

Right the first time

Emerging technologies are transforming the way mine design is approached, reducing risk and offering a new level of operational predictability

Mine design for optimal production has always been a challenging discipline. Geological survey findings must be married with on-site capabilities, production costs and the vagaries of global commodity markets, and much of this data is in constant evolution.

As miners strive to achieve the safest, most productive operations over the short, medium and long term, engineers and planners are turning to digital and virtual solutions informed by advances in big data and analytics.

Mining operations are already data driven, but there are now vast opportunities to turn this data into rich intelligence, which reduces uncertainty in design and planning.

Advances in data analytics will enable mines to optimise their operations

DARK DATA BECOMES VISIBLE

"In the past, we saw the generation of a lot of data that was simply inaccessible, so-called 'dark data', but now advances in big data analytics are making this information visible

and usable. Of equal importance, there is a new capability to integrate previously incompatible data sets and formats," explains Dr Nicolas Jeannée, a senior manager at Dassault Systèmes.

Donovan Waller, group head of technology development with Anglo American, adds: "This data will be able to reveal new patterns and trends that will be beneficial to existing mines and enable them to optimise their operations, but it will also be invaluable in the design of new mines."

Through its FutureSmart Mining innovation programme, Anglo American is developing a systems-based approach to integrated data management that cuts across entire mining systems, allowing for full communication between different mine functions and using advanced analytics and machine-learning algorithms to inform key decisions throughout the lifespan of its mines.

"This approach will enable us to

measure what matters in the face of complex data and make better judgements based on informed decision-making. These decisions will feed into automated processes and work with machine-learning algorithms to improve all functions," Waller says of the future.

According to research by NextGen Technological Advancements, the mining software market is expected to grow by a hefty compound annual growth rate of 18.2% to 2021, with a strong focus on design. Specialists in mining-specific technology believe there is a new capability for companies in the sector to harness technological trends and transform them into solutions for miners.

"Key to delivering solutions that add meaningful value and drive continuous improvement is deep industry knowledge combined with an antenna for emerging technologies," states Peter Johnson, managing director of Maptek, who sees a promising future for the sector. ►



► “R&D is central to our strategy, and we have been working closely with major operations to focus on extremely practical and high-impact technical needs at the operational and the decision-making level. Specific examples include addressing narrow-vein and panel-caving mining methods, as well as the drive for automated and more efficient solutions consistent with the current connectivity imperative.”

Maptek has recently launched a new strategic application for panel caving. It believes that robust tools for assessing economic feasibility are a prerequisite for minimising risk related to this new frontier for underground mining, which involves massive volumes of material and substantial capital investment. Maptek CaveLogic allows operations to consider all of their economic and geotechnical data to define the optimum footprint for caving operations.

PREDICTIVE SIMULATION

Anglo American is making use of advanced geological modelling software with technologies such as 3-D and virtual reality to generate predictive data models, but the company is already looking beyond 3-D imaging to create new geospatial information sets, combined with more traditional data sources to link time and space co-ordinates.

“This will allow us to link resources and look at information spatially and create richer information sets. We are in a position whereby we can create extra dimensions, and when these are viewed simultaneously, it provides much deeper insights than looking at mine design plans in the traditional way,” explains Waller.

Greater control over mining processes will lead to better productivity

Maptek continues to refine its predictive simulation tools. “We realised there was strong demand for integrated design options backed by smart tools for evaluating ‘what if’ scenarios. Our new Vulcan Grade Control Optimiser was developed in partnership with Newmont and Barrick, and early indications reveal its success in optimising daily activities and avoiding expensive, irreversible ore classification mistakes,” says Johnson.

He believes that solutions such as Vulcan are enabling engineers to reimagine the boundaries of mine modelling, adding entire new dimensions to how they use their data.

“An underground gold-silver mine in Nevada identified numerous gains from a better understanding of the ore system and out-of-the-box thinking around analysis of drill core logs. Geologists are now able to view the differences in lithology, rock conditions and alteration throughout multiple holes on drill fans and in three dimensions.”

Highly accurate 3-D digital representations are now widely recognised as mining assets that support processes from geological modelling to design, planning, execution and control. “Using this digital mock-up – harnessing and linking information from multiple sources – gives you the insight to make optimum decisions at every stage of mine development,” says Dr Jeannée, of Dassault Systèmes.

“You can design, visualise and then simulate operations in a unified environment. It also allows for the testing of ideas that would be prohibitive by cost or the complexity of execution in the real world. Virtual

testing and certification means that models, designs and schedules are always right, and right the first time.”

Dr Jeannée continues: “We’re expecting to see an increasing focus on generative design and parametrically connected applications. Having assessed the orebody extension, what if mine designers could just specify the geo-mechanical constraints and contextual information, and then let the system automatically design the optimal plan to access the orebody?”

“It would bring significant advantages over manually defined mine designs, especially if any change to the orebody could be seamlessly integrated into the design and the mine plan. Such technology is being applied today with our software in other industries, and we are now extending it to mining.”

The key challenges he sees are quantifying the uncertainties in the resource and the capability to integrate this data into design and planning schedules.

FULL LIFESPAN SOLUTIONS

Across the sector there is agreement that operations can expect to see increased capabilities for connectivity between orebody knowledge and mine execution and production systems.

