Metso made it possible to extract more profit per ton of rock by being smart about it.

That’s how we make the big difference, the Metso Way.

At Antamina, our process experts helped our customer analyze the impact of different ore types on production and product quality. Using Metso’s unique SmartTag™ ore tracking system they helped our customer develop a more efficient, integrated solution. This made it possible to increase production by 30% and reduce energy consumption by 20%.

Find out more about the Antamina mine optimization and how Metso makes the big difference at metso.com/showroom/mining

#TheMetsoWay
“Our bottleneck used to be the SAG mill’s liner change, but now that’s just another maintenance job among the rest.”

ANTONIO GÁMIZ
Plant Technical Director
Minas de Aguas Teñidas

METSO HAS DELIVERED six track-mounted Lokotrack® jaw crushing plants to Shimizu Corporation to assist in a major landfill project being carried out in the 2011 tsunami area in the Tohoku region of Japan. The new-generation LT120™ jaw crushing plants are expected to crush 6-7 million tons of aggregates on a demanding project schedule.

The earthquake and tsunami caused significant sinking of the ground level in several coastal areas in the northern part of Honshu Island. Before new construction works can begin, the level has to be raised by several meters with aggregates.

Shimizu is a major Japanese civil engineering and general contracting company specializing in post-tsunami civil works planning and execution. The LT120 plants were sold by Metso’s Japanese distributor UBE Machinery Co. Ltd., who will also take care of the service and parts related tasks.

Metso has signed a three-year life-cycle service agreement with First Quantum Minerals’ Kevitsa copper and nickel mine in northern Finland.

The AIM of the partnership is to reduce production downtime associated with grinding mill liner changes and maximize grinding efficiency over the life of the contract. “This solution will raise our utilization rate to a new level and will contribute significantly to our sustainable competitiveness in the challenging market situation,” says Timo Ikäheimonen, Planning Manager at FQM’s Kevitsa Mine.

As part of the life-cycle service agreement, Metso aims to increase the time between shutdowns through optimization of wear parts selection as well as decreasing the duration of shutdowns. Metso will take complete responsibility for the supply, installation and optimization of the mill liners.

Thanks to the fast installation process of Metso’s Megaliner™, downtime is reduced. Additionally, the use of Megaliner parts in grinding mills increases work safety since the attachment parts are installed from outside the mill.
I am not an expert on the macro economy, but the consensus view seems to be that global growth is slowing. This is heavily weighing on global commodity prices, at least on metals and oil. The outlook for the aggregates industry varies by region, but, in general, the level of activity correlates with the GDP. In times like these, it comes down to making operations more efficient and having the most capable and competitive partners and suppliers.

We have a global services network, a wide offering and deep industry knowledge to help you find the best solutions for your needs, solutions that improve productivity and reduce operating costs, all in a safe manner and in close collaboration with you.

I hope you enjoy reading about our solutions featured in this magazine. Let’s work together to find a solution that works for you. Don’t hesitate to contact us! In challenging times, you know who your true friends are.

PERTTU LOUHILUOTO
President, Services
(as of July 23, 2015)
THE NORDBERG® HP5™ CONE CRUSHER, like other new crushers in Metso’s Nordberg HP series, enables you to produce much finer products using fewer crushing stages, thereby lowering capital and energy costs. With a combination of optimized speed and a large throw, the HP5 provides the highest cone crusher reduction ratios on the market.

The HP5 delivers maximum power utilization per cone diameter, resulting in savings through a lower energy consumption per ton of end product and a lower recirculation load.

The advanced mantle and bowl liner fastening system eliminates the need for backing material and makes liner changes faster. Thicker liners mean more material to wear.

The HP5 cone crusher is also easy to disassemble: all components are accessible from the top or side.

In addition to being fitted with the latest in high-efficiency motors, the HP5 offers a higher output of finished product using the same amount of power.

The result is improved overall efficiency, and, as a bonus, lower carbon dioxide emissions, making it the most environmentally friendly crusher on the market.

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Introducing the latest Metso innovations sure to make a big difference to your operations

New mill discharge pumps expand Metso’s mining pump offering

**METSO IS INTRODUCING** an all new range of mill discharge slurry pumps. These heavy-duty mining pumps combine experience and knowledge to meet the market needs and demands for better wear life, service and significant cost benefits. The Mill Discharge Metal and the Mill Discharge Rubber lined slurry pumps are specifically designed for mill circuit applications and ensure sustained efficiency and maximum time between mill shutdowns.

The extremely robust pumps feature high-performance materials that are resistant to abrasion, corrosion and erosion. Heavy sectioned castings and liners help maximize maintenance cycles. The advanced impeller design minimizes entrance losses, and the double adjustment feature ensures that front and back impeller clearance is maintained. The consistent hydraulic design limits the inlet velocity at the best efficiency point at a specified head. This decreases the impact damage from coarse and heavy solids and results in even hydraulic wear, which means maintenance is kept to a minimum and production is kept to a maximum.

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**Improved spiral dewaterer series covers more applications**

**METSO’S EXPANDED SDC SPIRAL DEWATERER SERIES** suits a wider range of process conditions and applications than ever before.

The compact SDC45 models are the latest addition to the series and are specifically designed to meet the requirements of smaller process conditions and new applications. The SDC45 range incorporates variable pool and dewatering sections that increase the ability to tailor the machine’s capacity to meet the challenges of limited and intermittent process flows and conditions.

Metso has also developed a smart capability for the larger SDC60-40/100 dewaterers. The smart capability enables controlling of the installed Lamella packages to meet a greater span of varying process feed conditions.

Spiral dewaterers are designed for the separation and dewatering of solids from high volumes of water. Traditional mill scale handling is a non-continuous operation involving separation in open scale pits or lagoons where settled solids need to be recovered by labor-intensive procedures – excavators and buckets. Metso’s spiral dewaterer concept replaces orthodox scale pit installations and provides a continuous material recovery operation.

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**SLURRY PUMPS | MDM & MDR SERIES**

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**LOW EMISSIONS AND HIGH DEGREE OF SAFETY**
An opportunity worth a closer look

Crushed sand
The demand for economical and efficient ways to produce crushed sand is growing, as natural sand deposits located near growth centers are depleted and environmental regulations are tightened. At the same time, many aggregates producers are studying the possibility to produce crushed sand and addressing what to do with the growing piles of quarry waste that may contain a fair proportion of saleable fine aggregates.

S THERE A SOLUTION that would benefit all parties involved? Rolands Cepuritis, an expert on the use of crushed sand in concrete production, and Tero Onnela, Crushing Process Specialist at Metso, delve deep into the topic.

CRUSHED SAND CAN REPLACE NATURAL SAND IN MANY APPLICATIONS | Sand – whether extracted from natural gravel or sand deposits or made by crushing bedrock – is used in many applications because of its mineral and physical qualities. The most typical application for sand is concrete, where it accounts for approximately 30-40% of the material volume.

Tero Onnela drills into the basics: “Concrete is the most common man-made material; you can find it everywhere. It is an essential element in the construction of infrastructure and in the building industry. Most of the Interstate road network in the US is made of durable concrete that withstands heavy traffic and changing weather conditions. Dams – like the Three Gorges Dam in China, where Metso’s crushing equipment has been used to produce aggregates – are the biggest structures made of concrete.”

“Asphalt, which is common in road and highway construction, is the second most important application. There are also the so-called functional aggregates that are used, for example, for water purification in water treatment plants, golf turfs and bunkers, at children’s playgrounds, horse-riding arenas, as well as on roads and sidewalks in icy climates to prevent sliding and slipping.

In all of these applications, it is possible to replace natural sand with crushed sand, and even improve the properties of the end product.”

NATURAL SAND IS A DIMINISHING NATURAL RESOURCE | The use of natural sand is regulated by law in many places and totally forbidden in some places, like Japan. Some countries, including Sweden, have called for crushed sand to be used in place of natural sand whenever possible. In Australia, the constraints relating to obtaining approvals for the use of natural sand are increasing, too.

Illegal sand mining has become an issue in some developing countries where demand is unbridled and the regulatory consequences are minimal. Selling sand is considered a quick way to make money with very little investment – all that is needed is a truck, a driver and a place from which to extract the sand. This is one of the reasons why India, among others, has established a sand policy to encourage the creation of new manufactured sand units by favoring them in the permit process for new quarries.

“I would say there are three categories of countries. Take Sweden, where you have a special natural gravel tax to regulate sand mining. Some other European countries restrict the opening of new pits by other means. Then there are countries, like India, Singapore and Malaysia, that have huge problems with non-existent or quickly diminishing natural sand resources. In these countries, sand is mined from open pits, beaches, and inland dunes and dredged from ocean and river beds to meet the increasing demand. Legislation is not always in place or is just not effective,” Rolands Cepuritis adds.

