MANOEUVRING THE MOATS

Spanning the Mining Execution Value Chain

Submitted to:

The 2008 IQPC Conference on MINE HAULAGE

Author:

Karel Gilliland
Managing Director
MinLog Pty (Ltd)

tel: +27 (0)12 345-6325
email: karelg@minlog.co.za

ABSTRACT

There can be no doubt as to the impact made by computerised systems on operational efficiency in the mining industry over the past two decades. Whilst significant progress has been made with regards to the equipment process at an enterprise level, surprisingly little progress has been made at an operational level.

It is common practice today for a central control room operator to manage the primary production fleet of a mine, via a fleet management system which controls the activity of the load and haul fleet. This maximises fleet availability and utilisation, as well as efficiency, whilst managing production tonnage and grade targets. Other examples of process level automation include medium and short term planning, as well as the control of a fixed mining plant via a centralised SCADA system. In a similar fashion, more and more operations are using enterprise resource planning systems to plan, automate and optimise the mining supply chain on an enterprise level.

However, when it comes to automating or optimising across business channels, the mining industry is lagging behind. Terms like 'silos of automation', are often used to refer to the lack of integration across the mining execution value chain. The requirement for 'one version of the truth' is commonly expressed to indicate the need for aligning disciplines such as production, engineering and quality. 'Bridging the gap' is a phrase that was coined with regards to the divide between the production and enterprise levels. All of these phrases relate to the absence of a Mining Execution System on an operational level. This paper looks at this absence with a specific focus on the concerns for load and haul activities on the process level.

Considering an underground mechanised operation, we find that should the face activities not be synchronised, or if the incline conveyors not be considered, the haulage activities on the tramming level will be restrained. Similarly, in an open-pit scenario, it is not uncommon to find a short term plan for the week to be outdated by day two, resulting in sub-optimal recovery and in some instances, in the throttling of production in order to achieve the required blend for the consignment.

It is therefore argued that unless the operation is managed from an operational level perspective, through the introduction of the Mining Execution System, the goal of managing and optimising across the execution value chain, as well as aligning the executional and enterprise environments, will remain elusive.

INTRODUCTION

In medieval times a moat was considered a 'very important feature of a castle that made the practice of mining, in regards to digging tunnels under their fortifications in order to cause their collapse, very difficult.'

Considering our modern day mining environment, it is not uncommon to find moats surrounding the business process, forming part of the mining value chain. These moats are typically the result of a lack of integration between systems facilitating the different business processes and disciplines on a mine.

This paper serves to motivate that the mentioned lack of integration across the process level of the mining execution value chain, has a direct impact on the process level of efficiency, as far as it concerns load and haul activities, even if managed by a modern fleet management system.

For those of us who have been to an early morning production meeting, where mining equipment availability, utilisation and tonnage and grade are argued, and where the load and haul plan is agreed to for the next production cycle, you can sympathise with how difficult it is to look forward to these types of meetings.

Yet, considering that the root of the cause of all the arguments stemmed from the telephone call received from the plant manager at 3 am, with the blend of ore giving new meaning to the term flotation, we may be better equipped to understand the situation. How could this happen we ask, and how could it happen twice in one week? After all, the load and haul engineer sequenced his shovels in accordance with a short term plan. This plan was based on the medium term plan, and the medium term plan was based on the ore reserve. However, the ore reserve is only updated with the recent hole chippings on a three monthly basis, just before a new medium term plan is produced.

That is not to say that the information is not available before the shovels start loading.

Consider for a moment such an operation. The load and haul engineer receives a spreadsheet from the laboratory at the end of his day shift. For a moment he considers re-allocating his load and haul equipment, but since the short term schedule from the planning department states he has to load the material, and realising that the re-allocation of equipment will negatively impact tonnage, he does nothing. After all, the plan does say he must load the material. He debates discussing it with the planning engineer before the next

short term plan is compiled, but decides not to, as the concentrator will have learnt how to deal with the material by then.

If this does not sound unfamiliar, it is important to realise that by automating the flow of information between processes, much of the reliance on telephone calls or information being conveyed and understood correctly, would be eliminated.

