

TECHNOVATE

LEADING SERVICES FROM TECHNICAL SOLUTIONS



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INTRODUCTION

Dear colleagues

Technovate brings you the stories behind our solutions: the “what, where and who”. What are the benefits for your operation, where they have already been implemented and who developed them. You will also find key contacts if you need to talk to our team about any of our services or solutions.

Our multidisciplinary solutions and services are the result of partnerships between Technical Solutions' four departments: Research, Consulting, Field Services and Compliance; partnerships with other group functions; Anglo American operations, projects and business units; as well as external experts.

I view Technical Solutions' primary role as the development, delivery and implementation of sustainable solutions; playing our part in ensuring the Group benefits from the combined technical, engineering, scientific and technological expertise within Mining & Technology. Technovate brings you the results of applying this leading-edge technology across the entire mining value chain; our contribution to Anglo American's operational excellence.

Martin Dohm
Group Head: Technical Solutions



TECHNICAL SOLUTIONS: DRIVING VALUE FROM EXPLORATION TO MINE CLOSURE

Technical Solutions falls under the Mining & Technology group function.

We contribute to Anglo American's operational excellence by delivering and implementing sustainable multidisciplinary techno-economic solutions across the entire mining value chain, from orebody definition to closure.

Our client offerings are provided either as standalone solutions, or in partnership with:

- Technical Solutions' four departments: Research, Consulting, Field Services and Compliance
- other Group Functions
- Anglo American operations, projects and business units
- as well as external experts.



Briefly, our four departments specialise in the following areas:



Martin Dohm

**Group Head
Technical Solutions**

RESEARCH

- Technological innovations
- Expertise in mineralogy, ore characterisation mineral processing, extractive metallurgy, process development and analytical chemistry



**Rob
De Pretto**
General
Manager

CONSULTING

- Improvement opportunity identification
- Problem diagnosis
- Solution development
- Breakthrough technologies
- Sustainable implementation



**Llewellyn
Dippenaar**
General
Manager

FIELD SERVICES

- Risk mitigation associated with safety and production critical equipment
- Condition monitoring and operational support



**Kai-Uwe
Molzahn**
Manager

COMPLIANCE

- International and Group Technical Standards compliance measurement
- Metallurgical accounting
- Sampling
- Quality management systems



**Susan
Dry**
Manager

TECHNICAL SOLUTIONS: DRIVING VALUE FROM EXPLORATION TO MINE CLOSURE continued

An overview of our key areas of delivery and impact; and solutions provided and/or in progress.

TECHNICAL SOLUTIONS

Consulting
79, R172 million

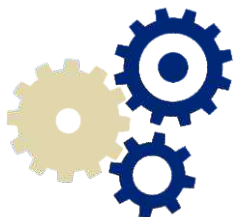
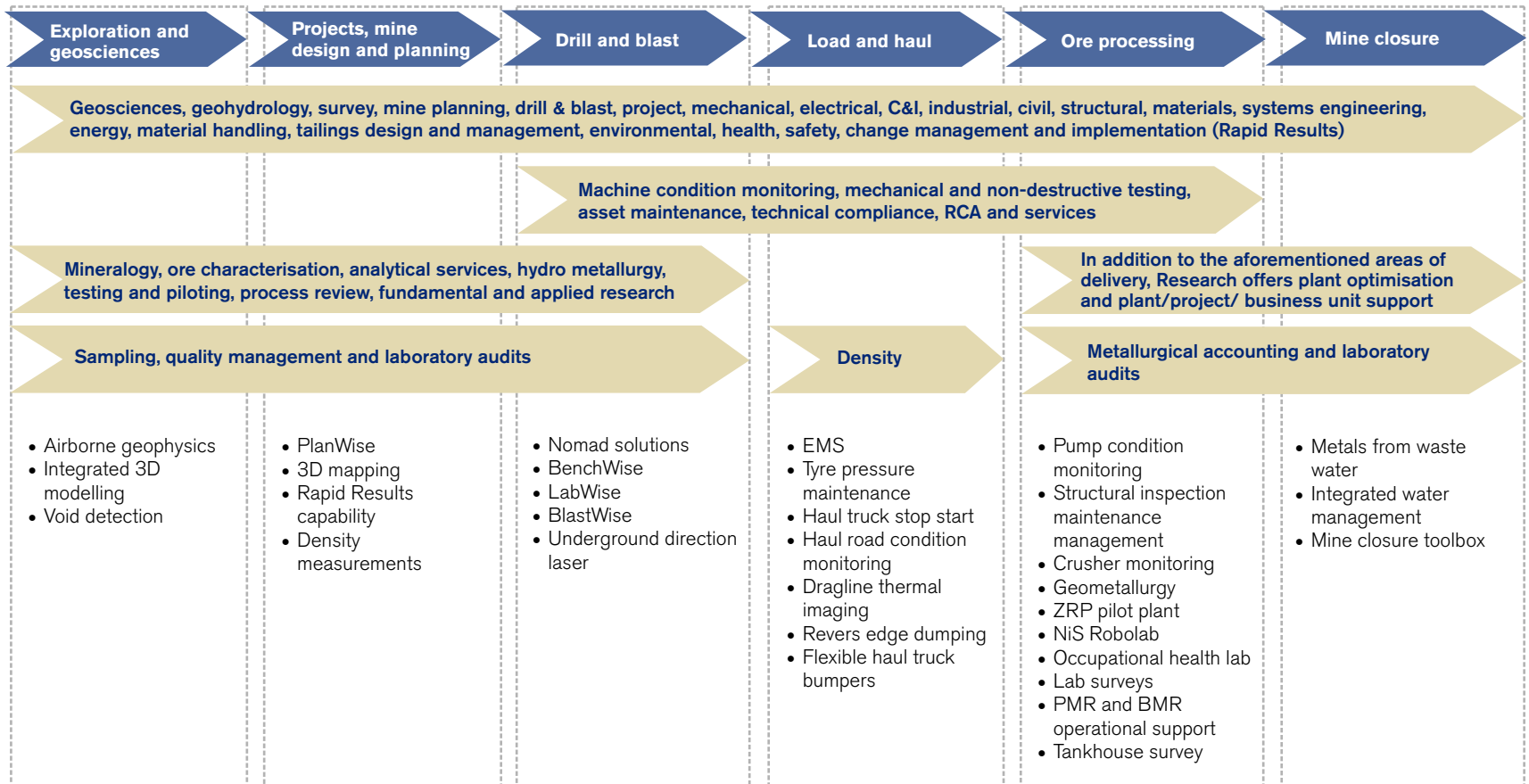
Field Services
50, R66 million

Research
348, R284 million

Compliance
9, R8 million

**Solutions
developed
and in progress**

Safety, benchmarking, water, energy and sustainable development



An overview of our implementation process, provided as stand-alone solutions or through multidisciplinary partnerships.



In-house Technical Solutions expertise: Consulting, Research, Field Services, Compliance

TS project manager

Phase 1

Phase 2

Phase x

Implementation

Goal

External expertise: operations, business units, functions, consultants, OEMs, universities and others



RESEARCH

Research specialises in process development and optimisation, metallurgical testing and analytical services for more cost-effective extraction of metals and minerals. Our teams of highly skilled engineers and scientists, using world class facilities, provide value-adding solutions, expertise and operational support, conferring competitive advantage to the Group.



Rob De Pretto

**General Manager
Research**



Rob Schouwstra

**Minerals and
Process Manager**



Les Bryson

**Hydrometallurgy
Manager**



Margaret Borrett

**Chemistry
Manager**

DIMENSIONALLY STABLE ANODES (DSA®) PILOT PLANT

- Improved operational efficiencies
- Better tankhouse working environment
- Financial advantage



Overview and benefits

A number of operational issues are experienced in the copper electrowinning industry. These include the energy intensity of the process, acid mist generation, current distribution and low current efficiencies, among others.

Technical Solutions: Research, in collaboration with an external partner, is piloting the next generation of Dimensionally Stable Anodes (DSA®); designed to address some of the electrowinning industry's biggest challenges.

The claimed advantages of DSA®:

- setting a new standard of true lead-free cathode quality
- the titanium anode structures are designed for long-life sustainability (25 years). The precious metal catalyst, tailored for copper electrowinning, having a 5 year service life will require recoating to rejuvenate the anode's performance
- DSAs eliminate the need for cobalt sulfate addition required for lead anode operation
- energy savings of 0.3 to 0.55 V when compared to current lead anode operation
- increased plant cathode output through increased current density operations
- no lead sludge generated; therefore eliminates removal
- improved current distribution, producing a smooth cathode with higher current efficiency
- reduced acid mist generation and capabilities to eliminate tankhouse acid mist.

Electrowinning

Electrowinning is the recovery of metal from solution by passing a current from an inert anode to a cathode onto which the metal is plated.



Research objectives

- The main aim of the project is to quantify the benefits and authenticate the capabilities of the next generation of Dimensionally Stable Anodes (DSA®).
- The pilot plant uses the same operating conditions as used by the San Francisco copper electrowinning plant (The San Francisco is one of Los Bronces' two electrowinning plants).
- A matrix of conditions is tested during the planned campaigns starting with the use of conventional lead anodes to establish a baseline for the study.



DIMENSIONALLY STABLE ANODES (DSA®) PILOT PLANT continued



Team

This programme was initiated by Technical Solutions: Research's hydrometallurgy department and an external partner, under the leadership of Bronwynne Ferreira, Research's process leader for solvent extraction and electrowinning (SX-EW).

Supporting data, analysis and materials are provided by:

- Process design data and technical support: Gabriel Zarate, senior process engineer, Copper, Chile
- Pilot plant operation and data analysis: Karen Voogt, project manager, and Xolani Maseko, process metallurgist, Technical Solutions: Research SX-EW
- Materials supply and waste management – Platinum: Rustenburg Base Metals Refinery



Location

A piloting facility is being operated and samples analysed at Technical Solutions: Research, Crown Mines campus.

The copper electrowinning cell is located at the centre of the photo.



Setting a new standard of true lead-free cathode quality.



Savings

Energy savings of 0.3 to 0.55 V when compared to current lead anode operations.

Who do I contact?

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Xolani Maseko
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GEOMETALLURGY AND ORE CHARACTERISATION

- Improved processing
- Improved mine planning
- Aids implementation of mitigation strategies



Overview and benefits

At its heart, Geometallurgy implies understanding the link between the geology of an orebody and its metallurgical response. It is key to the 'Resource to Metal' (R2M) programme, affecting optimisation of the entire value chain process.

Increased knowledge of these relationships means:

- improved information
- facilitates better planning
- allows implementation of mitigating strategies to overcome any inherent difficulties in processing the material.



Team

The multidisciplinary programme was initiated by Robert Schouwstra and Deryck de Vaux from Research. The research is conducted in collaboration with Mogalakwena geologists, in particular Trust Muzondo. Supporting data, analysis and materials are provided by:

- Platinum geologists: maps and drill coordinates
- the Eastern Bushveld Regional Laboratory (EBRL): chemical analysis data from blast hole drilling
- MinRed: statistical analysis of the data generated
- Mining & Technology: additional samples
- and the minerals and process research team at Technical Solutions: Research: analysis of samples from Mogalakwena.



Location



Samples from Mogalakwena's open pit platinum mine are analysed at Technical Solutions, Research: Crown Mines campus.



Research objectives

The current geometallurgy and ore characterisation programme focuses on the impact of the ore on the downstream processes. It investigates factors affecting orebody value, including:

- harder ore resulting in lower throughputs
- poor quality ore resulting in less value per unit mined
- operability problems making dewatering difficult, or requiring higher operating costs
- a successful outcome of this programme will maximise recovery, grade and revenue.



