DRIVING FORWARD WITH DATA

Neville Judd, Hexagon Mining, Canada, explores how surface drilling and blasting can be improved through drill hole correlation and data integration.

Drill and blast is the most important (and sometimes the costliest process in a mine), contributing greatly to the high cost trends of overall mining operations. Effective use of information to improve drill and blast processes can be the difference between an inefficient process and one that is optimised for costs, safety and desired fragmentation.

Mining operations have access to several types of data sets that include a multitude of different systems. This information can be used to improve, evaluate and apply processes for drilling and blasting. This may include different types of data from the different stages of the process (before, during and after the drilling and blasting operations), such as hole locations (planned and actual), penetration rates, drill operators, fragmentation (expected and resulting), explosive (design and usage), geology, vibration and others.

This information can be used on its own or combined for further analysis to reduce costs, improve safety and evaluate results. Improvements in mining software mean that drill and blast engineers can leverage this data and create reports to evaluate results and improve the drill and blast process. As users combine information from multiple datasets and establish standard operating procedures for reporting across multiple sites, the need for auditable, automated and sustainable workflows for handling the information becomes invaluable.

Hexagon Mining's suite of drill and blast solutions comprise rapid design and reconciliation tools for the entire drill and blast workflow. The company has helped mines to

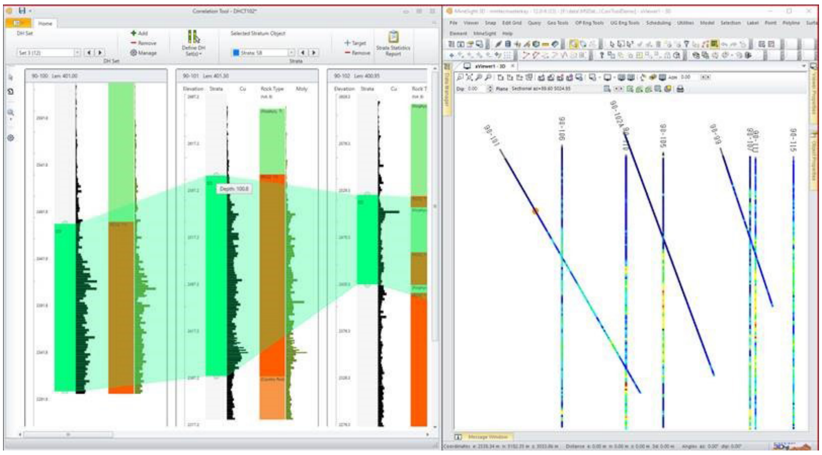

Figure 1. Stratigraphic mapping in Hexagon Mining's Drillhole Correlation Tool, using rapid streamlined design workflow.

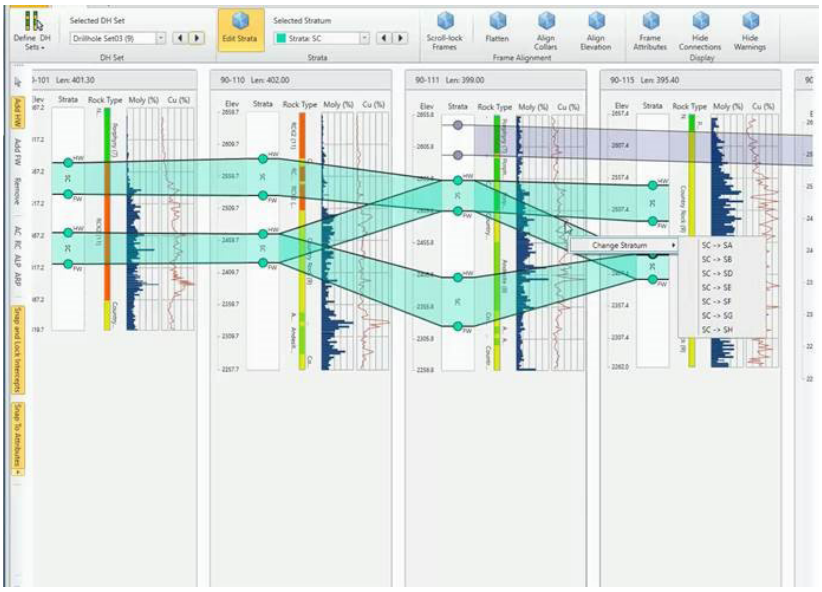

Figure 2. Integration between the Drillhole Correlation Tool and its MineSight 3D planning software for 2D or 3D visualisation.