THE MINING HIERARCHY

Before considering the impact on load and haul efficiencies on the process level due to the lack of a Mining Execution System on the operational level, we need to have an understanding of the mining and information technology hierarchies.

From a management perspective, the mining hierarchy of most operations can be represented comprising different layers, namely the equipment process, operations and enterprise levels (as depicted in figure 1).

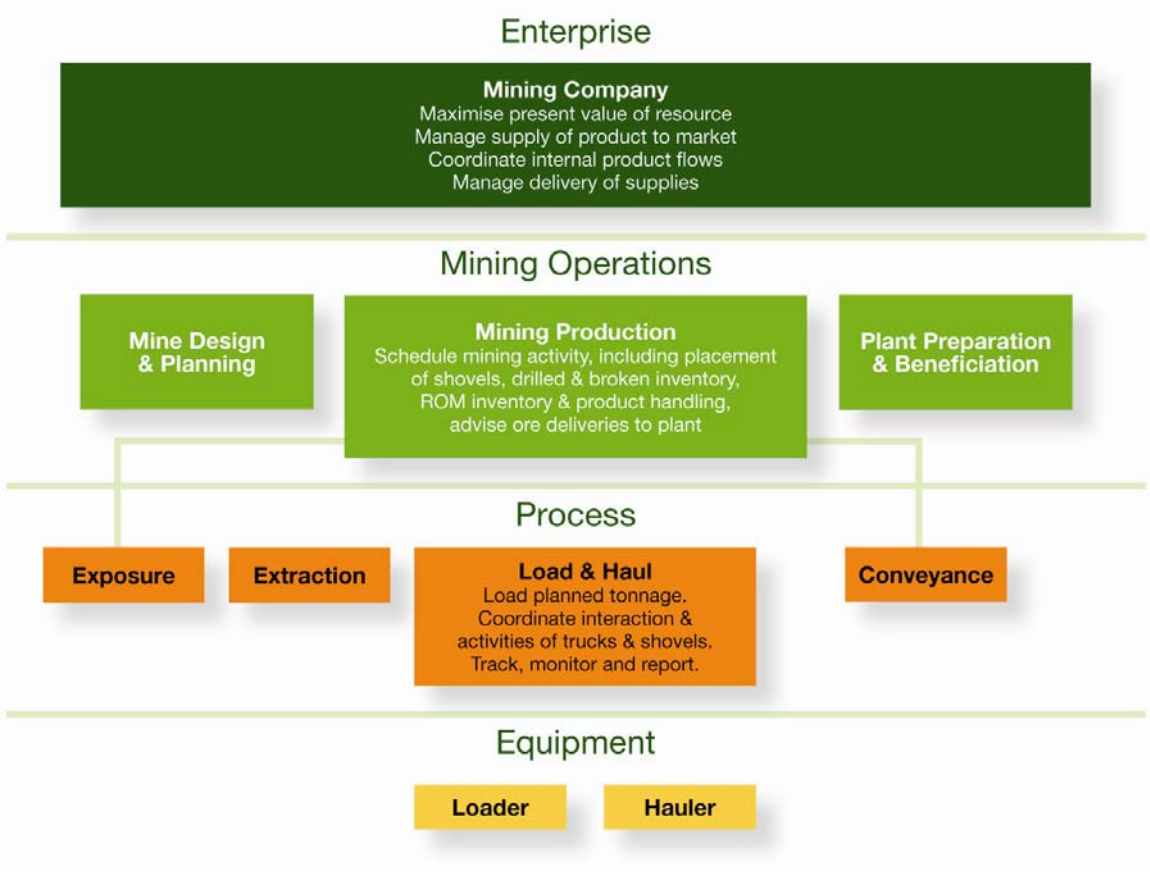

Figure 1: The mining hierarchy

The equipment level refers to the production unit, such as dozer cutting to design or build a dragline pad. The process level, in the context of mining production, provides for managing equipment in a coordinated fashion in order to achieve production targets. The operations level provides for monitoring and control across processes such as exposure, extraction, load and haul, conveyance and beneficiation. With the enterprise layer providing for the automation of the supply chain as well as equipment maintenance and product distribution.