Client feedback

The research has established active partnerships, collaboration and support between Research, Platinum, EBRL and MinRed.

GEOMETALLURGY AND ORE CHARACTERISATION continued

- Using the same money wisely
- Multidisciplinary research to optimise research to metal



Research outcomes to date

The study is in the data gathering and research phase. Studies conducted so far include:

- over 200,000 data sets from blast hole samples have been processed to establish links between geology, chemistry and mineralogy of the orebody
- 79 ore samples have been tested for hardness, 41 for flotation response and 77 have been subjected to settling tests
- links are being established between the ore hardness and flotation performance, and the rock type.

Validation of the models based on these links will result in the generation of estimates of plant performance without additional time consuming, expensive test programmes.

Geometallurgical systems and R2M systems, being set up by Alan King, could leverage off existing structures, at no extra expense.



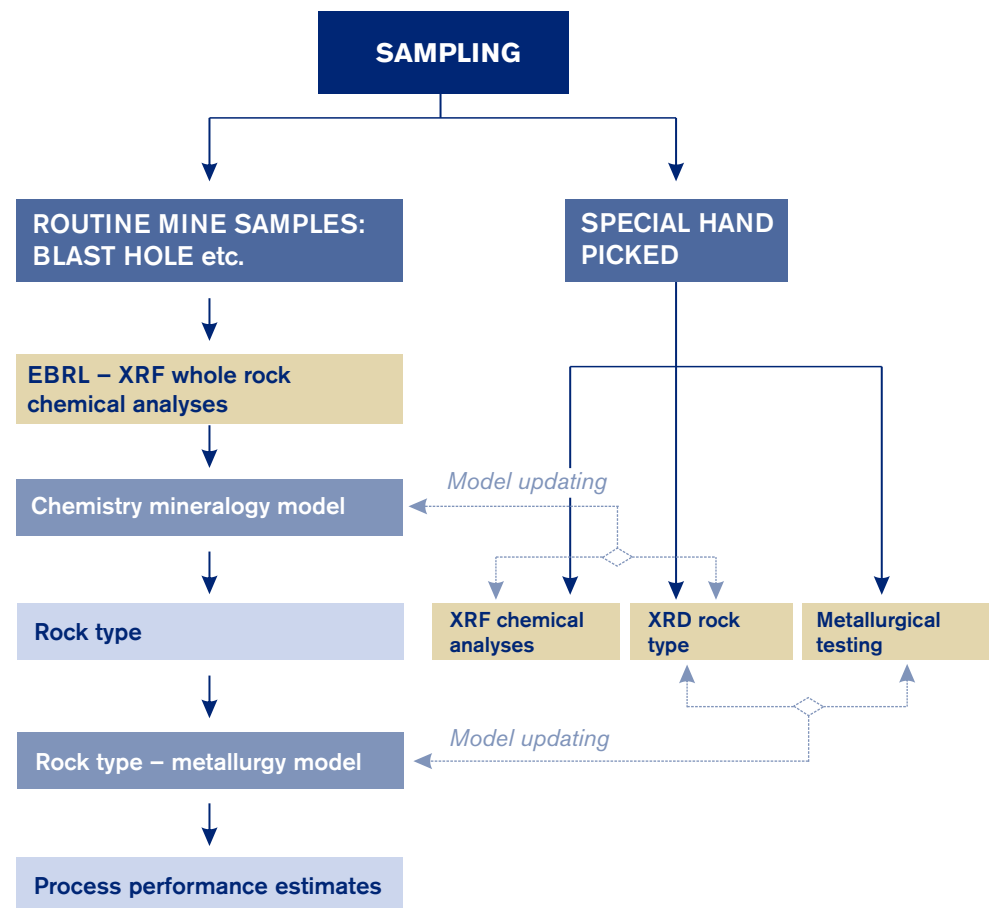
Financial gains



Mogalakwena's expansion plans include the development of a mega pit by expanding to the south and ultimately joining with the central and southern areas. The ores to the south are different in composition and characteristics from those currently being processed at the north plant.

A successful outcome of this programme will maximise recovery, grade and revenue through:

- better planning and estimation of the impact of these differing ores
- and optimisation of the metallurgical processes.



Ongoing improvements

The models generated thus far are from limited data sets and require further refinement and validation to establish better correlations and confidence limits. They will be further enhanced with data from differing rock types as the mine grows.

Who do I contact?

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COLLABORATION BETWEEN TECHNICAL SOLUTIONS AND RBMR ADDS VALUE TO THE GROUP

- Approved analysis
- Partnership



Overview and benefits

Technical Solutions: Research's Chemistry team and Rustenburg Base Metal Refineries (RBMR) have combined their expertise to develop a sound method to determine trace element concentrations in dissolved nickel electrode samples. This method results in a higher quality electroplated nickel that attracts a higher price.

The basic method

- Nickel sub-samples are dissolved in nitric acid of a guaranteed grade.
- This solution is then diluted for inductively coupled plasma-mass spectrometry (ICP-MS).
- Rhenium is used as an internal standard; it is essential to monitor signs of any deterioration during the process of measurement.
- The above process makes the ICP-MS a viable instrumental option.



The mass spectrometer (ICP-MS): Added accuracy

Research uses a specialised instrument, the inductively coupled plasma-mass spectrometer (ICP-MS), for the analysis of elements in solution. There are only four of these high resolution magnetic sector instruments in South Africa. This instrument is able to:

- resolve interferences to isotopes caused by the nickel matrix
- increase the number of trace elements determined quantitatively
- improve the accuracy of determination.



Collaboration and partnership

Research and RBMR have a long-standing collaboration. As support for RBMR, Research's Chemistry is able to provide:

- analysis of unusual samples
- statistical analysis of results
- specialist technical support.



Value add

The project adds value to Platinum as it has enabled RBMR to register their nickel cathode material on the London Metal Exchange (LME), the world centre for industrial metals trading and price-risk management. Prices on their three trading platforms are used as the global benchmark.



Team

The project team consists of Vicky Anderson, Moleboge Mogorosi, Keith McIntosh, Godfrey Moleme, Nazeera Khan and Willie Mahibila.

Who do I contact?

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CONSULTING

Consulting supports operational excellence by providing multidisciplinary techno-economic solutions and products, focused on sustainable mining, from exploration to mine closure. Our areas of specialisation include geosciences, project engineering and integration, safety and sustainable development, mining, drilling and blasting, comprehensive engineering services, quality assurance and change management specific to improved operational performance.



Llewellyn
Dippenaar

General Manager
Consulting



Alrien van der Walt

Manager Change
and Implementation



Abri de Wet

Manager Project
Engineering and
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Rudolph Botha

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Civil Engineering



Eric Gilfillan

Engineering
Solutions Manager



Digby Chapman

Manager
Mining Solutions



Wayne Pettit

Geoscience
Solutions Manager

CHUTE DESIGN IMPROVEMENT AND DISCRETE ELEMENT MODELLING

- Reduced chute blockages
- Reduced liner wear



Overview and benefits

Poor chute design and high spillage will influence the total cost of ownership of a conveyor system.

The damage caused by spillage build up will lead to:

- increased downtime through cleaning and lock-out requirements
- increased labour costs
- increased energy consumption as idler bearings degrade
- a general decrease in life of splicing, lagging and other ancillary systems.

Conveyor system at Los Bronces mine



Project locations



Team

The materials handling team at Technical Solutions provides detailed replacement and improvement plans for problematic chutes. Contact Technical Solutions and we will assist you in better understanding the costs associated with operating your problematic chutes.

Ongoing improvements

Our aim is to reduce implementation lead times for proposed chute modifications and to provide our services to more operations.

Value add

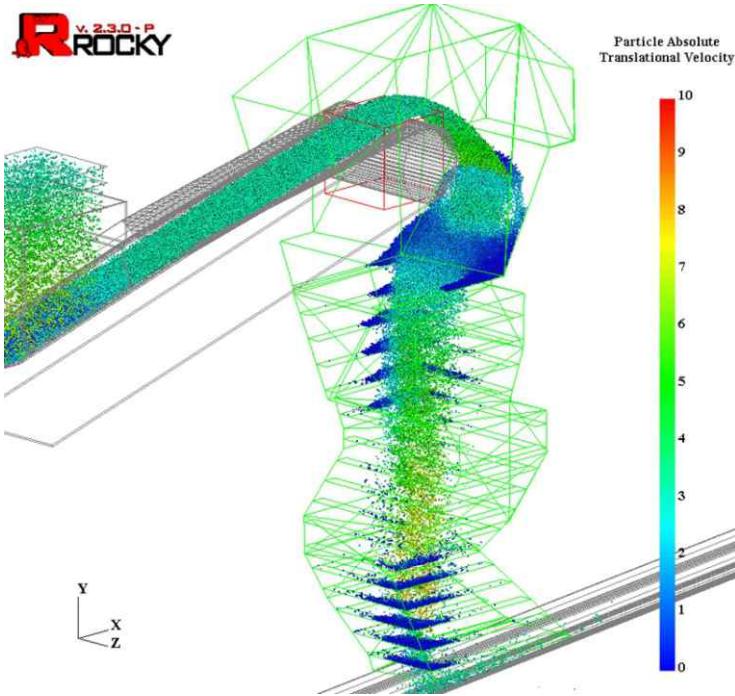


Recommendations implemented at Los Bronces were shown to lead to an overall improvement of some \$9.9 million per annum, which is comprised of reductions in downtime for chute failures, chute blockages, conveyor belt damage and misalignment.

CHUTE DESIGN IMPROVEMENT AND DISCRETE ELEMENT MODELLING continued

- Improved conveyor life
- Reduced labour cost

Implementation

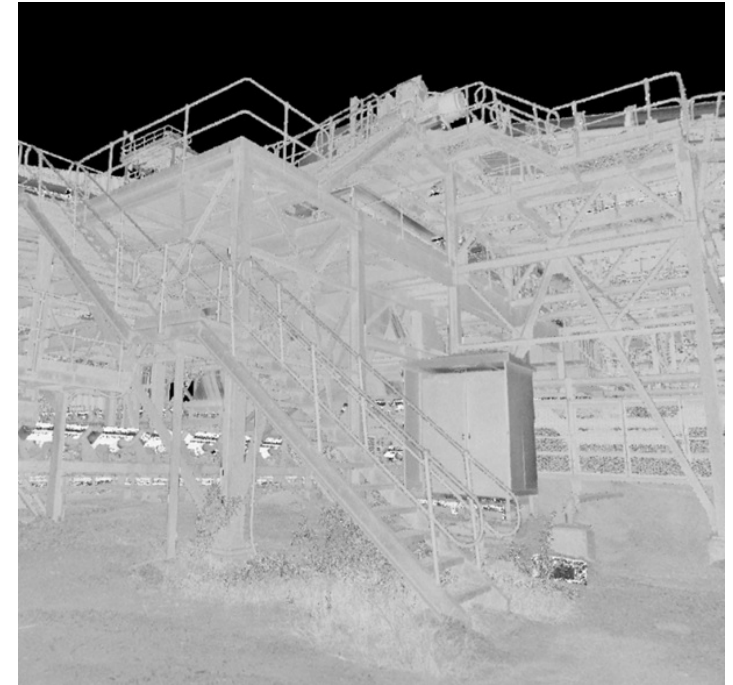


Picture left:

Discrete element modelling of a 25mm particle size iron ore chute at 4,000 tonnes per hour.

Picture right:

On site cloud scanning is conducted. The point cloud then used to create the computer aided design (CAD) models for the discrete element models.



