

SOLID

#2 2016

GROUND

A MAGAZINE FROM
SANDVIK MINING AND ROCK TECHNOLOGY

Canada:

**Profound
productivity**

Sandvik DR481i:

Bigger is better

Intelligence:

**Higher
learning**

**TRUST THE
BUCKET:**
an integrated
solution

Battery-driven equipment heralds the future
of emissions-free underground mining.

CHARGED

UP

SANDVIK

Dear reader,

THE MAIN HEADLINE on the front cover, “Charged up” (referring to our battery-trammed equipment and exhaust-free mining), can also mean “to be excited and full of energy” – and that’s very much how Sandvik Mining and Rock Technology is feeling about the future of our industry, with the innovative products and services that we are bringing to the market.

Today’s challenging market calls for ever-greater productivity and efficiency, and our focus is on supporting our customers in this drive. Just one example is the total bucket concept delivered to Europe’s largest copper mine, enabling a significant reduction in loader maintenance costs, optimized productivity and reduced downtime.

ENVIRONMENT, HEALTH AND SAFETY will always be a top priority for us, and we know that it will only continue to grow in importance across our industry. That’s why we are launching the aforementioned battery-driven mining equipment to address the potential health impacts of diesel particulate matter and other underground engine emissions – thereby also potentially helping to reduce high mine ventilation costs.

In the same way, we will continue to invest resources in intelligent solutions that make your mining safer and more productive. A number of customers who have a long history of using Sandvik equipment are now seeing the benefits of moving in this direction – see page 20 to learn how one customer is now using four Sandvik LH514 loaders (equipped with Sandvik AutoMine Lite) to muck in some of their mine’s lowest blocks. Not only are they benefitting from the improved safety provided, but also from the increased production hours (up to 30 percent more compared with the mine’s conventional loaders).

Sandvik Mining and Rock Technology is fully charged up to meet our customers’ challenges – those of today, and of the future.



LARS ENGSTRÖM
PRESIDENT, SANDVIK MINING
AND ROCK TECHNOLOGY

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Deadline defeated

▶ California State Route 91 is one of the enormous freeways that run through Southern California. When the Route 91 corridor in the city of Corona was widened, a key part of the project was to demolish a sizeable highway overpass. The challenge was to do it without ever completely shutting down the highway, meaning there was no room for unplanned downtime.

The contractor, Environmental Remediation Services Inc (ERSI), selected Sandvik hydraulic hammer Rammer 4099 for the project. The power-to-weight ratio and reputable performance in combination with the operator-friendly environment were important parameters in the selection.

"We were working Rammer 4099 in high-elevation scenarios for a solid 22 hours," says Glenn Beam, on-site ERSI superintendent. "It performed extremely well."

ERSI managed to simultaneously build back the structure and open new lanes during the demolition process. The project beat the anticipated completion date and opened up the freeway 11 hours ahead of schedule.



On top of the world

▶ Sandvik Mining and Rock Technology recently received an order to supply five Sandvik 1175E rotary surface drills to Julong Copper Industry Company Ltd in Tibet. The Julong mine possesses proven copper reserves of almost 10 billion tonnes, making it the biggest copper mine in Asia. At an altitude of more than 5,000 metres, it is among the highest mines in the world and it is also regarded as a model project to drive and develop the other mines in Tibet.

Sandvik DT922i includes the iSURE tunnel management tool.



Easier excavation with new jumbo

▶ The latest Sandvik tunnelling jumbo makes excavation easier than ever with improved automation technology and intelligent features. Sandvik DT922i tunnelling jumbo has been designed to maximize precision and performance while automating much of the drilling and planning process. The jumbo includes an intelligent control system that lets the operator choose between several different modes that substantially improve

drilling accuracy. It also comes with an ergonomic cabin that provides 25 percent greater visibility and guarantees reduced noise levels.

Sandvik DT922i is capable of excavating cross sections up to 125 square metres. Furthermore, it includes the iSURE tunnel management tool for creating accurate plans for drilling, charging and blasting, as well as data collection and analysis functions.

One-stop shopping

▶ A new global partnership agreement between Sandvik Mining and Rock Technology and Schenck Process Minerals & Metals ensures increased crushing-circuit productivity for customers. The partnership enables a single service provider for customers throughout the entire plant life cycle.

"Mid-tier miners are often looking for a system solution across the crushing circuit, and with this partnership they will benefit from the best solutions from Sandvik Mining and Rock Technology and Schenck Process product lines in a single offering," says Mary Verschuer, president of Minerals & Metals, Schenck Process Group.



Joint venture for mid-market equipment

▶ Sandvik is joining forces with Lingong Group Jinan Heavy Machinery Co Ltd in Jinan, China, to produce and sell surface and underground mining equipment. The joint venture will focus on sourcing, assembly, sales and service of surface drills, underground loaders and underground trucks. The products will be designed for the specific needs of mid-market customers and will be sold under an independent brand. While the initial focus will be to supply products for the Chinese market, the goal of the joint venture is to become the leading mid-market mining equipment supplier for other selected parts of the world.

Digging (and cycling) through Finland's longest tunnel

▶ In June, a Sandvik cycling team took part in the Pirkka Cycling Tour, Finland's largest cycling event, which started off through the Ranta tunnel excavated with Sandvik equipment. At 2.3 kilometres, it will be the longest highway tunnel in Finland.

Because of the large amount of drilling required on the project, the contractor purchased new drill rigs and equipment supplied by Sandvik. The new rigs are the latest fully automated Sandvik DT1131i three-boom units, which come complete with the supplier's

revolutionary iDATA control system.

Timo Laitinen, vice president of rock drills at Sandvik Mining and Rock Technology, was a member of the Sandvik team, riding the full distance of 217 kilometres.

"I felt very proud to race through the tunnel that Sandvik has helped to build," Laitinen says. "Our team wanted to race for the fun and challenge, and the Pirkka Cycling event was an excellent opportunity to promote physical and mental well-being, as well as team building in a safe and healthy way."



Vice president of rock drills Timo Laitinen leads the Sandvik team during the Pirkka Cycling Tour.

THE QUOTE

“Divesting the Mining Systems is an important step in consolidating Sandvik to its core operations”

Björn Rosengren, president and CEO of Sandvik, on the agreement to divest its Mining Systems operations to equity company CoBe Capital.



Sandvik launches battery-powered dozer

▶ The new battery-powered Sandvik LZ101LE dozer for low-seam operations improves underground working environments, eliminating exposure to emissions hazardous to miners' health. Sandvik LZ101LE has a push capacity of up to four tonnes and is remotely operated, enabling operators to work at a safe distance away from hazardous, unsupported areas of the mine. Additionally, the battery power pack is mounted on the machine, reducing the risk of running over cables.

Sandvik LZ101LE is an important addition to the supplier's low-profile portfolio. With improved safety, productivity and minimized ore dilution, Sandvik low-profile drill rigs are an ideal choice for working in tabular ore bodies, such as platinum and chrome mines. These rigs have been designed for development, rock support and production drilling in sections as low as 1.7 metres with optimum drilling coverage and performance, offering customers safer productivity and reliability and reduced operating costs.



ABOUT THE COMPANY

Founded in 2002, esco – european salt company has 16 locations throughout Europe with around 1,400 employees producing 5 million tonnes of salt per year.

Q & A

SALT OF THE EARTH

FOR THE PAST CENTURY, the Bernburg mine has produced salt in the heart of Germany. In fact, salt production can be traced back to the Middle Ages here. Today salt producer esco – european salt company mines and processes rock salt over a 40-square-kilometre area with the help of Sandvik LH621 loaders. Mine production manager Hans-Martin Müller, who grew up in Dresden, took some time out of his busy schedule to talk to *Solid Ground*.

Q WHAT ARE YOUR MAIN DUTIES AS PRODUCTION MANAGER?

With my team, I have to ensure that the requested rock salt is produced on schedule and is the right quality, focusing on the existing geology, available machinery and personnel. But above all I have to continuously ensure the safety of our colleagues at work. This is essential.

Q HAVE YOU ALWAYS WORKED IN MINING?

After my studies in mining engineering at the Bergakademie Freiberg, I started working for K+S in May 2007 at one of its potash mines. In May 2008, I started working for esco as assistant underground mine manager. Since December 2014, I've been responsible for the underground production of esco's salt mine in Bernburg.

Q WHAT IS THE BIGGEST CHALLENGE YOU FACE AT YOUR JOB?

Definitely this is the “bringing together” of all the diverse aspects regarding deposit, machinery and seasonal

production rates of rock salt. I must also do the same for all the different characters and qualifications of about 70 miners.

Q HOW WOULD YOU DESCRIBE YOUR RELATIONSHIP WITH SANDVIK?

As we are constantly modernizing our machinery, we have integrated three Sandvik LH621 loaders over the past two years. During the process of planning to purchase the loaders, we became aware of Sandvik personnel's outstanding knowledge of the special requirements for mining machines. Sandvik became a reliable partner in the supply of powerful and low-emission machinery.

Q WHAT DO YOU ENJOY MOST ABOUT YOUR JOB?

I really enjoy the everyday challenges and developments within the mine. I like the direct contact with the miners. Although they work separately, they form a strong team.

HANS-MARTIN MÜLLER

TITLE: Mine production manager

AGE: 34

LIVES: Nienburg/Saale, Germany

HOBBIES: Free climbing and sacred music

FAMILY: Wife Johanna and two children, Emilia (4) and Frederick (1)

Can copper help you lose weight?

▶ According to research from the University of California, Berkeley, copper is believed to be useful for burning fat, thus negating weight gain. Researchers found that copper “helps move fat out of cells – called adipocytes – and into the bloodstream for use as energy.” Trace amounts of copper are found in foods such as oysters, liver, beans and nuts. However, the study cautions against ingesting too much copper, saying it could lead to imbalances in other essential minerals, including zinc.



Top 10 mining jurisdictions in the world

▶ Canada's Fraser Institute think tank recently published its *Annual Survey of Mining Companies*. It ranks jurisdictions around the world based on geologic attractiveness and the extent to which government policies encourage or deter exploration and investment.

While only two European jurisdictions made it to the top 10 list this year – Ireland (4) and Finland (5) – the region's median investment attractiveness score experienced a notable increase.

Africa continued to improve its performance, a trend that began in 2012, buoyed by Burkina Faso (29). As a region, Africa now ranks ahead of Oceania, Asia and Latin America for its investment attractiveness.

