Double-header trains at Great Noligwa mine

by L. van Dyk*

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Synopsis

The project was aimed at evaluating the double-header trains implemented at Great Noligwa mine, looking at the changes from the old conventional trains to the new trains, and identifying possible improvements to obtain an even better and more productive tramming system. The methods used to evaluate the double-header trains at the mine included personal observations, time studies, personal interviews, technical research, safety analysis, cost analysis, production analysis, breakdown analysis, break test analysis, comparisons and working closely with engineering department and manufacturers.

Issues that were evaluated are the improvements in safety, cost reductions, tramming congestion reductions, better efficiencies, labour optimization, enhanced driver safety and maintenance. Shortcomings of the double-header trains were identified and recommendations made to improve on the shortcomings.

Findings of the evaluation study indicated the following:

- **Drastic improvement on safety**
- **Extreme cost reductions**
- **Reduction in tramming congestions and bottlenecks**
- **Better tramming efficiencies**
- **Optimized labour placement**
- **Enhanced driver safety**
- **More effective maintenance.**

Although there is room for improvements, the double-header trains were implemented with great success at Great Noligwa mine. It is currently the preferred tramming methodology at Great Noligwa mine, and is also implemented at other Anglo Gold Ashanti—South Africa shafts. This tramming system has huge potential for growth, not only in Anglo Gold Ashanti, but in all other older mines that experience major tramming problems.

Aim of project

Anglo Gold Ashanti are continuously aiming to find and implement new and improved ways to increase production and improve safety as cost-effectively as possible.

Because most deep-level gold mines were sunk years ago and are relatively old, it remains a huge challenge to implement new technology into these older mines. The difficulties of implementing new technology into previously established infrastructures is due to the existing structure/layout of these older mines and the costs involved to implement technology.

Technology, however, needs to be integrated into these mines to ensure their existence in the industry, and therefore Anglo Gold Ashanti invest in projects to test and evaluate new technology to enhance their business all over the world.

The project was aimed at evaluating the double-header trains implemented at Great Noligwa mine, looking at the changes from the old conventional trains to this new trains, and identifying possible improvements to obtain an even better and more productive tramming system.

Because the life of mine is running out, the grade is getting lower and more tonnages need to be trammed and hoisted to be able to keep up with the production targets as set down by management.

Due to continuous pressure for better performance and higher production at safer and more cost-effective rates, the double-header trains were implemented at Great Noligwa mine in 2003/2004 to:

- Improve safety statistics
- Reduce costs (labour, maintenance, breakdowns
- Reduce congestions in tramming
- Increase tramming rates
- Optimize labour
- Enhance driver safety.

To enforce the new double-header trains as the primary tramming system of Anglo Gold Ashanti, it was necessary to evaluate the system, review the results, and make a decision.

Methods used to evaluate the double-header trains

The methods used to evaluate the double-header trains at the mine included the following:

* *University of Johannesburg.*

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- Personal observations
- Time studies
- Personal interviews
- Technical research
- Safety analysis
- Cost analysis
- Production analysis
- Breakdown analysis
- Break test analysis
- Comparisons
- Consulting engineering department and manufacturers.

The double-header trains consist of:

- A span of 7 to 9 ten-ton hoppers with an eight-ton New Era Trident locomotive (Figure 1) on both sides (not remote controlled)
- Two competent drivers
- Closed circuit communication between the two locomotives (Figure 2)
- Radio communication between two locomotive drivers (Figure 3) and
- No locomotive guard.

The two locomotives are interconnected with an electrical communication cable (Figure 2) and controller system (Figure 4), which work together. When the one is pulling (master mode), the other is pushing (slave mode), thus prolonging the battery life of both locomotives, enhancing the power, and improving the braking performance and pulling strength. This makes it possible to tram heavy loads in excess of 80 tons per span in relation to the 28-ton average of the older trains.

Figure 1—New era Trident 8-ton locomotive

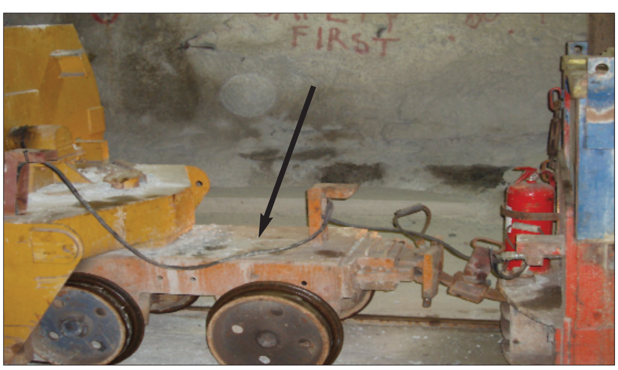

Figure 2—Closed circuit communication cable

The safety devices (emergency hydraulic braking system (Figure 5), speed controllers (Figure 4)) work together to improve the safety of the driver and equipment. The two types of hoppers mainly used are the:

- F10 ton Goldfields non-spill hoppers(Figure 6)
- 10 ton Gallison bottom discharge hoppers (Figure 7).