CRUSHED SAND IN CONCRETE PRODUCTION | Rolands Cepuritis is currently finalizing his PhD thesis on Development of Crushed Sand for Concrete Production with Micro-proportioning. He has a clear view of why crushed sand works well in concrete production:

“Concrete producers must meet certain minimum safety margins for the compressive strength of their products. The higher the variability of the raw materials, the higher the cement content needed to maintain a certain level of margins. Thus, at the end of the day, the cost of raw materials of a lower quality and lower variability is comparable to the cost of better quality materials, but of a variable quality.”

“With crushed sand produced in an engineered and controlled process, it is possible to achieve a stable quality. It is much more difficult to control the variability of natural sand, especially, if the sand is not washed,” he says.
The Norwegian Velde Pukk quarry uses Metso crushers and air classifiers to produce high-quality crushed sand that meets the strictest needs of its customers.

More on Metso Showroom:

Washing, however, is not always feasible due to problems like lack of space, availability of water resources, environmental issues from de-watering ponds and operational problems in places that experience freezing temperatures, e.g. in the Nordic countries.

“There are also other direct technical benefits from the use of the crushed sand. For example, natural sand grains are rounded as a result of weathering, whereas crushed sand particles are typically angular and of a rougher surface texture, enabling better bonding with the cement paste in concrete and thus providing improved strength properties at the same cement consumption (constant water-to-cement ratio).”

When you are developing a concrete product with natural sand, opportunities for improvement are scarce. But with crushed sand, there is a wider range of possible adjustments in the performance and you can find the best fit for different types of concrete.

A totally different hurdle is the acceptance of the use of crushed sand in the mix design. Queensland, Australia, for example, still requires 40% of the fine aggregate used in a concrete mix design to be made up of natural sand. This will need to change in the future to reflect the declining resource availability and improved availability of high-quality crushed sand products.

A BUSINESS CASE? | Legislation and availability of natural sand dictate the price of sand and thus profitability. There are also costs associated with obtaining the approvals, which can result in the resource not being economically viable to extract.

“Transportation costs from sand quarries contribute significantly to the overall cost of the product to the end user. If the end product is of higher value, like silica sand for glass manufacturing, higher transportation costs can be allowed.

Higher volume sand products with lower margins are a different case. The sand production site needs to be close to the location where it will be used,” Onnela explains.

“It’s a lot about economies of scale. If you have a good sand pit near the place of use, you just screen the sand to the right size. With crushed sand, you need to consider many other aspects. When crushing bedrock, production costs are higher and there are additional costs involved. Between 30-40% – and sometimes as much as 50% – of the crushed rock may end up in the quarry waste pile. The smaller the particle size and the softer the material quarried, the more waste that is generated. To improve profitability, you either need to reduce the amount of waste or figure out new uses for the fines,” Onnela clarifies.

“Particles <4 mm are often considered as waste, i.e. not good enough for any purpose. The material is often piled and, increasingly, producers have to pay waste fees for their piles. It would benefit all parties if fines could be used and sold for other purposes. In Finland, for example, this type of quarry waste can partly be used for surfacing driveways and yards.”

According to Onnela, making a business case is largely dependent on how the industry can develop and tailor the technical properties of crushed sand for different applications. It’s also a lot about educating and convincing the stakeholders about the good qualities of crushed sand so that it becomes acceptable and widely adopted. Naturally, pricing needs to be competitive.

“It is possible to use most of the rock for concrete production. A certain level of rock hardness is needed. Mica, which is difficult and expensive to remove, can also be a challenge. The question is: what does the market look like? Is there a lot of competition? In other words, is there a lot of sand available at a reasonable price?

“The quality of natural sand varies more than that of sand produced in an industrial process. Consistent quality is a typical
feature of crushed sand. Concrete manufacturers benefit from the use of sand that is of a stable quality because it allows them to use less cement, typically between 5-20% less cement. The decreased use of cement also benefits the environment through reduced CO2 emissions,” Onnela continues.

Cepuritis approaches the question with an illustrative case example: “Let’s take a case example from Norway. In this case, the transportation distance is short, less than 40 kilometers – both for manufactured or natural sand. The price for high-quality natural sand is 80-85 NOK per ton and the price for incomparable crushed sand as a by-product from coarse aggregate production is 30-33 NOK/t. There is room to spend money on improving the quality.”

“To add VSI crushing, you’d have to include 10 NOK/t in the production costs – and for fines classification, another 10 NOK/t. This would allow for a product with a higher profit margin. However, it’s not so straightforward: you also have to be able to invest considerable resources in the development of the whole process. The producer needs to work together with the customer and understand their needs – and do technical sales on a totally new level that is not typical to the aggregate market in general. It’s both a challenge and an opportunity.”

“Velde Pukk quarry in Sandnes, Scandinavia, is a good example of how to get the most out of the available raw materials. They operate within quarries, rock drilling, transportation, ready-mix concrete, floor sanding, landfill, asphalt production and paving, and also in the recycling of concrete and asphalt,” Onnela notes.

**CHOOSING THE RIGHT TECHNOLOGY**

“The production of crushed sand is usually a much more complex process than the simple extraction of natural sand. Stand-alone crushed sand plants are rare and the production is usually integrated with the production of coarse crushed aggregate,” Cepuritis explains.

“The exact layout of a crushing plant can vary. The production process usually involves several size-reduction stages, which include crushing, transport, size control and classification equipment.”

“In terms of the equipment, all the necessary technology is already there. Metso has lots of knowledge in this area and can provide valuable insight for customers considering the manufacturing of crushed sand,” Onnela says.

“Further development is always under way. The biggest gap is in the material technology for concrete. Until now, all text books have been written with the default assumption of using natural sand. Practical concrete technologists don’t understand the new crushed material or how to optimize its use. A lot of research has been done during recent years, but it hasn’t been applied much.”

“If you want to develop a crushed sand product at a quarry, you have to have a good understanding of the end material, i.e. concrete. You cannot just give a sample to your end customer – he will test it with current knowledge and, in many instances, fail. Instead, a much more direct technical sales approach is needed with the customer being educated in the possibilities of the new material and with lab trials conducted together – pretty much in the same way that concrete admixtures, for example, are typically sold,” Cepuritis concludes.
How can Metso help meet the challenge?

Metso has years of know-how in different solutions for sand processing and a good portfolio of related equipment.

HAPE IS A MAJOR ISSUE. This is where the crushing equipment’s role is critical to ensure an acceptable shape and size. Cone crushers, like the Metso Nordberg® HP™ and GP™ Series, enable the production of finer products together with coarser aggregates. They also lower the initial capital investment and save energy, due to the fewer crushing stages.

Metso’s HRC™ high-pressure grinding roll technology lends itself especially well to the production of sand. The inter-particle comminution method makes the cubical/angular product shape under the correct operating conditions.

Studies show that the best end product for various purposes can be achieved with high-velocity impact crushing. The Metso Barmac® VSI vertical shaft autogenous impactor improves the soundness and shape of the material and produces a quality that is very close to natural sand. Most other VSI crushers use metallic parts to crush rock, but the Barmac VSI uses the rock fed into the machine to crush itself. The better the end-product grain shape, the better its performance in concrete, asphalt and base mixtures. The rock-on-rock crushing and grinding action also provides the lowest cost per ton of any impact crushing method.

Classifiers are then used to remove the needed amount of fine particles and dust. Metso static Air Classifiers, which are environmentally friendly and economical to use, produce consistent sand quality.

IT ALL COMES DOWN TO END PRODUCT REQUIREMENTS | For concrete, there are two important demands. First, it needs to be easy to work with; it needs to have good workability. Secondly, it needs to reach the designed final hardened strength. Good, workable fresh concrete is easy to lay on a floor or cast pattern without too much physical effort. And the fresh concrete mass needs to stay uniform, without aggregate segregation or water bleeding. For asphalt and functional aggregates, there are grading specifications that must be met.

Fulfilling these demands requires the crusher product to be screened/classified. Sand top size, normally from 2 to 4 mm, is screened with vibrating screens. Rock dust/filler is classified most reliably by wet processing or by air classifiers. With concrete and asphalt sand, air classification is very suitable. Concrete sand can be tailored using two-stage air classification and mixing the classified filler back into the sand, if needed. In a basic case, one-stage air classification is adequate.

Dry asphalt sand is an economical solution that eliminates the need to evaporate water, which is an energy-intensive process in a hot mix asphalt plant.

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Go to Metso Showroom and find out how the Brazilian Incopel quarry is turning waste piles into profitable sand products with Metso’s HRC high-pressure grinding roll.

Scan the code or go to http://goo.gl/y3ckof
At Metso we believe that the look on a satisfied customer’s face when we have overcome their challenges is worth more than 1,000 words. The world of solutions that we deliver is truly our Showroom.