THE IT HIERARCHY AND THE MINING EXECUTION VALUE CHAIN

Looking at the IT hierarchy from a mining execution chain perspective (as depicted in figure 2), the term automation on the equipment level, invokes images of tele-remote controlled LHDs, even haul trucks functioning in an autonomous mode, monitored from a control room located several kilometres from the mining area.

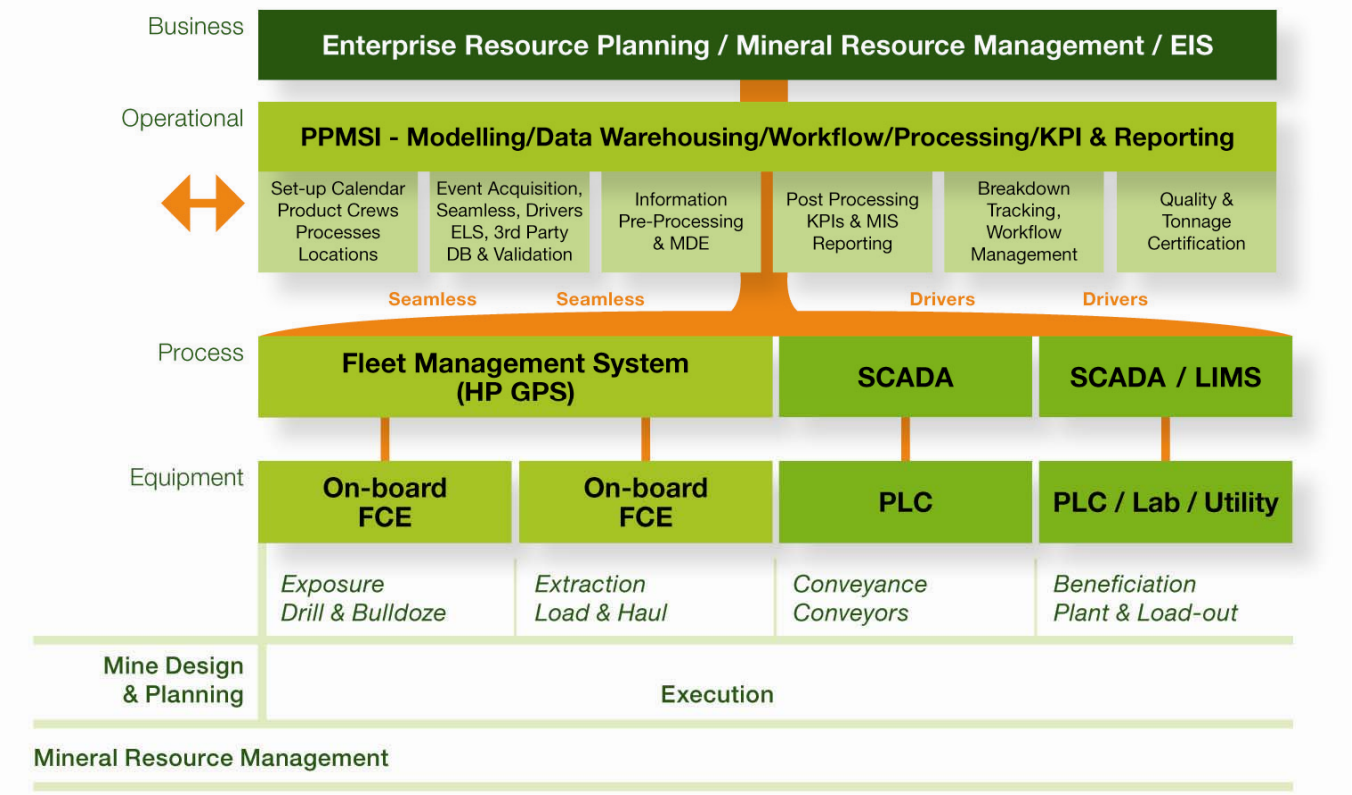

Figure 2: Mining Execution Value Chain

However, coordinating the equipment activities within a particular business process can be likened to herding CATs, unless the process level control system is in place.

