

The development and implementation of the Lonmin mechanized breast mining

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Over the last few years Lonmin Platinum and Sandvik have embarked on a unique partnership of collaboration through a systematic approach to developing equipment to mechanize and automate narrow reef platinum mining. After the initial design and manufacture of the equipment the key aspect is the integrating equipment, people and method into a mining system. Another key aspect of mechanization is the optimization of equipment utilization and this philosophy has ensured continual evolution of mining methods. This paper describes the trials and development that have resulted in the mining method described as Lonmin mechanized breast.

Introduction

The purpose of this paper is to describe the process of developing and applying new technology to stoping systems in the South African narrow reef mining industry because for the last hundred years the South African narrow reef mining industry has battled to control working costs in a labour intensive industry; and because it is the stoping method and mining methodology that are at the heart of the mining system. Introduce a more efficient stoping system and the mining system will look after itself. The technology currently used and applied to stoping over the last 100 years can be categorized as follows:

- The introduction of pneumatic rock drills early in the last century, the cumbersome rig mounted units being replaced by smaller, lighter hand-held units that were then made easier to use with the addition of an air leg. Water hydraulic rockdrills were introduced in the 1980s; they have the advantage of being twice the power of pneumatic rockdrills and operating at a lower noise level. The most recent rockdrill development is the electric rockdrill.
- Scraper winches to replace gravity and shovels to move rock — both in the face and the gullies — were first introduced in the late 1920s.
- Hydraulic props as a support method arrived in the 1960s.
- Some people argue that tungsten carbide inserts were equally important.

There have been a number of attempts to introduce different technologies into stoping, the most recent being trackless equipment. Where the stoping layout suits the technology it has been successful. There have been too many instances where a technology has been installed because it is fashionable.

At the end of the day the outcome from implementing change in the stoping system has to be safer and more profitable mining systems. It is the contention of the authors that change is only likely to be effective if the application of new technology is supported by the introduction and application of new mining layouts.

Details of the process in the development of the Ultra Low Profile suite of trackless mining equipment developed

through the Lonmin Sandvik partnership, primarily for the narrow reef, hard rock, South African platinum mining industry, are given in this paper. Together with details of a new mining layout that is currently being implemented by Lonmin Platinum.

Project 1,1

Right from the outset it was identified that the objective of this project was to develop a mechanized mining system that could operate in a narrow reef, hard rock mining environment having a stope width of 1.1 metres. The suite of equipment developed was known as the Xtra Low Profile (XLP) or Ultra Low Profile (ULP).

The following section describes the steps taken during the development of the technology and the interaction between potential end users (the mines), the manufacturers (the procos) and Sandvik South Africa who acted as the facilitator and choirmaster.

The customer Sandvik partnership

A key element to the success of this development has been the high level of trust exhibited between Lonmin Platinum and Sandvik. This is best demonstrated by describing an event that took place towards the end of 2001.

Sandvik and Voest Alpine had developed the concept of a hard rock cutting machine, primarily for use in the platinum mines of South Africa. This was in response to the generally held view of the platinum producers that continuous, non-explosive, mechanized mining was the pot of gold at the end of the rainbow.

This conceptual design was presented to Lonmin Platinum and through this the beginnings of the unique partnership were formed. They then visited Zeltweg and met with the Voest Alpine management and designers. The meeting went well but the obvious stumbling block was how to fund the design, manufacture and test of the first prototype. The chief executive of Lonmin then committed his organisation to purchase the first prototype, provide a test venue at his cost and pay for 50% of the trial costs.

Throughout the early part of 2001 there was extensive interaction between the customer, the proco and Sandvik. The result was that the prototype machine was operating in a test stope by the end of September 2001.

It was about this time that the objective of developing a more conventional mechanized mining fleet for drill and blast mining was also identified.

Sandvik has made a conscious effort to understand the customer's business at least as well as the customer. The production people on the mine concentrate on production and not on change. If Sandvik had concentrated only on selling equipment, then no one is pushing change. Sandvik has made every effort to understand the customer's performance measures and how they could be improved.

The proco Sandvik partnership

A second key element to the success of this development has also been the high level of trust exhibited between the Sandvik equipment manufacturers and the marketing team in South Africa. This partnership also has its roots going back some distance. The more traditional way that the procos and the marketing organizations have interacted is through the international offering team meetings where the procos would interact with all the different Sandvik marketing regions and attempt to identify what direction to take for the next generation of equipment. This strategy results in the sales/marketing organization concentrating on the placement of the procos' products into an existing mining infrastructure.