Here are the world's top mining investment destinations:

1. Western Australia
2. Saskatchewan
3. Nevada
4. Ireland
5. Finland
6. Alaska
7. Northern Territory (Aus)
8. Quebec
9. Utah
10. South Australia



+ Luxembourg is offering a 200 million euro line of credit to space mining companies that headquarter there.

PHOTO: RTIMAGES

Luxembourg aims to be Europe's space mining capital

▶ Luxembourg has agreed to buy a major stake in Planetary Resources, an emerging asteroid mining company. The country and the company said in a statement that the agreement seeks to speed the development of technologies to explore and utilize resources from asteroids. Earlier this year, the government reached an agreement with another space mining company, Deep Space Industries, to develop Prospector-X,

a small and experimental spacecraft.

Luxembourg is also offering a 200 million euro line of credit for entrepreneurial space mining companies that set up their European headquarters there.

Asteroids are packed with iron ore, nickel and precious metals at denser concentrations than those found on Earth, with estimated yields in the trillions of dollars.

US reviewing exhaust data for links to cancer

+ Battery-driven equipment eliminates diesel exhaust altogether. (See page 16 for more.)

▶ Studies by the National Institute for Occupational Safety and Health and the National Cancer Institute in the United States have found a strong link between diesel exhaust and lung cancer. This has sparked a review by the US Mine Safety and Health Administration (MSHA) of its current standards and policy guidance on controlling exposure to diesel exhaust for miners.

Many underground metal and non-metal mines use a variety of

controls to reduce exposure to diesel exhaust. These controls include ventilation, diesel equipment maintenance, ultra-low-sulphur fuel, diesel oxidation catalysts, new Environmental Protection Agency-approved engines and administrative controls, such as limiting the number of engines in a ventilation course and limiting idling time of diesel-powered equipment.

MSHA now aims to evaluate the effectiveness of the protections in place to preserve miners' health.

136.24

Weight, in carats, of the huge diamond recently unearthed at Alrosa's Nyurbinskaya pipe in Russia.



Pharaohs' gold still buried

▶ Gold mining firm Alexander Nubia believes there are vast amounts of gold buried in the deserts of Egypt, remnants of ancient mines. The Canada-based explorer thinks the value of that gold is in the hundreds of billions.

"Using modern mining techniques and technology, we hope to recover a lot of the gold that [the Roman and Egyptian civilizations] missed," says Mark Campbell, CEO of Alexander Nubia.

The untapped gold in Egypt has been largely ignored since President Gamal Abdel Nasser nationalized much of the country's industry in 1961 and 1962, focusing efforts on oil and gas. Today only one gold mine, Centamin's Sukari, operates in the region, with an output of around 440,000 ounces per year.

▶ The South Crofty tin mine in Cornwall, UK, could restart within two years.

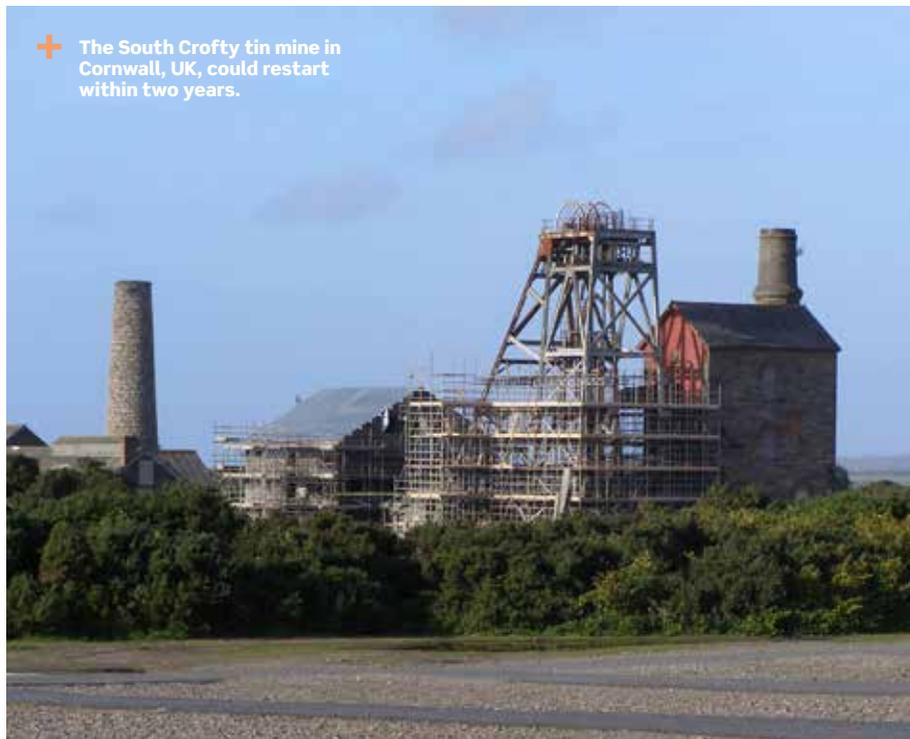


PHOTO: CHRIS ALLEN CC

Bronze Age tin mine set to reopen in 2018

▶ Canadian-owned Strongbow Exploration acquired the South Crofty tin mine in Cornwall, UK, and local media reports operations could restart within two years. Mining in the area dates back to the Bronze Age (between 2500-800 BC) and reached a peak in the latter half of the 1800s when Cornwall accounted for almost half the global tin trade.

"We think that really we will be down there

for decades," says Richard Williams, president and CEO of Strongbow, saying the company "needs to demonstrate to the market that there is potential for long-term mining at the site. At the moment, it is estimated that there is eight to nine years' mine life, but we think that really we will be down there for decades."

Early estimates suggest that there are millions of tonnes of ore ready to be extracted at 600 to 800 metres below the surface.

Copper supply thins amid imminent deficit

▶ The USD 149 billion pipeline to expand the world's copper supply is running into trouble due to hesitant lenders, technical and political obstacles, and electricity and water shortages.

Producers are counting on expansions and development of new operations to meet supply shortages they forecast will arrive towards the end of the decade.

Only six major projects to build new copper mines or expand existing operations will be completed by 2020, with two of those at risk

for delays, according to researcher CRU Group.

BHP, the world's largest mining company, says it will be "a little bit late to the party" under a plan for a major expansion at Australia's largest copper mine from about 2025.

"The mid-2020s is when we are targeting," Justin Bauer, BHP's head of resource planning and development for Olympic Dam, said in an interview. "We'd like to find a way to expand it and find a viable way for quite a large expansion. A cheaper way of processing ore is a really important step for us."

The Expert

+ Dr Andy Wetherelt is a senior lecturer and programme director in the mining engineering department at the University of Exeter. His research interests include blast vibration analysis, underground surveying methods and pit optimization.

THE MINING SECTOR is currently in a down cycle, the effects of which have miners the world over wondering when commodity prices will improve again. *Solid Ground* spoke to Dr Andy Wetherelt from the University of Exeter about the current climate in mining and what he thinks companies should do to stay competitive.

Q: How can mining companies avoid short-term thinking and foster growth during a prolonged down cycle?

A: Unfortunately, during the boom period costs escalated, primarily based on elevated salaries. Realistic salaries need to be implemented, and if necessary, pay cuts across the board need to be implemented. This also has to trickle down to OEMs and the complete “food chain.”

Q: What can mining companies do to improve productivity during these times? How can they ensure that investments in productivity won't be deprioritized once commodity prices improve?

A: Readjustment of the sector is necessary. A much more cautious approach is needed as commodity prices improve, slowly. The last very aggressive boom or feeding frenzy was created because the previous mining sector doldrums were very long and protracted. Controlling the mining boom or bust is very difficult.

Q: What can countries and regions do to assist miners during this down cycle?

A: Try to avoid profiteering by those directly and indirectly involved in the extraction industry and work with OEMs and governmental agencies along with trade unions. If one considers the converse, why should OEMs and employees suddenly demand, say, 50 percent price adjustments or salary increases just because the commodity value goes up? Once the commodity prices fall back, the employees and OEMs are then left high and dry.

Q: How can companies change their mindset on the benefits of implementing innovative ideas and technologies, like petroleum companies for instance?

A: The mining sector is much more traditional than the petroleum sector. Employee age and demographics play a large role in this. Traditional mining equipment is very robust and reliable in what is a transient and very aggressive environment. Technology and innovation have to be proven beyond normal trialling for any implementation to go ahead. Furthermore, there is an expectation that mining companies extract the valuable commodity while the OEMs do the R&D. While there is still a perceived demand to place the person directly at the “cutting face,” the necessary drivers for innovation implementation are very difficult to bring to the fore. ■



BUCKET BLISS

■ A total bucket solution from Sandvik has helped Europe's largest copper mine reduce loader maintenance costs, optimize productivity and reduce downtime, leading to vital savings in today's volatile commodity climate. Text: DAVID NIKEL Photo: ADAM LACH

WROCLAW, THE POLISH city that English speakers struggle to pronounce (it's vrots-waf), is currently the European Capital of Culture, and in 2016 it is also hosting the Theatre Olympics and European Film Awards. But the economy of the surrounding Lower Silesia region of Poland is driven not by culture but by the mining activity that takes place 85 kilometres to the north-west, around the small town of Polkowice.

A world away from the cultural attractions of Wrocław, Polkowice is home to around 20,000 people, but it is eerily quiet during the daytime. That's because 6,000 people disappear underground every day to work in the Rudna mine a few kilometres north of the city, with thousands more involved in the production process. Together with neighbouring operations Lubin and Polkowice-Sieroszowice, Rudna mines one of the world's biggest deposits of copper.

Producing 12 million tonnes of copper ore per year, the Rudna mine is the largest copper mine in Europe and one of the largest deep copper ore mines in the world. It's also one of the best-designed



Every day, around 6,000 people head underground to work in the Rudna mine.

mines in the European region.

Construction began in 1969, and the five-year project took learning and best practices from the previous decades of mining in the region.

Driven by continued demand from the telecommunications, power and construction industries, Rudna's mine life figures to extend another 40 years. But the price of copper on global markets has fallen by more than half from its 2011 all-time high, putting increasing pressure on copper producers like KGHM to uncover cost savings while maintaining the safety of the miners as the depths at Rudna plunge ever deeper. The newest expansion of Rudna to the valuable Deep Głogów copper ore





Rudna represents one of the largest copper reserves in Poland, estimated at 513 million tonnes of ore grading 1.78 percent.



▶ deposit could reach depths of 1.5 kilometres.