Today we find ourselves in a position where various commercially available software packages and systems have automated much of the mining execution value chain on a process level with computerised truck dispatching systems. They also manage entire load and haul fleets, whilst complex plant processes are controlled to set points in the SCADA environment.

In a similar fashion, mines are also increasingly becoming automated at the enterprise level, with the implementation of enterprise resource planning systems automating the supply chain and inventory, as well as dispatching finished products.

Whilst significant progress has been made with regards to the equipment, process and enterprise levels, surprisingly little progress have been made in the mining industry on the operational level. This situation has resulted in one of the biggest challenges we face today, managing process boundaries and providing for a single management information system for all disciplines, as well as linking the process level to the enterprise level.

LOAD & HAUL IN THE CONTEXT OF THE OPERATION

In order to better understand the impact of not having a Mining Execution System in place at an operational level on the load and haul efficiencies, even with a fleet management system in place, let us consider for a moment a simplified underground mechanised operation (as depicted in figure 3).

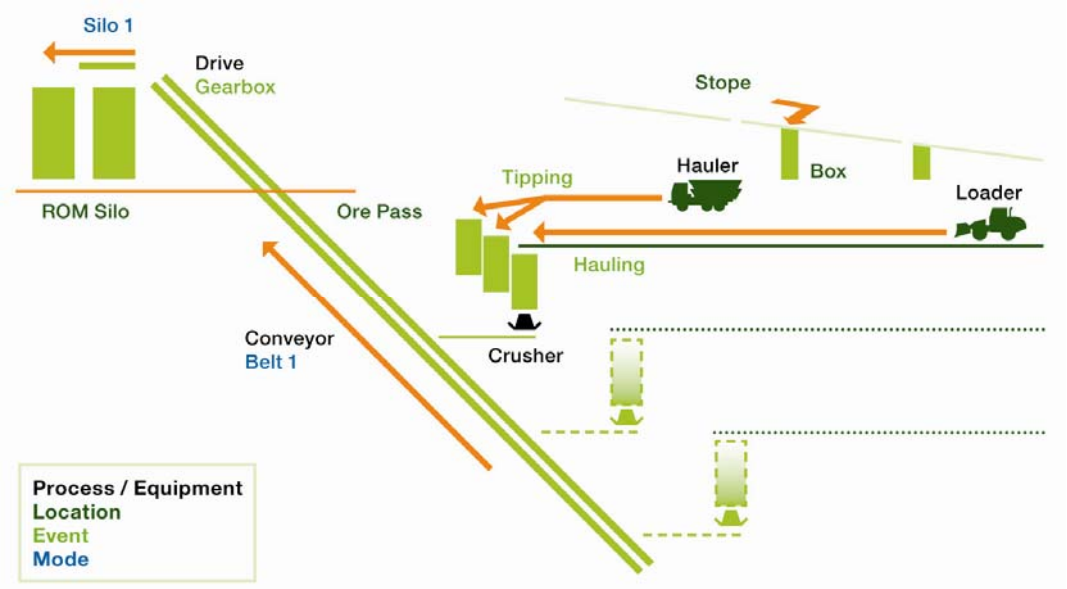

Figure 3: Simplified underground mechanised mining operation

It is clear in the first instance that extracting material from the face and moving it to the ROM location involves a combination of processes, comprising both a fixed and mobile plant.

In a situation where the peripheral processes interacting with the load and haul process are ignored, or where the various disciplines such as engineering and production generate information from different sources, the 7 am meeting will usually kick off arguments between engineering and production, as to the availability and utilisation of a fixed and mobile plant. Once availability and utilisation figures are agreed to, it now stands to be determined whether the stope activities took place as scheduled, and if so, whether the material was tipped into the stope box prior to, or after, the ADT arrived at the box. Furthermore, the production manager needs to assess whether the incline conveyor was operational at the time, since a full ore pass could have resulted in a chain reaction where the blast was lost.

Once production activity and the synchronisation of process levels have been cleared, the next challenge is to understand the material flow. Was the development end's waste tipped into the production ore pass, in which mode did the conveyors operate in, and what chutes discharged for conveyance to which ROM location?