Our solutions for mining
A state-of-the-art expansion and less downtime at Minas de Aguas Teñidas ........... 12
New chute linings increase uptime at Doña Ines de Collahuasi .................................. 21
KCGM invests in reducing emissions .............................................................................. 22
Production up, processing costs down at RTB Bor copper mine ................................... 32

Our solutions for aggregates
Beira Rio’s successful upgrade ......................................................................................... 18
Lokotrack LT220D saves fuel and increases production .................................................. 28

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More capacity, less maintenance

A revival is under way in the ancient mining district in southwestern Spain. MATSA, a key player, is reaping the benefits of having invested in a flexible, energy-efficient plant expansion. Maintenance collaboration with Metso provides a finishing touch for the state-of-the-art process.

**TEXT:** Sofia Williams and Mary Pat Meier-Eglin  
**PHOTOS:** Aleksi Koskinen

**IMAGE:** Metso’s systems engineering team designed a new crushing and screening plant for MATSA. The delivery included Metso’s new Nordberg NCHD heavy-duty mining conveyors, designed for 50,000 hours of continued use.
SEE THE STORY ON VIDEO
http://goo.gl/UnvRuX or scan the QR code

The world is our Showroom
The line was designed with enough capacity to produce more than we need so we can store enough mineral to support whatever maintenance is on. And now we are happy with the results of the design.

ANTONIO GÁMIZ, PLANT TECHNICAL DIRECTOR, MATSA
125 mm and 40 mm for the SAG mills and the 8 mm for the new ball mills,” Gámiz says.

“The reason why we need to get three different products is because the grinding size for the copper ore is coarser than for the polymetallic ore. For the copper, it’s about 35 microns; for the polymetallic ore, it needs to be less than 30 microns,” he continues.

Given the fact that the new crushing and screening line had to be able to feed both the old and the new grinding circuit as well as fit in a confined, pre-defined space, MATSA faced some major design challenges. The overall capacity of the plant had to reach 650 tons per hour. In addition, the plant could only comprise a single screening station.

NEW CRUSHING LINE ENABLES ENERGY-EFFICIENT GRINDING | With their deep knowledge of machinery and experience in commissioning hundreds of crushing installations, Metso’s systems engineering team designed the crushing and screening plant for optimum uptime and plant availability within the confined space.

“With the help of the new crushing line, we are achieving our targeted 8-mm feed for the ball mills and reaching the 650T/h planned capacity,” Antonio Gámiz says.

“The line was designed with enough capacity to produce more than we need so we can store enough mineral to support

MATSA is located in the province of Huelva on the Iberian Pyrite Belt. Extending from southern Portugal to Andalusia in southwestern Spain, the Iberian Pyrite Belt is one of the world’s oldest mining regions. It has witnessed miners from Phoenicia and Ancient Rome and hosted the original namesake mine of Rio Tinto. And there is no end in sight. After a slump in the early 2000s, the pace of mining activity is picking up and MATSA is leading the way.

The region is also home to the source of the famous Rio Tinto river. The river gets its amazing red color from iron and sulfide minerals in the soil. Its extreme conditions have even enabled NASA to utilize the river in their Mars research.

ABOVE: The Rio Tinto river gets its color from the minerals in the soil.
whatever maintenance is on. And now we are happy with the results of the design," he continues.

**DESIGN AND DETAIL MINIMIZE MAINTENANCE** | Metso’s process design and site layout includes pre-designed crushing and screening modules adapted to meet the unique technical specifications for the MATSA plant, the specs like feed hopper and chutes thicknesses, the high incline for the HP cone crusher’s feed hoppers and the conveyor discharge chutes.

Providing the technical expertise in the complete crushing and screening process, such as ore characteristics, ancillary equipment and capacity, chutes and conveying design, are essential elements in obtaining overall plant performance. For instance, most of the plant’s chutes are equipped with extremely wear-resistant Trellex Poly-Cer and rubber liners. To complete the design and ensure the best possible end-product quality and availability, Metso also supplies the crusher wear parts and screening media. This global approach and attention to process detail keeps maintenance to a minimum while increasing plant uptime and performance.

For conveying, Metso provided a new range of Nordberg® NCHD™ mining conveyors. These heavy-duty conveyors are designed with selected components for 50,000 hours of continued use. For MATSA, Metso equipped them with a dust encapsulation system, specifically designed at the interface between the feed chutes and the conveyor belts, to avoid material spillage and limit
media to MATSA. The goal of this partnership is to optimize service shutdowns and keep downtime to a minimum. And because Metso knows the equipment as well as the parts, the contract has resulted in some impressive improvements.

For instance, Metso has continuously collaborated with MATSA to further improve the wear life of the mill linings. Thanks to adjustments in the configuration, MATSA is now achieving more throughput and improved results.

“By working with a technician and looking carefully into the wear rates of each plate, we have been able to determine where to increase the rubber and where to change the configuration of the liners. This has improved the service life of the liners,” Antonio Gámiz explains.

“We are happy with the relationship with Metso,” he says.

PERSONAL PARTS STOCK GUARANTEES AVAILABILITY

In addition to extending the service life of the liners, Metso has managed to reduce the duration of the shutdowns drastically. According to Gámiz, the strategic location of Metso’s parts warehouses plays a vital role in the collaboration. Metso keeps a stock of mill linings in nearby Beja, and the grinding media comes directly from Metso’s factory in Seville.

“In the SAG mill, the changing of the liners used to take 72 hours, but we have been improving and changing the system, and now we are reaching a record of 44 hours. Our bottleneck used to be the SAG mill’s liner change, but now that’s just another maintenance job among the rest,” Gámiz concludes.

As a result of the successful partnership, the Trafigura Mining Group, the owner of MATSA, recently contacted Metso again with a new project prospect.

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More production, lower costs at Beira Rio
A plant upgrade with Metso equipment resulted in a 70-80% increase in production, improved end-product quality and a drop in power consumption.

**HE CITY OF UBERABA** is an important business center in Minas Gerais, Brazil. Uberaba has a strong tradition in the food production industry and is a renowned global hub for the genetic development of zebu cattle.

The construction of a new ammonia plant, due to begin operating in 2017, is providing another boost for the city’s economy. The project involves an investment of R$3 billion and strengthens Uberaba’s position among the 100 most important industrial centers in Brazil.

This positive momentum gave Beira Rio, a quarry located in a rural part of the city, the confidence to invest in a major upgrade in 2014. The transformation included the commissioning of a new crushing plant that replaces the old production line and serves to transform local basalt into mineral aggregates. Comprised of an assembly of Metso machines, the new line has enabled an increase in production from a level of 50 thousand tons per month to between 85 and 90 thousand tons. This increase allowed Beira Rio to move from a two-shift operation to a single-shift operation. And, thanks to the new design of the plant, the quality of the aggregates produced was also enhanced.

LAGGING CAPACITY AND EXCESSIVE ENERGY CONSUMPTION

The project is a natural continuum in the company’s history, which began in 1956. Its current owner, *Artur Braghetti Barillari*, is part of the third generation of managers and is the grandson of the founder. Directly involved in the company’s operations, Barillari believes that the redesigned production plant was well worth the effort of undertaking a complex civil engineering project and obtaining sustainable financing.

“Growth in local demand spurred our investment, which had already been on the drawing board for some time,” Barillari explains. “We take a preemptive, planned approach and we look after our assets in order to ensure their performance and availability. The new crushing plant has allowed us to meet our demand within – and even exceeding – our standard of quality,” he states.

Before the upgrade in 2014, Beira Rio’s production levels fell short of market demand. This meant that the quarry was
unable to meet customers' needs. In addition, Beira Rio had to deal with a production plant where the machines were often out of operation, despite having a highly-trained maintenance staff.

The aging equipment also meant high energy consumption per ton produced. The same was true in terms of manpower, because of the need for two shifts. In terms of quality, the production plant, comprising an old fine crusher and a cone crusher, resulted in a lamellar end product.

**INCREASED PRODUCTION, IMPROVED QUALITY** | With Metso's assistance, Beira Rio built a new crushing plant complete with a new line of machines. The new line includes a Nordberg® C120™ jaw crusher, two HP300™ cone crushers, conveyor belts, a feeder and two screens.

With this set-up, Beira Rio was able to increase its production by 70-80%, while at the same time improving end-product quality. The quality improvement is a result of the two HP cone crushers, which substantially reduce the amount of lamellar crushed stone. The leap in quality has also encouraged the company to plan an expansion of its crushing operations, with an eye to new market opportunities through the diversification of its production.

At the same time, the previous problems with the process have been improving. Beira Rio has witnessed a decrease in power consumption per ton produced as well as in its fuel expenses and generators used in its operations. The reduction of these expenses immediately led to a decrease in final costs, creating cost savings of more than 55% in electric power consumption.

