Mine scheduling software allows mines to better plan for the short, medium and long-term through production sequencing based on block models and a myriad of other inputs. The complication is that marrying strategic long term plans with the variation seen on a day to day and monthly basis can be very tricky, while there are also major differences between the approach used in surface and underground mining.

Unscheduled equipment downtime, unexpected changes in grade/geology, and even unforeseen climate extremes, can all throw scheduled production off the “long term track”, sometimes to a point where senior management may have difficulty understanding why particular blips in production have occurred. No matter what the original inputs and presumptions were in the original long-term schedule, in reality, short-term plans can be affected by a seemingly unlimited set of variables.

The best mine scheduling is elastic and adaptable to these types of unforeseen changes on a day to day basis, while still efficiently managing the longer term scheduling on a “metal accounting” basis. Whereas in the past, software was mainly relied upon to create mine designs such as open pit shells, mine-planning software is now required to offer a comprehensive solution across the management hierarchy – a schedule that considers not just when blocks are mined, but how they are processed, as well as incorporating information on equipment availability.

There is also a growing trend with larger companies toward corporate standardisation, both in terms of their software choices and the way this software is used. The adoption of a standardised approach to scheduling ensures consistency across different mine sites and planning horizons, whilst increasing the flexibility of planning staff.

**Gemcom**

Gemcom’s main scheduling-specific offering is MineSched, which according to the group provides scheduling for surface and underground mines of all sizes and types, improving productivity and profits beyond what is possible in manual scheduling. Engineers can easily create scenarios by using its 3D graphical canvas to setup material flows, blending targets and underground stope precedence, for example. They can also quickly compare multiple scenarios with its configurable and visually appealing scheduling dashboard.

MineSched 7.0 is the most current version of the software, and includes a broad range of enhancements to usability that make scheduling more streamlined and simpler than before. With the software, engineers can rapidly reproduce scenarios across development and production with a single mouse click to efficiently compare scheduling alternatives. Combined results can be viewed in MineSched’s unique dashboard to analyse the schedule.

Marni Rabassó, Director of Product Management for MineSched comments: “MineSched 7.0 further simplifies the creation of scheduling scenarios by combining development and production scheduling into a seamless workflow, enabling better overall schedules to be produced. It also combines interactive and automated scheduling to saving engineers time, allowing them to leverage the power of automation and make schedule adjustments selectively by period. This, coupled with the software’s ability to enable engineers to selectively schedule period by period to saves significant time in schedule creation. Engineers can also pause scheduling at any time to view the results up to the last full period scheduled and resume scheduling from any period negating the need to rerun the entire schedule.”

The latest offering from Gemcom, Gemcom Hub, is which is a data management optimisation solution, also has relevance to scheduling and planning on a support basis. Kevin Ward, Product Manager for Gemcom Hub comments: “Planning processes evolve at a given site to match the particular needs of the operation and the organisation. A prescribed workflow from a vendor would almost certainly not work in the general case, as workflows invariably involve multiple people and / or teams. This drives the need to manage two specific points – first a clear view of which file version is the correct one – especially if there are ‘what-if’ scenarios being compared and secondly, a clear hand-off between potentially multiple users of the data. Gemcom Hub works with any file type, so doesn’t restrict the users to a specific application tool set. It also provides data centralisation and rigidly enforces a Single Version of the Truth (SVOT). Clear visibility of version changes to the files affecting a given user, as well as the ability to lock files to avoid conflicts provide a robust yet easily accessed toolset to implement the workflow that makes sense at a given operation. Versioning allows access to previous models and scenarios in a controlled and auditable manner without the end users having to face the confusion of several similarly named files or folders.”

Many operations are remotely located, meaning that they are often dealing with poor communications infrastructure. To overcome this, Hub has been specifically designed to cope with transferring large files from remote locations over potentially poor or even intermittent communications channels.

