechanical problems
- No financial losses from incompatible stock/inventory management; most common spares are fully compatible with the new crusher
- Always latest-model crusher with maximum cost-effectiveness
- Up to 40 percent lower capex compared with an entirely new crusher system
- Extended warranty on all major components
- Operating and maintenance costs comparable with a new crusher
- Shorter downtimes, fewer delays
- Minimum disruption to feed and discharge arrangements



warranty covers 80 to 95 percent of the list price of the specified components, typically including top and bottom shell, main shaft and head centre, gear and pinion, Hydroset cylinder and cylinder cover, piston, hub, dust collar and eccentric.

On-site training responds to needs arising from things like changes in personnel, which can also create maintenance challenges. A two-and-a-half-day theoretical operation and maintenance training course gives the operators a comprehensive introduction to maintaining and operating the unit properly in its real-life environ-

ment, giving them the practical skills to maintain optimal performance.

THREE TO FOUR annual condition inspections by certified engineers are planned to coincide with the liner changes to avoid any extra downtime. Measurements are carried out and reported according to a set protocol designed by Sandvik. The one to two days of inspections provide data to diagnose any progressing maintenance issues and to propose corrective actions as required.

The aim is a proactive, predictive and preventive maintenance philosophy: the

owner can draw from accurate data-based predictions and prevent any issues in a controlled manner before they become acute. For example, the status report can include a quote for an imminent bearing change that should advisably be scheduled for the next maintenance stop.

The end users most likely to benefit from the Reborn service are mines and aggregate producers processing hard types of rock and thus experiencing greater than average wear and tear. Another area where the solution offers high potential includes any operation with low downtime tolerance.

SANDVIK SERVICE OFFER

INSPECTION



Each year, three to four inspections are planned and carried out by certified engineers. Generally, they coincide with liner changes so as to avoid additional downtime. They take one to two days, and the data gathered helps diagnose maintenance issues. From there, corrective action can be proposed and acted on immediately.

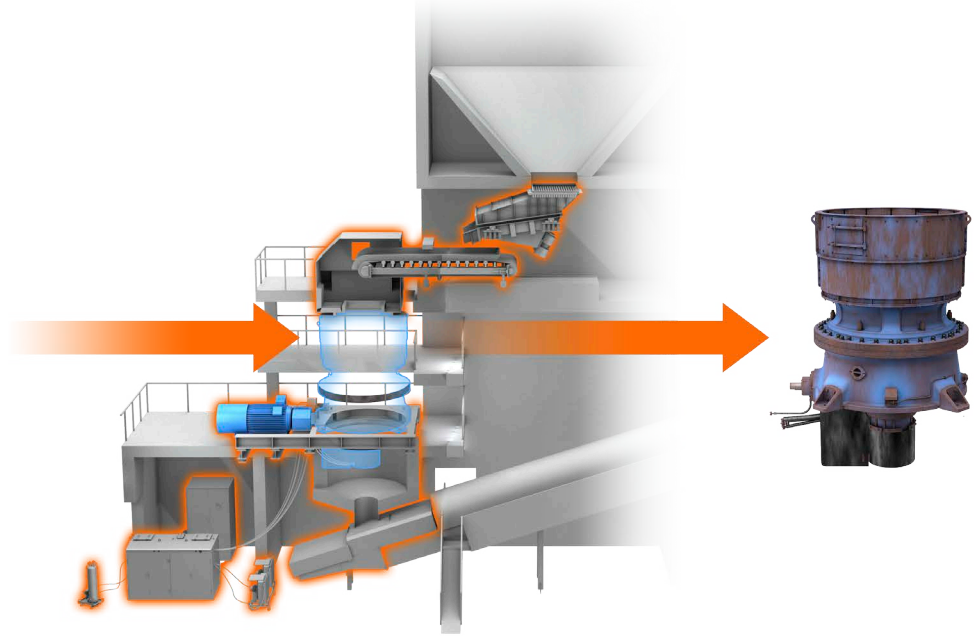
This is a proactive, predictive and preventative maintenance philosophy, which should save the customer time and money in the long term. A three-year extended warranty is also included in the offering, which helps maximize the uptime of the equipment and addresses any issues long after installation is complete.

TRAINING



Not only does Sandvik supervise installation, but on-site training is also given to the operators of the equipment. This is a benefit for existing employees, but it also helps new operators get to grips with the machinery quickly, ensuring that they can respond effectively to any maintenance challenges. This training consists of two and a half days

of theoretical operations as well as maintenance training, equipping operators with the knowledge needed to keep equipment performing at its peak. This is an ideal way to introduce employees to the tasks they will be facing when operating the unit in its real-life environment.



The well-defined service concept with clear component interfaces serves to eliminate uncertainties resulting in downtime. It eliminates the risk of omissions in orders of spare parts typical of regular overhauls.

In essence, the Sandvik Reborn solution keeps the crusher continuously updated with the latest design upgrades. It offers full reliability and performance levels comparable with a new crusher, plus additional value – the extended warranty and service offering – at a very competitive cost compared with a complete overhaul. ■

CUSTOMER CASE

CAPITAL AGGREGATES/ DELTA MATERIALS

Location: Marble Falls, Texas, USA

The US aggregates producer had a Sandvik CS440 cone crusher installed about 15 years ago for secondary crushing of competent sandstone. The feed material is from a primary jaw crusher, while the crusher itself feeds a tertiary crusher further downstream. Maintenance support is provided by the local Sandvik distributor.

After 15 years of operation, the Sandvik CS440 had started to suffer from mechanical issues. However, the ASRi 2.0 setting control system was recently updated. As the lubrication system was also in good repair, only the crusher required refurbishment. The Sandvik Reborn solution offered a cost-effective alternative to a complete overhaul by replacing only the worn-out components with minimal downtime. Reliability benefits were additionally achieved by solving the mechanical problems compared with the potential problems after an off-site weld and machining repair.



HIDDEN DEPTHS

■ Beneath Espoo, Finland, a project is under way to construct an underground wastewater treatment plant, large enough to treat water from more than 400,000 residents. Before it's finished, there's some excavation to be done.

Text: FRANCIS DIGNAN Photo: SAMIR SOUDAH



Hidden away from Helsinki, between the forests and golf courses of Espoo, Finland, a huge underground construction project is under way. For the past two years, Lemminkäinen Infra Oy, the contractor in charge of the tunnelling, has been digging, blasting and excavating. As its part of the project nears completion, an entire network of caverns and tunnels exists beneath this beautiful expanse of Nordic countryside.

The tunnels are being excavated as part of a major undertaking. The population of Espoo has grown by 10 times in the past 60 years, and as

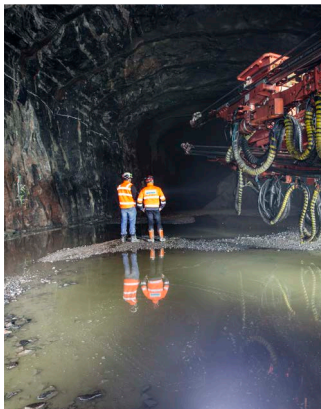
Espoo's population grows, the facilities need to adapt. With that in mind, the Helsinki Region Environmental Services Authority is building an underground wastewater treatment plant in Espoo's Blominmäki bedrock as part of its overall mission to help improve the environment. When the project is completed in 2020, it will be able to clean the wastewater of more than 400,000 residents. This is a big project, then, not only for residents now and in the future, but also for the environment. The new water treatment plant will be more efficient than the current one. In Finland, it has been



ESPOO WASTEWATER TREATMENT



Deep beneath Espoo, a Sandvik DT1131i drill rig excavates a vast network of tunnels.



illegal for a long time to transport untreated wastewater to the water system.