Given the challenge of reaching consensus as far as the aforementioned is concerned, the production manager may decide to command an end to the arguments since the primary objective of the morning meeting is to schedule the next production cycle. This however also requires knowing which faces are available, making an assessment on the process of inventory, allocating product and grade and scheduling the equipment for the next production cycle.

From the above mentioned information, it is clear that not only does the lack of an operational level system result in the constraining of the load and haul activities, it also impacts on production, recovery and supply chain management. If we believe that these issues apply only to underground mechanised mines, let us consider an open pit operation from a process level perspective. Looking at the fleet management system on a process level which facilitates extraction as well as load and haul activities, we can define the objective of such a system to improve the availability, utilisation and efficiency of the primary production fleet. It is also possible to manage product flow from the face to ROM locations by means of allocating equipment to extraction, loading and tipping locations.

To this effect, the FMS comprises of server software and software utilities, as well as field computer equipment. This is installed on-board of primary production equipment that

communicates in real-time via a data communications backbone (Wireless LAN) with the FMS server.

Fleet management systems typically provide for numerous activities such as the tracking and allocation of equipment, the management of the equipment cycle and status, as well as the management of production flow and grade. They also provide for a host of KPIs to be reported in real time and at the end of period.

Though the process level in the open pit environment may be automated to a large extent through the implementation of fleet management systems, little has been done to automate the flow of information linking the processes together.

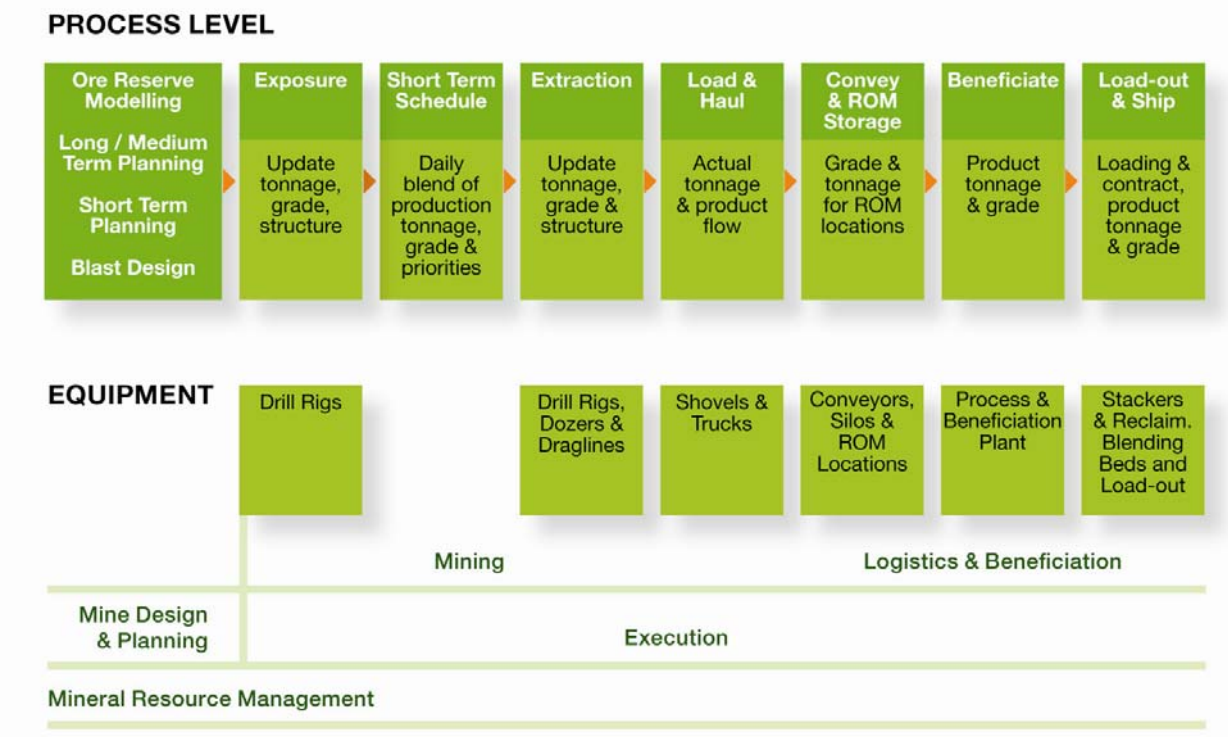

Figure 4: Mining Execution Process Flow

At most open pit mines, the load and haul engineer drives through the pit and then calls the concentrator before convening a meeting, where he will explain where the shovels and drills must operate, and what targets they must achieve for the next 24 hours.

