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An integrated mine development and supply system

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INTRODUCTION

In the face of intense global competition and other business pressures on coal miners, ongoing quality initiatives and continuous process improvements are needed to enhance business performance. By viewing a minesite in terms of key processes, rather then departments, and employing innovative technologies and better applying organisational resources, there exists enormous potential to achieve reductions in process cost and time.

The paper identifies and selects one critical coal mining process, namely the supply system, to think about how productivity improvements might occur and what changes might be employed to enhance overall system performance. While the supply system is only one of few processes existing at a minesite, the paper addresses only the supply process, but includes interaction across traditional interdepartmental boundaries. The paper has been prepared for a wide audience and is based on experience and observation at several underground mines however some of the concepts are a result of "dreaming" in the face of global competition.

BACKGROUND

Brambles Coal Services (BCS) has conducted a review into the potential for improvement of the supply and materials handling functions of thirty underground coal mines. The review identified some of the issues that adversely affect underground coal mining operations as follows:

1. development advance rates must satisfy longwall production;
2. unreliable supply infrastructure to support development can affect the ability to improve metres advance rate;
3. internal resources are stretched and not able to consistently address effective process improvement issues;
4. employees focus on tonnes with limited regard for cost control; and
5. some minesites are not fully aware of the root causes of the problems resident in their logistics processes and therefore no strategy improvement formulation or implementation is occurring

A significant number of respondents made comments that related to operational logistics and ineffective activities in the supply chain. Table 1 lists some high ranked problems that pertain directly to existing mine supply systems.

While every mine is unique, with individual / specific issues and needs, BCS has proposed a flexible Underground Supply System (USS) solution that can be tailored to a particular minesite. The USS is not directed toward issues of labour relations, mine conditions, equipment availability and panel layout, but rather applies to supply logistics and materials handling issues.

Brambles Coal Services, Newcastle

Table 1 – Typical mine site observations / problems / issues pertaining directly to existing mine supply systems

- Coordination of deliveries (stock control and double handling) issues;
- Minimum bulk handling of high usage items: stonedust, salt, diesel, soluble oil, ballast, concrete;
- Wastage: damaged pallets, broken drums, torn bags, gear returned to surface is trashed;
- Increasing requirement for greater quantities of stone dust spreading underground;
- Desire for "cassette" type storage / transport of strata support materials;
- Transport cycle times significant and increasing;
- High demand on Eimco's for underground materials handling;
- Foreign materials in coal stream (timber, packaging, steel); and
- Injury potential due to manually handling of strata control material

UNDERGROUND SUPPLY SYSTEMS

General

The Brambles Coal Services USS is not just another efficiency project that can be dumped on a minesite. It is an activity based process that delivers customer value and provides a mechanism to achieve regular overall process improvements. The primary objectives of the USS are to increase mining advance rates and reduce the cost per metre/tonne of mined coal, by addressing and improving minesite supply logistics. It is recognised that to succeed in the analysis and implementation of any solution a partnership relationship is required between BCS and the mine such that the proposed processes changes can be effectively designed and implemented and then have performance measures applied.

Approach

Analysis initially involves a joint understanding of operational activities, progressing through an assessment of specific issues that inhibit performance improvement due to inefficient supply and materials handling. An integrated solution based on the elements of the USS follows the joint party analysis that involves all organisational departments.

The framework given in Fig 1 is indicative of the staged approach of the analysis. The framework forms the basis of the supply system continuous improvement program, highlighting the need to understand the process activities, identify critical areas for review and measure progress against predefined performance indicators. A benefit analysis designed to provide a comparison between the present system and its associated costs, and the new integrated process solution and its associated costs, is also developed, such that potential savings can be quantified.

Fig 1 provides a framework to study the entire supply chain from a supplier's facility to the point of use at the min Typical areas that may be considered include:

- Planning and monitoring individual processes / procedures;
- Ordering and reordering processes (how are they communicated?);
- Supplier's packaging methodologies;

- Transport to minesite;
- Interaction / communication between supplier and minesite;
- Receival procedures at minesite;
- Surface handling / rehandling methodology at minesite;
- Storage facilities (bulk and otherwise);
- Materials transfer from surface to end user (including end user waste and the minimisation of double handling and manual transfer of supplies);
- Relationship between materials handling and people injuries;

High cost / usage materials must be studied within the context of individual supply chains, then studied with a more holistic view. Synergies in the management areas of, ordering format, receival procedures, storage, handling, packaging, transfer methods, damage and wastage should also be considered.

It is imperative that the supply system be viewed as a process and not in terms of departments, such that redesign from beginning to end, employing whatever innovative technologies and organisational resources necessary, can occur. The overall project is timetabled generally as follows:

1. Design (prepare functional specifications);
2. Project Management of the new process (follow through the functional specification and schedule tasks);
3. Training and document preparation for users;
4. Equipment installation (hardware);
5. Commission system (hardware and systems) ; and
6. Ongoing review and ongoing improvement (against performance measures).

