

Three major mining challenges and their technological solutions

by Fabio Mielli

The mining industry is a multifaceted industry with special characteristics that make efficient and intelligent operations uniquely challenging, and subsequently call for distinctive and tailored solutions. Not only does mining call for processes that are complicated and energy intensive, but complex material movements and an intricate logistical chain add to the industry's obstacles in achieving sustainability and performance.

This article explores three major challenges and the resulting issues currently being faced in the industry, as well as potential solutions to these impediments by use of energy management, automation and control strategies.

Challenge 1 - Availability of skilled people

Across the industry, company executives have realized the ominous and increasingly relevant problem of attracting and retaining skilled mining operations workers with the technical skills and knowledge to operate the most innovative technologies and equipment.

Though there are many explorations into the reasons for this decline (i.e., a decreasing amount of technical graduates or the locations of mining operations), as well as potential remedies, it is important to focus on understanding how progressive technologies and solutions can aid the industry in compensating for the lack of skilled people, thus resulting in smaller teams (Fig. 1).

Potential solutions

Advanced process control and optimization. In short, advanced process control (APC), or expert systems, are software systems that learn and understand mineral processes and their complexities. By leveraging artificial intelligence, APC is able to determine the best process set points and is able to consider critical process constraints such as costs.

Simultaneously, expert systems target major mineral processing concerns, such as throughput rates, recovery ratio, energy efficiency and process stability. APC also frees up the time of skilled operators, who may work in other core activities and devote more resources to helping novice operators, since such systems continuously mimic the best operator behavior.

Additionally, such solutions are easy to implement and require little maintenance after completion.

Figure 1

The scarcity of skilled workers is an ongoing and pressing problem in the mining industry.



Simplified control systems. A critical component of a modern process control system is the ability to help mining companies compensate for the scarcity of specialized people and limited engineering and maintenance teams.

As with any other modern technology, the need for differentiation has been driven by a lack of standardization and numerous proprietary approaches. However, as with any other modern technology, the market has started to naturally demand convergence.

Control systems, based on ethernet and web technologies, have gained market acceptance as their constant evolutions continue to improve in performance and ruggedness, making them more suitable for use in industrial environments.

Ethernet technologies simplify the overall system network, reducing the use of proprietary systems and eliminating middleware. These systems leverage the same rules as commercial ethernet, facilitating the maintenance of people intervention, as well as integration with a variety of other devices – ranging from IP cameras to particle size analyzers.

Web technologies have brought new features to the system, adding new maintenance and operational tools. For example, field devices feature embedded web servers, enabling maintenance teams to use any

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Figure 2

Mining KPIs presented in a comprehensive way.



tablet with a commercial browser as a maintenance tool as they freely walk mining areas.

Simplified engineering tools. In the mining industry, it is critical that engineering tools have a unique environment approach because the user must navigate among all the systems without the disruption of needing to open and close different applications. As such, the mine control system must be configured and visualized as a whole, following the mine’s physical hierarchy.

Additionally, engineering tools must be object-oriented and foster re-use. For example, a crusher will be a single entity, with control system operation logic, animation and faceplates for alarm and operation supervisions systems. Most importantly, the object needs only to be tested once – this significantly reduces engineering time. Thus, object-oriented configuration allows re-use for the same plant and, in some circumstances, for different mines as well.

Availability of skilled people vs. excess of data and information

Paradoxically, the use of numerous different mining systems and software generates a large amount of data that, compounded with the already pressing worker shortage, intensifies mining industry challenges.

In some operations, technology advances, specifically in the area of automation and control, have exponentially increased the amount of data available, causing an overload. This excess of data has had unintended consequences by making it difficult to pinpoint, analyze and evaluate the important details or, worse, cause operational personal to come to the wrong conclusions based on misleading data from different sources.

