SOLID GROUND

#1 2022

A MAGAZINE FROM
SANDVIK MINING AND ROCK SOLUTIONS

Intelligence:
Investing in communities

USA:
Remote and productive

The Expert:
Electrify now

New Gold New Afton

GREEN POWER PLAY

SANDVIK

Dear reader,

THE PAST TWO years have presented unprecedented global challenges: the pandemic, war, inflation. Like all organizations, Sandvik Mining and Rock Solutions needs to manage those situations, but they do not distract us from our focus on innovation and sustainability.

In this issue of our customer magazine Solid Ground, you will learn about our latest developments. For example, the recent acquisition of Deswik, a leading provider of mine planning software, which further enhances our presence within software and digitalization and enables opportunities for end-to-end optimization solutions.

STEP CHANGE

More and more customers are discovering the benefits of electrification and automation. For instance, how the industry's first 18-tonne battery-electric loader can help to improve cycle times while reducing heat, noise and greenhouse gas emissions (page 6), and how automation can help to improve safety, operational efficiency and productivity (page 18). It's not just the experts who think the time is ripe for change to electric (page 30): our customers are also increasingly keen to investigate how it can help them to drive responsible mining.

We continue to look to the future, particularly the part that additive manufacturing (AM) technology can play in helping us to optimize our global supply chain and offer new advantages to our customers (page 26), enabling digitally printed machine parts to reach them faster and more sustainably.

OUR COMMITMENT

At the same time, we continue to focus on our core technologies, our commitment to Corporate Social Responsibility and, of course, our people. Sandvik Mining and Rock Solutions is running a number of training programmes around the world to bring new perspectives and competences into the company and support the communities in which we operate (page 32).

Today's challenges, tomorrow's challenges: Sandvik Mining and Rock Solutions is committed to helping you meet them.

STEFAN WIDING,
PRESIDENT & CEO, SANDVIK GROUP

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An electric personality.

Solar panels, rainwater harvesting, low-carbon concrete and recycled materials all feature prominently at some newly built Sandvik facilities around the world.

Sensibly sustainable structures

Sandvik Mining and Rock Solutions is committed to sustainable business practices. Among other initiatives, this commitment includes focusing on halving the company's CO_2 footprint by 2030 and making its products and packaging at least 90 percent circular by 2030.

Examples of this policy put into practice can be seen in some newly built, sustainable facilities around the world. At the new 65,000-square-metre Khomanani facility in Kempton Park, South Africa, water-efficient fixtures, fittings and systems, as well as rainwater harvesting, will improve water consumption levels by 42 percent. There's also a lighting system that is expecting to achieve an energy savings of 48 percent.

In Perth, Australia, a 4,500-square-metre facility was built using Boral ENVISIA low-carbon concrete, with plans for solar panels to be installed shortly.

And during the renovation of the roof at the production site in Turku, Finland, the old bitumen coating was recycled and replaced with a new coating called Carrara. This is an ecological option that lowers the indoor temperature significantly during hot weather and cleans the air, actively reducing CO_2 emissions. The roof's 100 square metres of Carrara neutralize the annual emissions equivalent of 10 cars with its Air Care Technology.

Sandvik has launched its largest-capacity battery-electric truck for underground mining, TH665B .

Powering up

Sandvik is introducing its largest-capacity battery-electric truck for underground mining. The Sandvik TH665B prototype features a 65-tonne payload capacity and is, at the time of printing, completing factory testing in California. Continuing to execute on its BEV strategy by expanding its line of battery-electric trucks and loaders to include both larger and smaller size classes, Sandvik Mining and Rock Solutions will soon trial the TH665B at the Sunrise Dam gold mine in Australia in a long ramp haulage application before commercial production is expected to go forward in 2023.

The truck is equipped with Sandvik's patented self-swapping system, including the AutoSwap and AutoConnect functions, which enables quick and easy battery swap in a matter of minutes, and without any major infrastructure like overhead cranes or other heavy handling equipment.

Sandvik TH665B combines advanced technology built around electric drivelines and battery systems with the company's distinctive design. And with its efficient electric driveline, a fully loaded Sandvik TH665B is expected to be up to 30 percent faster on a 1:7 ramp than a comparable conventional diesel underground truck.

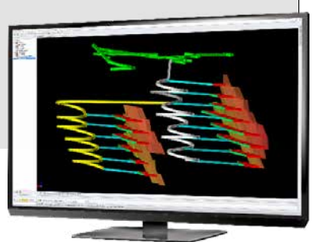
Each of the truck's four wheels is equipped with independent drives, resulting in a simpler driveline, improved overall efficiency and maximum power output. The Sandvik TH665B electric drivetrain delivers 640kW of continuous power, enabling high acceleration and fast ramp speeds.

Growth through acquisition

Sandvik has acquired Australian-based Deswik, the leading provider of mine planning software. Deswik is now part of a newly formed division called Digital Mining Technologies within business area Sandvik Mining and Rock Solutions.

By acquiring Deswik, Sandvik gains a top-tier supplier of integrated software platforms that support digitalization throughout mine planning stages, with more than 10,000 current licences. Deswik will further enhance Sandvik's presence within software and digitalization, and help accelerate growth.

Deswik will fill a value chain gap in Sandvik Mining and Rock Solutions' offering, increasing upstream mining coverage and enabling opportunities for end-to-end optimization solutions, including incorporating electrification at the mine planning stage.



Electric potash

BHP's Jansen Potash Project in Saskatchewan, Canada, is blazing an impressive trail. Not only does the project have the potential to be the largest potash producing mine in the world – with an anticipated initial capacity of 4.35 million tonnes of potash per annum – but Jansen Stage 1 is being designed with a focus on sustainability and technology.

That's why BHP has recently ordered 10 underground battery electric loaders and one electric tethered loader from Sandivk to be used at the mine.

"Electric mining equipment is essential to meeting our goals to reduce emissions, improve productivity and most importantly protect the health of our employees underground," says Simon Thomas, president Potash at BHP. "Jansen will have the lowest carbon emissions per tonne of product produced compared to any potash mine operating today in Saskatchewan."

FIRST OUT OF THE BOX

KAMLOOPS, BRITISH COLUMBIA. The industry's first 18-tonne battery-electric loader is helping New Gold's New Afton operation improve cycle times while reducing heat, noise and greenhouse gas emissions in Canada's largest underground mine.

TEXT: **ERIC GOURLEY** PHOTO: **ADAM LACH**

New Afton mine super-intendent Jeff LaMarsh wants to embrace electrification as part of the future of the mine.

OPERATOR DAYTON GRAY trams mining's largest battery-electric loader into a charge bay in the Lift 1 haulage loop at New Gold's New Afton block cave. There are no overhead cranes or forklifts in the converted re-muck, where the loader's self-swapping system disconnects and lowers a depleted battery, trams to pick up a fully charged battery and automatically connects it. Gray doesn't leave the cabin throughout the process, controlling the swap by following prompts on a touch-screen. Less than six minutes later he trams out of the charge bay and speeds up an incline.

New Afton mine manager Peter Prochotsky sees this process as the potential future of "refueling" for underground mobile equipment.

"It's a huge step change for our industry to move from diesel to electric, and I'm happy to take part in it," he says.

The loader, the first Sandvik LH518B 18-tonne battery-electric vehicle (BEV), is the first major piece of BEV infrastructure at New Afton. The gold mine, which blasted its first drawbell in 2011 and entered production in 2012, has a history of pioneering innovative new technologies that help ensure the safety and health of its employees while also improving productivity. New Afton was an early adopter of automation and is proud to be a first-mover in battery-electric mining.

In 2016, New Afton completed a feasibility study to determine the viability of its C-Zone ore body. The C-Zone, which contains approximately 29 million tonnes, is expected to begin production in the second half of 2023 and extend New Afton's mine life to 2030. New Afton considered electrification from the beginning due to the new ore body's depth 1,150 metres below surface, and mine superintendent Jeff LaMarsh said New Afton recognized a number of potential benefits of battery-electrification during the study.

"We want to embrace electrification as part of the future for our mine and potentially the future for the industry," says LaMarsh.

The C-Zone project was approved in 2019 and New Afton teamed up with consulting and engineering firm Tetra Tech and the British Columbia Hydro and Power Authority to complete a separate study on the economics of a battery-electric fleet on the C-Zone project.

"With that in hand, we decided to embrace battery electrification and learn about the technology prior to making a purchase decision for our C-Zone LHD fleet," says Prochotsky.

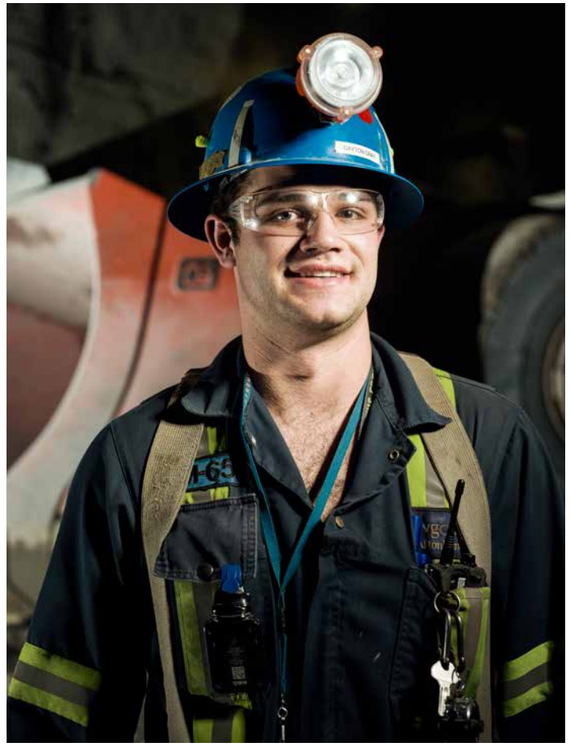
IN 2020, NEW Afton partnered with Sandvik for a three-month trial of the first Sandvik LH518B to build confidence in the loader before purchasing it. The mine established KPIs for availability, battery life and operating parameters, including mucking and tramming speeds.

