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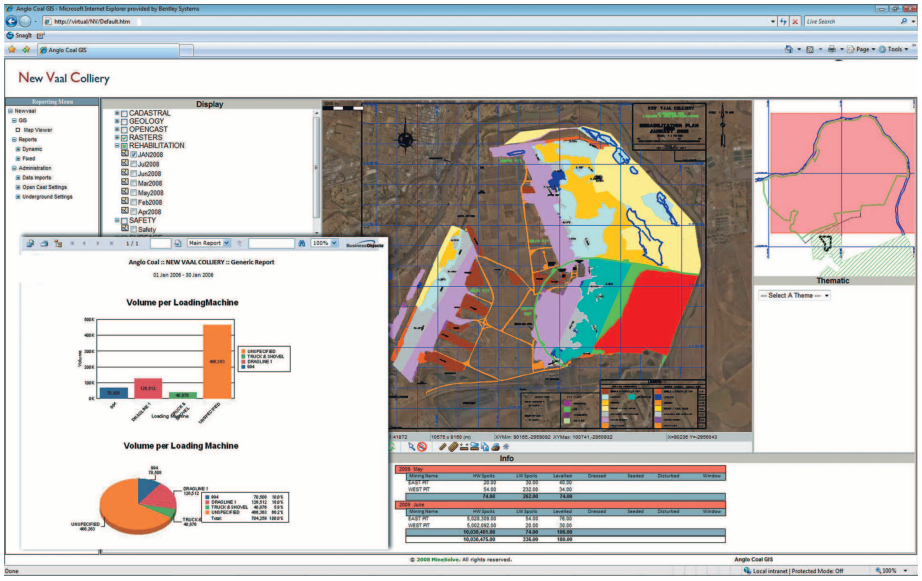
Inspiring Infrastructure

In October, Bentley Systems' *Be Inspired: Infrastructure Best Practices* Symposium and Awards in Charlotte, North Carolina, showcased some groundbreaking projects. **Daniel Gleeson** takes a look at the finalists in the mining category



At Anglo Coal SA's New Vaal coal mine, the use of Bentley Map and MicroStation helped standardise the workflow and produce accurate reports that can be analysed by management. This graphic shows an overview of the site via Geo Web Publisher and, to the left, details of volumes the loading machines have been achieving

Infrastructure is integral to mining. With well established infrastructure in the vicinity of a deposit, projects can potentially be fast-tracked into production. On the contrary, inadequate planning, design and construction can impact the viability and sustainability of a project over its life and affect the bottom line.

IM featured Bentley Systems in November 2009, p26. However the symposium made it clear that the company's software could be far-reaching for mining. Programs such as MicroStation, Bentley Structural, PlantSpace, ProSteel, ProjectWise, ProjectWise Navigator, Bentley Map and Geo Web Publisher have been used on these projects to an extent that even surprised some Bentley employees. These helped facilitate major infrastructure design and reporting that reduced costs and timings for the respective companies. These are only three examples, but as Bentley's software evolves, we could be seeing much more of its products in the mining marketplace.

Pieter Neethling, Global Solution Executive: Mining and Metals, spoke to ***IM*** about the direction the company was hoping to take in the next few years, saying that mining was going to play a big part. At the current time its mining customers are predominantly contractors and consultants. However, he is shaping solutions that will become more geared to owner-operators, covering the whole process from exploration, to construction, to production, to processing and rehabilitation. With the ever increasing need to go deeper to reach lower grade orebodies, Neethling and Bentley realise that 3D modelling software and integrated geospatial solutions will play a big part in the mines of the future, for owner-operators and consultant alike.

QMM ilmenite project, Madagascar

Starting with the winner of the mining category, Hatch Africa, whose work on the QMM ilmenite project (a partnership between Rio Tinto and the Malagasy Government) in Fort Dauphin, Madagascar involved the construction of the $900 million ilmenite and zirsill sand mining operation, with EPCM joint venture partner, Fluor. This included designing and building extensive ancillary services and infrastructure including the materials handling at the port, power station, mineral separation plant, wet plant, road, water supply and communications network. In addition to logistics, the island also posed environmental challenges for protecting flora and fauna.

