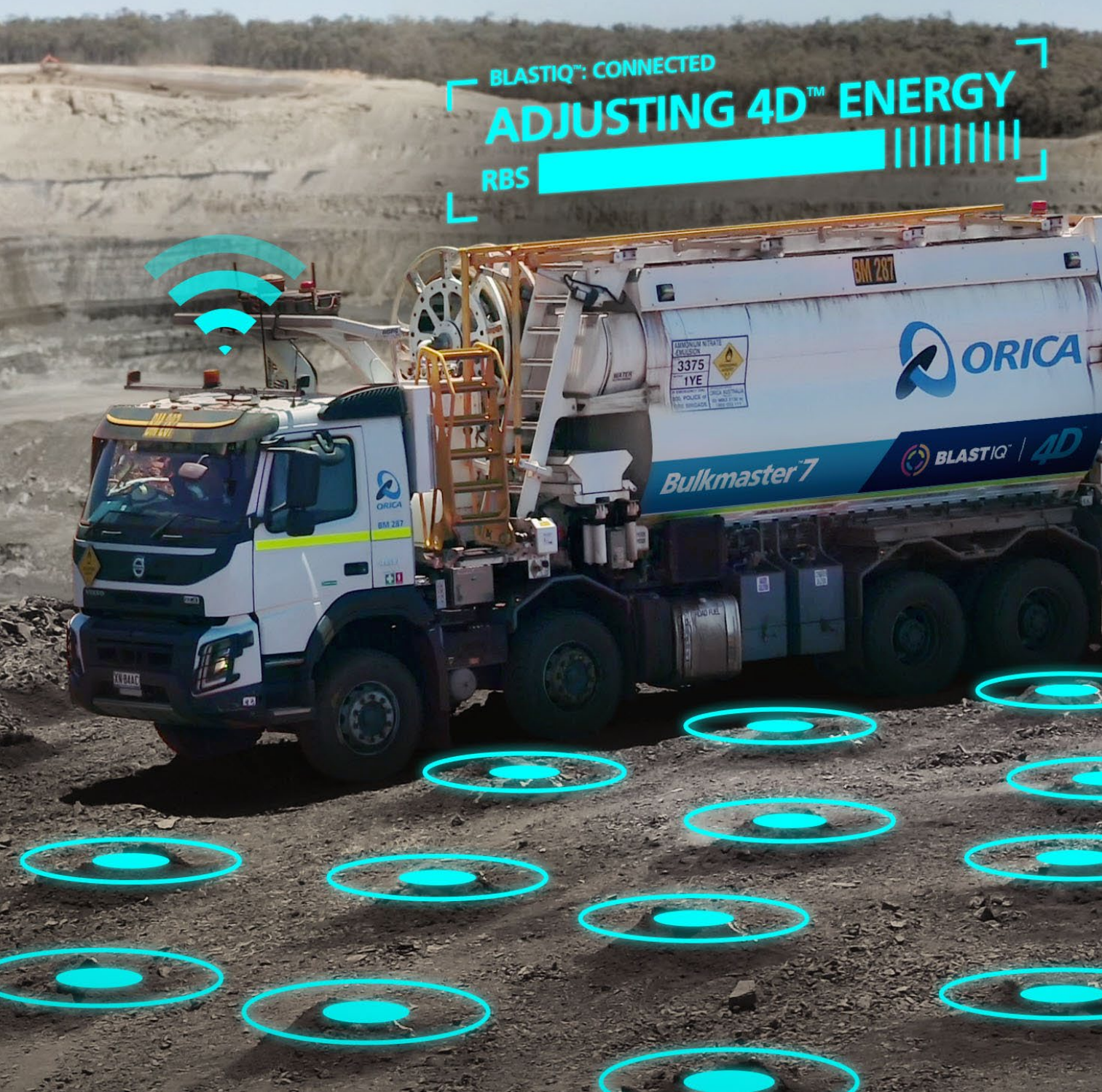
THE NEW DIMENSION IN BLASTING IS HERE



number of holes per round was from 9 to 30, the number of rows per round was 2 or 3, hole diameter was 150 mm (6 in.). Electric detonators were used. The hole-to-hole delay was 25 ms. The row-to-row delay was 92 ms. The booster was 150 gm (5.3 oz) Emulsboost. The explosive type was site-mixed emulsion.

For the blasts, overbreak ranged from 1.4 m to 10 m (4.6 ft to 33 ft).

The data from the blasts was fed into two software systems.

One did a statistical analysis, an Multivariate Regression Analysis (MVRA) that determined the statistical relationships of variables to arrive at a formula for overbreak. The other was a Random Forest algorithm (RFA). It "creates the forest with several trees of the subsection of data and combination of all of trees will produce the output." The output is the overbreak prediction.

