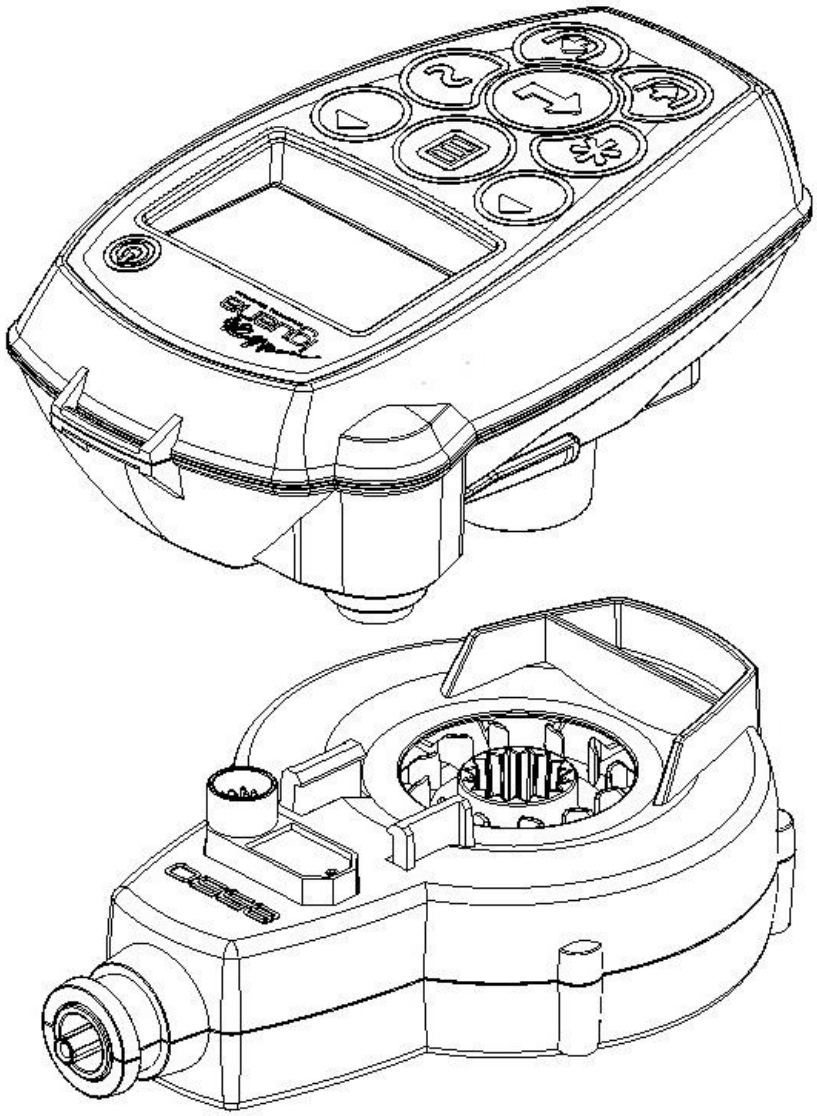
benchm8 8550 Deployment Options White Paper



iguana INDUSTRIAL SOLUTIONS

Version : 1·0

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Introduction :

Drill and blast is important·

No one denies that drilling and blasting is one of the most important processes in open cut mining and has huge impact on the cost of operations of a mine· Not getting it right creates safety issues, reduces the efficiency of excavators and crushers, increases fuel consumption and can create environmental issues ranging from fly rock through to fuming·

Are the holes drilled to plan?

It is widely accepted that the best way to ensure an optimum blast is to verify that the drilling is done accurately in accordance with the design· Many factors can affect a drill rig's ability to drill holes according to the plan· Holes may even have to be added in a different location because of the ground conditions·

Can't we just use drill logs?

Drill vendors are keen to suggest that drill logs provide a good indication of the actual hole depths and locations· Unfortunately, the drill logs aren't always able to reliably report the depth of the holes drilled with the required accuracy· There are various reasons for this, ranging from deflection of the drill due to ground conditions, through to inaccurate feedback on the drill rig sensors· Often drill depth measurement on the drill rig can be influenced by the position of the jacks·

The longer the interval between drilling and loading, the more important it is to verify the depth of holes· Drill tailings at the

top of the hole can be washed or blown back into the hole which reduces the depth of the holes.

These factors mean that the discrepancy between drill logs and true hole depth can easily exceed 1-2m in a 15-20m deep hole. In addition to this, drill logs cannot reliably indicate the presence of water in a hole or the depth of water. Loading ANFO into a wet hole can result in poor blast outcomes ranging from misfires through to dangerous fuming.

Tape measures work just fine... Right?.