Typically made up of 78 percent sandstone and dolomite, the tough material is loosened by drill-and-blast before being screened and hauled to the surface. Each year, the lone concentration plant produces around 1.9 million tonnes of concentrate with 23 percent copper content.

“WITH THE CURRENT price of copper so low it means we are close to the break-even point, so keeping production costs as low as possible is our biggest challenge,” says Tomasz Kras, one of the maintenance superintendents at the Rudna mine. “As we go deeper, the conditions become more difficult and unpredictable, and the cost of providing air conditioning, ventilation and safety systems is higher. It is a challenge for us every day to keep the cost as low as possible, but safety can never be compromised, so we look to the mechanized equipment for cost savings.”

An obvious savings opportunity for KGHM was the lifetime of lip plates on its underground loaders, which quickly wore out and frequently cracked due to the hard rock and difficult conditions. As KGHM looked outwards to its supplier base and even to local suppliers for help, Sandvik answered the call with a total

bucket concept for Sandvik LH517 loaders. Although they came at a higher initial investment than competing solutions, KGHM chose the integrated bucket ground engaging tool (GET) solution from Sandvik for its ability to deliver superior cost-efficiency over the long term.

“The total bucket concept focuses on four key areas,” explains Lukasz Niemasz, GET product line manager at Sandvik for Europe, North and West Africa. “Cast corners add strength and high wear protection to the exposed corners of loader buckets, often the first area to suffer from wearing and cracking. The hammerless design of the locking system allows for quick swap-outs of individual shrouds and easy retensioning of the shroud against the bucket lip. Heel shrouds and protector strips minimize the exposure of the bottom of the bucket shell, while our integrated Sandvik CPB system offers additional protection of the primary lip.”

Over and above the direct long-term savings in extended bucket life, productivity improved by maintaining the bucket’s form over a longer period, leading to an increased tonnes-per-shift ratio.

“The GET solution was brought to Rudna at a time when the mine had a problem with bucket lifetime,” Niemasz says. “We presented a solution that

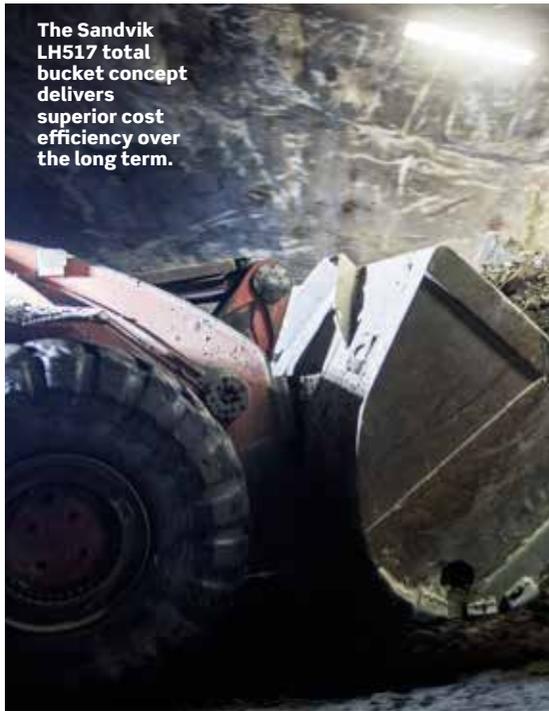
FULLY INTEGRATED WEAR PACKAGE - BY THE NUMBERS

- 12% lower annual cost per hour compared with barelip
- 20% bucket maintenance cost savings
- 94% better bucket productivity in reduced lost tonnes due to bucket capacity
- 95% of total Rudna fleet covered in three years

We are constantly striving to improve our product to help customers such as KGHM meet their cost challenges



Over the years, Rudna's relationship with Sandvik has developed into a partnership.



The Sandvik LH517 total bucket concept delivers superior cost efficiency over the long term.

SANDVIK SOLUTION ✦

- As part of an integrated bucket ground engaging tool (GET) solution, the mechanical lip system allows for quick maintenance, whether replacing or retensioning. The high-strength, high-hardness alloy provides high resistance to wear, resulting in a lower total cost per tonne. KGHM uses Sandvik GET 50-millimetre Heavy Duty Series 2 lip shrouds on its fleet of Sandvik LH517 loaders. In total, 21 Sandvik LH517 units and five LH209 units are in use at Rudna. Sandvik also supplies a team of engineers fully integrated into the KGHM maintenance teams.

would reduce maintenance costs over the long term, but would also benefit production by offering an overall bucket size of 8.4 cubic metres. Geometry over the life of a bucket is key to maximizing productivity.”

RUDNA'S 11 SHAFTS provide ventilation and transport to the 6,000 workers spread over the 78-square-kilometre underground city. A trip through a maze of dark tunnels reveals the well-lit C1 maintenance area, one of several that service the equipment used throughout the Rudna mine.

The man charged with keeping an efficient maintenance operation running is Rafal Brzezicki, the deputy maintenance manager for the C1 maintenance area. As well as doing regular service and repair work, his team run checks on equipment including Sandvik loaders between every shift.

“Our biggest challenges down here are caused by the conditions in which the

94

Percent better bucket productivity in reduced lost tonnes due to bucket capacity

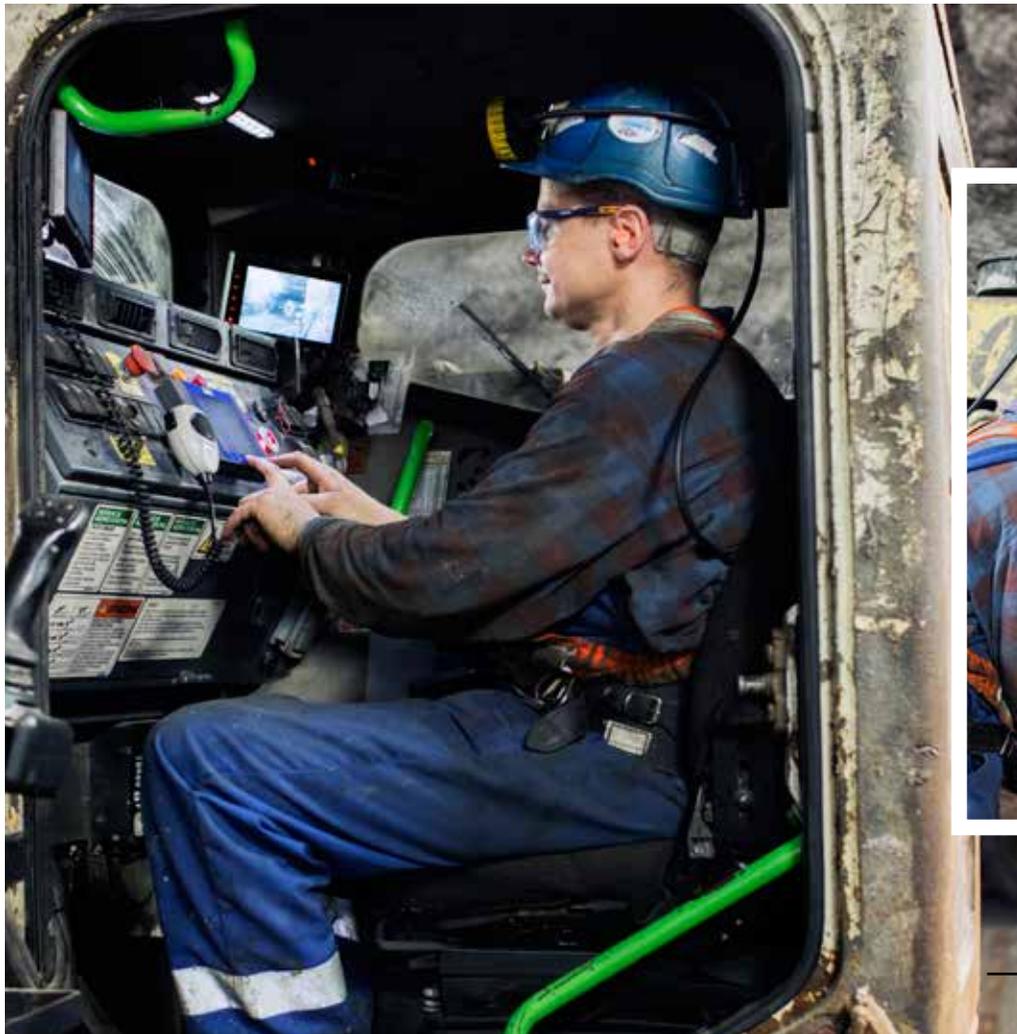
equipment is used in this division,” he says. “We struggle against water and mud getting into the machines and causing problems.”

Brzezicki explains that the introduction of the Sandvik GET system has resulted in identifiable cost savings in both the short and long term.

“We no longer need welders to repair loader buckets,” he says. “It used to be common practice to use welding for major renovations but also for minor repairs. Cracks appeared regularly, and the buckets used to crack. Every six months we had to replace lip plates or weld other lip protections. This made our work difficult because we needed a permanent welder and lots of equipment. The welder used to have lots of work, but now we almost forget about replacing or repairing buckets. The repairs take place after 12,000 to 13,000 hours. In the past, we would have replaced the bucket at least three times within that same period.”

A man wearing a white hard hat, yellow safety glasses, and a blue and black plaid shirt with a high-visibility orange and white safety vest stands in a dimly lit mine tunnel. The background shows industrial equipment and lights.

**Geometry over
the life of a
bucket is the key
to maximizing
productivity**



The Sandvik team develops new features based on feedback from the KGHM maintenance staff.



▶ **KGHM BEGAN USING** Sandvik equipment nearly 20 years ago. Over the years, that relationship has become a partnership, and Brzezicki now has several Sandvik employees working on his team on a daily basis.

One of them is Lukasz Rodowski. Among his duties, he maintains the 50-millimetre Heavy Duty Series 2 lip shrouds on Sandvik LH517 loaders, but he also passes on best practice to the operators.

“We try to help our customer understand how to avoid breakdowns,” Rodowski says. “We stress the need for prevention as a way to reduce costs and keep the equipment working as long as possible.”

Replacing a shroud is a relatively straightforward task for maintenance engineers. Each shroud slides over the lip and is held in place with a simple locking pin and cap screw.

“The Sandvik solution is ideal for maintenance,” Rodowski says.

“Replacing the GET wear parts is straightforward compared to fixed parts

such as rippers offered by competitors. GET removes the need for welding, and there’s no time lost to assembly.”

Niemasz explains that new features are developed by Sandvik product teams based on feedback from maintenance staff.