WEKA software was used for the RFA.

The statistical analysis arrived at a formula the study concluded "will help in suitable blast design modification for minimizing the back break and optimizing explosive energy." If BB is back break (m), B is burden (m), S is spacing (m), ST is stemming length (m), PF is powder factor (m^3/kg), and K is stiffness, then $BB = 28.47 - 6.04 \times B + 4.28 \times S + 1.20 \times ST - 7.31 \times PF - 7.19 \times K$.

The formula gives a prediction of overbreak that proved to not be as accurate as that generated by the RFA. "The prediction of back break by RFA is close to the measured back break," the study said. "Random Forest Algorithm technique can be used efficiently."

Sensitivity analysis followed and found that "stiffness ratio and stemming length are most influential parameters." The authors reported having no ties or connections to WEKA.

Presplit Blasting for Gas Drainage

A study[3] conducted on the 1312 face of coal seam No. 3 in the Sanyuan coal mine in South China found that computer-optimized millisecond presplit blasting gave better gas drainage and significantly greater seam permea-

[3] Zhao, Dan (2021). Study on the Technology of Enhancing Permeability by Millisecond Blasting in Sanyuan Coal Mine, DOI: https://doi.org/10.1155/2021/8247382

New Explosives System Offers Control, Optionality, and Ways to Improve Production

BY JESSE MORTON, TECHNICAL WRITER

Orica reported the new 4D bulk explosives system delivers explosive energy tailored to geology and the desired blast outcome. "4D will enable our customers to access a wider range of energy-matched explosives in wet, dewatered and dry blastholes, delivering optimized explosive energy in real time," said Adam Mooney, vice president, blasting technology, Orica.

The system is comprised of new bulk emulsion chemistry that enables a wider energy range, hardware upgrades to explosives delivery systems, or Mobile Manufacturing Units (MMUs), for improved loading accuracy, and the Orica LOADPlus control system for greater efficiency and productivity. It allows users to go beyond traditional thinking when planning and prepping blasts, Mooney said.

"Blasting has traditionally been considered in three dimensions: width, length and depth; however decisions on the application of explosives are often one dimensional in relation to the powder factor being applied to the blast, which typically does not account for differences in geology across the bench," he said. "This essentially means that the same explosive blend and density of product are usually applied to each blasthole across a blast pattern."

4D changes all that by offering more optionality, greater control and improved productivity. "4D combines emulsion blended with ammonium nitrate porous prills to support both pumped and augered loading methods across dry, wet and dewatered hole conditions," Mooney said.

That ensures "greater on-bench productivity by Orica's fleet of 4D MMUs without the need to change raw materials in the MMU," he said. "Our customers can now apply a wider range of energy and respond to geology in real-time, regardless of hole condition to achieve their desired blast outcome."

The long list of benefits include "the real-time tailoring of explosives energy to geology across a blast, delivering improvements in fragmentation and a more consistent muckpile, on-bench productivity and an overall reduction in drill and blast costs," Mooney said.

On-bench productivity and efficiency is improved by reducing "the quantity of explosives loaded into wet holes, matched to geology, enabling more holes to be loaded per delivery," he said. That saves "precious turnaround time and enables the loading of more blastholes per delivery."

The ability to auger-load low-energy, water-resistant 4D explosives into dry holes provides sites with long sleep times insurance against adverse weather events, "giving our customers the peace of mind that blast performance will not be compromised," he said.

The advanced bulk emulsion technology gives up to a "43% reduction in relative bulk strength for soft rock or technical applications, and up to 23% more energy for hard rock applications as compared to Orica's current product ranges," Mooney said. "Customers can better control blast vibration while adhering to their maximum instantaneous charge weight."

Among other things, that means less "over-blasting in soft, wet ground, resulting in lower explosives consumption and overall blasting costs," Mooney said. "The improved energy distribution and the potential for increase in bench heights enables customers to improve the productivity of drilling and blasting and mining near sensitive structures while meeting license requirements."

By matching the energy to the geology and conditions, the user can reduce post-blast fumes. "With the capability to load lower-energy, water-resistant products into damp or wet blastholes, 4D reduces fume risk especially in softer geology," Mooney said.

bility than did conventional simultaneous presplit blasting or simple gas drainage through boreholes.

It reported that previous literature had proven that presplit blasting's effects on seam permeability and gas drainage "can reduce or even eliminate hidden dangers," but that same literature mostly fails to "consider the existence of gas in the coal seam" and, instead, is only on "the coal and rock mass as a solid medium."

Gas drainage in the 1312 working face has historically been difficult. The study therefore sought to arrive at a process that would work for that seam.

The authors squared away a section of the seam roughly 400 m from the working face as a test area.

