

Easy to use in the field, the process includes the installation of marking elements and the generation of photos using a calibrated digital camera.

A BIGGER PICTURE IN BLAST DESIGN

Advanced digital photogrammetric 3D profiling maximises safety, accuracy and cost-efficiency in blast design, writes **Carol Wasson**.

Consider that less than 30 years ago, blast design was nothing more than mere guesswork and the manual use of a plumb line. Today, blast design is in the midst of another quantum leap. Current developments in new advanced digital photogrammetric 3D profiling are being driven by environmental concerns, production requirements and the need to ensure cost-efficient and, above all, safe blasting methods.

It's a new day in blast design - and one that is energising experts such as Robert McClure of Ohio-based Ram Inc, an international blast engineering and consulting firm that focuses on improving productivity and safety through blast optimisation, advanced technical services and training.

Mr McClure has been involved in each phase of blast design growth, from the early days of electronic initiation systems to 2D and 3D laser profiling systems - and now with the further developments of digital photogrammetric 3D profiling. Currently, he is assisting 3G Software & Measurement of Austria in further refining its advanced systems to best serve the mining market. "Due to its ease of use and simplicity,

digital photogrammetric 3D profiling is the new method of choice for blasting services engineers or those who blast in-house," says Mr McClure. "Similar to laser technology, it's a non-contact measurement technique which eliminates the need to put workers in a compromised safety position," he emphasises.

Mr McClure says that there are many factors that determine a blast pattern. "From that pit wall, we will drill a borehole and that borehole will be based upon the height of the bench, the material that we are blasting, and the distances to the surrounding areas for vibration control. We know that within a given borehole, we can load so many kilograms of explosives, and that a certain amount of explosives can fragment and displace a certain amount of rock," he says.

Furthermore, he explains that depending upon production requirements, there may be a very close or tight blast pattern, or alternatively, a pattern that is very large or spread out. "If we don't get a borehole in the right place, we're going to have a problem. If we have too much burden, there will not be enough energy to adequately fragment and move the material. If the burden is too light, then you can have a dangerous

fly-rock situation and the potential for an accident. Mother nature creates all kinds of surprises in geological structures - and we have to design around them - so that is why I am involved with new photogrammetric technologies," he says, adding that the speed and capacities of both digital cameras and laptop computers have allowed its successful adaptation to mobile, in-the-field use.

As such, Mr McClure is working closely with 3G Software & Measurement to apply its BlastMetriX3D software in numerous mining applications.

Dr Andreas Gaich, company director of 3G Software & Measurement, says, "BlastMetriX3D is currently the fastest and most effective system for the complete survey of a bench face. Nevertheless, we continue to refine the system and extend its capabilities, first of all taking the feedback of customers into consideration. Since customers use the system in many different countries, their wishes are quite different."

The continuous development of the system recently led to the integration of borehole deviation measurements. "We linked the software intentionally to several suppliers in order to give the customer maximum freedom of choice," says Dr Gaich.

Since its market launch in 2006, BlastMetriX3D has been successfully used in Austria.

Germany, Switzerland, Sweden, England, Ireland, Spain, Slovenia, Croatia and Romania, as well as the United States of America and South Africa. And the software package has netted its manufacturer several prestigious awards.

"Bottom line, the system facilitates 'proactive' blast designs. We can make adjustments as to where to place the boreholes, and to know exactly how much material is in front of that borehole. For example, if we drill too deep, we've wasted money in drilling and blasting costs, and the explosives that are detonated result in excessive vibrations as there is no adequate relief."

Mr McClure says that someone with a good understanding of blasting can ramp up very quickly to utilise all the facets of the software and acquire accurate face profiles. "It's also compatible with many auto-cad mining programs out there, so you can actually transfer information, or whole co-ordinates. There is a lot of flexibility," he says.

