

Mining data and gold

Technology moves fast; capabilities increase all the time. **John Chadwick** found Gold Quarry very pleased with the vast amount of data Minestar provides for open-pit machine management

Gold Quarry, which opened in 1985, is currently Newmont's largest open pit on the Carlin Trend, moving about 300,000 t/d of material from all areas of the operation. Currently it is producing from three main pits, two to the north and the original mining area, some 16 km to the south. The equipment in these three operations is controlled by Caterpillar's recently released Minestar FleetCommander 3.0. When Gold Quarry first began production, Newmont expected mining at the site to last just six years. However, many subsequent discoveries and expansions have allowed it to continue operating. That ever expanding history has led to a mine site of some complexity. That combined with the fact that, almost 100 different material types are mined, "was a challenge for Caterpillar," explains Newmont's Steve Micheli, who carries the title Minestar Analysis, Surface Mine Operations.

Micheli has worked his way up through almost 25 years on the mine, and has operated big shovels and trucks in the past. So, he has great accumulated experience to call on when evaluating a system like Minestar. He further comments that "there is so much data, but it's so useful."

Gold Quarry's use of Caterpillar's mining technology products began with the Computer-Aided Earthmoving System (CAES) and Aquila using GPS and Glonass. Both quickly established themselves as popular tools for operators and management. CAES reduces the potential for

misclassification of ore and waste as well as greatly improving elevation grade control during earthmoving operations. It provides other benefits as well – like increasing the safety of people and equipment.

The Aquila Drill System increases the accuracy, efficiency and safety of all functions relating to production blasthole drilling. Gold Quarry has a fleet of three Atlas Copco Drilling Solutions Pit Vipers (which can single pass drill to 12.2 m, the bench height in waste) and three multipass function DML drills. The bench height in ore is 11.1 m. Aquila improves the accuracy of drilling depth, provides feedback on the variation of bench geology, and improves safety and efficiency by keeping the operator in the cab. It records and measures multiple drill parameters to optimise machine utilisation and improve the overall efficiency of drilling and blasting operations. The Guidance System uses Global Navigation Satellite System (GNSS) to provide 3D positioning of the bit to ensure holes are drilled according to the designed drill pattern.

Gold Quarry's main load and haul fleet comprises three Hitachi 5500 hydraulic shovels, which load the Caterpillar trucks in five to six passes. There are two additional Hitachi excavators – one 3500 and one 2500. Multifunction loading is provided by a fleet of five Caterpillar 994F wheel loaders. There are 789s, 793Cs and 793Ds in the 45-strong Caterpillar truck fleet. The average haul is about 20 minutes.

Communications antennae at Gold Quarry, one of the largest gold mines in America

CAES and Aquila ran for about five months before the mine installed Minestar – originally the 2.1.3 version. MineStar FleetCommander is a fully integrated mine operations monitoring, reporting and decision support system that enhances mine site safety by delivering. It has recently been significantly upgraded to the 3.0 version. When *IM* visited the mine at the beginning of October 2009, MineStar FleetCommander 3.0 had been running for about three months, with just GPS on the trucks, not GLONASS.

As Micheli explains, "Minestar is a GPS truck assignment program. It actually assigns trucks to and from loaders, from the dumps to the loader, from the loader to the dumps. It tracks the different types of material so we keep all of our material where it needs to be, in the right places."

At any one time there are two controllers in the Minestar control room, which Micheli describes as "the heart of the Minestar system," in the offices close to the south pit. They use "various screens to keep control of the things that are going on within the mine."

"This screen," explains Micheli, "is a site monitor. This is almost a real life representation of the mine itself. The green segments are roadways, the shapes are weight point. The

trucks have to pass through the weigh points in order to complete their cycles.

"The travel progress monitor shows the trucks en-route to the loading tools and their estimated time of arrival. The ones at the far right in green have arrived at the shovel. The red means that they are currently loading at that loading unit." Another screen he points out is the cycle editor screen. "That's what counts, our loads and our tonnes and is the way Minestar tracks our trucks."