The same goes for personnel costs, since the company is now operating with only one shift. The new machines have also increased plant availability, reducing the need for maintenance operations.

“The plant was able to increase production by 70-80% while improving end-product quality.”

**HANDS-ON MANAGEMENT** | Beira Rio's company culture – and especially that of its management – also played a significant role in the change. Barillari is constantly present at the quarry. He often takes part in all phases of production, even operating excavators and directing the trucks that supply the plant. His habit of close supervision has continued with the new crushing line, where, among other things, he monitors proper operation of the conveyor belts.

The use of original parts is another basic principle at Beira Rio. This applies to all machines and involves all suppliers, both at start-up, as was the case for the new crushing plant, and in preventive, corrective and warranty maintenance operations.

**NEW INVESTMENTS ON THE HORIZON** | Barillari's active participation in operations is complemented by his administrative and financial management, where he carefully weighs the risks and opportunities of having a share in the local market in Uberaba. And despite the elimination of a shift, Beira Rio's expansion was so well configured that the company has now created 50 new jobs in the city.

Beira Rio is ready to keep pace with the growth of Uberaba. “The city will reach a population of 500 or 600 thousand inhabitants in the coming years, and we are preparing to meet all the needs of heavy construction and civil works,” said Barillari in a statement to the Uberaba newspaper.

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Metso’s delivery to Beira Rio

- 1 Nordberg® C120™ jaw crusher
- 2 Nordberg® HP300™ cone crushers
- Conveyor belts
- 1 CV-1510 feeder
- 2 CBS screens (7’x20’DD and 8’x20’TDD)
OMPAÑÍA MINERA DOÑA INÉS DE COLLHUASI is the fourth largest copper producer in Chile and currently ranks sixth in global copper reserves. To ensure future productivity and profitability, the mine decided to embark on a preventive improvement program. The objective was to detect potential problems in advance and to maximize the performance and availability of the existing equipment.

INTEGRATED SOLUTION ENSURES SUCCESS | As part of the improvement efforts, the mining company contacted Metso for the manufacturing and mounting of a new chute with four outputs for a 10’ x 11’ SAG mill. Pleased with the good results and the fact that all deadlines were met without any accidents, Doña Inés de Collahuasi soon decided to order three more chutes from Metso for the pebble stage. Metso’s unique ability to offer an integrated solution was one of the key factors in the company’s decision to collaborate with Metso.

“As a company we look for suppliers who can provide an integrated service that includes engineering, manufacturing as well as assembly,” Manuel Vera, Asset Management and Reliability Manager at Minera Doña Inés de Collahuasi, explains.

DIFFICULT MAINTENANCE AND EXCESSIVE WEAR A CHALLENGE | Metso’s integrated approach consisted of several phases, starting with the gathering of field data about the existing chutes in operation.

It turned out that the structures needed improvement and that a liner change-out was quite difficult. In addition, the chutes were unable to absorb the full impact of the falling mineral. All this added up to an insufficient flow, as evidenced by the large amounts of ore in the passageways and around the transfer chute. This excess material created premature wear in the conveyor belt and its support structure.

These findings were passed on to the design, where they resulted in proposed improvements that were then validated through HFS simulations. The design improvements will reduce downtime for liner change-outs and thus increase availability because less time will be needed for scheduled maintenance. Additionally, the new design included chute door systems for inspection and maintenance.

EXTENDED WEAR LIFE WITH TRELLEX POLY-CER | Trellex® Poly-Cer from Metso is a modular system made of ceramics and rubber, which makes the liners resistant to strong abrasion – even with a high tonnage and at high speeds. The new design of the chute liners makes maintenance easier by streamlining the change-out of the anti-wear plates within each structure.

Trellex Poly-Cer is designed to increase liner wear life. Thanks to its greater resistance, it is typically up to ten times more wear-resistant than its steel counterpart. Trellex Poly-Cer consists of ceramics (1400 HB) and rubber, offering both wear resistance and elasticity to absorb impacts.

IMPRESSIVE RESULTS | As a result of the new design, the service life of the chutes at Doña Inés de Collahuasi has increased. “The original design required maintenance every 20 days or so, but now the interval is longer, and we know that optimization of this can continue,” Manuel Vera says.

Metso’s integrated solution also included carrying out the actual liner change-out and the assembly of the new chutes, as well as a follow-up on the performance of the liners and a continuous improvement plan for the transfer chutes.

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Increased uptime at a Chilean copper mine

Metso’s redesign project of the discharge chutes at Compañía Minera Doña Inés de Collahuasi resulted in an increase in the service life.
A major win for both the environment and community

Kalgoorlie Consolidated Gold Mines (KCGM) is one of Australia’s largest gold producers. KCGM is the managing company of the world-famous Super Pit in the Goldfields of Kalgoorlie, Western Australia. KCGM has recently commissioned a new Metso carbon regeneration kiln as part of its AUD 98 million Emissions Reduction Project, which has eliminated sulfur dioxide and significantly reduced mercury emissions from its Gidji and Fimiston processing facilities. The project was supported by KCGM’s joint-venture owners Barrick and Newmont.

In 1893, three Irishmen, Patrick Hannan, Tom Flanagan and Daniel Shea, stumbled across 100 ounces of alluvial gold when they stopped to replace a horseshoe in the course of their travels. Hannan registered a claim on 17 June 1893, in Coolgardie, and so started the Yilgarn-Goldfields gold rush. The town of Kalgoorlie was founded in the same year.

Many early prospectors who came to the region were unprepared for the harsh living conditions they would face. Living only in makeshift shacks, thousands died from the lack of food, water, medical supplies and sanitation. But these conditions didn’t deter the influx of thousands more prospectors from all over the world, who often arrived with only a shovel and pan to seek out their fortune. It was the passion and spirit of these early pioneers that drove the success of the region, which has grown into Australia’s largest producer of gold. On the back of this success, infrastructure was established allowing the community to grow and prosper.

Dwindling alluvial gold deposits gave rise to underground mines, but by the 1980s they faced falling financial viability. This led to the development of the Fimiston Open Pit, when many existing leases and mines on the Golden Mile were consolidated. In 1989 a single management entity was formed - Kalgoorlie Consolidated Gold Mines. Today KCGM’s Fimiston Open Pit is a massive operation, popularly known as the Super Pit. At 3.5 km long, 1.5 km wide and over 600 m deep, it is so large that it can be seen from space and, despite its remote location, it is a popular tourist attraction. The City of Kalgoorlie-Boulder has developed into a dynamic and sophisticated regional center. It is Australia’s largest outback city with a population of over 30,000 people. Kalgoorlie’s gold production and the wellbeing of its community have always been intertwined in a symbiotic relationship.
Commissioning the new Metso carbon regeneration kiln; it combines cutting edge burner technology with a sophisticated control system that is integrated into the plant’s distributed control system.
Annually, KCGM processes over 12 million tons of rock to produce up to 800,000 ounces of gold. The Fimiston Open Pit is mined using the drill-and-blast method, with the ore transported by six-meter-high haul trucks. It is crushed down to nominal 300mm-sized rocks and then ground down to 0.2mm-sized particles before it is mixed with flotation reagents. This produces a gold-rich froth, which is dewatered in filters to produce a sulfide gold concentrate. A common practice is to roast this concentrate at 650°C, which vaporizes sulfur dioxide and other impurities like mercury.

Most of the gold ore found along the Golden Mile is intricately bound in various sulfide minerals, such as pyrite. The roasting process is the most efficient and cost-effective way to maximize the recovery of gold from the ore and has been used in the Goldfields since 1898. The downside of roasting is the presence of sulfur dioxide (SO2) and mercury in the off-gas emissions. Up until early 2015, KCGM used roasting at its Gidji Processing Plant.

As part of its Air Quality Management Plan, the company would stop the roasting process whenever prevailing winds could blow roasting emissions towards the town and residential areas. This resulted in unplanned stoppages and the sacrifice of up to one third of available production time. Improving air quality for the community and avoiding disruptions to production were the key drivers for research into alternatives to the roasting process. This year as part of KCGM’s AUD 98 million ‘Emissions Reduction Project’, a new larger ultra-fine grinding (UFG) Mill was installed at Gidji to replace roasting.

UFG reduces ore down to 12 micron particles, it is then subjected to a cyanidation process followed by adsorption onto activated carbon in a process called Carbon-in-Leach or CIL. Next, the carbon is recovered from the CIL process and transferred to the elution circuit. The elution process uses caustic soda and cyanide in a pressurized column at 110°C to strip the gold off the carbon. Once this step is complete, only the spent carbon is left behind. The carbon is then rinsed in water and sent for regeneration.
The gold continues on to another process called electrowinning, where it is converted into a solid that is deposited onto large plates using an electric current (approximately 3000 amps at 12 volts). The gold is then washed off the plates, dried, melted at over 1000°C and poured into gold bars.

