Mining
a division of IQPC

DRILL & BLAST

BEST PRACTICES IN DRILL AND BLAST

www.drillandblastevent.com.au

INTRODUCTION

With an increased industrial focus on cost reduction and operational efficiency in the mining sector, drilling & blasting operations are being conducted through more strategic avenues.

Mining companies recognise the need to improve analysis of site data, select appropriate tools and technologies, achieve higher fragmentation and improve exclusion zone management.

But what's being done and what can be done to realise these objectives?
Ahead of Drill and Blast 2014, **Mining IQ** has assembled insights into trends, frameworks and observations that reflect industry progress towards efficient and productive drill and blast operations.

TECHNOLOGY

Developments in information technology have gone through leaps and bounds, which have led to ripple effects in raising the standards of technology in drilling and blasting.

In drilling, there is now available advanced use of GPS guided drilling systems that continue to grow and improve precision and efficiency. Drill depths are accounted for more accurately, making it easier to assign the right amount of explosives in blasting.

New GPS-enabled applications have improved strata recognition capabilities that help drill and blast engineers develop more appropriate and more suitable blast designs. Engineers can create designs in the office and upload them to the drill rigs by remote means; drillers can see the patterns from their drill rigs as sent by drill and blast engineers from the offices.

Engineers can monitor and follow up drilling progress in real-time from the offices, from any location, depending on how they are connected. Blasting has also seen improvements; IT related advancements enable blasting practitioners to be able to blast from remote locations.

SELECTING COST-EFFECTIVE AND APPROPRIATE EXPLOSIVES

It is crucial to combine all parameters – inclusive of selection of explosives, rock properties and surface blast design – to devise efficient and cost effective blasting that achieves desired degrees of fragmentation.

Developing a practical approach to selecting explosives includes:

- Evaluating the rock characteristics as best as the available data allows;
- Identifying explosive characteristics required to break that rock to give optimum fragmentation;
- Choosing the most suitable explosives based on required characteristics;
- Running trial blasts;
- Conducting field observations and reviewing findings:
  - High speed photography
  - Vibration and noise monitoring
  - VOD measuring
- And implementing changes to improve.

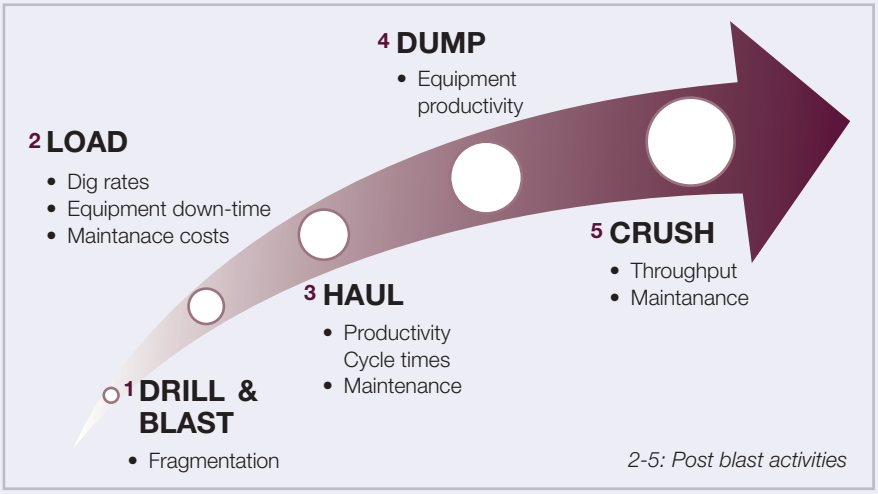
It is crucial that a selected explosive is:

- Readily available;
- Given technical and after-sales support and;
- Favourably priced and organisations can leverage upon scale to negotiate lower prices.

FRAGMENTATION

The key objective is to deliver a product that is broken well enough to maximise crusher throughput. That positions fragmentation as the main influence to performance of downstream activities in a mine.

As a consequence, the profit of a mining operation can be greatly improved through optimised fragmentation. Other unit operations can be greatly assisted by altering blast induced fragmentation.



