



Ensure Consistent Operations and Mineral Recovery with Machine Learning

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With the vast amount of effort and technological advances going into creating better electronic devices and energy storage, demands for natural resources will only climb higher. New tools and technologies become available to mining and metal companies almost every day. While some solve long-standing problems, others contribute little value to the business. It's true that digitalization can provide many business benefits—but only if properly implemented.

Deloitte reports that mining organizations seeking to enhance their analytics and AI maturity are asking three key questions:

- What are the global trends in other industries and how are they relevant for us?
- What are the specific use cases in mining and what value do they deliver?
- Where should we focus the investment and how should we approach the work?¹

Examining these questions, as well as the greatest opportunities and threats to your organization, can help determine where to focus your digitalization efforts. Consider some of the following tools and their applications in mining:

Autonomous, driverless trucks have been in use for the last decade and deliver fuel savings and improved safety. One miner has reported that using autonomous loaders and drilling systems over the last few years has increased productivity by 10 percent.²

Drones can help conduct geological and mineral surveys, ensure safety in blasting zones and areas ready for backfill. They can also provide crucial data for shelf design.

GPS allows for precision in surveying and managing extraction equipment, enabling greater ore grade control.



Supply chain digitization enables proactive planning, scheduling and execution, as well as more thoughtful responses to customer demands and supply chain disruptions.

Digital twins are virtual models of a facility using real-time data that allow scenario testing to optimize operations and production. They allow miners to evaluate a number of different options and make the best decisions, such as considering financially optimized maintenance models.

Prescriptive maintenance can ensure assets at all stages of the extraction and refining process are available when they're needed. Get advance warning of potential failures for shovels, haul trucks, trains, pumps, conveyor belts, hydraulic units and other equipment in processing plants.

Predictive quality tools tied to calibration and tolerances can help miners ensure products align to specification during the production process, rather than at the final product stage.

Shifts in the Industry

Incidents like the recent tailing dam collapse in Brazil have increased scrutiny on many mining organizations, coupled with demands for new, more costly safety measures. In some geographic regions, shifting regulations and laws present additional challenges. Over the last decade, commodity prices have fluctuated—and will likely continue to do so. All these factors call for miners to streamline operations to preserve and maximize profits.

In Deloitte's "Tracking the trends 2019" report on mining, experts state that to solve the value conundrum, miners must make technology a strategic priority "by acknowledging its role as an enabler across every facet of their business." The report goes on to point out the complex factors influencing the industry, including consumer awareness, social license to operate, geographic risk and access to input commodities: "it becomes clear that mining companies must take an ever-expanding range of issues into account when setting corporate strategy if they hope to create competitive portfolios robust enough to generate value across multiple scenarios." ¹

Most miners have long recognized opportunities for improvement; now implementing change has become imperative. Yet mining spend on innovation significantly lags compared to other sectors, and while some equipment is more modern, mining has changed far less over the last 50 years than most other industries. ³



According to Deloitte's 2018 report on mining trends, "...mining companies can only achieve true innovation maturity if they go beyond the basics of operational improvements to embrace innovation in a broader sense and embed a series of capabilities within the organization." Like many other industries, mining and metals organizations need to increase data analytics capabilities and technology savvy within the workforce. "It is no longer about finding willing hands to do the excavation and extraction, but finding the right analysts, programmers, and operators to control the technology," according to the Alaska Structures website.

Insight from digitalization can help mining companies improve operations and financial performance. Recent PwC research found that "adopting the right digital strategy now can dramatically improve margins - by as much as 16% on a tonne of steel."⁴ To achieve the benefits of digitalization, miners need to rethink their approaches, set new strategies and create a more technologically savvy culture than that of days past.

Fortunately, there are clear examples miners can follow as they determine the best ways to go about digitalization. A report by The Northern Miner pointed out that miners can learn from related industries that have begun adopting new technologies to streamline operations: "Another benefit for miners is the fact that the oil and gas industry is already several steps ahead in experiencing the disruption of the big data revolution. Miners are able to look across at their research industry cousins for inspiration and examples of best practices in bringing big data into exploration applications."⁵



Creating the Mine of the Future

In a report on the steel and aluminum industry, PwC researchers explained, “embracing the use of connected machines and sensors with the ability to communicate in real time with suppliers and customers, and refining processes based on data analytics, can lead to a significant increase in productivity – and profitability – in this highly competitive industry.”

At the Smart Mining 2019 annual conference, hosted by the Society for Mining, Metallurgy and Exploration, many companies shared the impact they’ve seen from digitalization. At every stage of mining and processing, digital is transforming the way companies work.