standardise drill and blast information across multiple systems. Most recently, the company has focused its attentions on helping geologists tasked with correlating stratigraphy and lithology layers using drill hole data by introducing the Drillhole Correlation Tool. This article will cover the tool and the process of implementing a drill and blast workflow, using both data at a site and information available from the electronic data warehouse (EDW).

A clearer picture for geologists

Geologists working in stratigraphic deposits must consider numerous factors to create a clear picture of what lies below the surface. Downhole geophysical data, rock hardness, lithology, structures and assay information are among the features which must be correlated to interpret the stratigraphy and lithology layers. All these data sources need to be evaluated and aggregated quickly to make decisions and communicate results to operations or other downstream stakeholders.

To address this challenge, Hexagon Mining enhanced its MineSight mine planning software suite with the Drillhole Correlation Tool. The tool is integrated with the suite's drill hole database manager, MineSight Torque, and its flagship visualisation solution, MineSight 3D.

Users of the Drillhole Correlation Tool can view and analyse drill hole profiles using Torque's SQL database in 2D, and the integration with MineSight 3D allows them to also visualise that information in 3D.

Those who deal with stratigraphic deposits – coal, iron ore, evaporites – and who typically deal with drill hole correlation types of plots, will benefit most from this tool. Not only can they look at stratigraphic layers, they can bring in information from grade values, hardness data, geophysical data; lots of information that can be used to improve their understanding of the deposit.

Using assay, geology and geophysical information displayed in the tool, the geologist creates one or more intercept points to eventually form strata intersections along drill holes.

The drill holes are projected vertically and can be moved so that corresponding layers are aligned horizontally. The resulting intersections are uploaded to MineSight Torque as intervals for further analysis and use with other applications.

Better integration for managing drill holes

The tool integrates with MineSight 3D for managing sets of drill holes to be used for correlation. The 3D software is the foundation of the company's mine planning suite and visualises output from all its products. Its core functionality includes creating and manipulating 2D and 3D data, editing, querying and plotting/display of all types of geology and mining data.

As a geologist creates and edits intersection points, the Drillhole Correlation Tool uses an intuitive set of rules to automatically connect them to display strata sections. For complex strata formations, such as bifurcations and pinches, the geologist creates explicit connections between intercept points or marks intersections as pinches.

The tool includes a basic set of validation rules that warn the user when intersections overlap and when intercepts are inconsistently flagged as pinches in different drill hole sets. The strata statistics report can be used to obtain descriptive statistics on strata.

The tool stores its own data in a local file. However, because it integrates with Torque, the user roles and security model of Torque are also applied when accessing data or uploading strata.

Help for modelling seam deposits

The tool responds to feedback from geologists seeking this functionality to better model their deposits. It fills a gap in the planning portfolio for modelling seam deposits, such as iron and coal, and will certainly help any geologist working with coal and stratigraphic deposits.

The tool is included with MineSight and any user with a MineSight license can visualise the correlation plots. However, users must have a MineSight Torque license to create new sections.

The tool's simple user interface is built on micro-interactions and validations. It allows for a repeatable workflow, better interpretation and fewer mistakes with overlapping seams.

Further integration is key to the tool's future. Geologists can use the tool for basic analysis, but given the other solutions there is potential for more integration. For instance, the company's high precision guidance for drills will allow it to pull in additional information on penetration rates, hardness layers and softness layers.

The next steps will be to look at where the company can pull in this additional information and improve the workflow for users. Overlaying those different data sources into one visualisation tool will further help validate correlations.

Geologists will be able to work with correlations using downhole imagery to visually identify changes in stratigraphy. Seeing stratigraphic details downhole will add another dimension to complement the downhole analysis, thus helping geologists to develop a better understanding of their subsurface.