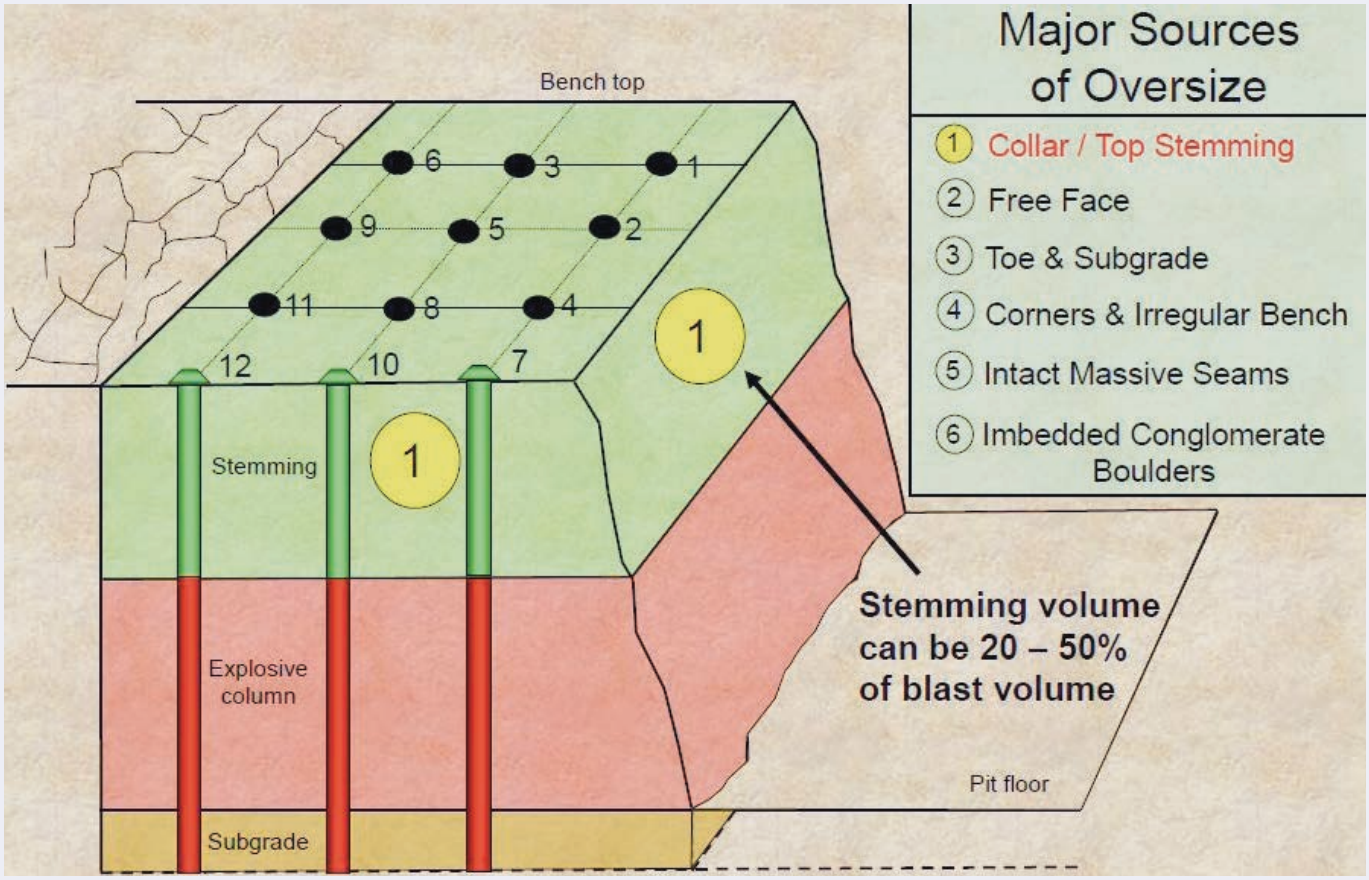
FINE MATERIAL

Excessive fragmentation, often a result of higher than optimum powder factor, leads to generation of significant amounts of fine material. While this will not be a problem for waste removal, it can have negative economic impacts on processing efficiency and the value of the product.

Coal fines:
- Are difficult to handle and present safety risks (respiratory disease/ explosion);
- Suffer low yields;
- Can carry excessive moisture and;
- Attract lower sales price.

Iron ore fines:
- Attract lower prices than lump ore and;
- Need pelletising to improve value (additional input cost).

Gold ore fines:
- Are prone to free fine gold losses through inadvertent washing by water and;
- Can impede leaching operations.



OVERSIZE

Under-blasting can lead to significant amounts of oversize rock which cannot pass through the crusher and will require size reduction before being taken to the crusher.

Conducting fragment break-up is costly and needs secondary blasting or use of a mechanical hammer for rock disintegration.