**DOWNSTREAM FROM ULTRA-FINE GRINDING** The implementation of UFG had a significant impact on KCGM’s downstream processes. **Mark Roberts,** Metallurgist at KCGM, explains: “The UFG process does not remove the sulfur or mercury as the roaster did. As a result, the mercury carries over into the CIL process, where it adsorbs onto the activated carbon, reducing its capacity for gold adsorption. This means carbon is required to be eluted more frequently to achieve the same result in the CIL process.”

Carbon can be ‘reactivated’ for reuse by treating it in carbon regeneration kilns that heat it up to 700°C, vaporizing the impurities still present following the elution process. Because the increased frequency of elution strips the capacity to regenerate the carbon, an additional carbon regeneration kiln had to be installed.

Roberts continues, “The mercury, which had previously been removed by roasting, is now present in the kiln. The existing gas scrubbers downstream of the kiln could not effectively handle the increased load, so a new scrubber and off-gas cleaning plant had to be designed and installed.”

**TAPPING INTO THE KNOWLEDGE OF A LONG-STANDING PARTNERSHIP** KCGM installed two Metso carbon regeneration kilns, in 1994 and 1997. Since then, they have relied on the company’s maintenance services and engineering knowledge to ensure that the kilns continued to perform efficiently. **Hratch Loussikian,** Metso’s National Product Manager, Pyro Systems, played a key role in the supply of the original kilns and has been directly involved in KCGM’s carbon regeneration process for over 10 years. He recalls, “When we tendered for the new kiln, our long-term involvement with KCGM along with our intimate knowledge of their process and requirements led us to produce a design that met the unique requirements of this project, while delivering a high degree of energy efficiency. I believe that this, combined with our history of delivering quality spare parts and services, led KCGM to choose Metso to supply the new kiln.”

**SUPPLY OF THE NEW KILN** Supply of the new kiln was a team effort between Metso and a number of its long-term business partners: Electrical Board Manufacturers for control and automation, Mining Combustion Services for kiln heating, and NEPEAN Engineering & Innovation for kiln fabrication.

Once the design was completed by Metso’s Pyro division, the kiln was fabricated and fully assembled at NEPEAN’s production facilities in Narellan, South West of Sydney. Electrical Board Manufacturers, assisted by Metso engineers, then installed and tested the control system before the kiln was disassembled and transported to the mine site, where it was reassembled in its final position.

**KILN OPERATION – HOW IT WORKS**

The carbon regeneration kiln is a rotating horizontal cylindrical design that agitates and gradually transports the red-hot carbon down the length of the horizontal drum. Three large burners indirectly heat the carbon up to 700°C. To prevent the carbon from burning at this high temperature, a steam environment and low negative pressure are maintained to keep oxygen out of the kiln.

With a focus on energy efficiency, the kiln is designed to channel the furnace’s hot exhaust gases through the center of the kiln, thus providing additional internal heating. As the gases exit the kiln they are used to dry and preheat the incoming carbon.

**AUTOMATION AND OPERATIONAL SAFETY** With the carbon at 700°C, great care has to be taken to ensure safe interactions between the kiln and the upstream and downstream processes, particularly in the event of any process malfunction. This means the kiln needs a safety shutdown system that operates independently of any external systems or power. A momentary loss of control by the DCS (Distributed Control System) or a power outage could have catastrophic results. The drum that carries the carbon runs at temperatures of between 850°C and 1000°C. Stopping the kiln drum from rotating, even for a short time, could harm the kiln.

Many customized designs were developed, and Metso played a very active role by sharing its insights and ideas to identify improvements and find solutions. **Paul Antcliff,** KCGM’s Project Engineer.
period of time, will cause the drum to sag under its own weight.

Loussikian explains, “Even the smallest changes in tolerances will have dramatic effects on the kiln’s ability to operate correctly; it may not operate at all. With no easy way to rectify damage, it is likely the kiln would be offline for up to 6 months while a new one is constructed and installed. Our design takes care of this problem with a special shutdown operation that is driven by a battery backup system in case of power failure. It keeps the kiln rotating until all the carbon is safely out of the kiln and the drum has cooled down sufficiently to safely stop.”

Once the kiln was assembled and tied in with the mechanical and electrical components of the upstream and downstream processes, testing and cold commissioning started. Although the kiln will be controlled by the site’s Yokogawa DCS, the kiln’s operation and control needed to be tested and proven independent of the DCS. Metso and Electrical Board Manufacturers designed a complete system that was only required to control the kiln’s operation during testing and commissioning. David Merrick, Electrical Board Manufacturers’ automation and control engineer, explains in more detail, “Once testing was complete, control of the kiln was transferred to the Yokogawa DCS. To ensure that control is exactly the same, our programming and our control interface hardware were integrated into the DCS. This was a complex process, but the cooperation from KCGM and Yokogawa made the process really simple.”

COOPERATION AND TEAM WORK
A KEY SUCCESS FACTOR | Replacing roasting with UFG impacted every process downstream, including the interaction between the newly designed kiln and scrubber. Unique engineering solutions had to be developed and applied throughout the commissioning process to ensure optimal performance of these two critical elements in the process.

According to Paul Antcliff, KCGM’s Project Engineer, a lot of cooperation was required between the various parties. “Everybody was committed to the success of the scrubber, and when problems arose everybody would be part of finding a solution.”

“Many customized designs were developed, and Metso played a very active role by sharing their insights and ideas to identify improvements and find solutions.
This included a strong participation in our HAZOPS (Hazards and Operability Study).”

In the final step, Mining Combustion Services commissioned the gas burners. Precise settings are critical for the effective and economical operation of the kiln, and all possible conditions need to be considered and tested. One example is air flow, which is an important factor in efficient gas burner operation. The unique design of KCGM’s scrubber affected air flow from the kiln, and so input from many parties was required to achieve optimum results.

Michael Allen, Mining Combustion Services, elaborates, “The scrubber has the capability of taking gases from one, two or three kilns. I don’t think that this has ever been done before.”

“KCGM’s effort and investment into the scrubber design is truly admirable. They spared no expense in getting it to work 100%. Every single chemical element from the process is eliminated. Even any volatiles not caught in the scrubber are incinerated. It is a fantastic tribute to the importance that KCGM place on the wellbeing of the community.”

AN OUTSTANDING RESULT | With the roasters no longer in operation, atmospheric emissions have been eliminated from the Gidji Processing Plant. Everybody wins: with emission reductions, the environment and community win and the process can run 24/7 without the need to halt operations due to prevailing wind conditions.

According to Max Wijasuriya, Metso’s Vice President Capital Equipment, the collaboration and knowledge sharing between the Metso and KCGM teams was a key success factor in delivering such a positive outcome.

“Working closely with our customers is what we do – we leverage our knowledge, people and solutions to help make the big difference,” he said.

To mark the opening of the new UFG Mill at Gidji, KCGM held a celebratory event attended by members of the local community and industry. This is a win-win for the community and KCGM, demonstrating how closely their success is intertwined.

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The fine crushing process of Finsveen Maskin AS consists of a static hopper silo, lifting conveyor, Lokotrack LT220D with three-deck screen, and an additional mobile screen for fines.
Production up by 25%, fuel costs down by 40%

In addition to increased capacity and fuel savings, the Norwegian crushing contractor Finsveen Maskin AS appreciates the easy transportability of the Lokotrack LT220D cone plant.

The figures verified by us are very convincing. The LT220D cone crushing plant with a full-sized screen increases capacity by 25% and consumes only 34 liters per hour, resulting in a 40% fuel savings compared to its predecessor, the LT1100™ cone plant,” comments Runar Finsveen, Manager of Finsveen Maskin AS, Norway.

“And, as a big added bonus, the LT220D, weighing only 48 metric tons, can be transported easily as one piece – no dismantling necessary. Metso has succeeded in reducing the weight of the new unit by about 10 tons compared to the old model.”

According to Runar Finsveen, better transportability is a big advantage in crushing contracting:

“We move our LT220D between sites about 25 times per year. Thanks to the hydraulically lowered screen, feeder and conveyors, getting the machine ready for
transport goes quickly and it can be transported on an ordinary trailer. Upon arrival to a new site, the unit is ready to work in 20 minutes,” Runar Finsveen says.

FUEL SAVINGS OF OVER 100,000 EUROS PER YEAR | Finsveen Maskin was among the very first companies worldwide to start operating the Lokotrack LT220D in August 2014. In ten months, more than 2500 hours have been clocked and some quarter of a million tons of aggregates crushed and screened.

Rune Finsveen expects to save 60,000–70,000 liters of fuel per year with the new LT220D. With the average price of diesel about 1 EUR/liter in Norway, the total fuel savings will range between 60,000–70,000 euros per year. At the same time, he will get 25-30 tons more production per hour compared to the LT1100.

