

# **Implementation of Truck Dispatch using GPS at New Vaal Colliery**

**N.P. Lothering**

Section Manager, New Vaal Colliery

**G.J. Stenzel**

Assistant Manager, New Vaal Colliery

## **SYNOPSIS**

The controlling of production equipment in opencast strip mines has traditionally been done manually and changes were made by either visual inspections or verbal instructions. The drive to develop and promote productivity created the opportunity for more sophisticated systems to be investigated.

Although computerised systems have been in use for some time by metalliferous mines, New Vaal Colliery was the first Anglo mine to negotiate a system which would automatically consider a wide range of variables, calculate possible configurations and then rearrange strategies to deliver coal at a predetermined quality and at ultimate utilisation.

This paper simplistically describes the implementation, safety advantages and integration with existing systems of the Dispatch Computerised Truck Allocation System at New Vaal Colliery.

## **INTRODUCTION**

New Vaal Colliery, a division of Anglo Operations Limited, is situated approximately 70 km south of Johannesburg, immediately south of Vereeniging on the Free State bank of the Vaal River.

The mine was conceived and designed in the early eighties and encompassed a number of unique parameters. The most significant is the very low quality of coal (with specific reference to the calorific value and ash content) which has to be extracted from

three different coal seams previously mined by underground method, using a common ramp system.

New Vaal Colliery is a large opencast strip mine contracted to supply 15,12 million sales tons of coal annually to Eskom's 3600 MW Lethabo Power Station. The coal delivered to the power station must conform to the following quality parameters on an air-dried contaminated basis.

<b>PARAMETER</b>	<b>RANGE</b>	<b>BASE VALUE</b>
Calorific Value	15,00-17,00 MJ/kg	16,0
Ash Content	27,00-41,00%	37,5
Volatile Matter	16,00-23,00%	19,5
Total Moisture	07,00-15,00%	12,5
Abrasiveness	130 – 800	450

The coalfield ranges, for calorific value, from 13-20 MJ/kg (air-dried) and ash content from 34-44%. It is therefore necessary to blend the different coal seams to ensure the proper operation of the colliery as well as meeting the aforementioned qualities.

Coal is mined from all three coal seams simultaneously and blending was done with a manual system with its own inherent problems.

It was therefore decided to investigate alternate methods of quality control with the concomitant benefit of optimizing the equipment

## **TRUCK DISPATCH AT NEW VAAL COLLIERY**

### **PROJECT OVERVIEW**

#### *Audit and Time Study*

New Vaal Colliery has been in production for ten years and as part of their re-evaluation programme, an audit and time study was done to determine the efficiency of selected operations. The study on the utilisation of the coal hauling fleet indicated that an investigation had to be done to examine means of improving the performance of the fleet.

## *Investigation*

An independent contractor was contracted to do an investigation into the reasons for the poor utilisation of the fleet. Through a simulation model of the pit, they concluded that under-utilisation was largely due to the queuing time at the tip, shovels, maintenance and refueling bays.

## *Analysis*

The report was analysed and the decision was taken to install a system that would monitor, control and limit queuing at the aforementioned locations. Several options were investigated and the decision was taken to install a system that would not only improve the utilisation of equipment, but also control various other variables in the mining environment.

An order was placed to supply a complete computerised Dispatch System including a Global Positioning System (GPS).

## *Objectives of Dispatch*

### *Safety*

- Vital Signs

Vital Signs are any digital or analog signal transmitted by a component or group of components, indicating the status of such electronic devices. Dispatch allows the continuous monitoring of up to 16 analog and 16 digital signals, warning the dispatcher of a specific high or low reading on any one of the signals. The decision was made to initially monitor five vital signs only and at a later stage investigate the feasibility of increasing this number. At present, the following vital signs are being monitored:

- √ Engine saver
- √ Electrical hours
- √ Mechanical hours

The monitoring of vital signs pre-warns of any defective condition arising and theoretically minimises the possibility

of electrical or mechanical failure, increasing safety conditions and preventing the loss of components.

- **Emergency Button**

An emergency button has been installed on all Operator Interface Panels (OIP) which allows the operator to summon assistance in case of an emergency. If for any reason an operator has no verbal communication with the control room, or due to an accident he is unable to communicate verbally, pressing of the emergency button will display an emergency warning on the dispatcher's console. The dispatcher will run a GPS Find on the machine and dispatch a supervisor to the machine. (In the case where the GPS antenna has been damaged, the GPS will give a last known GPS beacon location).