“Because our colleagues spend so much time in the mine cooperating with KGHM staff, we understand the challenges, such as the need to replace the corner shrouds more often than the others during the lifetime of the set,” Niemasz says. “To make life easier for the operators we have wear indicators built into each shroud that notify operators when the shroud should be replaced, reducing the likelihood of costlier damage to the lip or the bucket.

“We are constantly striving to improve our product to help customers such as KGHM meet their cost challenges. We listen to the feedback of our customers not only from the cost perspective of senior management, but also about the best possible set-up of the shrouds and the bucket from the maintenance engineers.” ■

About KGHM

- KGHM controls resources containing 22.7 million tonnes of pure metal copper in ore across Europe, North and South America. Its main locations are in south-western Poland, Canada, the United States and northern Chile.
- The company, which is 31 percent owned by the Polish government, employs more than 30,000 people worldwide, of whom around 18,000 are directly involved in production.
- KGHM is celebrating its 55th year of operation. Established in 1961, the company was formed by the coming together of mines in the copper belt of south-west Poland, where the Rudna mine would eventually open in 1974.

Text: TURKKA KULMALA Photo: MÅNS BERG Illustration: MATTIAS BORG

THE CLEAN TEAM

■ Awareness continues to grow about the potential health impacts of diesel particulate matter (DPM) and other underground engine emissions that also often dictate high mine ventilation costs. Sandvik is launching battery-driven underground equipment to help mines address present and future emissions challenges.



▶ **AS REGULATIONS BECOME** stricter, mines need cleaner-energy solutions that help reduce DPM emissions in their underground operations. Replacing diesel equipment with battery-driven versions helps eliminate such contaminants and associated respiratory risks while reducing operating costs.

Sandvik DD422iE, the mining industry's first battery-trammed development jumbo, and Sandvik LH307B, a 6.7-tonne, battery-powered loader, combine the freedom of operation typical of traditional diesel equipment with the major environmental, health and safety (EHS) benefits of electric power.

"Exposure to elevated diesel exhaust concentrations has been linked to negative health effects such as eye and nose irritation, headaches, nausea and asthma, and studies have shown it may even be a carcinogen," says Stuart Evans, vice president EHS at Sandvik Mining and Rock Technology. "This is why it was of utmost importance for us to introduce products that mitigate those risks."

Exposure to elevated diesel exhaust concentrations has been linked to negative health effects

SANDVIK DD422iE is the first automated mining jumbo that eliminates the need for a diesel engine for tramping from one tunnel to another.

The rig, designed for underground development drilling and tunnelling, uses electrical power to drill, relying on a mine's power supply network. Battery energy is used for tramping and active network compensation for higher performance during drilling. It does not need separate charging as the rig charges up its battery automatically during the drilling cycle.

Furthermore, downhill tramping does not consume power but rather tops up the batteries of Sandvik DD422iE. The transmission system of the carrier converts the kinetic energy from ▶

Downhill tramping does not consume power; rather it tops up the battery of Sandvik DD422iE.





TECH SPECS SANDVIK LH307B

- Trimming capacity: 6.7 tonnes
 - Standard bucket: 3.0 cubic metres
 - Approximate weight: 22 tonnes
 - Battery pack: Lithium titanate oxide (LTO)
 - Lower heat emissions: savings potential in ventilation
 - Less noise: improved working environment
 - Clean electrical power with no cable: improved operational flexibility, no limitations for vehicles in the same area
 - Advanced LTO battery technology: safer and faster recharging, long lifetime
- Value added**
- No exhaust emissions: better mine air quality, potential for ventilation cost savings

▶ the wheels into stored energy in the battery. A further benefit, compared with a conventional driveline, is reduced heat generation.

The elimination of the diesel engine essentially means zero emissions. In addition to major cost-saving potential in fuel consumption and fuel logistics, this also yields significant EHS benefits, an area that hardly any mine operator can overlook in view of increasingly stringent regulation and growing stakeholder expectations. Lower noise levels and elimination of exhaust emissions, including DPM, NOx and CO₂, provide a healthier and more pleasant working environment for operators and maintenance personnel. Optimal conditions may also offer potential to scale back mine ventilation.

In addition to the new battery driveline, innovations of Sandvik DD422iE include a 3D scanning navigation option and a new improved boom option. The navigation function shortens set-up time at the beginning of each drilling cycle and automatically scans overbreak and underbreak, providing valuable information to optimize the drilling operation. Smart boom positioning and drilling control system increase accuracy and reduce cycle times as well as drilling costs. The 3D navigation option is compatible with the iSURE drill plan design and data collection software. All this directly translates to more efficient mine development in terms of metres per month.

The universal electric system of Sandvik DD422iE is multi-voltage compliant, encompassing the range of 380–1,000 V and both the 50Hz and 60Hz frequencies. This means flexible usability in multiple countries.

The usable life of the rig's power pack is designed to cover its entire lifetime. The molten salt battery technology (sodium-nickel-chloride) reduces fire risk and thus further improves the EHS characteristics of the rig.

“The advanced battery driveline system with multi-voltage compatibility offers huge possibilities to all underground mine owners and drilling contractors,” says Johannes Väliavaara, product manager, development drills, for Sandvik Mining and Rock Technology. “This is a truly flexible piece of advanced machinery that delivers immense value for drill operators as well as mine managers.”

SANDVIK LHDS HAVE for many years thrived in demanding loading applications, both diesel-powered and electric versions.

Both conventional alternatives have their relative strengths and weaknesses: A diesel engine provides sustainable independent operational capability, but it also inevitably entails cumbersome and costly fuel logistics and exhaust emissions. Electric loaders eliminate the exhaust emissions altogether and also much of the heat emissions, but the cable prohibits the use of other vehicles in the same area and limits the





freedom of movement and tramping distance.

The new Sandvik LH307B brings the best of both worlds to underground mines: clean, emission-free electrical power, to provide the independence of movement similar to diesel loaders, yet without the related diesel emissions and costs.

The payload of 6.7 tonnes will be moved using components shared with the diesel version, with much the same performance characteristics. As with the diesel version, the Vehicle Control and Management system monitors all loader parameters, expediting troubleshooting and minimizing unscheduled downtime. Furthermore, Sandvik LH307B is ready for use with Sandvik mine automation and information management systems.

Lithium titanate oxide (LTO) battery technology enables rapid recharging for continuous operation with a single battery pack – in other words, there is no need to swap batteries during or between shifts. LTO batteries also have superior thermal stability and resistance to internal short circuits, making them one of the safest lithium-ion batteries. Liquid cooling guarantees a long battery lifetime across a broad range of ambient temperatures – long enough to cover the useful service life of the loader itself, in fact.

The single-battery strategy offers several tangible benefits. Eliminating the need for spare batteries effectively cuts capex costs. There is no need for a

The advanced system with multi-voltage compatibility offers huge possibilities

dedicated crane and battery swap area, which again cuts costs and also avoids the risk of damage to the battery and loader frame associated with battery swaps. In addition, operators and maintenance personnel can avoid a potentially significant risk of injuries caused by manual battery handling.

“In the future, as mines go deeper, one of the biggest challenges that mining at depth presents is the need for increased ventilation and cooling,” says Wayne Scrivens, product line manager, load and haul, Sandvik Mining and Rock Technology. “Sandvik LH307B offers the opportunity to reduce ventilation and heat as well as the obvious health benefits of no diesel exhaust emissions being emitted into the underground environment. These are also the first steps towards the goal of an all-battery electric fleet, completely eliminating the use of a diesel engine.” ■



TECH SPECS SANDVIK DD422iE ◆◆◆◆◆◆◆◆◆◆

- Feed length: 5.27 metres
- Hole diameter: 43–64 millimetres
- Weight: 27.5 tonnes
- Drilling coverage: 10.3 metres x 6.6 metres

Value added

- Reduced DPM, NO_x and CO₂ emissions
- Eliminates costs related to fuel logistics

- Potential for cost savings in mine ventilation
- Recharge during drilling – no interruption in production
- Multi-voltage compliant system allows flexible operations in any mine
- Improved underground safety thanks to long-lasting molten salt battery technology

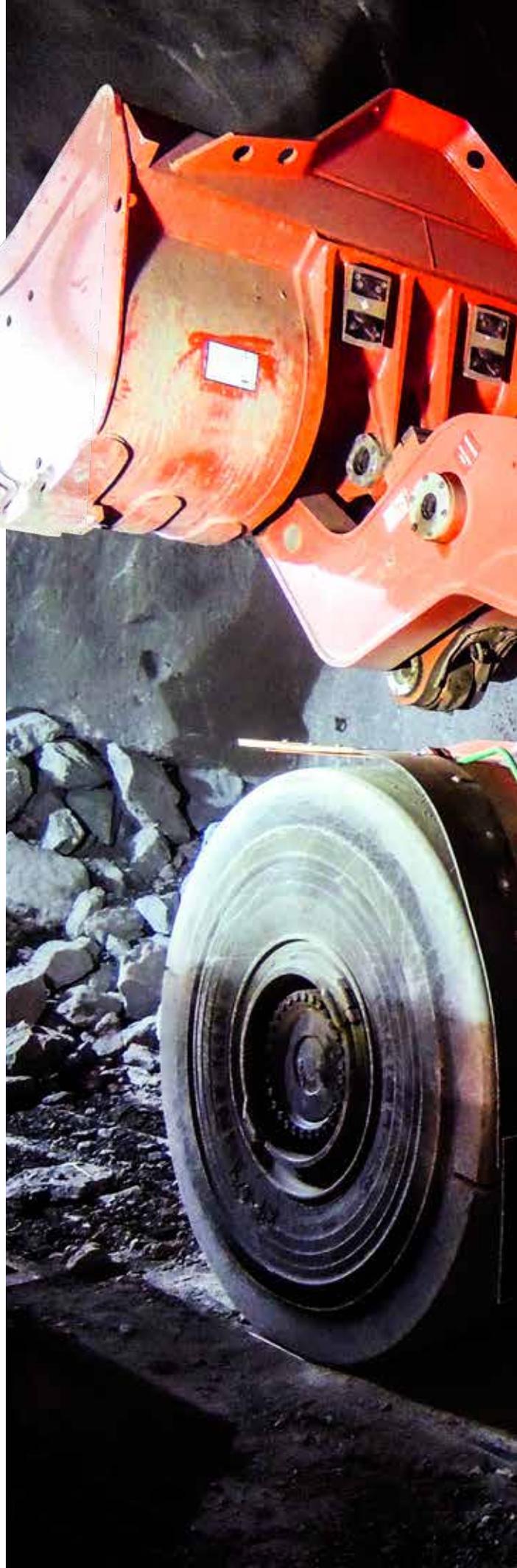
DEEP DIVE

■ Thousands of metres below surface in the world's deepest base-metal mine, an automated loading solution is improving safety, increasing utilization and reducing stope cycle time.