Finsveen Maskin concentrates on the contracting of secondary and fine crushing jobs. It operates in a manner commonly practiced in Norway: a dump truck feeds a static hopper silo, from which a conveyor moves the material up to the LT220D’s belt feeder.

The GP220™ cone crusher on board the LT220D is operated at a 16-mm closed side setting, providing capacity of about 130 metric tons per hour. The patented, centrifugal lifting conveyor takes crushed materials back to the screen, saving a lot of space.

Normally, the LT220D produces end products of 0–4 mm, 4–8 mm, 8–16 (16–22) mm, 8–11 mm and 11–16 mm, with an additional mobile screen further producing 0–2 mm, 2–5 mm and 5–8 mm grades.

Since delivery, the machine has performed well and without major problems. In the future, we are expecting Metso to react quickly to even the smallest concerns we encounter.

RUNAR FINSVEEN, MANAGER OF FINSVEEN MASKIN AS, NORWAY.
Lokotrack is loved in the land of rock

Norway is known for its beautiful, rocky landscapes cut by deep fjords. Lower elevations are covered with forests, but the steep mountains expose a hard, rocky surface and the higher elevations are snow-capped even in the summer.

Building tunnels, roads or bridges in Norway means that you have to extract rock and crush it for utility purposes. It’s no surprise that Norway was the first foreign country to buy the first track-mounted Lokotrack crushing plants in the 1980s. Today, the country’s Lokotrack fleet is one of the biggest in the world – more than 400 units.

Norway also runs the largest fleet of Metso’s newest tracked, two-in-one crushing and screening plants, Lokotrack LT220D. There are currently (summer 2015) ten LT220D units in operation around the country.

What is the secret behind Metso’s success in Norway?

“Our team of more than 34 Metso people in Norway believes in open and honest ways of doing business, and that has resulted in exceptionally long customer relationships. If we ever fall short of expectations, it’s important that we clearly acknowledge it and inform our customers immediately. We all want to help the customer and to succeed,” says Olav Hellekaas, Metso’s Country Manager in Norway.

Screening jobs from the age of 14

Runar Finsveen’s career in the crushing and screening business has already spanned more than 25 years. He actually started his first screening job at the age of 14 and was running a crushing plant just one year later.

Runar founded his first company at the age of 19, working with an excavator and a truck. Finsveen Maskin was established after a company merger in 2007. Today, the company has 22 employees and executes contracts around the village of Ba, south of Norway’s capital city of Oslo.

Before the LT220D, Finsveen Maskin operated Lokotrack LT105 and LT110 jaw plant models for primary crushing and an LT1100 for fine crushing. This year, the company’s secondary and tertiary crushing will produce 270,000 metric tons, and it has plans to increase it to 300,000 – 350,000 tons by 2016.

Daily service breaks ensure smooth operation

Normal working days at Finsveen Maskin tend to run about 12 hours long and usually include a one-hour service break. This way, the company ensures smooth, efficient operation and avoids unexpected breakdowns. The fact that the diesel engine on the LT1100 was operated more than 16,000 hours without opening is a good indication of the effectiveness of the company’s service culture.

“The service requirement for the LT220D seems to be rather minimal. We try to handle it on our own, but we do use Metso experts when necessary. We also get all our crusher wear parts and screening media from Metso,” Runar Finsveen says.

The trust in Metso was seen already when signing the purchase deal for the new Lokotrack LT220D:

“At that point, the machine was still just a drawing, but we trusted Metso Norway. Since delivery, the machine has performed well and without major problems. In the future, we are expecting Metso to react quickly to even the smallest concerns we encounter,” Runar Finsveen adds.

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More information: results minerals+aggregates 2/2015

» The world is our showroom
The flotation plant features 23 Metso RCS100 flotation cells and 16 RCS40 cells.
Together with Metso, the Serbian RTB Bor mine renewed the processing plant at its largest site, Veliki Krivelj. The result was a higher throughput and better recoveries with less energy consumption per ton of processed copper.

**THE RENOWNED** Serbian copper producer RTB Bor today enjoys the largest and most cost-efficient mining operation since the start of copper mining in the region of Bor, Serbia, 112 years ago. RTB Bor is located in eastern Serbia and excavates more than 40 million tons per annum of copper ore and overburden at multiple mining and processing sites: Veliki Krivelj (its largest site), Cerovo mine, the underground mine Jama, the smelter and copper slag processing plant, all of which are based in and around Bor, plus the Majdanpek mine and processing plant located some 80 km northeast of Bor.

**NINE DECADES OF PARTNERSHIP** RTB Bor and Metso share a very long history together: RTB Bor’s oldest equipment is a Metso-made cone crusher that was produced in 1927. The fact that the crusher is still running is evidence of the nine decades of partnership between the two companies.

Based on RTB Bor’s production growth strategy, its last five-year collaborative partnership with Metso resulted in an operational boost at its largest site, Veliki Krivelj: it revamped its crushing plant, refurbished the old grinding mills with the installation of newly designed rubber mill linings and a classification system, and built a completely new flotation plant with modern automation allowing for higher throughput and better recoveries with less energy consumption per ton of processed copper while never stopping its production.

In the constant race against time, costs and fluctuating copper prices, similar actions are also being planned and executed at RTB Bor’s other sites.

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Metso’s minerals processing solutions, worldwide know-how, local and strong footprint and expertise in process integration make it a reliable long-term partner and a global leader in this segment.

**BLAGOJE SPASKOVSKI**,
GENERAL MANAGER OF RTB BOR GROUP
Vertimill enhances ore slag recovery

The first phase of the slag processing plant reconstruction addressed the crushing and grinding circuits. The slag coming from the copper smelter is crushed initially with the 1927 model Symons 5½-foot "oldie" and then with a new Metso HP200™ cone crusher running in close circuit with a Metso CVB™ screen. The controlled – screened product from the crushing plant is fed to the grinding circuit. Fine grinding comes after primary grinding. Since May 2015, the fine grinding is performed with Metso’s Vertimill® VTM400™ grinding mill to a size of P80 of minus 40 microns at a rate of 42 metric tons per hour.

METSO’S VERTIMILL VTM400 vertical grinding mill significantly enhances RTB Bor’s recovery of copper slag reprocessing. After 1,000 hours of operation, the VTM400 has doubled the slag recovery rate, especially important since it has a 1.6–1.8% copper content.

Ivan Andelović, Main Engineer for the slag process, says: “The touch screen makes Metso’s Vertimill easy to use. Even after grinding the very abrasive slag that contains 50% silica, the magnetic liners and the grinding screw still look new.”

“The VTM400 is also easy to install and maintain, is quiet in operation and creates no vibration. Even a coin placed upright on the VTM won’t fall. Energy-wise, we save a lot of electricity because the vertical grinding mill can be operated with a small, 340-kW motor,” he adds.

“We are just waiting to get the automation system and individual flotation cells for the slag processing to get it perfect,” adds Goran Stojić, Flotation Plant Manager.

A MAJOR, POSITIVE IMPACT TO THE RTB BOR MINE ECONOMY | Metso’s assignment at RTB Bor was to come up with a holistic, integrated solution that takes into account the process from the mine all the way to the filtration. Maximizing the use of the existing infrastructure provided solutions with the lowest investment cost. All installation work was carried out with a minimum amount of production stops or disruptions to ensure constant cash flow for RTB. By mixing “tried and true” with “new and efficient” technology, higher plant availability was reached in a very short time.

The project was rolled out in multiple steps. The first step was the joint effort between RTB Bor’s maintenance team and Metso’s local service experts in 2009 to overhaul Metso’s Allis Chalmers 48 x 74-inch primary gyratory crushers. The secondary and tertiary crushing and screening plant was next on the list. The process started by assessing the condition of the existing crushing and screening plant and its design. Between 2010 and 2013, RTB and Metso focused on the efficient service and refurbishment of the existing equipment and the installation of three Nordberg® HP6™ cone crushers in the tertiary crushing stage to reach a finer, higher and stable production that enabled further optimization and increased capacity of the grinding sections.

The next step was to improve the grinding circuits. The three identical grinding circuits each consist of a combination of a primary rod mill and a secondary ball mill. After they were inspected, the grinding process with the finer feed coming from the crusher plant was simulated, and a new design for the grinding and classification section and the mill linings was developed.

A complete flotation plant that includes a total of 23 Metso RCS100 flotation cells and 16 RCS40 cells was installed and commissioned for both Veliki Krivelj and Cerovo ore processing. The work was carried out in seven phases to avoid production stops.