- **Monotony**

Before the Dispatch system was installed, trucks were always assigned to specific shovels for the full shift. This created a monotonous cycle where the same operator traveled the same route eight hours a day and possibly six days a week. Dispatch recalculates qualities and tonnages and constantly dispatches trucks to different locations as required. This ensures that a truck operator may be loading at all shovels in the course of a shift. This has some obvious advantages.

- **Safety Broadcasts**

Dispatch allows the broadcasting of safety tips or messages to either individual machines or the total fleet. The standard procedure for Safety Campaigns ensures that a full safety broadcast is done on Dispatch and all radio channels daily to ensure that pertinent matters are observed by all employees. Operators can for example be warned of poor road or weather conditions, or an operator can individually be notified to rectify sub-standard behaviour.

- **Operator Breaks**

Dispatch allows operators to have breaks on request during

their shift. Dispatch schedules breaks should not overlap and have more than one machine on stop at any one time. Due to the nature of the shifts, these breaks are only taken on the back shifts.

### ***Quality Control***

The objective of quality control is to eliminate the peaks and lows in the quality variance curve and supply a constant quality coal. The washing plant therefore does not have to rapidly change its parameters to maintain the correct quality sales coal.

One of the single most important functions of Dispatch is to control the blending of coal to achieve a sales product at a CV of 16 MJ/kg on an air dried basis in parcels of 600 000 tons.

The configuration of the software allows Dispatch to accommodate the loading and blending of coal from three coal seams and nine coal shovels over a seven-kilometer pit.

New Vaal Colliery supplies 600 000 ton consignments of coal to Lethabo Power Station, each consisting of 12 sub-consignments of 50 000 tons. Dispatch constantly monitors both the sub-consignment and consignment tons and qualities to ensure that the final sub brings the consignment in at the predetermined value of 16,0 MJ/kg (AD).

In summary, the communication sequence is as follows:

- Dispatch reads the coal qualities, sub-consignment tonnage and present feedrate from the plant using the MultiLink interface.
- Dispatch considers the status of shovels and trucks, the qualities of coal available at the Ready shovels and the position of the trucks relative to the tip and shovels. Trucks in the vicinity of shovels will not be re-dispatched until they have tipped their loads and request a new assignment.
- Dispatch will consider all the above parameters, run a simulation and dispatch trucks optimally in order to achieve the required grade of coal.

It is important to note that Dispatch attempts to deliver coal at the correct quality to the tip with minimal washing. If the predetermined quality can not be delivered to the tip due to any quality constraint, Dispatch will notify the dispatcher accordingly, and in addition suggest alternatives such as:

- Change pre-set qualities
- Wash a percentage of the coal
- Move shovels to alternative faces
- Standby some shovels, etc.

### ***Production***

The principle of Dispatch is to maximise run-of-mine production with the available equipment at a predetermined quality or alternatively achieve a desired production rate using the minimum equipment.

### ***Productivity***

The rationalization of departments, together with the increase in production, will in time increase the productivity of the colliery.

### ***Utilisation of Equipment***

In principle it means that the same work can be done with less machines or that more work can be done with the same amount of equipment.

### ***Maintenance and Refueling***

Both the maintenance and refueling can be handled automatically by Dispatch. The intervals and frequency of services can be entered into Dispatch, who will then request permission to assign machines for service (daily, weekly, monthly or major). The refueling can be handled by assigning trucks on a time or a fuel schedule.

Assigning trucks on a fuel schedule allows Dispatch to monitor the fuel consumption of the trucks at pre-configured values (running at different gradients, loaded and empty) and requests permission to assign a truck to the refueling bay when there is only a specified number of liters left. Assigning trucks on a time schedule allows Dispatch to request permission to assign a truck to the refueling

bay when there is a specified number of operating hours left, calculated from predetermined running hours per tank of fuel.

### *Supervision*

Due to the fact that Dispatch is constantly monitoring the movement and status of equipment, supervisors have more time to attend to problematic areas and minimising operational delays in the workplace.

### *Evaluation of Equipment*

A visit was scheduled by MMS engineers to evaluate the trucks and shovels and discuss the installation of the equipment.

The placing of masts and antennas was crucial (i.e. so as not to obstruct the vision of operators and to allow them free access into the cab). Extensive research was done to ensure radio reception throughout the pit, dictating the position of repeater masts.