**Runge**

Runge provides a comprehensive suite of tools to help analyse different production schedules and communicate these to the mine management. XPAC and XACT are the two main product offerings that are scheduling specific. Technical
impractical to follow the long term schedule to involved in a short term schedule makes it Mr Phillips states: “Whilst the level of detail differentiating factor in its scheduling products. The different scheduling horizons is a utilisation and operational efficiency.”

weekly, that’s used to maximise equipment shorter term focus such as quarterly and XACT is a complementary product with a establish accurate operating cost estimates. medium term scheduling timeframes. Long term schedules are used to identify strategies that generate the greatest value with the lowest associated risk, whilst medium term schedules introduce greater detail needed to establish accurate operating cost estimates. XACT is a complementary product with a shorter term focus such as quarterly and weekly, that’s used to maximise equipment utilisation and operational efficiency.”

Runge believes that the integration of different scheduling horizons is a differentiating factor in its scheduling products. Mr Phillips states: “Whilst the level of detail involved in a short term schedule makes it impractical to follow the long term schedule to MineSched’s interactive scheduling canvas

the letter, it is imperative that the longer term schedule is used as an overall guide to ensure shorter term schedules follows the mines strategic direction. Furthermore, longer term schedules will typically begin at some point in the future, and shorter term schedules provide the most reliable indication of the mines’ status at this point.”

The ability to satisfy a complex set of blending requirements has been a key strength of Runge’s scheduling packages and underpinned its early adoption by the iron ore and bauxite industries. But this requirement is not shared across all commodities and at many mines, maximising recovered grade or profit is still the main driver. At this type of mine, Runge’s dynamic cut-off grade techniques that identify the optimum cut off grade strategy for a given mining sequence is often used. The group does produce a range of tools that process geological models in order to generate reserves appropriate for scheduling at different planning horizons. The Block Model Aggregation tool can rapidly convert a block model with many millions of records into an aggregated model with any block size, in a manner that preserves the accuracy of the original data and avoids grade-smearing across material boundaries. The group is also well known for the applications that support its scheduling products. TALPAC is a world leader in truck and loader productivity estimation, whilst DRAGSIM and FACETS provide productivity estimates for draglines and long wall installations. A more recent product, HAUL NETWORK, allows the engineer to quickly build complex haul networks, visualise them in a 3D environment and find the travel time associated with any route through the network.

CAE

CAE Mining was formed in April 2010 when Datamine was acquired by CAE, followed up with the acquisition of Century Systems. These deals furthered CAE’s entry into the mining sector where it already provided professional services. CAE now offers a comprehensive suite of mining technical software for strategic through to short term mine design, scheduling and operations.

MineTrust provides a platform for organisations to ensure integrity of their data and an engine for defining and executing activities regardless of the applications or data formats in use. It provides the backbone for collaboration across an enterprise but importantly allows organisations to start small and grow their solutions at the pace they require.

In terms of strategic planning for an open pit mine, one conundrum is the time value question – if the right time to mine a block of ore depends on its value, but its value depends on when it is mined – when is the right time to mine it? NPV Scheduler uses a combination of mathematical rigour and operational practicality to resolve this issue and produce a strategic plan where both the mine design and the production schedule are optimised for maximum NPV. It uses geological block models and mining costs, commodity prices and pit slope parameters to create Lerchs-Grossman (LG) nested phases and an Optimal Extraction Sequence that maximises NPV. It then forms pushback shapes according to economic value,
production targets and engineering constraints, but where traditional scheduling applications confine the pushbacks to the LG phase boundaries, NPV Scheduler takes the phase boundaries as a guide while respecting the need for practical mining shapes. It then refines the schedule by adding further engineering requirements, including Haulage Analyser / Optimiser to specify the right truck fleet; Mine Flow Optimiser (MFO) to increase NPV by optimising cut-off grade; Material Allocation Optimiser (MAO) which re-allocates the processing of each block to optimise multiple blended products; and Multimine Scheduler, which solves the problem of optimising multiple mines simultaneously to meet shared production objectives. Finally, Geo-Risk Assessment (GRA) manages the uncertainty inherent in interpolating grade distribution by considering conditionally simulated block models in the strategic planning process.

