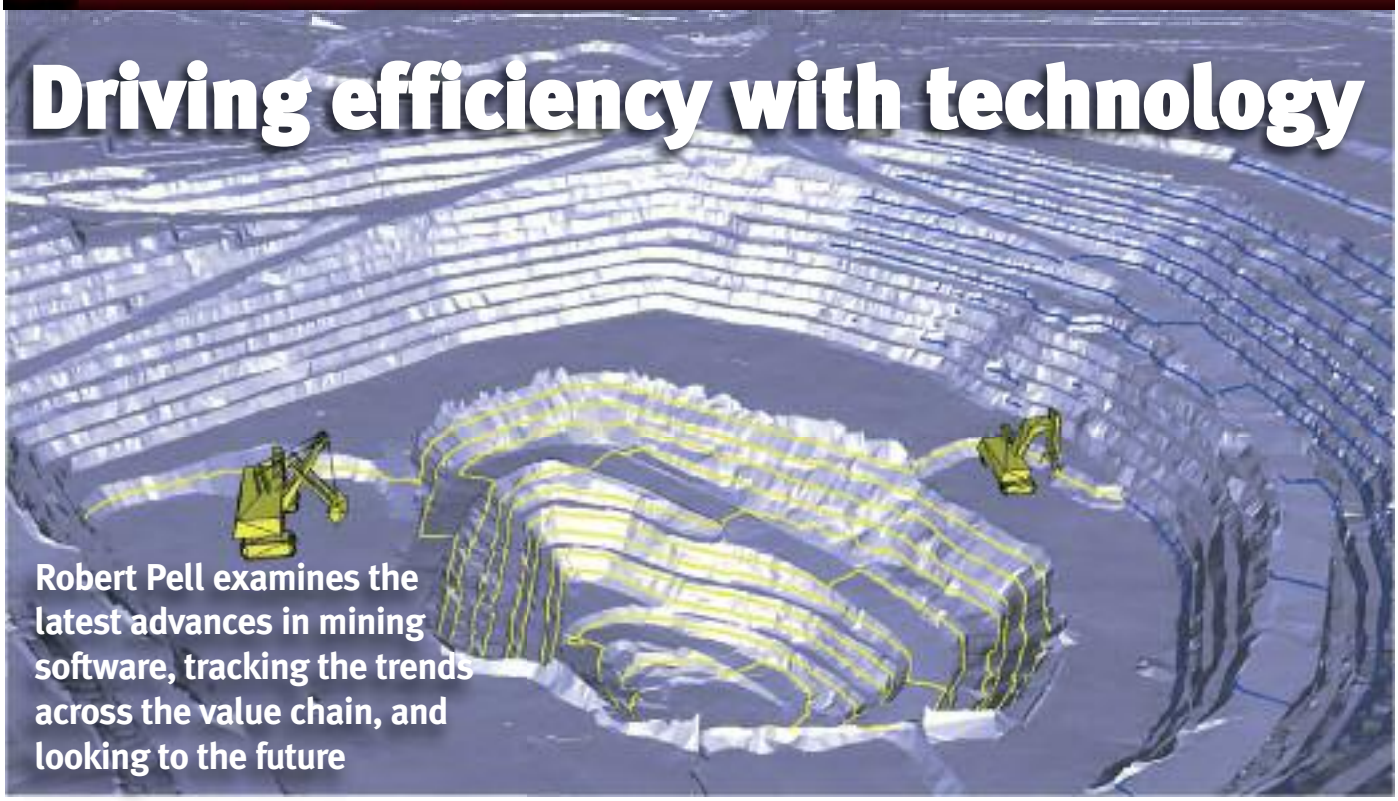
Driving efficiency with technology



Robert Pell examines the latest advances in mining software, tracking the trends across the value chain, and looking to the future

Connecting long, medium and short term planning

MineSight, an industry leader in developing mine planning and mine modelling software, is now part of Hexagon Mining. Hexagon says it "is the first global technology integrator to build a true mining vertical, with a span of technologies from exploration to operation." MineSight's capabilities in planning, scheduling and operational software are a great fit with Hexagon Mining's other technologies: fleet management and high-precision guidance from Leica Geosystems Mining, underground asset control from Devex and operational safety from SAFEMine.