Morné Fourie, Lead Structural Engineer for the project, explained that the use of CAD systems and MicroStation 8.1 (a now dated version) was very important to the project as a whole. Deliveries of construction components could take up to six weeks, and therefore the engineering had to be accurate to ensure that the schedule was kept to.

When the project started up the only way to reach the construction site was via a 16 km stretch of basic roadway, which could take up to three hours to navigate on some days. This was replaced with a new 16 km road that, by the end of the project, took much less than 30 minutes to navigate. The road leads to the new port which with the improvement in materials handling will aid government exports in the future.

Fourie said the most interesting part of the project was the construction and operation of the wet plant; something he was responsible for. The plant was built and floated on a pond with berms just above the water table, to ensure that personnel or equipment didn't have to constantly pump water out. When in operation, the pond floods allowing the dredging to start, creating a hole and constantly moving forward. The dredged material then passes through the floating plant with 95% (silica sand) discharged at the back. This process is carried out for the whole mining area and ensures that the dredged land can be re-established once the operation is complete. The plant is moved forward by four winches, with the land anchors constantly moved to allow the whole plant to follow the dredger through the mining path.

The minerals processing is very simple, with no chemicals involved. It relies purely on gravity, with the sand passing through spirals. Because of the differences in density between the ilmenite and sand, the denser ilmenite moves to the outside and can then be skimmed off. After mineral separation, the material is cleaned in the preparation plant, moving onto drainage bays where the product is kept for three days to solidify. The minerals then go into driers at a dry mill building. The ilmenite is then separated from the zirsill by magnetic separators.

The wet plant is 65 m x 45 m x 3.7 m high. It was fabricated in China in 16 sections and shipped to Madagascar. The product in the plant, while operating, weighs 2,902 t, the equipment weighs 1,814 t, steel work is 1,179 t and the pontoon is 1,541 t. This made the total weight

The floating wet plant at the QMM ilmenite project

7,437 t when floating. This weight issue was a worry for Fourie, with the structure, when originally floated, having a clearance of only 100 mm, emphasising the precise engineering needed for the project.

The entire plant was modelled using MicroStation 8.1, Structural Informa and PlantSpace, which ensured no clashes in the engineering. This included piping, electrical components and design and position of the spirals. Once the modelling was complete and clash detections were rectified, Hatch then used ProjectWise Navigator to display the construction for client review.

Fourie said that the Bentley products were integral to the construction of the whole operation. The advantages he listed included:

- Streamlining for inter-discipline interfaces by using live models
- ProjectWise Navigator made it easy to have formal layout reviews
- Direct transfer of structural models for shop detailing
- Accurate material take off
- With the right tools and talented people it was possible to execute the design of this project within a very small team. On the wet plant and the mineral separation plant this included two modellers, two full-time structural engineers and three part-time structural engineers.

An integrated geospatial solution, Anglo Coal

In contrast to the other finalists, Anglo Coal South Africa's use of Bentley was somewhat surprising. The New Vaal operation, which produces 16.14 Mt/y of saleable coal with a calorific value of 15 Mj/kg, is the sole supplier of coal to Lethabo Power Station in South Africa. To improve efficiency and increase the accuracy of reporting at the mine, it required a system to link spatial information to various databases, allowing analysis of possible outcomes based on changing variables. Most of this information was inextricably linked to the survey department, with the operation having 11 separate operations that it wanted to standardise.