"On all the trial parameters we evaluated, the LH518B exceeded all of our expectations," says LaMarsh, who was particularly impressed by the breakout force and loading capacity.

NEW GOLD

Canadian-focused intermediate miner New Gold operates the New Afton gold-copper mine in British Columbia and the Rainy River gold-silver mine in Ontario. New Gold produced 286,921 ounces of gold and 61.7 million pounds of copper in 2021.

Sandvik LH518B, the 18-tonne battery-electric loader, is the first electric vehicle on site at New Gold's New Afton mine site.



Operator Dayton Gray doesn't need to leave the cabin of the LH518B when it's time to swap out a depleted battery. He controls the battery change by following a few prompts on a touchscreen.

What stood out most for Prochotsky the first time he saw the loader operating underground was the lack of heat.

"Sandvik LH518B produces approximately 10 percent of the heat of a comparable diesel loader," says Prochotsky. "It's astounding how much less heat it produces, so it's been great for our underground workplace and environment. Battery-electric equipment has been seen to create a large occupational health and hygiene benefit for our employees. Ventilation to dilute heat, diesel particulate and dust in enclosed underground spaces is at a premium, and BEVs help us reduce these workplace contaminants."

THE BATTERY-ELECTRIC LOADER is also much quieter than its diesel equivalent.

"You can have a one-on-one conversation next to the operating piece of equipment, which you could never do with a diesel," says LaMarsh.

The biggest surprise for LaMarsh, though, was the loader's sheer power.

"Sandvik LH518B has significantly more mucking power," he says. "In a traditional diesel, you have to rev the engine to get all your hydraulic power, whereas in the BEV it's the maximum amount of hydraulic power, right from the get-go. The instant torque is beneficial, both for mucking and for starting on a ramp. From a productivity and efficiency standpoint, it's miles ahead of the competition in terms of the diesel equivalent, in our experience."

Starting, stopping and tramming short distances have had the biggest impact on the battery-electric loader's reduced cycle time, but Prochotsky says the biggest productivity driver is horsepower density.

"We have roughly four times the amount of wheel motor power in Sandvik LH518B than its diesel equivalent, so the up-ramp time is proportionately faster," he says. "Tramming up ramp, on grade, we typically estimate our diesel LHDs to move at about seven to eight kilometres per hour, whereas we're seeing speeds of 12 to 14 kilometres per hour with the battery LHD."

THE LOADER IS also helping New Afton achieve its greenhouse gas reduction targets.

"Part of New Gold's mission is to drive responsible mining," Prochotsky says. "We recognize that greenhouse gas emissions around the world are climbing, and we want to try to reduce our greenhouse gas footprint. When the scoop is in full production, we're reducing our GHG emissions by about 700 tonnes of CO_2 equivalent per year compared to a diesel LHD."

NEW AFTON MINE

Located approximately 350 kilometres northeast of Vancouver and 10 kilometres from regional hub Kamloops in south-central British Columbia, the New Afton underground mine occupies the site of the historic Afton open pit mine. Development began via decline ramp in 2007 and the mine reached commercial production in 2012. New Afton, which employs a workforce of approximately 650, produced 175,972 gold equivalent ounces in 2021, consisting of 52,452 ounces of gold and 61.7 million pounds of copper.

"We decided to embrace battery electrification"

New Afton's data on Sandvik LH518B shows that replacing one diesel loader with a comparable BEV is expected to reduce the mine's total greenhouse gas emissions by as much as 2 percent in a year, assuming full production.

"That's a really large number which, among other things, depends on how much we use the equipment and how much diesel we're offsetting, but for an underground mine even replacing one piece of diesel equipment with battery-electric can have a major impact on your total GHG reduction."

The energy consumption of Sandvik LH518B has been significantly less than New Afton's diesel equivalent loader. "The overall energy cost compared to diesel is about 10.9 percent while operating," says Prochotsky.

Sandvik LH518B is equipped with AutoSwap, a patented self-swapping system for the Artisan battery pack. The loader is also the first Sandvik BEV featuring AutoConnect technology, enabling an operator to swap batteries even quicker without exiting the cabin.

"The AutoSwap, AutoConnect technology has been smooth and seamless," says Prochotsky. "It's been a nice benefit for the operators, both in safety and efficiency, not having to exit the cab to unplug the battery."

NEW AFTON EVALUATED different charging methodologies. LaMarsh said the ability to swap batteries quickly is an advantage of Sandvik BEVs, as the loader doesn't need to be parked for an extended period.

"Sandvik LH518B was an attractive option for us because it has the battery swap technology as opposed to the quick-charging, and that really bodes well in a block caving operation," says LaMarsh. "Battery swapping helps ensure a lot more utilization of the equipment, whereas with a fast charge, you do need to have downtime to facilitate that charging. For us here in a block caving application, a battery swap is the leading technology in our minds. When you're relying on quick charge technology, every minute affects the equipment's utilization."

BATTERY SWAPPING ALSO enables New Afton to spread charging load over longer periods of time, helping to mitigate the aggressive power draw quick-charge solutions can place on a mine's grid.

"Battery swapping technology is a great option for us because we only need to charge the batteries to just under the discharge rate," says LaMarsh.

As New Afton expands down towards C-Zone, the mine is constrained by its original Lift 1 power supply of approximately 5 megawatts.

"We're going to carry that same cable diameter down deeper, so when we talk about electrifying C-Zone, we do need to ensure that the power demand stays within our cable capacity," says Prochotsky. "We see the best way to do that is to spread the load over a longer time period. We're still using the same amount of energy by electrifying our production fleet, but we don't have a peak power demand that exceeds the amount of power our cables can supply. Ultimately for C-Zone, we want to spread our power demand over the largest time possible."

New Afton currently uses Sandvik LH518B in the mine's Lift 1 haulage loop to load trucks and tram ore to the gyratory crusher. By 2023, the mine anticipates transitioning the loader to the new B3 cave to continue truck loading.

B3 is essentially an intermediate zone that will take New Afton from its current Lift 1 mining area down to the future C-Zone.

THE C-ZONE BLOCK cave is about 550 metres below Lift 1 and 1,150 metres below surface. Mining at the future production area's depth presents ventilation and operating cost challenges that Prochotsky expects BEVs and electrification can help mitigate.

"Mining economically at such depth can be complex, and we see battery electrification as one of the potential solutions to the challenge," says Prochotsky. "The virgin rock temperature increases the heat of the level while in production, so that and ventilation constraints both favour battery-electric equipment."

Battery swapping enables New Afton to spread the charging load over longer periods of time, helping to mitigate the aggressive power draw that quick charge solutions have.

Our workforce is receptive to new technology

New Afton will take delivery of two Sandvik Z50 battery-electric trucks during 2022, enabling the mine to benefit from its existing battery infrastructure and growing battery knowledge. Although the mine purchased the 50-tonne trucks as a production solution for its B3 mining area, New Afton mine managers anticipate using them to help accelerate C-Zone decline development until B3 production ramps up in the fourth quarter of 2022.

"It's always a challenge to get enough ventilation down to the face until we've established our permanent ventilation infrastructure," says Prochotsky. "By utilizing battery trucks, we expect we'll reduce the heat generated upstream of the development face and eliminate diesel particulate."

SANDVIK FACTORY PERSONNEL have supported New Afton with projected discharge rates and duty cycle modelling for Sandvik LH518B that Prochotsky said have been accurate.

"Sandvik is helping us understand the best staging for pieces of equipment, the best loop spacing, location of passing bays and charging stations, those sorts of design criteria that we can then implement prior to actually getting down to C-Zone," says Prochotsky. "We've always had a very good relationship with Sandvik. For a long time we've been using Sandvik drills and bolters underground, and to continue our relationship and move into automation and now battery-electric vehicles has been a natural progression."

"I personally believe electrification is the way of the future." LaMarsh says. "Being part of a group that gets to pioneer BEV technology in underground mining is really exciting.

"Every mine likely has a capital purchase or a maintenance replacement coming up in the next few years, and I think they would be missing out if they decided not to investigate or pursue battery-electric technology," he says. ■

New Afton Mine manager Peter Prochotsky is impressed by how much less heat the BEV produces compared with a diesel version.

The New Afton mine produced 175,972 gold equivalent ounces in 2021.

DRILL, UNINTERRUPTED

Automation has become a clear megatrend in mining, as companies try to maximize productivity, profitability and sustainability with new connected drill rigs. The limit for uninterrupted automated drilling operations, however, has mostly been set by the service life of the drill bits. But not anymore. Enter the Top Hammer Autobit.

TEXT: **TURKKA KULMALA** PHOTO: **SANDVIK**

We felt that the industry needed a more durable, automation-compatible bit

MODERN TOP HAMMER production drilling is a well-defined process that, with today's hardware and software capabilities, lends itself well to effective automation. With a modern drill rig, equipped with an advanced automation package, you could in principle just push the button and let the rig drill continuously until the drill bit is worn out. In practice this has been challenging, precisely because of the bit change. Automated bit changers are not yet widespread enough to substantially alleviate the problem.

Instead of focusing on bit changer solutions, Sandvik Mining and Rock Solution's Top Hammer R&D team approached the challenge from a different angle: "We felt that the industry needed a more durable, automation-compatible bit," says Robert Grandin, Top Hammer product manager.

GRANDIN AND HIS colleagues had key advantages that made them well equipped to tackle the challenge: Sandvik has decades of expertise with in-house carbide technology, including dedicated grades for mining applications, Wolfram tungsten supply from the company's own mine as well as in-house production of both tooling steel and drill rigs.

Autobit enables drilling over shift change and during blasting and ventilation.

The incentives were obvious enough. As an example, consider a typical underground production mine with two nine-hour shifts. No one is allowed to work down in the mine during blasting and ventilation, taking up about two hours per shift. The transfer of personnel during shift changes also needs to be accounted for, so let us assume 30 minutes for each trip up or down. This leaves roughly three hours per shift or six hours per day when all downtime components are accounted for.