While this sounds like significant effort, the framework, when applied to a defined timetable, leads to a planned and integrated solution that will lead to waste reduction, reduced injury, better utilization of resources, predictability and ultimately lower cost per tonne. For example the recent benefit analysis highlighted areas where implementation of a proposed USS at a single mine provided an ongoing financial benefit of 7.3 million dollars per annum in addition to intangible benefits like:

- Reduction in heavy vehicle movements over travel roads by 144 000 kilometres;
- Five percent improvement of wastage / damage;
- Improved safety in material handling;
- Enhanced performance measurement in panels;
- Potential to improve development rates without additional labour; and
- Improvement of planning and control of materials, people and machines both underground and on the surface.

Materials Flow

The materials flow schematic proposed at for high usage/cost items is given in Fig 2. The system involves an off-site store where strata control cassettes are salvaged, cleaned and refilled. The off-site store also prepackages conveyor belting and structure, pipes and fittings, hoses and mining cables such that these items are delivered to the central on-site store, in a manner where they can go directly underground. The central on-site store area is designed to support high usage mining consumables, while minimising disposable packaging that traditionally enters the coal production stream. In addition to the central store area, the minesite surface supports a main store that supplies traditional items such as, engineering spare parts and consumables, plus a bulk materials storage facility. Bulk minesite surface stored items including oils, stonedust, ballast, diesel and cement powder are supported by bulk supply underground transport equipment that is custom built to suit unique minesite conditions. Stonedust, ballast and concrete enter the mine through strategically located boreholes where they can be delivered close to the point of usage, again utilising custom built underground transport equipment.

The minesite materials flow depicted in Fig 2 supports an underground storage area for cassette rehandling however the activity is surplus for mines that have direct vehicle access from the surface. Delivery of supplies from the underground store is by custom built transport equipment, that mechanically interfaces with development and longwall mining equipment.

Information flow and the enablers for process improvement

While the materials flow diagram forms the basis of what is seen physically on site, it is the enablers of process improvement (process procedures, mechanical designs, computer based control) that provide a holistic approach to integrate all of the supply and material handling activities.

Process procedures means a functional specification detailing exacting process requirements and how information flows across and between various mine departments and to suppliers. Mechanical designs means tailor made engineered equipment that allows for effective distribution of supplies. Computer based control means establishment of an integrated information technology platform that links all mine departments, to provide a legitimate management information system that supports supply logistics.

The desire to build information systems across functional boundaries is not new and there are many examples of cross functional information technology "solutions" that never florished. In addition, there exists many minesite examples where information technology "solutions" failed or simply did not perform. Given this scenario, it is fundamental to understand what process procedures and computer based control means, at minesite level. Graham (1972) indicated that innovation in the use of information technology and communication must be combined with how information is used and structured. Graham's observation of the systems analyst, who had responsibility for designing computer applications, was first expected to redesign the process. As with the USS, one must focus on an agreed functional specification that addresses the differing needs for information, from all users, prior to the application of information technology.

Information flow depicted in Fig 3, and the subsequent management of that information is the basis of a successful USS. Information flows freely across and within departments to the key planning areas via a centralised communication facility. The forward planning ability of each production unit helps in the coordination between supply (includes the supplier, off-site store, on-site store) and production departments to allow for effective transport coordination and prioritising of value chain activities. The purchasing department has a through knowledge of current and forecast activities as opposed to having to rely on intuition and historical performance data alone.

Fig 4 represents the integrated information technology solution that supports the USS. It is built around the jointly generated functional specification and includes the following philosophies:

1. It is a holistic approach covering the entire supply and material handling aspects across all departments. It includes the three process enablers of process procedures, mechanical designs and computer based control;

2. Supply process is driven by panel performance;

3 Containerisation of supplies / materials;

4. Off-site cassette restocking;

5. Bulk handling of materials / ballast, stonedust;

6. Integrated surface material handling through a centralised facility

7. Underground transfer facility for interim storage of some materials (only necessary at some mines);

8. Mechanical reprovisioning of continuous miners;

9. Data communications to panels and longwall;

10. Delivery scheduling;

11. Interface and shared information with existing surface computing facilities.

The ability to receive performance data from production panels will not only drive the supply function, but allows for geological information, machine availabilities and the measurement of other production based performance indicators.

CONCLUSION

The USS is an activity based process built on a framework of continuous improvement. It involves a holistic approach that cuts through inter-departmental barriers in order to not only formulate a supply strategy, but to redesign the entire mine supply process, then implement the process and effectively monitor its process.

While every mine has some unique characteristics, the USS provides a flexible solution that can be tailored to a respective minesite. USS implementation can be efficiently timetabled in six overlapping stages, namely, design of the functional specification, project management, training, installation, commissioning and ongoing review.

The USS is but one of a few key processes on a minesite, and its implementation can provide both positive tangable and intangible outcomes that lead to a lower cost per metre advance or tonne of coal.

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