Figure 3—WallComm communication system

Figure 4—Astec control system

Figure 5—Hydraulic brake system

Figure 6—Goldfields non-spill hopper

Figure 7—Gallison bottom discharge hopper

Implementation problems

Problems that were experienced during implementation were identified as:

- Engineering new designs on the trains include the total redesign and layout of the driver cabin on the locomotive (Figure 8), implementation of an effective hydraulic breaking system (see Figure 5) and dual controller system (see Figure 4), and the design of larger hoppers with more tramming capacity (Figures 6 and 7)
- Routing of the communication cable was a huge problem during derailments and accidents as it always got damaged and needed to be replaced frequently
- Integration of new trains into the existing dynamic mining system was needed to be done carefully so as to prevent this dynamic mining system from getting out of balance
- Infrastructure limitations, as the dimensions of the tramming ways, tipping arrangements, turn-outs and workshops needed to be taken into consideration
- Implementation and running costs of the new trains in relation to the old trains needed intensive research
- Tramming pathways and distances of the new trains needed effective planning and consideration
- Tramming and possible down times needed intensive investigation to establish the optimal usage of the new trains
- The availability and delivery of broken ore/waste must be planned so as to optimize the tramming capacity of the new trains
- Management and optimization of rock distribution points needed to be effective to prevent blockages and excessive spills
- Damage of rock distribution points must be prevented
- Loading/discharging times of the new trains needed to be investigated to determine their effectiveness
- Derailments needed to be minimized to prevent damage to the new trains
- Breakdowns and maintenance on the new trains needs to be effective and carefully planned to optimize their usage.

Discussion

Five double-header trains were implemented at Great Noligwa mine on several levels underground. They were implemented at the main ore tramming areas and where congestion/bottleneck problems occurred.

Safety statistics

Safety was improved from a rate of almost daily tramming accidents/incidents in 2002/2003 to only one tramming accident and one incident in 2006 in these sections. This was mainly due to the reduction of the number of trains, the safer and better design on the locomotive, and the elimination of direct human contact during loading and offloading of rock (see Figure 9). The older tension braking system was replaced by a new hydraulic type braking system that is far better and more effective.

Figure 8—Driver cabin on locomotive

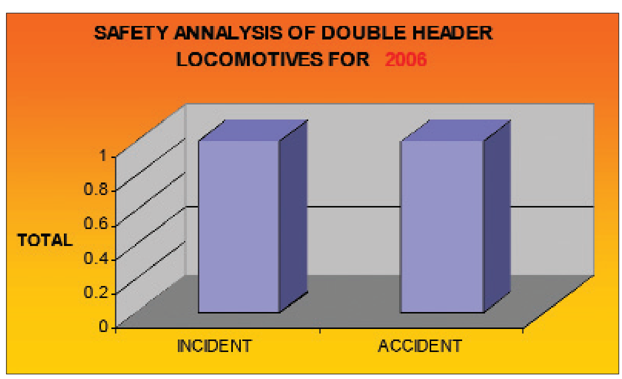

Figure 9—Safety analyses for 2006

Double-header trains at great Noligwa mine

Cost reduction

It would cost about R1.6 m for three conventional trains and R1.75 m for one double-header train (including loco and hoppers). The new trains seems to be a bit more expensive than the older trains but they have a direct saving of four people, less maintenance, better safety and more effective tramming rates. This cost saving does not include any support services.

Tramming congestion reductions and efficiencies

During the implementation stage there were major tramming congestions due to the number of smaller spans needed to tram the high frequency of rock on certain levels. The tramming congestions led to poor safety on these levels with high injury and accident rates, which were further boosted by unsafe working circumstances of the loco drivers and guards due to poorly designed locomotives. Because of the high number of locomotive spans required, maintenance, costs, breakdowns, congestions and bottlenecks were a daily burden on the transport section of the mine. Implementing the double-header trains at these specific problem areas had a direct influence on the safety, cost and bottleneck problems. One double-header train effectively replaces three conventional trains and reduces the labour by 4 people. Because these new double-header trains work interrelatedly, they have more power, better safety features, three times the tramming capacity of the older trains and prolonged battery life. They were proven to be three times more effective than the older smaller trains because the 8-ton locomotive was redesigned with better ergonomics, enclosed cabin, better layout of controls and more effective illumination. The efficiencies of the double-header trains are also a huge plus point for the mine. The five double-header trains moved a total of 2.1million tons of rock for 2006 (89% of total rock at the mine). The double-header trains trammed an average of 86 spans per day (5 double-header trains over 3 shifts). For the older conventional trains, to tram the same tonnage, you would need approximately 280 spans per day (see Figure 10). This shows the direct reduction of, costs, maintenance, breakdowns and labour. Effectively the double-header trains are three times more effective than the older conventional trains.