Blagoje Spaskovski, General Manager of RTB Bor Group, explains the boost in the old mine’s production results achieved through the close cooperation with Metso:

“Our mining operations at Bor and Majdanpek today have to mine lower copper grades of 0.3% before the open pits can be further deepened for the richer ore bodies. With Metso’s help, we were able to modify the minerals processing plant for better recovery even at variable and low copper grades, add an additional 6 million tons to our total annual production and achieve up to 14 million tons per annum production with the same building and energy infrastructure we previously used to float 8.4 million tons per annum.”

He continues: “In making the changes, the aim was also to raise the mine’s copper ore recovery percentage by more than 5% and decrease the electricity costs by 20% – all done with the lowest possible investment in buildings and by optimizing the use of existing infrastructure. With Metso’s minerals processing solutions, the mine has increased its production capacity significantly and, similarly, has decreased its crushing, screening, grinding and flotation costs by 15% per copper ton processed. This has created a major, positive impact to the RTB Bor mine economy.”
“With my long career of more than 40 years of experience in processing and flotation and in opening and operating nine different mine sites, I’m confident in saying that Metso’s minerals processing solutions, worldwide know-how, local and strong footprint, and expertise in process integration make it a reliable long-term partner and a global leader in this segment,” says Spaskovski.

METSO’S HP6 CRUSHER A PROVEN STEP FORWARD | Spaskovski explains that the mine operation was successfully renewed in different phases:

“A key milestone in the project was the replacement of the old Allis Chalmers crushers with modern Nordberg HP6 cone crushers. In fact, today one HP6 does the job of two or three of the old crushers. The HPs allowed us to decrease the feed size to the grinding circuit from 25 mm to 100% minus 16 mm.”

“This makes a big difference for grinding. Electricity costs are a key issue for any mine, but this means that we can also grind much bigger quantities using the same mills and the same amount of electricity,” Spaskovski adds.

DOUBLE THE LIFETIME WITH METSO’S MILL LININGS | One of RTB Bor’s key renewal projects included installing newly designed rubber mill linings in Metso’s old Allis Chalmers grinding mills.

“Since installing the first Metso rubber linings in our ball mill in 2011, we have processed some 12 million tons of ore per grinding section; in early 2015, we changed the first mill head rubber linings but have not yet needed to change the shell linings. This means we doubled the lifetime with Metso’s rubber mill lining solutions that are now installed in all our ball mills at Veliki Krivelj and the Cerovo plant,” comments Saša Milić, Flotation Plant Manager.

AUTOMATION HELPS TO REACT QUICKLY | New plant automation, including several elements from Metso, was installed in 2013-2015. As an integral part of the flotation plant, Metso delivered a new PLC system that collects all of the key information from the process, as well as a new OCS Optimization Controlling System that works in tandem with the VisioFroth system and the cameras installed at all key flotation cells to enable full control of the plant parameters.

“With the new automation, we can see in real time what’s happening in flotation and react quickly depending on the grade variations from four different orebodies. It takes just minutes to receive a chemical analysis, compared to previously when it took several days,” Milić comments.

“As a result, we have succeeded in increasing our copper percentage in concentrate after flotation by more than 20%, which is a good achievement and sufficient for our new smelter,” he adds.

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We simply couldn’t fit all the success stories we wanted to share with you into this issue. Fortunately, there’s a lot more to read, watch and discover online.

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Bulk ore sorting improves profitability and sustainability

Pre-concentration is more than an industry buzzword. Removing barren material early enough can bring significant savings, especially in today’s low-grade mining operations. It also reduces the environmental footprint of the mine due to lower energy consumption, greenhouse gas emissions and water losses per ton of product.

IGH-GRADE ORE DEPOSITS are depleting fast. Consequently, the mining industry has to take on lower-grade deposits, which are more difficult to extract. These deposits require the mining, movement and processing of larger volumes of material per ton of valuable mineral. The transportation, comminution and processing of these large volumes is expensive and energy intensive.

Low-grade ore bodies generally contain a large proportion of liberated barren gangue, or, in other words, material of no worth. What if there was a way to eliminate this barren material from the process early on? This is exactly what pre-concentration is about.

Pre-concentration is the rejection of gangue from coarse feed. It increases the grade of the ore proceeding to the next stage of processing and avoids feeding the plant with material that will
Bulk sorting increases the resource utilization by reducing the cut-off grade. More valuable metal is extracted, while the processing plant treats less tons at higher feed grade.

**The Break-Even Cut-Off Grade** is the grade at which it becomes economically feasible to mine a block of material. By treating only material that is above the cut-off grade, only material that adds value is processed.

**Consider a Hypothetical** copper deposit with a cut-off grade of 0.25% copper delivering 110 million tons of ore to the processing plant with an average grade of 0.39% copper. With the inclusion of bulk ore sorting, the cut-off grade is reduced to 0.20%, changing the delineation of the ore body and pit shell and increasing the amount of above cut-off grade material. The resulting average grade of mined ore is reduced to 0.35% copper. However, bulk ore sorting upgrades this to deliver 102 million tons of ore with an average feed grade of 0.45% copper to the processing plant (using conservative estimates of sorter performance in which 90% of the copper is recovered in 70% of the mass).

**Overall,** almost 8% (8 million tons) less ore is treated by the processing plant, but at a higher feed grade and with 5% more contained metal than the base case scenario without bulk ore sorting.

Cost more to process than the respective value of the contained valuable mineral. Less tons of ore are treated per ton of product, thus reducing the costs, energy and water consumption. This effectively creates more value with less impact, improving the resource efficiency and sustainability of the operation.

Because gangue tends to be high in silicates and typically harder and more competent than the valuable minerals, removal of this hard and barren material prior to comminution stages also has the potential to significantly reduce energy consumption and processing costs and may also reduce ore transport requirements.

“With bulk ore sorting, ore that previously didn’t qualify for processing may be upgraded.”

**What is Bulk Ore Sorting?** Bulk ore sorting is a pre-concentration technology in which large volumes of barren gangue are separated from a fully loaded conveyor belt based on the grade as measured or inferred from a sensor measurement. With bulk ore sorting, ore that previously didn’t qualify for processing may be upgraded, making it economical to treat and improving the resource utilization. More valuable metal may be extracted from the resource, while the processing plant treats less tons at higher feed grade.

Bulk ore sorting could also be used to separate ore types to treat via different process routes or to reduce dilution and ore loss in mining operations by improving grade control. It is an efficient way to deal with uncertainties of grade, particularly where the complexity of mine geology makes the estimation of grade difficult. This helps the mining operation to achieve the planned cut-off grade and optimize extraction of the resource.

**Current Sorting Technologies Can’t Handle Large Volumes** Ore sorting relies on measuring a property that is different in the valuable and waste components using some form of sensor. A variety of sensors are available, and those commonly used in industrial applications include photometric, electromagnetic, radiometric and x-ray. Sensor-based ore sorting is not new, and it has been shown to be technically feasible. However, in the minerals industry, it is currently only used in some niche applications, such as industrial minerals (e.g. calcite, rock salt or talc), diamonds and other gemstones.

Current sorters separate individual particles. They require careful feed preparation so that individual particles can be detected and measured, and ejection is usually achieved by blasts of compressed air. Therefore, current sorters have very low capacity (up to 300 tph for larger particles and much less for smaller particles), making them unviable for high tonnage pre-concentration.

To make sorting viable for pre-concentration, it should be applied to bulk quantities of ore, such as on a loaded truck tray or a fully loaded conveyor belt.
NEW DEVELOPMENTS UNDERWAY | The Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) is developing a sensor using magnetic resonance (MR) that has the ability to rapidly measure batches of ore on large primary production conveyors. The MR sensor is well suited to a bulk ore sorting application, as it is penetrative and can measure large throughputs on fully loaded conveyor belts. In addition, the measurement response time is rapid, thus allowing diversion of different grade streams in an ore sorting application. However, the MR sensor measures an individual mineral (not element) and may have limitations measuring ores with complex mineralogy. The sensor is currently developed for chalcopyrite, a dominant copper mineral, and with further development could potentially be applied to other minerals.

Using several types of sensors together may be a way to overcome the limitations of the different sensor types. A control system is also required to interpret the data from the sensor or sensors and make an “accept” or “reject” decision, and a diversion system, such as a diverter gate, is required to separate the valuable batches of ore from waste. Metso has developed conceptual designs for implementation of bulk ore sorting on plant feed or in-pit conveyors treating up to 3,600 tph and with belt speeds of up to 5 m/s.

EXPLOITING THE HETEROGENEITY | Most mining deposits are naturally heterogeneous and lend themselves well to bulk ore sorting, but it should be implemented as early in the process as possible before excessive mixing occurs. Material presented to the sorter needs to have sufficient grade variability occurring in large enough batches of material for effective separation. But every time the ore is rehandled, transferred, crushed or blended, the degree of mixing increases; reducing the variability and thus the potential for effective separation of batches of barren gangue from ore. Therefore, either in-pit or plant feed conveyors provide the best opportunities for bulk ore sorting; early in the process the sorter can exploit the natural heterogeneity of the deposit. However, current mining practices are generally designed to

LIMITATIONS OF CURRENT TECHNOLOGIES

A REVIEW of existing sensor technologies indicates that most are currently not suitable for bulk ore sorting, as they are either not sufficiently penetrating or are too slow for effective separation.