First the authors used ANSYS/LS-DYNA software to optimize hole spacing.

The software found that blasts from holes spaced at 5.5 m to 6 m created cracks that, as desired, ran the distance between the holes. At 5 m, the damage between the holes was too great. Beyond 6 m, "the stress wave" combination effect is weakened and the holes then aren't connected by cracks. "Therefore, 5.5 m is selected as the best spacing to ensure the through-effect of cracks and save costs for the project," the study said.

The test area was divided into three parts, each separated from the others by roughly 35 m. On one part, three blastholes were drilled 5.5 m apart, and would be blasted simultaneously. "The distance between the observation hole and the blasting hole was 2.25 m," the study said.

On the second part, three holes, also spaced at 5.5 m, would be blasted with millisecond (ms) timing.

Previous field observations showed "the commonly used differential interval time is 15 to 75 ms, usually 25 to 30 ms," the study said. The software then was used to create numerical models based on 0, 17, 25 and 42 ms.

The models showed that "delayed blasting cannot change the energy produced," but the blasting can be "superimposed" by the delay, and "the action time" can "be prolonged to achieve the best blasting effect."

Based on the numerical modelling results, the authors determined

Multiple customers in Australia are trialing the system, "each with their own unique focus," Mooney said. "For example, with one customer, we are demonstrating how 4D technology can reduce their overall drill-and-blast cost through lower explosives consumption, as well as better manage vibration in specific areas of their operation."

Another customer is using it with Orica's Clear range of bulk explosive products to demonstrate the reduction of fume risk in soft and wet ground. "We are also responding to interests in the North American market with our 4D technology set to enter the region by early 2022."

New Orica MMUs will come standard ready for 4D. "4D is available on our Bulkmaster and Pumpmaster fleet of MMUs, which now include the Tread and Amerind supplied delivery systems," Mooney said. "This enables seamless deployment of the technology to our customers globally."

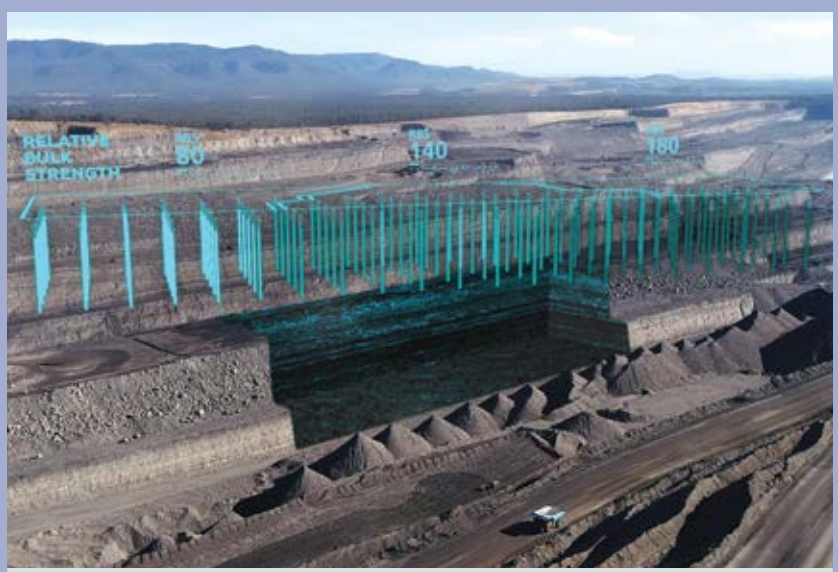
The system can be readily integrated with other Orica solutions for additional capabilities and benefits.

When paired with BlastIQ, a blast optimization platform, "the capabilities of both can be maximized to deliver the best blast outcomes far more efficiently," Mooney said. "Customers can gain a much deeper understanding of the geology and blasthole conditions to maximize 4D capabilities and effectiveness."

4D can be paired with SHOTPlus, Orica's advanced blast design software, to enable designs "based on the required energy, irrespective of hole condition," Mooney said.

"Blast designs developed in SHOTPlus can be wirelessly transferred via BlastIQ to the LOADPlus smart control system in the MMU to streamline the loading of blastholes according to blast design, thus eliminating the need for manual input," he said. "As-loaded blast data can also be transferred to BlastIQ with the continuous logging of MMU process drives for product quality control and assurance."

The advent of 4D "reinforces our commitment to technology innovation and is in line with our customer-centric technology roadmap and vision of transforming drill-and-blast operations to unlock greater mining value, and create safer and more productive blast outcomes for our customers," Mooney said. "Our 4D capability demonstrates how our new technologies and solutions can be easily integrated to enable our customers to think differently, mine more efficiently and operate more precisely."



Orica's 4D matches the required energy to rock strength in real time. (Image: Orica)