In asking the Lyon factory to produce a low profile (LP) face drill rig for the chrome mines Sandvik moved in a different direction. The first four rigs were delivered to South Africa in early 1999. By the end of 1999 the productivity of the rig had been demonstrated and additional rigs were on order. The need for a complementary loader had been highlighted and, following some design work by EJC, a number of EJC 115s had been ordered. By the end of 2000 orders from Sandvik for the new drill rig and loader accounted for a substantial part of the business of both Lyon and EJC. This strategy of understanding the mining process and developing appropriate technology to match the mining process was a first for South Africa.

Good relations had been developed between Sandvik and the procos. When Sandvik, in collaboration with Lonmin, identified the need for a new suite of equipment to operate in a stope height of 1.1 metres the procos were receptive.

It is interesting to note that the platinum mines had picked up on the low profile equipment developed from the chrome mines and had started to implement low profile room and pillar mining. The difference in the orebodies, chrome with a channel width of 1.65 metres and UG2 platinum with a channel width of 0.8 metres, resulted in lower shaft head grade and lower precious metal recoveries. The LP suite of equipment has been very successfully used, especially in development at mines like Union Section. Aquarius has also been very successful in applying the LP equipment to narrow reef mining for platinum.

Recognizing need

The need for mechanization in the platinum mines is driven primarily by the recognition that it is getting more difficult to recruit handheld rock drill operators. The job involves hard physical effort and has lost the 'macho' status that it once occupied. HIV/AIDS is also an issue with probably up to 50% of the workforce being infected; when you feel sick the last thing on your mind is hard physical effort. The average age of the current rock drill operator work force is greater than 45 and the high noise levels have resulted in ever increasing occupational health costs. The job is also

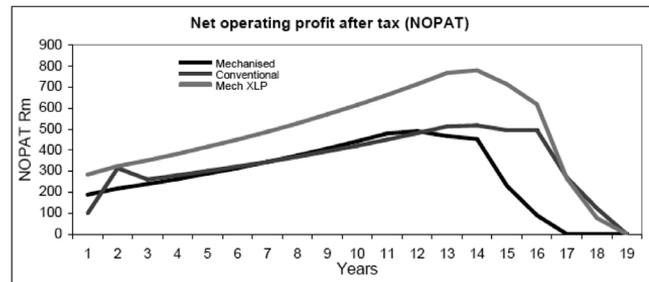


Figure 1. Profitability comparison of different mining methods

very dangerous and 25% of the platinum mining incidents/accidents occur within 5 metres of the face.

Mining at a stope width of 1.8 metres, as with the LP equipment, compared with the targeted 1.1 metres results in a lower grade product. This, in turn, results in less metal recovery, as shown in Figure 1.

The basic assumption is a defined volume of precious metal ounces per month. The 'conventional' curve is based on an average cost of a number of different mining operations applied to a defined orebody. The 'mechanized' curve assumes mining with LP equipment at 1.8 metres stope width. The lower cost per ton of mining means that profit looks the same over the early years. However, lower recovery in the flotation process results in the mine being mined out two years early and a NOPAT over the life of the mine being 18% lower. Mining with XLP equipment at an average width of 1.2 metres delivers 40% more NOPAT over the life of the mine, compared with conventional mining.

The prime need is *safe, cost-effective production*. Implementation of the technology will require recognition of different needs. Mechanization is a substantial departure from conventional mining and all levels in the mine, from operators to senior management, will require training to gain the desired skills.

Initial meeting between Sandvik and Lonmin

In September 2001 Sandvik RSA organized a meeting involving Lonmin and procos. The meeting took the form of a one day workshop to discuss the needs of the platinum mines and how, potentially, Sandvik could contribute to satisfying these needs. Present from Sandvik Mining and Construction were representatives from EJC, Lyon, TechCentre in Tampere, Eimco Bluefield, rock tools and Sandvik RSA. Lonmin were represented by the operations director, the general managers from the three mines, their mechanization and automation team, and a number of other



Figure 2. EJC staff getting down to work

mine operations personnel.

Generally there was a high level of representation. The discussion were far ranging but suffice it to say that when Lorne Massel got back to Toronto, his first meeting was held under the table to reinforce the magnitude of what became Project 1,1.

First internal project meeting

This was held in Lyon on 4 and 5 October 2001. There were a number of presentations and discussions with the following conclusions.

- Only about 1% of the mining is mechanized. The balance is conventional hand-held drilling and scraper cleaning.
- Conventional mining has a shaft head cost of about R120-00 per ton. In areas where mechanized room and pillar mining is practised the shaft head cost is R75-00 per ton. However, the higher mining width of 1.7 to 1.8 metres results in cost per reef ton being similar to conventional mining.
- About 35% of areas currently being mined, or planned to be mined, consist of the UG2 reef at dips of less than 14°. This was determined to be the market tackled by Project 1,1. The UG2 mineralization is typically less than 800 mm in width.
- Two different ore winning systems were considered:
 - Continuous mining with non-explosive rock breaking processes such as controlled foam injection, penetrating cone fracture and rock cutting. The meeting was updated on progress with the Voest Alpine ARM 1100 machine.
 - Mechanization of the drill-blast-load process. Project 1,1 would pursue this mechanization option.
- The required suite of equipment would be a face drill rig, a roof bolter and a loader. At this stage it was considered practical to mechanize both conventional mining and room and pillar mining. However, as discussions continued it became obvious that the most practical mining method for mechanization was room and pillar mining.