Ultimately, a combination of visual images, downhole data, and human training will help the company define algorithms that give a best fit correlation, saving geologists time, and allowing them to quickly generate more accurate models. More sources of data, including photometry, means that machines can be taught to generate good approximations.

Quickly and easily overlapping multiple sources of information will allow users to generate the basis of their stratigraphic model, which can be carried forward into the modelling procedure.

The company believes that drill hole correlation will help to enhance and establish the company in stratigraphic modelling. A complete solution, delivering good results while saving time, is the goal.

Summary of a drill and blast implementation case study

Combining information from a variety of datasets and formalising standard operating procedures for reporting across multiple sites, requires auditable, automated, and sustainable workflows. An EDW exists at some mines, performing the task of aggregating and standardising data formats. A data warehouse team extracts data from the source systems and transforms it so that it is meaningful for decision support.

A recent case study attempted to show how information can be used to make decisions and improve processes, using an EDW for managing drill blast information. The study outlined the process of implementing a drill and blast workflow, using both data at the sites and information available from the EDW.

Figure 3. Cuajone drills.

Figure 4. Cuajone blast holes.

The mining company manages multiple mining sites across the world that use different systems and sensors for supporting the drill and blast workflow. The solution for each site was different, but standardised extract transform and load (ETL) workflows were designed and implemented using the same tools. Hexagon Mining's mine planning software, MineSight, was used for transferring data from the source database to a destination blast hole database, and for analysis and visualisation of this data.

The mining company maintains a comprehensive EDW that provides consumers, with the correct permissions, access to standardised data in its central repository. For this implementation, fragmentation, explosive and drill systems data were used in conjunction with MineSight for aggregation, modelling and results evaluation.

Explosive data

The EDW is set up to store raw and aggregate data so that engineers can use this information for reporting or as part of the daily workflow. For example, information from the explosive contractor is converted from a csv file to a table in the relational database using an automated SQL server information service routine. This provides consumers with information on the explosive, shot, hole profile and water level. Once the information is stored in the database, it can be appended to the actual blast hole record and used for downstream calculations or planned vs actual shot reconciliation.

Fragmentation data

The fragmentation system includes an image of the muck pile with every bucket load and a timestamp of when that image was taken. The system is set up to automatically capture and analyse the fragmentation image, and then store that information into a database once it has been validated by an engineer. However, the actual fragmentation image is not georeferenced to a known spatial location. To obtain the location, processing steps link the timestamp from the fragmentation system with the shovel position at the time that image was taken. When joined together, this provides data users with both the tabular and spatial information related to the blast fragmentation. A blast hole model can then be generated with this fragmentation data using MineSight, to conduct analysis based on rock type or other geological characteristics. Thus, joining these two datasets provides a wealth of information that can be used to obtain indicators, such as dig rates, operator efficiency, among others.

Fragmentation data are typically visualised and reported in MineSight using the p80 value from the fragmentation system. The data are first extracted from the EDW and stored in the blast hole database (MineSight Torque). Once the data is in MineSight, it can be contoured, scaled and visualised along with the blast outlines and explosive data. This provides rapid feedback on where the blast has achieved its fragmentation goals and where there are challenges that need to be addressed. Along with the visual inspection, users can further analyse the results by looking at the relationship between the fragmentation, the rock type or other parameters.

The relationship between actual fragmentation and the energy used for the blast can also be visualised and reported. Although the energy between shots can remain constant, the resulting fragmentation can vary depending on joints, rock types or other factors.

Additionally, if it is discovered that the rock in some areas is harder than others, the explosive amount or type can be adjusted to achieve a more uniform fragmentation across the blast.

Although using the EDW provided many opportunities to standardise and streamline the workflow, challenges were encountered while using this data. These included timeout issues when running longer queries and data duplication when running ETL processes multiple times.

Conclusion

Standardising information across multiple systems for improvising drill and blast workflow adds value to the operation by allowing sites to make data-driven decisions that will improve production. There are additional opportunities in the future to add value to the system by migrating all the semi-automatic ETL processes and reports to fully automated routines.

Using actual data quickly via standardised workflows will allow engineers to have more time for analysing data and making improvements. GMR