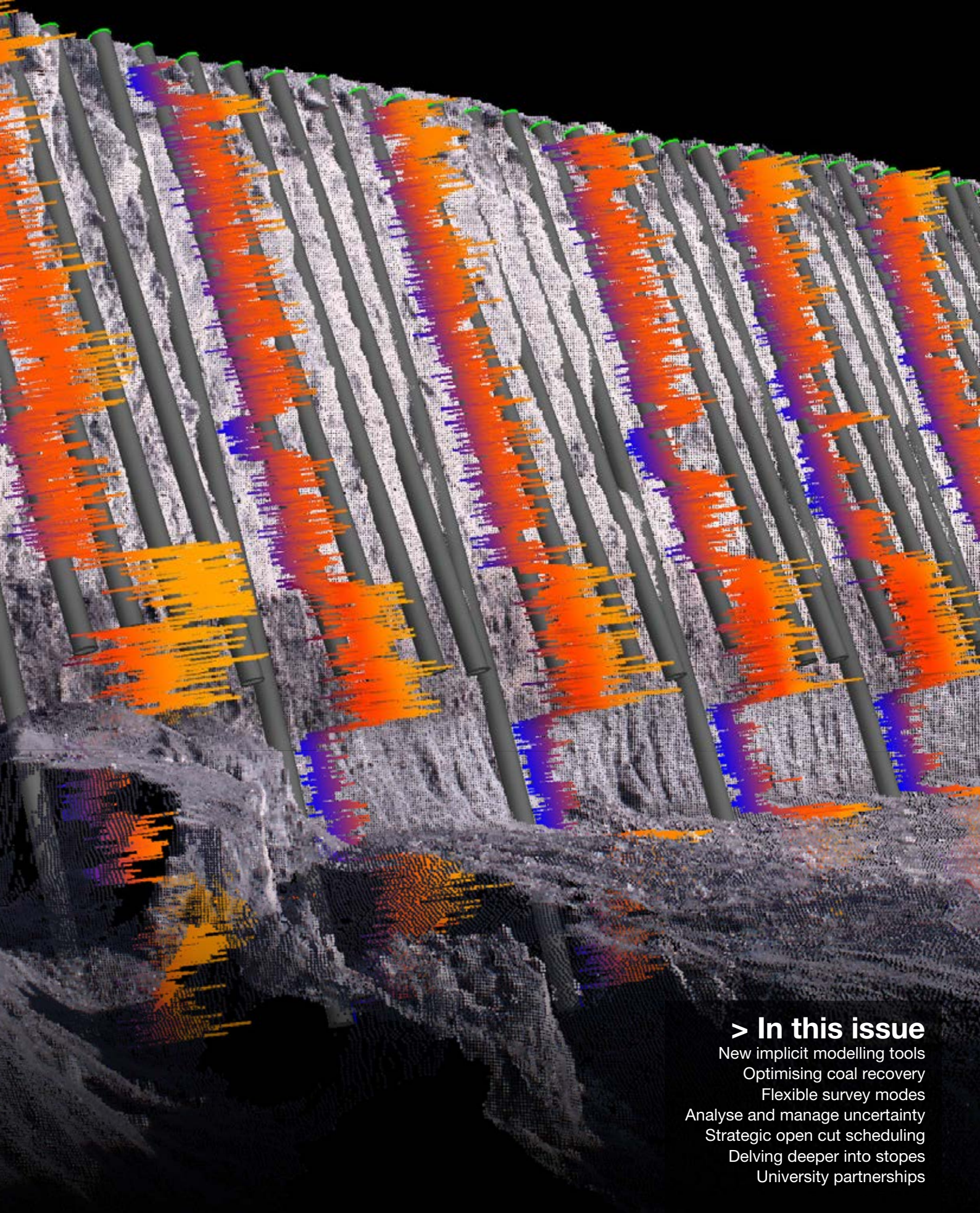




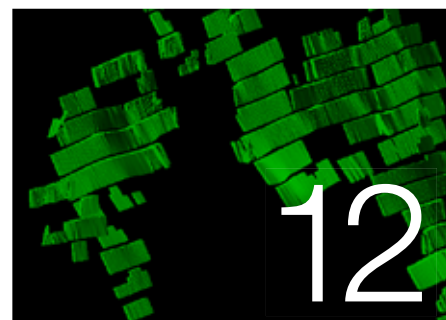
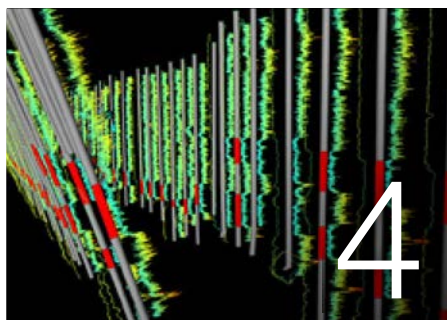
> In this issue

- New implicit modelling tools
- Optimising coal recovery
- Flexible survey modes
- Analyse and manage uncertainty
- Strategic open cut scheduling
- Delving deeper into stopes
- University partnerships



International student games

57 teams and 400 competitors from around the world competed in the 37th International Collegiate Mining Games recently in Kalgoorlie, Western Australia. Maptek was pleased to support the host team, the WASM Wombats.



In this issue

This issue focuses on optimisation challenges. Maptek employs a three tier approach to meeting operational needs.

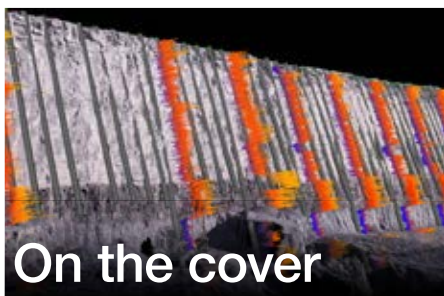
We develop and upgrade solutions using in-house expertise. The enhanced speed of Vulcan Pit Optimiser is a good example.

We sponsor development conducted by external research specialists. Consider the recent underground tools such as Level Designer and Stope Optimiser.

We acquire products that complement our portfolio, such as Evolution scheduling and mine planning.

Product development is concentrating on integration and seamless workflows between I-Site, Vulcan, BlastLogic, Eureka, PerfectDig and Evolution. Contact your local Maptek office for a demonstration.

We hope you enjoy this issue and welcome feedback at forge@maptek.com



Geophysical traces can be used to accurately define coal strata for validating resource models

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RBF added to implicit modelling

Maptek™ Vulcan™ will include expanded implicit modelling options with the addition of uncertainty modelling and radial basis function modelling in 2015.

Uncertainty

Defining a geological structure from drillhole data is inherently uncertain. Huge orebody volumes are often inferred from relatively small samples. Drillholes may be widely spaced and the data does not necessarily provide an accurate picture of the geology.

Geologists must rely on their experience and judgement to determine a realistic model for an unseen orebody. There are many possible alternatives that need to be evaluated in a short time.

Maptek™ has responded to this challenge. Uncertainty modelling will be added to implicit modelling options in the next release of Maptek™ Vulcan™. Multiple models of the orebody can be automatically generated from the same drillhole data.

Being able to apply financial information to these scenarios results in greater confidence in the economics of a model for assessing the viability of mining.

According to Vulcan Product Manager Eric Gonzalez, 'When evaluating models for uncertainty, a big component - the geological structure - tends to be ignored, usually due to the complexity involved in building these models.'

'An easy to use tool that produces several scenarios for the same set of geological structures allows for a more comprehensive assessment of risk at any stage of a project.'

