MECHANISED PILLAR EXTRACTION

With an undeclared resource of almost 2.2Moz contained within strike and dip stability pillars, a significant opportunity exists to extract a percentage of this resource, provided the mining method used does not induce excessive seismicity and/or dramatically impact regional stability.

To this end, a mechanised method of extraction has been devised based on conventional, large diameter drilling. Not dissimilar to raise boring, a 350mm hole is drilled into the pillar along the reef ensuring minimum dilution and maximum grade. Phase one of the investigation has been completed with relative success, satisfying most of the key performance indicators. During phase two, which will begin in early 2017, the future mining concept is to be developed into a deployable, practical method of pillar extraction and should be complete by the end of 2017.
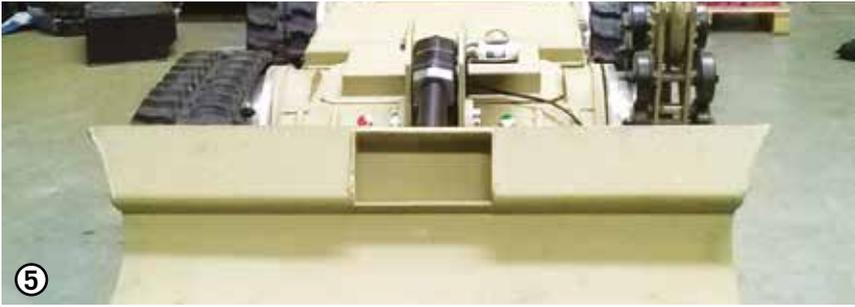

ADVANCED TRANSPORT PROGRAMME

Ore, men and material transport requirements contribute substantially to unit costs for both gold and platinum mines. Sibanye's conventional mines use a combination of battery, electric and diesel powered locomotives, achieving average efficiencies of 45-55%. Trackless mines have fleets of larger diesel-powered vehicles that consume significant amounts of diesel with similar efficiencies.

Cost pressures and recent, potential legislative developments around the use of diesel has spurred the need for more efficient mobile machinery. Sibanye's Safe Technology function is currently pursuing a two-tiered approach to developing the drive train of the future which, although currently both in locomotive form, is applicable to mobile machinery in conventional and trackless mines. The initial tier is the development of a 10-ton hybrid locomotive that uses a low emission diesel generator, coupled to an advanced battery system and highly efficient asynchronous permanent magnet motors, capable of regeneration. Its overall efficiency is estimated at 85-90%, a vast improvement on that of standard battery, electric or diesel equipment.

Tier two of the programme is investigating the use of compressed natural gas engines (CNG) to drive machinery and to assess the complexities around the use of CNG underground, inevitably applying the technology as the generating component of the hybrid locomotive drive train.

Both phase 1 prototypes showed immense promise and the phase 2 prototypes are expected to be delivered for assessment in Q2 2017.

Stope mechanisation programme

Registered as a "quick win" project at the Phakisa Innovation Hub, the stope mechanisation programme seeks to develop a suite of mechanised machinery, capable of being adapted to the narrow tabular environments prevalent in both gold and conventional platinum mining, and of performing drilling and cleaning operations. Increased efficiency and accuracy of the units will improve the rate and quality of mining, reduce pay limits and allow for additional resource to reserve conversion. Most importantly, a significant advantage will be the removal of employees from danger zones with greatly increased safety performance.

The first set of mechanised equipment is complete and will deployed in January 2017 for qualification in Sibanye's planned Burnstone mine. Additional funding of R19 million has been secured by our technology partner, CMTI, for an additional two sets which will be deployed in a conventional mining section of Sibanye's Rustenburg platinum operations.

In the short term, the intention is to prove the capability of the MT100 and MT1000 platforms in a representative environment with the Dozer and multi-drill attachments respectively. The long-term view is to qualify the breaking mechanism and develop remote operating capability, further removing employees from dangerous work areas and enabling access to previously restricted areas and ore bodies.

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MINE DIGITISATION PROGRAMME

There is a common misconception that, in mining, data availability and integrity is lacking, however, recent assessments suggest that this is not the case. The increasing legislative requirements on mobile machinery, for example, have resulted in the necessity for complex digital systems capable of detecting personnel and machinery interaction. An unintended but beneficial consequence of these requirements is that the majority of Sibanye's mobile machinery is equipped with highly effective asset management and utilisation measurement tools. Recent insights into the data available have shown the potential to deliver comprehensive asset and behavioural management tools for use by management to improve the efficiency and safety of their mobile machinery a relatively low cost to the investment required by legislation.

This is one of many examples of where current systems can be leveraged to improve the performance of measurable assets. The mine digitisation programme is intended to investigate where current systems are underutilised and where parallel systems can be integrated to improve business intelligence.

Examples of mine digitisation projects:

1. **General Electric equipment health monitoring project:** Using equipment monitoring systems (SCADA) to develop health profiles of critical equipment in order predict failure and mitigate associated losses

2. **Rail-bound equipment behaviour and asset utilisation investigation:** Using logged driver behaviour and asset utilisation data to provide intervention and coaching and determine overall equipment effectiveness, which is also applicable to trackless mining machinery (TMM)

3. **On-board load and location measurement of load-haul dumpers (LHDs):** Monitoring overall equipment and operator effectiveness by determining loads hauled and location (in the Platinum Division)

4. **Latent data transfer concept:** Reversing conventional mine networking configurations and using personnel and assets to transfer data, maximise data network reach and reduce the cost of infrastructure

These projects are examples of areas in which maximum value is derived from seemingly one-dimensional systems.

Current mining horizon improvement programme

In conjunction with the evolutionary projects mentioned above, the Safe Technology department is conducting a number of short-term projects intended to improve current mining methods:

- **Personnel locator system:** Search and rescue tags being developed for use in employees cap lamps, which together with scanners will facilitate the location of employees underground in the event of emergencies

- **Electro-hydraulic hand-held drills:** Using highly efficient and effective electro-hydraulic drills to replace conventional air-driven equivalents. This will enable quicker penetration rates, reduce power consumption and improve environmental conditions

- **Localised hydropower hand-held drills:** As above

- **Non-throw loading:** Comparative study of "non-throw" type conveyer loaders that can provide substantial safety benefits by removing the operator from the danger zone and eliminating the throw movement

- **GST tube rig:** Improving the accuracy and comfortability of drilling with the use of a simple air-powered and manoeuvred rig

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CAPTIONS:

① *RD2000 raise bore rig in operation during pillar extraction trials*

② *Sibanye hybrid locomotive*

③ *Sibanye compressed natural gas locomotive*

④ *MT1000 with multi-drill attachment*

⑤ *MT100 with Dozer Attachment*

⑥ *MT100 with Sweeper Attachment*

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