Mine on demand

IBM

Executive summary

Productivity has become the new mantra in recent years for the mining industry. Ever since the "super cycle" of the commodities price boom came to an end, industry executives have realized that a blind chase for value can lead to significant structural costs and productivity defects in the mining process, which ultimately decrease profit. Many chief executive officers (CEOs) have responded to this market volatility by making significant cuts in capital investments.

Possessing more operational ("back to basics") profiles than their predecessors, industry leads now realize that in addition to improving short-term cash flows, they need to:

- **Make sustainable gains in productivity**. Programs aimed at improving productivity need to have an enterprise-wide impact, beyond pilot programs that address people or equipment. These productivity initiatives also need to be accepted across all operations and made sustainable going forward by emphasizing truly continuous improvements.
- **Respond with more agility to fluctuating market demands**. Business agility requires a supply chain design that enables faster responses to shifts in market demands and prices. With improved business agility, it's possible to optimize net results per quarter—right down to margin-per-hour operations.

Transforming the supply chain design in this way requires a forward-looking understanding of market demand, scenario-based planning, optimal resource allocation and flexible scheduling decisions—all of which necessitate changes across people, technology and processes.

However, there are numerous structural challenges to realizing these requirements. They include, among other things, surging market volatility, uncertainties in the supply and operations environment, pervasive organizational silos and fragmented IT environments.

This white paper proposes what we call "Mine on Demand" as a solution to overcoming these challenges and responding with more agility and speed to shifts in market demands. "Mine on demand" is a combination of end-to-end integrated business processes combined with advanced technologies, such as analytics, big data and integrated mining of technical and enterprise systems. This methodology has been used successfully in the steel and automotive industries, and we believe it can be equally effective when applied to mining operations.

The mining industry's responses to market trends

As explained in the introduction, the end of this "commodity super cycle" has triggered a large number of initiatives across the mining industry. The "volume at all cost" trends from the recent past, in which tonnes were pushed out with little consideration for cost impact, have left a legacy of structural efficiency problems. These include non-integrated supply chains, lack of controls and analytics as well as misaligned metrics that encourage volume as opposed to margin-per-ton production. This trend also contributed to expansion projects that now conflict with the new reality of rapidly changing market demands.

The immediate responses of austerity measures and capital expenditure cuts were followed by longer-term productivity initiatives. These initiatives spanned across the original manufacturer equipment (OEM) suppliers (autonomous mining, for example), operations control centers, and process and continuous improvement projects as well as data technology-driven projects.

Mining industry executives commonly declare that productivity is the biggest challenge to the mining sector. This is because productivity typically drops as the size of the operation increases, especially during the super cycle of the commodities price boom.

However, productivity improvements alone aren't sufficient. Supply chains must be agile to adapt and sustain themselves as markets structurally change.

Requirements and obstacles to improving productivity and agility in mining

Nimbler mining operations require a supply chain design that allows for rapid responses to shifts in market demands and prices. However, transforming the supply chain in this manner necessitates changes across people, processes and technology, some of which include:

- *A clear forward-looking understanding of demand*, including the order book, forecast of market demand and commodity market behaviors and sentiments.
- *Scenario-based planning*, achieved through simulation during the mine planning phase to allow optimal response to demand and price shifts.
- *Optimal resource allocation and scheduling decisions* based on a holistic detailed view of the integrated supply chain, from mine to client.
- *Inventory transparency for demand fulfillment*, such as ore bodies to be bridged to the enterprise supply chain systems as inventory from source to fulfill of demand.
- *The dynamic allocation of inventory*, including work-in-process to the order book as demand changes.
- *Data integration across all operational mining (technical) systems* to provide one consistent view of execution status and its implications for the business.
- *Closing the gap between scheduling and execution* by handling daily deviations from schedules, production and logistics to maintenance disturbances and schedule updates.

While these changes may seem radical, virtually none of these concepts are new. They've been applied to numerous (often customer-facing) industries, such as steel and automotive. But a number of structural challenges in the mining industry create unique barriers to transforming the supply chain through the aforementioned methods. They include:

- A steep increase in commodity market volatility in recent years (companies have shifted some commodities from long-term contracts to spot-market buying).
- Uncertainties in mining supplies, with deviations in mining volume and grade between survey results and mine plans.
- Operations in remote locations which constrain resource availability, limit infrastructure readiness (rail, roads, and shipping) increase cost and often add geo-political risks.
- Uncertainties in operations environment, (regardless of mining methods such as open-pit or underground mining), including variations in geology, treatment, terrain, weather and more.
- Organizational silos (mine, rail, port, ship, commercial, trading, mining assets) leading to organizational and communications disconnects.
- Over 300 stand-alone mining technical systems deployments in mining operations to accommodate specific requirements, influenced by mining professionals' personal information needs and preferences.
- A complex disconnect between "enterprise" and "workplace" systems, where resource production volume and quality become an event that the value chain needs to subsequently address.