Client feedback

Meshal Ruplal, vice president for Engineering at Copper in Chile, said: “Ernesto (Holzmann) did an excellent job in implementing several of the rock boxes that you proposed. Obviously we had to modify the designs slightly to cater for the realities on the ground. We have gone through winter and I can attest that the chutes worked exceptionally well with no significant blockages. Seeing as the system has performed so well during winter I can definitely say that the changes recommended by Technical Solutions and the DEM software simulation worked successfully. Well done Technical Solutions and Ernesto for an excellent job done.”

Who do I contact?

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REDUCING EXPOSURE TO DIESEL PARTICULATE MATTER (DPM)

- Zero Harm
- Reducing diesel exhaust emissions
- Mitigating serious health risks



Overview and benefits

Consulting's Safety and Sustainable Development (S&SD) is an active partner in establishing indicators of diesel exhaust emissions and implementing reductive measures at Anglo American operations.

S&SD is facilitating the first phase of this multidisciplinary programme.

In support of the key Anglo American Global Health Objectives for 2013, Technical Solutions: S&SD is contributing to an extensive programme to counter the uncontrolled emissions from diesel engines and the health risks of excessive occupational exposures to these emissions, including diesel particulate matter (DPM).

Currently, engine exhaust emission levels and DPM exposure limits are legislated in Australia, Canada, United Kingdom and USA, to name a few countries. No limits are presently legislated for several countries where Anglo American operates, including South Africa and South America. There is a high probability that regulatory requirements will be reviewed in these countries.

Objectives

- to reduce the overall effect of DPM across the Anglo American operations, by decreasing the emissions from diesel engines, the level of occupational exposures and the extent of exposure
- to strive for "Zero Harm"
- to mitigate serious health risks
- to adopt and implement the appropriate actions



Achieving the objectives

- DPM levels are dependent on the fuel quality (low sulphur is best), engine-type and age, as well as the effectiveness of the exhaust filter systems used across the mining operations.
- In countries where low emission diesel is available, significantly lower levels of DPM emissions are achievable through the use of higher tier engines, combined with low maintenance active catalytic filters.
- These lower levels have become the benchmark.
- As a leading mining company, Anglo American will strive to match the lower levels of emissions (and exposure), through the implementation of a multidisciplinary programme across its global operations.



Diesel particulate matter (DPM) is part of a complex mixture that makes up diesel exhaust emissions.

The approach

To establish an appropriate course of action within the Anglo American Group, a three phase approach to instituting diesel exhaust emission indicators was proposed for roll-out across the organisation.

REDUCING EXPOSURE TO DIESEL PARTICULATE MATTER (DPM) continued

- Multidisciplinary global programme

Some health-impact facts about DPM



- Exposure to DPM has widely documented negative health effects.
- In June 2012, the International Agency for Research on Cancer (IARC) declared that DPM be classified as a Group 1 carcinogen (highest level of carcinogens).
- This classification has led to a new global awareness and a pressing need for improved risk management and pre-emptive action around DPM exposure.
- DPM is “respirable”, ie. easily deposited in the lungs, if inhaled.
- DPM is associated with the carcinogenic effects, mainly due to the organic carbon component.
- DPM is also known to cause irritation of the eyes and the respiratory tract, exacerbate asthma, and induce cardiovascular and cardiopulmonary disorders.

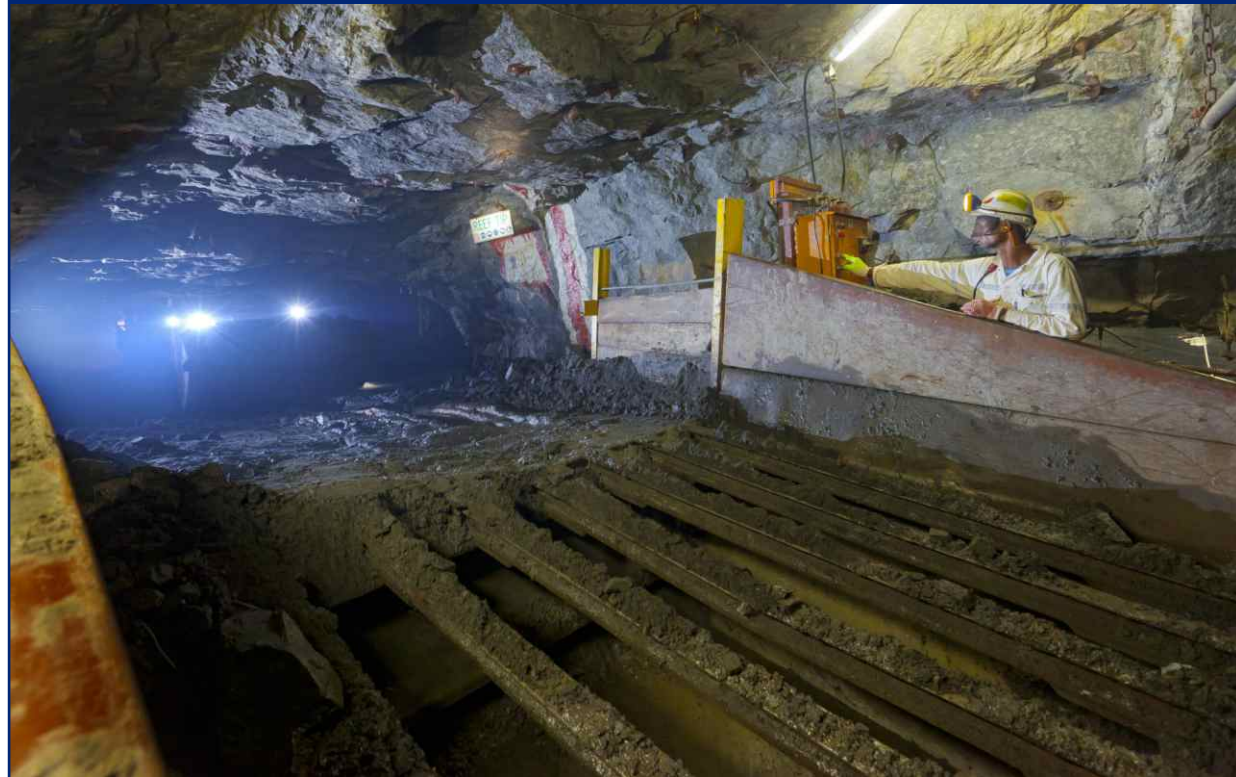


Team

The programme includes expertise from across the operations in various disciplines:

Technical Solutions: S&SD, Occupational Health (Occupational Hygiene and Occupational Medicine), Mining, Engineering and Supply Chain.

DPM and mining



- 1 The health impacts of DPM have become a much more active focus area in mining, given that much of the equipment used is diesel dependent.
- 2 Exposure is of greater concern for underground mining, where the build-up of fumes is much more severe, due to no natural ventilation; this also applies to surface semi-enclosed areas such as loading bays and workshops.
- 3 In open pit mining, there is some dilution of diesel fumes through natural ventilation.

REDUCING EXPOSURE TO DIESEL PARTICULATE MATTER (DPM) continued

Implementation: Phase 1

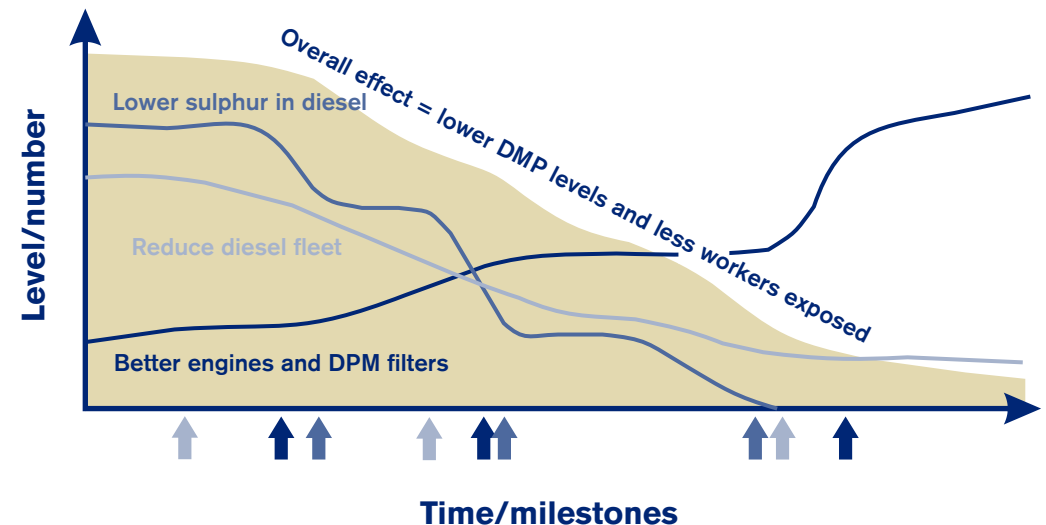
- Facilitated by S&SD, Phase 1 aims to collate and analyse Group-wide high-level baseline data on the main factors contributing to the risk of DPM exposure at the operations.
- A high level data set on DPM indicators has been requested from each business unit.

Indicators include:

- Diesel quality available; diesel fleet in use; exhaust treatment currently in place; vehicle engine tier and power ratings
- Number of people potentially exposed – the number of individuals regularly exposed to DPM in the various areas of the operations
- Estimated average DPM level, including average total and elemental carbon levels, if available
- Vehicle/equipment type: load, haul, dumper, etc.

Phases 2 and 3 will be reported on as they are implemented.

Anglo American's DPM programme



Health and safety benefits



The reduction of DPM levels, will contribute to the health and safety of our employees, providing clean air benefits, fuel savings, improved occupational and community health.

Cost reduction



This programme will contribute to reductions in the costs and impacts to the company in terms of health and technical outcomes, including mitigation of potential compensation liability.

Who do I contact?

Claudina Nogueira, Health and Safety Advisor: Technical Solutions - Consulting, claudina.nogueira@angloamerican.com

Frank Fox, Group Manager: Occupational Health
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Marco Biffi, Principal Ventilation Engineer, Mining & Technology
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EQUIPMENT MONITORING SYSTEM (EMS) FOR HAUL TRUCKS

- Remote condition monitoring of haul trucks to provide early warnings of failures
- Uses existing on-board data



Overview and benefits

As a predictive tool for early warning of possible haul truck failures, the potential benefits of EMS include:

- improved maintenance planning;
- less downtime, cost saving;
- avoidance of catastrophic failure; and
- improved operator safety.

The product was developed in partnership with Met Coal Australia, with funding from Mining & Technology's Technology Development department.



Client feedback

A reliability engineer at Drayton mine, Metallurgical Coal, Australia said:

"EMS transforms raw data into concise, useable information. Excellent co-operation between the site and EMS team. If the system remains flexible and collaborative. EMS will continue to improve. An invaluable addition to maintaining critical production assets and predicting the health of our trucks."