Labour optimization

Not only is there a direct saving of four people per span, but overall there is a huge reduction in the cost of maintenance, breakdowns, labour and support services.

Enhanced driver safety

Because of the poor safety statistics of the older trains, intensive research and design went into a better and more user-friendly driver cabin for the new locomotive. It was designed to have better ergonomics for the health and safety of the driver. The layout of the cabin was changed from an open cabin to an enclosed cabin, with the controls, brakes and communication system placed in such a manner that they were easily reachable and manageable for the driver. The old steel seat was replaced with a comfortable leather bucket seat that faces in the direction of movement. Illumination was also improved on the outside of the cabin (see Figure 8).

Additional

As with all new implementations, it took time to resolve the problems that occurred. Through the investigation it became clear that it took about two years to resolve the majority of problems on the double-header trains. This was seen in the reduction of the breakdowns and improved maintenance of up to 75% from 2003 to 2005. As an example, derailments came down from 18 to 4 per month.

Intensive research and planning also went into the routing of the communication cable between the locomotives, since this was one of the major problems that occurred. Each locomotive and hopper has its own piece of communication cable enclosed in the frame (not exposed to the environment) with well-protected connection points on either side. A shorter piece of communication cable is then plugged in from one hopper to the other, which ensures that only a short piece of cable is exposed to the environment that can be damaged during derailments. It also means that the whole cable does not have to be replaced if there is damage to it (see Figure 11).

Recommendations

A huge problem exists in the communication among the locomotive drivers and the control room, workshop and tramming office. Due to the infrastructure in the deep-level gold mines, it is difficult to install and maintain an effective telephone system underground. This leads to circumstances where the driver needs to walk long distances if a breakdown or derailment occurs to report the incident. It is recommended that intensive research must be done into a more efficient and reliable communication system between the driver and the control room. The communication system could be a fixed feature on the locomotive to prevent it from getting lost.

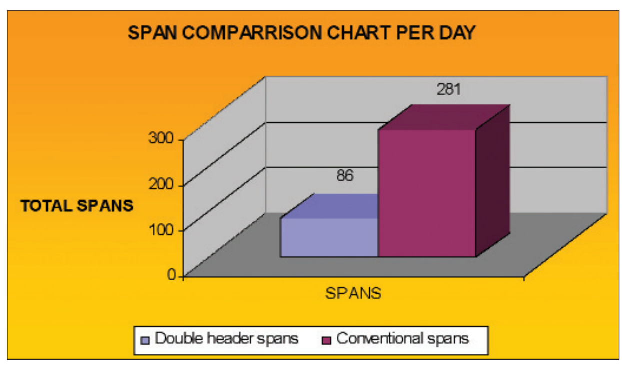

Figure 10—Span comparison chart

Figure 11—Communication cable with connectors

Double-header trains at great Noligwa mine

The communication system will enable the drivers to report immediately to the control room and the workshop if anything happens. It will reduce the current time lost due to poor communication.

Another point that needs extensive preplanning before the new double-header train system can be installed is the planning of the fleet. Investigations should be done on what type of hoppers can be integrated into the existing tramming system with the fewest possible changes to be made. If this is not done, the mine will end up with two or three different types of hoppers and then the mine will be bound to implement methods to accommodate all these different hoppers at the tipping points, which might become a problem. It is recommended that the fleet be kept as standard as possible.

Track work needs to be kept in excellent condition. Due to the heavy tramming loads, excessive wear of tracks may occur, and this must be maintained especially if it is the main tramming area of the mine.

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Conclusion

The double-header trains were implemented with great success at Great Noligwa mine. As is the case with many new projects, this project also had its problems in the initial implementation phases, but with a dedicated and hard-working team these problems were resolved.

There were a huge improvement on safety, cost reduction and labour optimization. The problems with bottlenecks and congestions were resolved and evidently the output tonnages to the shaft and plant were higher than in the past.

This is currently the preferred tramming methodology at Great Noligwa mine, and is also implemented at other Anglo Gold Ashanti-South Africa shafts.

Although there is room for improvements, this tramming system has huge potential for growth, not only in Anglo Gold Ashanti, but in all other older mines that experience major tramming problems. ◆