Hexagon Mining acquired Leica Geosystems in 2005 as part of a long-term strategy to deliver solutions across the entire lifespan of a mine. The Leica brand supplies advanced 3-D mapping software targeting underground features as well as remote-sensing monitoring systems designed for early warning and real-time measurements of sub-



millimetric displacements in dams and mining infrastructures.

"Our efforts to continuously improve integration of Leica with our MineSight software means we are in a position to supply end-to-end survey and monitoring solutions throughout the life of a mine," says Ian Blumel, planning product manager with Hexagon Mining.

"This is important as it helps to reduce the time to determine the difference between your actual development and your plans. All mines want to be able to save time and make better decisions quicker.

"We see our role in taking a mine owner's long-term plan for mine development and then shaping that plan into medium-term plans, short-term plans and then down to how we can optimise their operations at the level of each shift. It is about looking at the same plan, but at how it can most effectively be executed on different timescales."

FOCUS ON INTEGRATION

Another key trend is the focus on the integration of data into a single platform that allows multiple users to share data from multiple functions across multiple applications.

"In a mine, a myriad of different processes is taking place simultaneously and information from all of these must be brought together and visualised. If reliable real-time data can move from your plan to operations and back again, then you gain speed and confidence in your decision-making," states Blumel.

Hexagon Mining points to its success in the Peruvian Andes with Grupo Mexico's subsidiary Southern Copper Corporation (SCC) at its ▶



The adoption of Hexagon Mining's Minesight and Jigsaw software has helped SCC achieve among the lowest production costs in the world



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Hexagon Mining has had success at SCC's Cuajone mine in Peru

Cuajone and Toquepala mines, two of the largest in the world.

The adoption of MineSight and Jigsaw software has helped the company to achieve among the lowest production costs in the world. From December-quarter 2015 to December-quarter 2016, SCC increased operating performance (EBITDA) by 90.6% and net income by 183%. The company was able to cut the operating cash cost per pound of copper by 14% to 95 cents, making it the highest margin major copper producer in the world.

The mines deploy MineSight software to manage fleet management, mine planning, ore control, and drill and blast from a single platform.

"Having as many programmes, accessories or tools as possible in one single platform is very beneficial, because you get integrity of information. The data is more reliable and therefore the work one performs has a greater level of certainty," notes a spokesperson for the mine.

"Since we adopted an integrated approach to mine management, we've been able to make day-to-day decisions in real time. We've been able to reduce execution times and make better use of human resources."

Maptek Cave Logic allows operations to consider all of their economic and geotechnical data to define the optimum footprint for caving operations

Hexagon Mining has targeted planning for haulage operations in particular. Its MineSight Schedule Optimizer (MSSO) is used by hundreds of mines to determine the most productive cut-mining sequence. In December of last year, Hexagon Mining released Version



11, featuring a new Multi-Entry tool to address the difficulties of sequencing and modelling waste dumps with multiple access roads – a challenge facing surface mines around the world.

OPERATIONAL STABILITY

The Holy Grail for miners is to achieve operational stability and consistent performance at every stage of the lifecycle of a mine. But it is an innately variable and volatile operating environment. The digital revolution, particularly the capability to capture and aggregate complex data from multiple sources and translate it into an immediate course of corrective action, is setting apart the most productive miners.

In the past year, much has been made of the opportunity for mining to learn from other industries. Dr Jeannée sees achieving operational stability as imperative if miners are to progress with the incremental improvements that characterise 'lean' operations in manufacturing and processing industries.

"We are responding to an increasing demand from miners for collaboration and visibility across multiple departments, synchronisation of work flows across the enterprise and the tracking of all activities against agreed plans," he says.

"Greater control over mining processes and the ability to systematically identify and address issues such as high unit costs and low output are what will lead to greater productivity at higher margins."

Dassault Systèmes has worked for several years with a mining partner on an in-house technology project to design and implement a mine improvement programme covering planning, scheduling and execution. The objective was ambitious: to double output and achieve a 44%

improvement in unit production cost without any new capital investment in machinery.

"During any shift in an underground mine, hundreds of different tasks must take place in a co-ordinated manner. We introduced a short interval control process that has been adopted by some leading manufacturers. It splits each shift into a number of parts, and a centralised control and monitoring system capable of aggregating data from many different sources means that corrective action can be taken straight away if there is any deviation from the scheduled output, rather than taking a reactive stance when the shift has ended and an opportunity has been lost," he explains.

Dr Jeannée also points to the need for governance structures that can facilitate the cultural and organisational changes involved in embracing a way of working where the data 'silos' of past working practices are consigned to industrial history.

"Organisations with an open, collaborative culture, which can visualise their data globally across the enterprise, will see other benefits. For example, it is common for capital-intensive projects in mining to run over schedule and over budget. The right governance structure not only supports operational stability, it also facilitates an integrated approach to the design, engineering and construction of capital projects," he says.

"Dassault Systèmes 3DEXPERIENCE is a platform that has already empowered consistent and significant growth for leading companies across multiple industries. Several mining companies have started to deploy it for governance, mine design and operations in different regions, and we anticipate increasing adoption of this sort of technology by the mining industry in the years to come." ♥