Oversized fragments at an iron ore mine in Western Australia

UNIQUE FACTORS THAT INFLUENCE FRAGMENTATION

1. By increasing the powder factor conventionally, there will be some improvement in fragmentation. However, if the explosives are redistributed by taking a small portion from the main column and placing it into the collar zone, it will improve the fragmentation in the stemming area dramatically.

In 250mm or 270mm diameter holes, the amount of explosives required in the collar zone, as a stem charge, is only between 30kg to 60kg. For some operations, the collar zone could represent anywhere from 20% to more than 50% of the tonnage of volume in a blast block that has no explosives.

If powder factors are increased conventionally, there won't be a significant improvement in the fragmentation. A large improvement will only be achieved by redistributing a small amount of explosives in the collar zone.

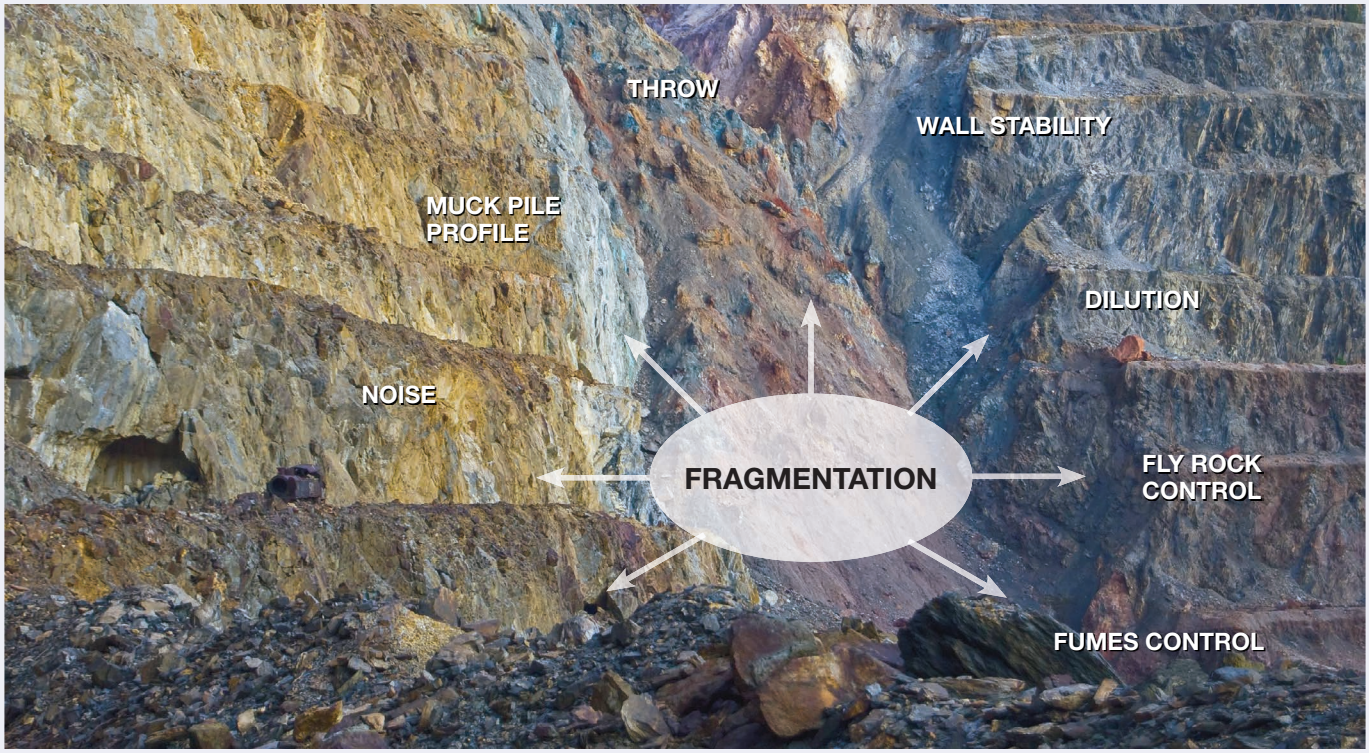
2. When it comes to primers, using only one or two in a hole is acceptable. However, if multiple primers are used, especially if there's a very long explosive column through which they're equally spread, there will be significant improvement in fragmentation.

Three main benefits that result from multiple priming include dramatically increased fragmentation, substantial casting improvements, and complete elimination of oxides of nitrogen fumes.