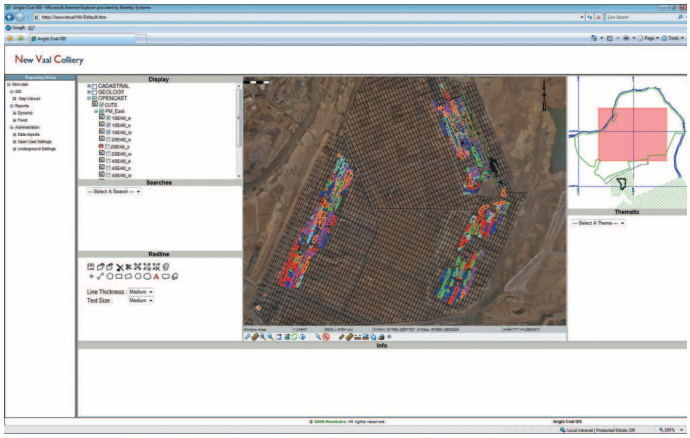
Johan Fourie, Technical Services Manager of the New Vaal coal mine, explained that "The drive behind the solution was to bring together information from different disciplines into a managed environment in which management can retrieve relevant information to make sound business decisions." This involved the implementation of a geospatial information solution (GIS), which is where the use of Bentley Map and MicroStation came in, standardising the workflow. This, in turn, produces accurate reporting that can be analysed by management; comparing daily, weekly, monthly and quarterly estimates.

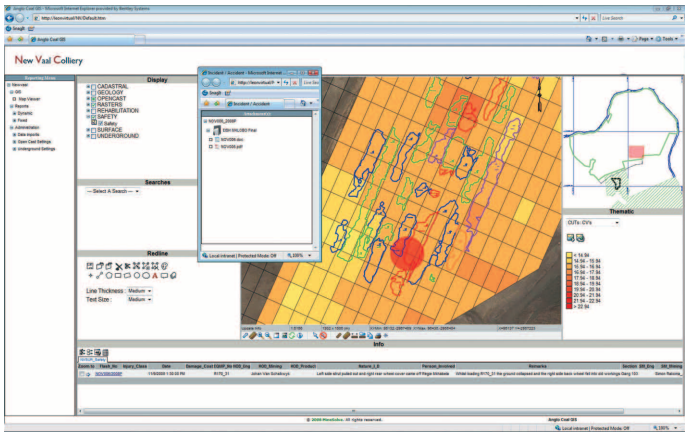
The survey process was streamlined by using an input resource that captured data input, and resulted in output of an organised and secured storage facility with powerful reporting functionality. Fourie said in October that the survey department currently had a single data source – Survey Server – which includes an SQL database, regulatory maps, photos, Word documents and Excel spreadsheets to name but a few. "In the past, survey department data was manually captured in Excel spreadsheets, but through Bentley Map technology, data is intelligently captured and dynamically entered into the database", he said. By streamlining its workflows using Bentley technology, Anglo Coal has improved its efficiencies.

"All features are now pre-defined and also linked to the SQL database. In the Bentley Map command window, the feature is selected and the surveyor can start drawing the polygon (area to be mined). Once a polygon is completed, the area is automatically calculated and the surveyor must verify it. There are drop down lists to select the mining pits, seams mined and loading machines used to move the material. All the relevant information, for example, mining cuts, blocks, elevation, etc. can be entered."

He continues: "Easy reporting is probably the most significant motivation behind this integrated solution. It is relatively easy to put standards and

The left screenshot shows a particular area of the New Vaal mine site with individual seams of the open pit highlighted. On the right, the round red dot shows where an incident occurred on the selected section of the mine and the text below the graphic summarises the event





workflows in place through Bentley Map to break down silos and integrate data sources. But to retrieve relevant data in a logical format, from the data sources, is a challenge."

To tackle this problem, the team set up three standardised reports. **Dynamic** reports were designed for the mine management to report on different variables over different periods. **Fixed** reports were available to mine management through to the Anglo Coal corporation and dual **Web Publisher** reports were available to executive personnel. Dynamic reports are composed of dates, equipment, waste data – including overburden and interburden, fields such as survey data, area, volume and the loader used. This allows production results to be circulated to management with speed and accuracy, ensuring that any operation problems are rectified before production suffers. These reports are comprehensive; however the reader can specify which data he/she wants to access. This can include overburden shifted on a particular day, dragline data, production rates on a specific seam and so on.