It may be obvious but it is worth stating that conventional mining is well developed and a perfect match for the technology used. Face lengths, gully lengths, support practices, drilling method, cleaning in the face and the gully, ore transport in rail bound hoppers, etc. are all integrated to provide a system that delivers the required blast, on time, 85% of the time.

Changing the technology without changing the mining method was unlikely to result in an optimum mining method. Room and pillar mining in wider orebodies has been extensively mechanized, mining at 1.1 metres would create its own specific system problems but it was not necessary to create a totally new mining method. However, it was recognized at an early stage that it would not be possible to integrate mechanized stoping with the use of sticks or hydraulic props as a support methodology. This, in turn, highlighted the importance of developing and integrating a suitable roofbolting support strategy.

The preliminary equipment specification or functional requirement was identified as follows:

Face drilling jumbo

Requirements

- Work in a stope width of 1.1 metres plus or minus 10%.

- Be capable of drilling parallel to the footwall, hangingwall and sidewall.
- Suitable for operation in dips up to 14°.
- Drill a least a 1.5 metre hole and potentially a 2.4 metre hole.
- Equip the drill rig with two booms and two drifters.
- High mobility was a must and skid-steering was an option.
- Remote control should be considered/offered.
- Drilling should be electro-hydraulic.
- Trimming could be electro-hydraulic, though there were advantages in considering diesel-hydraulic.
- Typical room width would be between 10 and 13 metres.

Constraints

- Stope width 1.1 metres plus or minus 10%.
- The reef rolls and has an undulating contact.

Roof bolter

Requirements

- Bolt in minimum stoping width of one metre.
- Install bolts of up to 1.5 metres in length.
- Bolts should be installed vertically.
- Hole size should be 25 to 28 mm in diameter for resin bolting. A second, less preferred option was a 35 mm diameter hole and end anchored bolts.
- Install 15 to 20 bolts per shift. Drilling with pneumatic handheld rock drills and multiple changes of steel it takes 15 to 20 minutes to install a bolt.
- Remote control to be studied/offered.

Constraints

- Roof height.
- Small hole diameter required for resin bolting.
- Bolt heads protruding below the hangingwall.

To investigate

- Rotary drilling as compared to rotary percussive drilling. The hangingwall peroxonite has a hardness of between 110 and 250 MPa.
- The electric Hilti drill.
- Other options.

It was recognized at an early stage that roof bolting was the key to this method of mining and likely to be the hardest nut to crack.

The loader

By this time EJC had done their homework and had already defined a loader concept.

Requirements

- Both diesel and electric drive were required.
- The drive mechanism was to be hydrostatic.
- It would work on grades up to 14°.
- The bucket capacity was to be two cubic metres and the bucket fitted with an ejector plate.
- Productivity should be 50 tons per hour.

Constraints

- Operator visibility.
- Operator safety.
 - Ability to generate sufficient traction to load the bucket.