One of the best things about a tape measure is that it's a pretty simple piece of gear. On many mines the measurement of hole depths is done with the good old fashioned tape measure. To make use of these measurements, the data has to somehow get back to the blast designers who can then use this information and decide if modifications to the blast plan are needed. In many operations, shot firers will measure the depths and scribble the numbers on a print out of the plan. This gets handed back to someone in the office who then types in the data to some software (often an Excel template) to get back to the designers. Needless to say, this is inefficient, error prone and hardly the best utilisation of highly paid mine workers.

Maybe a PDA/Tablet can solve this?

Many solutions have been developed that provide operators with an 'electronic clipboard' where they can enter the measurement data on the bench. While this reduces the data entry to a single point, it is still not ideal. Firstly, manual data entry is still present and this presents an additional opportunity for error.

Secondly and more importantly, the entry of data is difficult to do without putting down the measuring tape. This slows down the operation. In most cases two operators will measure the depths of holes and call out the measurements and identity of the hole to a third operator. The third operator enters the data into the tablet or PDA. This is not a productive use of manpower. It means a bench qualified operator is now performing a data entry task. If the third operator could also be doing measurements, the job could be done much quicker. As a simple illustration if there were 600 holes to be measured and each operator was able to measure 100 holes an hour, it would take a 3 man crew where one was operating a tablet, 3 hours to measure the holes. If all 3 operators were able to do measurements at 100 holes per hour, the job would be done in 2 hours.

This is a 33% improvement in just the measurement time. Something most companies would be very happy to have.

Priorities and fear of the idle asset.

On every mine there is tremendous pressure to ensure that the large, impressive and very expensive diggers and trucks are fully utilised. Any hold up in drill and blast is very quickly felt downstream. This pressure often results in shot firers and blast engineers being forced to take shortcuts that no one likes.

It is not as uncommon as it should be, to see operators measuring the depth of holes ahead of an explosives loading truck and calling out the depth of the hole. Loading in this situation is not being done to an engineering generated charge sheet. If a hole is out of specification, there is no way for a drill to be brought back for

corrective action as there are loaded holes in the area of operation.

If a hole was drilled too shallow and loaded to the specified collar, the blast would produce protrusions of hard material at grade level which can damage and slow down diggers and graders.

If the holes were drilled too deep, the resulting floor would be uneven. This will make the next drill and blast operation that much more difficult and error prone.

Worse still, on occasion, loading is done against the original blast design and no measurement is done. This is not something anyone likes, but it has been seen to happen. If a hole was too shallow but loaded as per the design data, the stemming collar would be too short and the explosives would be insufficiently constrained leading to poor fragmentation and a high likelihood of fly rock.

Drill and blast professionals prefer that charge sheets are generated from data accurately reflecting the conditions on the bench after the drills have completed the drilling operation.

Unfortunately, on many sites, the processes for getting the hole depth measurements back to engineering do not function in a timely manner. The most common problem is the double handling of the measurement data such as transcribing hand scribbled measurements into Excel or similar program. Another common issue is that it takes too long for the measurements to be done. Efficiency in the measurement process pays big dividends.

It is difficult to track the quality and quantify the value of a good blast. It is however, painfully easy to track and cost the

idle time of a large asset such as a digger or dump truck. This means that drill and blast teams often will do whatever it takes to be able to fire a shot and keep the diggers working. Even when this means compromising the quality of the blast. However, compromises in the quality of drill and blast affect just about every process downstream and reduce the efficiency and profitability of a mine.

How the benchm8 8550 fits in.

What does the benchm8 8550 do?

The benchm8 (pronounced 'benchmate') 8550 aims to assist the operator with the task of measuring the depth of holes. It automates the measurement task for the operator and stores the measurement data electronically. It takes away a great deal of operator manual handling and completely removes the need for manual measurement data entry.

Playing well with others.

The benchm8 system has an open and extensible architecture and this allows it to be easily integrated to a variety of operational environments. In this section we present four modes of deploying the benchm8 system. These range from utilising the system with its standard 'out of the box' functionality through to site specific integration including high precision GPS. These are of course only a few examples of what can be done and there is scope for site specific implementations.

Example 1 : Standard, 'out of the box' functionality.

The standard benchm8 8550 units allows the user to measure and collect the most important hole data. All this data is stored in a comma separated variable (CSV) file which can easily be opened with Microsoft Excel.

The image below shows an example of a standard data file opened in Microsoft Excel.