FOR EXAMPLE, laser-induced breakdown spectroscopy (LIBS), laser-induced fluorescence (LIF) and photometric sensors are surface-only measures (not penetrating into the rock). X-ray fluorescence (XRF) has a beam size and penetration of only a few millimeters. Therefore, these sensors cannot provide a representative measure for the large quantities of heterogeneous material required for bulk sorting.

Prompt-gamma neutron activation analysis (PGNAA) and pulsed fast and thermal neutron activation (PFTNA) sensors measure elements and can penetrate the full cross section on a loaded conveyor belt. However, currently the measurement speeds are too slow for effective bulk ore sorting. The measuring takes minutes rather than seconds.

WHERE TO PLACE A BULK ORE SORTER?

A BULK ORE SORTER for pre-concentration could be located anywhere from the mining face to the grinding circuit feed. The best location depends on the particular operation and will be affected by factors such as:

- mine type and mining methods
- location of waste dumps and processing plant
- operating costs of the mine, sorter and downstream processes
- impact on productivity in the mine and plant
- changes to layout
- space required
- environmental impact
- Greenfield operation or retrofit to an existing operation
Blend out the variation and provide a consistent, stable feed to the processing plant. The mining industry typically takes a ‘one size fits all’ approach and endeavors to treat all the ore from a deposit through one extraction process. The process is designed for the average or typical ore. This often means that the process includes a blending strategy to ensure a stable feed grade to the plant. Maximizing the value of bulk ore sorting requires a shift in mining practices. The goal should be to exploit the natural variability in the deposit rather than blend it out.

“A PERFECT COMPLEMENT TO IN-PIT CRUSHING AND CONVEYING | Because the natural heterogeneity of the ore makes sorting more effective, a bulk ore sorter should be placed as early as possible in the process. This also avoids extra costs and the lost capacity associated with treating non-economic material. In fact, the benefits of discarding barren material early on are carried through all the downstream process steps.

In almost all cases, bulk ore sorting would need to be implemented after primary crushing to present material at a size that can be handled by the sorter. Each additional crushing or material transfer stage incorporated prior to sorting increases mixing, costs and unnecessary energy consumption, so these should be avoided if possible.

Conducting bulk ore sorting at the mining face, either in-pit or underground, allows ore and waste to be directed to the appropriate destination (waste dump or process) immediately. The feasibility of this approach will depend on having suitable space available for the sorter as well as on the mining method employed and potential impact on mining productivity.

Underground pre-concentration, prior to haulage or hoisting, produces solid waste underground, which can be combined with tailings and cement from the surface as required and disposed of as fill. In open-pit mines, bulk ore sorting could potentially fit well with in-pit crushing and conveying systems. The sensor(s) would be located on a conveyor leaving the pit, and would use a flip gate to separate waste and ore onto their respective conveyors. Furthermore, a system equipped with multiple flip gates could be used to separate different ore types onto separate stockpiles, which could be either blended according to the downstream process requirements or sent to different process routes.

MULTIPLE BENEFITS IN BOTH GREENFIELD AND BROWNFIELD OPERATIONS | By removing coarse barren material,
pre-concentration has the potential to significantly reduce the amount of material that requires downstream processing. If conducted close to the mining face, it can potentially reduce ore transport requirements by rejecting barren gangue and transporting less ore to the processing plant. Pre-concentration effectively upgrades the plant feed; less tons of ore are treated in the processing plant per ton of product, thus reducing the costs, energy and water consumption per ton of product.

In existing operations with fixed plant capacity, the production rate can be increased after sorting due to the increase in feed grade. In Greenfield operations, the size of downstream processing equipment can be reduced – reducing the capital and operating costs – or the production rate can be increased.

Additionally, bulk ore sorting can reduce dilution and ore loss in mining operations by improving grade control. In some cases, mining costs may be reduced, with the bulk ore sorter providing selectivity thus allowing less selective mining processes.

**BETTER RECOVERY, LESS TAILINGS** Pre-concentration can upgrade previously uneconomic material to valuable ore. It may enable the recovery of valuable components from waste dumps, low-grade stockpiles and marginal reserves that would otherwise be uneconomical to treat.

The environmental footprint of the mine is also reduced, due to lower energy consumption, greenhouse gas emissions and water losses per ton of product. Less fine wet tailings are produced, requiring a smaller tailings storage facility and minimizing the surface impact. Even though the waste dump area may, in some cases, increase, the dry coarse waste from the sorter could be useful as aggregate or for other fill purposes.

Despite the apparent benefits, the uptake of pre-concentration has been slow. This is possibly due to perceptions of unacceptable metal losses, insufficient understanding of ore characteristics, and a lack of understanding of the systemic impact. However, metal losses in pre-concentration are offset, if not completely compensated for, by the increased recovery in downstream processes due to the higher feed grade, and the overall economics of the project benefit from reduced costs and/or increased production.

Limitations in sensor capabilities and, most importantly, the low throughput of the existing individual particle sorters is also a significant deterrent to application. A bulk ore sorting system, on the other hand, is much simpler, less expensive and has a much smaller footprint than the current individual particle sorting technologies available. The additional costs associated with bulk ore sorting are likely to be outweighed by the reduction in either downstream processing costs or by the increase in production.

**MORE INFORMATION:**

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ETSO has once again been awarded in the Chilean Ranking of Suppliers of the Mining Industry. Metso was ranked first place in the Mining Industry’s Best Performance Supplier of the Minerals Processing segment and third place in the Best Overall Performance Supplier of Mining. Phibrand – a company specializing in industry marketing – conducted the study for the fourth time in collaboration with Chile’s Ministry of Mining, the Industrial Suppliers Association of Mining (Aprimin), Chile’s National Mining Society (SONAMI), the Association of Engineering Consultants (AIC), and Editorial Group EDITEC, a leading publisher in Chile.

“It’s a huge privilege to receive recognition in the fourth consecutive study that places our brand at the pinnacle of excellence. The market is becoming ever more challenging, but we have managed to make a big difference for clients through our knowledge, people and solutions,” said Aldo Cermenati, Senior Vice President, Pacific Rim Market Area/Country manager Metso, Chile.

The study analyzes criteria such as levels of trust in the brand, quality of products and services, responsiveness to problems, and opportunities to meet future challenges.

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Our bottleneck used to be the SAG mill’s liner change, but now that’s just another maintenance job among the rest"

ANTONIO GÁMIZ
Plant Technical Director
Minas de Aguas Teñidas

The aim of the partnership is to reduce production downtime associated with grinding mill liner changes and maximize grinding efficiency over the life of the contract. “This solution will raise our utilization rate to a new level and will contribute significantly to our sustainable competitiveness in the challenging market situation,” says Timo Ikäheimonen, Planning Manager at FQM’s Kevitsa Mine.

As part of the life-cycle service agreement, Metso aims to increase the time between shutdowns through optimization of wear parts selection as well as decreasing the duration of shutdowns. Metso will take complete responsibility for the supply, installation and optimization of the mill liners.

MTSO HAS DELIVERED six track-mounted Lokotrack® jaw crushing plants to Shimizu Corporation to assist in a major landfill project being carried out in the 2011 tsunami area in the Tohoku region of Japan. The new-generation LT120™ jaw crushing plants are expected to crush 6-7 million tons of aggregates on a demanding project schedule. The LT120 plants will be operated as single units, producing 0-200 mm aggregates for landfill.

The earthquake and tsunami caused significant sinking of the ground level in several coastal areas in the northern part of Honshu Island. Before new construction works can begin, the level has to be raised by several meters with aggregates.

Shimizu is a major Japanese civil engineering and general contracting company specializing in post-tsunami civil works planning and execution. The LT120 plants were sold by Metso’s Japanese distributor UBE Machinery Co. Ltd., who will also take care of the service and parts-related tasks.

Metso has signed a three-year life-cycle service agreement with First Quantum Minerals’ Kevitsa copper and nickel mine in northern Finland.

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Metso made it possible to extract more profit per ton of rock by being smart about it.

That’s how we make the big difference, the Metso Way.

At Antamina, our process experts helped our customer analyze the impact of different ore types on production and product quality. Using Metso’s unique SmartTag™ ore tracking system they helped our customer develop a more efficient, integrated solution. This made it possible to increase production by 30% and reduce energy consumption by 20%.

Find out more about the Antamina mine optimization and how Metso makes the big difference at metso.com/showroom/mining

#TheMetsoWay