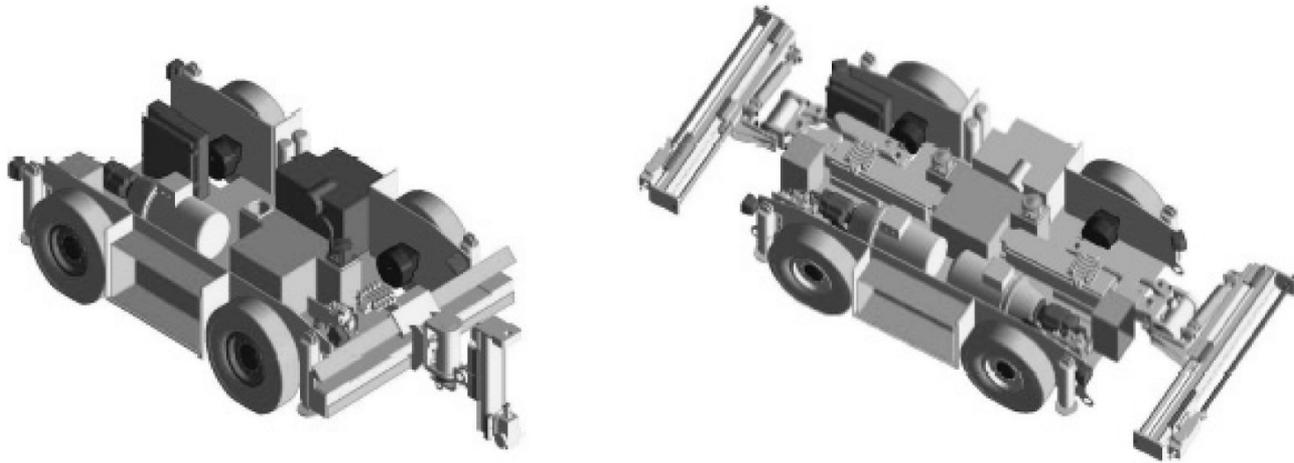


Figure 3. Roofbolter concept in January 2002 and conceptual face drill rig

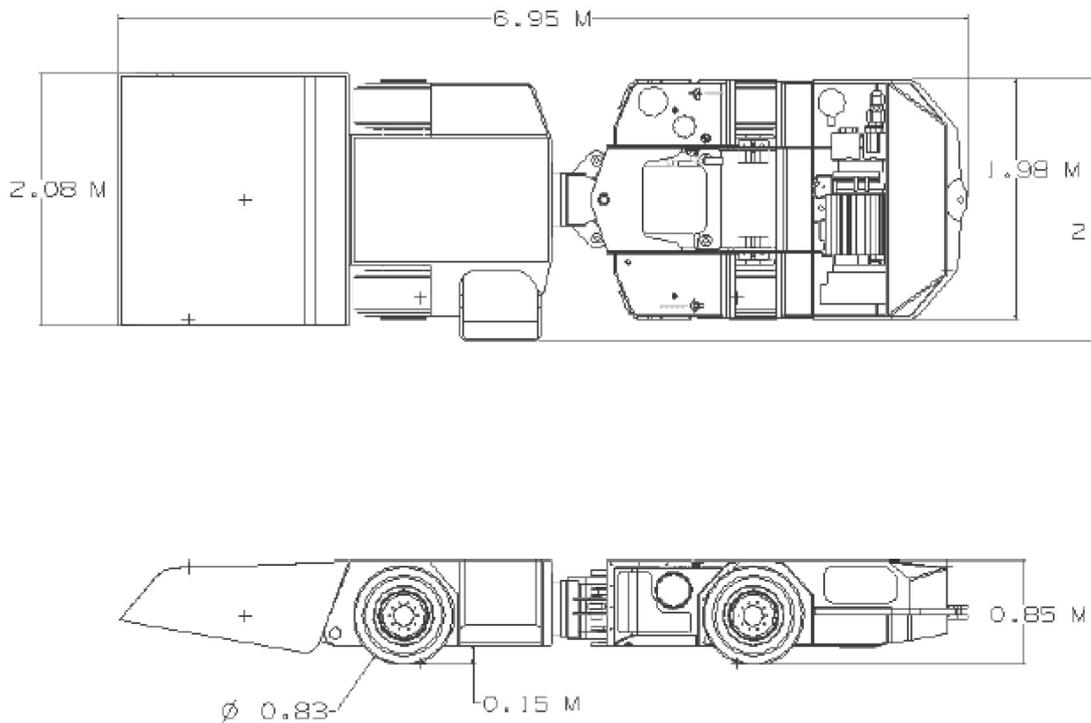


Figure 4. Detail of the EJC 88 LHD

Initial calculations suggested that with a fleet of one face drill, one roof bolter and two LHDs it would be possible to achieve a production rate of 16 000 tons per month.

Second internal project meeting

Held in Lyon on 24 and 25 January 2002. Prior to this meeting a visit had been arranged and a report had been prepared on the two sections of the mines that were using semi-mechanized narrow reef mining. The findings are summarized below.

Bleskop Section

They were mining UG2 reef at a rate of 3 000 tons per month at a mining width of between one and 1,2 metres. Drilling was by hand and holes were 1.2 metres long. Support by roof bolts on a 1.5 x 1.0 metre pattern, bolts were 1.5 metres long, end anchored and installed by hand.

Cleaning was with two Long Airdox battery coal scoops. Scoop size was about 2.5 metres by 8 metres with a maximum height of one metre above the tyres. All tyres were fitted with chains.

Bafokeng Rasimone.

This is a section mined from surface. Access is via a decline straight of the highwall. Access development on dip and strike is carried out with two Axera LP drill rigs and two EJC 115s. Mining is in the Merensky Reef. The mine had been started by a contractor who had recently been removed from the site and the mine was now picking up the pieces. Drilling was by hand.

Roof bolting on a 1.5 x 1.5 metre pattern using a Fletcher roofbolter from the coalmines, approximate dimensions were 0.8 x 2.2 x 5 metres. Cleaning was with a Long Airdox coal scoop. The size of the unit was 0,85 metres

over the canopy with a foot print of 3 metres by 8 metres. Volume of the bucket was 1.7 m³.