Radial basis function

Vulcan will also include a new radial basis function (RBF) option, which will complement the existing proven geostatistical estimation technique for implicit modelling.

Geologists will be able to choose both methods from the same mine planning software, and verify which technique suits their deposit, leading to greater confidence in the final model.

Implicit modelling allows geologists to quickly assess a potential model and make adjustments before building it.

The key benefit is that geologists can easily analyse the risk for the many possible alternatives.

'They can evaluate the risk and perhaps decide it's worth paying for more drilling', said Gonzalez.

'We integrate RBF, faulting and uncertainty modelling within a single system and workflow. Engineers and geologists can assess risk at all stages of modelling and mine planning.'

'Users can tailor their modelling approach to what works best for each scenario.'

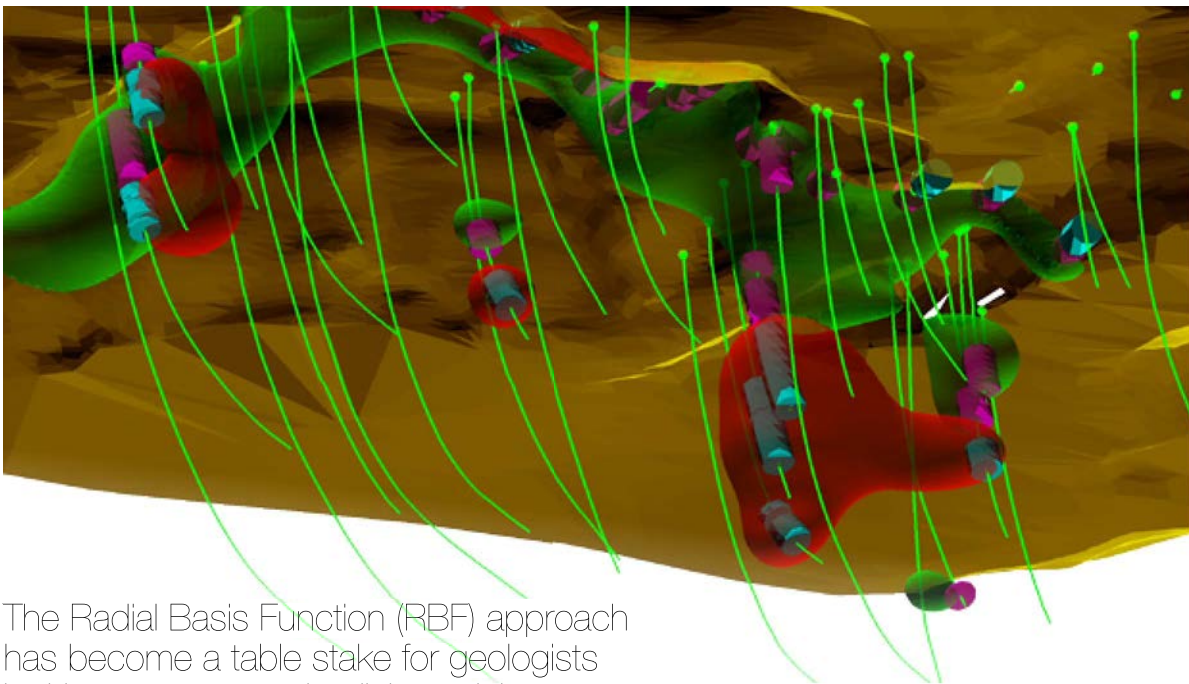
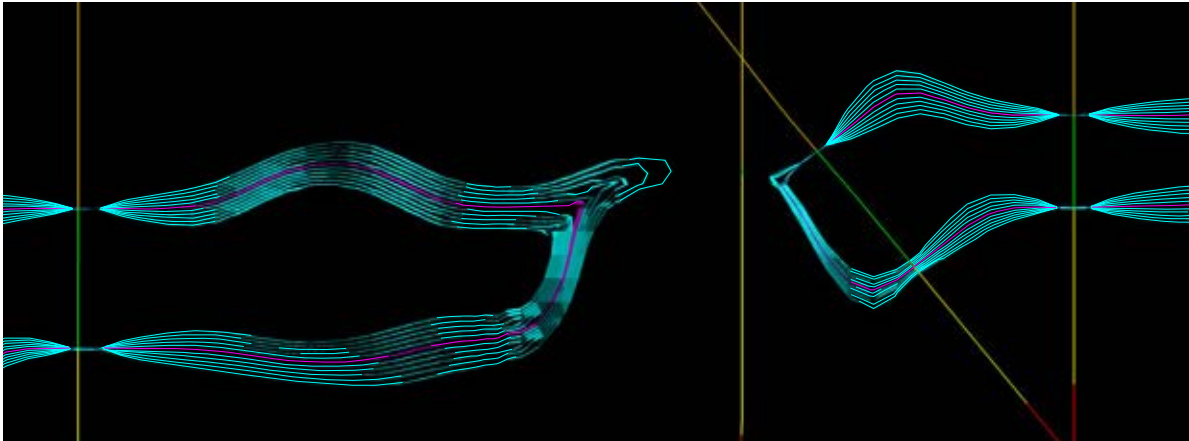
Structural trends

Structural trends are a key input for most complex geological modelling. Implicit modelling using either RBF or the geostatistical technique takes better advantage of shared structural trends for related domains. Domains with shared or independent structural trends will be defined and modelled together in a single run.

Implicit modelling will now include an enhanced smoothing method that still honours the drillhole data. Users will also be able to leverage existing anisotropies.

The new release also delivers several new methods for creating local anisotropies for implicit modelling, grade estimation or simulation. This will allow the grade estimation to match the complex folded structures identified through implicit modelling.

'Our primary aim is to help users be more productive with Vulcan. We continue to improve implicit modelling so that as much information as possible is available for making smarter decisions,' concluded Gonzalez.



The Radial Basis Function (RBF) approach has become a table stake for geologists looking to create an implicit model from drillhole data.

Productive solution for coal recovery

An innovative approach integrates geophysical interpretation, modelling and blast management to improve coal recovery and enhance overall productivity.

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Mines rely heavily on resource models to design and schedule day-to-day operations. However, the models are only approximate; the actual position of strata in the pit can vary from the resource model by several metres. This can lead to loss and dilution, costing time and money.

Accurately determining the location and geometry of the coal within the pressured production environment is a complex process, but is vital for success.

Maptek™ provides an innovative productivity solution focused on two fundamental processes:

- > Validation of the resource model
- > Accurate execution of drill and blast

Productivity solution

The solution combines 3D geophysical interpretation of gamma logs and/or measurement while drilling (MWD) data to accurately model strata, with a drill and blast design and an accuracy management system.