Latest Minestar

In that short period, Micheli and many others at Gold Quarry had been suitably impressed. When Caterpillar released MineStar FleetCommander 3.0 in May 2009, it stated that it "builds on proven results and delivers an additional 5% productivity improvement compared to previous versions." Micheli agrees with that. He also noted "free assignment gains" – operations are seeing even greater productivity improvements when they allow the system to assign trucks automatically with no restrictions. Letting the assignment engine run automatically also allows mine controllers to focus on other operational needs (*IM*, November 2009, pp61-62).

"It has really been a good relationship [between Caterpillar and Newmont]," says Micheli. Gold Quarry had been running Minestar for about five years before it was selected for a field follow for the 3.0 version.

Some of the upgrades to the 3.0 version that Michael Murphy, Marketing Division Manager of Caterpillar Global Mining Technology Marketing, highlights are:

- New touch screen display
- Improved assignment module through tighter integration with mine model
- Enhanced tyre management and blending capabilities
- Continued leader in open architecture (readily accessible to the equipment provided by other vendors).

Micheli highlights a number of updates that the mine has found particularly useful. The upgraded site editor and CAD capabilities eliminate the need for an external mine site design program. New features enhance the ability to create and maintain accurate digital site representations. "This is good to use to keep the mine model up to date," Micheli explains. New software also supports decision making by evaluating 'what if' impacts of making changes to the production plan during the current shift. The software helps controllers make decisions to optimise productivity.

He is also impressed with the amount of troubleshooting the system can be used for. It has lots of troubleshooting tools and can, for



Two controllers in the MineStar office

instance, be used to look for holes in the pit radio network.

Troubleshooting machine health is another facility. The Gold Quarry trucks use Cat's VIMS (Vital Information Management System) – a powerful tool that provides operators, service personnel and managers information on a wide range of vital machine functions. Numerous sensors are integrated into the vehicle design. Now it is moving to use MineStar Health, linked into the VIMS. This can:

- Save component failures and extend component life
- Reduce phantom breakdowns
- Provides full fleet health monitoring and efficient data analysis
- Improves maintenance practices.

Micheli notes that Minestar Health is proving to be very useful for operator training – which Gold Quarry has to do a lot these days. Its data can be used to show up bad practices, etc.

There is a considerable amount of rehandling in the operation, which is considerably simplified by Minestar and the RFID tags the trucks carry. Anywhere the trucks are loaded from a hopper; Minestar recognises the truck and automatically instructs the system how many tonnes to load on any one machine.

Similarly operations in the fuelling bay are controlled and monitored through the Aquila Fuel System.

CAES shovel display on a Gold Quarry machine

Developing the data

In another operator safety initiative, Gold Quarry hopes to incorporate the images of the vehicle behind taken from the trucks' rear looking cameras onto the Minestar screen. Cat has not yet agreed on a timeline for this. Version 3.0 includes an upgraded onboard display that is easier to read, yet smaller in footprint. The screen offers an 18% increase in viewing area, in a unit that takes up 27% less volume in the cab. The screen also features higher resolution and supports 256 colours for enhanced readability in all lighting conditions. The easy-to-use touch screen display improves the operators' ability to accurately input information without memorising keypad functions.

The haul roads already look good but Micheli explains that under a haul road optimisation project, using Minestar, the mine will equip one of its Cat 24 motor graders to really get the roads into good shape. The trucks also have the Road Analysis Control (RAC) product that provides monitoring of haul road conditions. It





Cat 994F wheel loader servicing 793 trucks

provides real time feedback to the operator about haul road conditions which are detrimental to cycle times and powertrain, frame, suspension components and tyres. On two of the trucks information is passed on through the telemetry system to mine control for immediate remedial action to be ordered.