They had five scoops and had just ordered a sixth for a planned production rate of 50 000 tons per month (current production was closer to 25 000 tons per month).

Loading was by pushing into the rock pile. There was no digging or breakout action, and all scoops were fitted with chains. When loading, the bucket was pushed down onto the uneven footwall, lifting the front wheels off the footwall.

Ventilation in this kind of room and pillar mining was poor.

Following this study it was recommended that the production target for a suite of equipment in Project 1,1 should be 10 000 tons per month.

The outcomes from this meeting included the following:

- Success with the roofbolter development was identified as the key to overall project success. The bolter requirements were defined as:
 - Installation of 1.5 to 1.6 metres long, 20 mm diameter, resin grouted bolts.
 - An investigation into the practicalities of developing a shorter drifter.
 - A more detailed evaluation to be conducted comparing rotary drilling with rotary percussive drilling.
- Concept drawings of the face drill, roof bolter and LHD were considered.
- It is interesting to note that the EJC 88 has a footprint of 14 m² compared with the 24 m² of the Long Airdox battery scoop.
- It was generally considered that we were going in the right direction and that conceptually we were on the right track to address the mines' requirements.
- The requirements for a utility trailer and a cable handling system were also identified.

The second day was spent discussing the marketing strategy and it was decided that the marketing plan should be in place by the end of April. Issues discussed included the following:

- With Project 1,1 we are not selling equipment but a new mining system and a solution to the perceived socio-economic problems facing the narrow reef, hard rock mining sector. The new mining system should be safer and more productive, resulting in increased benefits for all shareholders and stakeholders.

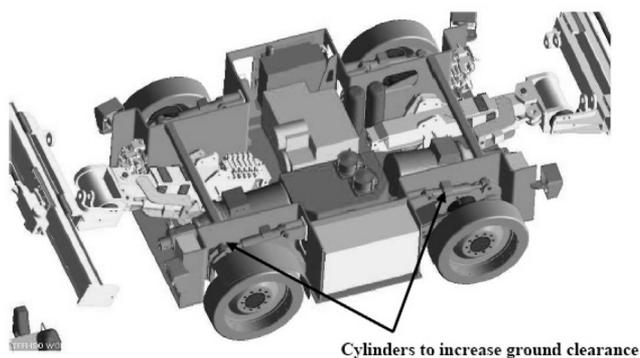


Figure 5. The face drill with details of where the components fit

- Identification of trial sites and customers who would make a quality commitment to the 'productionization' of the prototype units.
- Patent protection.
- Sending service technicians from South Africa to both EJC and Lyon.
- Comparative cost of Long Airdox units.
- Selection and training of operators for the mine trials — includes training of trainers.
- Recommended spares parts lists.
- Field engineer from procos on site during testing.

Third internal project meeting

This meeting was held in Johannesburg on 9 and 10 April 2002. The interaction between procos and Sandvik RSA is part of the Sandvik business model. There is frequent interaction and visiting between the various organizations. However, on this occasion every effort was made to expose those responsible for designing the equipment to the underground environment.

The other internal change that had been made was the establishment of a separate low profile underground drilling department under Timo Laitinen. This was in recognition of the increasing importance that this section of the business was having on the fortunes of Sandvik Mining and Construction. Alain Comorge was appointed to head up this new division and he assumed the responsibility for product development in place of Alexandre Miralles. It is interesting to note that for the duration of Project 1,1, the original champions are still driving and that, as the status of the project advances, more and more people are being co-opted onto the team.

Progress and items discussed at the meeting included:

- Report back on studies into rotary roof bolting and the development of an ultra short drifter.
- Marketing strategy, market volumes and mining costs, market potential and a comprehensive breakdown and review of platinum mining in South Africa.
- Key performance indicators for the trials and identification of test sites.
- After-sales support.
- ISO 14000 compliance issues.
- Timing details for prototype manufacture and testing at procos.
- Planning for customer visits to view the finished product before shipping.

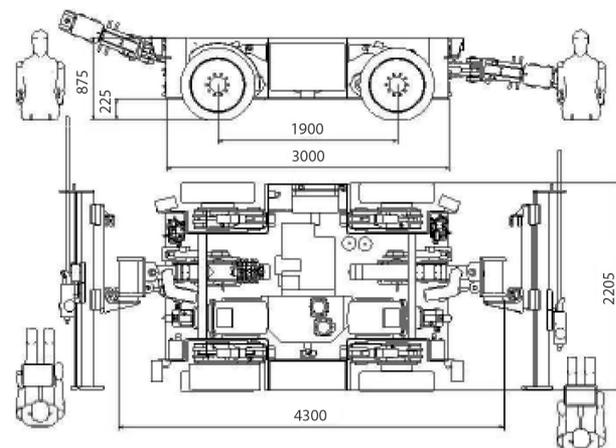


Figure 6. Face drill dimensions and operator position

- Feed back on equipment development status from the procos.