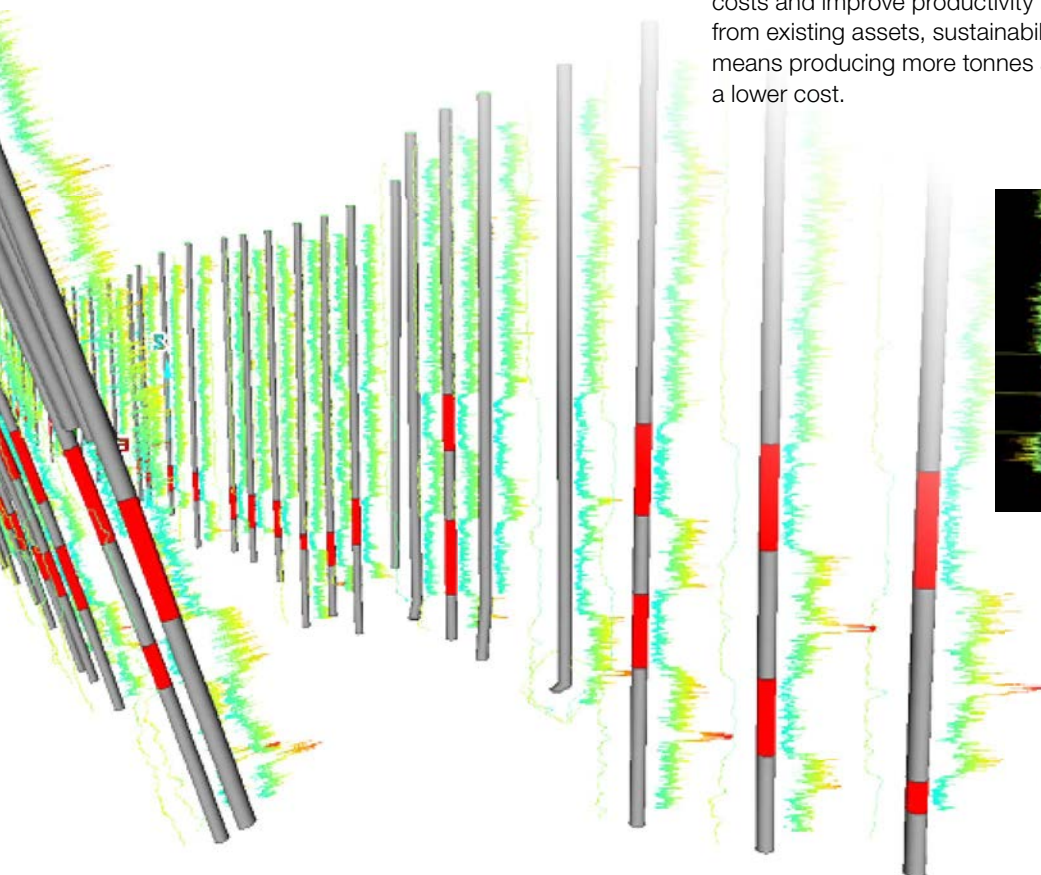
This integrated approach simplifies complex tasks and enables fast interpretation and informed decision making. Importantly, it frees up engineers and geologists from tedious data formatting and validation tasks. Their expertise is maximised when they can focus on planning and continuous improvement.

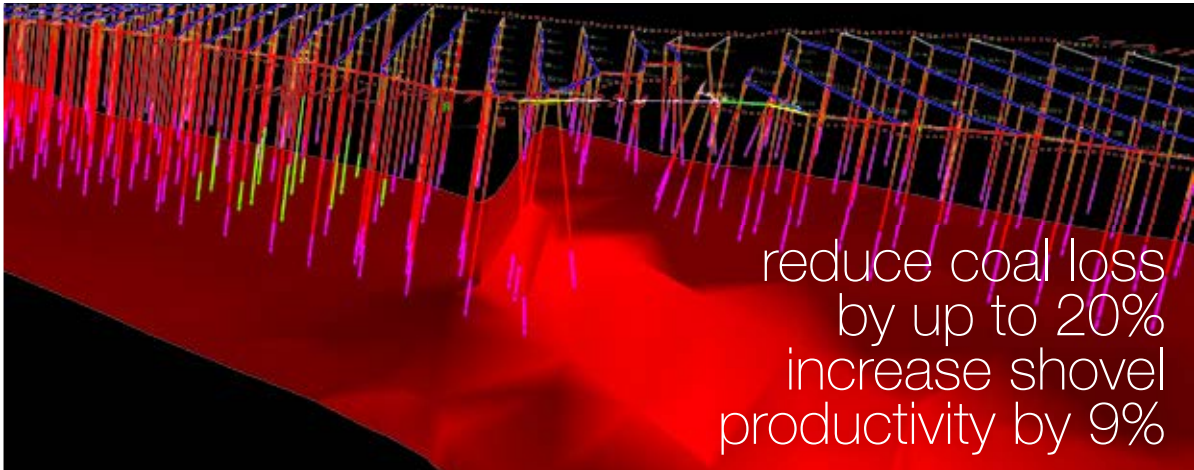
Today, as operations aim to cut costs and improve productivity from existing assets, sustainability means producing more tonnes at a lower cost.

Maptek enables mines to maximise the recovery of coal while increasing digger productivity through better fragmentation.

The starting point is the original Maptek™ Vulcan™ blast design shell derived from the resource model. Geophysical drillhole data is collated ready for interpretation. A further source of data is provided by a Maptek™ I-Site™ highwall scan for digitising coal and other strata that is easily distinguished.

All of the data is brought together in Maptek™ Eureka™ for interpretation and modelling. Eureka is used to configure and display up to three alternate attributes of the Gamma or MWD data and automatically assign lithology boundaries. The geologist quickly reviews and, if necessary, edits the lithology for holes with insufficient trace.





reduce coal loss
by up to 20%
increase shovel
productivity by 9%

Accurate coal surfaces, accounting for faults, together with strata used to define hard bands, are modelled with a click of a button and passed on to the drill and blast engineers.

Using Maptek™ BlastLogic™, the blast design is applied and checked. Embedded charge rules automatically adjust backfill amount, explosive decks and stemming relevant to hole length, hardness and handling of wet holes.

Tie-up design and analysis tools support easy comparison of multiple scenarios, enhanced with the blast modelling of vibration, air-blast and fragmentation.

BlastLogic manages the drill and blast process tightly through near real-time tracking, so drilling and charge placement conforms with design. This effectively pre-empts risk, productivity and cost issues.

Blasts and trends are catalogued and blast analytics drive design and process improvements.

Quantum improvements in productivity, recovery of minerals and workflow efficiency are tangible, high-value benefits that mines are seeking.

Determination of accurate geology and structure, aligned with a reliably executed optimised blast design, will deliver a well-shaped blast that increases digger productivity while protecting the coal seam.

Aside from operator ability, material digability is the main factor affecting production. Fragmentation is a central factor influencing dig rates, and blast damage leads to loss and dilution of coal. Improving performance in any of these areas will favourably impact profitability.

Design complexity

Using BlastLogic, companies can execute more complex blast operations than ever before. Drill and blast engineers can manage dipping seams and find the correct balance to blast away hard caps without damaging the coal.

Incremental improvements in different areas can add up to a major increase in efficiency and optimisation of the mining cycle overall. The Maptek solution provides a mechanism for achieving these benefits in a standardised and repeatable way.

Email solutions@maptek.com.au

The best survey solution for your task

Laser scanning is widely used in mine survey for its safety, accuracy and speed. We compare the benefits of different modes of operation now available.

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In this study, surveys were conducted using the same Maptek™ I-Site™ 8820 laser scanner in three different modes: tripod, vehicle mounted stop-go and continuous.

Tripod scanning collects the most accurate data from one setup and is typically used for highwall survey. Standard scan referencing involves setting up the tripod over a known or GPS-referenced position and backsighting to a known position.

However, as laser scanning has made workflows more efficient, surveyors might need to move up to 50 times a day. Tripod setup becomes onerous.

Our solution was the I-Site vehicle mount. Originally requiring two GPS units for backsighting, the system now uses an inbuilt compass and GPS streaming that records scan position and direction while driving.

The laser scanner is attached via a custom mount which fits standard roof racks and remains in place for multiple survey locations. In stop-go mode, the surveyor drives to each location, stops and conducts the laser scan from within the vehicle, and moves on.

