QMASTOR©: A Tool for Quality Management and Stockpile Tracking

Don Cameron

Meeting customer specifications, avoiding financial penalties and maximising profits are key issues in exporting coal. This article describes an innovative technique utilising differential global position system (DGPS) technology for the management of coal quality through stockpile and blending operations.

The application of DGPS is novel, yet practical, and potentially serviceable within and beyond the coal industry.

Introduction
On the one hand, the coal industry must grapple with a chemically complex and heterogeneous mineral and, on the other, meet buyers’ contracts which typically specify multiple quality parameters. Inability to meet these specifications results in either severe financial penalties or consignment rejection. To ensure contract specifications are met within acceptable tolerances, the whole coal industry is geared to an intensive sampling and analysis cycle through exploration, production and ultimately ship loading. This cycle provides data on specific parcels of product and allows for judicious blending of different quality parameters.

Unfortunately, when many parcels of coal of different qualities are stockpiled together, quality definition within the stockpile is blurred. The parcels may be distinctly different, but they look the same - black. QMASTOR© (quality management and stockpile tracking optimisation routine) is a quality management and stockpile tracking system which solves the previously intractable problem of maintaining quality profiles of stockpiles during stacking out and reclamation activities. The system provides a real-time inventory status which allows proactive quality scheduling and alleviates the need for expensive downstream sampling and analysis.

Objectives of the QMASTOR© System
QMASTOR© was designed in response to a need for a stockpile management system at BHP Coal’s Port Kembla Number 4 stockpile area. Fig. 1 shows typical truck and front-end loader operations at Number 4 stockpile.

The need for the system at BHP arises from the complexity of the processes operating at that site. Factors include:
- three washeries, operating as individual production units feeding the stockpile area,
- the storage of up to 20 coal types,
- residence time on the stockpile area is variable depending on shipping time and coal type: it can be up to 12 months, with numerous incremental additions/orfakes during this period,
Stockpiling and reclaiming is performed on an 'as needs' basis and does not follow a routine schedule, the stockpile pad area consists of numerous smaller stockpiles, client cargoes normally consist of a complex and finely-balanced blend from numerous stockpiles.

**Design objectives**

This complex nature of coal movements, primarily performed by a mobile fleet, demanded an innovative solution to the problem of tracking quality. A superior materials management system was required to optimise stockpile usage, reduce operating costs and provide a real-time quality data management and planning facility. Specifically QMASTOR® needed to:

- provide an automated, real-time monitoring system for the accurate location of the heavy equipment used on the stockpiles, from which the location of coal parcels could be interpolated,
- develop a zonal stockpile model which collated coal position data, delivery tonnage and quality information, whilst retaining live reporting capabilities,
- generate a reclamation system to meet shipping schedule quality requirements,
- provide an economic optimisation routine to 'profit maximise' the blend,
- display 'real time' stockpile and machinery status,
- reduce the need for downstream sampling and analysis, and
- develop a tonnage reconciliation system to balance stockpile inputs and outputs.

The conceptual configuration of the QMASTOR® system is shown in Fig. 3. These needs were met by:

- developing a differential GPS configuration for locating the heavy equipment on stockpile. Accuracy requirements dictated the application of DGPS but, in addition, there was also a requirement for polling of multiple working vehicle positions. A solution was custom built,
- developing a radio telemetry system to transmit vehicle positions (coal parcel locations) to a central computer,
- multi-tasking various proprietary and customised software programs to create a tool to collect, sort, store and report data and interpolations and ultimately maintain a 'live' stockpile quality and tonnage model,
- development of an economic optimisation program (C++) which finds the optimum blend of reclaimed coals from all available stockpile zones to match up to 13 quality parameters specified by the customer,
- employing a hand-held or vehicle-mounted GPS unit to accurately survey stockpiles on a regular and as needs basis in order to efficiently reconcile inputs and outputs.

The hand-held GPS unit is shown in Fig. 4 attached to the QMASTOR® vehicle used for perimeter and stockpile volume surveying.

**QMASTOR® interface with BHP management**

The QMASTOR® base station and central computer are located at CCI’s offices, some 2.7 km from Number 4 area. CCI manages the system and is responsible for maintaining all stockpile inventories, preparing blending and cargo assembly recommendations and providing all information required by BHP to make production management decisions on the distribution of clean coal.
Access to the QMASTOR® system is available to BHP via a dial-up link.

Implementation
The implementation process confronted many challenges. Not all of them were technical. Of particular note was the complex communications telemetry. Since satellite signals, vehicle poll requests and two-way radio signals between base and loaders were being conducted through a common radio system, synchronisation of this traffic was a major issue. A solution emerged through employing a novel piggyback modem set-up. Fig. 5 shows the installation of radio and GPS equipment in a front-end loader.

The implementation phase of QMASTOR® began over 12 months ago with the purchase and installation of the DGPS and computer hardware. The correlation between shipment and QMASTOR® predicted shipment analysis is well within analysis tolerance and allows Collieries Division to proactively plan delivery schedules for future shipments. Downstream sampling has been reduced by some 65%, and is likely to be eliminated totally in the future.

Conclusions
QMASTOR® has provided a quality tracking solution through BHP’s clean coal stockpiling operations where none existed previously. It allows for the accurate prediction of the quality of reclaimed coal, thus meeting the challenge posed by divergent customer specifications. Not only are financial penalties avoided, but each cargo is ‘profit maximised’ through the economic optimisation routine.

Foreknowledge of reclaimed coal quality facilitates several cost reduction elements. Downstream sampling and analysis are reduced. Direct loading of coal from washery product bins to port can be considered because the other blend components will be accurately predicted. Transportation costs can be significantly reduced since coal need not be cycled through Number 4 area.

The ancillary benefits of QMASTOR® include the powerful supervisory and trouble-shooting tool provided by real-time equipment monitoring and the capacity to retrospectively play back previous loader operating shifts.

The system provides confidence in stockpile quantities resident in Number 4 area, and is an indispensable tool for reconciling production operations and verifying the performance of process weightometers and truck weighbridges which measure stockpile inputs and outputs. The system offers a cost efficient kinematic stockpile survey method which can be used daily if required.

Acknowledgments
The author wishes to acknowledge the contribution to QMASTOR®’s development provided by Leica Instruments Pty Limited and the various sub-contractors who provided essential components. BHP Coal Collieries Division, BHP Steel Flat Products Division and BHP Engineering personnel gave freely of their time and knowledge during the development process. South Coast Equipment personnel provided important services during the development, and their on-going involvement in the project is appreciated. CCI Holdings Ltd provided the environment and encouragement necessary to complete this project.

Don Cameron is Director of Carbon Consulting International Pty Ltd (CCI).