Other products include Interactive Short Term Scheduler (ISTS), which is primarily geared to the needs of the site based short term mine planning engineer and provides the level of detail that is required to produce an operational plan.

The schedule is constructed in ISTS with reference to the main activities which can include drilling, loading, hauling and processing. The user can elect to use ISTS interactively where the mining blocks are interactively selected and the production targets are tracked. This requires the minimum of configuration and allows the schedule to be developed by focussing on material movement without the need to specify the equipment being used.

In short term scheduling the waste haul cycle time can be an important factor in determining the truck requirements. For instance short and long haulage of waste may be used to smooth out the required hours to optimise the utilisation of the available hours. To provide a better estimate of cycle time of the dump haul it is possible to model the dump as enclosed surfaces and to link the mine schedule with the dump schedule.

The inclusion of a sophisticated blending solution further enhances ISTS as it means highly complex targets can be used to drive the mining sequence. CAE Mining's Mineable Shape Optimiser (MSO) module, which can take financial parameters along with practical mining constraints and automatically produce detailed stope designs for underground mines.

In terms of strategic planning for underground operations, a planner must consider issues such as the location of declines, intersecting structures at the right angles, optimal ventilation layouts, future exploration potential, and many more. The huge number of considerations requires a broad knowledge and a willingness to incorporate feedback from review groups.

Mine2-4D helps in this process by providing tools that speed up the process of design and scheduling. Automated design tools, data preparation and integrated scheduling allows the engineer to rapidly produce a large number of options, and spend the time on review and analysis rather than digitizing designs or transferring data. Animation of schedules is a valuable tool for quickly identifying problems that would not be found by studying a Gantt chart or spreadsheet.

Once mining has begun, new data is always becoming available, whether it is intrinsic rock properties like grades from additional drilling, or external factors like changing prices, costs or exchange rates. The constant need for...
review and adjustment means that the eventual mine rarely resembles an initial design. However, detailed and robust designs that have flexibility built in based on scenario evaluation and risk assessment are a valuable asset that can ensure the financial outcomes for the mine are not compromised. This is the ultimate purpose of strategic planning.

The next version of Mine2-4D will include a number of key enhancements to the user interface to streamline processes even further, improve the graphics, make it easier to combine multiple projects and integrate long and short term schedules. The release is planned for the third quarter of 2011.

Accurate daily prediction of ore and waste requires an estimation method that best suits each individual orebody. Consequently, the processes employed in ore control at each mine are unique. Indeed, different processes are sometimes used in different parts of the same mine. CAE Mining’s OreController is supported by the powerful MineTrust framework; this allows modelled processes to be implemented accurately within software and for the resulting ore control system to sit within a robust collaborative framework where data is protected and processes are managed. OreController has been designed to resolve the costly problems that occur during the life of any mine where the geometry and the quality of the orebodies are continually assessed. Huge decisions are made on the back of these estimates.

Maptek

Maptek has been developing software for 30 years to help mines with geology, engineering, survey and grade control applications. The company tells IM: “The aim of long-term mine planning is to maximise NPV through determining the best sequence of material extraction, right blend of materials and supply of product to end users. Short-term and medium-term plans must always have the long term objectives in mind, recognising that the plans are only as good as the data on which they are based.”

Maptek Vulcan is the 3D modelling, mine planning and scheduling package which encompasses the full mining life cycle from exploration through to production and rehabilitation. In Vulcan, the mine scheduling functions are tightly integrated with the entire geological modelling and mine design process. “Vulcan’s modular nature allows flexible configuration for any operation” says Eric Gonzalez, Vulcan Global Product Manager. “Short-term schedules can be defined by the mine planning engineers, while long-term scheduling is of interest to strategic management.”