Brisbane co-operate Office said:

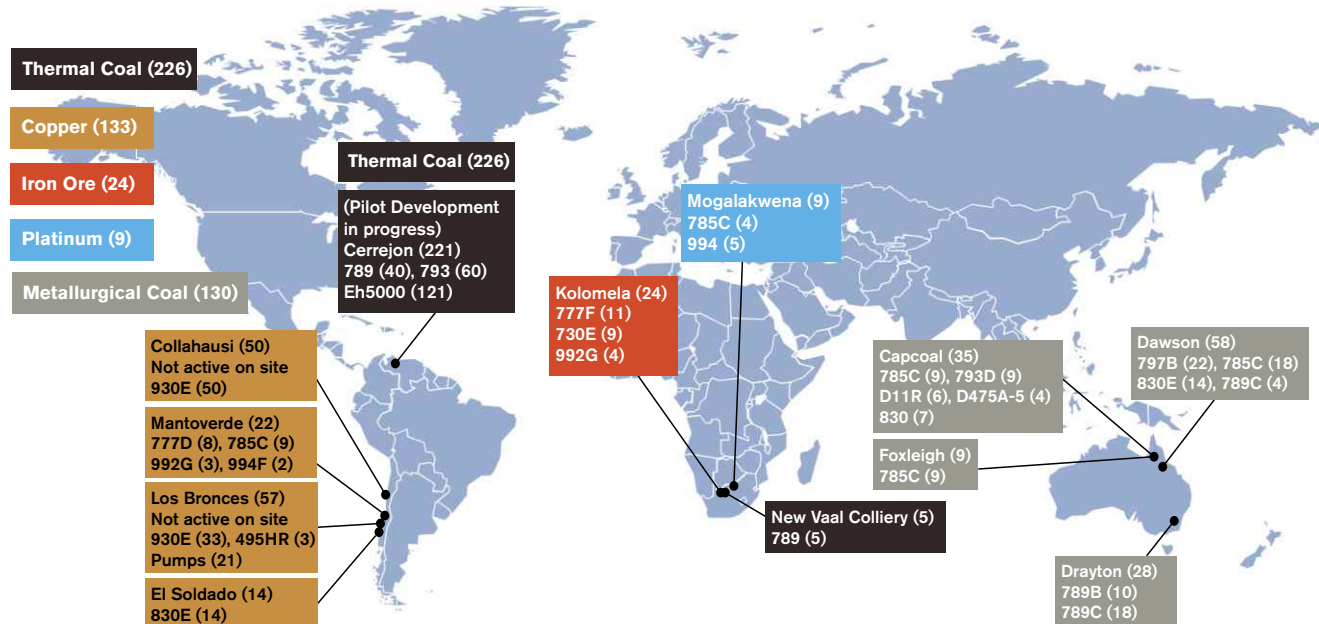
"As you know I am a great believer in EMS and we've had some big wins with it this year. I do think it's only the 'tip of the iceberg'."



Location



EMS is used globally by over ten operations. The map below illustrates the current footprint of EMS:



Data management

The processing engine compares the status of a machine to an ideal, or fingerprint state, to predict failure.

- Predictive data (any shortfalls between status quo and ideal/fingerprint state) is made available to the user via a simple web interface dashboard.
- The EMS team also analyses the processed data and provides the mine with a weekly summary report.
- A teleconference call between the mine's maintenance team and the EMS technicians identifies and flags major equipment issues, closing the loop for feedback and assisting implementation.

2011 Applaud Award winner

EMS for Haul Trucks won a 2011 Applaud award in the **partnership** category.

The award was shared by the Technical Solutions EMS team and the Dawson mine team for "showing how great innovation can spring from collaboration and partnership".



EQUIPMENT MONITORING SYSTEM (EMS) FOR HAUL TRUCKS continued

- No hardware installation required
- A continuous process for seamless implementation
- 2011 Applaud Award winner



Team

The EMS team, based in Johannesburg, South Africa, is employed by Technical Solutions, Consulting. It comprises dedicated EMS technicians, data analysts and engineers.

Ongoing improvements

Many sites have asked for website changes and changes to the processing back-end tool equipment.

How is Consulting responding?

Consulting has a project in place to improve the system as per the customers' requests and requirements. Workshops and user forums are planned to facilitate the feedback on improvement suggestions and to ensure customer satisfaction.



Financial gains

For the year 2012, Australia has realised a return on investment of 3.5:1 implemented value by using EMS.



EMS for other equipment



EMS can be applied to virtually any piece of equipment that requires condition monitoring. Current applications include wheel loaders, rope shovels, dozers, pumps, and an underground longwall miner. Timelines for implementation may vary.

Who do I contact?

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Jose Prozzi: jose.prozzi@angloamerican.com

FLEXIBLE HAUL TRUCK BUMPERS

- A flexible bumper that can be fitted to large haul trucks
- Significantly reduces the possibility of light vehicles being crushed during a collision



Overview and benefits

The bumper has an energy absorption mechanism, which reduces the impact acceleration experienced by the light vehicle during a collision, and also prevents the vehicle from getting stuck under or crushed by the larger haul truck body and tyres. This bumper is one of the last “barriers” in place to reduce the potentially fatal result of collisions between light vehicles and haul trucks.



Team

The bumpers were developed by Technical Solutions and tested at Anglo American's Thermal Coal sites.



Location



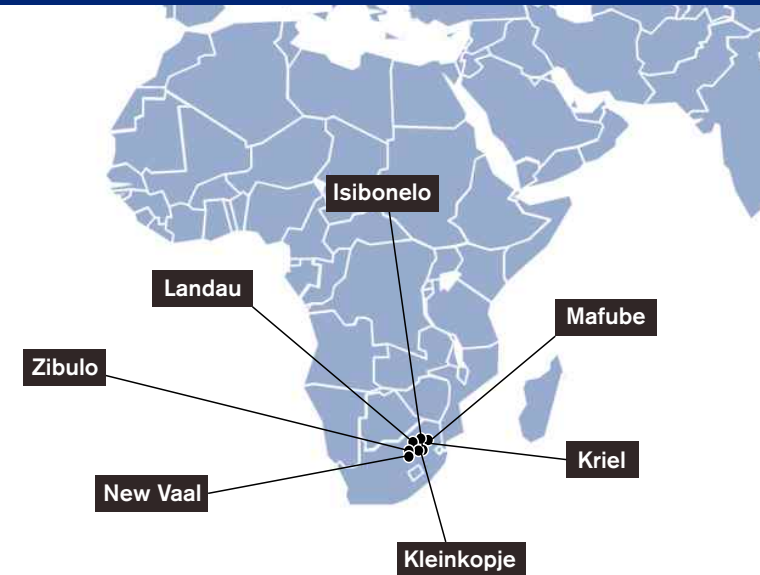
Thermal Coal is in the process of implementing haul truck bumpers within its operations.

Bumpers for the following fleets have been delivered to site:

- Euclid R170 – operating
- Hitachi EH3000 – operating
- Hitachi EH3500 – operating/being installed
- CAT 789 – operating/being installed
- Komatsu 730 – being installed.

The following bumper types have been delivered to site:

- Hitachi EH1600
- CAT 777
- Komatsu 785.



Implementation and timelines

Technical Solutions is continuously updating the drawing register to accommodate the various haul truck models. The current drawing register includes the following models:

- | | | | |
|------------------|------------------|-----------|----------------|
| • Euclid R170 | • Hitachi EH3000 | • CAT 777 | • Komatsu 785 |
| • Hitachi EH1600 | • Hitachi EH3500 | • CAT 789 | • Komatsu 730. |

Approximately 30 days: Ordering and site delivery for fitment of existing bumper designs.

Approximately 15 days: New bumper designs can be added following a site visit by the Technical Solutions team to measure the required dimensions and generate the drawings. A new set of manufacturing drawings takes about 15 days to deliver, dependent on resource availability.

Please note: The site is responsible for fitment and modifications to the drawings as required.

FLEXIBLE HAUL TRUCK BUMPERS

continued

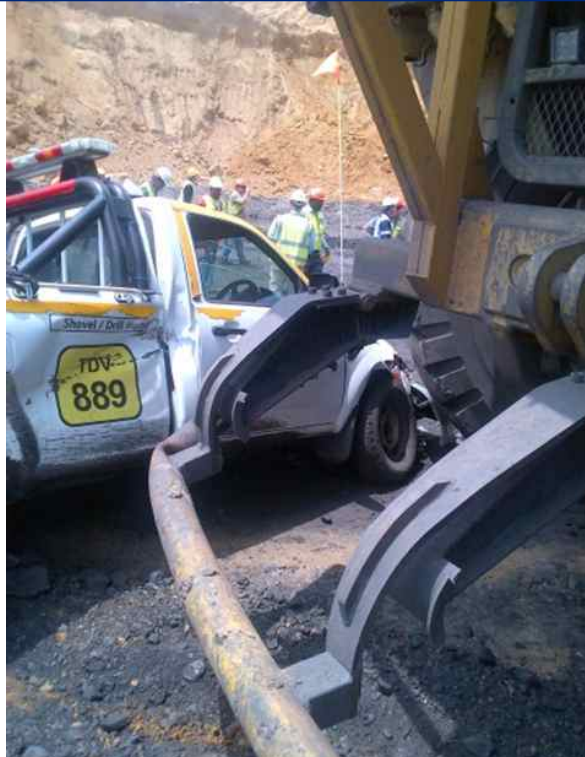
- Safety barrier reduces the risk of fatality during a collision
- Flexible absorption system tested in the field at speeds of up to 30km/hour



Client feedback

Thermal Coal had an incident between a Euclid R170 haul truck and a light vehicle on the night of 31 October 2012. The Euclid R170 truck was turning away from a shovel and collided with an empty light vehicle (no passengers or operator). The bumper pushed the light vehicle for approximately five metres before the shovel operator stopped the haul truck operator.

Damage to the light vehicle was minimised by the bumper. The haul truck would probably have crushed the vehicle if the bumper had not been fitted.



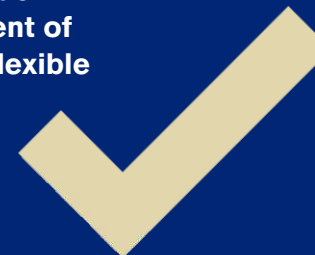
Ongoing improvements

The bumper design was modified to allow the bumper to pivot around a central axis, allowing the bumper to pivot upward in case of the bumper making contact with ground. A spring was introduced to provide some resistance against this movement, thereby reducing the effect of the bumper 'hopping' due to vertical excitation.

A modular component design has been introduced to facilitate the ease of fitment and replacement of damaged component parts.

Value-add = Zero Harm

Besides adding value in avoiding replacement of light vehicles, the flexible haul truck bumper reduces fatalities and increases Zero Harm.



Who do I contact?

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ANGLO AMERICAN MINE CLOSURE TOOLBOX

- Assists operations in strategic long-term mine closure planning
- A decision support and management tool
- Spending scarce money wisely



Overview and benefits



The Toolbox facilitates the integration of the physical, biological and socio-economic dimensions of closure, the effective implementation will improve the accuracy and future success of the closure plan. The benefits include:

- identifying and implementing closure opportunities;
- reducing closure liabilities and preventing value destruction;
- spending the same money wisely (no additional operating cost in most cases);
- expanding the focus from rehabilitation and physical closure to planning for sustainability beyond mine closure; and
- creating socio-economic systems that endure beyond the time a mine ceases to operate.

The Mine Closure Toolbox was developed by the then 'Anglo Technical Division' over a three year period (2005 to 2008) and has been refined and implemented by the same team since Technical Solutions was established in 2009.



Location



The Toolbox is currently being implemented throughout Anglo American managed operations across the world and is available in English, Spanish and Portuguese.



%

More than 85% of all Anglo American managed operations are using the Toolbox.



Client feedback

Dorian Emmett Group Head of Safety & Sustainable Development said: The Mine Closure Toolbox has played a significant role in trying to get consistency within the Group in closure planning, accounting and reporting. From a corporate viewpoint, having consistency in planning, reporting and accounting of current and closure liabilities is fundamental to managing our business better. It also enables asset optimisation and prevents value destruction through better planning and understanding of current and potential liabilities.