Before the plant is constructed, the tunnels to house it must be excavated. It might seem more sensible to build something like this above ground, as that's the more traditional way and it wouldn't require the sheer amount of excavation work that's taking place here. However, the increased initial effort is well worth it in the long term. Locating most of the plant underground is better for the surrounding landscape, for a start. The space can be used more efficiently, since building underground avoids the need to work around roads and existing structures, and in some cases wildlife. In addition, the facility is less exposed to the sometimes harsh environment of Northern Europe.

THE MOST IMPORTANT part of these initial stages of the construction project was to get the tunnelling right, and Lemminkäinen Oy is responsible for

this. "It's a huge project," says project engineer Jarkko Meriläinen. "The area we're excavating underground is bigger than the size of 14 football pitches, and the caverns themselves can be over 20 metres high, and are typically 20 metres wide, with one nitrogen hall that is 26 metres wide."

WITH A PROJECT of this size there will always be challenges, whether in the planning stage or when it comes to the excavation itself. "One of the biggest challenges is the size and the scale of the project," says Ville Nupponen, production manager for Lemminkäinen. "We have to do so many different things at the same time, and the schedule is tight. It's really important that we get the planning right, as this makes everything else easier."

PLANNING DURING THE project was a vital part of this contract, impacting every level of development. Meriläinen

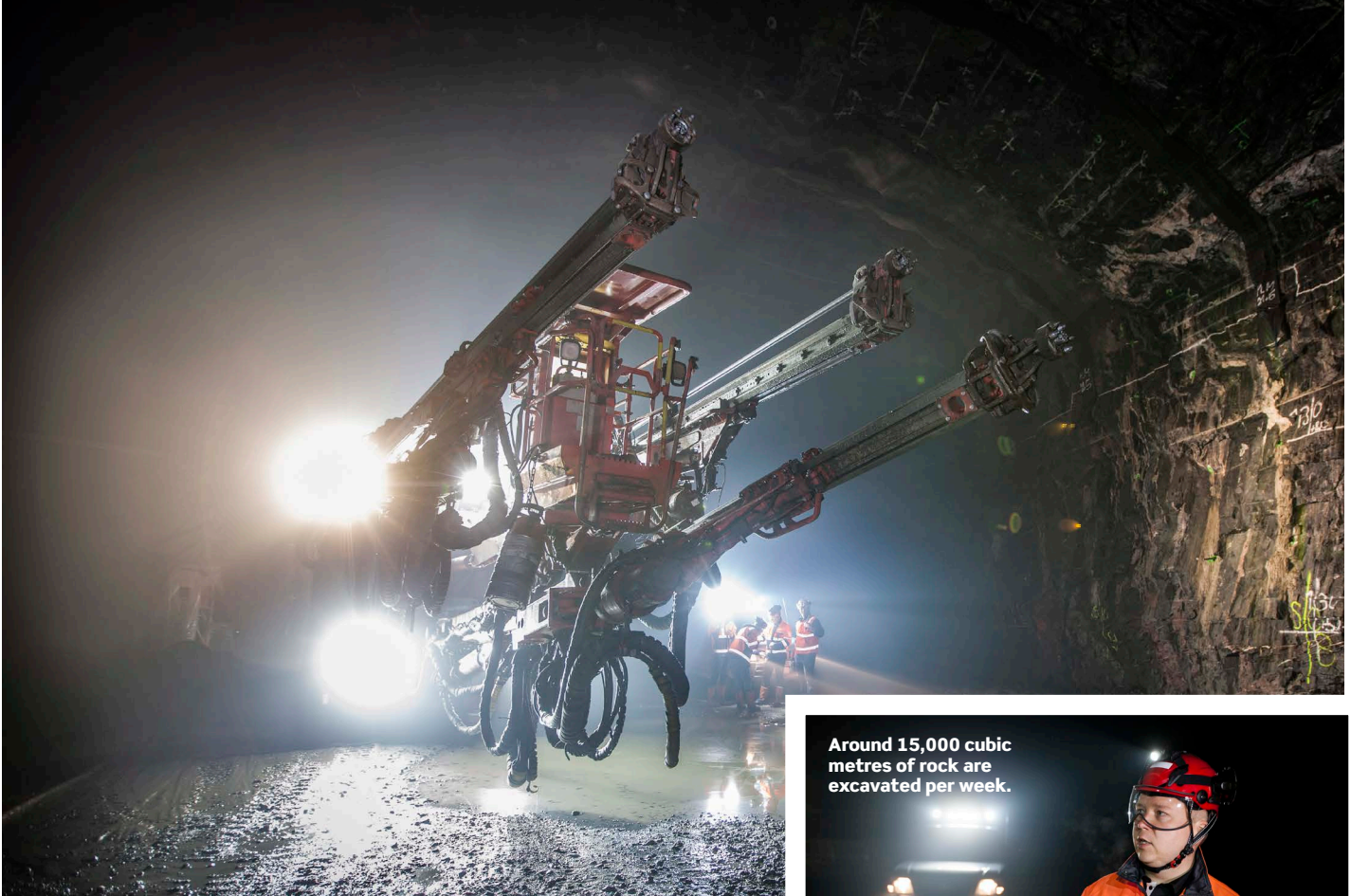


In these special places, we used Sandvik drills due to their accuracy and reliability.

SANDVIK SOLUTION

In the Blominmäki underground wastewater project, Lemminkäinen uses two Sandvik DT1131j jumbos, Sandvik iSURE software, technical support and aftermarket services from Sandvik. Working closely together is important to ensure that the equipment, systems and support meet the needs of the

customer. The Sandvik equipment provides the tunnelling capabilities Lemminkäinen needs, while the Sandvik iSURE system is there for the planning and analysis for the complete tunnel project. It's a cooperative relationship with a focus on excellent productivity and safe operations.



Around 15,000 cubic metres of rock are excavated per week.



explains the method used: “In some caverns the excavation is even done in nine separate parts due to the big profile and high tolerances for excavation. We start with the top of the tunnel, then excavate the middle parts, and finally the sides.”

LEMINKÄINEN USES THE Sandvik iSURE software together with Sandvik DT1131i jumbos to manage the excavation process. Sandvik iSURE enables drill and blast plans to be designed and uploaded to the equipment, and the collected data can be analyzed after the excavation has

taken place.

Tommi Mannelin is a computerized drill and blasting method (CDBM) engineer for Lemminkäinen, and he spends a lot of time with the Sandvik iSURE system. “I’ve been working with the system for seven and a half years, and the software certainly makes my job easier,” he says. “It saves time, and the driller doesn’t have to think about the task, as the drilling can be fully automated from the plans. The only real challenge is that sometimes the theory of a plan can be different to

how it actually is in reality.” For optimal functionality, the system needs to be implemented in both the processes and the equipment.