Some operators raised the scanner head on platforms for increased scene coverage. While I-Site laser scanners are tested to IP65 for rugged operation, the benefit of scanning from the higher vantage point must be balanced against error tolerance for data accuracy, especially in windy conditions.

I-Site Drive is the latest survey innovation from Maptek. Data can be collected continuously while the vehicle is moving. The scanner head is mounted at 45-90° to the scene. I-Site Drive uses an RTK GPS link with an inertial navigation system to continuously update the vehicle position.

The result is extremely fast field pickup with automatic scan registration as the vehicle moves. Data registered in local coordinates leads to extremely fast processing.

Scans are previewed in real time on the tablet. Simply drive past scenes again to capture missing data.

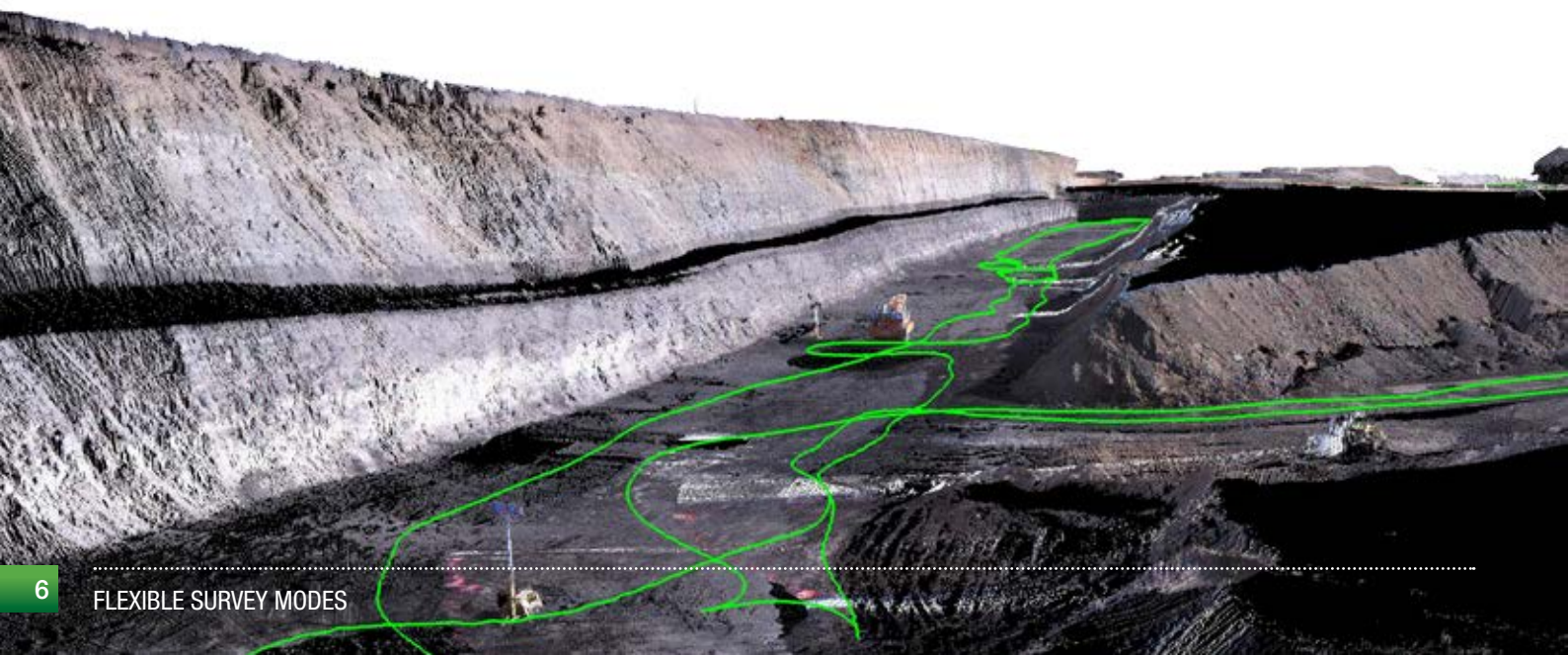
Comparison study

A rehabilitation area was scanned with the I-Site 8820 laser scanner, comparing the three modes of use. The scanner has a maximum range of 2000m and an accuracy of 6mm.

Tripod scanning from eight locations took 55 minutes and provided the most accurate data as reference for the study. Registration by scan name and backsighting to a radio tower 8km away established the data in local coordinates.

Scanning the rehabilitation zone using the stop-go method required nine locations and was completed in 35 minutes. Global registration was required to correct the compass orientation.

Using I-Site Drive the same scene was scanned in seven minutes. No registration was required and the point cloud data was process-ready. Lack of vehicle access led to poorer coverage of surrounding areas. A simple 360° scan over the missing area would provide supplementary data if needed.



Conformance

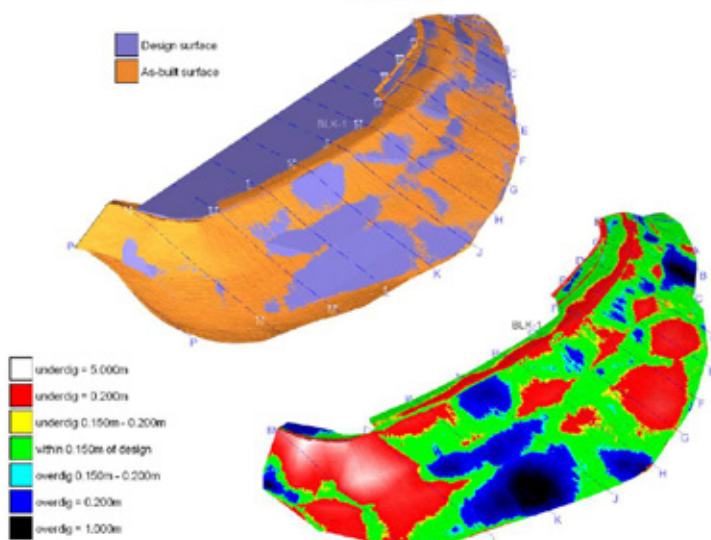
Minor volumetric differences were noted between tripod, stop-go and continuous scanning modes.

	fill m ³	m ³ diff	% diff
Tripod	311,103		
Stop-go	311,616	513	0.016
Drive	311,016	-87	-0.028

Using the pre-release conformance reporting module in I-Site Studio, results from each scanning mode were compared to the design surface, showing a close similarity between tripod and stop-go especially.

	wall underdig	wall overdig	bench underdig	bench overdig
Tripod	85%	3%	39%	20%
Stop-go	86%	2%	40%	20%
Drive	91%	2%	41%	24%

Finally, laser scans were compared to aerial lidar to check scan positioning. Differences in point spacing between I-Site scan data and heavily filtered lidar data results in the greatest deviation between outputs, particularly for horizontal surfaces.



Summary

Each survey method has particular benefits. Tripod setup mode will always produce the most accurate survey data. Vehicle mounted stop-go survey is safe and cost effective, avoiding tedious tripod setups and allowing more scans to be completed.