### *Final Configuration*

New Vaal Colliery, together with the suppliers and contractors extensively discussed the configuration to customise the software requirements for the system. New Vaal decided to involve the operators and get their commitment by allowing them to be part of the project team. The operators appointed representatives, their project being to discuss and recommend the OIP layout. One of the major issues regarding the layout was to determine whether the buttons should be iconised or not as there are still some illiterate operators employed by the colliery. Interesting is the fact that even the illiterate operators opted not to have iconised buttons, committing themselves to learn the layout and operation of the panel. In order to assist these operators, the buttons were placed in chronological order to allow them free usage of the system. Although Dispatch using GPS does not require manual operation to run the system, the decision was taken to manually operate the system to allow operators to understand the principle.

### *Control Room Modifications*

On the recommendation of other mines utilising Dispatch systems,

it was decided to set the control room up where there would be no visual contact with the mining operation. Experience has shown this to be critical, as dispatchers tend to run the operation from visual observations rather than allow Dispatch to do its normal algorithmic calculations. New Vaal decided to establish the Dispatch control room in the mining office block as it would not only satisfy the above requirements, but also make Dispatch easily accessible to all supervisors. The involvement of everyone was felt to be important, especially during the commissioning stage of the system.

### *Workshop Preparation*

During previous installations on other mines, Dispatch equipment was used in the course of other normal operations (i.e. conduit, masts, brackets etc). New Vaal established a complete lockable workshop in addition to a lock-up bay where the bulk of the hardware was kept. Only contractor and supplier technicians had access to these areas to ensure reasonable security.

### *Arrival of Hardware*

The arrival of the hardware was delayed due to a harbour strike, but the installation of equipment was ahead of schedule due to a well-prepared workshop.

### *Installation of Hardware*

Some problems were initially encountered with the installation of the hardware, as it became apparent that masts and transponders could not be installed where it was originally planned. The proposed areas made it impossible for operators to gain safe access to their cabs and also limited their vision with regard to the rear view mirrors. This emphasises the importance of involving both the operators and engineers in the initial evaluation of the equipment.

### *Configuration of Software*

Before the configuration of the software was completed, the communication between Dispatch and the machines was checked to ensure proper reception throughout the pit. It was imperative to have the repeater operational as soon as possible to allow time for alternative arrangements if reception was poor. The original repeater location was therefore

moved to the top of the discard silo however, communication problems were still being encountered one month after commissioning. Passive repeaters were installed in strategic positions, which solved the problem, not only in the North Pit but also in the rest of the pit. (The repeater has since been moved to an area that is centrally situated for the life-of-mine reserve). During the period while the software was being downloaded from MMS, debugging of truck and shovel systems was completed.

### *Acceptance of Software*

After completion of the initial software configuration, a list of outstanding requests and items was compiled and submitted with the Take-Over Certificate. The Take-Over Certificate was signed after Dispatch was successfully operating 24 hours a day.

## **Project Planning**

### *Project Preparation*

The decision was taken to involve NUM and a delegation of operators in the decision making on pertinent issues of Dispatch.

The delegation participated actively in these meetings, but when technical matters were discussed became bored, as they had no interest and understanding of the technicalities concerning computer hardware and software configurations. It was then agreed to have special meetings, which they attended to discuss operational matters only.

After operational problems were resolved, presentations were made to all operators in order to introduce them to the system with particular reference to its operation and the relative advantages thereof.

As a follow-up, group meetings were scheduled but were unsuccessful, as operators tended to discuss operational problems rather than Dispatch issues. Individual on-the-job discussions proved to be fruitful as operators were uninhibited in their comments and concerns, providing positive feedback, which was implemented to improve the operation of the system.

As part of the preparations, New Vaal Colliery was afforded the opportunity to visit both Sishen Iron Ore Mine and Jwaneng Diamond Mine by courtesy of their management in order to introduce our operators and other staff to the Truck Dispatch System. The information, both technical and operational gained from these mines was invaluable with almost 50% of our operators having the opportunity to see a system in operation. All these operators spent a morning on the Dispatch machines, allowing them to discuss the operation, advantages, disadvantages and any other concerns they may have had in complete confidentiality with other operators.

One of the main concerns was that Dispatch would be used as a disciplinary tool, but the positive attitude of the Sishen operators ensured that our operators left with a clear perception that this was not the case.

The knowledge and impressions of the New Vaal operators were used to promote Dispatch, which resulted in advanced acceptance, by all other operators.

### *Project Implementation*

From the outset, the decision was taken to involve the operators throughout the project, from the initial planning phase to the final implementation of the system.

From the time of modifications to the Dispatch control room, operators were encouraged to visit as frequently as possible to allow the operators to grow with the system. This proved to be a success.

The hardware was installed on the machines with no prior briefing to the operators. Curiosity made them inquire about the nature and function of the equipment installed and when this would be operational. This illustrated the commitment and interest of operators in the system.