FOR THIS CONTRACT, Lemminkäinen chose two fully automated Sandvik DT1131i jumbos. Lemminkäinen had originally used the two rigs on another project. The Sandvik jumbos were originally delivered to Tampere for the Rantatunneli project, the longest road tunnel in Finland. That was a different kind of project, as the tunnel was located under a residential area in the city centre. This meant that tolerances were tight and vibrations had to be monitored closely. While in Tampere, these two jumbos were given names – Anna-Kaisa, after the mayor of Tampere, and Irene, after the second chairwoman of the city board.

Whether this naming of the rigs conveyed good luck is hard to say, but

ABOUT LEMMINKÄINEN

Lemminkäinen is an expert in complex infrastructure and building construction in Northern Europe, and is one of the largest paving companies in its market area. It employs 4,700 professionals and aims to build a sustainable society alongside its customers. The company

specializes in urban environments, traffic projects and industrial and power plant projects. It also builds and maintains road networks, and it constructs apartments and commercial premises.

the project finished well ahead of schedule. Lemminkäinen was happy with the two jumbos, so it brought them along to the project in Espoo. Once the excavation neared its end there, one of the drills was moved to another underground wastewater treatment plant in Mikkeli, leaving Anna-Kaisa to finalize excavations in Espoo.

“IN THESE SPECIAL places, with such tight tolerances, we used the Sandvik drills due to their accuracy and reliability.” Meriläinen says. Nupponen adds, “The accuracy of the DT1131i is a big benefit, as we need the tunnels to be of the highest quality.”

On an average week, Lemminkäinen excavates 14,000 to 15,000 cubic metres of rock. One week, the contractor removed 17,000 cubic metres.

Any job of this size is only possible if equipment remains productive and reliable and the various contractors and stakeholders work together. Sandvik

and Lemminkäinen have a strong relationship and have been partnering together for many years. Juha Kukkonen, Sandvik sales manager for tunnelling drills, says the partners have cooperated a lot to develop the systems, including iSURE, and also to make sure they have the equipment which suit their needs the best.

ADDRESSING THE SPECIFIC demands in Espoo, he says, “With the Sandvik i-series drills we had three main goals for the equipment: for them to be fast, accurate, and user-friendly. From the feedback we’ve had, we feel that these criteria have been fulfilled. The accuracy of the machines was vital for this project, and the DTi series includes many accuracy features, such as robust booms and highly developed compensation models. In addition, Lemminkäinen has taken out the rod handling system, which means that the side feeds can be driven very close to the walls of the

tunnel, and they get excellent results in terms of excavation quality.”

Soon the excavation work will be complete, and the framework will be there for the construction of the new underground water treatment plant. You won’t be able to tell from looking at this unassuming location from above, but something special is going on beneath the surface that is set to silently help an entire community. ■



The network of tunnels covers the equivalent area of more than 14 football pitches.



SANDVIK DT1131i TECH SPECS

- Tunnel size 10.92 x 18.21 m (maximum)
- Coverage area 20-183 m²
- Hole diameter 43-64 mm
- Hole length Up to 6,085 mm
- Rock drill Sandvik RD525, 25kW
- Control system iDATA
- Transport length 17.78 m
- Transport width 2.95 m
- Transport height 3.69 m
- Basic weight 45,500 kg





Generation next

■ The new generation of intelligent Sandvik mining trucks teams up with the company's industry-leading AutoMine and OptiMine automation and information management solutions to revolutionize haulage operations. Automated truck haulage offers tangible benefits in safety, productivity and profitability.

Text: TURKKA KULMALA Photo: SANDVIK



The mining truck is a proven standard solution for most underground haulage applications, as the 500,000 operating

hours of automated Sandvik trucks over the decades testify. Yet the workhorse of underground haulage is not immune to today's pressures to innovate and evolve. Key trends include replacing diesel with lower-carbon fuel sources and growing reliance on sensors to monitor mobile assets. Sandvik Mining and Rock Technology's new generation of mining trucks replaces distributed and hazardous underground operations with centralized hubs and autonomous vehicles.

THE 'SMART' SANDVIK productivity approach is to operate fewer but bigger trucks – to accomplish more work with a smaller fleet amplified by automation. Furthermore, a smaller fleet of high-capacity trucks reduces underground congestion.

“Our capability to offer efficient matching three-pass loading productivity pairs of loaders and trucks over a capacity range of 15 to 63 tonnes, which greatly boosts overall productivity, is unique in the entire industry,” says Mark Ryan, product line manager for underground trucks at Sandvik. “The newest additions are Sandvik TH551i, with a capacity of 51 tonnes for tunnel sizes of 5 x 5 metres, and Sandvik TH663i, with a capacity of 63 tonnes for tunnel sizes of 6 x 6 metres.”

All the new features and upgrades aim at tangible improvements in productivity, profitability and safety.

“More advanced mining automation is a key to many of the new improvements,” says Jarkko Ruokojärvi, product line manager for automation at Sandvik. “The vehicle control and management system of the new trucks is fully integrated with both the AutoMine Trucking system for entirely autonomous haulage traffic and the OptiMine system for data collection and reporting.”

BENEFITS

- Up to 30 percent higher productivity compared with earlier models thanks to continuous operation, less downtime, consistent output, high-speed production, extensive tracking and reporting possibilities
- Up to 50 percent lower opex and capex thanks to reduced damage, multi-machine control, smaller fleet and extended unit lifetime
- Improved safety for the operator and maintenance crew thanks to the elimination of underground, isolated work areas and better ergonomics
- Substantial sustainability benefits through the potential to cut back the haulage fleet: fuel and consumable savings, lower emissions
- Tested reliability even in extreme environmental conditions

AUTOMATED TRUCKS



Automation enables the removal of people from potentially hazardous areas.

This built-in automation readiness with the AutoMine onboard package ensures quick and easy installation and start-up even as a retrofit.”

OptiMine complements AutoMine Trucking with a data collection and reporting capability to provide visibility over the entire haulage fleet. Production, utilization and condition KPIs can be visualized and analyzed to support production decisions and predictive maintenance. The system supports conventional USB data transfer, Wi-Fi networks and also data-bearer application for handheld devices in areas with no network coverage. As a modular solution, OptiMine can be expanded to include location tracking, scheduling and task management functionalities.

AUTOMINE TRUCKING ENABLES both

haulage level and decline ramp applications. An isolated haulage loop of autonomous trucks can cover several underground areas. In decline ramp use, a specific ramp is isolated for autonomous trucks. While unmanned haulage during shift changes and blast clearing is an obvious application, continuous autonomous operation is also possible by dedicating an entire decline for truck haulage. The resulting automated production cycle is supervised from a remote location, potentially with multiple units under each system operator. The higher utilization rate, boosted by added operational hours, directly translates to a higher tonnage.

Improved safety is another key driver for increasing mining automation. Removing people from potentially

hazardous areas simply means less risk. AutoMine Trucking relocates vehicle operators from the mine environment to an ergonomic control room. Working alone is eliminated, which further reduces fatigue. In this context, “remote” can mean anything from the mine office at the surface to a workspace in the nearest town.