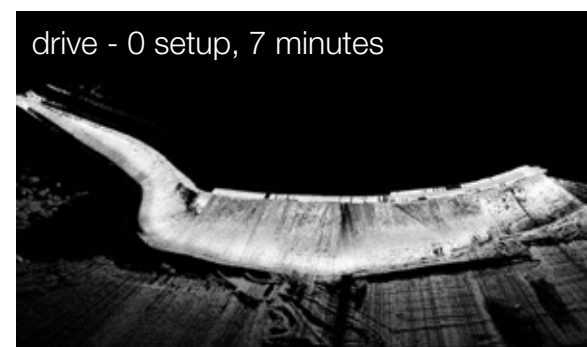
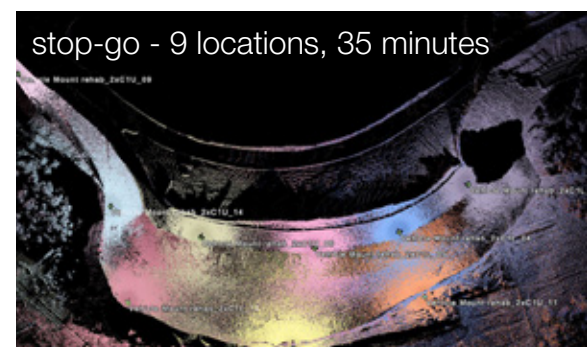
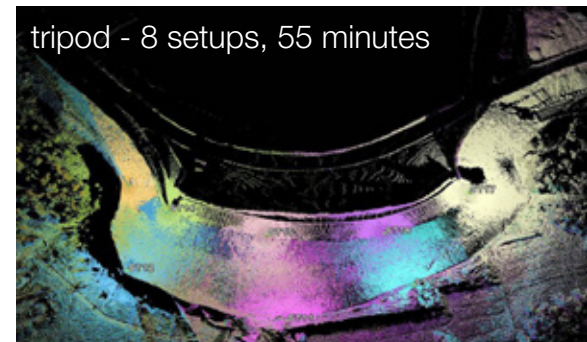
The I-Site Drive approach allows an unbeatable area to be scanned for the time taken. While it has a slightly restricted maximum range, surveyors can easily switch between continuous and stop-go scanning modes to overcome this.

Data accuracy in all cases was better than aerial methods.

I-Site laser scanning technology provides the most versatile survey workflows. Surveyors can confidently select the approach that best matches their accuracy and efficiency goals.

Email solutions@maptek.com.au

Rehabilitation zone scans



Simple conformance reporting reveals differences between as-built and design surfaces.

Quantifying risk in the face of uncertainty

Maptek™ provides a unique approach to pit optimisation and geostatistical analysis to improve mine planning decisions.

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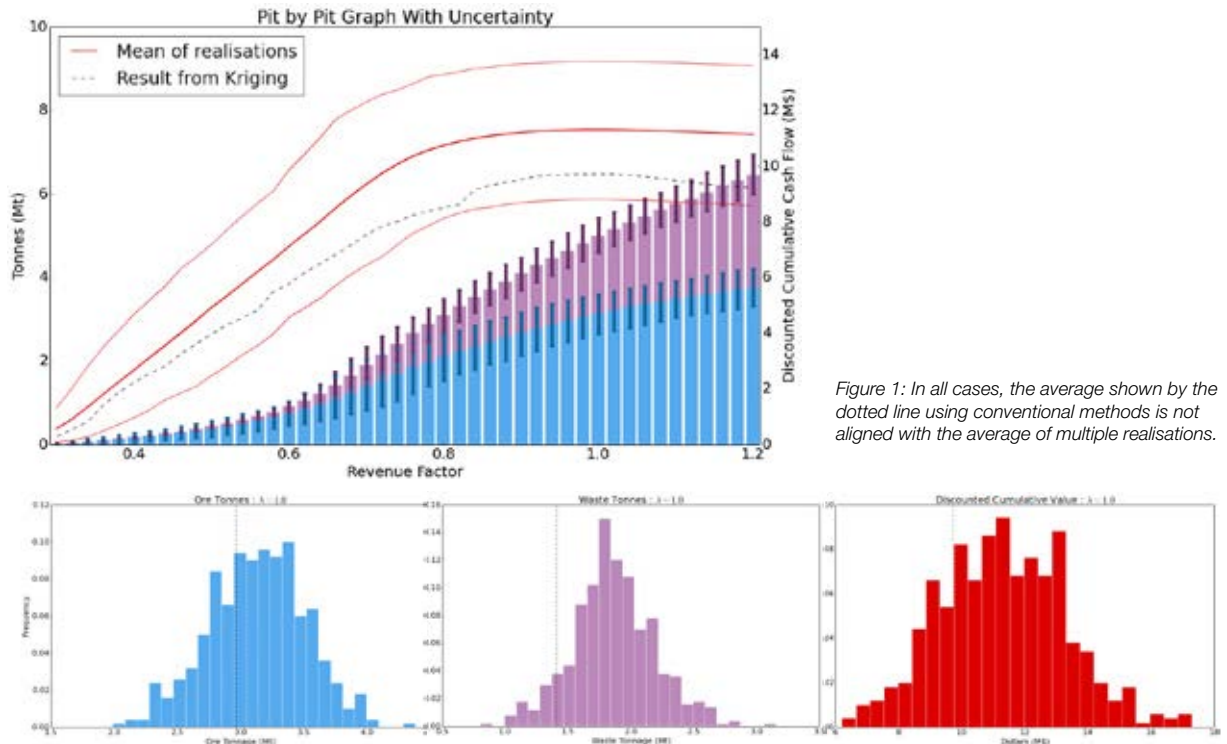


Figure 1: In all cases, the average shown by the dotted line using conventional methods is not aligned with the average of multiple realisations.

Today it seems that the only thing that can be said with certainty about mining is that there is uncertainty! Managing the risks of changing commodity prices, fluctuating exchange rates and the unknown extent and quality of a geological resource challenges engineers, geologists and investors. Decisions must be made with imperfect knowledge and in the presence of economic and geological uncertainty.

Quantifying uncertainty generally requires sensitivity studies which analyse many different scenarios. While value can be realised from this approach, explicitly analysing uncertainty requires substantial time and computational effort.

A distribution is more convincing than a single number, especially when that number may not even be average. Complex non-linear

processes, such as mine planning, will generally not give an average output for average input. The results are probably biased and often only a full sensitivity study will reveal the true average.

Software such as Maptek™ Vulcan™ provides comprehensive geostatistical and mine planning tools to use in tandem with sensitivity studies. Vulcan also provides efficient ways to automate workflows and vary parameters across different scenarios.

The scenario

Consider the decisions facing stakeholders in a greenfield open pit copper mining project: investors trying to decide their level of involvement and a mining engineer tasked with developing a high level long range mine plan as part of a pre-feasibility study.

After promising geophysical surveys and surface sampling, a small drilling campaign is launched and 43 holes are drilled. With so few data points the mining engineer realises that a single estimated model will most likely not deliver enough data to make informed decisions. The investors are similarly wary. It is unclear whether this deposit is worthwhile.

It is difficult to know how to proceed. The same situation will be faced in different mining decisions, such as where to put the mill, and whether expansion is a good idea.

Both mining engineer and investors understand the weakness of using an average model or an average copper price. The first step is to model the uncertainty.

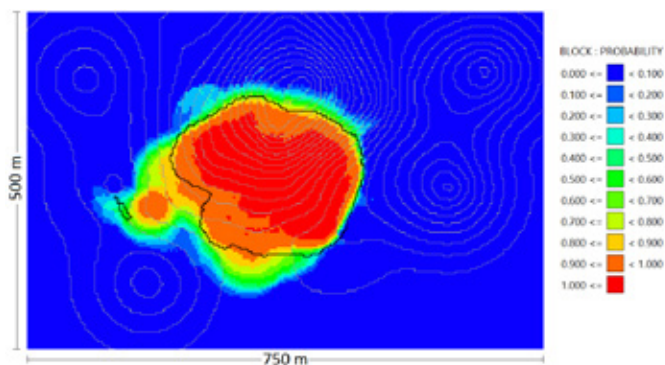


Figure 2: Intersection of the probability model with the surface. The ultimate pit crest for the estimated model is shown as a thick black line. Blocks are coloured by their probability of falling within the ultimate pit, accounting for geological and economic uncertainty.