ANGLO AMERICAN MINE CLOSURE TOOLBOX continued

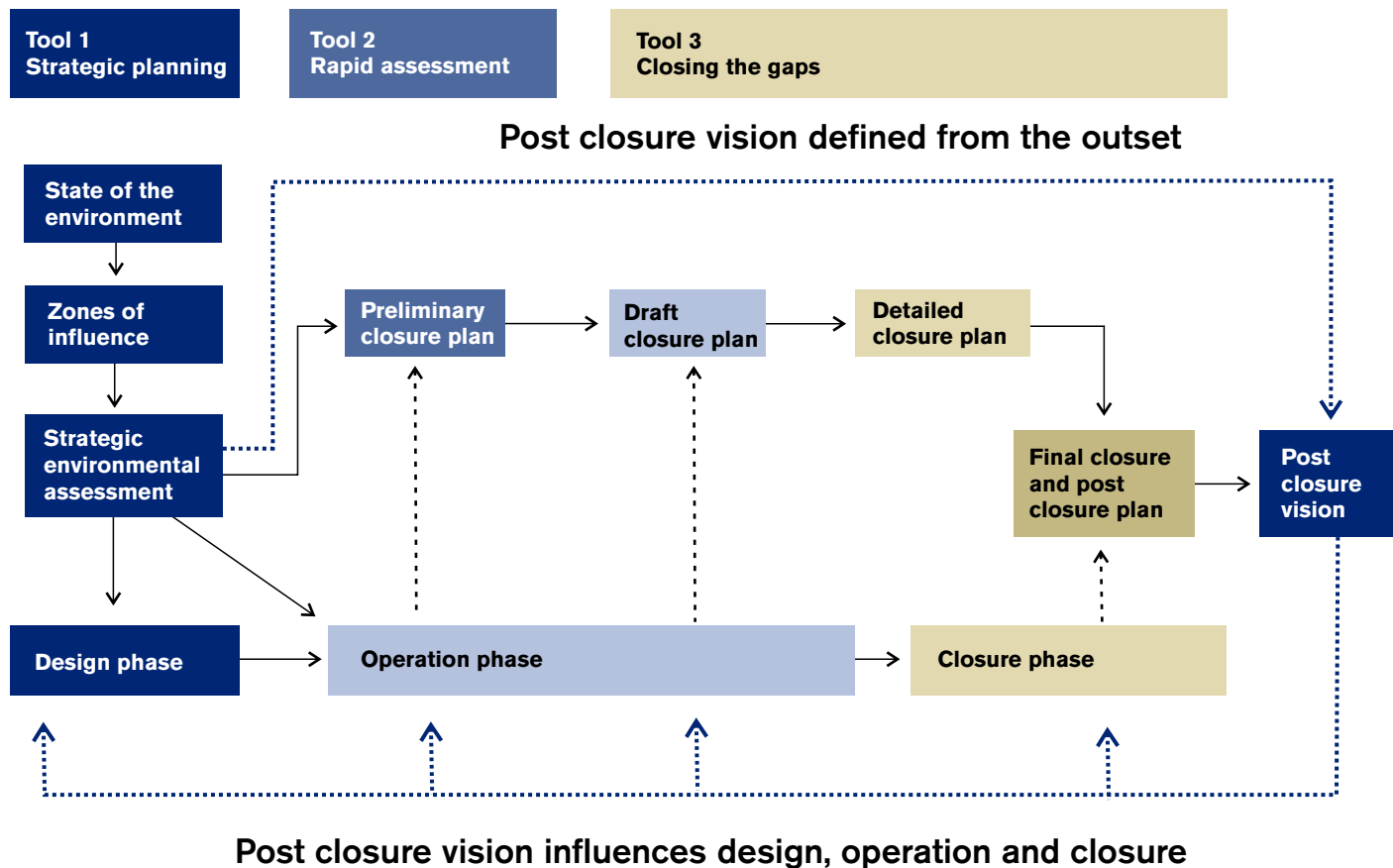
- Achieving socio-economic systems that endure beyond the life of mine
- A positive legacy



The toolbox: An integrated design

For use in project development and planning, to ensure that brownfield and greenfield sites are planned and designed with closure in mind. It comprises:

- **Tool one:**
A strategic planning tool that is used in the development of a closure vision.
- **Tool two:**
A rapid assessment tool that identifies the current level of confidence and gaps in the closure plan.
- **Tool three:**
A tool that focuses on closing the identified gaps to achieving the closure vision.



The three tools overlap to ensure that infrastructure, physical, biological and socio-economic aspects of mine closure are addressed in an integrated manner, and to provide confidence in the closure plan and its liability estimate.

Who do I contact?

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CHAGRES SMELTER SAYS 'YES' TO IMPLEMENTING RAPID RESULTS

- Connects strategic objectives to the operational changes required
- Creates awareness of performance objectives



Business objective

Chagres Smelter's management set out to increase the smelter's performance by curbing fuel consumption, increasing metallurgical output and enhancing the smelting rate.

Rapid Results was identified as the ideal approach for connecting the smelter's strategic objectives to the operational changes required to enhance performance and become more cost efficient.



Team

The projects' teams were restricted to eight members that represented various disciplines from a grass-roots level to key role players.

Participants were challenged to offer innovative solutions to the identified performance constraints in an open and safe environment.

The composition of the team lends itself to cross functional learning, where participants acquire in-depth knowledge about processes that they are not necessarily involved with on a day-to-day basis, equipping them to understand the real impact of change, which is accelerated by daily performance tracking.



Operation

Chagres Smelter is located 400 metres above sea level in Region V in the municipality of Catemu, 100 kilometres north of Santiago. The Chilean smelter's productive process is undertaken by means of a modern Flash, a technology known for its low emission levels, making Chagres an environmental leader in Chile's mining industry. The smelter processes copper concentrates from Los Bronces and El Soldado.



**2012
APPLAUD
AWARD
WINNER**

The fuel saving project realised a 9% decrease in the daily consumption of fuel, 29% in diesel and 7% in natural gas.



CHAGRES SMELTER SAYS 'YES' TO IMPLEMENTING RAPID RESULTS continued

- Generates innovative solutions in an open and safe environment
- Implements rapid cycles of measurable change

1 Improvement results: Project wave 1

The first wave of improvement projects at Chagres Smelter illustrate how a structured process like Rapid Results can generate learning, tap experience from a diverse team and generate tangible results. The projects involved in the first wave included:

- **“On the way to Saganoseki”** a fuel saving project that realised a 9% decrease in the daily consumption of fuel, 29% in diesel and 7% in natural gas. These results were partly attained due to the increased training of workers on the use of fuel as well as internalising the control of consumption among operators. Saganoseki is a smelter located in Japan and is considered to be one of the most energy efficient copper smelters in the world and a great role model to which this project team aspires.
- **“Copper with Ears”** set out to achieve a metallurgical output of 97.3% within 100 days, achieving 97.61% at the end of the implementation period. The project's name underlines the importance of being attentive and listening to improvement suggestions and operational enhancement ideas that are put forward.
- **“Fast and Furious”** planned to establish the smelting rate of dry concentrates in the flash furnace to 75 tonnes per hour within 100 days and generated 45 improvement initiatives. The smelting rate during two months of the project was influenced by the quality of the concentrates and despite the best ever fusion rate achieved during one of the months of 76,4tph, the two-month below average performance affected the attainment of the set goal. The team performed well regardless and generated valuable learnings from the implementation.

By default, performance reporting and meetings continue on a formal and informal basis, even after the completion of the projects' timeframe.

2 Successive improvement projects: Project wave 2

Since the completion of the first wave of improvement projects, additional subset projects have been identified, underlining the cyclic nature of the Rapid Results methodology.

These initiatives included:

- Lowering S emissions;
- Reducing total injury frequency rate; and
- Copper recovery improvement phase 2.

Rapid Results helps create awareness about performance objectives and empowers people to become part of the solution. Daily performance measurement keeps the focus on the key performance indicators, and prompts quick, effective decision making.

While Rapid Results helps to identify, implement and sustain operational improvement, sustaining the discipline of the process after the projects' completion is imperative to achieving successful, long-term change.



Who do I contact?

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OPERATIONAL PERFORMANCE AT DE BEERS VOORSPOED MINE

- Material impact on performance
- Continuous and sustainable improvement
- Synergy between management and teams



Business objective

Voorspoed mine's principal objective is to ramp up production by 2014 to approximately 750,000 carats per year by:

- Implementing improved efficiencies using the Rapid Results approach;
- Optimising its new equipment to the value of R180 million to boost the tonnage hauled; and
- Implementing measures that will position the plant to treat up to 4 million tonnes per annum.

Management set out to improve the mine's production, plant throughput, waste management system and material receipt system using the Rapid Results methodology.



Team

The composition of the team is critical to the success of Rapid Results.

The project team comprises site management representatives, multidisciplinary and multilevel members. The teams are facilitated by Tshepo Gabe, Continuous Business Improvement Manager at Voorspoed and supported by Arien van der Walt, Strategy and Performance Manager: Technical Solutions.



Operation

De Beers Voorspoed mine is an open-pit kimberlite mine that is situated 30 kilometres north-east of Kroonstad in the Free State, South Africa. It currently mines at a depth of 150 metres. The mine was expected to produce over ten million carats during the life of the mine using standard drill and blast techniques. As is the case with mines such projections are continuously reviewed and Voorspoed is no exception.



Voorspoed mine

Team members from Research visiting Voorspoed mine and team members from Team Ferrari, one of the six participating project teams at Voorspoed mine

2012 Applaud Award winner

Arien van der Walt, change and implementation manager: Technical Solutions and specialist in **change management initiatives** was awarded the 2012 Applaud Award in the **partnership category**.



OPERATIONAL PERFORMANCE AT DE BEERS VOORSPOED MINE continued

- Eliminates silos
- Develops a culture of innovation
- Addresses and responds to the real status quo

1 Improvement results: Project wave 1

The first wave of projects started in the second half of 2012 and contributed to the mine achieving record production during 2012, including:

- Increased production by mining 12% more waste out of the pit;
- Plant throughput improved by 9%; and
- A waste management system cleared redundant scrap to reduce rehabilitation liabilities.

Once the first wave of projects is completed, monitoring and tracking results continues as the second wave of improvement projects commences.

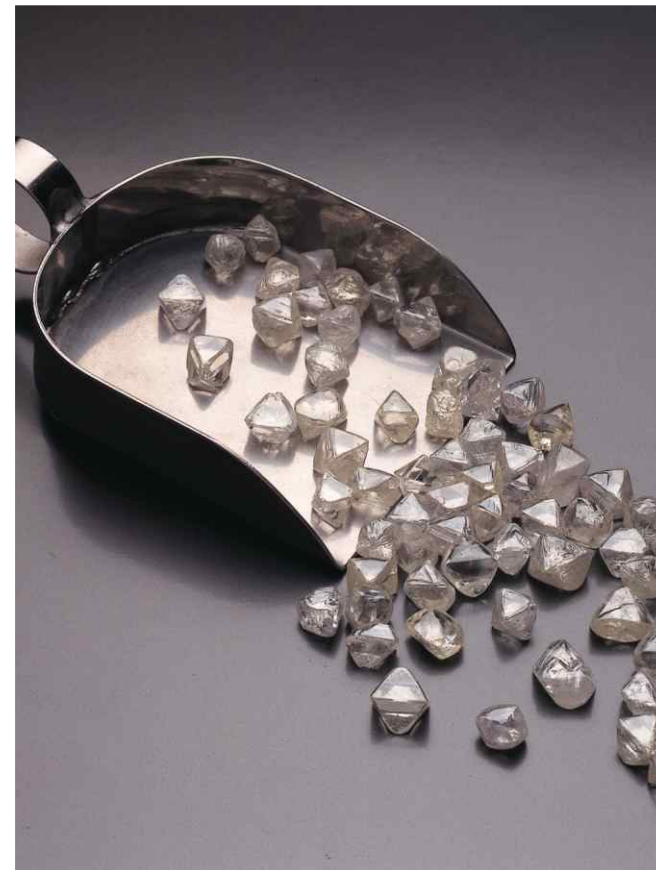
2 Successive improvement projects: Project wave 2

Voorspoed mine's critical production challenge for 2013 is the unexpected change in the geology of the resource, the nett effect being the unavailability of kimberlite to mine. The overall effect is approximately a 31,000 carats deficit incurred year to date.