A number of technologies can provide miners with the data and insight they need to set those strategies. The right tools can effectively answer the questions “How do we make sense of all the data we have already acquired?” and “Are we collecting the right data to guide our decisions?” Innovations in technology can help mining companies not only answer their historical questions, but delve deeper, gaining precise insight that can guide better decisions moving forward.

Historical questions	New questions
How do we cut down on maintenance costs?	How do we ensure equipment never breaks down?
How do we increase our yield?	How do we improve our extraction or refining methods with a limited budget?
	How do we ensure our final milled product is within spec and change to new products with minimal re-tooling and test runs?
How do we reduce waste?	How can we just get the ore we are after?
	How do we optimize our resources, time and equipment?
Are we keeping our employees, environment and community safe?	How do we ensure we don’t cause harm to employees, the site or the environment?



Asset Reliability: A Smart Area for Digital Focus

Asset performance management (APM) solutions provide a sound entry point for digital investments, Ensure the equipment miners need is available to keep production on track. Having the appropriate assets available is critical for successful operations; without this element in place, other efforts to optimize will falter.

APM can address many of the key challenges facing miners, through a variety of different methods.

Prescriptive Maintenance Analytics

During extraction and processing, **prescriptive maintenance analytics** can ensure the necessary haul trucks, shovels, crushers and conveyors are available. Using advanced pattern recognition and machine learning, these tools identify normal, abnormal and failure signature agents signatures for different machines and components. When an issue appears, the system issues an alert describing the exact problem, root cause and time to failure, which guides operations and maintenance leaders directly to the fix.

While condition monitoring solutions are in place in many mining operations for gearboxes, rollers, drills, ventilation on demand and other equipment, these tools only offer alerts that something has gone wrong. Prescriptive analytics provides operators a chance to proactively respond, helping to prevent damage or a catastrophe. In addition, scheduling maintenance before breakdowns occur allows miners to accommodate for out-of-service equipment; this also reduces costs and the risk of injury to workers associated with equipment failures.

Prescriptive analytics can monitor other critical assets in the mining process, such as the dams, pumps, tanks, actuators and pipelines used to manage flotation and recovery, trains and conveyors used for transporting ore and finished products, or furnaces and continuous casting equipment.

Digital Twin

Make better decisions with reliability, availability and maintainability analytics of your mine, mill or refinery, built on a virtual model of the equipment and process using real-time data. Uniquely designed to take process flows into account, the solution identifies the impacts of failures, upgrades and repairs on overall performance and revenues. This can help create greater mine-to-mill alignment, Ensure that decisions made during extraction don't negatively impact processing or recovery.

Digital twin technology can help monitor and improve a wide range of critical equipment and processes that are found in mining. For example, flotation and recovery require optimized configurations and controllers to effectively separate the target minerals from tailings, which must be properly pumped and stored to avoid any negative community or environmental impact. In order to increase recovery, digital twins can help determine what size tank cells or actuators to use, how they should be configured and the appropriate feed input settings. For continuous casting in refineries, turrets, oscillating molds, cooling chambers, induction stirrers and numerous rollers must operate in unison and within tight parameters or serious problems could arise. Equipment failures as well as products that are out-of-spec or too expensive to produce can be avoided with a proper digital twin providing relevant guidance.

Prescriptive Analytics in Action

One of the world's largest fully integrated zinc and lead smelting and refining complexes wanted to improve their metallurgical operations. The team recognized they had an opportunity to improve preventative maintenance by using information from their process signal historian. This customer made extensive use of autonomous agents for early warning of degradation in their metals refining processes and equipment. The system provided guidance of a time-to-failure of roughly 40 days on a process crucial pump. The maintenance and reliability team acted and performed a detailed SWOT analysis to determine the best course of action based not only on the tool's insight, but on the site's production forecast as well.

Agents successfully predicted imminent failures and issued actionable prescriptive advice allowing staff to make more informed decisions about equipment servicing and operation. The customer's site benefitted from approximately \$2.1M USD in cost avoidance in 2016 and even greater financial savings in 2017. Safety and environmental performance improved as well since staff get alerted to potential risks long before they become severe problems.

At the 2019 Smart Mining conference, one company outlined how they created a digital twin of their conveyor system with the goals of increasing efficiency, reducing power demand and decreasing operating expenses. The tool allowed the company to optimize operation and maximize capabilities using variable speed and adjusting tonnage capacity components, as well as better manage spare parts inventory.