Along with the latest Vulcan 8.1 release, Maptek has delivered two new mine planning modules – Short Term Planner and Stope Optimiser. The Vulcan Short Term Planner is a collection of scheduling tools for open pit mines, using and outputting Vulcan data for short to medium term planning.

“The new decision tool allows users to analyse various scenarios in advance, and is configurable to each operation”, added Gonzalez. “Results are stored in block models and as 3D regions which makes them available for reserving, statistics and all the available general analysis tools in Vulcan.”

The Short Term Planner Sequence Reporting tool interacts directly with block models to generate product requirements. Multiple cut-off grades can be applied, without having to pre-calculate them. Blocks are scheduled interactively across solids using linear and radial accumulation techniques. This accumulation is restricted to each period of the plan across the mine and plant targets.

Restrictions can be applied for capacities, hours of crushing, product quantity and any variable in the block model which can be accumulated. The fact that it does not need predefined cut-offs, and interacts with the block model, reduces data preparation time, meaning that planners can focus on the generation of plans and analysis of results.

Users can define stockpiles for multiple products, modify targets, change cutoffs and alter equipment positions easily. It is also possible to configure initial stockpiles and their extraction sequence to simulate various scenarios for material rehandling.

Vulcan tools can be used creatively to improve mine performance. Core Mining Studies in Chile recently developed a tool for optimising dump filling using Vulcan design and haulage profile tools, complemented by linear programming in MS Excel. Planning engineers are responsible for defining the shape and optimum physical location of waste dumps, and establishing an extraction sequence using the long term planning information. The actual sequence of waste dump filling is often based on day-to-day decisions, in the hands of shift supervisors or short term planners.

The new optimising method allows evaluation of multiple alternatives, and is applicable to stockpiles, ROM stockpiles and dumps for either short or long term planning.

Vulcan 8.1 also saw the release of a new, fully integrated module for producing optimised mineable shapes. Vulcan Stope Optimiser reads a Vulcan block model with grade or economic information, creates a reserve table, outputs a series of plan and section polygons, and generates stope triangulations. The stope optimiser can quickly run multiple alternative mining scenarios by mining method, cut-off grade, stope dimension or orientation.

Newmont Asia Pacific recently used the Stope Optimiser to assess how cut-off grade variations could affect its Tanami underground gold mine expansion plans. The Stope Optimiser was also used to evaluate grades and stopping widths for the narrow vein Villa orebody.

Scenarios can be compared using section or plan polygons or triangulations. The software might do 5,000 to 20,000 iterations to work out the optimal stope shape.

Mincom

A critical element in the drive for increased production and improved efficiency is mine planning and modelling. Mincom MineScape is a powerful suite of integrated solutions delivering extensive geologic-modelling and mine-design functionality for open cut and underground mining operations for coal and metalliferous deposits. MineScape is the mine planning component of the Mincom Intelligent Mining Solution (IMS) suite.

In 2010, Mincom introduced MineScape 5. Featuring significant new functionality requested by leading mining companies
around the world, MineScape 5 helps speed the development of more accurate plans, thereby improving the predictability and profitability of operations across the entire mining value chain.

MineScape 5 also delivers powerful tools to improve mine-planning accuracy at the start of a project, speed the ability to update plans in the face of constantly changing field data, and optimise resource coordination to decrease costs associated with idle equipment.

“Mining companies today are under increasing pressure to boost output from their existing mines and bring new projects online quickly. However, the long-term performance of an operation is completely dependent on effective mine modelling and planning,” said John Jessop, Vice President of global mining solutions, Mincom.

Since announcing MineScape 5 last year, the MineScape product has experienced rapid uptake in the Asia Pacific, North America and Europe/Middle East/Africa regions, gaining more than 50 new customers, including Western Coal, Ambre Energy, Peabody Energy, Kazakmys and Vale Exploration. The product has also generated significant new license commitments from existing customers.