SANDVIK TH663i TECH SPECS

● Payload capacity	63,000 kg
● Dump box, standard	36.0 m ³
● Dump box range	24–40 m ³
● Total operating weight	45,000 kg
● Max. speed	31.3 km/h
● Diesel engine	Volvo TAD1643VE-B with diesel particulate filter (DPF) (optionally Cummins QSK 19)
● Engine output	565 kW (758 hp) (optionally 567 kW/760 hp)
● Emissions	Tier 2 (optionally Tier 1, Euro Stage I)
● Transmission	Allison 6625 series
● Axles	Kessler D106 series, wider axles
● Automation	AutoMine onboard package and OptiMine data collection unit fully integrated with the machine design

ADDITIONAL SAFETY FEATURES include a proximity detection system interface for flexible connectivity with third-party control systems. A trainer seat helps ensure the safety of new crew members learning their jobs in real-life conditions. The on-board jacking system, tyre monitoring system and easy ground-level access for maintenance tasks improve the efficiency and safety of the maintenance crew.

A key productivity feature of the new trucks is the integrated weighing system (IWS). As the mines go deeper and tramping distances increase,

Larger automated trucks allow for a smaller fleet, reducing congestion.



assessing the payload by guesswork is not sufficient anymore. Every tonne counts and each haulage trip must consistently carry up a full payload. IWS has provided consistent accuracy rates of 93 to 94 percent in operational use since 2013.

Sandvik TH663i has wider axles, which increase the stability of the vehicle by 15 percent. This enables an upgrade to a new, larger and stronger 40-cubic-metre dump box from the standard size of 36 cubic metres.

In terms of profitability, the new intelligent mine trucks essentially offer increased production with no increase in fixed costs. Multi-machine control and improved operating discipline can reduce operating costs by up to 50 percent. Better availability and improved performance mean that mines can achieve the same production volume with fewer trucks.

THE ADDITION OF four to eight

SANDVIK TH551i TECH SPECS

● Payload capacity	51,000 kg
● Dump box, standard	28.0 m ³
● Dump box range	24–30 m ³
● Total operating weight	41,000 kg
● Max. speed	35.8 km/h
● Diesel engine	Volvo TAD1642VE-B
● Engine output	515 kW (691 hp)
● Emissions	Tier 2 (optionally Tier 4i, Euro Stage III B)
● Transmission	Allison 6625 series
● Axles	Kessler D106 series
● Automation	AutoMine onboard package and OptiMine data collection unit fully integrated with the machine design

productive hours each day, which otherwise would be wasted for blast clearance, can increase production by as much as 30 percent compared with earlier Sandvik trucks.

A site trial in early 2017 at a northern European mine operating in highly demanding conditions verified the benefits of the new intelligent mining trucks teamed up with AutoMine Trucking. New, deeper-lying ore bodies represent a cost-effectiveness

challenge for this mine. The team of an automated loader and truck enabled continuous operation also during blast clearance and yielded a production increase of 10–15 percent, validating the viability of the concept in a demanding ramp haulage application.

With the next generation of automation on the horizon, the benefits to mining are clear. Productivity and employee safety will improve, and it's another step forward in profitability. ■

Practice makes perfect

■ With remote Australian mine sites often long distances from professional emergency services, on-site emergency response crews need to feel confident handling just about any type of crisis. The Mining Emergency Response Competition (MERC) held annually in Perth helps them hone their skills and get prepared for a range of scenarios.

Text: DANIEL DASEY Photo: SUE HO



The Mining Emergency Response Competition is held annually.

In a public park near the centre of Western Australia's capital of Perth, a jet aircraft is on fire. Flames are spouting from the plane's port-side engine. With an explosion seemingly imminent, an emergency response crew is doing its best to contain the blaze.

It's a dramatic and alarming scene, but while the emergency crew and flames are real, you won't hear about the fire in the news. The scenario has been staged as part of the Mining Emergency Response Competition, or

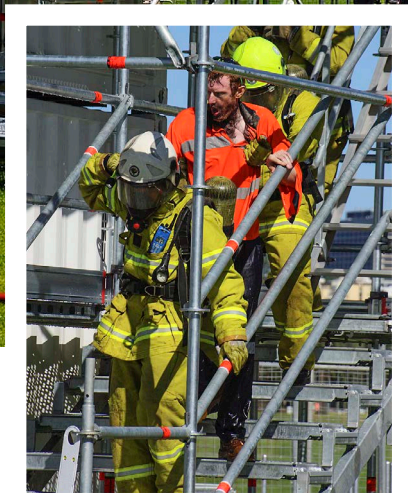
MERC – an annual contest aimed at improving the skills of emergency response crews working at Australian mine sites. As well as extinguishing aircraft fires, competing teams in the annual three-day event can be called on to deal with anything from simulated chemical spills and building fires to horrific disaster casualties.

"We try to make the scenarios as

realistic as possible, and so they're based on events that have been reported to the local Department of Mines and Petroleum," says Jen Pearce, one of the founders of the competition. "In the past, we have simulated everything from road crashes in dark, stormy environments to crush injuries from heavy machinery, and vehicles that have toppled over highwalls."

WHILE IT MIGHT sound gruesome, MERC plays a vital role in improving safety and incident preparedness. Mining in Australia is often conducted at extremely remote locations, sometimes hundreds of kilometres from major centres. With professional emergency services such as the fire brigade and ambulance service often many hours' drive away, mine operators address the risk of accidents by having trained professional and volunteer emergency response teams on site. "MERC is aimed at giving these individuals the opportunity to train and hone their skills in a safe, controlled and realistic way so that if they're confronted by a real situation they are confident in their response," Pearce says.

The first MERC competition was held seven years ago when the critical-services company PWR and



first-aid services firm Red Earth Health Solutions realized a forum was needed in the Perth area for the nation's mine-site emergency response crews to come together, share knowledge and train.

From humble beginnings in 2010, the competition has grown to host 300 participants annually, including competitors, volunteers and sponsors. Held close to Perth's central business district in Langley Park, the event attracts thousands of onlookers for the two-day competition stage. Competitors come both from Western Australia, where MERC is staged, and the rest of the country, taking in operations including Argyle Diamonds, Rio Tinto Iron Ore, FMG, BHP Nickel West, Newmont Boddington Gold and Synergy. Pearce says there has also been interest from overseas mining operations that are keen on viewing the

event and possibly taking part in future competitions.

PWR GENERAL MANAGER Nick Groen says the event provides benefits in a range of areas. "The training aspect is imperative, but being able to test your skills in a controlled and safe environment is also very important," he says. "A lot of these teams don't get that opportunity to do so on a regular basis. And being able to network and see how other companies and other teams respond in similar situations and be able to learn from one another in that environment is imperative."

Each of the 12 teams competing at a

Teams compete across a range of activities, all geared towards honing skills that will be useful in a real-world scenario.

MERC event comes from a different company and consists of six competitors, a reserve and a manager. The teams compete across seven disciplines over the two competition days – road crash rescue, vertical rescue, emergency response readiness, confined space rescue, firefighting, hazardous materials and first aid.





Camaraderie is right at the heart of mines rescue.

is amazing how the skills of rescue volunteers vary between sites and team members,” he says. “For the vertical rescue challenge, there’s no point creating an overly complicated solution when a standard 2:1 haulage system with an in-line mechanical advantage can be used.”

CRAWFORD SAYS COMPETITORS go back to work with improved knowledge and team spirit. “Camaraderie is right at the heart of mines rescue, and you can absolutely see this at MERC,” he says. “It’s then transferred back to site, and we hear from past competitors that that team bond is cemented on site and helps build a solid foundation for carrying out rescues.”