	A	B	C	D	E
1	IGUANA benchm8 HOLE DATA LOG				
2	SW Version : 1.1				
3	GUID:28424533-30303432-1000010A-61009763				
4	SerialNumber: 10A6197				
5	Cassette ID:000004-37A961				
6	Zero Offset:0.270m				
7	1/05/2012 13:07				
8	Row	Column	HoleDepth	WaterDepth	Time
9	G	41	16.2	0	13:10:16
10	G	40	15.7	0	13:11:47
11	G	39	16.5	0	13:13:07
12	G	38	17.5	0	13:13:44
13	G	37	18	0	13:14:24
14	G	36	21.4	0	13:15:02
15	G	35	20.2	0	13:15:48
16	G	34	20.5	0	13:16:37
17	G	33	23.1	0	13:17:23

File header

Hole Data

Figure 1 : Standard Data file

The key data for each hole is immediately visible. Each hole is identified by a row and column value. This is followed by the hole depth and water depth if there was water in the hole. This file is generated automatically and stored in the main body. There is no manual data entry of measurement data.

The operator follows a measurement sequence that is similar to the operation with a tape measure. Instead of the operator manually lowering and pulling up a tape, a motor in the unit runs the weight to the bottom and retracts it up to the top. All this functionality is in a rugged, ergonomic hand tool that slings across the shoulder of the operator.

No manual data entry is required in this measurement cycle. When the weight is retracted to the top, the measurement is displayed on the screen of the device and once the operator presses the 'Enter' button to accept this, the data is written to file automatically.

No special software or hardware is needed to access the measurement data. The benchm8 8550 unit connects to any computer with a USB port and the device appears as a flash drive on the computer. The data files can be directly opened in Microsoft Excel.

The image below shows the operational flow of the standard system with 'out of the box' functionality. The arrows are numbered to show the process flow in a typical chronological sequence.

Operational Flow

1. Blast design
2. Drill plan
3. Drilling performed
4. Measurement of hole depths by benchm8 8550
5. Data transferred by USB to Engineers PC
6. Charge sheets generated based on actual hole conditions.
7. Explosives loaded according to charge sheets.
8. Good control of process results in Great Blast Outcomes.

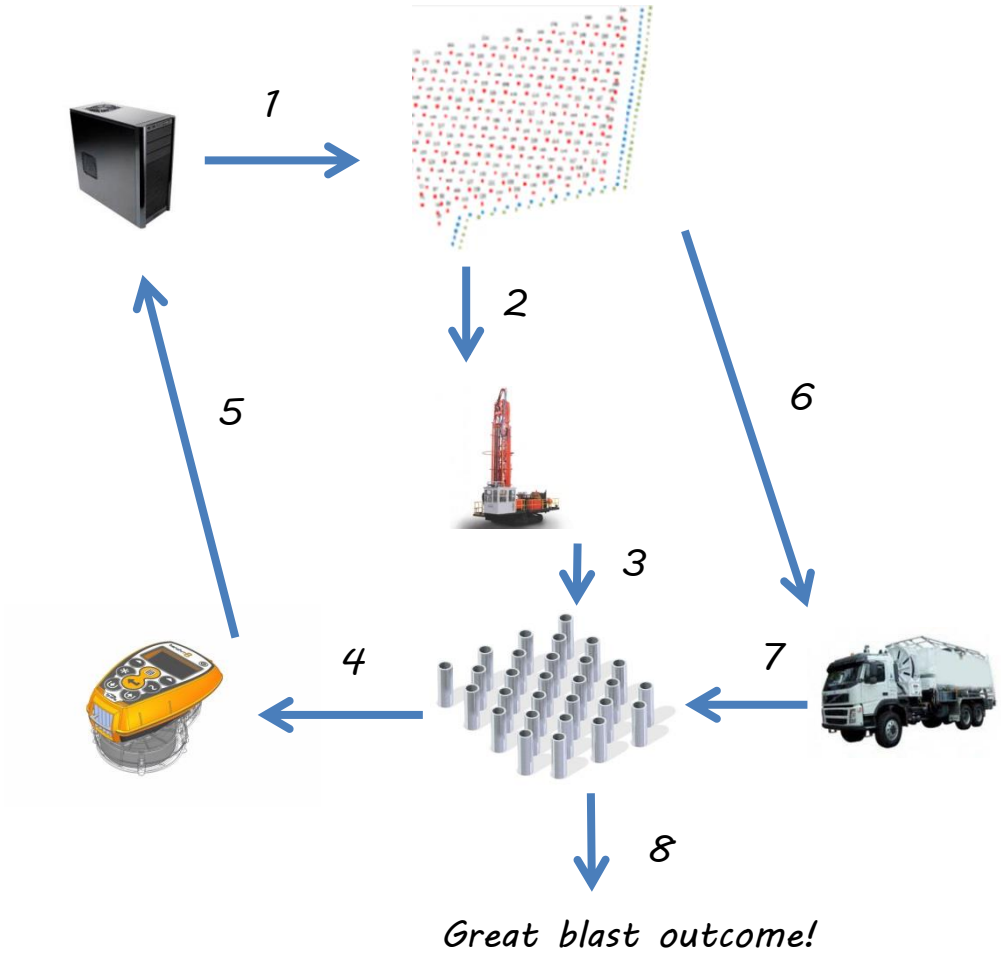

Figure 2 : Example 1, 'Out of the box' functionality.

