

It came from Africa

The second deepest gold mine in the world took nearly 14 months to restore after its shaft flooded and infrastructure was severely damaged in a seismic aftershock. Advanced 3D modelling software helped with the rebuilding task. By **Brooke Showers**

Aftershocks rocked the shaft and infrastructure at AngloGold Ashanti's Savuka gold mine in South Africa, bursting underground dams and flooding the shaft in 2009.

The seismic event measuring magnitude 2.7 produced a series of severe aftershocks at various magnitudes that led to a series of rock falls at a portion of mine.

A few million dollars worth of equipment in the shaft was damaged during the event.

The underground mine is situated 90km west of Johannesburg in South Africa and stretches a massive 4km underground. It was once the deepest mine in the world.

In the heart of this African rich gold region, the earth is prone to seismic events and the depth of the Savuka mine added to the risk.

The \$30 million project to restore operations and infrastructure first required the Savuka shaft to be modelled using 3D software.

The shaft refurbishment project was carried out internally by AngloGold's design and consulting service, which specialises in the South African region.

Designers used Bentley software systems MicroStation and Structural Modeler to model the underground landscape, four conveyor systems, steelworks at the silo and load station, control chutes at the silo and loading flasks at the shaft.

The project team were able to preassemble and package the necessary equipment and components needed down the mine, some of which weighed several tonnes.

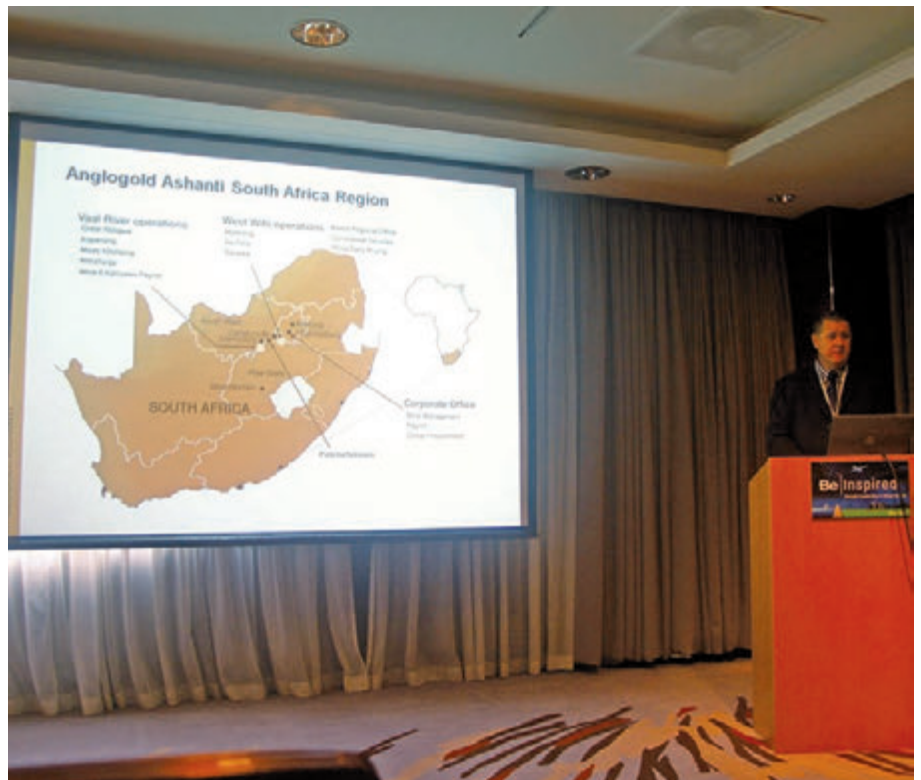
The underground components were prepared in order to fit properly down the shaft and hauled into allotted spaces.

For its Savuka shaft redevelopment work, AngloGold earned a place among finalists at the Bentley Be Inspired Awards for Innovation in Mining and Metals held in Amsterdam in November.

At the time of the seismic incident, Savuka was producing 40kg of gold per month.

Based 2km below sea level, the mine was in low production mode and past its prime after operating for more than 50 years.

The strategically important mine is centrally positioned to deliver emission pumping and ventilation services to the two Mponeng mines alongside it.



AngloGold Ashanti designer Martin Allerston describes the shaft project which reshaped the deep mine damaged by seismic aftershocks.

One level of the Savuka shaft completely lost its pumping station.

Tragically, one pump attendant employee died as a result of the incident. Fortunately other workers were able to evacuate in time.

The mine was completely flooded from the second level down and 155 megalitres of water had to be pumped out before access to the shaft and action could commence.

A damage assessment determined the whole system was affected and the ore pass lost.

There was extensive damage to the side wall and loading station and the pump station was completely destroyed.

Although the twin conveyor belts feeding the system were not damaged, the ore pass feeding the conveyor system was crushed in the seismic event and the conveyor system was rendered useless.

Production stopped at the Savuka mine immediately and severe limitations were imposed on the pumping and ventilation

services at the other two mines, hampering operations there.

Dewatering the flooded shaft and repairing the infrastructure so the necessary services could resume was the highest priority.