Text: **MICHAEL MILLER** Photo: **SAMIR SOUDAH**



Kidd Operations employs approximately 850 people between the mine and mill.





Kidd Operations

- Company name: Kidd Operations
- Parent company: Glencore Canada Corporation
- Location of mine: 28 kilometres north of Timmins, Ontario, the hometown of country pop star Shania Twain
- Number of employees: Approximately 850 between the mine and mill; it is the largest private-sector employer in Timmins
- Annual output of ore: 2.25 million tonnes in 2016 - equivalent to the volume of 76 Empire State Buildings
- Main metals produced: Copper and zinc, silver as a by-product
- Annual output of metal: Approximately 40,000 tonnes of copper and 60,000 tonnes of zinc
- Operations started: 1966
- Operations scheduled to end: 2022
- Depth of mine: 9,880 feet (3,000 metres)
- Distance from surface to bottom on spiral roadway tunnel: 24 kilometres

Sandvik LH514 loaders equipped with Sandvik AutoMine Lite enable mucking in the four-hour period between shifts.



With the automation we get a lot more hours on our units



Loading and dumping are done tele-remotely from the surface with the Sandvik AutoMine Lite system at Kidd Operations.

THE KIDD OPERATIONS copper and zinc mine in Timmins, Ontario, 700 kilometres north of Toronto, is the world's deepest base-metal mine at 9,880 feet (3,000 metres) below the surface. To get a sense of how deep the mine is, consider Toronto's CN Tower, at 457 metres the tallest free-standing structure in the western hemisphere. You could stack six and a half of them, one on top of the other, and not quite reach the depth of the Kidd mine.

Mining at such depth creates many challenges, both technical – from seismicity considerations to the atmospheric pressure that increases temperatures, straining ventilation systems – and logistical – getting miners and materials from surface to some of the deepest production levels can take more than an hour.

From the surface, a cage takes groups of the mine's employees down to a level 4,700 feet (1,430 metres) below the surface. Even deeper at level 88 (that's 8,800 feet, or 2,680 metres, below the surface) a Sandvik LH514 is working autonomously to maximize production through the mine's busiest production zone. On another level one of the mine's four automated loaders trams into a

stope and quickly re-emerges with a load of muck, an area that is currently closed due to seismic restrictions.

THE MINE HAS been using Sandvik equipment for half of the 50 years that it has been in production. Today, Kidd Operations relies on four Sandvik LH514 loaders equipped with Sandvik AutoMine Lite to muck in some of the mine's lowest blocks.

The automation system needs an isolated area to ensure the safety of the people working in the mine, and a steel mesh gate – as close as anyone is allowed to approach – is a vital first physical barrier. Beyond it is also an infrared light barrier that, if broken, automatically and immediately stops the automated loader. Even when a barrier is broken intentionally (to move the machine for planned maintenance, for example) the mine conducts a comprehensive sweep of the level before reactivating operation.

THE SANDVIK LH514 trams out of sight to dump the load and then returns for another. Loading and dumping are done tele-remotely from surface with this Sandvik AutoMine Lite system. Seven onboard cameras and two

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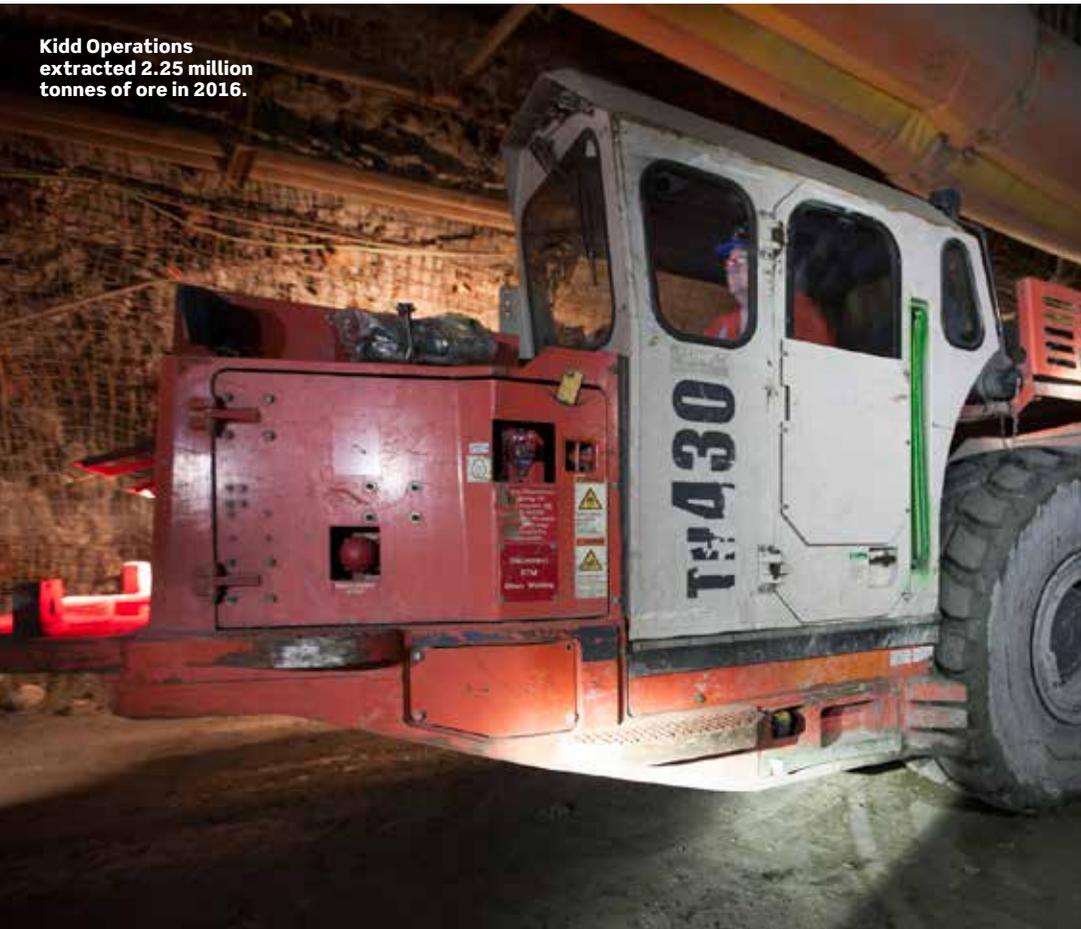
Daily mucking hours Kidd Operations has achieved with its automated Sandvik LH514s

scanners show the operators above ground what is going on all around the loader and enable them to intervene, if necessary. The loader travels the pathway between the stope and the dump site on its own, as it has been “taught” where to go.

A critical eye on utilization and efficiency drove Kidd Operations to solutions like Sandvik AutoMine. Ryan Roberts, manager of mine operations, acknowledges that the current mining environment is challenging, but he says the goal is the same as always: how to safely and efficiently extract the maximum tonnage out of the ground.

“We have to do all that we can to keep our costs as low as possible, but that shouldn't really change whether the metal price is high or low,” he says.

Kidd Operations
extracted 2.25 million
tonnes of ore in 2016.



USING AUTOMATED LOADERS adds complexity to the operation. Areas where automated loaders are tramping need to be closed off to personnel – in some existing mines, such as Kidd Operations, this can mean securing an entire level – and mechanics need to be trained in automated components. Despite these complexities there are clear benefits, Roberts says.

“The utilization of the automated loaders is 12 percent higher than that of manual loaders,” he says. “They’re much higher utilized because we don’t need to stop for blasting, gas conditions or seismic restrictions, and they can keep running while people are going up and down the shaft.”

Jeff Sullivan, Kidd Operations’ automation specialist, says the Sandvik AutoMine Lite system was originally brought in to increase productivity by reducing downtime between shifts.

“Our usual shifts were about 10 hours, and we were losing about two hours of that first shift,” he says. “It takes so long to travel underground here, based on depth of mine and travel to and from the workplace.”

Kidd has benefited from the ability to operate its automated Sandvik LH514s for as many as 21 hours of mucking per day, a 30 percent increase in effective production hours compared with its conventional loaders. The mine was even able to reduce its total loader fleet by three units, in part due to the gains it has obtained implementing Sandvik AutoMine Lite.

“With the automation we get a lot more hours on our units,” says Andy 



Seven onboard cameras and two scanners show the operators above ground what is going on all around the loader and enable them to intervene, if necessary.

Kidd Operations relies on four Sandvik LH514 loaders equipped with Sandvik AutoMine Lite to muck in some of the mine's lowest blocks.



Kidd Operations started mining in 1966, and the mine has extended its production life to 2022.



The distance from surface to the bottom of the mine on a spiral roadway is 24 kilometres.

► Saindon, the mine's senior engineer production coordinator. "We can muck between shifts, and also during seismic activity after a blast and during gas checks on levels where no personnel are allowed."

The operators have received the automated units favourably, Saindon says.

"They like it because it's safer, more comfortable than operating within the mine, and they're away from potential hazards, dust and fumes," he says.

UP ON THE SURFACE, the Sandvik automated loaders are monitored by people sitting at separate workstations, concentrating on two computer screens each. The screens can show the position of each Sandvik automated loader on a map, the view from the loader as seen by an onboard camera, or even the operation of an underground rock breaker. Multiple levels feed mucked material through ore passes down to transfer levels, and the mine can move its automated loaders between levels and transfers to maximize the efficiency of the production fleet. Transfers are the mine's production bottleneck and Kidd Operations have worked with Sandvik to reduce cycle time in these crucial areas.

Sullivan ticks off a few of the

challenges presented by mining at such a great depth. "We run into huge rock pressure in the structure of the mine, high temperatures, high humidity, ventilation problems – it's hard to get air that deep, but we need to make sure our employees and our equipment have enough air to operate," he says. "The Sandvik automated loader allows us to operate in areas of the mine where we usually can't send employees, such as areas prone to seismic activity following blasting activity or where gas restrictions may limit human access.

"We have to have that muck off the ground – we can't let it sit there," he says. "We can then take control of the level, because when we operate in robot mode we own the whole level. All people and other equipment come off the level, and only the robot operates there."