Three improvement projects were identified, making up the second cycle of projects that started in March 2013 including:

- Increasing the shovel rate from 997 tonnes per hour to 1,150 tonnes per hour;
- Reducing the plant headfeed downtime by decreasing engineering and operational delays, as well as implementing measures that will allow the plant to treat alternative ore sources to supplement the ore from the pit; and
- Optimising the receiving yard activities.

This set of projects will be completed by mid-2013, at which time management will identify and decide upon the next set of opportunities – a logical spinoff from the previous project waves. This continuous cycle of short-term projects drives the maturity of the overall system.



Rapid Results develops synergy between management and the teams, eliminating silos and ensuring that the solutions address and respond to the real situation at the mine.

Partnership and collaboration becomes the blueprint for on-going improvement successes, creating sustainable, measurable value and a proven approach to facing and overcoming the challenges of mining.



The results are tangible:

- big chunks of continuous and sustainable improvement occur;
- a material impact on performance is made;
- a culture of innovation and continuous improvement becomes part of everyday mining for the teams involved.

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KOLOMELA MINE TAKES LEAPS IN ADVANCING OPERATIONS

- Escalating results
- Measurable performance improvement
- Sustainable value



Background

In April 2012, Kolomela's management commenced a theory of constraints (TOC) intervention to diagnose the capacity issues experienced. As a result, a production model was determined for the mine and a list of critical issues developed. Rapid Results was selected as the implementation approach to address some of these critical issues.

A TOC 'war room' was established to measure the daily performance of the improvement projects. This initiative facilitated improved communication and learning across all functions at Kolomela.

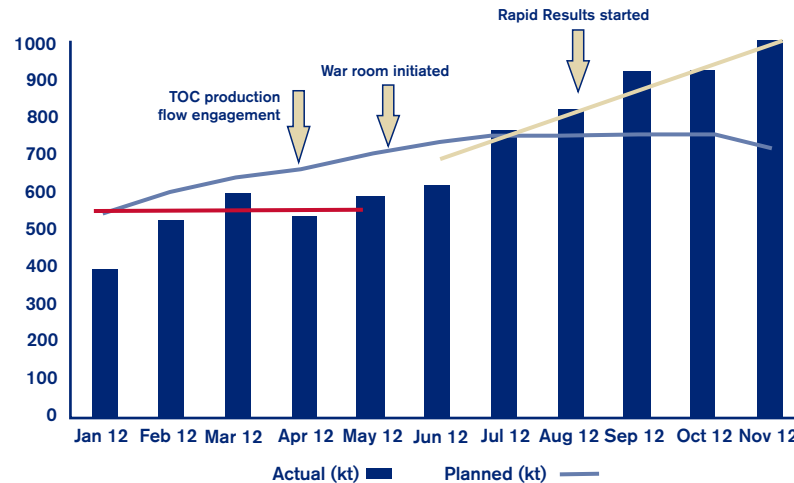
Rapid Results

Rapid Results has been fundamental in achieving critical, shorter-term objectives that respond to Kolomela's strategic goal of producing budget tonnes of direct shipping ore.

This improvement methodology requires appointing project teams, setting targets, generating and experimenting with ideas to meet the targets, and daily measurement of performance - all in a tight 100-day timeline.

Kolomela is currently implementing its third improvement project wave using the Rapid Results methodology.

Kolomela ore production



“The Rapid Results methodology makes sense. It is a simplistic, forward-looking approach that focuses on value. The results generated through the programme since 2012 at Kolomela are escalating, impacting measurably on our production flow and overall performance.”

Henk Storm,
manager
operational
readiness/asset
optimisation at
Kolomela mine



1 Improvement project wave 1

- Project “Bums on Seats” set out to increase production tonnage by improving direct operating hours. Machine hours lost per day were reduced from 335 to 130 hours per day over 100 days.
- Safe “25X Brother's Keeper” project aimed to achieve consecutive safe days, increasing the number of safe days from an average of two to five.
- Project “Quality Drillers” was tasked to reach and exceed mine production targets, reduce cost per tonne and improve morale and achieved a sustained increase in metres drilled by 20-25% and increased the drill quality in terms of redrills, position and depth.

2 Improvement project wave 2

- Project “Horse Power” addressed fuel consumption. The project created understanding of the complexity around fuel due to interdependencies and improved data gathering to manage efficiency rather than consumption.
- Project “Toktokkies” focused on further improving drilling; it increased the number of quality drill metres and achieved consistent drilling improvement of more than 30%.
- Team Thusano focused on safely increasing waste production from 73,000 tonnes per day to 90,000. The team consistently exceeded their target, even setting record production during the project period.

KOLOMELA MINE TAKES LEAPS IN ADVANCING OPERATIONS

continued

- Increased production tonnage
- Improved safety performance
- Enhanced communication

Enablers of success

After just two waves of Rapid Results projects:

- Drilling has improved by 50% from an average of 1,200 metres per day to a daily average of 1,806 during the last four weeks of the 100-day Rapid Results period.
- Penetration rate has improved from an average 19.6 metres per hour to 23.
- Improved average direct operating hours from 8.34 to 12.43 hours.
- Waste production increased by 36% from 73,000 tonnes to an average of 99,000 tonnes over the last four weeks of the Rapid Results period.
- The team achieved their target weekly average of 90,000 tonnes, which has now become business as usual for daily production.

%



Key learnings

- Use initial diagnostics to prioritise critical issues.
- Keep brainstorming sessions informal.
- It is critical for the godfather (project sponsor) to be completely supportive, enabling execution with sustainable results.
- Manage project execution in line with the critical path.
- Add milestones to the project steps.
- Appoint a strong team leader with good project skills.
- Appoint the right team and transfer project accountability and ownership.
- Allocate and clarify tasks and responsibilities.
- Communicate regularly and visibly.
- Develop a team's understanding of the full mining value chain.
- Implementation needs to be sustainable.
- Manage change and resistance.
- Express thanks and give operation-wide recognition and reward for demonstrating changed behaviour.



**2012
Applaud
Award winner**

Alrien van der Walt, change and implementation manager: Technical Solutions and specialist in **change management initiatives** was awarded the 2012 Applaud Award in the **partnership category**.

Performance improvement integral enablers

- Visionary leadership
- Management's participation, buy-in and support
- Explicit goals
- Disciplined project management and effective execution capability
- Open communication, improved information flow, cross learning and networking
- Change management
- Daily performance measurement and analysis
- Recognition and reward.

Who do I contact?

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**Change and implementation
manager: Technical Solutions**

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PLATINUM IM IS CHANGING IT SOLUTIONS INTO BUSINESS RESULTS

- Increases the visibility of the value chain
- Instils new, innovative ways of operating
- Enhances productivity, service delivery and client satisfaction



Business objective

Platinum Information Management (IM) is converting traditional technology-based assignments into business focused projects that deliver business results using an improvement and change management methodology called Rapid Results. Rapid Results is supported by Mining & Technology's Technical Solutions function.



Rapid Results has helped Platinum IM to expand the teams' operational capacity and level of innovation.

Alrien van der Walt, change and implementation manager: technical solutions and specialist in **change management initiatives** was awarded the 2012 Applaud Award in the **partnership category**.



Projects

Some of the first Platinum IM projects that have been implemented using the Rapid Results methodology:

The project management information (PMI) project:

Platinum IM developed a project management information reporting dashboard, providing management with a single source, near real time report on the status and health of Platinum's capital project pipeline that it delivered in 100 days versus an unfinished 18 month attempt previously at the same deliverable.



Single source, near real time reporting

Fast forward mining daily reporting project:

This reporting solution presents mining data automatically and directly from the source to management without any human interaction, eliminating human error and time delays. It is available electronically and on mobile devices and allows management to drill down into further information as required. For the first time, quality production, safety and labour reports are available on a daily basis to management across operations, enabling fast, meaningful business decision making. Rapid Results helped put the client into the driving seat of the project, upping the project's success.



Quality production, safety and labour reports available on a daily basis to management

Windows 7 roll-out project:

This traditional IT upgrade project involved migrating 2,800 personal computers from Windows XP to Windows 7. Rapid Results helped the team overcome obstacles and come up with innovative ways of achieving the set goal.



Innovative ways to achieve goals



We have raised the bar and stretched ourselves to achieve challenging, shorter-term objectives. As a result, we have upped our productivity, our service delivery and our client satisfaction and have challenged our service providers to do the same."

Shawn Fisher, head of Platinum IM

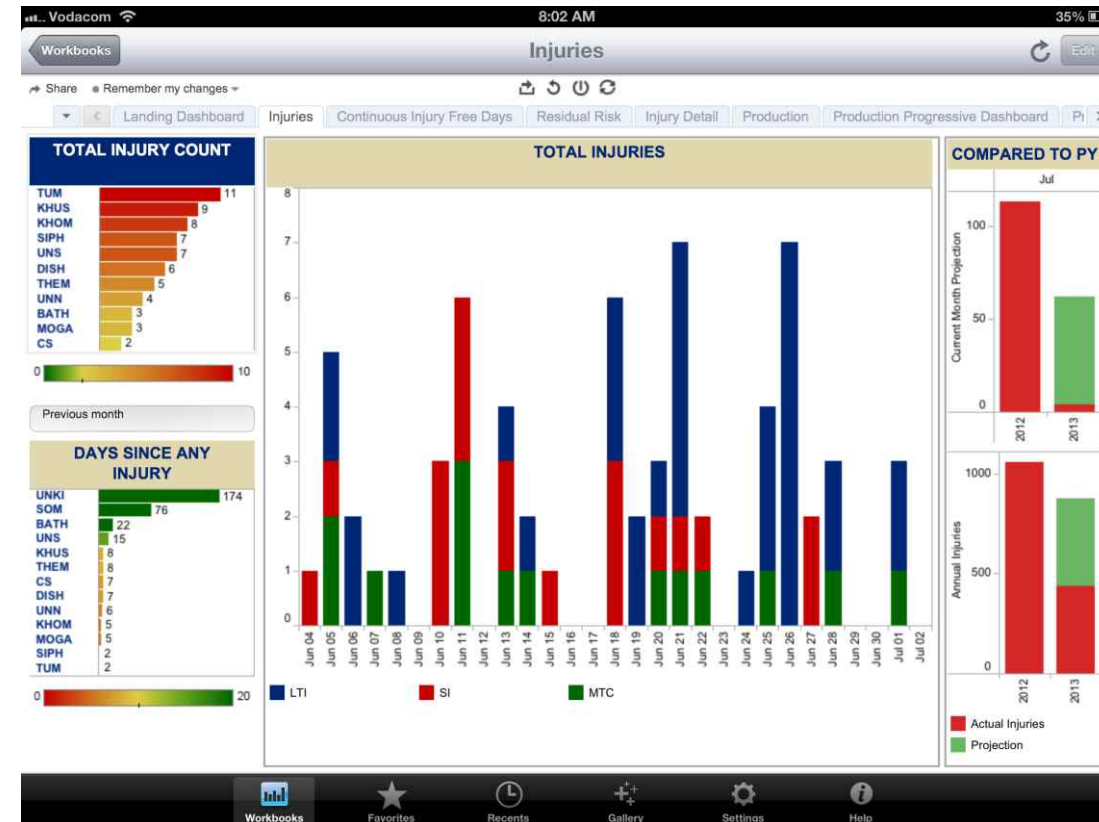
PLATINUM IM IS CHANGING IT SOLUTIONS INTO BUSINESS RESULTS continued

- Simplifies project deliverables
- Increases client participation
- Delivers sustainable change

Methodology

- Reverse engineering**
 Platinum IM applied reverse engineering to its projects, defining the results first and setting 100 days for the teams to achieve the objectives. The Rapid Results approach helps to define project deliverables into smaller, shorter-term quotas, increasing their achievability.
- Implementation team**
 A broader project implementation team composition was needed to achieve the defined objectives. Individuals outside the IM team were identified and invited to participate in what was previously perceived as "IM" projects. This brought additional expertise to the teams, and added broader visibility of the business value higher up the value chain.
- Project ownership**
 Shorter-term deliverables significantly increase the buy in and participation by clients, which helps to transfer the project ownership to the client. Traditionally IT projects are IM driven; setting the client in the driver seat improves the rate of adoption and adds to the project success due to their increased commitment and support.
- Internal resources**
 Platinum IM used internal resources for the development, implementation and support services for the information solutions. As a result, sustainable business solutions are delivering cost and time efficiencies and improving overall client satisfaction.
- Sustainable operational improvements**
 Rapid Results has helped Platinum IM achieve sustainable operational change by transforming some of the daily processes and systems; implementing additional checks and controls; and ensuring buy-in and support at appropriate levels.