One of North America’s leading surface coal mines successfully implemented MineScape’s integrated mine-planning solution to replace its previous software systems and Excel-based methods used for geologic modeling and mine planning. With MineScape, the mine was able to increase the frequency rate and accuracy of its mine plans to stay current with incoming data, ensuring its mine plans reflected the latest information, thereby minimising or eliminating production cost variance.

With newly streamlined geological modelling and mine planning processes, the mining operation was able to reduce the time required to build geologic models by 75%; decrease the time needed to complete long-range mine plans by 60%; improve the accuracy of geologic modelling and mine design and increase minable reserves and extend mine life.

In April 2011, Mincom released other new enhancements to its market-leading suite of software for mine design and modelling. Further augmenting the industry’s most robust mine-planning solution, Mincom MineScape v5.2 now offers multi-language support including Russian, greater performance improvements to increase mine-planning speed, new design features, and enhancements that further increase usability.

Additionally, the MineScape 5.2 release introduces four new plug-ins:

- **Haulage Roads**, which guides engineers through the process of planning mine-haulage roads and dragline paths. Complex road designs can be completed in minutes, allowing engineers to compare multiple design concepts, including horizontal and vertical alignment and cut-and-fill volumes;
- **Ring Design**, which provides an interactive, three-dimensional Computer Aided Design (3D CAD) environment from which users can perform underground ring drill mine design and blasting. Rich visualisation and design tools enable users to take into consideration both planned and prior mining at different levels, and generate complex underground mine designs within minutes;
- **Underground Survey** is specifically designed for underground surveying, which provides storage, management and processing of large quantities of survey-point data, as well as standard survey and orthogonal measurements. The 3D CAD visualisation tools enable users to view any selection of survey points and measurements stored in the database;
- **Schedule 3D** is an extension of the MineScape Schedule tool, which provides 3D visualisation of mining blocks. Typically used for underground mine scheduling, Schedule 3D enables users to create, visualise and select designed underground stoping blocks, giving engineers a clear understanding of the scheduling steps, thus streamlining the process.

MICROMINE

MICROMINE’s Pitram Shift Planner is the company’s primary module for planning tasks in a shift. It utilises the power of Pitram’s real-time data-collection capabilities and historical data to help set up, validate and track progress against mine-production plans. The offering is aimed at managers responsible for achieving shift production targets. In most instances this will be the production supervisor or shift boss. Mine managers and operation managers can monitor progress against the mine plan in real-time; however, on most occasions it will be the people responsible for allocating equipment
and operating in a particular shift who will use the module. Shift Planner is a real-time planning and tracking tool where tasks relating to locations or equipment (including tramming and downtimes) are scheduled across the shift. Pitram’s real-time tracking capability is then used to indicate progress against a task. Where actual progress deviates from the plan, the impact of the deviation for the current or subsequent shift is shown, allowing production supervisors to reallocate resources to minimise disruption.

Dennis Kattowitz, Corporate Sales Manager for Pitram at MICROMINE, comments: “Companies will typically start with a Pitram management-reporting and data-collection system, allowing all their key production data to be captured and displayed in real-time to stakeholders throughout an organisation. Depending on an operation’s needs, value-added modules such as the Shift Planner and the Grade Control module will then be added.”

The Pitram Shift Planner differs from other short-term scheduling modules in that its responsibility is to take a schedule, turn it into a single-shift plan, accommodate incomplete tasks from the previous shift, and ensure in real-time that the tasks for the current shift are complete.

**Mintec**

The Tucson, Arizona-based group believes that its “end to end” solutions set its MineSight software apart from other offerings. “We offer a genuine E2E solution where others do not. We are also independent and answer to no one but our clients”, said Mark Gabbitus of Mintec’s Perth office, MineSight Applications, Australasia.