Now that Kidd Operations has successfully implemented the Sandvik AutoMine Lite system, the mine is working with Sandvik to continuously improve it. "Improved setup and relocation of our automated loaders and developing isolated areas to ensure auto-only protection of the loaders are the next steps forward in maximizing the loaders' production," Sullivan says. ■



“They are much higher utilized because we don’t need to stop for blasting”

SANDVIK SOLUTION

● Kidd Operations has used Sandvik loaders for 25 years, and Sandvik has delivered four Sandvik LH514 loaders equipped with Sandvik AutoMine Lite to Kidd Operations' Kidd copper and zinc mine in Timmins, Ontario. The mine received the first system four years ago, in 2012, and it is scheduled to receive a fifth system by the end of 2016. The systems have made a significant contribution to the mine's

productivity and its workers' health and safety. With the automated systems, the operators can work from an air-conditioned room on the surface. Seated in a comfortable chair in front of computer monitors, an operator can see on a map exactly where the loader is at any moment, and onboard cameras display a continuous picture of what's around it.

SANDVIK DR481i

Text: TURKKA KULMALA Photo: GREG PACHKOWSKI

TOMORROW MACHINE

■ **INTRODUCING** a new heavy-duty rig for large-scale operations in open-cast mines. Sandvik DR481i, for up to 406-millimetre holes, is engineered to maximize productivity in terms of sheer volume and tonnage while at the same time delivering a lower total cost of ownership.

■ **IT IS THE MASSIVE SIZE** that first meets the eye in the forthcoming Sandvik DR481i surface drill rig. With the mast raised, it stands 32 metres tall, and has a base weight of almost 200 tonnes. The crawler-mounted system expands the hole size range of Sandvik surface drill rigs from the previous maximum of 311 millimetres up to 406 millimetres. Like all larger surface drills, it uses a rotary system in which the rotating drill bit cuts or crushes the rock with sheer downward force. Primary applications of this hard-rock rig include iron and copper mining.

“We are expecting operating lifetimes exceeding 100,000 hours,” says Tab Siegrist, global product line manager surface drills at Sandvik Mining and Rock Technology. “This rig has the potential to loyally serve a mine for more than 20 years. Sandvik DR481i will offer a great balance between maximum productivity and cost efficiency. In fact, we are pretty confident that the drill with Compressor Management System (CMS) savings can pay for itself over its lifetime.”

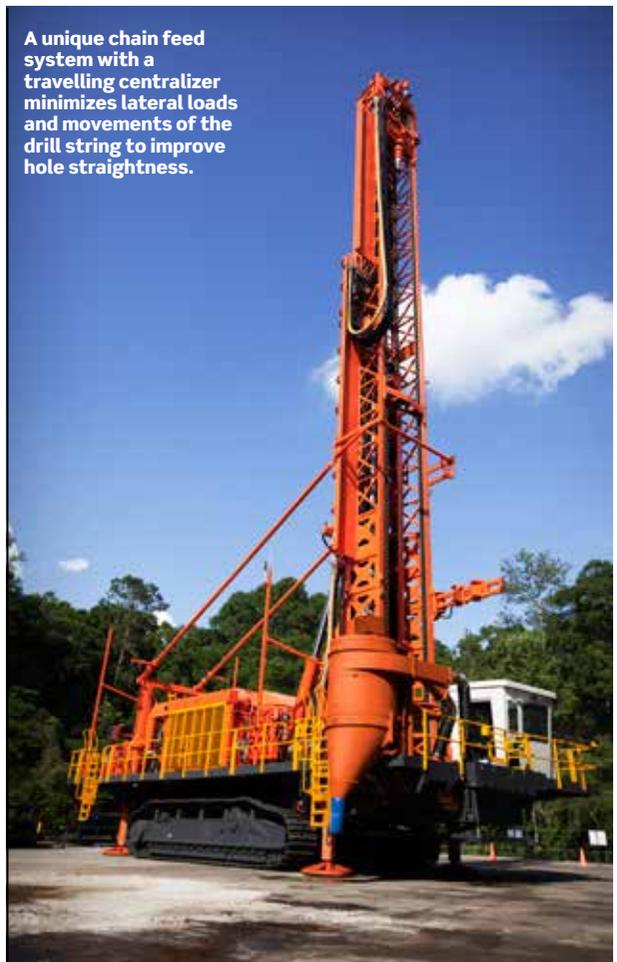
Sandvik DR481i will feature an inertia rotary head with advanced technology designed to increase drilling efficiency. The mass of the rotating components in this system has been

increased by adding flywheels to the input pinions to effectively maintain constant momentum and counteract any obstructions causing vibrations. The extreme pulldown capacity of 54 tonnes not only enables high penetration rates but delivers the bit load to maximize penetration for the rotary bits of today and tomorrow.

THE EXTENSIVE 21-metre single-pass capacity is sure to be appreciated by large-scale hard-rock mining operations. The dual speed system offers a fine feed rate for drilling and fast feed for manoeuvring the drill string.

The mast features a unique chain feed system equipped with a travelling centralizer to effectively minimize lateral loads and movements of the drill string and to improve hole straightness. Straighter holes translate to improved rock fragmentation as well as less throw and rock scattering during blasting. The travelling centralizer additionally increases the usable life of both the rotation head and the mast. The mast struts are designed for quick automatic raising and lowering. No manual handling is required, as with many comparable surface drills. In combination with safe access to the mast service points, this improves both productivity and ease of maintenance.

A unique chain feed system with a travelling centralizer minimizes lateral loads and movements of the drill string to improve hole straightness.



100K

Expected operating lifetime hours of Sandvik DR481i

THE POWER GROUP of Sandvik DR481i is based on the next-generation 1,118 kilowatt Cummins QSK50 diesel engine to comply with future Tier 4 emission control requirements. A key component in the power group is also the patented Sandvik CMS, which substantially decreases the load on both the engine and the compressor. When no power is needed, the CMS simply eliminates the load. Extensive field testing has shown that the CMS can help to cut fuel consumption by more than 30 percent. Furthermore, the reduced load means extended maintenance intervals and increases the service life of the engine, compressor and other components.

Ease of maintenance in general is a key design feature of Sandvik DR481i. The 360-degree walkways and ladders designed according to ISO 2867/AS 1657 provide safe and convenient access to the cabin and all key service points. All regularly replaced filters are centralized in a single stand. The filter stand also includes a centralized

TECH SPECS SANDVIK DR481i ◆ ◆ ◆

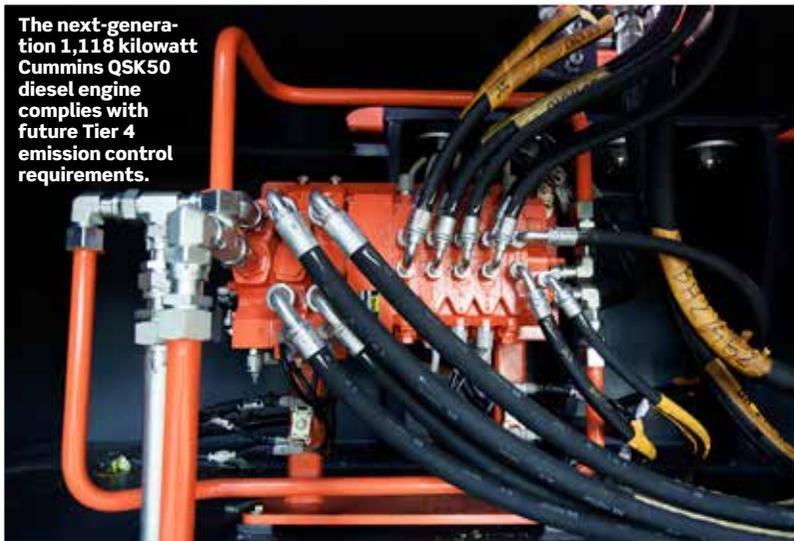
- Hole diameter: 270–406 millimetres
- Max. bit load: 72 tonnes
- Feed system: chain
- Single-pass depth: 21 metres
- Total depth: 42.5 metres
- Operating weight: 197 tonnes



Everything in Sandvik DR481i is designed to deliver our customers value



The next-generation 1,118 kilowatt Cummins QSK50 diesel engine complies with future Tier 4 emission control requirements.



A single operator may use the tele-remote control to operate several rigs from the control room, away from hazardous locations.

▶ sampling point for all key fluids to facilitate preventive maintenance, as opposed to potentially unnecessary scheduled servicing. The entire power group is installed in a separate sub-frame and can be easily lifted off for more extensive maintenance. All maintenance tasks are supported by comprehensive health monitoring and diagnostics systems for reduced troubleshooting time and improved availability.

SANDVIK DR481i is available with scalable automation options, ranging in four levels from basic auto levelling, 3D navigation and energy management modules up to remote non-line-of-sight operation. A mine manager can first select a simple option and later upgrade as required. In the most advanced configurations, a single operator may use the tele-remote control to operate several drill rigs from a control room, potentially thousands of miles away.

SAFETY IS ALWAYS the top priority for Sandvik, and Sandvik DR481i is no exception. A major advantage of tele-remote control is the ability to keep personnel away from any hazardous locations. The new large cabin offers excellent ergonomics and built-in support for efficient dual air-conditioning systems. Tilted windows reduce glare and the heat load. Simple access to service points helps to ensure that the maintenance crew returns home each day safe and sound.