Multivariate Process Analytics

New analytics tools can find correlations, trends and other valuable information hidden within big data that was inaccessible through previous data analysis methods. One paper presented at Smart Mining 2019 described how the authors “used powerful data mining and machine learning algorithms, predictive and behavior analytics tools, and big data manipulation software to analyze accidents data of the US mining industry over the last several decades.”⁶

The latest solutions can deliver multivariate analysis tailored to the unique needs of continuous and batch processing found in mines with flotation and recovery as well as in metal refineries. As ore changes with each block or polygon extracted, flotation and recovery can be adapted based on the chemical composition of the slurry. Specific changes in stirrer tip speed, supply feed flow-rate, tailings flow-rate, and air supply can enhance recovery to reduce process variability. Multivariate analytics tools enable mines to mill and cast the right material when and where they need it. The technology ensures products are refined to customer specifications, reducing waste and recommending process adjustments to make certain products remain on-spec.





Driving Successful Technology Selection and Adoption

In a recent interview on The Northern Miner podcast, Goldcorp manager of mine automation Daniel Lucifora said that his team is trying to introduce new technology into the organization where it makes sense and they can see tangible payback. “We try to target applications that are going to improve our life of mine, as well as the net asset value for that particular operation,” he said.⁷ He went on to stress the importance of gaining alignment between vendors and miners on realistic understanding of what technology can deliver “so the expectations can be met and they’re fair and reasonable.”

Lucifora also outlined the role of change management in Ensure the desired outcome. He explained that introducing process changes for disruptive technologies can be difficult because people are used to operating in a certain way. Companies need to show them that a different way can be better “and try to get them to adopt that process and embrace the technology so it’s really placed in a situation where it can succeed.”

Choose specific processes or assets to optimize, then add additional ones over time to build a holistic view of operations. The long-term goal is to create an environment where data can guide intervention at any stage to increase productivity, minimize losses and drive profit. Shorter term, however, miners need to identify the greatest bottlenecks within their operations and remove those in ways that deliver positive returns. Increasing uptime, safety and efficiency through APM can provide the type of quick wins with solid return on investment that serve as a foundation for larger digital transformation over time.



A Strong Starting Point for the Digital Journey

As miners begin the shift to new technologies and ways of automating, there is a pressing need to balance short-term returns with long-term vision. Establishing more efficient systems and processes while building out data management and analytics capabilities will be key. APM tools, which make sense of some of the massive amounts of data generated and collected during mining processes, offer an ideal way to create immediate cost savings and process improvements while developing the foundation for further digitalization investments. According to Deloitte, “To be sure, analysis of historical data will continue to enable insight from trends and patterns to identify opportunities for progress. At the same time, however, miners will rely even more on real-time data, derived from processing equipment and sensors during operation, to identify key drivers of process variability and drive rapid operational improvements.”⁸

Many of the latest APM solutions from AspenTech deliver these exact capabilities and do not require dedicated data scientists or engineers to develop models – they adjust based on real-time data and machine learning. In addition, these solutions can be implemented in weeks, quickly delivering value to the organization.

New digital technology solutions allow miners to conquer both old and new challenges. In particular, APM tools help make sure equipment is rarely taken out of service, resources are utilized more efficiently and targeted ore is extracted with minimal tailings. Most importantly, employees, communities, the environment and the only liveable planet we know of stay safe when we apply intelligent machine learning and digital solutions.

Endnotes

- 1 [“Tracking the trends 2019.”](#) Deloitte, 2019.
- 2 [“The 4th Industrial Revolution: How Mining Companies Are Using AI, Machine Learning and Robots.”](#) Bernard Marr, Forbes, 7 September 2018.
- 3 [“Tracking the Trends 2018.”](#) Deloitte, 2018.
- 4 [“Agility in metals: digital transformation in the steel and aluminum industry.”](#) Dr. Nils Naujok and Holger Stamm, PwC. 22 February 2019.
- 5 [“Using Big Data and AI for Smarter Mineral Exploration.”](#) The Northern Miner. 26 March 2018.
- 6 “Application of Predictive and Behavior Analytics for the US Mining Accidents Data Analysis.” *Z. Hyder and K. Siau, Missouri University of Science and Technology, presented at the 2019 SME Annual Conference & Expo, 26 February 2019.*
- 7 The Northern Miner podcast. [“Episode 122: Innovation Strategies for Miners.”](#) 16 October 2018.
- 8 [“Tracking the Trends 2018.”](#) Deloitte, 2018.

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