Daily reporting dashboard - outcome from Platinum IM project using the Rapid Results methodology



Who do I contact?

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RAPID RESULTS: AN INNOVATIVE APPROACH IMPLEMENTING IMPROVEMENT

- Builds problem solving capacity
- Delivers immediate, sustainable results
- Proven approach



Business objective

Rapid Results, a Technical Solutions' competency, is a structured approach that equips management to improve operations by building their employees' capacity to solve everyday problems by implementing innovative solutions using successive cycles of project waves that focus on results.

The methodology is applied in achievable, short-term cycles that deliver immediate, sustainable results that are tracked and monitored on a daily basis.

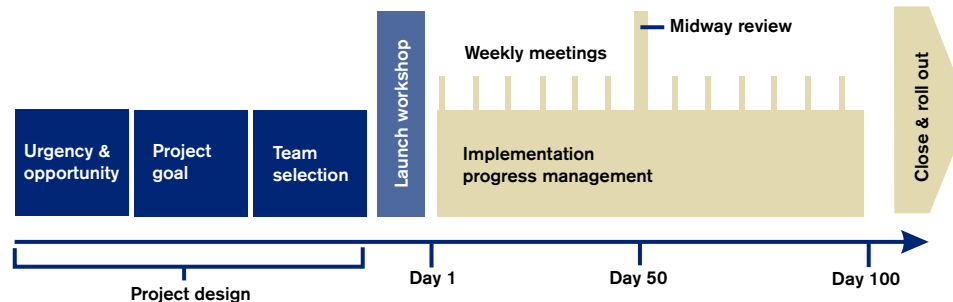
Partnership and collaboration become the blueprint for ongoing improvement successes, creating sustainable, measurable value. Rapid Results is a proven approach to facing and overcoming the challenges of mining.

Application

Since 2008, the methodology has successfully been utilised at over 30 Anglo American operations in varying degrees, across multiple projects and disciplines where the Rapid Results process has facilitated continued improvement. The approach can be applied to any situation, project or discipline, for example: solution implementation; business improvement; site turnarounds; new technology implementations; and innovative asset optimisation.

The additional value generated between 2010 and 2012 from optimising processes in the mining value chain by implementing Rapid Results has involved inter alia:

- production,
- processing,
- quality enhancement,
- tyre life,
- absenteeism,
- drilling quality,
- equipment availability,
- truck loading,
- information management, and
- automation.



	2010	2011	2012
Operations	10	11	12
Projects	18	35	40

Rapid Results facilitated projects at Anglo American from 2010 to 2012

2012 Applaud Award winner

Alrien van der Walt, change and implementation manager: Technical Solutions and specialist in **change management initiatives** was awarded the 2012 Applaud Award in the **partnership category**.



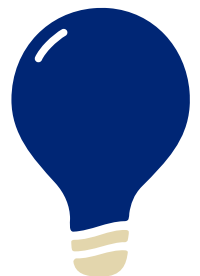
Key differentiators of Rapid Results

Typical interventions

Long-term strategy
Top-down implementation
Results are visible over long period
Master plan
Management responsibility
Develop tools
Change with resistance
Analyse first

Rapid Results

Short-term cycles, long-term impact
Bottom-up implementation with a top-down design
Short-term results (tracked and communicated daily)
Site specific solutions – no blueprint
Management support
Implementation tools
Change without resistance and with renewed energy
Start immediately



RAPID RESULTS: AN INNOVATIVE APPROACH IMPLEMENTING IMPROVEMENT continued

- Partnership and collaboration underline the success
- Delivers measurable value



Benefits

Rapid Results helps operations achieve measurable results immediately, creating the foundation for sustained progress for the long haul. This is a fundamental difference from typical improvement initiatives: Rapid Results delivers tangible benefits:

- **Sustainable value:** Extracts pure value from our operations by equipping managers to align performance with strategic objectives.
- **Innovation:** Waves of 100-day projects engage the creative energy of the teams to explore solutions to defined challenges. Within this timeframe, the team experiments with alternatives until they find a pathway to achieving their defined goal.
- **Implementation capacity:** A continuous cycle of short-term projects drives the maturity of the overall improvement system and strengthens the team's implementation capacity, delivering sustainable results.
- **Teamwork:** Rapid Results places multidisciplinary and multilevel people who don't normally work together around one table to find answers to challenges, shifting the focus onto the results.
- **Strategic:** Takes smaller elements of a long-term strategy and applies it in achievable, successive, short-term cycles. This synchronises the operation's strategy and the team's efforts, resulting in a unified focus that immediately starts delivering on strategic priorities.
- **Partnership:** Rapid Results develops synergy between management and the team, forging a two-way process where the solution design is influenced by a top-down approach and implementation is affected from the bottom-up with accountability resting on the team.
- **Culture of improvement:** Rapid Results creates a culture of continuous improvement. It helps break down traditional silos, taps individual experience and expertise, and designs sustainable solutions that respond to the real status quo.



Start implementing Rapid Results

- 1 Contact Technical Solutions: Consulting
- 2 A step-for-step process guides management through the team selection criteria and the planning phase
- 3 The process throughout the 100-day project wave is coordinated by an on-site business improvement representative with the support of the strategy and performance manager from Technical Solutions
- 4 The team selected dictates the level of innovation and type of solutions used to achieve the identified objectives over the limited timeframe

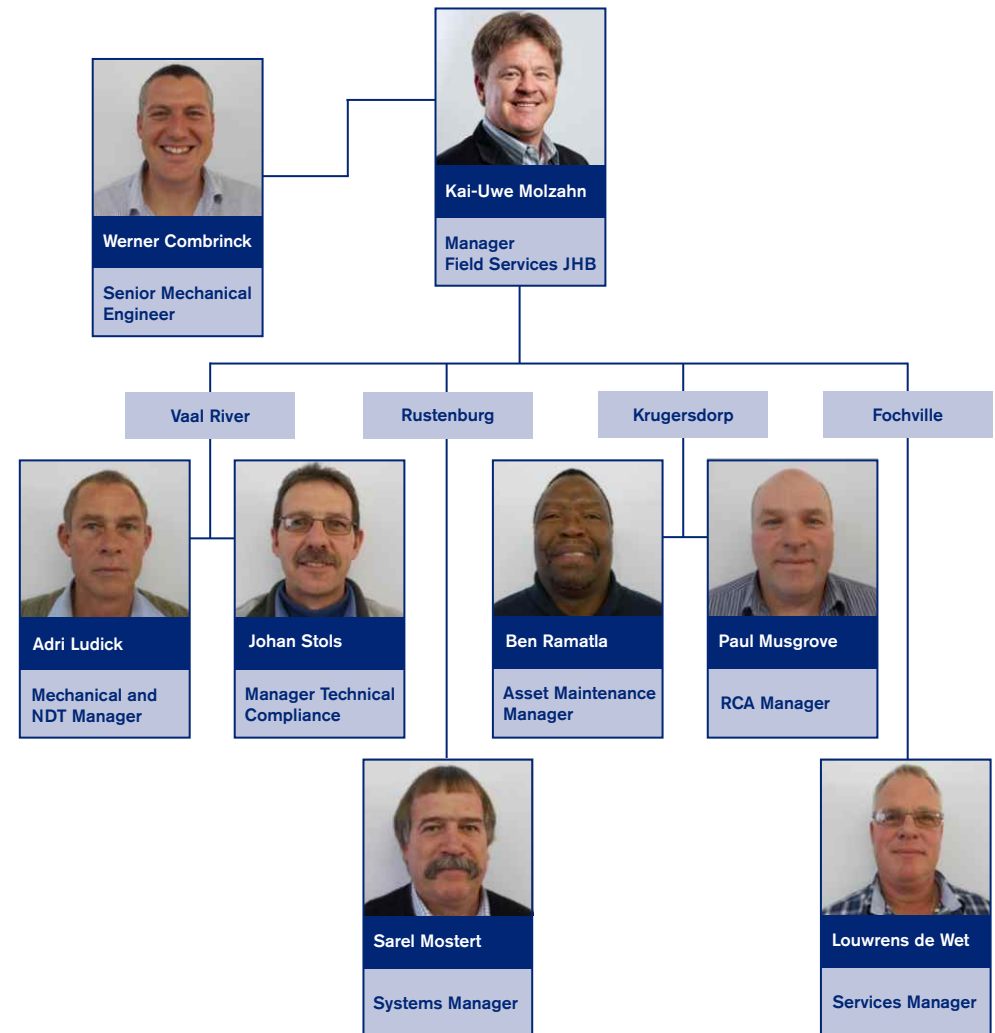
Who do I contact?

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FIELD SERVICES

Field Services plays a significant role in reducing safety and operational risks. We support operations with specialised and multidisciplinary services and resources; identifying and mitigating risks associated with safety and production critical equipment. Our highly skilled and experienced inspectors are on call 24/7.



ROPE CONDITION ASSESSMENTS (RCA): NAMDEB AND TABLE MOUNTAIN AERIAL CABLEWAY

- Non-destructive rope inspections
- Risk mitigation
- Maintenance of safety-critical equipment



Overview and Benefits

Rope condition assessment (RCA) is done as a legal requirement, stipulated in the SANS 10293:1996 Code of Practice for Steel Wire Ropes.

Regular RCA ensures the safe and economic operation of ropes installed on safety-critical equipment including:

- mine winders, chairlifts, incline winders, shaft rope guides
- elevators, flare/stack stay ropes
- stacker/reclaimers and belt wagons.

It has also proven invaluable for rope manufacturers as part of their quality assessment (QA) process at the final closure of new ropes.



Namdeb

RCA inspections improved safety at a Namdeb shallow-water inshore diamond mine. The tests were carried out on the aerial rope way system (ARS).

- The ARS transfers people and supplies from the shore to the probe drill platform (PDP), mounted in the seabed.
- The inshore project operates in a harsh environment with a high moisture and salt content, requiring annual rope condition assessments.

Aerial cableway ropes assessed by Field Services



Cape Town's Table Mountain aerial cableway

Regular RCA inspections are conducted on the Table Mountain aerial cableway.