Planning engineers faced with new open-pit projects in the pre-feasibility and conceptual stages, utilise MineSight Economic Planner (MSEP), which enables them to design mining sequences and to generate life-of-mine schedules. MSEP’s pit optimisation program, MSOPIT, has recently received two powerful enhancements. The first, released with version 2.0, was multi-threading, which increased the program’s speed considerably. The second enhancement, released with version 2.1, was to make the program 64-bit. The improvements not only quicken the speed of calculation, but dramatically increase the amount of data the program can process. Tests comparing the effects of these changes on the program’s performance have produced very positive results. Faced with challenging cases comprising complex slopes, numerous constraints, and multiple pits, the multi-threaded, 64-bit version ran nearly 70 times faster than MSEP version 1.05. “Multi-threading empowers MineSight to exploit multi-core processors and perform simultaneous calculations in parallel processes,” said Mintec president, John Davies.

With geometric results in hand, MineSight 3D (MS3D) is put to work in detailed phase design. The program provides interactive display, editing, and plotting of all types of data, including drillholes, blastholes, composites, models (3D block, stratigraphic, and surface), and survey data for open pit and underground.

More detailed scheduling is undertaken by MineSight Strategic Planner, (MSSP) which addresses long-term planning with the kind of detail that is essential for a life-of-mine plan: equipment requirements, quality/quantity constraints, phase and bench scheduling and stockpile handling all come under MSSP’s microscope. Recent improvements to the program include faster runtimes in minutes, auto mapping, true blending, and automatic stockpile reclaim.

MineSight Interactive Planner (MSIP) provides flexible and interactive options to quickly design mining cuts, allowing planning engineers to create detailed short and medium-term project plans. Recently added to MSIP is the Material Manager, for short-term schedulers which are tasked with generating cuts that meet production or mill goals.

Practical short to medium-term project schedules are generated using MineSight Schedule Optimiser (MSSO). The recently improved MSSO determines the most productive cut mining sequence to achieve the highest project profitability. Version 3.50 of the software introduced in 2011 adds a CPLEX optimisation engine so both LINDO and CPLEX optimisation engines can do schedule calculations.

Used in tandem with MSSO and MSIP is MineSight Haulage. MSHaulage estimates tonnage, net operating hours, mechanical availability and utilization to obtain immediate short-term planning requirements for trucks and shovels. The program can pre-calculate the times for each road segment and uses a combination of haulage nodes and roads to find the best haulage path. A recently added trolley assist module allows mine planners to explore the potential benefits of adding this alternative power source for diesel haul trucks.

When it comes to managing drill and blast, and grade control, Mintec believes that its MineSight Axis provides a complete suite of operational tools.

MineSight Axis Drill & Blast has been used successfully at Freeport-McMoRan’s Morenci mine in Arizona. The company invested in imaging and drill fleet management technologies, and used MineSight to manage and analyse the data. In three years, in conjunction with other initiatives, it saved more than $120 million on horizontal accuracy, states Mintec.

Complementing the software is MineSight Torque, which represents a new generation in drillhole management. It tackles the complexities of geometodelling, managing drillhole, blasthole, and other sample data in a Microsoft SQL Server database.

The Advanced Reporting and Charting (ARC) tool is standard in several MineSight products, and recognises the industry’s need for reports to be customisable, repeatable, and easy to create.

**Minemax**

Perth-based Minemax specialises in mine planning and scheduling solutions, which cover the whole spectrum of strategic and operational mine planning. Minemax Scheduler is their original solution for strategic planning.
iGantt is the first product in the market to integrate a Gantt chart, 3D mine visualisation, and dynamic reporting in a single application. Tempo according to Minemax is currently the only product in the market for integrated and optimised mine planning and scheduling in a collaborative environment.

This year has seen a record number of new Minemax Scheduler licenses. In consultation with customers, Minemax is now making further improvements. Jim Butler, Minemax Managing Director comments: “It has always had the capability through its powerful optimisation engine to help miners make informed business decisions on project investment, capital expenditure and acquisitions. The design goals are to make this power accessible to even more people.”

iGantt provides underground customers with an easy-to-use 3D visual scheduling and Gantt chart environment that integrates with major mine design packages. Its auto-scheduling module is becoming more popular due to its ability to both schedule and determine development heading rates in a single pass algorithm. The next release of iGantt will have the ability to export a time-based colour coded view of the scheduled design in dxf / dgn formats for communication to operations.