This is for the most part, done without consideration for the up and down stream processes forming part of the execution value chain, rendering the fleet management system less effective; particularly if not applied in the context of the short term plan, inventory,

fragmentation, LIMS results, crusher state, and product handling constraints, stockpile grade and many other process level parameters.

MINING EXECUTION SYSTEMS

This leads us to the area of automation that has lagged behind the others in the mining industry. Termed the operational level, it is located between the enterprise and process levels and more specifically, targets the need for a Mining Execution System.

This then begs the question of how we:

- Span the process boundaries between planning, exposure, production, beneficiation and product distribution - 'Manoeuvre the moats'?

- 'Create one version of the truth,' by providing a single information base for disciplines such as engineering, production, planning and quality?

- 'Bridge the gap' by integrating the process level with the enterprise level systems, effecting vertical integration? and

- Provide for optimisation across the mining execution value chain?

In short, the requirement is for an MES to provide for the ability to model the mining execution value chain from an operational perspective, allowing the operation to track, monitor and manage product flow and equipment performances across process and disciplines. You also must allow for the automation of the flow of information between processes at the business unit level. This is referred to as horizontal integration, as well as the process between the process level and the enterprise level, termed vertical integration.

PUTTING THE PUZZLE TOGETHER

Prior to putting the puzzle together, the first question that springs to mind is why the mining industry has lagged behind other industries as far as IT hierarchy is concerned.

- The answer lies perhaps in the variability of the parameters governing the operational processes partied to transforming rock to salable product;

- Or perhaps in the fact that a 'bill of materials' for assembling product does not apply in this instance.

- On the other hand, it may be the fact that mining configuration is in a constant state of flux, not affording us the ability of working with a steady state process.

- One could also argue that it is due to the constant disturbances impacting the executional process.

For the above reasons, it is therefore no surprise that the mining industry cannot apply the traditional manufacturing execution systems solution to its unique environment.

Turning our attention to the conceptual architecture required for automation on the operational level, we note three distinct components.