Minestar currently collects the drilling and rock recognition data provided through Aquila – hardness, depth of hole, etc. are all reported. There is also a capability to optimise blasting through the use of this data. While that is not used yet, it is another example of the myriad data available that can be used to make the mine operate more efficiently.

Shift changes are a key area in which system management can raise efficiency. Thousands of production hours are lost each year to shift changing in open pits. Micheli worked with Caterpillar to incorporate future machine assignment into Gold Quarry's system. This means that the new operator coming on at shift change can be directed to the correct bus delivering him or her to the right place in the mine to find their machine.

Jack Henris, Mine Manager, explains: "With Minestar we are able to achieve more sustainable mining. The reasons being primarily, there's less equipment, less fuel used and less waste. We're just being more efficient all around, with the combination of the Minestar system and also the Caterpillar equipment."

Longevity at Gold Quarry

Located 11.3 km north of Carlin, Nevada, Gold Quarry is 90.1% owned by Newmont Mining. Its life goes on and on. The Gold Quarry mine is a

sediment-hosted, micron gold deposit primarily within the Devonian Rodeo Creek Formation. End of 2003 reserves were about 6 Moz. In 2007, a group of long-term planning engineers and geologists working at the Carlin operation recognised an opportunity to add more ounces to Gold Quarry's life. A systematic study showed the potential for a 300- to 400-Mt layback on



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the west wall of the Gold Quarry pit. The layback could add about five years to the life of the mine, as well as add 2-3 Moz (recovered) to Newmont's output between 2014 and 2021 - a large gain for a relatively small investment.

Nevada is the leading gold producer in the US, by far, though its output has been falling this decade. In 2001, the state produced 8,924,000 oz, but last year output had fallen to 6,173,000 oz. Newmont's Nevada operations sold just over a third of Nevada's 2008 gold production – 2,225,000 oz. The costs applicable to sales were \$460/oz, with a further \$111/oz for amortisation.

Consolidated gold sales were expected to decline in 2009 to approximately 1.8 to 2.0 Moz, primarily due to lower expected ore grades, fewer expected oxide leach pad

additions, the continued suspension of a third-party operated processing facility and lower recoveries at Mill 6 and the completion of underground mining activities at Deep Post by the end of 2009. Costs applicable to sales in 2009 were expected to be approximately \$535 to \$575/oz, primarily due to lower production and lower by-product credits from Phoenix copper sales, partially offset by lower diesel costs and a full-year of power provided from the new power plant completed in mid-2008.

Gold Quarry is a large, low-grade disseminated gold deposit hosted in Silurian-Devonian aged sediments. Gold bearing hydrothermal fluids appear to have migrated upwards along faults and then moved outward along favourable stratigraphic horizons and structural intersections.

The gold is finely disseminated within the host rock. Oxidation is controlled by a combination of depth below surface and proximity to structures. Refractory mineralisation results from a combination of silica and/or pyrite encapsulation of the gold and, in some areas, the presence of naturally activated organic carbon. Carbonate and sulphide levels vary throughout the deposit.

This complex mineralisation necessitates the classification of material within a variety of different ore types for recovery of gold by different processes. Available process options include heap leaching, milling, flotation, and roasting. Each process option has different costs and recoveries depending on the ore feed characteristics. Proper estimation of tonnages and grades in each metallurgical classification is critical for economic evaluation and planning. Ore classification is dependent on the understanding of spatial distributions of sulphide sulphur, carbonate carbon, organic carbon, preg-robbing carbon as well as the ratio of cyanide soluble gold to fire assayed gold¹.

As Micheli said, integrating Minestar "was a challenge for Caterpillar." But its success is producing great results and will do well into the future. It is playing its role in keeping a low-grade gold mine productive and prolonging the mine life. **IM**

Reference

1. Allen L. and Baumann M., *Interaction of grade and metallurgy simulations in assessing uncertainty for ore routing determinations in the Gold Quarry deposit*, SME Annual Meeting, February 2007, Denver.