Goldcorp is one of the largest gold producers in the world with projects in South, Central and North America. Goldcorp's flagship operation is Peñasquito, a worldclass, polymetallic deposit that started production in 2010 which is one of the largest mines in Mexico. Since the early stages of the project, Goldcorp has used the most advanced technologies available to maximise its value. However, the implementation of optimum mine plans has been challenging to put into practice. This is due to the fact that the mine operation involves more complexity than the plans usually reflect. This challenge is an industry wide issue that presents opportunities for improvement.

Mine planning methodologies and procedures that connect long, medium and short term planning strategies are essential in bridging the gap to produce optimum mine plans that can be practically implemented in the field.

The Peñasquito mine is a typical open pit truck and shovel operation located in Zacatecas, Mexico. The ore deposit contains mineralisation of gold, silver, lead, and zinc hosted mainly by two breccia pipes: Peñasco and Brecha Azul. The oxide ore is delivered to the heap leach from which gold and silver doré bars are recovered. Similarly, the sulphide ore is delivered to the crusher and mill circuit from which lead and zinc concentrates are produced. There are three main dump locations to store the waste mined. The waste dump facilities have a combined storage capacity adequate to handle the amount of waste mined over the expected life of the project. It should be noted that a portion of the waste material is discharged directly into the dumps by the haul trucks.

However, some of the waste is delivered into a crusher that feeds a conveyor belt system which transports the material into a stacker which places the waste mined in the dump facility. In addition to that there is a tailings storage site that was designed as a zero discharge facility in accordance with environmental standards.

Mine planning studies at Goldcorp Peñasquito assist management with the evaluation of multiple mine planning alternatives from which those that are most viable and aligned with the company's objective are selected, refined and implemented. This process is cyclical as the mine plans are constantly updated to adjust to the changes in the business environment.

The long term mine plans are prepared in collaboration by a team of engineers that consists of corporate staff engineers, onsite engineers and consultants. The information is communicated across Mexico, The United States and Canada in English and Spanish. In addition to that, there is diversity on the tools used to complete the mine plans. Historically, most of the cutting edge mines planning tools available in the market have been tried at Peñasquito. Therefore, the validation and data translation from one software to another and from one team to another one is an inherent part of the process. Each team member that participates in the process along with the corresponding tool used to complete the required task or analysis adds value to project and complements the mine plan.

The first task for the mine planning engineers is to calculate the economic pit limits at the selected evaluation price and corresponding costs scenario. The pit optimisation results are calculated based on the block value stored in the block model.

The net smelter return (NSR) model used to determine the value of the block is quite complex and includes the metal revenues minus the smelter recovery/payables, treatment/refining charges, penalties, freight costs, etc. It should be noted that multiple scripts with alternative logics are used to calculate the value of the block under different assumptions. This allows the engineers to evaluate worst/best case scenarios under different model assumptions in order to manage the risk and help management with the decision making process. Similarly, these scripts are continuously updated and modified to reflect new information as it becomes available.

After the economic pit limits are determined and the corresponding reserves are estimated, the next step is to sequence the pit. For this purpose a series of incremental pit shells are created which follow the best economic mining direction and satisfy certain design parameters and constraints. Initially, the incremental pit

shells are scheduled at a high level to determine the best mining sequence. Then, the more feasible alternatives are refined and detailed pit designs are completed using the optimised pit shells as a guideline.

The detailed designs are used for reserves reporting and scheduling. The haul profiles are created to ensure feasible material movement and determine the equipment requirements for the life of mine studies. Similarly, waste dumps are designed and sequenced to ensure proper storage of the waste material and minimise the haul hours.

The life of mine plans created by the long term planning engineers, serve as the guideline for the medium and short term plans to ensure a cohesive mine planning strategy. Traditionally, most of the long term planning scheduling tools, provide analytical schedules that identify the pushback bench reserves that need to be mined by period.