NOW, LET'S FURTHER assume a typical hourly cost in the range of USD 300 for the drill rig. If drilling could go on by means of automation during those three unproductive hours per shift, and consequently six hours per day in a two-shift operation, this would create great potential for cost reduction. To be precise, assuming about 330 operational days per year, it would rack up potential cost savings in the range of around USD 600,000 per rig for each year (6 x 330 x 300).

And even that is not all. Most mines are profitable, so there is the potential added revenue from drilling during blasting and ventilation as well. This adds up to a total annual financial impact in the range of USD 1.2 to 2 million.

In other words, Sandvik had a clear business case for creating its new automation-compatible drill bit, Autobit, enabling mine operators to drill over shift changes and during blasting and ventilation.

The key to Autobit's success is a roughly doubled first regrinding interval compared with a standard bit. After the first regrind, Autobit's performance matches a standard bit, but it is still entirely usable for regular manned production.

Looking at the concrete features of the drill bit, Autobit has a larger button protrusion and a very aggressive button profile. The cemented carbide grade is SH70, Sandvik's best-performing self-hardening Powercarbide grade. The face of the bit is carved out for more efficient flushing performance when the carbide buttons are worn. The gauge buttons, on the outer rim of the bit, are fully ballistic and angled aggressively, at 40 degrees. The flushing grooves on the side of the bit are generously dimensioned to also increase the flushing rate. The current range only has an even skirt design available, but a Retrac model is designed for more challenging rock conditions and includes the ST58 and ST68 tube drilling systems. The hole sizes currently available are 102 mm and 89 mm.

A modern automated drill rig needs a more durable bit to reap productivity rewards.

As a somewhat coincidental side effect, Autobit's superior service life makes it an excellent choice for simplicity-minded customers who want to avoid drill bit regrinding and the related logistics altogether by only using new bits, simply running them to destruction with no regrinds at all.

SUPERIORITY IS NO hyperbole when it comes to Autobit. Test results show that Autobit achieves at least 100 percent and sometimes up to 200 percent more drilled metres before the first regrind compared with a comparable standard bit. The total service life of the bit has been at least equal to a standard bit and sometimes up to twice longer, depending on the interaction of the rock conditions and the self-hardening carbide grade. Its long service life makes Autobit a great solution also for customers without an automation programme.

Autobit is an industry first in terms of offering the first truly dedicated drill bit for automated top hammer production drilling. It clearly creates a strong offering in the marketplace, compared with the competing polycrystalline diamond (PCD) technology, which still offers two to three times higher performance than cemented carbide, but at an almost 10 times higher price.

"It's quite amazing the enormous values our bit design and carbide development engineers can unlock when focusing their efforts on specific customer challenges," says Grandin.

AUTOBIT - BENEFITS

- Enables drilling over shift changes and during blasting and ventilation: substantial potential for cost savings and increased revenue.
- 100 percent longer first regrinding interval compared with a standard bit: significant increase in productivity.
- Performance comparable to a standard bit after the third regrind: no unnecessary waste, can still be used for manned production after the automated drilling capability is lost.
- Sandvik's best-performing self-hardening Powercarbide grade SH70: up to 30% longer regrind interval and service life compared with standard grades.

THE HEART OF AUTOMATION

JUNEAU, ALASKA. Automated loading has helped Coeur Alaska's remote Kensington Mine improve safety, productivity and cost.

TEXT: **ERIC GOURLEY** PHOTO: **ADAM LACH**

The Coeur Alaska Kensington Mine operates on a very compact 100 hectares, and thanks to positive exploration results is hoping to extend mine life for more than 10 years.

THE COEUR ALASKA Kensington Mine's boat-in boat-out workforce travels up to two hours one way to arrive at the mine site, but even the operation's most veteran miners say the scenery is worth it.

Twice daily, employees board a bus in Juneau, Alaska's state capital, for a 37-kilometre ride to a port. A 45-minute boat ride up Lynn Canal offers picturesque views of rugged mountain peaks and seasonal whale watching opportunities. Employees then board another bus at the mine's dock facility for the remaining eight kilometres up an all-weather gravel road to the mine site.

Accessible only by boat, floatplane or helicopter, the Kensington Mine operates within a compact footprint of more than 100 hectares in the Tongass National Forest, the largest national forest in the United States. Mean annual precipitation at site is over 100 inches, with winter snow accumulations higher than 3 metres possible at the mine's portal.

Commercial production began in 2010 and the gold mine reached the million-ounce milestone in 2019. The mine had initially anticipated a 10-year life at 1,130 tonnes per day under its plan of operations approved in 2005. Coeur's mining and processing improvements allowed the mine to increase throughput to 1,815 tonnes per day, and continued investment in exploration and positive returns have extended the mine life to approximately 2025. In 2020, Coeur invested USD 8.6 million in exploration at Kensington and another USD 11 million in 2021 focused on extending mine life. In 2022, Coeur Alaska received approval to increase tailings and the waste rock storage capacity necessary to extend mine life for at least another expected 10 years.

> **Using automation to control an underground LHD was very exciting to us**

THE OPERATION'S REMOTENESS creates unique operating conditions, including power generation and load management and on-site emergency services. All parts, food and fuel arrive via a once-weekly barge from Seattle, so planning and supply chain logistics are essential to the mine's success.

Implementing operational efficiencies also helps offset higher operating costs at the remote site. One of the most impactful technologies the mine has adopted in recent years is automation.

Kensington's automation journey started after mine management visited Sandvik's booth at the MINExpo INTERNATIONAL 2016 trade show.

"The idea of removing the miner from the drift and using automation to control an underground LHD was very exciting to us," says former General Manager Mark Kiessling.

The mine was entering a fleet upgrade cycle and concurrently explored several automation systems. Operations Manager Kyle Beebe said Sandvik's proposed benefits, ease of implementation and cost relative to alternatives were deciding factors in choosing the AutoMine system.

"We also chose Sandvik because they had the systems ready to go already on the machine, as opposed to having to be retrofitted," he says.

Coeur Alaska purchased a new Sandvik fleet in 2017, including two AutoMine-equipped Sandvik LH514 14-tonne loaders. Beebe said although the primary motivation for implementing loader automation at Kensington was improving safety by replacing line-of-sight remote with tele-remote operation, increasing production by using automated equipment to continue muck haul operations during shift changes and blasting cycles when employees can't be in the mine was a close second.

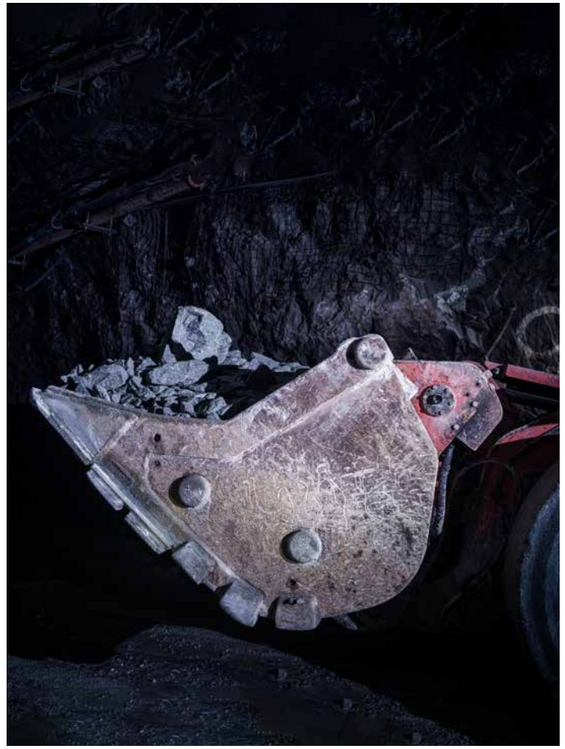
Kensington implemented AutoMine during 2018, bolstering its wireless network backbone to support automated areas and working through some early teething issues and cultural acceptance challenges with the new system. The mine moved 4,000 tonnes of ore with AutoMine in 2019, and as system reliability improved it mucked 4,000 tonnes in January 2020 alone. The mine saw the gains continue to increase during 2021.

"Being able to move that material and really have no human-machine interaction has just been fantastic," Kiessling says. "It's really changed the way that we think about how we remote stopes and how we muck material. We're recognizing big productivity gains."