The 'Out of the box' deployment strategy works well where:

- Hole IDs are in a grid that has a simple incrementing pattern.
- Operators are able to measure along a row or column of holes. In this scenario, the benchm8 8550 can automatically index the hole ID to match the physical hole ID. The operator is free to walk from hole to hole performing the measurements. The hole ID only has to be edited at the start of each row or column of holes.
- Operators are able to get the data back to engineering either by returning the benchm8 8550 unit to engineering or by extracting the data file and emailing or otherwise transferring the data files back to engineering in a timely fashion.
- Blast engineers have an easy process available for importing data into their blast design software to generate charge sheets. Most blast design software provide some functionality for this.

Operators do not need any technical skills to use the system which keeps training requirements low and ensures consistency of results.

Considerations for 'Out of the box' deployment.

- Hole IDs should have a naturally incrementing pattern that fits with the auto incrementing or decrementing capabilities of the benchm8 system. If this does not exist, the operator will frequently have to edit the ID of holes. For example, if the operator is forced to measure across an echelon, the hole ID sequences will be very disjointed. This adds some time to the measurement process. It should be noted that this is still faster and more efficient than writing

down the information with pen and paper or separately measuring and then entering the data into a tablet. Also, all operators are able to work autonomously and there isn't one operator wasted on data entry.

- If operators do not have an easy way of orientating themselves on the bench to identify the holes they are measuring, there is the scope for the misidentification of holes.
- The data on the benchm8 main unit is accessed by connecting the unit to a computer via USB. The data file can be emailed or copied to a shared directory. A mechanism for this data transfer to occur in a timely fashion must exist in order to allow engineering to utilise this data.
- Engineering must have access to a mechanism for importing the CSV data into their blast design software in order to generate charge sheets.

Scope for expansion

Iguana Industrial Solutions can provide site specific utilities as an option to assist with transferring data into blast design software packages. This would be in form of a software package installed on a PC that would read the benchm8 log files and send the data through to blast design software. There are a variety of mechanisms that can be employed for data exchange. This ranges from file exchange mechanisms (CSV or XML files etc.) through to transactional mechanisms such as web service calls using SOAP or JSON etc. Our extensive software expertise makes this integration a low risk and cost effective option.

Example 2 : Integrated with High Precision GPS.

The benchm8 8550 has a number of expansion interfaces built into the main body. Each unit has a serial port and a Bluetooth interface that can be used to integrate with other devices.

In this example, we look at the deployment of the benchm8 system with high precision GPS. Iguana Industrial Solutions can supply preconfigured, fully independent high precision GPS units that provide sub metre or decimetre accuracy. These units utilise an Omnistar subscription to obtain high precision corrections and are thus independent of mine base stations and radios.

Of course Iguana can also supply or integrate with GPS units that use corrections from DGPS base stations on site. The benchm8 is able to integrate easily with high precision GPS systems from Leica, Trimble etc. In most cases, the benchm8 would communicate with the GPS units via Bluetooth. A wired serial port is also available if necessary.

The GPS coordinates can be corrected to reflect mine coordinates which are used in the blast designs.

This mode of deployment is similar in many ways to the 'Out of the box' mode of deployment described in the previous section. The main difference is that hole IDs become redundant because holes are now tagged by the GPS coordinates of the hole.

The image below shows the operational flow of the system integrated with high precision GPS functionality. The arrows are numbered to reflect the process flow in a typical chronological sequence.

Operational Flow

1. Blast design
2. Drill plan
3. Drilling performed
4. Measurement of hole depths by benchm8 8550. Each measurement is tagged with the high precision GPS coordinates of the hole.
5. Data transferred by USB to Engineers PC
6. Charge sheets generated based on actual hole conditions.
7. Explosives loaded according to charge sheets.
8. Good control of process results in Great Blast Outcomes.