However, for medium and short term planning more detail has to be added to the plan in order to define how the bench mining cut sequence will proceed. This requires direct input not only from the planning engineers but also from the operations personnel to ensure a feasible excavation pattern. At this stage access into the bench has to be considered not only for the excavators but also for the drills and the mining trucks. Adequate operating space must be provided and safety considerations have to be observed during this process. Similarly, other factors have to be considered such as construction or removal of high voltage electric posts and the associated cables that supply the power for the electric shovels. Additional water management considerations must also be taken into account to ensure proper drainage of storm water runoff via spillways, culverts, ditches, berms, dry wells, submersible pumps. Similarly, geotechnical considerations have to be observed and monitored for safety reasons which may limit the areas available for blasting and extraction. If the shovel is digging in a confined area, it may be necessary to remove the shovel before the blast and bring it back afterwards. All of these factors have a direct effect on mine production which the medium and short term engineers have to reflect in their extraction plans.

Therefore, the strategy dictated by the long term plans are not always achievable but provide a reference for the medium and short term engineers to use as a guideline. It should also be noted that additional discrepancies between the exploration and production models introduce deviations to the plan. Lastly, the engineers must provide the operators the precise location of the mining extraction areas and the operators must conform to it in order to minimize the deviations from the plans.

The mining polygons provided by the long range plans are usually subdivided into finer cuts that represent excavation paths subject to minimum minable widths to fit the equipment. These cuts are designed to meet specific plan objectives and can be designed in more or less detail to meet tonnage and grade targets as shown below.

Certain mining considerations have to be implemented into the medium and short term plans in order to make the schedules practical. For example, the number of open benches has to be limited to prevent the shovel from moving from one bench to another. Similarly, vertical separation among phases may be necessary for safety reasons. The schedule has to be checked period by period graphically and analytically to ensure that the excavators assigned can be physically and timely moved from one mining area to another one from period to period subject to the excavation rates and other constrains. The mining rate for each phase may vary by elevation depending on a number of factors such as the space available. In some benches there may be enough room for two or more excavators while in other levels there may only be enough room for one excavator.

Detailed haul profiles are designed to reflect the available routes for each period from the mining cuts to the existing and future destinations such as waste dumps and stock piles. The cycle times for the truck fleets are calculated based on the detailed haul profiles and calibrated against field observations and data obtained from the fleet management system. The creation of the mine plans is monitored and updated on a regular basis to make sure that the operation stays on track and that production milestones are achieved according to plan. For example, the rolling plan forecast is completed and updated every month.

This allows for monthly plan corrections and reconciliation between the extraction plan and the actual mined out areas. Therefore, the creation of plans and the continuous supervision of its implementation go hand in hand to make sure that the operation stays on target, so the mine productivity and profitability can attain its maximum potential.

A range of people and software is used for the preparation of the mine plans. Every mine planning tool has its strengths and limitations, thus the application of multiple tools helps to assure that the problem has been approached from multiple angles in order to get the best possible results. However, there are some challenges with the translation of data from one platform to another one, each one with different assumptions and levels of details. For example, the long term plans may assume full and partial bench reserves while the short term plans may be based on production polygon cuts. Therefore, it may be difficult to reconcile plans prepared with different assumptions and levels of detail. However, as new technologies and software become available it is possible to close this gap and provide an integrated mine plan. “The traditional approach followed by Mintec over the last 40 years is to develop a series of tools to help the mine planners complete their tasks and produce a robust mine plan. This has led to a complete suite of mine planning software which assists the engineers and management with the strategic analysis, decision and implementation of the business plan. However, with the evolution of mine planning software there are new tools such as MineSight Schedule Optimizer (MSSO) which can be used for long, medium and short range planning. In the case of Peñasquito, the short term plans used to be prepared with MineSight Interactive Planner (MSIP). However, this was a manual process and very time consuming. In April of 2012, Goldcorp implemented the use of MSSO at Peñasquito to generate and optimize their short term schedules. The first task was to reproduce with MSSO the schedules previously produced with MSIP. The second task was to find opportunities to improve the mine plan and optimize the schedule. The successful implementation of MSSO for the rolling plan forecasts lead to its application for medium term plans as well. In 2012 and 2013 there were significant developments in MSSO such as the ability to schedule on partial cuts, equipment/haulage integration, multi-period optimisation and scheduling. These developments among others enabled MSSO to be used for long term planning as well. Early in 2013, the long term schedules generated with MineSight Strategic Planner (MSSP) and other third party scheduling tools were validated and reproduced with MSSO. Thus, MineSight Schedule Optimizer became essential not only for short term plans but also for medium and long terms plans. There are many advantages associated by using the same tool for long, medium and short range schedules. For example, the integrity of the data is kept under a single database, therefore the validation of data and the time required to import/export data formats is kept to a minimum. With MineSight Schedule Optimizer (MSSO) the plans can be refined and additional levels of detailed can be added within a single interface. The results can be quickly visualised in MineSight 3D and mining rules can be added dynamically for user control. Also, the software training required for mine engineers to transition from short to medium or long range planning is kept to a minimum.”