“Everything in Sandvik DR481i is designed to deliver our customers value, whether it be maximized productivity or minimized total cost of ownership,” Siegrist says. “Furthermore, the advanced safety features and the smaller carbon footprint, thanks to our CMS, also help mine owners to achieve their sustainability goals. This truly is a machine for tomorrow and years beyond.” ■

Value added

- Higher productivity through increased drilling power, faster penetration rates and advanced control and automation systems
- Lower total cost of ownership through efficient maintenance and fuel savings
- Automation minimizes variation between operators
- Comfortable and safer thanks to the new cab and improved safety features

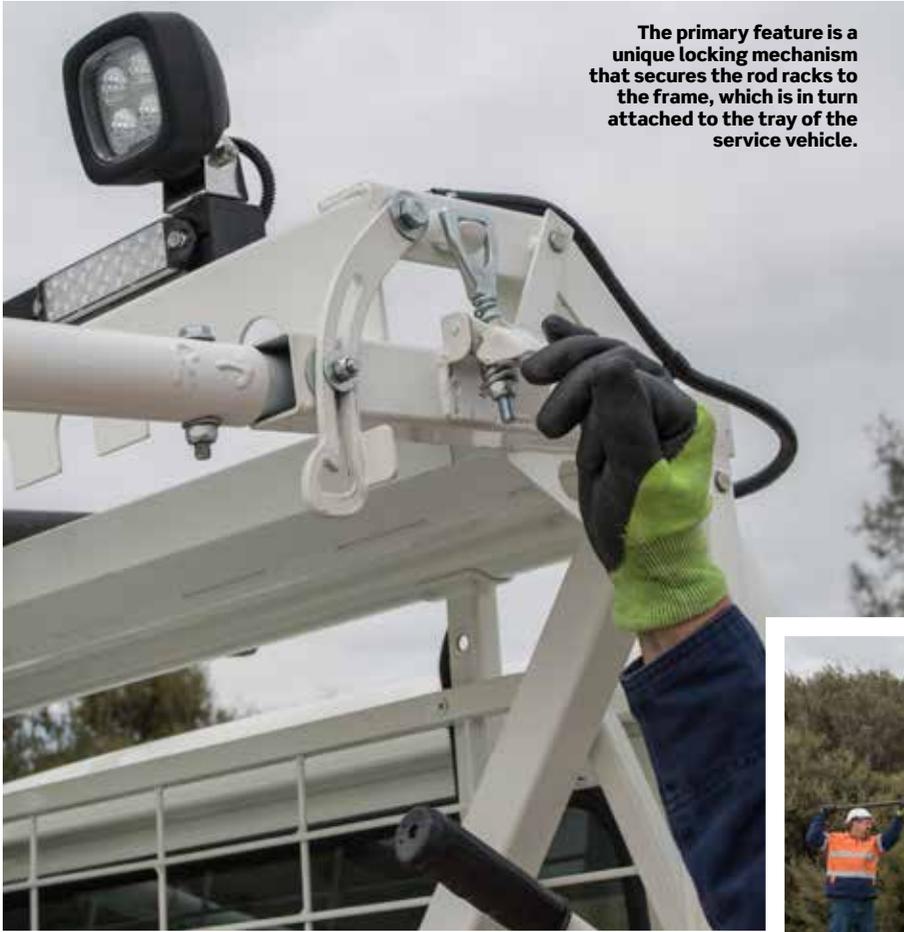


SAFER TRAVELS

■ Sandvik Mining and Rock Technology in Australia has turned a near-miss into a safer transportation solution for drill rods on service vehicles.

Text: DAVID NIKEL Photo: PETER BARNES





The primary feature is a unique locking mechanism that secures the rod racks to the frame, which is in turn attached to the tray of the service vehicle.



The new design enables personnel to safely transport drill rods without their sliding around or falling off the vehicle.



THE NEW RACKS are quickly establishing themselves as the gold standard across the competitive Australian mining industry, with Sandvik receiving inquiries from a diverse range of customers.

Although the new rod rack design may be a success story, it's one that began in unfortunate circumstances.

Deep underground in a South Australian gold mine, a drill rod came loose from the rack on a Sandvik vehicle. It fell forward before rebounding off the rock and back towards the cabin. The drill rod smashed the windscreen but narrowly missed the service technician who was driving the vehicle.

ALTHOUGH NO ONE was hurt, the serious incident demanded instant attention from Sandvik.

"We immediately began a thorough investigation, and it soon became apparent such incidents had happened before but gone unreported," explains Darren Male, rock tools operations manager at Sandvik Mining and Rock Technology.

ALONG WITH Mark Bannister, product sales and support for underground hard rock mining at Sandvik Mining and Rock Technology, Male began to identify potential solutions. The team worked with external engineers and manufacturers to develop the optimum design.

"It was one of those projects without an obvious solution, so we had to consider many different possibilities before we arrived at the final design through a process of elimination," Male says. "One of our biggest challenges underground is weight, so the solution had to be light yet load-bearing."

A product of more than six months of design and engineering work, the new design enables service technicians to safely and securely transport drill rods without their sliding around or falling off the vehicle to which they are attached. The primary feature is a unique locking mechanism that secures the rod racks to the frame, which is in turn attached to the tray of the service vehicle.

The solution is available as a flat-packed bolt-on package to existing Sandvik vehicles. Unlike any previous

Byrne Australia

Founded in 1987 just months before the stock market crash, Byrne Australia weathered the storm to establish itself in a challenging market and become the largest underground mining contractor in Australia.

Current projects include all level and vertical development production activities at the Prominent Hill mine, and decline, lateral and vertical development stope production using long hole and air leg methods at the Jundee mine.

In addition to working as lead contractor at gold, copper and nickel mines, the group also offers specialist shotcreting and shaftlining services for mining and civil clients, raise drilling and box holing services to meet any vertical development requirements, and a range of multidisciplinary engineering services.

There's reduced risk that with sudden braking, the rods will move



The rods are double-clamped and strapped down to ensure secure transport.



▶ rack used by Sandvik, the new solution is certified for road use throughout Australia, extending the potential application.

Sandvik is a drilling supplier for Byrnecut Australia, the country's largest underground mining contractor, at five sites across Australia. The customer was pleased with the new rack's benefits.

"There's reduced risk that with sudden braking, the rods will move or fall forward off the vehicle," says Peter Hallman, Byrnecut Australia Safety, Environment, Quality and Training manager.

"The rods are double-clamped in place and strapped down with no chance of them moving, but also the design of the rod holder helps reduce the potential for manual handling injuries," he says.

Byrnecut Australia is happy that every possible outcome has been considered and that running these vehicles on their sites should help reduce risk of the original incident reoccurring.

Byrnecut takes a pragmatic approach when such incidents occur. When it comes to safety, the company seeks to make continuous improvements over time.

"Although this type of incident is rare, it's important to understand that they may happen from time to time," Hallman says. "Risk assessments are not foolproof.

We try to identify every possible outcome and mitigate the risk of anything happening. This process involves many people, but unexpected occurrences can still happen. What's important is for the relevant party to take responsibility for the situation, quickly resolve it, and learn from it to prevent any recurrence."

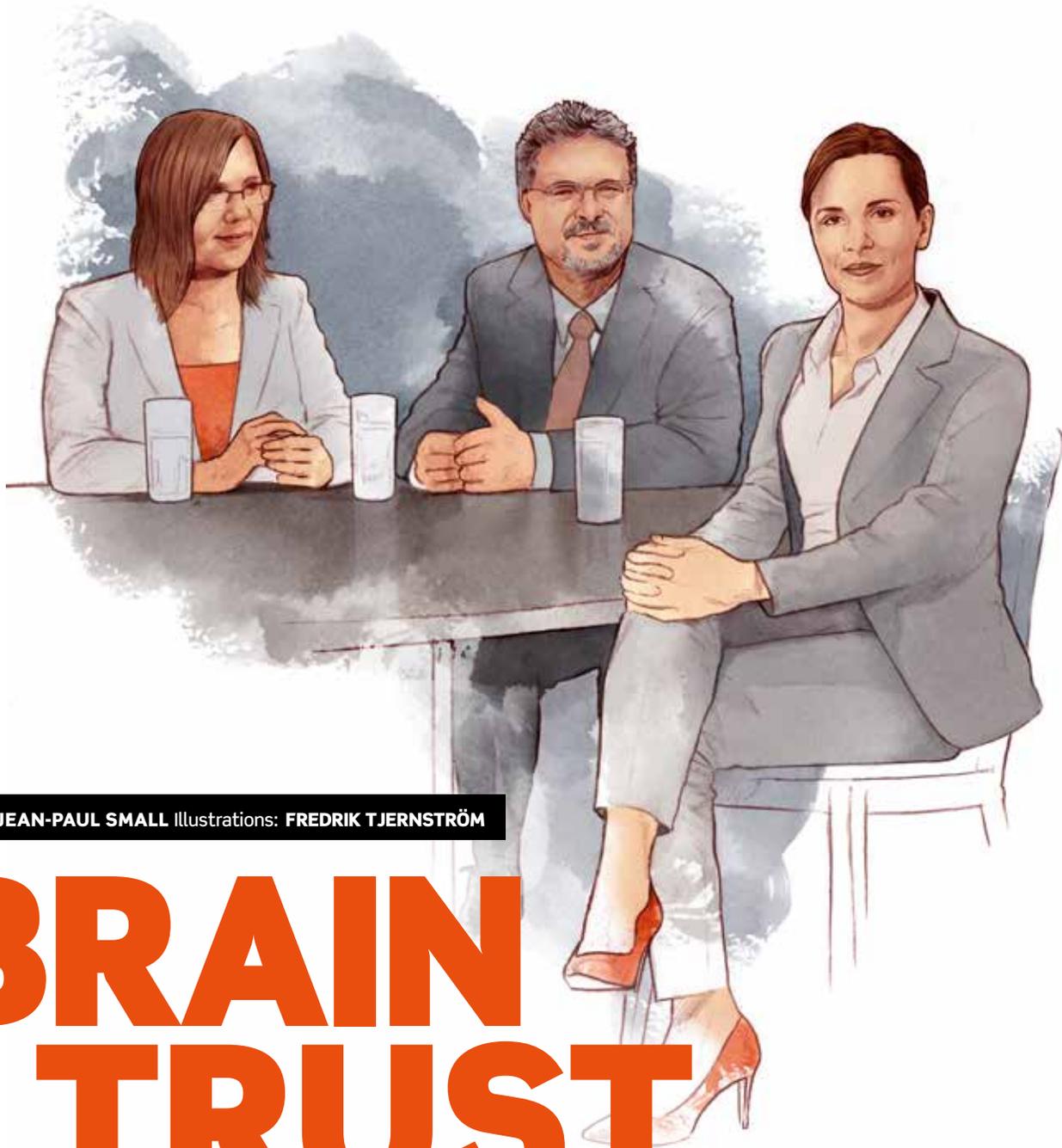
For Byrnecut, working with contractors who take safety seriously is paramount.

"What we expect of any contractor is a focus on safety through their own safety management system," Hallman says. "Part of our process of appointing contractors is to review their systems and to check that they are compliant with what we are trying to achieve. This includes risk-assessing all equipment on site and seeing that they have processes in place for investigations, reporting of hazards and reporting of any issues identified during the risk-assessment processes."