Additionally, the constant need for accountability and performance management drives a surplus of “reporting creation,” and often uses a painful manual process to collect, process and deliver the information such as spreadsheets and reports. These tasks deviate people from their core business, consume large amounts of valuable worker time and often deliver inaccurate results.

Potential answers

Data aggregation and production intelligence tools. To combat this dilemma, mining operations are moving to IT solutions and architectures to integrate dissimilar applications in ways that achieve common information, centralize data and better data exchange and orchestration. In addition, individual vendors’ systems aim to be friendlier and use open standards so information is accessible.

Manufacturing/mining execution systems. Using data aggregation, a production manager is able to customize his or her personal computer screen to show energy efficiency information, particle size, grade, cost and emissions. All he or she needs to do is drag and drop the KPIs, reports and trends that are important to current needs, even if the information is coming from different sources and layers (Fig. 2).

At a higher level, a plant manager can aggregate and visualize even more information, including data that is not necessarily limited to process information. Energy and utilities consumption from the office buildings, along with IT and processing units, can be aggregated into a single screen. Basically, users can customize their screen with information relevant for their needs from all available data sources.

Beyond data aggregation and performance visualization, a mining execution system (MES) is able to understand and combine this information to deliver business and production insights, including:

- Downtime analysis.
- Maintenance strategies.
- Overall equipment effectiveness (OEE) analysis.
- Cost analysis.
- Metal accounting.
- Reconciliation.
- Inventory and tracking.
- Quality control and reporting.

Challenge 2 - Sustainable mining

A mining company successful in sustainability is synonymous with a successful company. According to a recent study, from the consulting

Figure 3

Advanced metering device.



firm A.T. Kearney, industries with a commitment to sustainability presented better performance against their competitors in times of financial turmoil.

Energy efficiency. Energy in mining operations is a central topic of concern, as it ranges between 20 and 40 percent of the typical mining operational cost. It is a multifaceted variable involving government regulations, societal pressures, cost and competitiveness.

The U.S. Department of Energy acknowledges the mining industry can reduce its energy use by as much as 600 trillion Btu/year with best practices and ongoing research and development. However, some basic challenges have to be tackled to identify the best strategies to achieve such results, these include:

- Financial justification of an energy efficiency project or initiative.
- Limited energy information or an excess of information.
- No systematic or consistent approach to energy improvement.
- Identification of energy drivers and the context of their consumption.
- Accountability and commitment of people and process areas.

Carbon management. Building an accurate carbon footprint requires data – and lots of it. In fact, most sustainability teams significantly underestimate the time and effort required to gather this data. Energy use typically constitutes more than 90 percent of an organization's greenhouse gas emissions. Therefore, to calculate a carbon footprint, you must have access to energy usage data. However, energy data is rarely available in electronic form – a surprise to many, given today's technological tools.

Potential solutions for energy and carbon management

Carbon and energy management strategy. Everything has to start from a strategy.

The suggested energy strategy in mining and mineral processing operations has to follow a well-structured approach, and is a mix between planning and technologies. Operators must understand how energy is purchased, where it is being used and why, and then use this information to recommend and implement energy conservation measures. Additionally, it is critical that both strategic targets and results are visible, in order to leverage the energy spent across the entire enterprise and to develop a comprehensive and robust energy and sustainability strategy.

Technologies.

According to a recent report from Verdantix, carbon and energy management software tools will grow more than 50 percent between 2010 and 2014. However, the study also points out that construction and base materials companies will have a modest investment against other energy intensive processes, such as oil and gas and telecommunication sectors.

Metering, monitoring software and energy management systems. A comprehensive energy management system combines three major tools:

- Power metering solutions: Devices that measure the entire spectrum of energy utilization including water, air, gas, electric and steam (Fig. 3).
- Monitoring software: Solutions that collect data from the metering system and present the information in a comprehensive way.
- Enterprise energy management systems: Systems that manage information in order to control the cost, quality and reliability of energy.