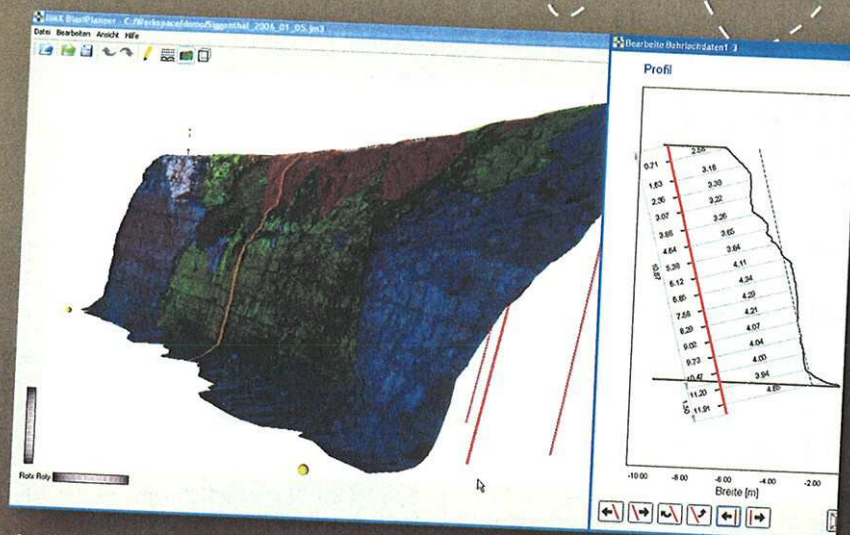
HOW DOES IT WORK?

The system consists of a calibrated SLR camera, a changeable zoom lens, markers, 3D reconstruction software, 3D software for blast planning and a notebook computer. The workflow process consists of setting up the markers, taking pictures of the area using the calibrated off-the-shelf camera, generating a 3D image on the computer, planning and optimising the blast, and printing the borehole plan and profiles.

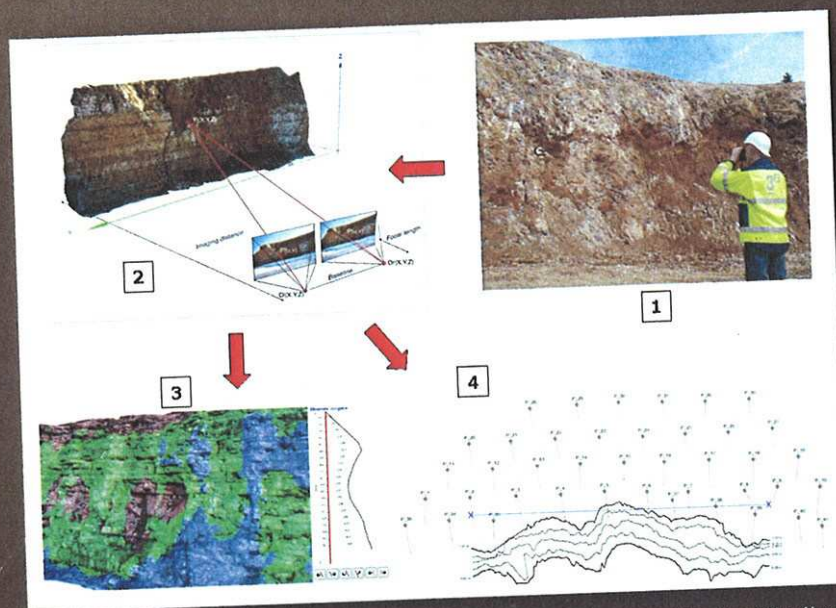
The digital camera serves for data collection at the site. As a system component, the camera is calibrated, making it a measurement device. The blast areas can thus be taken by two photographs from different arbitrary positions, without the need for additional surveying. Then the BlastMetriX3D software generates a three-dimensional image (topography plus photo) from the two photos showing the geometry of the bench very accurately and forming the basis for the drill pattern.

"The actual high-resolution digital 3D stereo image gives us a perspective on the blast that we do not get from any other technologies. The pictorial display allows us to colour code, rotate, and zoom in and out, while giving us a 360-degree view of the minimum and maximum burden around the boreholes," says Mr McClure.

Once a 3D image of a rock wall is ready, it can be interactively inspected with the BMX BlastPlanner software, and the blast



A snapshot of the BlastMetriX3D software



From two freehand photos, (1) a 3D image is generated for (2) planning and optimising the drill pattern of a blast. The result includes (3) the 3D image, profiles, minimum burden and (4) the drilling plans.

can be designed. By inputting some fundamental geometric parameters of a blast such as burden, side spacing, or desired inclination of boreholes, the resulting profiles ensure that face irregularities can be optimally considered, and that the loading of the boreholes can be optimised according to the bench face geometry. The blast design software allows one to enter the locations of the boreholes relative to the established reference points, along with the inclination and depth. The software generates standard profile drawings and the burden information can be displayed as

colour coding on the 3D image. According to the manufacturer, the great advantage of the system is that it allows the operator to combine both survey information and images, allowing for the blast hole explosive loading to take into account both burden and geology at the same time.