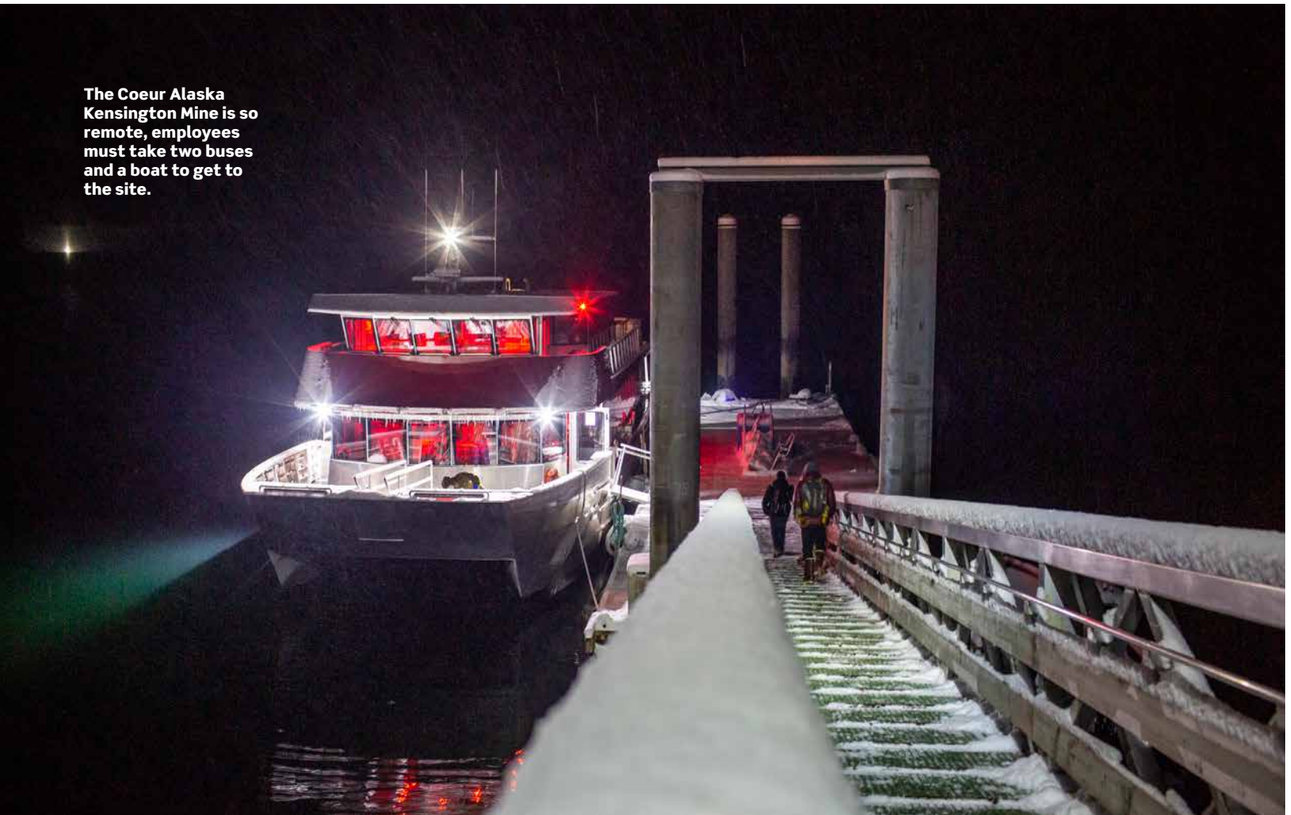
BRYAN NORD, MANAGER of IT and Business Intelligence, leads development of Kensington's automation programme. Through hiring full-time automation technicians, training operators, identifying common issues and resolutions and improving long-range planning, Kensington increased its AutoMine utilization by more than 20 percent in 2021.

"Our automation team is constantly working to improve our infrastructure, reporting, operating procedures and maintenance quality to give us the best chance of success," Nord says. "We expect our sustained usage to continue improving."

Although Kensington's initial implementation of AutoMine was tele-remote operation, its application has evolved as system acceptance and utilization have steadily increased. The mine mucks remotely, but tramming and ore pass dumping are capable of being fully autonomous.



Bryan Nord, Manager of IT and Business Intelligence, leads development of Kensington's automation programme. The site increased utilization of AutoMine by 20 percent in 2021.



The Coeur Alaska Kensington Mine is so remote, employees must take two buses and a boat to get to the site.

KENSINGTON MINE

Located approximately 72 kilometres northwest of Juneau, Alaska, the Kensington underground gold mine is located in the historic Berners Bay Mining District, which has had more than 100 years of resource development. Accessible only by water or air, Kensington is owned and operated by Coeur Alaska, a wholly owned subsidiary of Coeur Mining, Inc. The mine, which employs a workforce of approximately 400, produced 121,140 ounces of gold in 2021.

We also chose Sandvik because they had the systems ready to go

"While we have explored full automation, our current mine design precludes the use of full automation, and sequencing requires us to be ready at a moment's notice in a variety of areas. This lead us to optimize AutoMine usage mostly in tele-remote and semi-autonomous operation," Nord says.

Operations Manager Kyle Beebe (top) and former General Manager Mark Kiessling see AutoMine as a way to strengthen productivity at Kensington.

KENSINGTON CURRENTLY USES its automated Sandvik LH514s both to move ore from stopes to muck bays on automated levels during shift change and to move ore from stopes to ore passes, typically during shift change but also for full shift cycles.

"These are the two most efficient uses that introduce the least amount of downtime due to disarming levels for drill crews," Nord says. "We often target levels that have access to an ore/waste pass for full-shift work as we can easily set up a loader and have it run continuously."

Nord said that although Kensington doesn't currently track metrics to quantify the benefits of AutoMine compared to manual mucking, their team noticed that stockpiles stayed fuller when running AutoMine. The mine has moved as many as 42 buckets down an ore pass during a three-hour shift change.

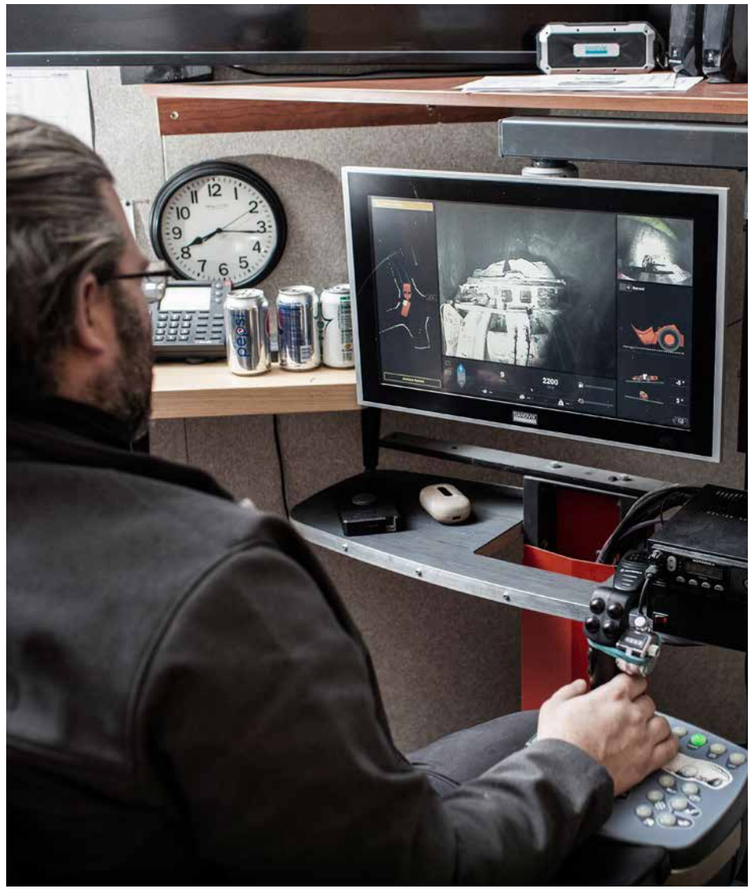
"That represents 42 buckets that didn't need to happen during regular operation," Nord says. "That KPI led to a freeing up of resources around the loader to shift elsewhere where they were needed. We free up personnel hours to do other work that needs to be done.

"Once the mine ops group saw that it was reliable and able to produce these tonnes when no other activity was going on underground, that's when people really started to get the vision of why we were doing this," he says. "Now folks are like, 'Hey, you know, this is working, this is good, what else can do we do with this?'"

Kensington's main limitations for AutoMine operations revolve around loader and operator availability, and sequencing with drilling also remains a challenge.

"With AutoMine, we've turned several

Implementing operational efficiencies at Kensington helps offset higher operating costs at the remote site.



With AutoMine, Kensington has turned several hours of previously unproductive downtime every day into a boost to their tonnage rates.

hours of previously unproductive downtime every day into a boost to our tonnage rates," Nord says. "While there have been challenges applying automation to our drill and blast stoping method and in current workings that were designed without any consideration for automation, the system now functions beyond original expectations. With proper training, improved support from Sandvik and familiarity with the equipment, our automation team has seen a drastic improvement in utilization and a marked decrease in work stoppages," Nord says. "Sandvik has supported us well in our automation journey, with some small hiccups and challenges along the way. AutoMine has a lot of benefits. The learning curve and cultural acceptance challenges are not insignificant but can be managed, and once implemented, we believe it can improve safety and productivity."

Now that Kensington has overcome challenges of shoehorning loader automation into established mine workings not designed for the technology and proved the benefits of AutoMine, the mine is looking forward to generating even more value from automation in the years ahead. As mining begins in the Elmira deposit 800 metres east of the Kensington main deposit in 2023, Coeur Alaska has planned and designed the new ore body specifically around automation to maximize the benefits.

"Engineers now look for opportunities to incorporate AutoMine in all new production designs, giving us the flexibility to utilize automation to move material more efficiently," Nord says. "We are currently implementing an automated loading system with Elmira, where we believe we can capitalize on automated muckers during shift for an ongoing benefit. As we continue to expand the role of automation, the cost benefits and cycle time gains are expected to become even more significant."

KENSINGTON IS ALSO exploring a truck transfer level application for AutoMine in the new deposit.