Emissions reporting. The emissions reporting software approach summarizes the corporate emissions performance by aggregating data from all business units into a single solution. This data enables users to track performance and report on the success of an organization's emission reductions projects. To provide an accurate analysis, this solution compares monthly CO₂ output to targets and base year totals, made possible with breakdowns of CO₂ output by commodity (fuel type).

Intelligent motor control centers. As mining operations rely heavily on low voltage electrical motors, the introduction of new technologies that target motor performance have a direct impact on energy savings, maintenance costs and commissioning time.

A key feature of intelligent motor control centers (iMCC) is the integration of intelligent devices and device-level networks for control

and automation that deliver improved performance.

Since iMCC integrate process control with smart motor devices (motor protection relays, smart circuit breakers and speed drives), it addresses savings in energy-intensive applications such as ventilation, pumping and compressed air installations.

Production energy optimization. The mining execution systems gain even more power if combined with an energy management system, as this provides the opportunity to optimize energy utilization. This approach, called production energy optimization (PEO), merges the best of two worlds — mining intelligence tools that streamline and optimize production, maintenance, downtime and financials, and energy management systems that control energy consumption as well as model and forecast energy use to enable better planning and intelligent energy spending.

This powerful combination provides data contextualized to understand energy intensity. This results in the ability of users to capture real-time data production information associated with energy drivers and allows them to forecast energy usage by generating an energy model against production scenarios.

In parallel, such technology drives dynamic objectives, where the new energy target is compatible with new production scenario. Fixed objectives are not always appropriate if production has new characteristics.

Challenge 3 - Extreme and remote mining

Today, for various reasons (such as materials scarcity and grade reduction) mining operations are often located far from developed centers and cities, and frequently are located in isolated areas with extreme weather conditions.

This environment not only compounds the challenge of retaining skilled people in the industry (and proliferates the obstacle of working among smaller, more spread-out teams), but also calls for specialized equipment able to meet ruggedness requisites, which, in turn, require comprehensive maintenance strategies.

Potential solutions

Virtual control rooms and redundancy. Systems based on ethernet/wireless and Internet technologies allow mining operations to be monitored and managed remotely from central locations, up to the device level. Additionally, similar processes from different plants can be compared and best practices exchanged.

However, this concept requires robust systems

on both sides. The local mining control system has to be virtually fail-proof, as a consequence of reduced production and maintenance teams close to the operation. The same need is necessary for the central control room supervision systems, as these systems control and monitor mine operations miles away.

For such remote critical applications, system redundancy is required. The control hardware has to have processors, power supply and communications redundancy able to perform switchover in case of failure of the primary system. Additionally, the switchover has to be “bumpless” for the system, or have virtually no disturbances for the process.

More advanced control hardware allows primary and standby processors miles away from one another. These can be useful for some extreme requirements.

The supervision/operator system may also have redundant servers. Besides being protection for server failure, additional servers can be used for a better performance of the system managing massive data traffic (I/Os, alarms, trends). Additionally, advanced clustering technology, mixing central and distributed servers, allows users to create new architectures that will help safeguard plant reliability.

Autonomous systems. Extreme mining is strongly linked to autonomous systems concept.

Mining companies are doing serious investigation into autonomous equipment and machines, such as trucks and excavators for both safety and efficiency reasons. The technology can range from remote operation and semiautomatic operation, to a complete autonomous system with virtually zero human involvement.

The biggest challenge is not just for the equipment to be completely autonomous. A system must be devised that involves the simultaneous movement of multiple autonomous machines, all operating together in a coordinated way while following a schedule and maintaining proper position and safety measures in order to avoid collision. In addition, the entire system must be intelligent and capable of adapting to production changes and unexpected events.

Conclusions

These solutions are examples of how energy, power and automation combined can help mining tackle some of its main challenges. Beyond the strategies described here, there are many other approaches that can be used to address these concerns, from process and business improvements to new mining and extraction techniques. ■