Once the hardware and software were installed, training commenced to ensure proper operation of the system when commissioned. Operators, dispatchers and controllers were all trained simultaneously in the Dispatch control room to allow everyone to freely observe the effect that their actions would have on one another.

The integration with interfaces was written into the software and will be discussed later.

Although most operations can be monitored from the Dispatch control room, visual contact with the coal tipping area is still required to ensure that spillage or other obstructions do not interfere with the coaling operation.

A remote video system was installed to allow the dispatcher visual observation of the area, and also to monitor the level of the tipping bins. An added benefit is that the zoom and rotation facility of the camera can also be used to monitor other mining operations across the mine.

### **Progress Monitoring**

The progress of the Dispatch is being monitored by comparing statistics on daily and monthly intervals. The period of monitoring included six months before Dispatch to allow a full history comparison.

This period includes the following phases:

- the original system
- the hot seat changeover which was introduced two months immediately before Dispatch
- the commissioning stage of Dispatch
- the transition period into Dispatch
- full Dispatch implementation

Modular recommended that Dispatch performance be measured by TKPH (ton kilometer per hour) hauled. These statistics are however not available in the old system and it was decided to use the following parameters to monitor and compare performance:

#### *Production Monitoring*

Production is being monitored by comparing the total material moved per truck hour (coal, overburden, parting, ash and discard).

#### *Machine Monitoring*

In the short-term the mechanical and electrical hours are monitored on all the diesel equipment. The mechanical hours being the engine hours and the electrical hours the wheel motor hours. The electrical hours are expressed as a percentage of the mechanical hours and referred to as the use of utilisation. In the longer term it is envisaged that Dispatch will reflect an improvement in this statistic due to less idling time.

### *Quality Control*

As mentioned before, a comparison is being made on the variance curve of qualities to determine whether the quality control by Dispatch can minimise the peaks and lows in the curve.

### **Integration of Interfaces**

Although Dispatch is a self-contained unit, it was necessary to integrate some of our existing systems with Dispatch.

#### *Interface with LAN*

The interface with the LAN is necessary as all other interfaces are linked through the stack switch to Dispatch.

#### *Interface with MIMS*

MIMS is an Anglo recognised program tool which monitors and records machine performance and costing. Dispatch is used to provide MIMS with the breakdowns in a format acceptable to MIMS on a daily basis. Before the commissioning of Dispatch, breakdown information had to be recorded manually into MIMS on a daily basis.

This function is now being performed automatically by Dispatch in 25% of the time normally taken. The sequence of breakdown events with Dispatch is:

#### ■ Dispatch Equipment

An operator will enter a Dispatch breakdown code into the system. If the artisan on his inspection finds a different type of breakdown, the new code will overwrite the previous and the final report is

printed to MIMS. This also allows for full machine costing.

## ■ Non-Dispatch Equipment

Breakdowns on non-Dispatch equipment will be entered manually into Dispatch by the controller. Once a breakdown has been entered, Dispatch will handle it as though it was Dispatch equipment.

Every time a breakdown is recorded into Dispatch, a job card is automatically generated and placed in a printer queue. MIMS imports this job card and allocates a MIMS job card number to it to allow for the costing of machines.

A complete revised copy of the Dispatch Breakdown Report is downloaded into the printer queue daily. MIMS uploads this file and translates this into its database. It is crucial to ensure that colloquial names in both Dispatch and MIMS correspond to allow full and complete interface between the systems.

### *Interface with Gradecon*

Due to the fact that the effective operation of Dispatch depends largely on the quality control of the coal, it is imperative to have the correct qualities of working faces available to Dispatch. In the old system, the quality of individual faces was entered daily into a spreadsheet used for calculating the loading plan. Presently, the geologist edits the Gradecon data, adds contamination and downloads this file into Dispatch. Dispatch updates the database, recalculates the required qualities and redirects trucks to obtain the required sales CV. The downloading of the Gradecon file is easy and allows for qualities to be updated on an hourly basis if so required.

If Dispatch cannot make the required grade of coal from the available Gradecon quality, it may require the plant to wash a certain percentage of the feed. Alternatively it can suggest the stopping or moving of shovels, or ultimately to lower the minimum acceptable quality.

In order to minimise the manual input into Dispatch, a system is being developed whereby a shovel is instructed to accept the quality of any block within a 50m radius. The pit layout provides for coal blocks 100m x 40m. Each block has been given a centre co-

ordinate from where the shovel will read the qualities.