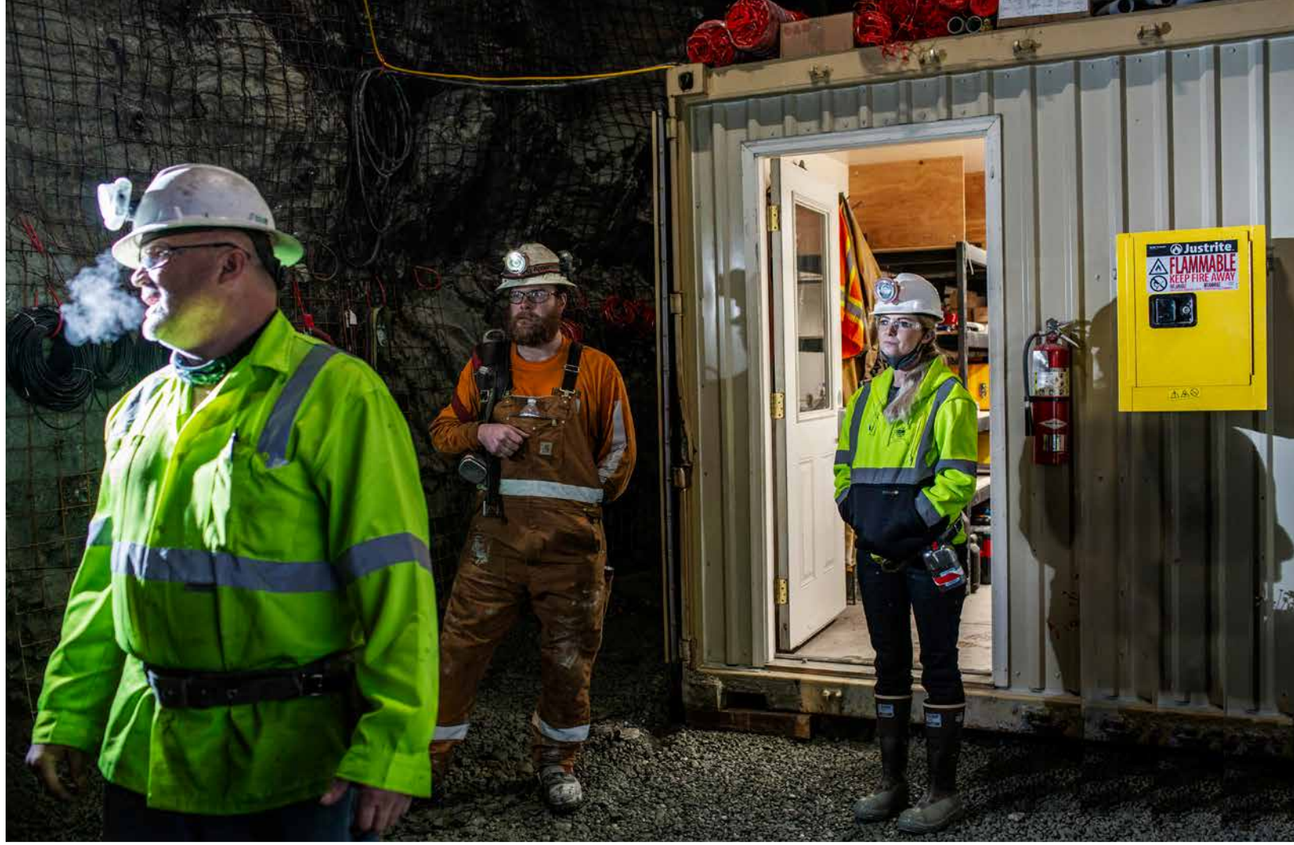
"We've done the design work to incorporate the aspects of automation that we believe will make it a more intelligent design and it'll make it more cost efficient," Kiessling says. "We're really excited about that opportunity, not only from a loading standpoint, but potentially from a haulage standpoint and advancing the concepts of automation in this new mine."

Automation has already helped improve safety and productivity and reduce costs at Kensington, and the scalable technology has further potential to improve the economics of existing and yet-to-be-identified ore bodies.

"The fantastic thing about it is that using automation and using those efficiencies, being able to mine during shift change and being able to mine smartly and control multiple machines has the potential to lower our cost structure and allow us to take material that may have been marginal before and allow us to lower our cutoff grade and potentially pull that material into the mine plan," Kiessling says. ■

COEUR MINING

Coeur Mining, Inc. is a US-based, well-diversified, growing precious metals producer with four wholly owned operations: the Palmarejo gold-silver complex in Mexico, the Rochester silver-gold mine in Nevada, the Kensington gold mine in Alaska and the Wharf gold mine in South Dakota. In addition, the Company wholly owns the Silvertip silver-zinc-lead development project in British Columbia and has interests in several precious metals exploration projects throughout North America. Coeur produced 348,529 ounces of gold and 10.1 million ounces of silver in 2021.



Automation has already helped improve safety and productivity and reduce costs at Kensington.

SMART PARTS

For millennia, humankind has made use of subtractive and formative technologies, such as casting, forging and turning, to make useful products out of metal. Now there is a new alternative: additive manufacturing, also known as additive shaping or 3D printing. Sandvik is scouting this novel territory to optimize its global supply chains and to offer new advantages to its customers.

TEXT: **TURKKA KULMALA** PHOTO: **SANDVIK**

ADDITIVE MANUFACTURING (AM) is clearly an enabling technology with major potential in terms of benefits such as lower material use, lower tooling costs and shorter lead times. The value of AM parts is expected to grow at a compound annual growth rate of 15 percent, from USD 12 billion in 2020 to USD 51 billion in 2030. This alone makes it understandable that Sandvik sees AM as a potential tool for optimizing global supply chains.

With its longtime world-leading position in metal powder and the widest range of AM alloys on the market, Sandvik has, since 2013, made sizeable investments into a broad range of AM printing technologies. In 2019 Sandvik acquired a significant stake in BEAMIT, the first AM hub in Europe. Together, both companies have leading expertise across the entire AM value chain.

"You need to have real value to shift from conventional manufacturing to AM. The overall focus is on finding the right application technology for your organization and then prove it on business case," says Abhijit Bhalgat, deputy general manager for parts sourcing in India, Sandvik Mining and Rock Solutions. He has led this additive manufacturing initiative of Sandvik Mining and Rock Solutions since November 2017 and, together with his team, redesigned the parts for AM and calculated and validated the business cases to ensure value addition by shifting from conventional processes to AM and implementing it into serial production.

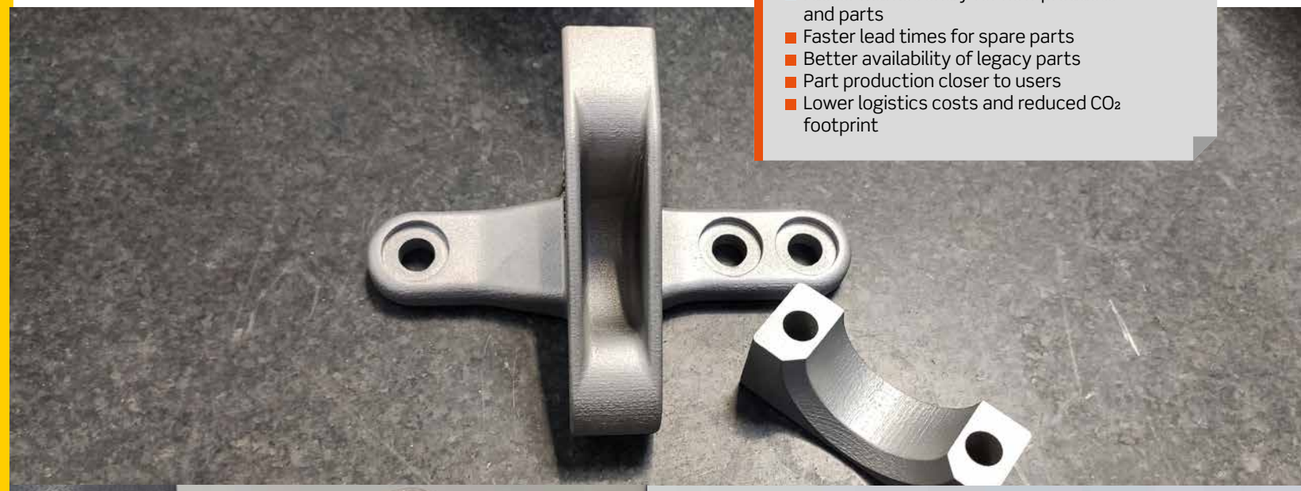
The value challenge is that a simple replication of parts designed for welding or casting by AM will almost invariably result in a prohibitive cost, mainly due to the higher hourly production cost and more expensive materials. The challenging cost structure must be justified with substantial benefits. A business case for AM exists when it creates a unique advantage in terms of productivity, lead time or logistics, or enables a complex geometry that is not achievable with conventional processes.

THE KEY TOOL to achieve this is topological optimization, in other words redesigning the part to remove any unstressed, non-functional masses and leaving only the structures necessary for transiting loads. This can cut back the weight of the component by 50 percent on average, and in some cases up to 85 percent.

Another key factor for the feasibility of AM is the number of components to be produced. The shorter the production run, the more

BENEFITS OF ADDITIVE MANUFACTURING PARTS

- Faster market entry for new products and parts
- Faster lead times for spare parts
- Better availability of legacy parts
- Part production closer to users
- Lower logistics costs and reduced CO_2 footprint



According to Abhijit Bhalgat (right), deputy general manager for parts and sourcing at Sandvik Mining and Rock Solutions, value is the key to switching to AM.

relevant AM is because the economies of scale inherent in conventional technologies require large production quantities. Conversely, the possibility to eliminate most of the conventional tooling costs can be crucial in low-volume parts.

"The objective of Sandvik's AM initiative was to improve our customer service as well as to explore the added value this technology can bring in individual business cases," Bhalgat says.

ANOTHER DRIVER WAS the heavily localized geographic footprint of spare parts production: 92 percent of Sandvik Mining and Rock Solutions' spares are made in the EU and North America, with Finland alone accounting for 50 percent. However, the primary markets are in Australia, South Africa, the Americas, Russia and India. Combined with a long tail of legacy parts sourced on a case-by-case basis, there is clearly an incentive for leaner logistics.

Moreover, AM creates possibilities to ensure availability by reducing the risk of any existing parts supplier going out of business or losing interest in a low-volume part. End-of-life-cycle components and slow-moving items are less price-sensitive, so the cost premium linked with AM is less of an issue. The project also aimed to reduce spare parts inventories and net working capital by cutting back on unnecessary stock and avoiding minimum order quantities. Having AM closer to end users also helps to shorten supply chains, reduce lead times and trim logistical costs, including warehousing and customs fees.

Bhalgat's team screened and analyzed roughly 15,000 proprietary SMR parts with an annual volume of less than 10 for their AM potential.

The catalogue boiled down to 140 shortlisted parts with the greatest potential for AM, which were then screened even more closely to around 40 viable business cases. Sandvik's Bangalore Design Centre in India redesigned the parts for AM together with BEAMIT Group, and production has taken place at BEAMIT's European facilities.

The results were impressive: the average weight reduction was 25 percent, yielding a similar cost reduction because logistics costs are directly proportional to the weight.

Another win was in sustainability. With an average shipping distance of 11,000 kilometres, bringing parts production closer to the end users makes business sense and yields environmental benefits. Factoring in the carbon emissions data per air mile and average annual sales, the achievable emissions reductions average roughly 50 percent, ranging between 17 percent and 75 percent.