The most significant change to the face drill had been the introduction of hydraulic cylinders to increase ground clearance. Operating in the constraints of a narrow stope with limited ground clearance it had been realized that bridging of the equipment would be an ongoing problem.

At the end of a very busy week it had been agreed that:

- The first trial would be held at Lonmin starting in November 2002. The second trial would start about three to four months later on an Anglo Platinum mine.
- For these trials the customer would pay for any required mine infrastructure development, rental of the equipment and full operating and maintenance costs. Sandvik would be responsible for development of the technology, training, technical support and trial management.
- It was essential to proceed with the development of the Ultra Short Drifter for use on the roofbolter.

Fourth internal project meeting

The meeting was held in the EJC facility in Burlington on 16 and 17 July 2002. The following formed the main thrust of the two days' discussions.

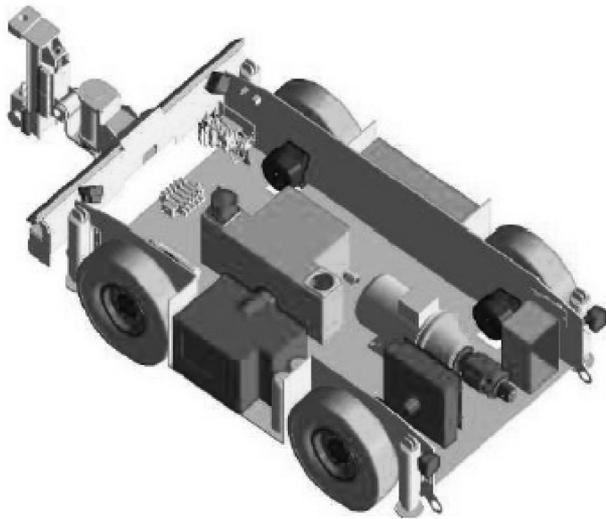


Figure 7. The roofbolter still to be fitted with the adjustable ground clearance jacks

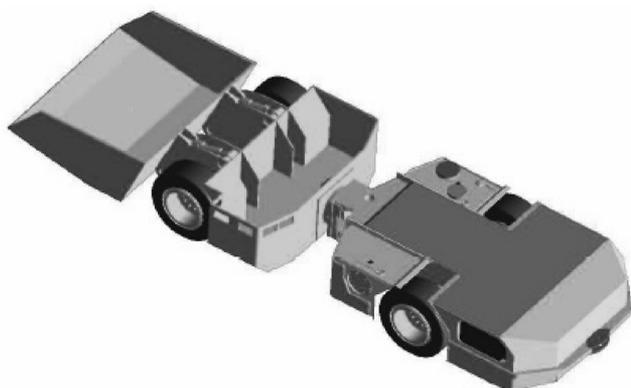


Figure 8. Solid edge model of EJC 88

- Detailed discussions on the what, where, when and how of the customer trials scheduled to start late in 2002.
- Detailed discussion on the hydrostatic drive system and the CANbus interface with the engine. The hydraulic system should remain closed for substantially longer than is the norm. Ideally it should only be opened once a year. To achieve this objective the LHD has been fitted with a long time filtration system and a water extraction system.
- Sandvik RSA has developed a model of mining cost and production performance. Based on this model it was agreed that a production performance of 6 500 tons per month was realistic. (Two shifts per day and 22 days per month.)
- Technical and operator training of Sandvik RSA personnel for equipment from Lyon and EJC was in hand.
- Performance KPIs for the trials now had to be agreed with the customers.
- Sandvik also had to start allocating staff and resources for the trials.
- Cable management was still an issue that had to be resolved by the local team.
- The ultra short drifter was on trial and looked as if it would be ready by the end of 2002.
- Detailed discussion on the required support form Deutz.
- Extensive planning for customer visits to Lyon and EJC to see the prototype equipment.

The use of a hydrostatic drive system has been a major departure from EJC's more traditional mechanical drive trains. The MD of EJC, Lorne Massel, regards this development as so crucial to the further development of his company that he has arranged for all members of his staff to undergo a hydraulic training programme.

Customer visits

Towards the end of September 2002 Lonmin Platinum visited EJC in Burlington and Lyon to view the finished prototype equipment.

In all thoughts and consideration of Project 1,1 it must be remembered that the competition is not the other mining equipment manufacturers of this world but rather the way things have been done for the last hundred years in the narrow reef, hard rock mining industry.

Underground trials

Underground trials have two main components: firstly is the need to demonstrate that the equipment carries out the function that it was designed for and secondly that the mining method employed is adequately productive.

With the XLP fleet of a face drill, roofbolter and LHD there were a number of teething problems. This was mainly because Sandvik followed a different development route. The more normal approach is to develop a new machine and then conduct extensive trials in a controlled environment. In this case the new machines were rushed into production environments and the result was an integration of the equipment performance trial and the mining method trial. The equipment performed with different reliability.