### *Interface with MultiLink*

As mentioned before, Dispatch not only considers the quality and tonnage of each sub-consignment, but also that of the consignment. Dispatch attempts to deliver each sub at a CV of 16 with the final consignment having a point variance of less than 2.

The plant writes the progressive quality and tonnage for the sub and the consignment at two-hourly intervals to an ASCII file.

Dispatch then recalculates all these parameters and variables and re-dispatches trucks to different shovels and locations to maintain the contract CV.

### **Outstanding Issues to be Solved**

At present a blending schedule is in place which is operational and effectively being applied. A system is presently being implemented which will allow New Vaal to be able to monitor more details, such as tons stacked out, tons reclaimed and percentage of coal to be washed. Some outstanding issues still have to be solved regarding the interfacing of detailed information between MultiLink and Dispatch.

### **Progress to Date**

Dispatch has proved itself financially as well as operationally. The benefits of Dispatch are far reaching and can not be measured in money terms only. Some of the operational benefits are:

- Safety      Due to safety measures such as:
  - √ emergency buttons
  - √ vital sign monitoring
  - √ safety broadcasts
  - √ operator breaks
  - √ monotony of loading in the same face

Operators are more conscious of the environment

they work in and of Management's commitment to their wellbeing. Truck accidents have reduced from 22 in 1994 to 14 in 1996 year-to-date.

- Increased Supervision  
Production supervisors now spend more time attending to problematic areas instead of supervising trucks. The ability of Dispatch to display operations in real time on the network allows supervisors from both the production and engineering disciplines to monitor the performance of equipment on a continuous basis.
- Attendance  
Time keeping has improved due to the fact that Dispatch records the presence of each operator as they log onto their machines.
- Simulations  
The simulation module in Dispatch has improved the efficiency of planning functions drastically. Any possible scenario can be created from where Dispatch will simulate the result of any such cases.
- Management  
Dispatch proved to be a great management tool. Although it is not used as a disciplinary tool, justice was done in various cases of equipment damage where the guilty party could be identified by extracting dot traces of equipment involved during the time of the accident.
- Accuracy  
The status of machines is constantly being monitored and

recorded which allows for the minimum distortion of statistics by mining and engineering disciplines. Due to the login and logoff facility available in the Dispatch system, the sequence of any event can be reconstructed to the nearest second if so required.

- Labour Reduced by 11 people
- Trucks Reduced by 2 trucks at current production levels
- Tons per Wheel Motor Hour Increased by 63,7 tons per wheel motor hour
- Queuing Time Reduced by 2,57 hours per truck per day
- Service Bay Congestion Improvement of 3,2 hours per day for total fleet
- Consistency Consignment improvement on average of 0,11 MJ/kg per consignment
- Diesel Total saving of 19,22% of F95 budget (before Dispatch)
- Machine Costs Saving of R18,00 per truck running hour for the period under review

## CONCLUSION

The planning and implementation of the project in retrospect was as important as the operation of the system itself. Minor detail such as the machine panel layout and the acceptance of the system by the operators proved to have been critical to the success of the system. By courtesy of Sishen Iron Ore Mine and Jwaneng Diamond Mine, we were able to introduce the system to more

than 50% of our machine operators - allowing them to see a system in operation and discuss issues with the other operators.

Dispatch is a system worth considering at any mine producing large tonnages of coal at set parameters. The system is a self-contained unit, which has the ability to either monitor and archive machine and production statistics and costs, or be integrated into existing systems. It is a highly cost-effective system which was proven at New Vaal Colliery by reducing the payback period from the original 19 months to a mere 4 months (in working cost only).

## **RECOMMENDATIONS**

The Project Leader should be a person of high standing who is knowledgeable on the operation of the mine and its people as it is often required to draw on resources not readily available to the average person. Such a person should have above average relation skills, with both lower and upper structures and be able to negotiate successfully. The ability to meet deadlines on projects is of paramount importance.

After approval of a new Dispatch system, close liaison should be maintained with other mines running successful systems to discuss details pertaining to the organisation, planning and installation of the system.

A Dispatch Administrator must be selected well in advance of the commissioning to ensure continuity of the software configuration. Such a person should preferably have Unix experience but must definitely be computer literate.

Care must be taken to ensure that statistics that will be used to compare the before Dispatch and after Dispatch performances are available. The original New Vaal contract stated that Dispatch guarantees a 5% improvement in the TKPH. These figures were never available in the Before Dispatch era and alternative means had to be used to prove the feasibility of the system.

## **ACKNOWLEDGEMENTS**

The author wishes to thank the management of Anglo Operations Limited for permission to prepare and present this paper.