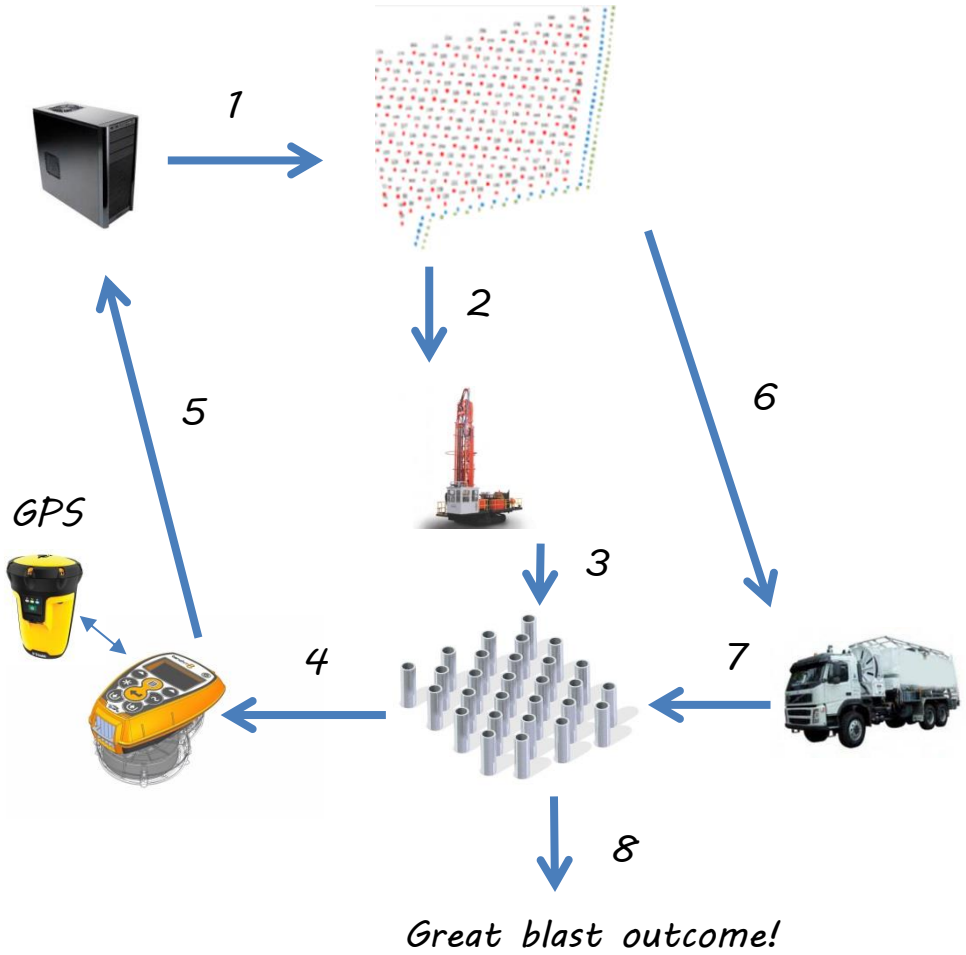

Figure 3 : Example 2, System with high precision GPS functionality.

The addition of high precision GPS does not change any part of the hole depth measurement or water depth measurement process. This is the same simple process. The operator now is equipped with another piece of hardware. Typically, the high precision GPS unit is in the form of a 'smart antennae' which has

all the GPS functionality built into a compact antenna that is mounted on the end of a pole. The operator carries this pole mounted antennae and sticks it into the drill tailings that form a cone around the top of the hole before performing the measurement.

When the hole depth measurement is written to file, the high precision GPS coordinates of the hole are written as well.

The data files are extracted by USB and are ready for importing into blast design software.

The Integration with High Precision GPS deployment strategy has the following benefits:

- Holes that are not in the correct position can quickly be identified.
- Accurate hole data can be collected even when there are no pegs or other hole identifying features on the bench. For example when holes have been drilled by driverless drill rigs.
- There is no need for the operator to be concerned with hole IDs. Having the hole measurements tagged with the GPS coordinates allows the measurements to be correctly associated with the appropriate holes in the design.
- The operator is not slowed down by hole IDs which are not sequential because the operator does not have to enter the ID of holes.
- Operators do not need any technical skills to use the system which keeps training requirements low and ensures consistency of results.

Considerations for integration with high precision GPS

- Decimetre accuracy is sufficient when the burden and spacing are more than 1 meter. It may be necessary to use higher precision GPS when smaller burdens or spacings are used.
- The best results will be obtained by the operators placing the GPS in the same relative position on each hole.
- Omnistar based GPS systems, require an initial fix on power up and this can take up to 15 minutes. Once a fix is acquired, there are no subsequent delays in obtaining readings. High precision GPS systems that use corrections from local base stations on the mine typically have much faster start up fix times.

Scope for expansion

Most blast design software have mechanisms for importing measurement data. If sites need assistance with this, Iguana Industrial Solutions can assist with utilities for this. There are a variety of data exchange mechanisms ranging from file exchange to transactional methods.