3. A major problem lies in the field controls, particularly when loading wet holes to eliminate explosive contamination and dilution.

OTHER FACTORS

It's important to conduct blasting operations within a framework that considers multiple blast outcomes:



TRENDS IN FRAGMENTATION

A global trend is emerging in which mining companies are subcontracting out the total blasting services (including drilling). Some companies have even subcontracted all work functions at the mine and processing plant.

Over time, mine management becomes fully reliant upon their explosive suppliers, to the extent that all in-house blasting expertise is permanently lost.

However, there's increasing interest in optimising all blast requirements and objectives in the primary blast design. It's often the case where operators skimp on the blast design to save money; but this leads to costly problems including floors, highwalls, vibration and fumes.

Furthermore, achieving optimal fragmentation distributions to satisfy plant requirements plays an important role.

A mine can be set up in one of two ways; either the plant is set up to accept whatever fragmentation the blasting group produces, or the plant dictates to the mining teams the fragmentation distribution they will accept.

To achieve what the plant wants, electronic detonators are required. Without them, this will remain unattainable, regardless of the blast design. With the electronic detonators, the explosives need to be redistributed by putting a stem charge in the collar zone, use very short delays of one to two milliseconds, and use multiple primers.

Each of those three by themselves will improve fragmentation closer to what the plant wants, but if all three are used, holistic achievement is guaranteed.

"A lot of people don't do things right in the primary design, so they end up with oversized rock that you can't even get into the primary crusher. So they have to go back in and use an impact hammer, or they have to blast it again to break it into smaller pieces."

– R Frank Chiappetta, Explosives Applications Engineer and President of Blasting Analysis International.

AIR DECKS

Air decks can be used at the bottom of a hole, in the centre of an explosive column, or at the top of the explosive column. If a bottom hole air deck is used properly, it will minimise the subdrilling.

A mid column air deck will improve the fragmentation in the centre of the bench, and a top air deck will get more energy distribution into the collar zone. A top air deck will not be as effective as a stem charge in the collar zone, but it will still produce some fragmentation improvement.

These three air decks are designed to improve fragmentation with fewer explosives. Every time an air deck is used, in a 250mm or 270mm hole, it is possible reduce the amount of explosives by one to two metres per hole.

STRESS WAVES

Another method to improve fragmentation relates to the application of stress waves, but it can only work by using electronic detonators. Traditional methods focused on non-electric systems, where the shortest hole delay possible was approximately between 9 and 42 milliseconds.

However, when using electronic detonators, operators have the capability of programing a hole delay to have only 1, 2, or 3 milliseconds between holes. When this is undertaken, more of the available energy in the explosive column is utilised.

The shock waves produce much better fragmentation between any two adjacent holes in a row, rather than to waste energy in the form of unwanted ground vibration, air blast or flyrock. Many surface mines in Chile are using stress waves in blasting operations.

EXCLUSION ZONES – BACK TO BASICS

FUME MANAGEMENT ZONES (FMZS)

Developing and managing an effective blast fume and hazard management strategy is critical to safety and operational success. It's important to:

- Ascertain what the exclusion zones should be;
- Develop an effective communication plan to ensure that all parties involved know where the exclusion zones are and what times areas should be cleared and;
- Plan the clearance out in order to safely clear the zones, shoot the blast and get back to work as quickly and efficiently as possible.

"The Fume Management Zone is often the most difficult area to determine with any accuracy so many safeguards are built in and zones are expanded for the margin of error. The first priority is to make sure no one is in the path of any flyrock, dust or fume; the second is to make sure you are able to react to changing conditions and alter your clearance zones if necessary."

– Steve Simmons, Drill and Blast Coordinator, Anglo American.

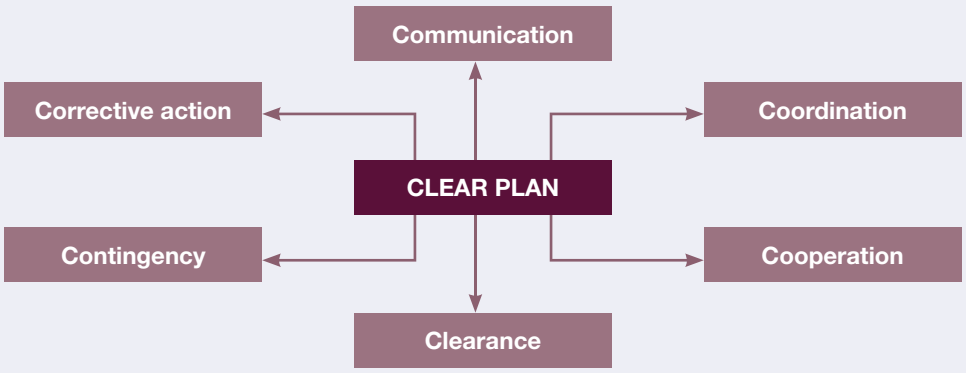
Developing an FMZ requires calculating the expected volume of fume, its expected path, and application of specialised fume modelling software. Plotting fume paths on area maps helps to identify affected areas and sensitive areas.

