Courtesy of Orica

Improved data collection and fragmentation analysis technologies, such as those developed by Orica and applied at Boliden's Kevitsa nickel mine in Finland (above), are helping optimize blasting practices for the entire production process.

Smart blasting

Capturing, understanding and harnessing data is key to controlling blasting costs through continuous improvement

By Herb Mathisen

With a thorough understanding of the geology, it is time to begin planning the blast pattern and design. Then, drill the holes, load them with pre-selected explosives and charge the blast.

Now, as the shovel begins to fill trucks with ore to bring to the mill, it is time to get to work to figure out how to make the blasting even better.

There are many areas miners can choose to focus on to wring as much value from that rock for as little cost as possible. Some approaches optimize fragmentation to more easily move and crush the rock, while others pinpoint how the ore moved in the blast to ensure all of the valuable rock is sent through the mill.

Fortunately, there is a technology out there for whatever needs to be tracked: from site-wide software that details the financial impact of the blasting strategy on downstream stages of the operation, down to customized explosive loads that allow the targeting of different types of rock along the depths of each hole with more or less energy.

The common denominator with all of these products is that data is king: the more that can be captured and the better it is understood, the quicker improvements needed to optimize blasting and reduce costs can be made.

Planning the blast

BLASTMAP III, BME's blast-design tool, lets users plan out all aspects of their surface blasting. Customers can use the software to simulate a blast and also generate predictive vibration and fragmentation models from their blast design based on inputs that include rock characteristics, hole and explosive properties, timing, delay, pattern and spacing and more. "With the predictive tools, you can start to really optimize things as you gather and record more physical information," said Scott

Scovira, BME's global manager, blasting science. The more real-world results plugged into the software, the more robust and representative the models become. "You can continue to calibrate the different models within the program, so if somebody becomes an expert user with this particular tool, they really can get the best possible blast outcomes, based on the designs that they're using."

The software also has a costing model built into it, specifying how much the blast design costs in explosives, detonators and boosters. BLASTMAP generates reports from every blast, maintaining a record, which keeps miners from repeating past mistakes, said Scovira. "The drill and blast role at most mine sites has a fairly high degree of turnover and being able to pass that history from one drill and blast engineer to the next is really critical," he said. BME recently enhanced BLASTMAP with a burden relief feature, which aims to give miners a degree of control in the shape of the muckpile to make it most suitable to the methods they plan to use to move it.

Orica offers its own blast design software package called SHOTPlus as part of its digital blasting suite. SHOTPlus now integrates geotechnical data into the blast design process by supporting measure-while-drilling information from smart drills which enables rock hardness values and other geotechnical data to be used to determine the appropriate energy down the blast hole.

To zoom out on the effect blasting has on overall site costs, miners can use DataCloud's MinePortal mine-to-mill software that plugs in data streams from each part of the operation and links them together in one place. "I think anyone can look at single-correlation factors, but it's the interdependence between a number of factors that actually matters. It's a lot harder for us as human beings to just look at data and see," said North Jones, business solutions consultant with DataCloud. "Basically, our first step is bringing everything together and then looking for cause and effect."

MinePortal can let miners track a problem in one stage of the process and work back to find a solution. For instance, it can identify a contaminant in ore from one area that is causing processing issues and let the customer seamlessly blend that ore with ore from another area to reduce the contaminant's effects in the mill. "Instead of just spending money on the hopes that something has an effect down the road, we're able to quantify whether that effect actually appeared or not," said Jones.

A dashboard display lets users view their cost per tonne through each stage of the mining process. By spending a few more cents per tonne on blasting to fine-tune fragmentation, users may actually save five cents per tonne downstream. "In a lot of cases, there is still that siloing, so people are looking for individual savings and not necessarily looking at the bottom line of the company," said Jones. "It's nice to be the blasting manager and say you saved five per cent, but if you really cost the company more money overall, did you really achieve anything?"

Time to blast

When it is time to decide on explosives, Dyno Nobel's Delta E^2 lets miners pack each borehole with up to six different energy profiles. Jeff Averett, senior manager for bulk products and delivery, explained that miners can use rock hardness data gathered from a smart-drill or other geologic models and customize the energy profile of the explosives to specific types of rock in the hole, changing it up at different depths. "We're targeting

Courtesy of BME

BME's latest BLASTMAP offering includes a feature to help control the shape of the muckpile, suiting it to the excavation method.

that energy," said Averett. "It's pretty common that you might be over- and under-shooting in the same blast, so you're going to get a wider fragmentation range."