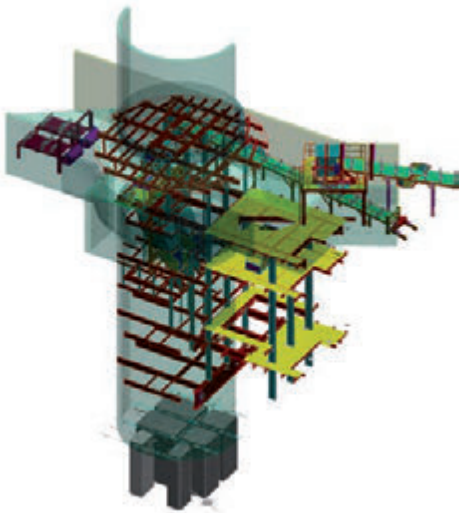
Designers visited the mine site and as soon as the 2D drawings were produced the team started putting together sketches of the steel work.

AngloGold Ashanti designer Martin Allerston said tremendous effort was required to get the materials and the equipment to the right location underground.

"The opening to the shaft only allowed a limited space to get the steel works through," he said.

All the steel had to be designed to a certain size to fit underground.

Two shaft systems 2850m underground was the final destination for much of the equipment and the logistics involved in getting the steel works down there was complex. ▶



A 3D model of the redevelopment of the Savuka mine shaft at AngloGold Ashanti's Savuka gold mine in South Africa. Image courtesy of AngloGold Ashanti.

Transporting the steel works into the confined areas of the shaft involved extremely delicate manual handling. The final installation required bags of cement to be carried in.

Models were created for the Savuka ore pass using the Bentley software and 2D drawings extracted from parts of the initial design.

"Bentley provided us with accurate detail and design," Allerston said.

All the design work was completed in Bentley MicroStation and Bentley's Navigator system, formerly known as ProjectWise, for the presentations.

Users involved in the shaft development were able to visualise the designs if they didn't have the Bentley programs by viewing the models in a 3D Adobe pdf format.

MicroStation is computer aided design software used by engineers, architects and constructors to design, model, visualise, document, map, and sustain infrastructure projects. The software has realistic graphics and an interactive user interface for viewing 3D models.

The program streamlines the design and modelling process and reduces the number of software products designers need to use.

Bentley Navigator is used by infrastructure

teams to review and analyse project information and has highly versatile viewing capabilities.

This enables greater project insight and helps avoid costly onsite errors.

In addition, teams can analyse projects virtually to detect and resolve clashes, simulate project schedules and even produce 2D and 3D pdfs for consumption by a wider audience.

All the designs were done with MicroStation and the design service costs were 50% below normal costs.

The refurbishment project's design component only used a small portion of the budget allocated for the works. This was due to it being an internal design service, the low costs of labour and the 3D approach speeding up equipment assembly.

"With this project, I liked it to be very accurate with the modelling and design work, for which 3D is an invaluable component," Allerston said.

"Manual surveying is important but it is not best practice. There are much better technologies out there now that can be utilised."

Because of the unknown and adverse conditions, even with normal designs, underground conditions make it difficult to get equipment to fit.

The 3D technology helped visualise the rock structure to prevent problems.

"One of the key factors is rock formations, so we can never predict exactly what's going to happen," Allerston said.

"You either get over-break or under-break.

"[If] you get under-break, you need to go do your whole steel process again or you have to get the mine deeper.

"We try and keep the blasting as little as possible and the haulage sizes as small as possible.

"The wider you start going the more stress you get on the rock, the more danger of rock falls.

"So the 3D helped us to get the right sizes in and model it and see what would fit.

"We preassemble all the steel work on site before we take it underground to see if it will work."

Allerston said 3D design was a more effective way of mapping shaft data but did require some extensive field work and

mapping initially to populate and quantify the data in the design.

A lot of extra work would have been involved if the structure was redeveloped based on 2D designs only. If something happens on the ground, there is no live model to play "what if" with.

Animations of the shaft's progress were presented at the weekly board meetings.

"If they can see what they are getting, they are relaxed and happy," Allerston said.

The mining professionals also can then visualise what will and will not work.

AngloGold managed to minimise the production losses associated with the time out for the repairs to the shaft thanks to the 3D design method speeding up the process.

In South Africa, 44% of fatalities recorded in 2006 were caused by either seismic-related or gravity-based rock falls.

Seismic-related rock falls occur when energy is released in the rock mass causing ground movement and possible rock falls.

Gravity-based rock falls of rock occur when loose ground is not sufficiently stabilised or supported.

"It's not a natural earthquake zone," Allerston said. "It's very much mining-induced seismic activity.

"We do have to do very comprehensive seismic monitoring."

Ground management was initiated at the Savuka mine in 2003 but three years later there was a sharp increase in fall-of-ground fatalities.

A high-level review of the fall-of-ground management at AngloGold's South African operations led to a change in processes.

All risk management systems were integrated at mine and corporate level and a two-tier fall-of-ground management committee system was established.

Research, development and technology for mine layout and design remain integral to the strategy.

"A key aspect of the strategy is a move from lagging to leading indicators," AngloGold Ashanti rock engineering manager Johan Laas said.

"We're still developing a system for consistent tracking of leading indicators, but the critical point is to identify and mitigate risks before an event happens, rather than analysing causes after the fact." **AMM**



More than just a search engine

Whether you're looking for a new supplier, company or product information, career change, or the latest industry news and events, *SearchMining.net* will provide you with the answers.

www.searchmining.net