Example 3 : Integrated with benchm8 Visualisation Module.

The benchm8 system is available with a Visualisation Module. The Visualisation Module is a wearable computer that communicates with the benchm8 main unit via Bluetooth.

When deployed with the Visualisation Module, each operator is given a wearable computer in addition to the benchm8 8550 system. The Visualisation Module wearable computer is an Android based computer that is the size of a large mobile phone. The multi-touch interface and bright screen allow the operator to easily view and navigate the bench plans that are loaded. The

computer is lightweight and is unobtrusively strapped to the forearm. This allows ease of use whilst ensuring that the operator's hands are always free.

Before the operator goes out to the pit, the Visualisation Module is loaded with blast plans for the locations where the operator may be working. It is possible to define a 'mission' where operators are given a plan which they measure against. This allows engineering to check on the status of a critical part of a blast. It also provides a systematic means of defining a sample of the holes for measurement for quality assurance purposes.

The operator is able to see where they are on a bench by having a map of the plan on the Visualisation Module. The multi touch interface allows the operator to easily zoom in or out of the map and to sweep the screen to move around the map as needed. The holes that need to be measured and the status of holes is indicated by colour.

- Black : hole does not need to be measured.
- Yellow : measurement required.
- Green : measurement done and depth within specifications.
- Red : measurement done and depth is out of specification.
- Blue Line on hole : hole measured and found to contain water

The image below shows the operational flow of the system deployed with the Visualisation Module.

Operational Flow

1. Blast design
2. Drill plan
3. Drilling performed
4. Blast plan transferred from blast design software to Visualisation Module.
5. Measurement of hole depths by benchm8 8550. Hole IDs selected using map on Visualisation Module. Data stored on Visualisation Module.
6. Data transferred to blast design software from Visualisation Module.
7. Charge sheets generated based on actual hole conditions.
8. Explosives loaded according to charge sheets.
9. Good control of process results in Great Blast Outcomes.

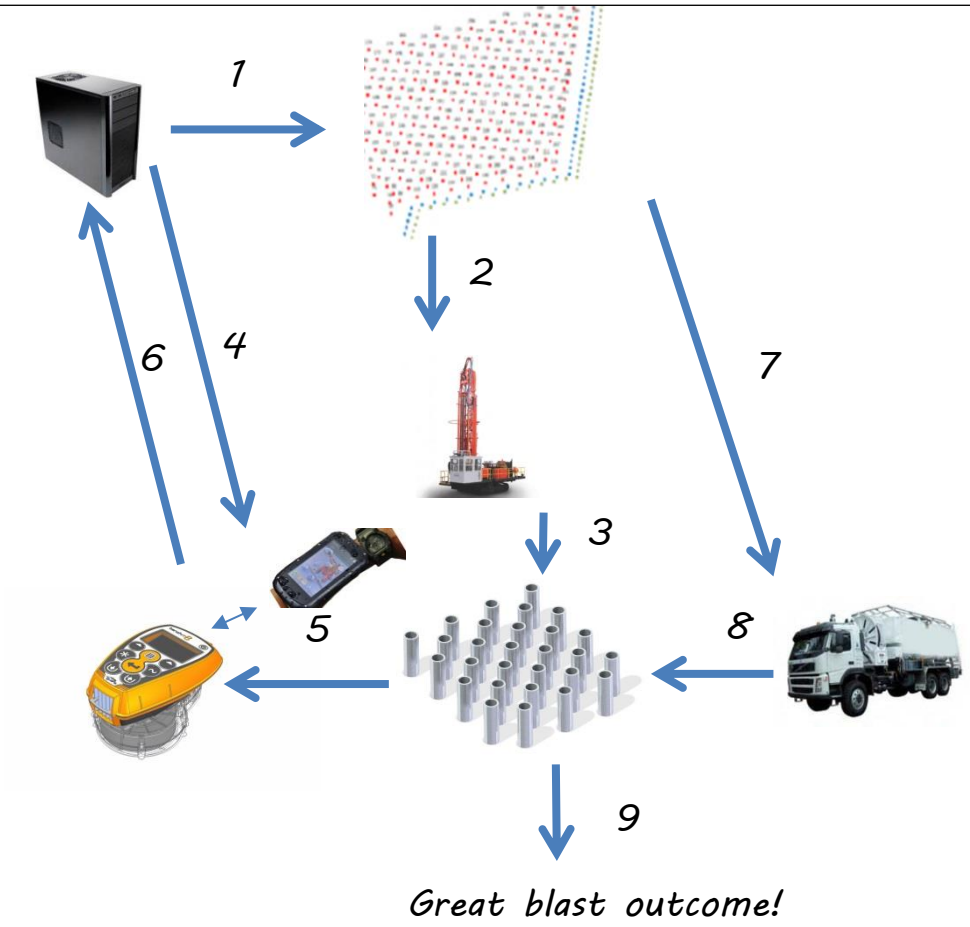

Figure 4 : Example 3, System deployed with Visualisation Module.