Groen says the event is made possible by the support of local industry and equipment suppliers such as Sandvik. “The Sandvik involvement has meant that we have had mining equipment at the event for the first time,” he says. “We try to simulate scenarios and incidents, but actually bringing in the equipment gave a whole level of realism to the event that helps people visualize it. It adds something extra to the event.” ■

Volunteer judges assess the practical and applied knowledge of each team, and winners are then selected for each event and for the overall competition. Cash prizes are donated to charities on behalf of the victors.

Pearce explains that as well as providing emergency services at the mine site, emergency response teams are also frequently called on to assist off-site in the case of things like motor vehicle accidents, meaning the skills they are honing at MERC help the wider community.

Richard Crawford, the emergency services and security supervisor at Fortescue Metals Group’s Christmas Creek operation in the Pilbara region of Western Australia, is also chief adjudicator for MERC. He oversees all events and is particularly involved in the vertical rescue scenarios. “It really

SANDVIK SPONSORSHIP

When Malcolm Mauger, business line manager, load and haul at Sandvik Mining and Rock Technology, heard from a customer that the 2016 MERC event was in urgent need of mining equipment to stage rescue scenarios, he immediately wanted to help.

After meeting with competition organizers, Sandvik agreed to supply a mining truck, an underground drill and a loader for the event, marking the first time that mining equipment

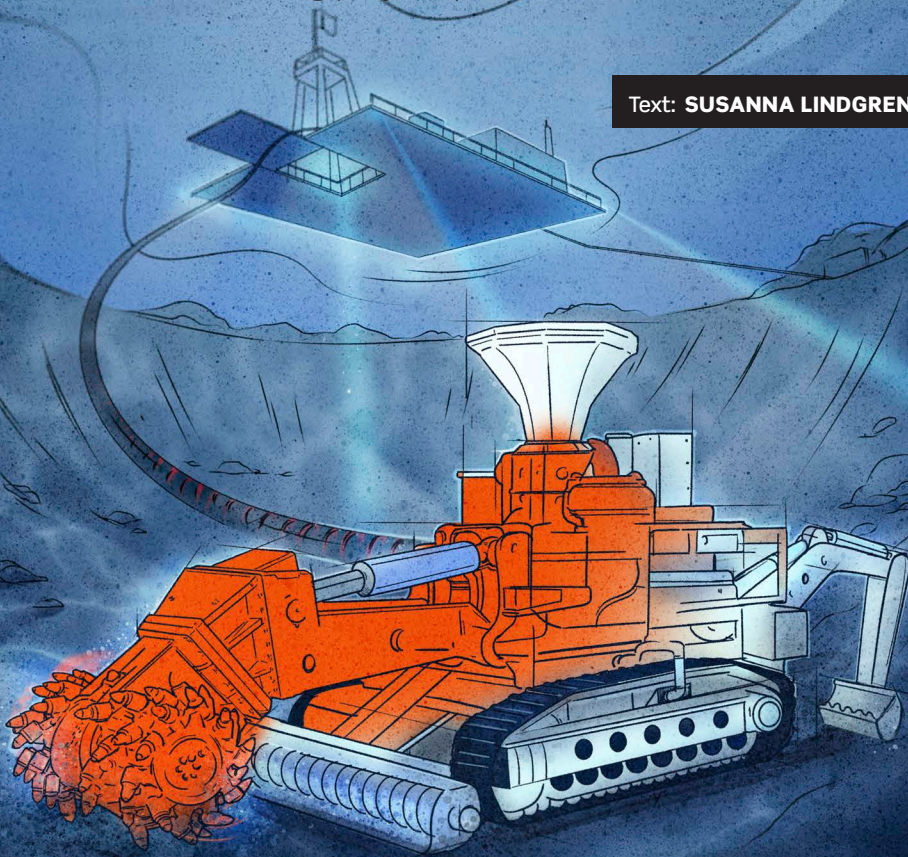
had appeared. A number of Sandvik staff also volunteered to attend the event to answer any questions from the general public. “The loader was used in a simulation where a car had crashed under it and the teams had to extract a person out of the vehicle,” Mauger says. “The simulation for the drill involved someone who had had their arm pulled off from the feed to the boom and how to deal with that.”

Mauger says while Sandvik focuses on using safety to prevent accidents and MERC focuses on what to do if an accident does occur, both organizations take the issue extremely seriously. “All the simulations at MERC are meticulously planned months in advance by experts up until the simulations are carried out on the day,” he says. “Even after the simulations are carried out, they are reviewed to see what learning can be taken for the next year’s event.”

UNDERWATER FRONTIER

■ With an estimated 100 billion euros' worth of unexploited minerals sitting submerged in abandoned European mines, the EU-funded underwater mining project ¡VAMOS! aims to discover how to access them.

Text: **SUSANNA LINDGREN** Illustrations: **RITHUSET | STHLM**



FOR CENTURIES EUROPE has been actively mined, and most of the easily accessible mineral deposits are depleted. Deeper-lying minerals have not been fully explored, though, as they require excavation at greater depths, in small deposits or in populated areas where larger operations are not feasible. It has been estimated that the value of unexploited European mineral resources at a depth of 500 to 1,000 metres is approximately 100 billion euros. ¡VAMOS! – the Viable Alternative Mine Operating System project

– is attempting to find new ways to get access to these resources and enable the excavation and rehabilitation of unexploited and abandoned deposits of critical minerals, particularly those hidden under water.

“THE ¡VAMOS! OBJECTIVE is very straightforward,” says Jenny Rainbird, project manager at BMT group, which is coordinating the project. “It is to build a life-size prototype robotic underwater mining machine with associated launch and recovery

equipment, and to prove that the concept of mining in open-cast, water-filled and land-based mines is viable and economically possible.”

BMT is a London-based scientific consultancy firm with the administrative role in the project, which involves a consortium of 17 partners from nine European countries. Started in February 2015, the project is scheduled to run for 42 months, and by July 2018 Rainbird and her team should be able to present the outcome. The result is already visible. A prototype submerged



Sandvik Mining and Rock Technology supplies the underwater mining machine with the cutting equipment and the frame.

containing the frame, the cutting unit at the front and the back stabilization,” Restner says.

THE MANUFACTURING HAS required a lot of modifications to standards, but even if the partners are based in different countries there have been very few technical glitches, and nothing too big to rectify on site.

“The technical coordination has been challenging, but the fact that a lot of new technology is involved is also a huge benefit,” Restner says. “jVAMOS! is a technical demonstration of how different subsystems can work together. The result is a fully remote-controlled and reliable mining system with a built-in evacuation plan to make sure no equipment is lost in operation.”

Besides being a testing ground for new mining technology, the project is expected to yield many other positive outcomes. Mining under water means minimal waste-removal cost compared with open-cut mining. There are minimal dewatering costs, minimum costs for barrier construction or barrier maintenance, and no drawdown on aquifers that can affect groundwater or neighbouring areas.

“AND THERE WILL be no blasting noise, no ground vibration, no dust nuisance, no personnel in the mine, and it will be a quicker set-up with cheaper capital costs than in an underground mine,” Restner says.

The estimated cost of the jVAMOS! project is EUR 12.6 million, of which EUR 9.2 million comes from grants and the rest is funded by the consortium. All those involved have high hopes for the return on investment.