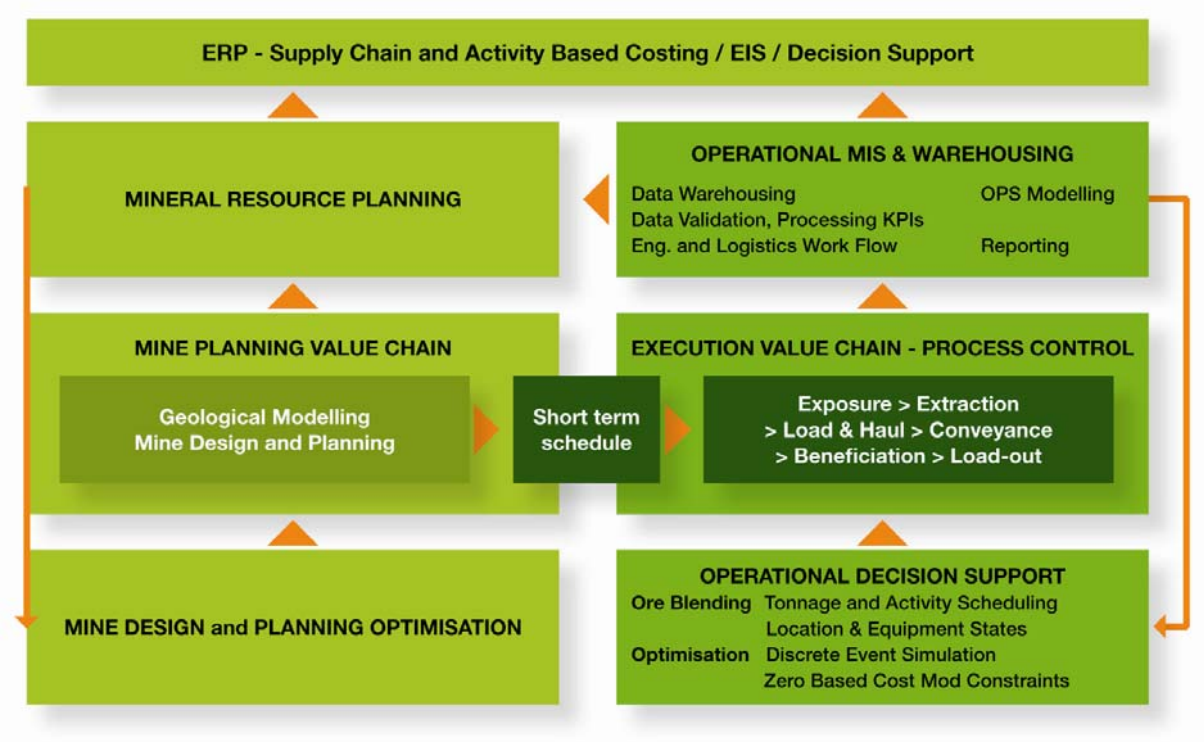

Figure 5: Mining Execution System

The first of these is the operational MIS and warehousing component, which provides for a single operational information base with the ability to do the following in a generic fashion:

- Model the operation with regards to mobile and fixed plant and processes.

- Provide for workflow and data validation.

- Provide for pre and post process data and information in a way that it can be utilised by management whilst also providing decision support with the required input.

A second component of the solution is the requirement to provide for ***information flow***. This can be effected in one or two ways. The first is to interface systems, resulting in outputs from one process that provides direct input to up or downstream processes. The second option is where all data is routed to a central repository, or data warehouse. Intuitively, the second is preferable because when it is combined with enterprise service bus architecture, it becomes possible to integrate rather than interface the best of the breed systems.

The third component of a Mining Execution System relates to decision support tools. Though decision support tools are already in existence at some mining operations, inputs are for the most, a means of manual data entry.

This will result in decisions being made based on outdated or incorrect information. Current decision support tools seldom provide for optimisation across the value chain, therefore optimising one process at the cost of another.

IMPLEMENTATION APPROACH FROM AN MES PERSPECTIVE

When considering the implementation approach for effecting an MES solution, it is important to follow a top down approach instead of falling into the trap of building a bottom up solution.

After an extended period of frustration in the 7 o’clock morning production meeting, it is easy to comprehend that most production managers will reach a saturation point when they will start to demand from the technical department, a solution which is too often expressed in terms of the 'how' to provide for the solution, rather than 'what' is required from the solution.

It is therefore not uncommon for the technical department to receive an instructed request that all production equipment needs to be tagged and tracked in order to monitor the operation.

Given the urgency of the requirement, it often results in a situation where such an initiative has not been budgeted for. This could lead to the technical department sourcing a local RFID supplier who knows a 'database expert' who is willing to configure a so-called pilot site. What normally starts off with a rapid progress, seldom fails to end in a store full of spare

parts that never served the need of production, but rather delivered the technical components demanded. So what are the alternatives you may ask?