The deployment with the Visualisation Module has the following benefits:

- Because the operator has a copy of the blast plan, they can immediately see what the design depth is. This allows

discrepancies to be quickly noted. Timely decisions for redrills can more effectively be made.

- The Visualisation Module does not change the way that the operator performs measurement of holes. Hole IDs are not entered but instead selected from the map.
- If a hole that is not in the original plan is located, it can be created by selecting the location on the map.
- The Visualisation Module is similar to systems which provide operators with a tablet to enter data into. The big difference is that with the Visualisation Module, measurement data is automatically transferred directly into the record for the selected hole on the plan. There is no manual data entry.
- The forearm mounted Visualisation Module is more convenient and cost effective than carrying a larger tablet computer. This means that every operator can easily have one and be productive on the bench.
- Operators do not need any technical skills to use the system which keeps training requirements low and ensures consistency of results.

Considerations for the deployment of Visualisation Module

- The Visualisation Module is an Android based computer which is actually a rugged mobile phone. This means that it may not require management by mine IT as compared to a Microsoft Windows based computer. Iguana Industrial Solutions can fully support these devices remotely via the internet if required.
- It will be necessary to consult mine IT to allow Wi-Fi access for the Visualisation Module to communicate with the mine's blast design software. If Wi-Fi access is unavailable, data exchange via USB can be used.

Scope for expansion

The Visualisation Module software can be expanded to allow the operator to enter any other data that is of interest.

There are many options for data exchange between the Visualisation Module and the mine specific blast design software. Files can be transferred via USB or via networking methodologies such as FTP. Alternatively, transactional methods such as using web services can be employed. An upload or download of data can be done when:

a. the operator is in the office where there is Wi-Fi connectivity; or
b. if there is access to Wi-Fi networks in the pit, data for each hole can be updated in real time back to the blast design software server. This provides engineering with real time measurement data to work with.

An industrial Wi-Fi access point can be supplied which would create a standalone Wi-Fi network in the pit. Using this network, operators would be able to see the status of the measurements for all benchm8 units on the bench. For example, if three operators were working, each operator would be able to see the overall status of the bench including holes measured by their colleagues. This would provide a quick and up to date indication of what was left to do. This also means that any one Visualisation Module could then be taken back to the office to transfer measurement data to the blast design software using Wi-Fi or USB as appropriate.

The Visualisation Module of course can be implemented with other tablet or PDA hardware. For example, if a mine has existing

infrastructure in place and would like to integrate this with the benchm8 8550. Integration can be done with any device that has Bluetooth serial port capability.

Example 4 : benchm8 Visualisation Module and High Precision GPS.

It is possible to merge the solutions discussed in the last two sections. This is a system where the benchm8 8550 is deployed with the Visualisation Module and high precision GPS.
The options that exist for high precision GPS have been discussed in Example 2. The benefits of capturing the hole location together with the depth measurements have also been established.

Similarly, the advantages of having access to a map of the plan in a form factor that is graphically rich and leaves the hands free has been discussed in Example 3.

The image below shows the operational flow of the system deployed with the Visualisation Module and high precision GPS. In this image, communications with the blast design software is shown as taking place via Wi-Fi.

Operational Flow

1. Blast design
2. Drill plan
3. Drilling performed
4. Blast plan transferred from blast design software to Visualisation Module.
5. Measurement of hole depths by benchm8 8550. Hole IDs automatically determined using GPS coordinates of hole. Data stored on Visualisation Module.
6. Data transferred to blast design software from Visualisation Module.
7. Charge sheets generated based on actual hole conditions.
8. Explosives loaded according to charge sheets.
9. Good control of process results in Great Blast Outcomes.