“It is very difficult to predict the return because it also strongly depends on the future of the raw materials market,” says Marco Recchioni, project adviser at the Executive Agency for Small and Medium-sized Enterprises of the European Commission. “One of the key advantages of having a common research programme like this is to facilitate that cooperation among private and public entities worldwide. One of the biggest challenges for a research and innovation action like jVAMOS! is usually to bridge the gap between the project results and the market. The EU is providing plenty of opportunities to support similar

The big strength of this prototype is that it's small and agile.

mining vehicle has been built in Newcastle upon Tyne in the UK by Soil Machine Dynamics (SMD), which specializes in subsea remotely operated vehicles. The launch and recovery vessel is built by the Damen Shipyards Group in the Netherlands, and the positioning navigation awareness system comes from INESC, the Institute for Systems and Computer Engineering at the University of Porto in Portugal, together with their development partners ZfT and FEMU. Sandvik Mining and Rock Technology provided the cutting equipment and the prototype's frame.

“I don't think it would have been possible to run a project like this without the international cooperation, as all partners have cutting-edge expertise in their fields,” Rainbird says. “Like the sensors provided by INESC and the knowledge of virtual reality provided by the marine surveying company BMT – all were necessary to build an unmanned machine that can be operated from the surface.”

The outcome is an underwater robot that will circle around the mining machine, gathering data to give a

complete picture of what's going on under water.

“THE DEVELOPMENT OF this new sensing technology may well be the most important part of the project,” Rainbird says. “There is zero visibility while mining under water, as the cutting will disturb the water with fine sediments.”

Three of the larger industrial organizations, Sandvik Mining and Rock Technology, Damen and SMD, have already worked together on a marine mining project for Nautilus Minerals, where Sandvik provided the cutting units for the world's first deep sea mining equipment.

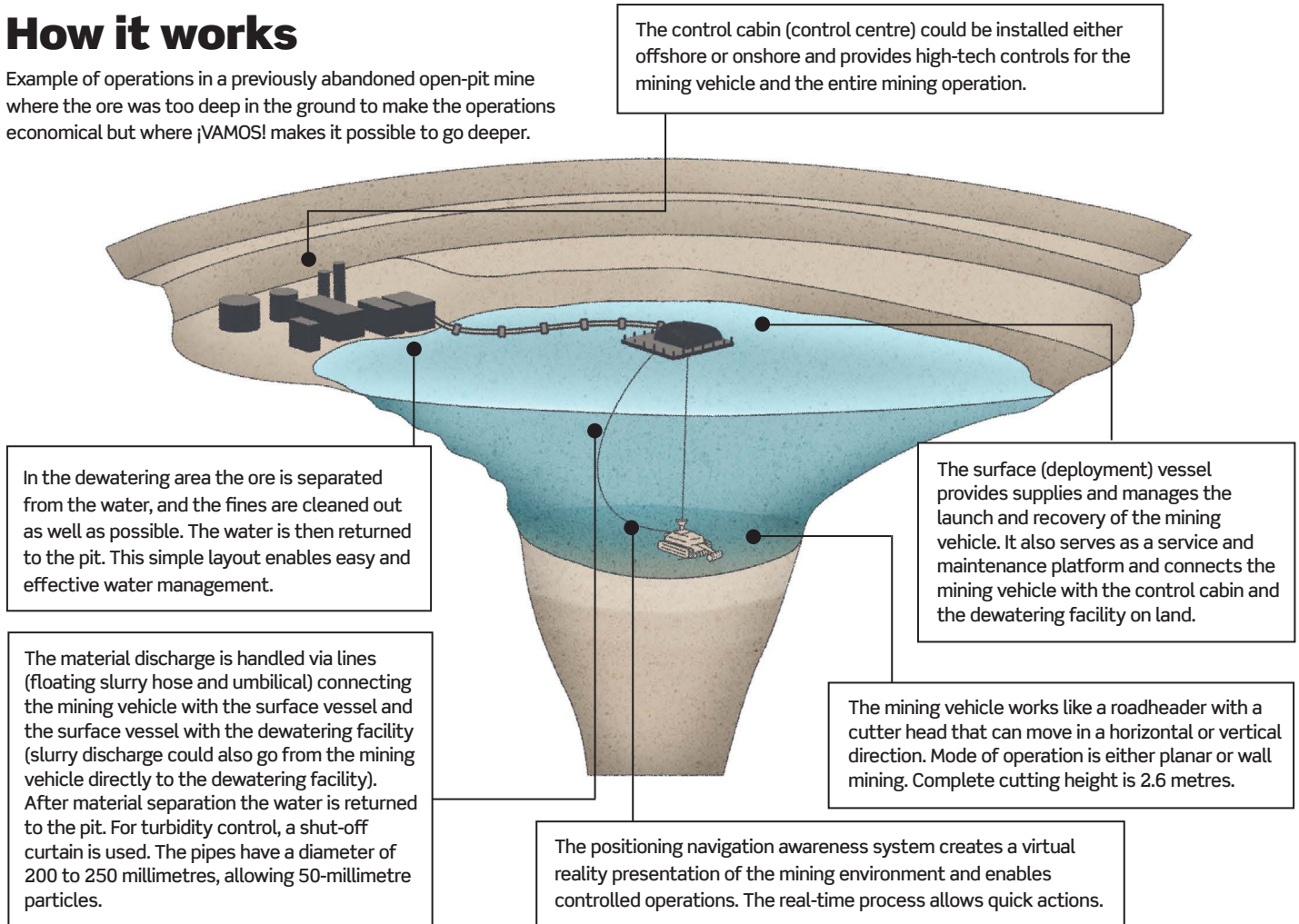
“The idea of jVAMOS! was inspired by the Nautilus project, which is one of the most important currently ongoing marine mining projects,” says Uwe Restner, product and commercial manager, hard rock continuous mining and mechanical cutting at Sandvik. “As Sandvik wants to keep a foot in the door for the future submerged mining market, we were keen to participate in jVAMOS! as this is a project that pushes for further innovation in the mining equipment sector.”

The initial proposal was that Sandvik should supply just the cutting equipment, but at an early stage SMD asked Sandvik to make the frame for the underwater mining vehicle as well.

“While doing the frame we ended up supplying the whole base unit

How it works

Example of operations in a previously abandoned open-pit mine where the ore was too deep in the ground to make the operations economical but where iVAMOS! makes it possible to go deeper.



initiatives to fill this gap. Some examples are the Horizon 2020 Innovation Action topics, EIT RawMaterials and the European Investment Fund.”

The iVAMOS! mining system is scheduled for testing in late 2017. The first test on a real site will be in a flooded kaolin mine at Lee Moor in Devon, UK. The second testing will be on harder rock, in a water-filled haematite and siderite open-pit mine in Vareš in Bosnia and Herzegovina.

“**ANOTHER VERY POSITIVE** aspect of the Horizon 2020 research programme is that each partner will be able to exploit their proprietary results as they prefer,” Recchioni says. “This enables a cascade of positive impacts, increasing competitiveness and creating numerous new jobs not only in mining

and equipment manufacturing industries, but also in many other neighbouring sectors.”

Rainbird agrees. “There is quite a potential in European open-cast mines for the 20 critical minerals where the EU only supplies very small portions, but there are also many other uses where the prototype can be useful,” she says. “For example, working on submerged tunnels, water mines that have ore underground, or any type of treacherous conditions where you can imagine that an unmanned vehicle could be used.”

The current configuration of the prototype has a changeable pick attachment, and attaching a grabber could make it useful for completely different applications.