Yet another major benefit is a significant reduction in lead time, on average 37 days. This means parts can be delivered around 50 to 70 percent faster, and also increases component efficiency, which leads to energy consumption reduction and performance enhancement.

A great example was a fuel tank cap where brass was replaced with aluminium, yielding a total weight reduction of 78 percent. The added benefits included branding with the Sandvik logo and having the part number printed on the cap.

Some challenges still remain to be tackled. A hydraulic manifold was light-weighted by 82 percent, from 36.55 kilograms to 6.65 kilograms. But despite the impressive results, successful field tests and positive feedback, the added cost was not viable.

What comes next? "The AM screening project is now advancing to its second phase," Bhalgat says. "We will fine-tune the criteria and ignore parts approaching the end of their life cycle. This will leave us with some 5,500 parts with the most potential for a reanalysis."

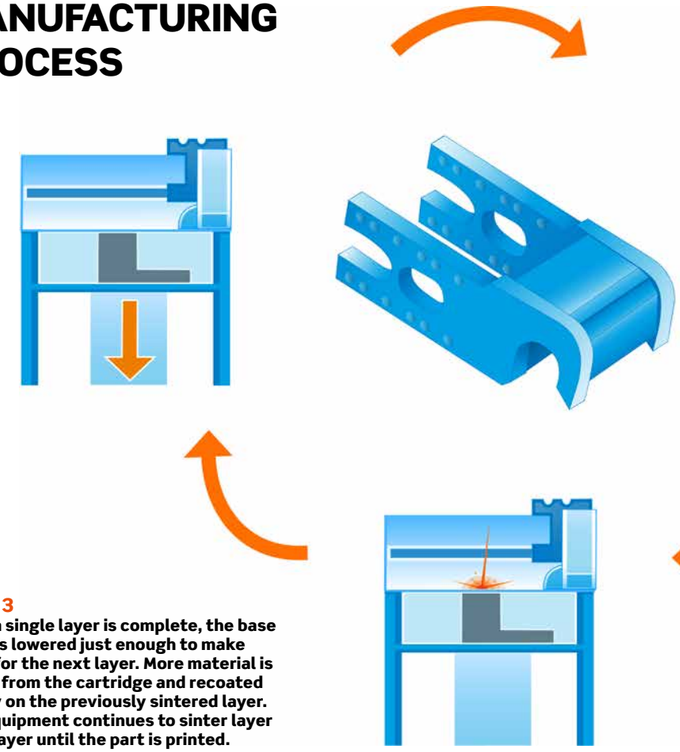
AM is a rapidly evolving technology and likely to expand significantly within the next 10 or 15 years. Where does Sandvik see itself in all this?

"AM technology is evolving very rapidly and still has to develop a lot in order produce larger, faster and more consistent parts at an economical price," Bhalgat says. "As an end user, the biggest challenge is to have a viable business case. The industry, including equipment and powder manufacturers, universities and other research institutions are working on the current limitations, and the technology is expected to mature in the next decade. By then, we will be ready to use it at full strength. Ultimately the aim is to convert around 5 percent of our inventory, some 3,000 individual parts, into additive manufacturing by 2030." ■

3 KEY PROCESSES FOR METAL

- **Powder bed fusion**
  Currently most reliable, dominant technology
  No post-process sintering
- **Direct energy deposition**
  Big components, on-site repairs
- **Binder jetting**
  Evolving upcoming technology
  Lower cost, faster
  Requires separate post-process sintering

ADDITIVE MANUFACTURING PROCESS



STEP 1
Once the 3D data of the part is transferred to the AM equipment, a recoder assembly pushes powdered metal material from the powder supply to create a uniform layer over the baseplate.

STEP 2
A laser then draws a 2D cross section on the surface of the build material, heating and fusing the material until that layer is complete.

STEP 3
Once a single layer is complete, the base plate is lowered just enough to make room for the next layer. More material is raised from the cartridge and recoated evenly on the previously sintered layer. The equipment continues to sinter layer upon layer until the part is printed.

Sandvik and Boliden partner to trial additive manufacturing

Swedish mining and metals company Boliden has partnered with Sandvik Mining and Rock Solutions to run a trial with machine parts printed digitally and installed on underground drill rigs.

The trial with Sandvik involves a set of specially redesigned components additively manufactured at a Sandvik-managed facility in Italy, with their performance being monitored on machines in Boliden's underground mine worksites — first at the company's Garpenberg mine in Sweden and then at a site in Ireland.

One of the many benefits of digitally printed parts locally is that parts get to customers much faster and far more sustainably. Maintenance and repair operating items (such as the bushes, brackets and drill parts that customers need to change every 3,000-4,000 hours) will be the first items digitally printed.

The Expert

Max Planck once said that "science advances one funeral at a time". His point was that for any progress to be made in scientific endeavours, old thinking must be put to rest. Such is the case with electrification. Dr Nesimi Ertugrul, an associate professor at the University of Adelaide's School of Electrical and Electronic Engineering, shares his thoughts on why the time is ripe for the change to electric at mine sites.

Q: . CAN YOU EXPLAIN WHAT YOU MEAN WHEN YOU SPEAK OF A SYNERGY BETWEEN GRID TRANSFORMATION IN DOMESTIC POWER NETWORKS AND MINING POWER NETWORKS?

A: That synergy is based on the development of autonomous microgrids with distributed energy resources, primarily using renewable energy. Most mine sites are in remote areas and only few of them are connected to the domestic power network, but even then, usually via long transmission lines.

Therefore, it is logical to develop stand-alone microgrids with renewable energy (solar and wind, and possibly with hydrogen in the near future), which can eliminate the limitations of the centralized network approach. Since microgrid structures are already shaping grid transformation, they can form the power grid in mine sites without significant modification.

Furthermore, electricity infrastructures and operational and maintenance costs of mine sites heavily involve diesel engines and generators, which have an impact on the cost of energy. Mine microgrids can respond to such limitations while supporting a 100 percent renewable powered transformation.

Electricity transformation of the grid by the integration of renewable energy sources, along with maturity in battery storage solutions and electric vehicle technologies, have accelerated mine electrification. While several commercial electric machineries and battery vehicles are already available for mines, some hydrogen-powered vehicle trials are also underway for large-haul trucks on mining sites.

Q: WHY DO YOU THINK THAT NOW IS THE PERFECT TIME FOR ELECTRIFICATION, PARTICULARLY AT MINE SITES?

A: It's probably about the advances in power electronics, which is the enabling technology in renewable energy and electric transportation systems. In all applications involving power electronics, similar circuit topologies use semiconductors to convert electric power to perform specific tasks. For example, in a microgrid application, a bidirectional converter can charge a battery or feed an electric load, and an identical converter can also charge the battery in an electric vehicle when it is stationary or drive an electric motor (or control it as a generator during braking) when it is mobile. In addition, the advances in semiconductor switches (specifically development in wide bandgap devices) enabled the development of high-power density (volumetric and gravimetric) converters at low cost. Therefore, the mature products of power electronics naturally became available in mining equipment.

Q: WHAT BENEFITS ARE AVAILABLE TO MINERS CONCERNED ABOUT THE COST OF ELECTRIFYING THEIR EQUIPMENT?

A: We can't underestimate the reduction of carbon emissions as a driver for change from combustion engines in mining equipment.

However, I believe that the major benefit for conversion to electric in mining is about the improvements and opportunities in system efficiency and ease of control. Diesel engines have an efficiency not more than 35 percent at rated load (at rated speed and torque) and much lower at light loads. It should be emphasized here that at low efficiency, significant heat and high emissions (diesel particulate matter) are produced as well. However, electric motor and drive efficiency can be more than 80 percent in a wide range of loads. In addition, in the mining industry, uptime needs to be maximized. Electric motor drives have several other benefits to miners, including low noise and vibrations, increased reliability, fewer mechanical components and reduced maintenance and service cost. Furthermore, the electrical systems make the monitoring of mine activities for process control and fault detection seamless and easy, which is critical for future mine sites.

Q: HOW DIFFICULT IS THE RESKILLING OF STAFF AFTER MINE ELECTRIFICATION HAS COMMENCED?

A: It is both difficult and easy, but most of all necessary. Not all mine workers need to have a similar level of knowledge on electrification. At the highest levels, mine owners must be convinced of the value of electrification, so they need to have the knowledge of how the overall integration works. Ground-level engineers, however, must be trained on a number of fronts, including power electronics, motor drives and microgrid system components and control. At the University of Adelaide, we are already training students to be ready for these new electric realities. Therefore, we have instituted a variety of programmes to help the future workforce in the field. As a part of these, we have developed courses covering all modern distributed energy technologies. We have also created the Australian Energy Storage Knowledge Bank, where we share modern microgrid platforms with utility-scale battery storage. In addition, we are leading the mine electrification programme of the Future Battery Industries Cooperative Research Centre in Australia, which also aims to train the mining community at large.

Small steps bring big changes

Sandvik Mining and Rock Solutions runs various training programmes around the world to help local people become service technicians. Run in different ways and with different areas of focus, each initiative shares the aim of bringing new perspectives and competences into the company, while also supporting the communities where it operates.

TEXT: **DANNY CHAPMAN** PHOTO: **SANDVIK**

OVER THE PAST few years, numerous Sandvik Mining and Rock Solutions sales areas around the world have been developing specific local initiatives and solutions to bring new competences, and in particular new perspectives, into the company. The initiatives involve engaging directly with the local communities where Sandvik Mining and Rock Solutions has its operations. And many involve collaborations with local technical schools.

"Working with local schools and universities comes quite naturally to the markets," says Ann-Sofie Gustavsson, previously global director learning and development, Sandvik Mining and Rock Solutions, "because these are the best places to find and recruit new people. But another key aim of these programmes is to help make sure that we widen our recruitment base.

"We have a very male-dominated industry," Gustavsson says. "But we can broaden our gender perspective or ethnicity perspective by encouraging people from these backgrounds to join us via our various training initiatives. In India, for example, there is work underway to bring more women into the organization. While in Canada, the sales area has done a great job to set up initiatives with local indigenous people."