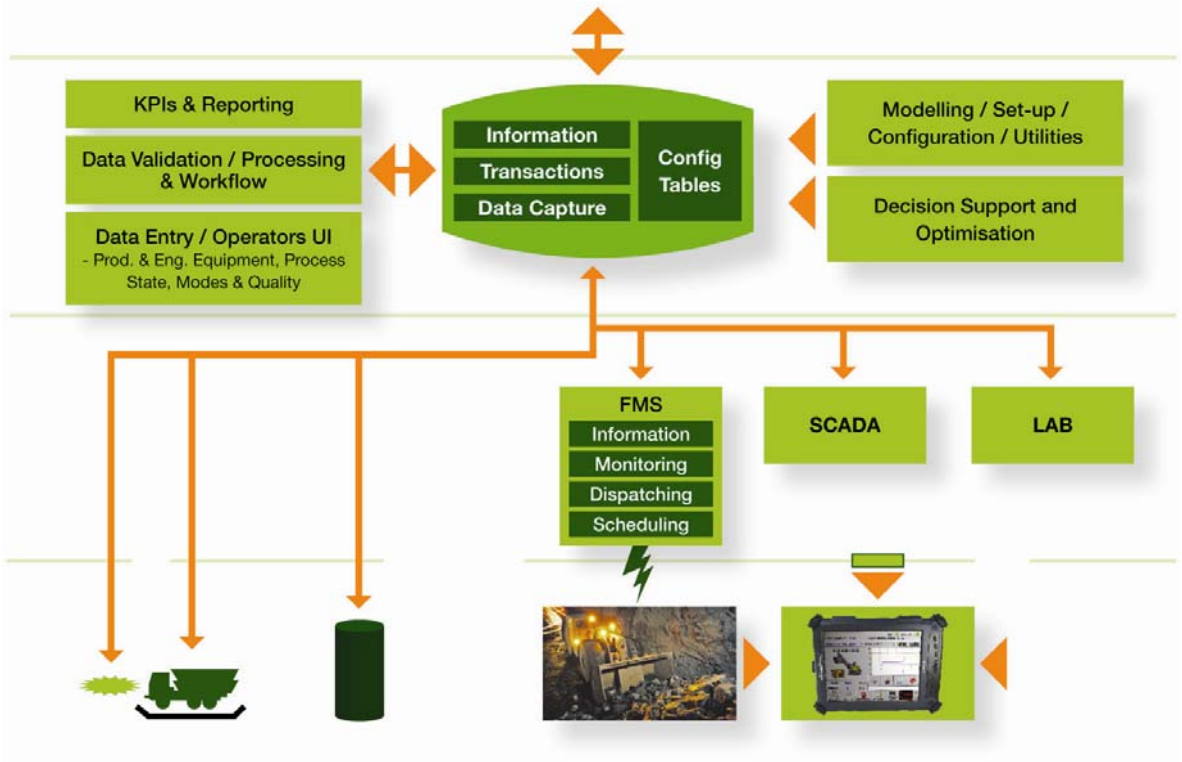

Figure 6: Operational, process and equipment level implementation

First and foremost an understanding is required of the operational process and product flow, addressing exposure, extraction, load and haul, conveyance and beneficiation in some instances. Next is understanding the KPIs to be reported for decision support to management and third party systems. Once the aforementioned has been defined, measurement points can be identified. With measurement points identified, related processes requiring modelling on such things as mode composition and hierarchy, as well as related production and engineering quality parameters, can all be defined.

Only once all of this has been determined, the data capturing options can be considered. In some instances, we may decide on manual data entry and this could take the form of entering tally sheets at the end of the shift.

Alternatively, data may be available via a third party system typically operating on the process level such as the SCADA system controlling the fixed plant and the LIMS system. Data could also be gathered by means of equipment level devices such as a weighbridge or reader at the tipping location. It could also be that the situation lends itself to the

implementation of a fully fledged fleet management system, which again needs to be configured keeping the MES requirement in mind.

Finally, having the equipment, process and operational layers of the IT hierarchy in place, decision support systems can be linked to the operational warehouse.

CONCLUSION

The universal driver in the mining industry is the need to reduce the cost per unit of product produced. This goal is also the key driver for the use of computing applications in the mining industry.

Though significant use of computers has long since been accepted as an unqualified contributor with regards to improving the mining business, we have seen that surprisingly little work has gone into the engineering of a system on the operational level. The result of this gap in the information hierarchy is reflected in silos of automation on the process level, as well as a disconnection with the enterprise resource planning systems.

This leads to sub optimal efficiencies, not only from an enterprise and operational perspective, but also from a process level perspective, impacting on load and haul efficiencies, amongst other things.

It is therefore concluded that unless a Mining Execution System approach is provided for on the operational level, optimising operations across the value chain will remain elusive.