An additional use of the system is the comparison of 3D models before and after blasting for the determination of the blasted volume and the assessment of the face quality.

The manufacturer states that it generally requires less than an hour to take the photos, generate the 3D image and create the borehole

plan. The whole process can be done on-site on a mobile computer mounted in a car or truck.

PHOTOGRAMMETRIC VS LASER TECHNOLOGY

Whether photogrammetric or laser, either is a huge advantage over manual operation, says Mr McClure, who estimates the use of 2D laser technology as fairly significant in the quarry market. "I would guess that the use of 3D technologies would not exceed a single-digit percentage of operations at this time," he says.

He says that upgrading from manual operation often occurs after an accident, as manual operation requires a worker to be tethered at the wall. "At that point, many operations opt for 2D laser technology, which is the most inexpensive route. But it doesn't give you the big picture that you really need, as it just allows you to shoot one simple cross section," he says.

Although it is an excellent tool, Mr McClure says that the only disadvantage of 3D

laser technology is that it is an advanced, cumbersome system that requires a technician with a very strong background in laser profiling.

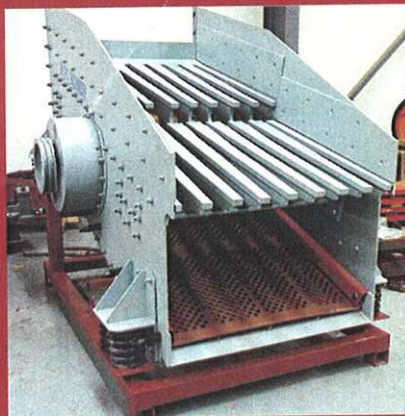
However, the biggest shortcoming to laser technology is its inability to identify certain material consistencies such as mud versus rock. "The laser range finder will map out the XYZ coordinates but it does not identify material type. It will show mud as a solid - when, in fact, if we were to load explosives in a mud cavity, the whole mud zone could become a potential hazard as it does not have the consistency and competency of the geological structure - and that is a big concern in blasting," he says.

One of the biggest advantages of the 3D photogrammetric system is the colour coding. Mr McClure points to a scenario where the blast design may require four metres of burden. "The software will take the mean face value or the average face measurement and place boreholes accordingly. Then the image will be colour-coded.

Everything less than four metres will show in red, while green indicates burden at four metres and blue shows burden which exceeds four metres. So, in the software, we can shift the boreholes and as you do that the colour will change. This allows us to get the appropriate distribution and optimisation of energy. From this point, we can custom load our explosives which will then allow us to get the optimal result," he says.

But last and most importantly, the best in laser technologies and the use of new 3D photogrammetric methods allow the development of "proactive" blast designs. "In other words, let's profile it first and then lay out the boreholes. Then if we can't drill exactly where we want, let's go back in and profile again - and have good information on exactly how to load that borehole in the cost-effective and safe manner," explains Mr McClure. •

Carol Wasson is a freelance writer for the aggregate and construction industries.



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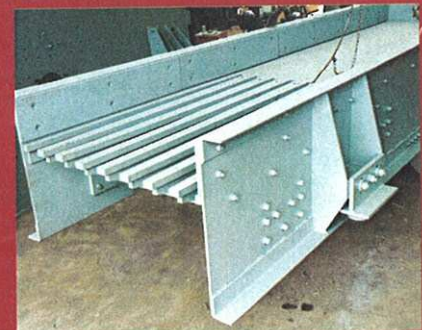
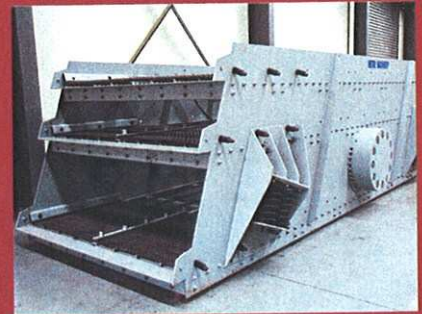
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