Tempo is focussed on a number of key business problems based on market research that Minemax carried out with its customers in 2008. At the top of the list was lost value associated with a short-term plan not following a long-term plan. Tempo can be used to either generate a strategic or long-term schedule or import it from another solution. There is a dedicated importer for Minemax Scheduler schedules and a generic importer that has been configured to import from other packages such as XPAC and MineSched. The long-term plan is published into a separate collaboration database to be used for both web-based reporting and as a reference schedule for the next level down of scheduling. Tempo then uses its plan alignment optimisation functionality to transform the long-term plan into a medium-term plan all the way down to a production plan.

Tempo also serves as a bridge between mine planners and downstream process or logistics planners. Through its collaboration features, multiple mine schedules can be easily combined for regional reporting through Tempo’s web-based reporting solution using SQL Server. Rio Tinto have been using this type of collaboration for the integrated planning process of their Australian iron ore operations. Minemax are configuring Tempo for another iron ore producer such that the published mine schedules are used by the port logistics planner for short-term supply chain planning that matches planned stockpile builds from multiple mines with shipping demand. For one of BHP Billiton’s operations, Tempo is being installed to coordinate the mine planning process to produce stockpile builds on specification with the downstream planning of reclaiming stockpiles for process feed.

SimMine
The SimMine planning package, developed in Sweden, is a relatively new offering in the market, was designed to offer powerful software to plan, simulate and evaluate the development process underground. The SimMine package allows users to test long and short-term schedules ahead of time to see if development targets can be met, and to compare different scenarios to yield an improved development schedule. It also allows users to analyse multiple infrastructure scenarios; identify critical paths and critical start dates in development projects; evaluate best shift schedules to meet development rate demands; test what priorities will best achieve development goals; and underground to simulate drift development with both single and multiple headings for long-access drives. In equipment terms, SimMine can help users find the most cost-effective way of developing a mine and decide on the optimal fleet size, number of operators and shift schedule.

The customer would import their existing mine layout, design the simulation model and set the parameters. The development plan is then created according to time limits and priorities, and a simulation is run and evaluated.

Patrik Stenlund, CEO told IM: “The big difference between SimMine and other planning programs is that SimMine is a good tool to use after you set up your plan to see if it is doable or not and what you need to change. It is a great tool for letting you know in advance where your bottlenecks will be and when you need to act to prevent these bottlenecks. You don’t need any programming skills to use SimMine and it is easy to learn, and after you have model your mine in SimMine and found a satisfied solution you can always return this information back to the original planning tool you used if you prefer to use that.”

Carlson
Carlson supplies a range of mine scheduling software for both surface and underground operations, known collectively as the Carlson Mining Office Suite. It contains modules for Geology, Surface Mining and Underground Mining. Some 95% of the US coal industry uses Carlson Software, and overall there are over 800 mining companies using its systems. The Carlson Geology Module is a mining add-on to AutoCAD or use the built-in IntelliCAD for the complete geological modelling package. The process from importing drillholes, validating the data and modeling the ore to reserve calculation is seamless. Other factors such as 3D viewing of the drillholes and blocks, cross sections and queries are part of the process for the geologist.
to accurately represent the ore body for mining. The Carlson Surface Mining Module contains the necessary tools for complex surface mine design and scheduling with equipment timing. The typical progression of the steps would be to create and layout pits, calculate reserves, then schedule the mine. Other design factors come into play, such as cross-sectional design with dragline range diagrams and 3D pit and fill design routines.