BLAST CLEARANCE

All time savings in clearance can only be realised at the front end – from shutting down pit up until firing of the blast. Controlling fume movement following the blast is not possible and the pit will remain closed until the "all clear" is established. Building the appropriate policy means it needs to be process driven, not people driven.

Blast plans are mandatory to ensure that blasts can be conducted safely and securely (it involves a risk assessment) and to ensure adequate control measures are put in place. It also assists in an investigation should there be an accident or complaint, and reconciling stock in the magazine should there be a discrepancy.

Blast plans also enable continuous improvement, providing benchmarks for future blasts of what worked well and what didn't.



CLEAR PLANNING

Blast Controller

One person in charge of clearing the blast zones

Blast Guards

Know exactly where they are supposed to go, guard locations marked on ground and Blast Controller physically confirm their locations

Blast Sweepers

- Know their route, know who they may encounter, know where people have to evacuate to
- Use multiple sweepers for large areas
- Pre - clear inactive areas

COMMUNICATION

Every stakeholder and potentially-affected party must be fully aware of the blast; from on-site employees to visitors, neighbours and the public. It's also important to ensure that the time, place and expectations are established from the beginning.

COORDINATION

Prior to the blasting day, it's important to schedule blasts to reduce equipment interactions. All teams involved require training and comprehensive understanding of their roles and the plan. There should also be sufficient availability of LV, gas monitors, loud speakers and related utilities.

On the blasting day, a pre-blast meeting is crucial to address if:

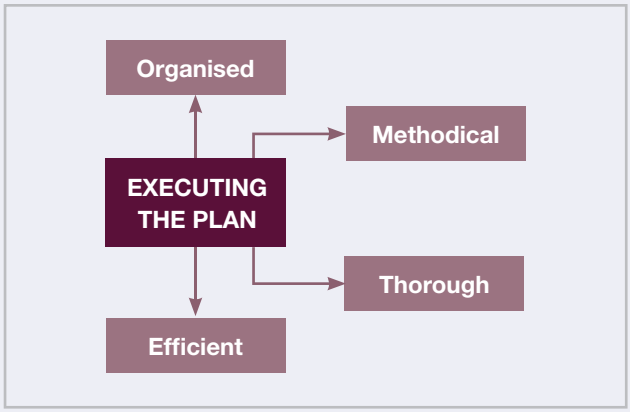
- The shotfirer is ready;
- Adverse weather is approaching and;
- Everything is operating optimally.

COOPERATION

Blasting operations require holistic buy-in from stakeholders down to line management and ground staff, and operations need to be ready to progress on time and shut down. Any delayed movements cause a ripple effect – clearance requires discipline.

Furthermore, contributions from everyone to ensuring complete clearance of people and equipment from blast zones, and machines are left in a way that they can be efficiently cleared, significantly reduces risk.

CLEARANCE



Machine operators and supervisors can assist clearance efforts by clearing machines and guarding area until sweepers conduct visual confirmation and secure the area. Rushing any stage of the operation leads to mistakes, including forgetting staff whereabouts, incomplete checks and increased danger levels to conditions.

CONTINGENCY

In the instance that unplanned or unforeseen variables occur and disrupt original plans, having a backup plan will allow improved recovery and faster adaptation to new circumstances. Have an alternate time or date and a go/no go threshold in order to deal with factors such as weather, equipment issues or lack of blast preparation.

CORRECTIVE ACTIONS

Evaluate execution of the clearance plan and identify the positive and negative qualities. If the clearance target time was not reached, conducting an investigation into the reason why will enable implementation of corrective actions for future blasts.

CONCLUSION

The rapid advances in technology are significantly influencing the way in which mining companies are conducting drilling and blasting.