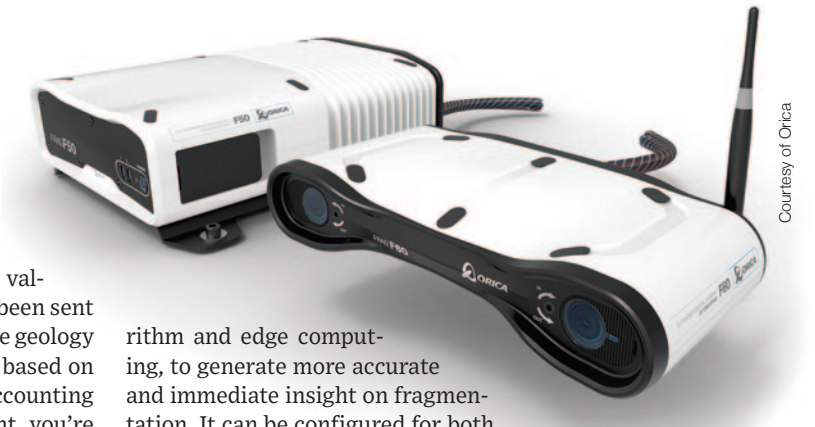
This technology, he said, is especially useful to differentiate between waste rock and the ore heading to the mill. "Even if the rock hardness in those two different areas might be similar, we can still lower the powder factor in the waste material because they just need to dig that and get it to a dump somewhere," he said. "We can essentially steal energy from the waste portion of the shot and concentrate that in the ore part of the shot automatically and keep the overall powder factor within a specific budget, or even lower it potentially," Averett said.

Customers can also use Delta E^2 to make up for drill constraints, by spreading out their patterns and increasing the power of the explosives in the holes. "We lower their drilling costs and can still produce good, or even sometimes better, fragmentation," said Averett, adding the extra blasting cost is more than made up by the savings in drilling.

After the blast

When the dust has settled, the Blast Movement Monitoring System (BMM) from Blast Movement Technologies (BMT) allows miners to monitor the movement of the ore from the blast. Sensors packed into separate planned holes send their locations below the surface of the muckpile to a drone buzzing overhead. This data is transmitted to a display that lets customers direct shovels to where the ore actually is. This reduces ore loss and dilution, ensuring more of the valuable rock winds up in the mill, not the waste pile.

Jeff Loeb, BMT's global consulting manager, said understanding what happened under the surface of the muckpile is crucial because rock movement varies by depth. "You might have an average movement of four metres. But in one part of the blast, it might move one [metre] and another part of the blast, it might move nine [metres], so you need to have multiple sensors in the shot to capture that variability and make sure that the translation's accurate," he said. "You need to be within about



Courtesy of Orica

Orica's FRAGTrack system includes binocular cameras and image processing software to generate immediate feedback on blast fragmentation.

0.3-metre accuracy when the shovel goes to dig that line, especially in a high-grade gold mine."

In a single blast using the BMM system, the Dalgaranga Gold project in Western Australia reduced ore loss by 19 per cent, recovering 2,874 tonnes of ore, valued at roughly $140,000, which would have otherwise been sent to the waste pile, according to BMT. "You have the entire geology team that's dedicated to delineating where the ore is, based on samples before the blast," said Loeb. "If you're not accounting for blast movement, or not measuring blast movement, you're basically just ruining all of that hard work and money that you spent trying to figure out where the ore is in the first place."

Loeb said this lets miners focus their attention on fine-tuning their blast designs to achieve the ideal fragmentation. "Whatever the movement is, it doesn't really matter because we're measuring it," he said.

When it comes to monitoring fragmentation, Orica has brought automated rock-sizing-measurement technology, FRAGTrack to market.

Raj Mathiravedu, Orica's vice-president of digital solutions, said, "this state-of-the-art fragmentation measurement device is designed to improve productivity and optimize drill and blast through the integration of fragmentation data into the drill and blast planning and design processes. This creates an opportunity for our customers to significantly improve downstream outcomes."

FRAGTrack is a plug-and-play system that uses binocular cameras, a proprietary hybrid 2D/3D image-processing algorithm and edge computing, to generate more accurate and immediate insight on fragmentation. It can be configured for both operating face-shovel, for continual assessment of particle size distribution at the dig face of a muckpile, as well as above the operational conveyor, allowing the determination of both volume and mass of material.

The system integrates with Orica's BlastIQ optimization platform to allow real-time online access to each blast.

The system tags each sample with GPS coordinates and associates it with a precise location and time in the blast area, enabling customers to understand the geological domain, blast boundaries and improving mining metrics such as excavation productivity and plant throughput.

According to Mathiravedu, "FRAGTrack is built on more than 20 years of history in fragmentation analysis technology internal to Orica, but we decided to develop this into a commercial system so we could enable our customers to deliver those gains themselves, as well." CIM