Fourie said "the value added is more far reaching than purely monetary value."

The return on investment for New Vaal includes:

- Savings through standardisation – business unit (BU) to BU
- Savings through knowledge management – single source
- Through secure data
- Through time management
- Real-time publishing.

One question Fourie asked in his presentation was: "Why stop at pure mining data?" Some of the slides he included showed reports on incidents at the operation – photos of damage and reports of what happened and details on the mining licences the company had obtained. This can extend further though. The team's next steps are to incorporate planning, environmental, geological, dispatch and safety data into the GIS. Fourie also mentioned that Anglo Coal had taken note of the results that the operation had been achieving and may look to roll out such programs in other operations.

BHPB Rapid-Growth Project Newman Hub, PDC Consultants

BHP Billiton retained PDC Consultants to provide mine information modelling with intelligent 3D review models and shop detailing for more than 7,200 t of mechanical and structural steel and associated platework at the Newman Hub, in the Pilbara of Western Australia. The expanded mining operations will include a car dumping facility, crushing and screening plant, coarse ore stockpile, stockyard and train load-out facilities, 12 conveyors and transfer stations, and associated infrastructure. The mining process was streamlined, with the company having all crushing and screening facilities at the mine, instead of the port, reducing the environmental footprint required.

A 3D rendered photorealistic image of the BHPB Bulk Material Handling facility

PDC Consultants, as Martyn Weir, Managing Director, explains is "one of the largest design and detailing companies in the world servicing the mining, oil and gas, process and industrial sectors. Our unique, 3D modelling technology is world leading in building information modelling (BIM) technology and ensures we remain at the forefront of the design, detailing and drafting industry."

ProSteel 3D software was used to model and detail complex mechanical items, including bins, curved trusses, transfer chutes, and liner systems. The scope of work included building BIM systems, fully intelligent 3D review models; including all vendor items and electrical cable chase; integrated and collaborated systems between engineering and detailed design, and 2D shop-detailed drawing; with a total of 49,000 drawings and fittings produced with four associated BIM files per drawing. Electronic fabrication data was also used as well as material take offs.

The team worked within the detailed design stage to look at construction sequencing to maximise work offsite and improve safety planning in this stage. Some of the BIM tools used included construction sequencing and planning, also known as 4D modelling, and logistics management to provide project assurance and delivery optimisation. These tools increased off-site pre-assembly and improved engineering and integration into project extraditing software, as well as giving the team the ability to do lifting and constructability studies.

One of the most impressive graphics that PDC showed was the 3D model transfer chute constructed in ProSteel with the maximum amount of detail possible. As Weir says, the "intelligent 3D models of transfer chutes are built from conceptual design, building millimetre perfect models that are then linked to 3D BIM systems and can be utilised and integrated into client operating and maintenance systems."

One of the key requirements for BHP was to have readily accessible information to go into its liner systems. Once this information was delivered to BHP, it was able to use the 3D systems to have full intelligence of the systems. It could also link this information back into the 2D PDF deliverables that are integrated into the company's operating and maintenance document management systems.

Feedback from BHP in regards to the solution that PDC provided included:

- Schedule – "Potential for three to four months improvement on overall schedule"
- Cost – "Significantly reduced the extent of re-work, unambiguous communication between engineering and construction, efficient resolution of construction and erection anomalies enabled the project to implement vastly improved data management practices"
- Safety – "Constructability, operability and maintainability were enhanced utilising these tools, resulting in an optimised and safe project and ultimately a safer plant"
- Environment – "Efficient planning…reduced land clearances required for storage."

These three projects, all very different in scope and design, display how Bentley's products can be integrated into infrastructure decisions in the early stages. In the case of the New Vaal coal mine it also shows that they can be valuable at the production stage. ***IM***