There are specialised enterprise blast accuracy management systems dedicated to routine design and task management of drill and blast operations at surface mines. Simultaneously, new methodologies are being developed to enhance fragmentation, such as more focus on primary design and using multiple primers in blast holes.

Organising and managing exclusion zones is a critical component to the overall success of blasting operations, having direct impact on health and safety, operational expenditure and continuous improvement.

As more focus is placed on efficiency and productivity, technology and operational strategy will become an integrated asset in the mining industry for drilling and blasting.

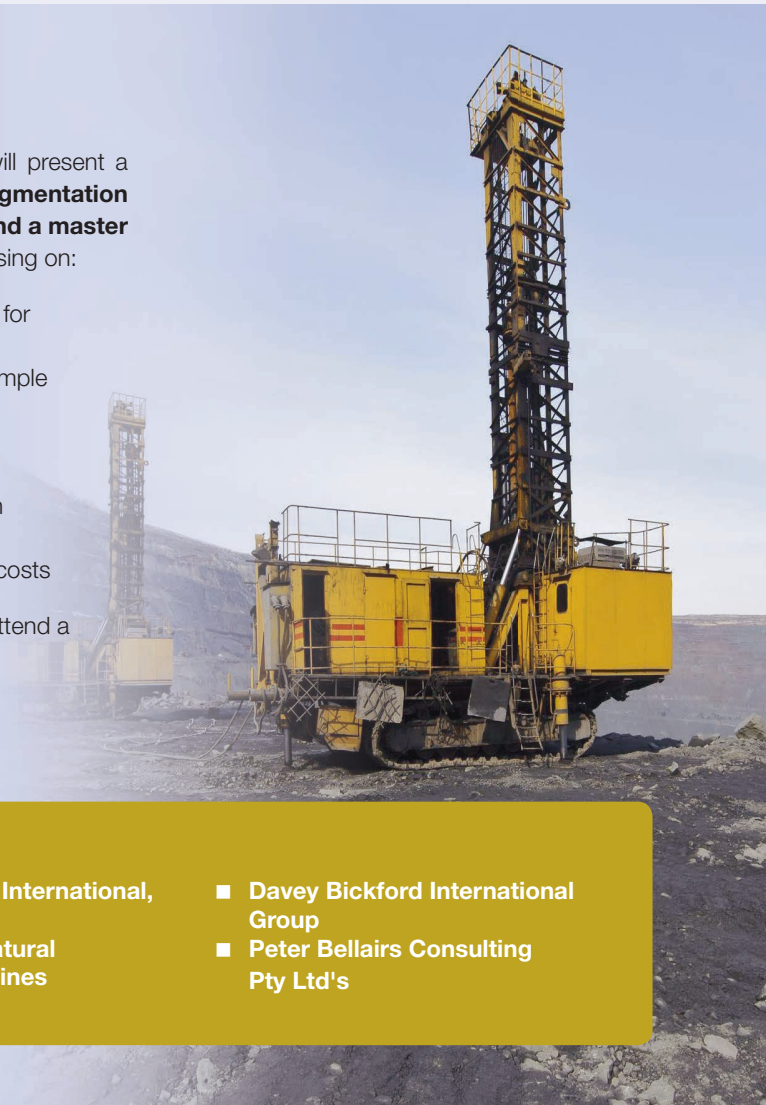
DRILL AND BLAST 2014

R Frank Chiappetta, President of Blasting Analysis International, will present a keynote address on: **Practical methods for achieving better fragmentation with unique blast designs which cater to the site conditions, and a master class session on: Optimising your drill and blast strategy**, focusing on:

- Necessary requirements to satisfy the fragmentation distributions for processing plants
- Stem charge and air deck blasting theories: applications and example calculations
- Determining the optimum hole, row and deck delays to increase fragmentation, casting and to minimise ore dilution
- Outlining problems with single hole signature analysis for vibration predictions, and how to handle this effectively
- Understanding blast design influence on the total mining system costs

Steve Simmons, Drill and Blast Coordinator at Anglo American, will attend a panel session on: **Future directions in drill and blast**, discussing:

- The increasing use of information technology
- Automation and its potential to solve skill shortages



ATTENDING COMPANIES INCLUDE:

- **Xstrata Coal – XCQ**
- **Anglo American**
- **Rio Tinto Coal Australia**
- **Leighton Contractors Indonesia**
- **CSIRO**
- **Blasting Analysis International, USA**
- **Department of Natural Resources and Mines**
- **Davey Bickford International Group**
- **Peter Bellairs Consulting Pty Ltd's**