The high-tech future

To stay competitive, companies must look to technology to improve efficiency, write John Jessop and Eduardo Gallestey

In the coming years technology convergence will allow innovative mining companies to not just survive, but prosper. Despite the tumult in the world today, the long-term outlook for all major mineral commodities remains positive.

As Western economies creep back toward growth and developing nations emerge, minerals will be critical to their success. To meet the expected demand, new mines, expansion of existing facilities and increased exploration are in the pipeline for most mining companies.

Unfortunately, responding to this opportunity is becoming more difficult as short-term price fluctuations and economic uncertainties make planning for growth more difficult. New ore reserves are more technically challenging to extract than at any other time in history – being located in either remote locations, politically charged regions, or both.

Business imperatives to improve performance and manage costs – combined with a chronic shortage of skilled labour, and on-going pressures to increase safety and reduce environmental impacts, all compound the difficulty of operating a mine. As a result, mining companies must look to innovative ways of leveraging technology to thrive in the face of all these challenges.

This is not the first time innovation has been needed to get a dramatic increase in productivity. The mining industry has already been through a number of technological step changes. For example, the gradual mechanisation of underground mining in the first half of the 20th century – including the development of conveyors, loading machines and drill rigs – dramatically increased tonnage per miner.

More recent advances, such as longwall mining, driverless trucks and developments in remote operations and control systems, are enabling today's miners to produce an order of magnitude more than their predecessors, with fewer workers and better safety than at any time in the past.

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LEAPS IN PRODUCTIVITY

Other industries, such as manufacturing, have made leaps in productivity and responsiveness through new technology, such as assembly lines, automation and 'just-in-time' methodologies. Elements of these concepts are now being investigated for their application in mining.

In this scenario, the 'mining factory' connects and orchestrates the production processes to optimise throughput and profitability based on ore-body quality variations, production capacity and market demand. Materials-handling is increasingly automated and new technologies enable continuous, rather than batch-based, processes. For example, the replacement of haul trucks and rails with in-pit crushing and conveying, and large overland conveying systems.

To support these greater levels of efficiency and automation, software and business processes need to transform alongside physical systems.

This change is taking the form of greater integration, visibility and 'intelligence' across operational technology (OT) production-control systems, information technology (IT) and the geotechnical information that manage the company's critical assets, logistics, planning and operations. The result will be unprecedented agility in response to changing conditions in the operations, and to both supply and demand fluctuations.

As the convergence of these areas of technology, IT and OT systems draw more and more information from real-time systems into software, there are four key areas that will enhance efficiency, responsiveness and profitability across the mining value chain:

- intelligent production;
- intelligent response to critical asset condition;
- demand-driven planning; and,
- reduced energy consumption and waste.

INTELLIGENT PRODUCTION

Production lines have a major bearing on overall productivity. If mining companies are able to optimise production functions precisely based on near real-time demand, market conditions and available ore types, they can achieve significant improvements.

Take, for example, the optimisation of dosing and flow rates. While many miners already have advanced process controls (APC) for automating the management of dosing and flow rates in real-time, most are unable to align this easily with the real-time conditions in the market.

For instance, miners are unable to connect information on relative product pricing, data on feed material and information from sales contracts, because this information is stored in disparate systems, often in a completely different unit from the control room operators.

With the convergence of business IT systems and process control OT, the APC system can refine the set points to maximise return for the current feed material and product pricing based on information from the sales system and global pricing index. The net result is that

miners are able to increase plant recovery and optimise the product mix based on market pricing.

INTELLIGENT RESPONSE

Failure of a critical production asset can have a catastrophic impact on a mining organisation's ability to meet heavy production targets.

Consider the failure of the main conveyor in a mine. That scenario could easily result in losses in production totalling hundreds of thousands of dollars per hour.

While a comprehensive asset management strategy, coupled with an enterprise asset management (EAM) system purpose-built for mining and regular inspections can go a long way to preventing such failures, miners need to leverage technology to take this process a step further.

As business IT and OT become easier to integrate, more real-time data on asset conditions will be available to streamline maintenance and enable condition-based monitoring. When business analytics are applied to this wealth of real-time data, miners can get insights into the real condition of these critical assets.

In the case of the above conveyor, if the temperature sensor were to detect an over-current condition, an alarm would be generated and the control system could slow the drive to reduce risk.

When integrated, these OT systems could connect directly into the IT systems without operator intervention and automatically raise a work order with the nearest crew.

Once the crew finishes the repair, the completion could be instantly reported, allowing the systems to be returned to normal in the shortest possible time.