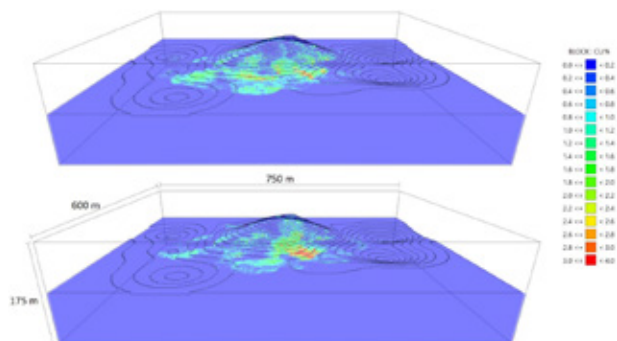


Figure 3: Simulated realisations of copper grade, with semi transparent blocks coloured by copper content.

The solution

Vulcan provides powerful tools to model geological uncertainty using conditional simulation. Mining engineers can team up with geologists and use established geostatistical workflows to generate a block model with many different equi-probable realisations of copper grade.

The models can be checked visually and statistically, and assessed for histogram and variogram reproduction. Post-processing the simulated model is easy. Summary variables such as probability above cutoff grade or variance in copper values are calculated and displayed for mine planning.

A long range mine plan is calculated for each realisation using a simple script and the Vulcan Pit Optimiser.

In effect, the engineer is using Monte Carlo simulation to transfer the geological uncertainty through the mine planning process and then synthesising the results. When this process is completed for each realisation, histograms which describe the breadth and the many possible alternatives provide greater direction than a single value.

An improved graph (figure 1) includes error bars for ore and waste tonnages. The value line is bracketed by the 10th and 90th percentiles, revealing the risk inherent in the project.

The dashed line shows the result of a standard averaging kriging workflow. This is clearly biased, despite using averages for all inputs. The histograms and pit by pit graph show that complex non-linear processes with average inputs do not give average results.

Investors can see exactly how the discounted value varies and make decisions based on the risk they consider acceptable. The mining engineer is now equipped with verifiable and robust results which enable risk-qualified decisions.

A simple block by block script can calculate the probability that a particular block is within the ultimate pit. The probability model can be used for planning and for visualising results.

The intersection of the model and topography (figure 2) clearly indicates where the ultimate pit could be, based on the underlying geological and economic uncertainty. Estimation only provides a single delineation indicated by the bold black line,

but with simulation the entire spectrum is revealed. This probability model can also be used for sequencing the most likely blocks first and planning future drilling activities.

Summary

Analysing uncertainty at an early stage allows plans to be developed which account for all possibilities. The Vulcan workflow ensures that the embedded analysis tools do most of the hard work.

In this case study, 500 realisations were generated with more than 1.7 million blocks. In total 23,000 ultimate pits were calculated by Vulcan Pit Optimiser in less than 10 hours. Ore and waste tonnage, value and other metrics can be exported into Microsoft™ Excel™ for further analysis. This process can also be automated to provide a streamlined reporting procedure.

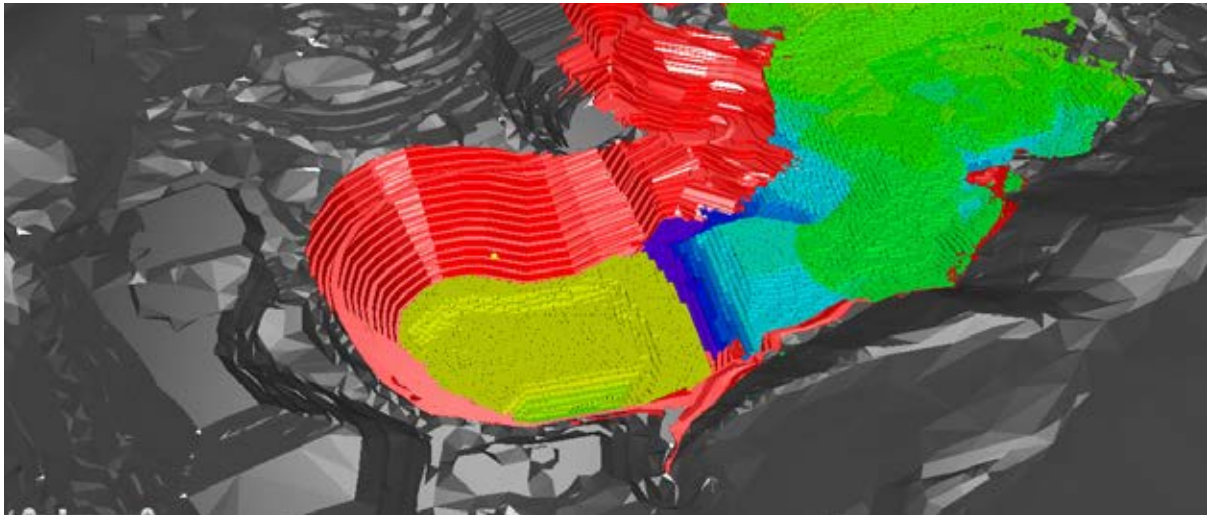
Uncertainties in geological, economic and geotechnical parameters can be quantified and analysed, allowing for flexible plans and confident decision making.

Extract of paper presented at SME 2015.

Strategic approach to scheduling

Maptek™ Evolution optimises the scheduling process, maximising project revenue and dramatically reducing the time to run schedules.

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Cutoff grade optimisation is the single most value-adding task a mining engineer can bring to a project.

However, the process has traditionally been the domain of experts and has been deemed too difficult or expensive to implement.

Imagine having to unlock the value of a project to the tune of millions of dollars. Now imagine doing so with a simple, intuitive tool that allows you to have full control of this process.

The ability to do this is no longer in the realms of the experts. Maptek™ Evolution puts the expertise in your hands.

Strategic approach

Strategic scheduling is different from day-to-day scheduling, as the mining engineer will, on occasion, need to look at the bigger picture.

For example, what is the best approach to mine these reserves now the price has halved? What happens when and if the price

improves, and will I be able to incorporate these changes without sacrificing practicality? How can I easily update my existing schedule with the new reserves?

What is the best way to take into account the latest processing technology which allows me to schedule ore that wasn't previously considered economic?

All of these issues have an effect on the cutoff grade. As changes happen over time, the cutoff grade policy needs to change as well.

Evolution provides users with a simple, intuitive interface. The complex geo-metallurgical model includes economics of mining and processing, variable pricing strategies and process recoveries to determine an overall cutoff grade policy.

Evolution combines multiple process and stockpiling strategies with detailed constraint modelling to ensure the overall result maximises value and produces a practical schedule.

Evolution will also model dynamic capital allocation and perform closure cost modelling.

Evolution can rapidly assess thousands of schedule scenarios to present the optimal net present value (NPV) and takes into account factors such as multiple reserves, stage release strategies and variable recovery rates.

Easy to use

A simple and effective workflow guides engineers through a step-by-step scheduling process and provides detailed, readable reports and graphs to present to management, boards and shareholders.