“The big strength of this prototype is that it’s quite small and very agile,”

Rainbird says. “The purpose has never been to excavate in tonnes but to cherry-pick the most expensive and rare materials.” ■

THE iVAMOS! PROJECT

The iVAMOS! project is part of the European Union’s framework programme Horizon 2020, the biggest research and innovation programme funded by the EU, with nearly EUR 80 billion available over seven years (2014-2020). The aim of the initiative is to secure Europe’s global competitiveness, drive economic growth and create jobs by investing in technical breakthroughs and world firsts by taking great ideas from the lab to the market. The iVAMOS! consortium was granted funding for its proposal on “Mining of Small and Complex Deposits and Alternative Mining” under grant number 642477.

LIFE FINDS A WAY

In Butte, Montana, this former mine is now home to billions of litres of toxic water. What lies beneath, however, is all the more interesting.

Text: FRANCIS DIGNAN Photo: GETTY IMAGES

▶ THE HARSHTEST ENVIRONMENTS

can sometimes be home to the biggest surprises. Even at Earth's extremities, it's possible to find communities thriving. Whether that's in the form of the Arctic fox, which doesn't start to shiver until temperatures drop to a staggering minus 70 degrees Celsius, or the nomadic humans living in the Sahara Desert, there are few places on Earth where some sort of life form won't survive, and even thrive.

You'd be forgiven for thinking that a toxic lake might be one of those places devoid of life entirely, but in the case of Berkeley Pit you'd be mistaken.

This former open-pit mine in Butte, Montana, is now a man-made lake, 1.6 kilometres long and 800 metres wide, that contains more than 150 billion litres of toxic water. The water is heavily acidic and has taken on an almost blood-red colour from the copper and iron deposits. However, this hostile environment is also home to new species of fungi that could lead to important advances in modern medicine.

Two researchers from the University of Montana have been studying the environment in Berkeley Pit, testing the life forms known as extremophiles in several different settings, mainly to see how their qualities that allowed them to adapt to this toxic water could be utilized in different ways.

Don and Andrea Stierle, both PhDs and research professors, have been studying the organisms and environment in Berkeley Pit for many years now, and the couple have made some interesting, potentially groundbreaking discoveries.

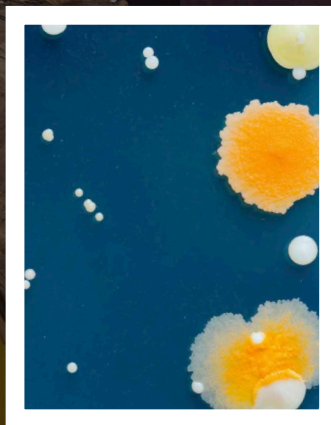
Among the first of these was the identification of a fungus that showed signs of being able to fight cancerous cells, which they found in a water sample back in 1998. As it

was an entirely new species, it was given the name *berkeleydione*. Soon after, they found another unique species, which again produced a compound that attacked cancer. The only reason their work has not become more widespread is that they don't have the facilities to do their experiments on a larger scale, and to find out whether these compounds and extracts would be safe to use on humans.

The experiments didn't stop there. Recently they discovered an entirely new antibiotic, *berkeleylactone A*, which works in a different way to the ones we use today. In a time when both people and pathogens are becoming ever more resistant to existing antibiotics, this could be the huge leap needed to help humans fight off infections in the future. Again, it will be a long time before this can potentially form the basis of medications, as more testing and investment are required, but it's an exciting development.

The mine, which produced 320 million tonnes of ore and at its peak provided a third of the copper used in the United States, is now a little-known tourist attraction that costs 2 US dollars to enter. To the naked eye it's a huge man-made lake with crimson water contrasting against sandy pit walls, and occasionally clear blue skies, which can make for beautiful and haunting vistas in equal measure.

Just as when the mine was operational, though, it's beneath the surface where the real magic is happening. Deep in this toxic body of water, adaptive and potentially revolutionary life forms are thriving. Life always finds a way. ■





Solutions for every task

Sandvik Mining and Rock Technology has an extremely broad range of equipment and services, and as we serve more than 130 countries, it's on a truly international scale. Whatever your task, Sandvik has the right solution for you.

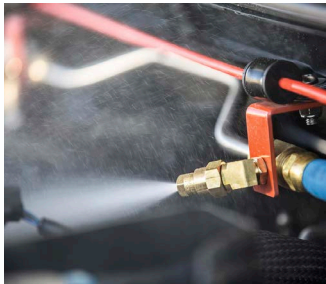
Learn how you can save on parts and services with the Sandvik 365 iPad app. Use the ROI calculator to see how you can boost your bottom line.



iOS

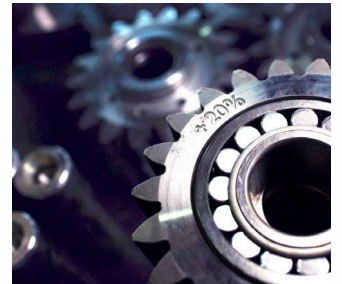
ENVIRONMENT, HEALTH AND SAFETY (EHS)

Stay safe. Our objective is to eliminate harm to people and the environment. EHS is a fundamental consideration in all Sandvik operations, especially product development. Our ambition is to provide the safest products on the market. From our emission-reducing Compressor Management System for surface drills to fire protection, our products are designed to minimize environmental impact and reduce health and safety risks in your operations.



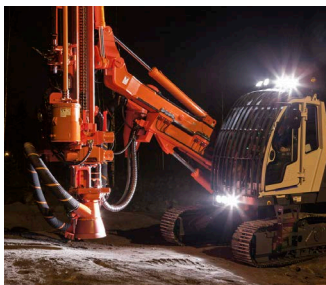
GENUINE PARTS AND SERVICES

Prioritizing uptime. In an industry where an hour of downtime can cost thousands, Sandvik 365 parts and services can save you millions, with round-the-clock service, qualified engineers and genuine parts on demand. When you can predict your productivity, you predict profitability. We not only supply industry-leading mining and construction equipment, our comprehensive aftermarket offering includes service solutions to add even more value to your operation, and genuine parts to extend your equipment lifetime.



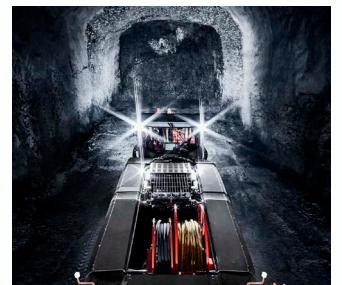
SURFACE DRILLING

Power and precision. Sandvik surface drilling equipment is renowned for durability, reliability and productivity. For decades, our surface top hammer, surface down-the-hole and dimensional stone drilling rigs have delivered low total cost of ownership in quarrying, opencast mining and construction applications. We specialize in engineering surface drilling equipment that marries power and precision while improving operator safety and productivity.



UNDERGROUND DRILLING

Know the drill. Sandvik underground drill rigs are engineered to maximize your productivity in mining and tunnelling applications. Equipped with high-performance hydraulic rock drills, they are ergonomic, efficient and reliable. Every underground drill rig and rock drill we engineer is designed to deliver you the lowest possible cost per metre drilled and a low life-cycle cost. Our drills range from robust, simple rigs to automated units that deliver extraordinary production rates.



CONTINUOUS MINING AND TUNNELLING

Always advancing.