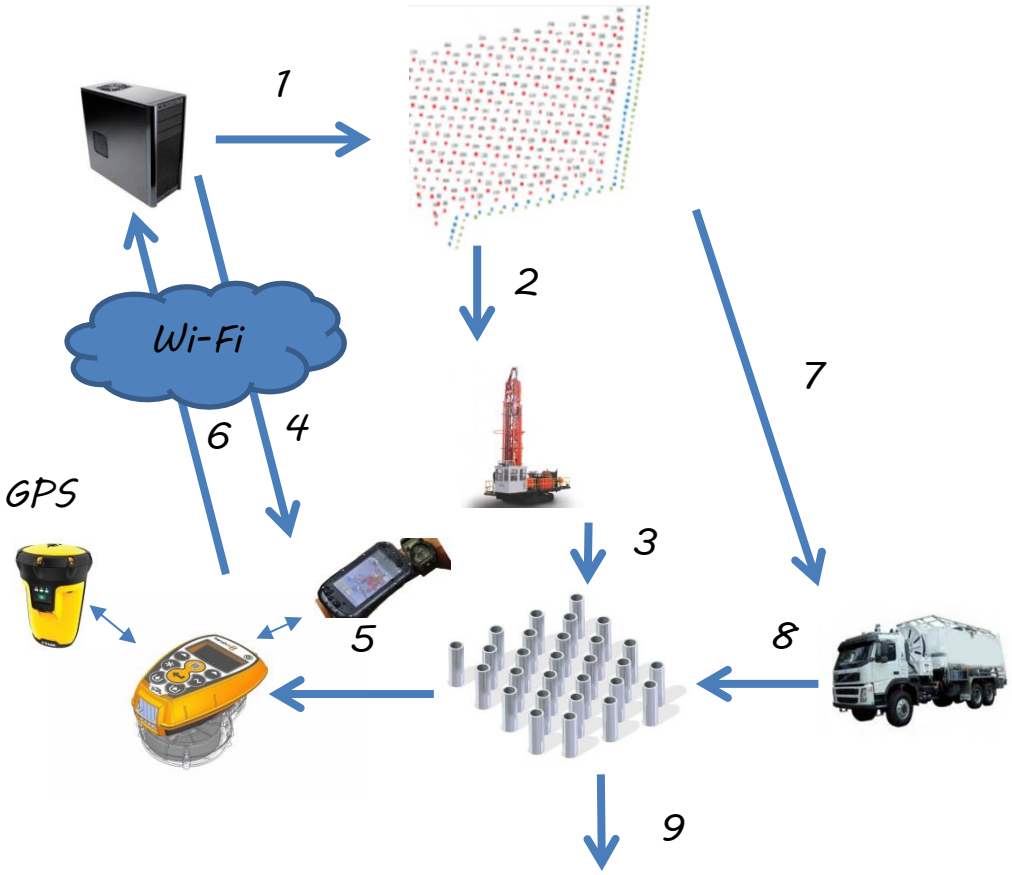

Figure 5 : Example 4, System deployed with Visualisation Module and High Precision GPS.

The deployment with the Visualisation Module and high precision GPS has the following benefits:.

- As with the standard Visualisation module, the operator has access to a map of the blast. With the addition of high

precision GPS, the map defaults to showing the operator exactly where he or she is on the blast.

- The scope for error in selecting a hole is significantly reduced because the Visualisation Module suggests the hole ID to the operator based on the GPS coordinates. If a hole is misidentified, it can take a great deal of time to reconcile where the error was made especially where there are no hole markings. Worse still if this mistake is not picked up, it can compromise decisions made based on these measurements.
- If a new hole that is not in the plan is found, its location can very accurately be entered into the plan. This is done automatically without manual data entry when an operator selects the 'New Hole' button.
- The Visualisation Module and high precision GPS do not change the way that the operator performs measurement of holes. This remains a simple operation.
- Operators do not need any technical skills to use the system which keeps training requirements low and ensures consistency of results.

Considerations for deployment of Visualisation Module and high precision GPS:

- The considerations for this deployment are the same as those discussed in Examples 2 and 3.

Scope for expansion

In situations where the existing blast design software has limited server capability, Iguana Industrial Solutions is able to provide PC based software to allow for smooth integration.

Iguana can also assist in the setup of wireless networks on the pit to assist in the smooth deployment of the system.

Conclusion·

The benchm8 8550 system has been engineered to be simple to operate but to have the flexibility and power to allow solutions to be scaled up·

It improves the drill and blast process in the following ways :

1. Makes the measurement of hole depth less labour intensive and increases the productivity of operators in the field·
2. Electronically captures the measurement data which removes manual data entry resulting in better data integrity·
3. Provides measurement data in a format that is easy to use by drill and blast engineers·
4. Allows easy integration with high precision GPS which reduces the possibility of misidentifying holes·
5. Can be deployed with a Visualisation Module that provides excellent clarity of the blast for operators· This helps improve productivity and accuracy in the field·
6. Flexible architecture allows for various deployment and integration strategies which are cost effective and low risk·

In this white paper we have presented some of the many deployment options that are possible· Talk to us, to see how the benchm8 8550 can help you get better outcomes from your drill and blast process·