- The face drill was very much the star of the three machines and has seen relatively little further development. The incorporation of independent wheel



Figure 9. Roof bolter in a mock-up stope 1.1 metres high



Figure 10. Face drill carrying out test drilling

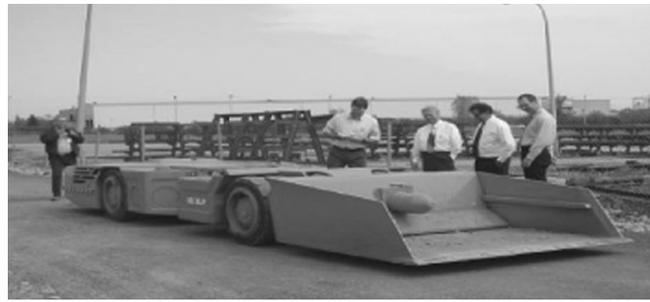


Figure 11. Partners proudly observe the proto type



Figure 12. The competition

movement was a big success and these machines have not experienced any problems of grounding the frame and the machine getting stuck.

- The roofbolter body was fine but the drilling feed has seen a number of developments and is currently on about the fourth generation. A bigbreak through was the successful introduction of the ultra-short drifter. This drifter was developed specifically for this bolter and is only 300mm in length compared to the more normal dimension for a drifter of this power of 650 mm.
- The loader was a different story. To operate successfully it needed to push into the rock rather than load up the front of the rock pile as in conventional LHD operation. This put high tramping loads on the tyres and these were originally fitted with chains to provide good traction. This solution was expensive and it was difficult to keep the chains tight and effective on the small wheels. A second solution was to develop a new tyre that gave a reasonable life and good traction. It was also impossible to design a machine having a relatively small footprint with a conventional mechanical drive transmission. Consequently, the loader was designed with a fully hydraulic powering system with hydraulic wheel motors. The hydraulic solution employed was not entirely successful and much effort was expended to get the hydraulics to work efficiently.

However, the choice of mining method and the application of the equipment were equally problematic, probably even more problematic than the equipment issues. This is probably because the technical issues can be seen and understood by equipment designers and solutions quickly developed and tested. It is more difficult to bring

about major changes in the mining layout expeditiously and this was coupled with a lack of mechanized mining expertise that was available to design optimal layouts to maximize the potential of the equipment.

- The low profile equipment had mainly been used in a room and pillar mining layout and at an early stage it was decided that the XLP fleet would be used in a similar layout. Initial trials were using the equipment for room and pillar mining. Some of the early problems encountered were related to blasting and a full advance of the face was rarely achieved despite the input of ‘blasting engineers’. Room and pillar mining has a relatively large number of faces and moving equipment from one short face to another consumed a lot of production time. The tipping points for the LHDs were often 60 to 100 metres away from the loading point and it was soon realized that the constricted mining height limited tramping speeds and equipment productivity, this was the biggest drawback of room and pillar mining. To make this even more complicated there were three different XLP room and pillar mining trials going on at the same time.
- Attention was then focused on a mining layout that has a closer relationship to conventional mining. Longer panels cleaning into a gully with rock movement in the gully with larger, more traditional LHDs, these would tip onto belt conveyors. Thus, the merits of on reef mining with no footwall development would be realized; extraction ratios would improve and the mining sequence was more easily understood. The layout is called mechanized breast mining and is shown in Figure 13.

Mechanized breast mining is described as follows:

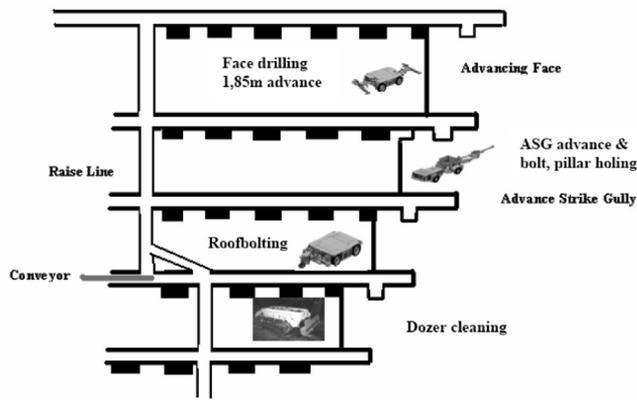


Figure 13. Mechanized breast mining

- Carry the reef access on the reef horizon, rather than in the footwall. The major benefits are that we obtain current information on the orebody and the excavation pays for itself. The major disadvantages are that the excavation has to follow the reef and is not suitable for traditional railbound transport. To cater for reef variations and the need for water drainage, this excavation has to be substantially above strike. Access dimensions will be determined by the equipment used, typically 3.5 metres wide and 1.7 metres high on the down-dip side of the gully.
- Make the faces as long as is practical given the constraints of face drilling equipment and minimum pillar spacing. The face drilling constraint is a function of shift time and equipment drilling rate. The maximum skin to skin dimension between pillars is currently about 33 metres; there has been good experience from Union Section over the last twenty years that these pillar dimensions and the use of elongate support elements provides practical and safe mining.
- Make the extraction ratio as high as practically possible by minimizing the ore left in pillars. Work by CSIR for PlatMine has shown that grout packs can be used to replace pillars. With advance orebody information, is it practical to use ore loss from potholes as regional support, grout packs for areal support and roofbolts for face support?
- Assuming a mining process that allows two blast per twenty four hours, then a minimum of three stope faces is required: one to support, one to drill prior to blasting and one to clean. In practice, to accommodate the ground loss due to potholes and other discontinuities there should be at least four and preferably five faces per equipment fleet.



Figure 14. Axsess Rig for Gully development.

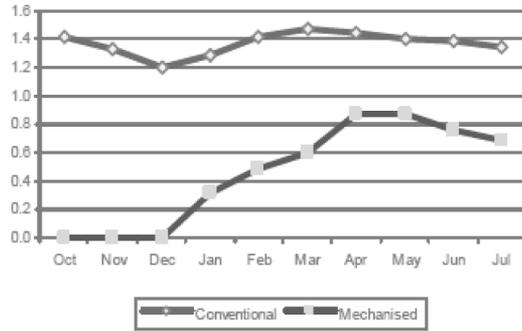
- Roofbolts are installed as face side support, leaving an open area between the face and the first row of elongates or grout packs of five to ten metres.
- The advance strike gully is carried between five and eight metres ahead of the panel face. Gully roofbolts are installed after the roofbolt holes have been drilled with the Axsess gully rig and then the face is drilled by the same rig. Where necessary this unit also drills the down-dip sidewall to create what will be the pillar holings as the down-dip face advances. This procedure ensures that ventilation is kept along the face. The Axsess rig is shown in Figure 14.
- At Karee Mine, in the Merensky Reef, face drilling is 1.9 metres in length and advance per blast is 1.85 metres.
- A large portion of the reef is blasted into the reef gully and the balance is pushed into the gully by the remotely operated bulldozer. The rock in the gully from both the face blast and the gully blast is loaded by the 777 LHD and trammed to the conveyor loading point. The conveyor tipping point is advanced after every sixty metres face advance.
- Conveyors are installed every fourth gully and the LHD loads from the three faces above and the one face below the conveyor. To provide access to the loading point the stope width is opened out to a height of 1.7 metres and a width of four metres in the raise line, using the XLP face rig. Following the second blast in this higher section, the broken rock is levelled by the bulldozer and the next round is drilled at the normal stope width of 1.2 to 1.3 metres.
- After completing their face activities, the face drill rig and roofbolter are returned to the top of the panel, back along the gully, down the raise, along the gully and into the lower face. When reaching the bottom of the section the units are loaded onto a skid and dragged to the top of the series of faces by the 777 LHD. The cycle is then restarted.
- To minimize equipment lost time it is imperative that the cycle of activities is maintained.

Partners

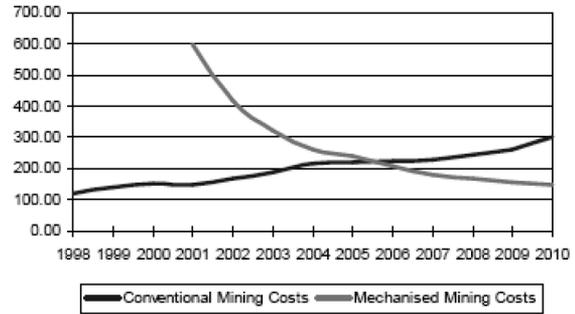
While the technology and the mining method have been developing Lonmin have gained more confidence in the suitability, commercial benefit and practicality of mechanized mining. In a presentation by their CEO, Mr Brad Mills, in September 2005 at the Strategic versus



Figure 15. Remotely Operated Bulldozer.



LTIFR per 1 000 tons production



Production costs rand/ton

Figure 16. Slides

Tactical Conference organized by the SAIMM, slides in Figure 16 were presented to support Lonmin's decision to mechanize 50% of production by 2010.

Conclusion

The initial meeting between Lonmin Platinum and Sandvik that led to the development of the XLP equipment and the

development of mechanized breast mining was held in September 2001. Here we are five years later and, in partnership, we have developed new equipment and new mining methods that will have a huge impact on safety, production and costs not to mention the critical importance of attracting talent to the both these progressive companies. A real win-win deal and all those who have participated should, justifiably, be proud of their achievements.