- The aerial cableway conveys people and supplies up and down Table Mountain.
- The cable car is one of the Western Cape's major tourist attractions.
- The cableway comprises a haul, a heel and track-ropes.
- The haul rope operates from the bottom of the mountain and the heel rope from the top of the mountain.
- The haul and heel-ropes are magnetically tested with the rope passing through the test head, at a stationary point at the bottom and the top of the mountain, respectively.
- The cable cars are run on stationary track ropes.
- To inspect and magnetically test the stationary track ropes, Field Services' RCA inspectors travel in a small man carriage behind the cable car, on top of the track ropes, with the test heads passing over the track ropes.
- Normally the haul and heel ropes are assessed every six months and the track ropes every two years, the frequency of the assessments may increase as the condition of the ropes starts to deteriorate.

ROPE CONDITION ASSESSMENTS (RCA): NAMDEB AND TABLE MOUNTAIN AERIAL CABLEWAY continued



Location

Anglo American operations in South Africa, AngloGold Ashanti, Harmony, Sasol, Lonmin, Xstrata, Rio Tinto, Vedanta and Scaw, off-shore oil rigs, marine cranes, funiculars and Cape Town cableway.



Team

Paul Musgrove: manager RCA; Jaco Pretorius, Rynhardt Smit, Anthony Ehrke, senior machinery inspectors; Roger Henwood, Bafana Radebe and Nico du Plessis, machinery inspectors.



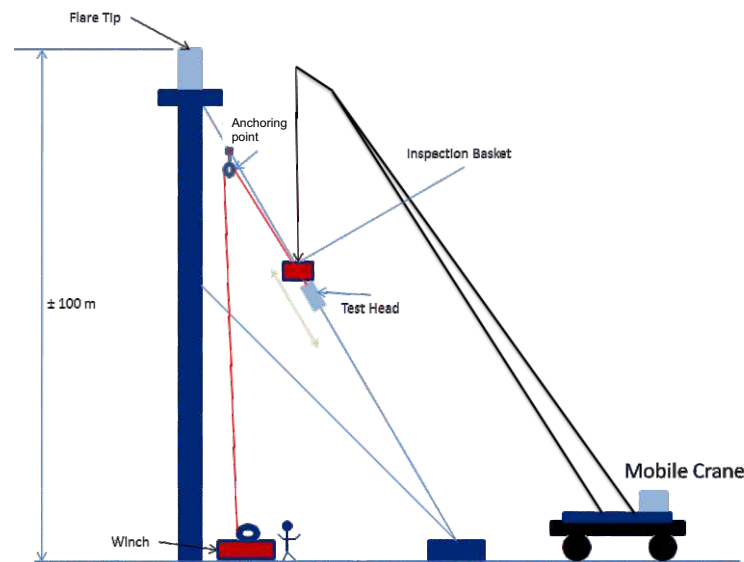
Client feedback

Eino Pinehas: project engineer, Strategic projects, Namdeb

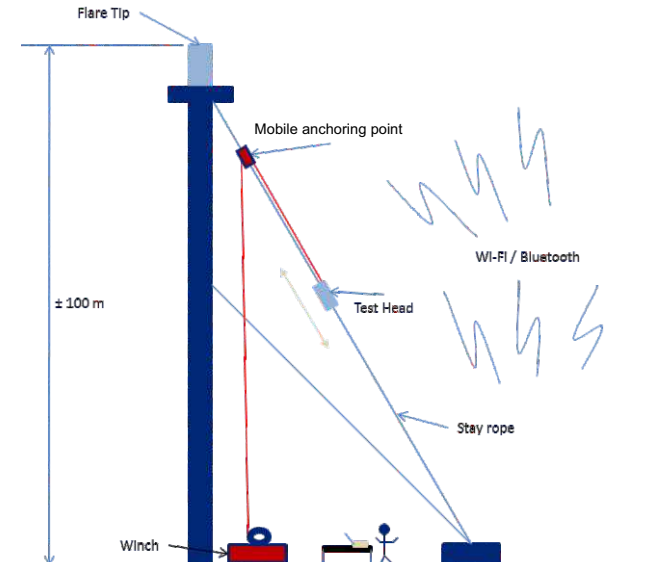
"Field Services' rope condition assessments offer an effective method to ensure that our ropes are not compromised. Due to the environment in which we operate bi-annual RCAs are essential for maintenance and safety."

Ongoing improvements

Technical Solutions: Field Services', in collaboration with an external partner, has developed a mobile anchoring point (MAP), for use during flare rope inspections. Field Services is also expanding its capability to include RCA on dragline and shovel ropes.



Current method for testing stay ropes



Innovation: The mobile anchoring point (MAP) – new method for testing stay ropes

SAFETY AND PRODUCTION

Technical Solutions: Field Services' newly developed rope testing equipment and techniques meet the legal requirements, stipulated in the SANS 10293:1996, and will benefit safety and production.

Who do I contact?

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UNDERGROUND ENVIRONMENTAL MONITORING SYSTEM (EMS)

- Innovation keeping pace with increased risks of growing production demands
- Improved management of underground fire risks



Overview and benefits

As a detection and early warning system of possible fires the benefits of the underground EMS include:

- a single sensor detects all possible hazards – smoke; CO; CO₂; methane; air velocity, etc.
- on-board processing capability – the sensors themselves set off audible and visual warnings
- provides control room operators rapid access to processed data
- continuous improvement via online analytics
- increased security features



Team

The system was developed by Technical Solutions: Field Services in collaboration with Thermal Coal and third party suppliers.

The EMS system is a 2013 Applaud Award nominee in both the Partnership and Innovation categories. The nominated team is Raymond Wright (Field Services), Aven Rajah and Gerhard Bester (Thermal Coal).



Location

Approximately 70 sensors were implemented for on-site trial at Zibulo colliery, located in return airways of all production areas and additional areas.



Data management

- Third party suppliers provide cutting-edge sensors, detectors, state-of-the-art communication and user-friendly interface graphics
- “Manage by alarms” system supplies data to alert possible incidents as, or before, they occur
- Continuous improvement via online analytics
- Quick access data includes:
 - status of the gasses under measurement
 - warnings/alarms of any abnormality and pre-defined reports
 - automatic daily emails and access to trends for analysis of circumstances leading up to an event.



Client feedback

Gerhard Bester, the technical superintendent at Zibulo colliery, said:

“It’s a great improvement on what we had before. It is far more user friendly and it alerts us when the sensors need to go for calibration. That all makes maintenance far easier and more effective.”

David Kgoboko, general manager at Morupule Coal mine said:

“This is fantastic and I would like to encourage you to keep up the good work. Underground EMS is absolutely crucial to us and it is good to see it being rated the best amongst other Anglo American coal mines”.

UNDERGROUND ENVIRONMENTAL MONITORING SYSTEM (EMS) continued

- Multi-function sensors
- High speed data
- 2013 Applaud Award nominee

Ongoing improvements

Sensors

- Replacing P16 (measures air velocity, CO, methane and temperature), and the S16 (metal oxide semiconductor (MOS), CO and temperature) with the P50 (measures CO; CO₂; O; CH₄; MOS; air velocity; volatile organic compounds (VOC); temperature; barometric pressure and humidity).

Upgraded wireless connection

- Long-term internal battery supply with short-recharge cycle times

SCADA (Supervisory Control and Data Acquisition)

- Auto-configuration when the SCADA detects a new sensor installed on the network
- Improved dashboards reporting tools

Implementation

On completion of the trial at Zibulo, aimed for December 2013, the system will be available for all global operations.



The limited technology of first generation sensors (AerView and AerView II)

Worked on preparatory designed telemetry system resulting in slow communication, via power cable, from underground to surface control room.

Only able to do detection on one source, ie one source per sensor; a smoke sensor, CO sensor, methane sensor, air velocity, etc.

No built-in intelligence. The sensors were limited to providing an analogue output proportionate to their designed source of detection. All signals were sent to surface for processing and possible alarming on the surface computer.

All alarming underground was controlled from surface processing and accomplished with separate equipment for audio, and for visual alarms.

Was not a recognised or widely used industry standard, therefore the number of suppliers was limited.

No local display to indicate its current reading.

System was stand-alone and could not be integrated into other systems.

Cutting-edge technology of new generation sensors (new EMS solution)

Works on a high speed digital communications system: RS485, Modbus, Ethernet, Local Area Network (LAN)

Has the capability of detecting multiple sources. A single sensor detects all possible hazards: smoke; CO; CO₂; methane; air velocity, etc.

Built-in intelligence has the capability to determine possible alarm incident on-board without the need for processing on surface. Internal diagnostics can help to diagnose the source and/or cause of the fault.

Does not require alarming from surface. Sensors have built-in audio and visual capability and internal alarm processing.

Known and widely used industry standard, therefore opens the Group to a wide variety of suppliers for sensors. This increases opportunities and partnership with Supply Chain.

Local display on the sensor for real-time readout of all the values of detection.

Able to integrate into other systems, eg air velocity readings automatically cutting power to continuous miner (a separate system) to prevent cutting when the air flow falls below allowable limits.



Cost avoidance

The Goedehoop Hope Shaft fire of 2004 cost approximately \$80 million. Today, a fire under the same circumstances would cost in excess of \$130 million. Fortunately, no lives were lost in the 2004 fire. EMS will enhance the safety of our underground operations.

Who do I contact?

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COMPLIANCE

Compliance promotes operational and technical excellence through risk identification and corrective action implementation. Our areas of specialisation include: geological, metallurgical accounting and laboratory reviews; international and Group Technical Standards compliance; manufacturing certified reference material; density determination techniques; and quality management systems.



Susan Dry

**Manager
Compliance**



Busisiwe Mtotywa

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Proficiency
Testing and CRM
Certification**



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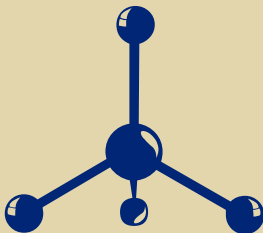
NEW DENSITY DETERMINATION TECHNIQUE — THE COREPYC

- An industry first for density measurement
- Reduced bias in grade and tonnage estimates



Overview and benefits

The CorePyc is a novel instrument that addresses the inherent problems and limitations related to conventional density measurement techniques.



Density plays a major role in the economics of the mining industry, particularly in resource estimation. Poor density measurements can lead to significant biases in grade and tonnage estimates.

Key components influenced by density factors include:

- life of mine planning
- waste handling
- stripping and dilution.

The benefits of the CorePyc include:

- accuracy and reduced bias
- exceptionally precise ($<0.1\%$ relative standard deviation)
- sample material remains completely intact during the analysis
- improved sample representivity and reduced sampling errors
- strict quality control procedures developed and implemented
- traceability to international standards
- working range from $1.3\text{--}6.4\text{g/cm}^3$.

Applications

The CorePyc is suitable for the measurement of:

- drill cores (from 280mm whole PQ (85mm in diameter) up to 1m whole NQ core (48mm in diameter))
- reverse circulation chips, rocks and most other types of mineral samples or crushed material, including metallurgical research and plant material.

Ore types tested include: iron, platinum, copper, coal, niobium, phosphate, kimberlite, etc.



Implementation

The CorePyc has gone into commercial production and it is expected that the new technique will significantly impact improved density determinations in the mining industry.



Team

The CorePyc has been developed by Technical Solutions: Compliance in partnership with an external supplier. Team members include Susan Dry, Jerry Pelo and Musa Sukwana.

Inherent problems and limitations in current techniques:

Density measurement techniques have changed little over time and basic displacement methods are used to determine the volume of drill cores.

Current problems and limitations include:

- operator dependency
- sample preparation issues
- fragile or broken samples
- small or non-representative sample portions
- porous or soluble materials.

Who do I contact?

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