Maptek Mine Scheduling Solutions Manager Steve Craig said Evolution reports provide a snapshot of all the stages of a mine's schedule. Each schedule can be completed within minutes, providing insights into how the reserve performs under different operating parameters and conditions.

After comprehensive analysis, a tactical level schedule can be selected.

'Users don't need to worry about doing any scripting, they just get presented with the information. Evolution provides a smart, intuitive workflow for the user to then work through these more detailed levels of scheduling.'

Standard reports illustrate how the day-to-day operation of a mine aligns with its long-term strategic plan.

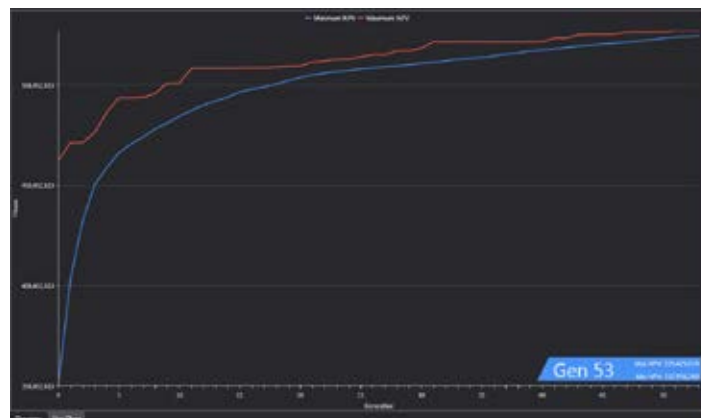
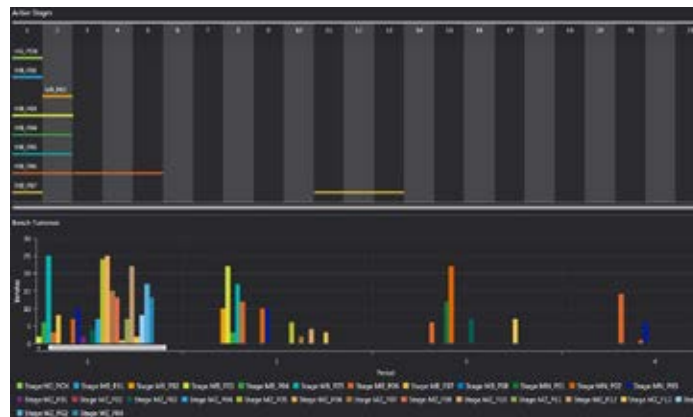
'That's critical because you don't want the mine to move off on a tangent away from the strategic direction you've set,' Craig said.

Reports can be produced on demand to respond to changes in commodity prices or market conditions.

'The first thing many engineers check each morning is what has happened overnight on the markets. Prices and exchange rates are fundamental inputs into generating a mine plan.'

'Given the dynamic and somewhat chaotic price environment, it makes sense to be nimble, modelling the effect that changes to major mine planning parameters can have on the mine plan and hence the overall value of the project.'

The interface between Evolution and Maptek™ Vulcan™ is tightly aligned so moving data between the systems is simple and auditable. New schedules can be analysed very quickly if a new model is presented to the engineer, typically within hours.



Traditionally it could take days to analyse these impacts. Evolution can provide a new scenario for consideration up to 10 times faster.

Bringing the data to life

Reports can be printed for analysis or integrated with Vulcan to produce 3D representations showing how the reserve would change over time based on the schedule.

Visualising the area on a bench to be mined at each stage streamlines communication between mine planning and scheduling teams.

'A picture tells a thousand words,' Craig said. 'You're opening up a dialogue between the planner and the production engineer. That's critical because you want buy-in from the people who are going to be implementing your plan.'

Evolution is being used to schedule open cut iron ore, copper, uranium and gold mines and allowing users to make informed, confident scheduling decisions to reduce costs and maximise resources.

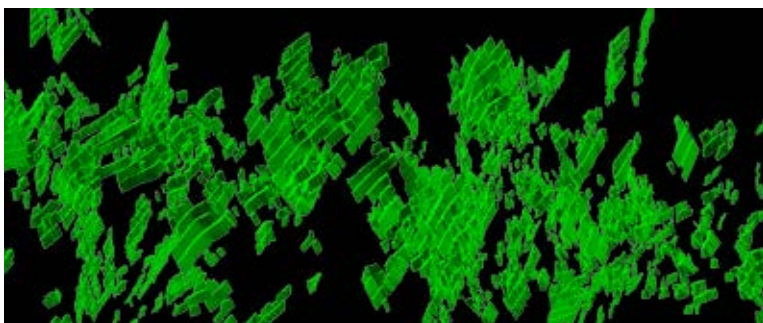
It is an agile, dynamic solution for targeting complex, real world challenges.

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Stope design optimisation

Maptek™ stope optimisation tools handled a complex underground mine design challenge, delivering accurate results in less time than ever before.

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Dundee Precious Metals (DPM) owns the Shahumyan Mine in southeastern Armenia. The complex narrow vein deposit produces gold, copper, silver and zinc from highly variable widths which range between 0.2m and 3.5m. Veins are generally closely stacked en echelon and are found in swarms and networks.

The mine resource model is updated annually for long term planning. It is necessary to review and redo stope designs in order to keep the life of mine plan current.

Updating stope shapes for the complex deposit has been a complicated and completely manual process. A quicker solution was required to allow for more rapid and timely strategic evaluations.

DPM provided the block model for testing and evaluated the Vulcan™ Stope Optimiser in collaboration with Maptek™.

The resource model is particularly large given the sub-blocking regime and narrow nature of mineralisation. Once the resource model was split into manageable partitions, Stope Optimiser easily handled the model with no requirement for reblocking.

The deposit has already been partially mined out, so the mined blocks were excluded from the optimisation run. Rotated block models are no problem, nor are variations in orebody strike.

Stopes were generated using Stope Optimiser. The main challenge in modelling was due to the shape of the narrow veins, requiring multiple stope heights. In addition, suitable space must be allowed for development activity on each level, and manual post-processing is also required to remove the small number of operationally unfeasible stopes.

The final stope design was produced much faster than traditional manual methods.

Inputs to the optimisation process are saved in a specification file for future use. Varying stope heights can be input honouring the sub-level constraints. Multiple height combinations are available via panel inputs and sub-units can be defined. Varying stope widths can be based on lower and upper constraints.

Footwall and hanging wall dilution can be accounted for. Upper and lower bounds for strike and dip can be input and varied by footwall and hanging wall locations.

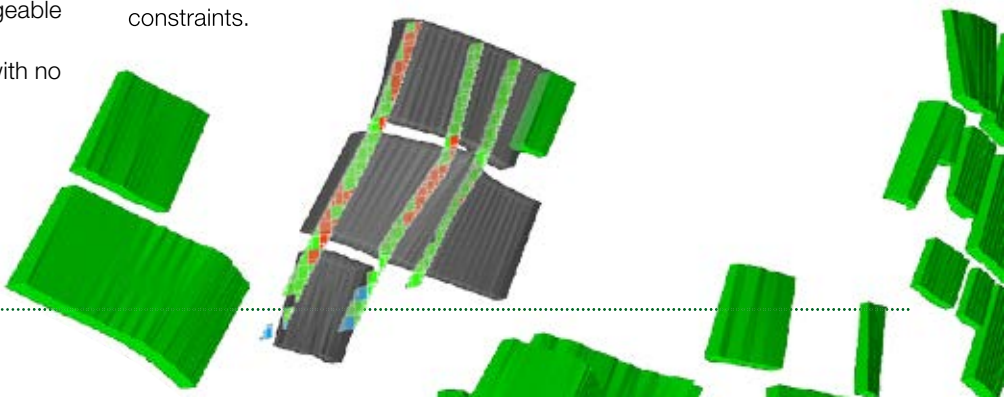
A standoff distance from mined or exclusion zones can be defined. Optimisation can be performed using grade or value cutoffs with single or variable values.