Some sales areas have been running training programmes for several years. In Ghana, the Sandvik Mining and Rock Solutions sales area has been running internships and graduate training programmes in collaboration with universities since 2008.

With the experience they have gained in recruiting new service technicians from the local area, Gustavsson says, the sales area in Ghana is now able to focus on encouraging more women to become service technicians. "We don't always need to develop something new," she says. "We can sometimes use an existing process but change it a little to make it more attractive for a broader base of people."

AS WELL AS working with students, Sandvik Mining and Rock Solutions is engaging with even younger people in some countries. "Our division in Austria has been exposing preschool-age kids to the world of mechanical cutting," says Gustavsson. "I still have a small girl's words singing in my ear, 'I will be a mechanical engineer when I grow up' and that is something that is really positive."

It is through this kind of engagement that Sandvik is helping to ensure that there will be a diverse talent pool for the future to draw from. But Gustavsson also stresses the importance of working with the local communities where Sandvik operates.

"It is important from a sustainability point of view and a corporate social responsibility point of view," she says. "We need to make sure that we support the local communities. And there are many ways through training that we can give something back. In India, for example, we have run a training programme for our female staff on financial independence. These women then take that back to their community, as well as other values and ways we work in Sandvik, and they talk with their friends and family in the community about this.

"There are changes happening," Gustavsson adds. "In India we have recently recruited our first female managers. These are small steps, but many small steps will bring about big changes. And our training programmes to recruit new local talent are an important part of this." ■

Canada

Mexico

Brazil

Indigenous collaborations in Canada

A BRAND NEW Sandvik Mining and Rock Solutions training programme has been developed in Canada in collaboration with the indigenous communities that live near new mines being established by Sandvik's customers.

As resources are depleted in historic mining regions, new mines are increasingly being developed in remote regions of Canada, such as Nunavut, a vast but sparsely populated territory in the north of around 40,000 mostly indigenous people. Finding skilled people to work in mines in this region is challenging.

"Local talent is an obvious option," says Dan Gauthier, Sandvik Rock Tools business line manager, Canada. "It makes it easier to get our people to our customers, which contributes to our 'making the shift' purpose of becoming a more sustainable organization. It also helps us build relationships within the communities where we operate to develop a sustainable talent pool. And diversity within our workforce brings in different experiences and points of view."

To engage the local community in Nunavut, Gauthier and his team first held a job fair to explain what job opportunities there might be at Sandvik for local people, and how the community could directly benefit from the growing mining industry.

"The community leaders provided us with marketing and resources to host the job fair to start things off," Gauthier says. "Following that, we were able to work out an arrangement where we would provide training and equipment and the community would provide us with facilities and help promote the programme."

A GROUP OF around 12 people are now expected to enrol in the first session, which is scheduled to begin in 2022. "We hope to conduct quarterly sessions with groups of six to 10 going forward," says Gauthier. "The participants will gain introductory knowledge in the products that Sandvik provides while also learning how to safely use the equipment to service these products. They will develop transferable skills that are not only limited to Sandvik, providing the local community with additional employment alternatives." ■

Mining for talent in Mexico

SANDVIK MINING AND Rock Solutions has been collaborating on training programmes with different technical schools in the mining regions of Mexico since 2007. More than 150 students have been trained and another 36 students will become new service technicians this year.

"The market in Mexico for our business is very challenging in terms of finding people with the technical knowledge we need," says Julio Guzman, Human Resources Sandvik Mining and Rock Solutions Mexico, who is in charge of the training programmes. "So we invest in six-month programmes to give recent graduates their first work experience."

The schools that Sandvik collaborates with in Mexico prepare the students with general knowledge and then provide a list of candidates who match Sandvik's technical profile. Sandvik then presents the programme to them to see if they are interested.

The training covers safety, health and the technical skills required to work with Sandvik products, mainly in preventive maintenance. Each student is assigned a tutor who gives direct feedback on the activities they are doing.

"The students obtain knowledge and work experience that will help them to have a successful start in the company," says Guzman. "It has become a very strategic labour source for us. But it helps the students have a career within Sandvik or outside it. So we are providing development and job opportunities for the local community beyond Sandvik."

Guzman adds that they are also now trying to increase the balance between women and men. They have adjusted their advertsiments to be attractive for both genders, and they have started a campaign which focuses on inclusivity. "Now, as result of our efforts, for the first time we have two women starting the training course at once."

Lilian Escobedo is the only female service technician to have completed the Sandvik Mining and Rock Solutions Mexico training programme. "After studying mechanical engineering at university I received professional development at Sandvik, performing in different positions of the maintenance area within the company. The training helped me to obtain basic technical knowledge, such as reading hydraulic, electrical and symbology diagrams, and it enabled me to integrate more quickly into the realities of work. I started working in the workshop as a technician rebuilding equipment. I am now working as a programme planner for the service contract area. I have achieved much more in my career than I imagined, thanks in part to the learning obtained on the courses with my instructors." ■

Diversity at Brazil's Sandschool

AT THE SANDVIK Service Centre in Vespasiano, Minas Gerais, Brazil, new facilities have recently been created to provide an in-house training programme for new Sandvik technicians. The first 12 participants completed their training at the new Sandschool in December 2021, after which they started work with Sandvik in different regions of Brazil.

As well as providing participants with a career development plan with full Sandvik support, the new training programme in Brazil also provides Sandvik with a new diverse labour force.

"The Sandschool programme is, and will continue to be, an opportunity to bring more diversity, equity and inclusion to Sandvik," says Luciana Gomes, human resources coordinator, Sandvik Mining and Rock Solutions, Brazil.

"We are strongly committed and aware of our social responsibility, the importance of developing the workforce, generating jobs and contributing to the economy of the locations where we operate," adds Gelio Figueredo, parts and service business line manager, Sandvik Mining and Rock Solutions, Brazil.

The full-time training programme was developed with Parts and Services Division support. Theoretical training is taught by experienced Sandvik technicians, and practical classes are held at the Vespasiano Sandvik Service Centre, whose facilities include an equipment monitoring centre, professional training centre with Sandvik simulators and an optimized workshop.

The Sandschool programme in Brazil offers an opportunity to bring more diversity, equity and inclusion to Sandvik.

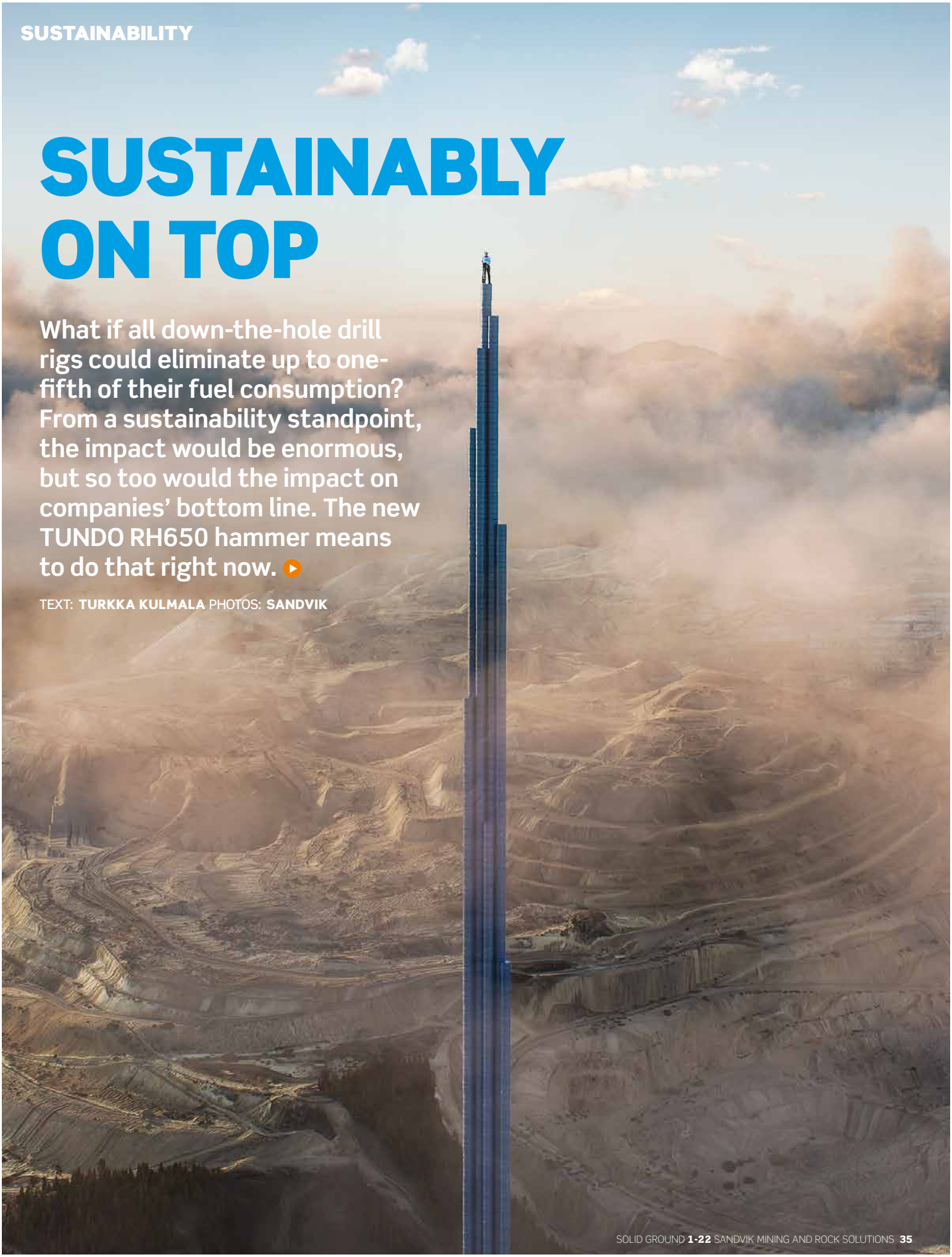
"To select the participants, we advertised the training and then looked for the most diverse profiles that fit our purpose and core values," says Gomes. "The focus on women participants was essential to achieve the programme's objective, because in the mining industry we still have a predominantly male workforce. Inclusion is important for our industry sustainability and innovation. And Sandvik will benefit by having diverse talent who will contribute to the solutions that our customers need."