Sandvik has proved its commitment to safety not just for itself but for the industry as a whole, following its decision not to patent the new rod rack solution. The benefits of the new rod racks are something Male and Bannister believe all sites, customers, contractors and competitors should have access to, improving site safety for everyone. ■



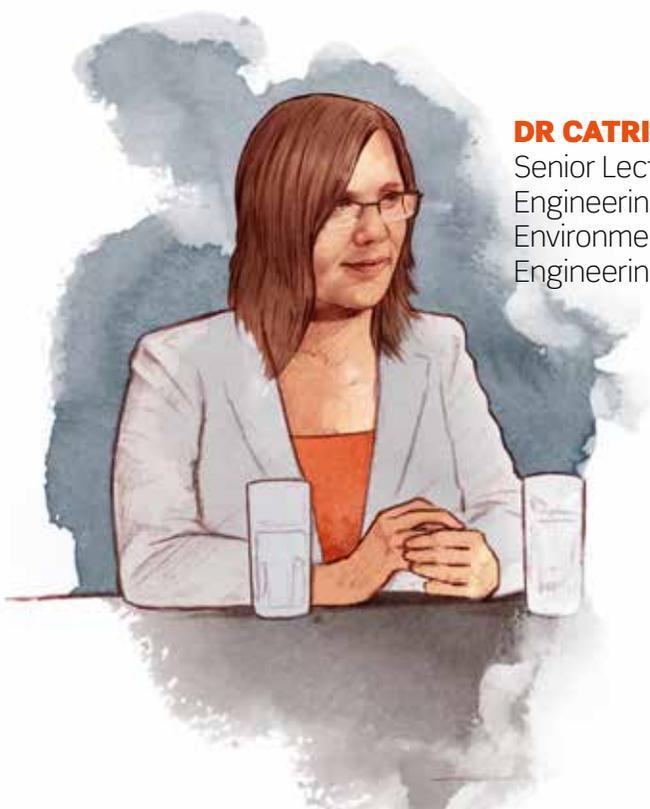
Sandvik decided not to patent the new design as the company feels all sites, customers and even competitors should have access to the rod rack solution.



Text: JEAN-PAUL SMALL Illustrations: FREDRIK TJERNSTRÖM

BRAIN TRUST

■ **Changes in mining** have traditionally moved slowly, but if the industry is to find ways to reverse its “accumulated deficit of transformational innovation” (Ernst & Young, 2014), it should start with mining graduates. *Solid Ground* spoke to professors at leading mining educational institutions about their opinions on how new realities are affecting graduates’ education and what everyone can do to positively influence mining’s future.



DR CATRIN EDELBRO

Senior Lecturer, Mining and Geotechnical Engineering, Department of Civil, Environmental and Natural Resources Engineering, Luleå University of Technology

SOLID GROUND: IS THE TOTAL NUMBER OF STUDENTS ENTERING MINING PROGRAMMES INCREASING OR DECREASING, AND WHY?

PETER KNIGHTS: We believe that there are two factors driving the low number of enrolments in mining engineering. The first is concern over the lack of job security in the mining industry. Over the last four years, some 20,000 people associated with the mining and resources industry in Australia have lost their jobs. To be fair, some of these job losses are the result of large resource projects being completed, but there is a conspicuous lack of new projects available to provide employment opportunities. The second factor is the concern over the future of coal, intimately linked with climate-change fears. Nevertheless, the outlook is positive as most growth predictions conclude that there will be a rise in mega-cities in Asia within the next half century, which require the coking coal produced at three-quarters of the coal operations in Queensland.

CATRIN EDELBRO: Indeed. The number of students enrolling varies and is linked to ore prices. High prices on the market are shown in newspapers, on the Web and on TV. In general, this attracts students to our sector.

SG: TRADITIONALLY, WHAT TYPE OF COMPETENCIES DO MINING COMPANIES TYPICALLY SEEK, AND HOW HAS THAT CHANGED OVER TIME?

CARLA BOEHL: Employers expect “job-ready leaders.” We work closely with mining companies, and they constantly give us feedback and updates on their needs in the workshops we organize with them.

CE: The larger companies still want the experts and specialists who can be taught by our traditional MSc programmes. However, small and medium enterprises (SMEs) need more entrepreneurial skilled graduates in order to have production from the first day. The younger generation seem to be, or could be, more innovative and entrepreneurial in their way of thinking, and therefore the universities need to have a closer collaboration with the industry and SMEs. The students like and want more of real problems that are complex, and less of well-defined and often non-realistic problems. Students and faculty need to work more cross-disciplinarily.

PK: Mining companies have traditionally sought technically competent graduate mining engineers for planning, scheduling and operational applications. Over time, these skill requirements have expanded to include increasing awareness of socio-environmental issues and an ability to work as part of multi-disciplinary teams. As the industry increasingly embraces automated equipment and remote operations centres, we are seeing a requirement for mining engineers to have greater awareness of control fundamentals as well as data analytics skills.



DR CARLA BOEHL

Senior Lecturer and Researcher in Engineering Asset Management, MEA Course Leader Asset Management, Western Australia School of Mines, Curtin University

Collaboration between industry and academia is essential for attracting and developing talent



SG: HOW CAN UNIVERSITIES HELP TO CLOSE COMPETENCE GAPS IN GRADUATES, PARTICULARLY AS MINING MOVES MORE “FROM THE GROUND” AND “INTO THE CLOUD” - I.E., BIG DATA USAGE?

CB: Universities are developing capabilities, particularly in data and computational thinking, for their current and future students. At Western Australia School of Mines, we focus in particular on big data analytics, simulation, modelling and optimization and visualization.

CE: One of our future visions is “zero entry,” which means no humans in the production area. In the long run, this means that the data collected in the field today needs to be collected in the future by sensors, scanning equipment, photogrammetry, etc. Hence the new generation of engineers need to be able to analyze and evaluate the data in another way compared to today. Still, basic knowledge needs to be taught by the universities, which also need to cooperate closely with industry in order to teach the students how to interpret data.

PK: The University of Queensland is looking at introducing a greater emphasis on systems engineering within the mining engineering degree. The ability to understand and model complex systems is integral to autonomous systems as well as complex multi-disciplinary socio-environmental problems.

SG: HOW IMPORTANT IS THE COLLABORATION OF ACADEMIA AND THE PRIVATE SECTOR FOR ATTRACTING AND DEVELOPING NEW TALENT INTO MINING?

CE: In other sectors, such as mechanical or technical design, it is very common to talk about business models regarding product development. The people in the mines do not yet use that language. The “standard offer” from business and entrepreneurial schools needs to be transferred to a content that is specific for the mining sector.

CB: Public research is a critical area where industry and university need to collaborate in facing and embracing disruption. Even a small increase in our efficiency at converting research into innovation could produce substantial dividends. The evidence indicates that when collaboration works, it leads to great results and successful innovations.

It is clear that both industry and universities need to innovate in their approach to collaboration and diversity – not just in attributes such as gender but in diversity of thought, skills and experiences. For universities this means better aligning of research, being more open with findings and more flexible. For industry it means changing the mindset from philanthropy to commercial opportunity, seeking out and investing in long-term research relationships with universities and immersing those researchers in industry.

PK: Collaboration between industry and academia is essential for attracting and developing talent. University can impart theory, but it is not until students see theory put into practice that true understanding results.

SG: THERE IS AN AGEING BABY-BOOMER GENERATION OF MINERS THAT IS APPROACHING RETIREMENT, TAKING MANY YEARS OF ACCUMULATED KNOWLEDGE AND EXPERIENCE WITH THEM. IS THIS A POSITIVE OR NEGATIVE FACTOR FOR THE INDUSTRY?

PROFESSOR PETER KNIGHTS

Professor and Head of Division of Mining, School of Mechanical and Mining Engineering, The University of Queensland

PK: I would argue that there is a younger generation of mining engineers who were promoted too rapidly to management positions throughout the boom period. This has left a deficit of senior mining engineers with the depth of experience that is ideally required – typically in excess of 10 years of technical experience. These engineers need the ageing baby boomers for advice, and so I see no shortage of consulting opportunities for retiring grey-haired baby boomers.

CB: The positive is obvious because many baby boomers have accumulated experience of doing just the same thing over and over again. So it is better to bring in “fresh air,” new ways of managing and solving problems, and diversity. Yes, it is sad and emotional to see some of the great leaders and entrepreneurs who still have “rubber on their boots” saying goodbye to move on to retirement, but that’s the ageing cycle, and no one has yet invented the magic pill that will keep us alive and well forever. ■



” The insects bring up small particles that contain gold from the deposit’s fingerprint, or halo, and effectively stockpile it in their mounds

TINY EXPLORERS

Can termite mounds lead to hidden treasure?

Text: **JEAN-PAUL SMALL** Photo: **ISTOCK PHOTO**

▶ **THROUGHOUT HISTORY**, gold prospecting techniques have varied almost as much as the uses for the glittering, precious metal. Labour-intensive methods such as panning, dredging, sluicing and hard-rock mining have all been tried over the centuries as humans attempted to get to the gold at all costs. After thousands of years of mining, most major gold and other mineral deposits near the surface have been discovered, and miners now need new tools to explore deeper underground.

Research published in the scientific journals *PLoS ONE* and *Geochemistry: Exploration, Environment, Analysis* may have discovered a way for nature to do the “heavy lifting” of this deeper prospecting work. The study found that at a test site in the West Australian goldfields termite mounds contained high concentrations of gold. This gold indicates that there is a larger deposit underneath the surface.

“We’re using insects to help find new gold and other mineral deposits,” says Commonwealth Scientific and Industrial Research Organisation (CSIRO) entomologist Dr Aaron Stewart.

“These resources are becoming increasingly hard to find because much of the Australian landscape is covered by a layer of eroded material that masks what’s going on deeper underground.”

Termites and ants burrow into this layer of eroded material to build their mounds that are made up of an extensive system of tunnels and conduits that serve as a ventilation system for the underground nest. It is here that a fingerprint of the underlying gold deposit is found as traces are brought to the surface.

“The insects bring up small particles that contain gold from the deposit’s fingerprint, or halo, and effectively stockpile it in their mounds,” Stewart says.

Termites could provide a cost-effective way of exploring for new mineral deposits with less environmental impact, reducing traditional and often expensive exploration methods.

Mineral resources make up \$86.7 billion of Australia’s exports, and new systems are required to sustain production. Stewart’s work has also found that insects carry metals in their bodies.

“We’ve found that metals accumulate in the excretory systems of termites,” he says.

“Although the insects may not concentrate metals in their bodies, they actively rid themselves of excess metals. This process shows up as little stones, much like kidney stones in people. This finding is important because these excretions are a driving force in the redistribution of metals near the surface.”



56,700

An ounce of gold weighs as much as approximately 56,700 termites.

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