It includes many intelligent routines for complex surface mining techniques and design. Pit design and layout uses several pit layout algorithms to represent actual mine pits or simply to subdivide reserves into smaller production blocks for reserves or scheduling. The layout can be of any shape and extremely complex using commands such as Pit Matrix Layout and Layout by Advance. Pits can be further subdivided and identified by ownership automatically for instant lease and royalty calculations by owner using the property lines. After the reserves are calculated, the mine planning and scheduling begin. Production equipment fleets for overburden and the ore is defined based on shift and hourly rates. Maintenance and availability factors can be added for rate variations. De-rating by date, bench thickness or bench number is an advanced setting for each unit. Surface mining rates can be based on overburden removal or ore tonnage. Advanced equipment options allow for de-rating by time of year, thickness or bench number. Rehandle tables can be applied to thickness of the benches for each piece of equipment. Equipment calendars can be applied to individual or collective equipment fleets. Equipment scheduled hours/days can be reviewed graphically and even edited graphically. Equipment and period reports are instant. Multiple calendars may be created for "what if" scenarios. Calendar reports are instantly produced by year or each piece. In the pit based Production Timing, colour coded blocks will highlight the production timing and production statistics. *Pre-scheduler* runs report the production by time period to give an initial starting point. Equipment will mine through single pits or predefined directional attributes associated with the pits.

Even in large single-pit examples, the equipment will detect the undulations of the material quantity and quality to produce distinct production values for each month or other user-defined mining period. Timing can be based on calendar periods or tonnages of coal or other mineral, or on volume of overburden. Customised production requirements can be set and timing blocks can be stacked vertically as well as laid out horizontally, with precedence requirements. Benches may be offset or staggered to mine in a "stair step" fashion. The benches may also be strata-based, elevation-based, or combined with a block model and mined by quality. Surfaces may be output for each pit and bench for graphical 3D representation of each period.

The Surface Mining Module also contains interactive Range Diagram options for detailing dragline sequences and associated volumes. IM

### Precision digging for truck level ore blending

Accuracy of planning also involves crossover into other technology areas such as high precision positioning systems for mining equipment. While fleet management systems primarily focus on elevation monitoring for accurate measurement and comparison of machine progress to engineering design, there are situations when even greater accuracies are required.

At an oil sands mine in Northern Alberta they use Wenco International Mining Systems’ Fleet Management System and BenchManager program to meet a specific need to blend ore at the truck level. It is critical that the operation maintains a consistent delivery of a predetermined blend of ore to the plant in order to optimise the extraction of bitumen from the sands. Wenco’s BenchManager (BM) application is used to calculate the ore blend as loaded on each individual truck. The mine's complex ore body and blending (tracking 22 qualities, three of which are used for blending) requires that the shovel heading and precise bucket position is always known.

To ensure constant heading knowledge Wenco’s BenchManager system incorporates redundancy by using two methods to calculate and maintain orientation; CoR and Novatel’s ALIGN, with the ability to automatically switch between the two.

CoR is Centre of Rotation and is calculated from the antenna at the back of the shovel, which records the rotation of the machine. ALIGN is a GPS / Glonass based azimuth orientation system that uses two receivers and antennas to form a short baseline to maintain orientation. An accuracy of 0.4° is achieved based on a minimum 1 m baseline; the longer the baseline, the more accurate the azimuth.

A third party arm geometry system with a modified algorithm to allow for split bench digging is added to the application. This allows the operator to dig in layers of constant elevation. Even after all of these processes and checks to determine as accurately possible a valid dig location, each dig location is only considered a "candidate" until verified by an algorithm within BenchManager called the "Bucket Processing Model." The bucket dig locations within the dig blocks are then compared to the plan to determine the ore grade for each bucket.

With this information the blended ore grade for each truck is determined. Wenco's BenchManager and Fleet Management System have always had a high level of integration. While the shovel is loading, the truck coordinates are sent to the BM application. Truck identification number and incremental payload is displayed to the operator. Material types and ore qualities of the load are determined from the BM application and sent to the FMS for blend point truck assignment decisions. The mine can now accurately determine each bucket dig location in the face and materials that have been dumped in the truck.