Abdel Ananda is one of the Sandschool participants. "I have technical training in industrial mechanics and a degree in logistics," he says. "I started my professional career in 2012 as a young apprentice in the mining industry. Since then, I have specialized in maintenance planning for heavy equipment. I applied to join the Sandschool programme because I was looking for technical knowledge to specialize in maintenance services in the underground mine fleet. I hope to gain an opportunity for professional growth and financial stability to take care of my family." ■

SUSTAINABLY ON TOP

What if all down-the-hole drill rigs could eliminate up to one-fifth of their fuel consumption? From a sustainability standpoint, the impact would be enormous, but so too would the impact on companies' bottom line. The new TUNDO RH650 hammer means to do that right now.

TEXT: **TURKKA KULMALA** PHOTOS: **SANDVIK**



ENGINEERS ARE CURIOUS creatures. They like to tweak and tinker with their products on a never-ending quest for a simpler, more elegant solution. Always aiming for better productivity at a lower cost and reduced emissions, of course. Sometimes the improvements are gradual, and sometimes the new approach offers a revolutionary leap in efficiency.

Revolution is a big word, but it's not so far-fetched as it might sound when talking about Sandvik Mining and Rock Solutions' latest innovation in down-the-hole drilling: TUNDO RH650 DTH hammer.

It all started from a crude pencil sketch on graph paper and a simple question: What if we use a solid piston in a DTH hammer instead of the conventional hollow design, making it possible to substantially decrease the length of the piston?

This might sound like a minor finesse of production engineering, but it is not. This is because the design of the piston dictates the air cycle of a DTH hammer, and the air cycle is directly linked to the compressed air consumption, which in turn determines the load on the drill rig's compressor.

The load on the compressor goes hand in hand with the fuel consumption.To have a hammer that can deliver the same power, but at lower air flow requirements, therefore translates into lower compressor loads, and thus leads to fuel savings. The new solid piston hammer does exactly that. It can run at lower airflows and still maintain high pressure and deliver high penetration rates. If the compressor allows for higher pressure (30 bars) you can get additional productivity gains compared with conventional hammers.

> **TUNDO is a truly remarkable step in DTH drilling and something to be proud of**

"Solid pistons enabled us to design a compact, high productivity hammer," explains Johan Bergquist, product manager, DTH Hammers, Sandvik Mining and Rock Solutions.

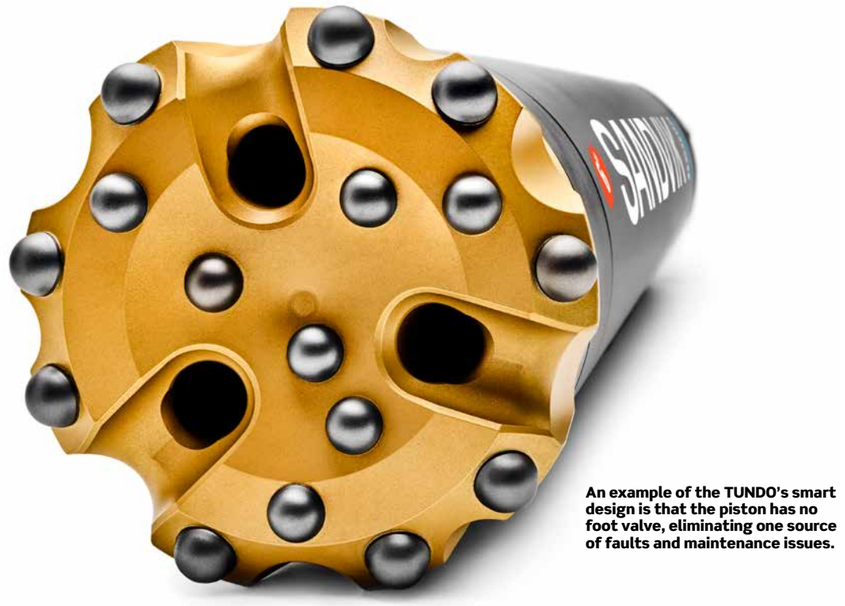
In other words, this new solid piston design results in a smaller, lighter hammer – roughly 20 percent shorter than a comparable standard DTH hammer. The weight reduction, which is proportional to the length, is similarly around 20 percent.

Both drill rig operators and maintenance crews will certainly be glad about the smaller size of the hammer, as it means easier and safer handling. Smaller, lighter DTH hammers are also less costly to transport. In fact, less is more in virtually any area over the life cycle of a DTH hammer, and not least in the CO_2 footprint, which is reduced in life-cycle stages of the hammer, ranging from manufacturing through all the operational stages until it is discarded.

Elegance in engineering also means simplicity. One example of this in the new TUNDO RH650 is the fact that the piston design has no foot valve, eliminating one source of faults and maintenance issues. The reduced air consumption of the hammer also makes it compatible with five-inch and six-inch drill rigs. Yet another improvement is a simpler design in the drill bit, where the change into a solid piston relocates the bulk of air flow into splines, providing superior lubrication.

The design of the TUNDO ultimately means easier and safer handling for operators and maintenance crews.

Even the CO_2 footprint is reduced in life-cycle stages of the Tundo hammer, from manufacturing to operational stages.



An example of the TUNDO's smart design is that the piston has no foot valve, eliminating one source of faults and maintenance issues.

FOCUSING ON THE most common six-inch DTH hammers, conventional designs require an air flow ranging between 23 and 25 cubic metres per minute at a 24-bar operating pressure, which generally necessitates a drill rig in the six-inch class. The standard five-inch rigs are generally not capable of producing this kind of air flow with flow and pressure. Here the TUNDO RH650 DTH hammer and its air efficiency change the game remarkably, thanks to the ability to downsize the drill rig to the more affordable five-inch class. In addition to the lower capex of a smaller machine, this means that the same productivity can be maintained with lower air consumption – again directly reducing both the fuel cost and CO_2 emissions.

Some mine operators or quarry owners may also appreciate the better mobility and easier relocations afforded by a smaller rig. If the choice nevertheless falls on a large six-inch rig, such as the new Leopard DI650i DTH, perhaps due to operational reasons, the new TUNDO RH650 DTH hammer offers significantly higher productivity at 30 bars.

TUNDO RH650 hammer's significant advantages were verified in comprehensive field tests, which included both conventional Sandvik DTH hammers and products from key competitors. The results show substantial reductions in air consumption compared with all comparable hammer designs, ranging from around 10 percent to more than 30 percent.

THESE KINDS OF percentages translate to substantial figures in fuel litres and opex dollars. Assuming a mine operating some 15 Leopard DI650i DTH drill rigs, each racking up 5,500 hours per year, the resulting reduction in diesel consumption would be 3.3 million litres. CO2 emissions would see similar reductions.

"You can never be totally satisfied in this industry, because the moment you fall too much in love with your product, the progress stops," Bergquist says. "And that's something we really can't afford, considering all the productivity and sustainability challenges our customers are facing. But TUNDO is truly a remarkable step in DTH drilling and something to be proud of. For a moment, I think we can just be really happy about it. Until we make something even better." ■

TUNDO RH650 DTH HAMMER – BENEFITS

- Enables drill rig downsizing: lower capex
- Boosts drilling productivity: more metres drilled
- Lower fuel consumption: major cost reduction, lower CO_2 emissions
- Lighter and shorter design: easier and safer handling, lower CO_2 emissions from transport.

Glowing jellyfish

Aequorea jellies **have a green fluorescent protein that a team of researchers from the Chalmers University of Technology in Sweden isolated onto electrodes and exposed to ultraviolet light. The result: electricity.**

Really alternative energy sources

EVERYWHERE YOU LOOK, people, places and organizations are moving towards using renewable energy alternatives instead of scarce fossil fuels that emit CO_2. At Sandvik, we've formally committed to cutting our CO_2 emissions to net zero by 2050 at the latest.

And while solar and wind are abundant, carbon-neutral energy sources, they are not necessarily best suited for every scenario, such as an underground mine.

Where should we look for the next clean, abundant energy source? A lake? Dancefloor? Toilet? Yes, yes and yes. Some ingenious minds in the scientific and industrial communities have been busy researching uber-alternative energy sources, and you may be surprised at what they've uncovered.

HERE ARE FIVE unusual, unconventional and downright cool ways to generate energy in the 21st century. ■

Feces

As unpleasant as it sounds, feces contains methane, which can be used as a natural gas (no pun intended). Officials from the UK estimate that waste from only 70 homes could generate enough fuel to drive a car for more than 16,000 kilometres.

Exploding lakes

Yes, you heard me. There are three of them in the world and they are very dangerous. Trapped methane and carbon dioxide threaten to bubble to the surface if the water's temperature rises, which would have fatal effects on the people and wildlife living close.

Lake Kiwu in Rwanda is one such place, but the government has built a power plant that guzzles these gases to power three large generators, which produce 3.6 megawatts of electricity, almost enough to power a third of the country.

People

The heat generated by the human body can warm an office building, house or subway station — at least, that's how Swedish property administrator Jernhuset is using it. The company is capturing body heat from subway passengers passing through Central station to heat water, which is then pumped through the building's ventilation system.

(Good) Vibrations

At Club Watt in Rotterdam, the Netherlands, floor vibrations from dancers are powering the club's light show. Captured by "piezoelectric" technology, the vibrations produce an electric charge when put under pressure, giving new meaning to electric moves.

LEOPARD™ DI650i
TIME FOR A NEW LEADER

Our Leopard™ DI650i down-the-hole surface drill rig delivers long-term productivity and superior stability with robust and reliable main components – seamlessly integrated with scalable automation and state-of-the-art technical solutions.

Explore the new Leopard™ DI650i:
ROCKTECHNOLOGY.SANDVIK/DI650i

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