The information gathered from the long range plans is transmitted seamlessly to the medium and short range engineers. Similarly, the

information gathered from the medium and short range plans are retrofitted into the long term plans to make them more representative. The end result is a strategic business plan in which the first periods are broken down by month according to the rolling plan forecast, followed by quarterly and yearly forecasts in which long and short term planning strategies are integrated and perfectly aligned.

Assembling a project team in which the members understand how their work connects to each other and serves the long and short term goals of the organisation is key to producing and implementing an integrated mine plan. "Ultimately, mine planning philosophies have to align with mine operations so the mine plans can be realised in the field. Therefore, the performance of the mine must be monitored and measured to ensure that the business objectives are met according to the strategic vision of the organisation. Similarly, the mine plans have to be flexible and adaptable in order to respond to changes in the conditions of the operation and the business environment.

Introducing Atlas and Blast

MineSight's latest new releases include Atlas 1.9, in direct response to requests from mine planners. "We are dedicated to ensuring our clients get more time to make decisions while MineSight takes care of details," said Glenn Wylde, MineSight Vice President-Technical. "Short-term planning in particular is fraught with pressure so Atlas is designed to make life easier for mine engineers." Atlas 1.9 adds a whole new world of CAD design. Gone are the days of countless click-click-clicks to design mining cuts. Atlas's automatic activity designer builds mining activities straight from a centreline, and clipped to a limiting boundary, allowing you to easily adjust the swath and target tonnes or volume. Quick hotkey adjustments can revise the swath and all automatically built cuts can be pushed to the activity model and be assigned to a resource. "We want the user to be able to spend more time refining the schedule than perfecting CAD skills," said Wylde. Atlas 1.9 further integrates MineSight Axis for grade control. Axis users will now be able to build their daily dig mining blocks directly from Atlas or MineSight Planner. You can quickly build remaining stocks of block-outs from fleet management dig-points. Improved Gantt printing, simple to configure rolling reports and the automatic ability to complete tasks by a given date are also included in Atlas 1.9. Since being introduced last year, Atlas has been adopted by planning departments in some of the world's biggest mines.

Finally, MineSight has added precision and dependability to one of mining's most challenging steps with a new drill and blast management utility. MineSight Blast improve the process of design and execution of drill and blast plans from within MineSight 3D. Within a single interface, you will be able to design drill patterns, apply blasting parameters to holes and do the tie-in of a shot. Mark Gabbitus, MineSight Product Manager-Operations said: "MineSight Blast will redefine blasting. A bad blast can undo all of the good work done by geologists and engineers to develop a robust block model and mine plan. So it is vitally important that the blast design and execution minimises error and interprets the effects when things do not go to plan."

Incorporating a modern design interface, MineSight Blast will design and manage drill and blast patterns interactively on screen while storing all of the design (and actual) information in a SQL database. Direct links to drill fleet management and explosive vendor systems will enable easy automation of data transfer between the design tool and the operators. See what's happening in the pit in near real time and make intelligent business decisions. MineSight Blast will link directly to MineSight Atlas so mine planners can update their schedule based on actual drillholes and lengths to get more accurate times.

Several factors affect the quality of a blast. The geology and geotechnical characteristics of the rock are unchangeable, but the blast pattern parameters, such as hole spacing, depth, diameter and amount/type of explosive used, can be modified. The ability to change these parameters dynamically in response to as-drilled information is critical to achieving good fragmentation. Future releases of MineSight Blast will include blast simulation, analysis and optimisation to reduce the workload on drill and blast engineers and enable them to change or optimise blasting parameters at critical stages.

Starting later in 2014, MineSight Blast will be released in a phased approach with Version 1 set to include enhanced drill pattern design features, such as offset rows, volume of influence solids and naming rules. Versions 2 and 3 will see the addition of blast design tools, pattern tie-in options (manual and automatic) along with simulation and optimisation options.