Once data is entered, stope shapes are automatically produced to specification, in a repeatable and optimal way. Splitting, smoothing and merging options allow users to finetune the stope shapes.

Stope Optimiser allows users to generate a stope design which delivers the expected ore grade. It increases accuracy in mineral resource conversion and minimises manual design work. Individual designs take into account stope geometry along with geological constraints.

When Stope Optimiser is implemented, DPM expects that the mine planner will be able to quickly identify the mineralised portion of the mineral resource above a cutoff while also accounting for practical mining parameters. This will allow the mine planner to confidently proceed with development plans.

*Thanks to
Dundee Precious Metals*



University partnerships

Expert tuition for civil mining engineering students



Maptek™ is continuing to foster the next generation of South American mining engineers through providing software and training to universities.

The Maptek™ Vulcan™ Introduction course at Universidad Católica del Norte in Antofagasta, Chile, taught 49 under-graduate Civil Mining Engineering students the software basics.

Instructed by Víctor Cavieres of Maptek South America, under the guidance of Professor José Luis Vázquez, students developed an understanding of Vulcan.

Professor Vázquez said Vulcan software was an 'essential tool' for any professional working in the mining industry.

'The students are very aware of this. They are the ones who demand to learn how to use Vulcan,' he said. 'Trainee mining engineers are expected to understand the software which the companies use.'

Students learnt how to handle object attributes and triangulations in a 3D design environment. They also created and manipulated databases and were introduced to block modelling.

Similarly, Marcelo Arancibia from Maptek South America held a series of lectures for students from Pontificia Universidad Católica de Chile which is based in Santiago.

He presented sessions on Geostatistics, Stationarity, Spatial Analysis, Variography and Kriging during May and June to 60 Civil Mining Engineering undergraduates.

The lectures aim to increase students' awareness about ore resource estimation using geostatistical tools and provide a platform for further individual study.

The sessions were held at the Maptek South America office in Viña del Mar.

Maptek South America takes pride in supporting students, as well as providing training. Technology open days allow students to visit the office and familiarise themselves with all Maptek products in preparation for joining the workforce.

Thanks to Universidad Católica del Norte and Pontificia Universidad Católica de Chile

Maptek Calendar

2015

June 11-12

Africa Australia Technical Mining Conference
Adelaide, South Australia - Booth 1
Technical presentation on crusher scanning

June 28 - July 1

American Rock Mechanics Association
San Francisco, CA, USA

July 13-15

Iron Ore 2015
Perth, Western Australia - Booth 20

August 12-14

AIMS (Australian Institute of Mine Surveyors)
Perth, Western Australia

August 24-26

Fragblast 11
Sydney, NSW, Australia - Booths 15 & 16

September 21-25

Perumin Extermin
Arequipa, Peru - Booths 1591 & 1592

October 7-8

Québec Mining Exploration Association
Montreal, QC, Canada - Booth 324

October 7-9

7th Bowen Basin Geology Group Symposium
Brisbane, QLD, Australia - Booth 37

October 7-10

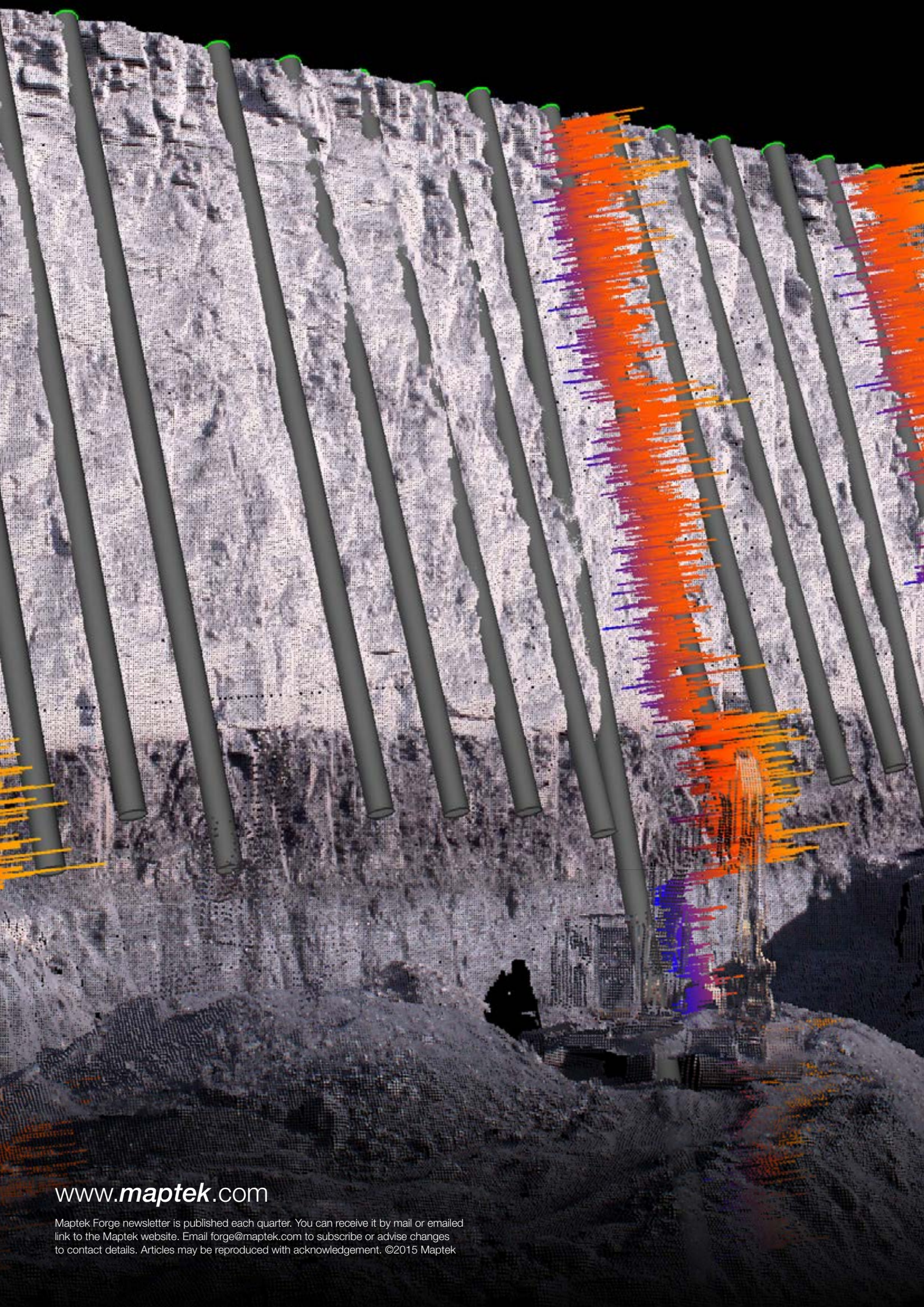
XXXI International Mining Convention
Acapulco, México - Booths 1529A & 1531A

October 14-16

XVII South American Maptek Users Conference
Viña del Mar, Chile

November 17-18

NewGenGold 2015
Perth, Western Australia



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