The ability to apply predictive analytics to a combination of OT and IT data automates what would otherwise be a time-consuming process involving multiple decision-makers. Ultimately, condition-based monitoring makes high-reliability asset management more cost-effective. ►

"The difficulties associated with co-ordinating supply and demand across the mining value chain are well known"

Technology helps mining companies to optimise the workings of the whole value chain

Photo: Fortescue Metals

DEMAND-DRIVEN PLANNING

The difficulties associated with co-ordinating supply and demand across the mining value chain are well known. Many mining companies experience bottlenecks in their supply chains, which can delay deliveries. This, in turn, can lead to increased unit operating costs and reduced profitability.

The supply chain extends from the extraction of raw materials to the transport of products to the end customer. To reach production and productivity targets, mining companies need to achieve high operational performance and efficiency across supply chain.

Among the principal causes of supply chain bottlenecks are difficulties in inventory planning, output planning and demand forecasting. These challenges in marrying supply to demand often result in inefficient production flow, large stockpiles and not being able to provide customers with the product grades they desire.

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Conversely, better integration and automation across processing plant operations, mine planning and asset maintenance/management guarantees the right product is available at the right time. In addition, it ensures that equipment maintenance can be scheduled to minimise any loss in production, while maintaining the required level of availability.

What is required is a unified management view of data from business IT and OT systems that offers visibility into all production variables including delivery contracts (demand), current inventory, mine plans, equipment availability and transport schedules. To further anticipate demand, this information can be supplemented by market-based demand information such as stock levels, customer demand trends, fuel and commodity pricing.

In a coal-mining value chain, for instance, visibility into real-time conditions can be provided by online coal-quality analysis sensors. When these sensors discover that the actual blend deviates from the target blend, a control sequence could automatically be triggered.

This control sequence would use the inventory system and its data on the stockpile to realign the reclaimer's actions and correct the blend to meet the customer's specification. The result is production within specifications, with no penalties and guaranteed customer satisfaction.

This holistic view enables the full implications of short-term, medium-term or operation-recovery decisions to be understood, improving the overall performance of the entire operation.

REDUCED ENERGY CONSUMPTION

Energy efficiency fundamentally helps mining operations reduce costs. It can also help improve overall productivity and support compliance with environmental mandates.

Improvements in energy efficiency can be driven not only by improvements in mining processes and technologies, but also by greater visibility and process control across the value chain through information integration and process optimisation.

For example, more accurate and near real-time process control made possible by combining asset and flow-rate data with ore quality information can reduce energy consumed, while increasing overall throughput.

Technology convergence of IT and OT information can reduce energy demands in a number of ways. Examples include:

- understanding the energy profile of a site (where and how energy is used for extraction, conveying and hauling, and what opportunities exist for conservation or leveraging alternative energy sources);
- the ability to forecast energy requirements and schedule plant activities in relation to 'on-the-grid' energy demands and costs, so that energy-intensive activities take place at off-peak times when energy costs are lower;
- leveraging 'what-if' planning for completing energy-intensive production steps in order to maximise energy efficiency and reduce energy costs;
- ability to track and report on energy consumption for compliance purposes and/or as a baseline for energy efficiency programmes.

TECHNOLOGY-DRIVEN MINES

Perhaps the best and most visible example of these must-have benefits coming together is in the remote operations centre, designed to manage operations with minimal on-site supervisory intervention.

The ultimate success of these remote operations centres lies in their ability to control processes on-site and more importantly, to bring the key functions together into a single environment. The integration of IT and OT systems allows organisations to create a unified, highly collaborative enterprise that can be controlled remotely.

The combination of communication technologies with real-time input from sensors and logical devices deliver connectivity and data from the heart of the operations.

By applying information technologies, such as business intelligence, all of this data can be transformed into actionable insights and easily shared across key stakeholders.

While this integration is extremely high-value, many mining companies are struggling to achieve the results they desire due to the complexity of integrating their systems, data and operations.

To reduce cost and risk associated with moving to a connected architecture, companies will seek to implement open systems, while at the same time minimising the number of vendors in the ecosystem and relying on providers who offer the widest range of 'building blocks' for straightforward implementation and integrations.

This approach will reduce the time it takes from any investment to cover its costs, while ensuring that existing and future investments can add maximum value for the longest possible time.

The market is already starting to see this kind of technology confluence enable companies to make dramatic advancements. For example, an integrated power generation and coal mining company in Europe has made significant progress toward this vision.

Although a relatively simple scenario due to the short production cycle and easy processing and demand model, it represents the ultimate goal of future mining projects.

Mining organisations are different from any other industry. They experience extreme variability of conditions in the field that makes the monitoring, control and the artificial intelligence applied even more important to the success of these operations.

Next-generation technology (converging both IT and OT) provide the visibility and insights required to improve the power of the control operations, while integrating many operational 'silos' (drill-blast, load-haul, concentrator, smelter) that typify many mining operations today, enabling mining organisations to operate with a more complete and actionable view of their operations.

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