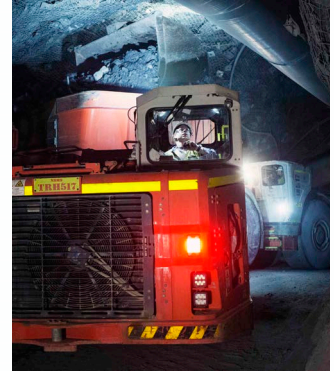
Sandvik continuous mining and tunnelling equipment reflects the unique advantages of total in-house control over the equipment and cutting tools alike. Optimized cutting technology and machine design result in high productivity, long service life and low total costs.



LOADING AND HAULING

Reliable loaders and trucks.

Sandvik underground loaders and haul trucks are engineered for safety, productivity and reliability in the toughest of applications. Rugged, compact and highly manoeuvrable, the ergonomic products offer enormous capacity for their size and return a very low cost per tonne.



CRUSHING AND SCREENING

Maximum size reduction.

Sandvik crushing and screening solutions are engineered for productivity in mines, quarries and civil engineering projects. We offer advanced solutions for any size-reduction challenge, stationary or mobile. We can upgrade existing plants, deliver complete solutions and effect turnkey installations. We also supply individual crushers and screens, as well as key components and consumables. Whether you're crushing tonnes of hard rock or producing several sized aggregates with our mobile screens, our solutions deliver the robustness and versatility you need.



BREAKING

Hit harder.

Sandvik breakers and demolition tools make short work of difficult jobs. They are optimized to deliver high-impact cutting or crushing forces, with high power-to-weight ratios, easy interfaces and simple connections. Whether you're looking for breaker booms for your crushing applications or hydraulic breakers for your demolition projects, we have the precision tools and equipment you need to get the job done efficiently.



MINE AUTOMATION

Complete control.

The AutoMine family covers all aspects of automation, from single equipment to full fleet control. In the safety and comfort of a control room, operators can simultaneously control and monitor the movements of a fleet of driverless loaders, trucks or drill rigs. By adding remote monitoring and process management capabilities, supervisors are able to directly communicate with equipment and operators from wherever they are working.

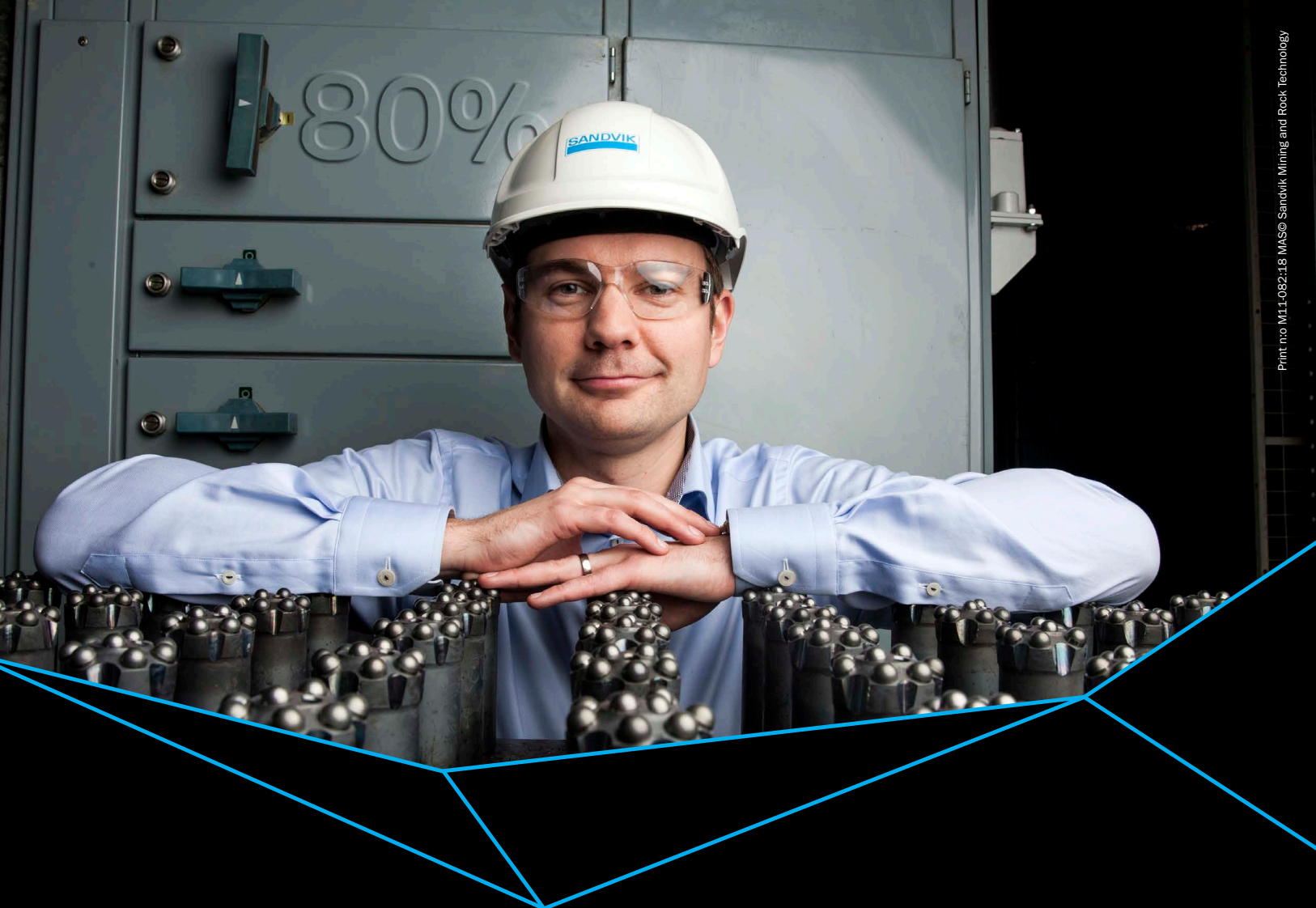


ROCK TOOLS AND SYSTEMS

Deep impact.

Sandvik offers the world's most comprehensive range of tools for exploration, rock drilling, raise boring, coal cutting, mineral mining, tunnelling, trenching, road grading and cold planing. As world leaders in steel and cemented carbide technology, our products have revolutionized the rock drilling industry, while our advanced tool systems for mining equipment raise productivity sharply.





TRUST THE NUMBERS

SANDVIK 365 - ROCK TOOLS YOU CAN COUNT ON

Up to 80 percent longer grinding intervals*. Up to 60 percent longer bit life*. A unique, innovative design with a new, more wear-resistant cemented carbide grade to deliver unprecedented improvements in durability, productivity and safety.

We've reinvented the top hammer drill bit to create a rock tool that delivers the long life you expect. Our 'top centre' bit features a raised front, making room for more inserts as well as larger flushing holes and bailing grooves. More gauge buttons increase resistance to diameter wear, extending bit life. Coupled with GC80, our resilient new cemented carbide grade, you'll drill more metres per shift than with a standard bit, thanks to fewer bit changes and faster penetration rates.

Learn more about how our rock tools can make your drilling more productive and profitable, 365 days a year, at home.sandvik.

*Test results are to be considered as results reached under certain and controlled test conditions. These test results should not be treated as specifications and Sandvik does not guarantee, warrant or represent the outcome of test results in any or all circumstances.