Many stakeholders claim the mining industry has lacked agility by nature. As a player in commodity markets, it has been a price and demand taker and dependent on a host of "uncontrollable" factors such as ore body configurations and geo-political circumstances. However, we believe that significant advances in the productivity and agility of the mining industry can be made today with optimized business processes and technologies that are readily available.

The "Mine on demand" methodology for optimal agility and productivity

"Mine on demand" is a combination of end-to-end integrated business processes and advanced technologies that can eliminate the silos across organizations. Together, these processes and technologies enable mining companies to more rapidly respond and adapt to shifts in market demands and prices while also optimizing their financial performance.

These outcomes are achieved through:

1) **Optionality in mine design:** The exploration of multiple mine planning and design options, including how the ore reserve will be exploited. The aim is to optimize the net present value of the business over the entire planning horizon.

2) **Optimization and flexibility in scheduling:** The optimization of multiple mining operations schedules that allow linkages between market demand and mining operations.

Ultimately, the goal of "Mine on demand" is to bridge the gap between supply- and demand-related processes, as shown in Figure 1 below.

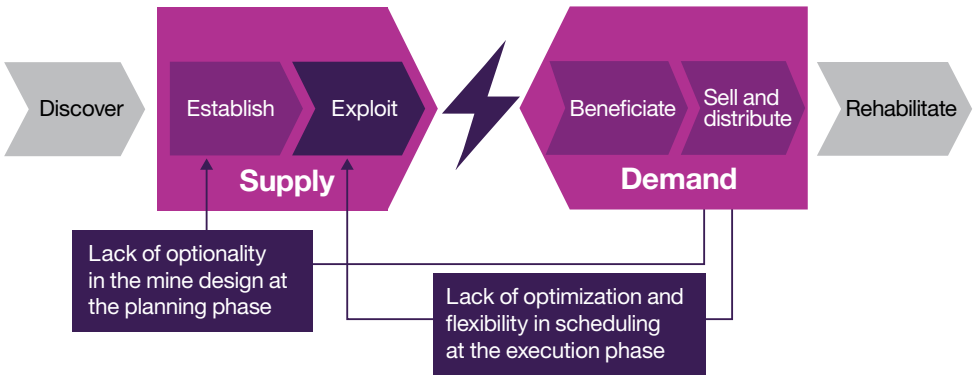

Figure 1. "Mine on demand" bridges the gap between supply- and demand-related processes.

This gap arises from a lack of optionality in mine design at the mine planning phase, and a lack of optimization and flexibility in scheduling at the mine execution phase.

The sections that follow describe how to address both challenges.

Optionality in design at the mine planning phase

To respond appropriately to market demands, mining companies need optionality in the mine design process. This concept is best suited for mining companies with end-to-end integration (mine-beneficiate-sell), close to the end client of the product.

By considering various mine design options in conjunction with market scenarios, mining companies can better plan and execute mining initiatives in line with market demand fluctuations.

The current mine planning practice is to establish a metal price and cut-off grade assumptions. Mining rates, mining materials and deployment resources are then defined in the life-of-mine plan. But this approach can be very static and, by definition, not accommodating the reality of today's market fluctuations. Therefore, this method can almost certainly lead to sub-optimal cut-off grades, contributing to minimal discounted cash flow over the life of the mine.

To respond with more agility to market conditions, mining companies need to examine many market scenarios quickly and easily. Information technology today allows this optionality by delivering a template- based mine design approach relevant to the mining method.

For example, an advanced mine design technical system can be used to understand the underlying rules, geometry and patterns inherent to any given mining layout and to create a template for that mining layout. Moreover, by using this system to manipulate the input parameters for the template-aided design in an underground platinum mine, it's possible to:

- Change level intervals
- Change the panel-length
- Change raise line spacing and the number of panels
- Change board and pillar dimensions

All these changes impact proposed mine plans and responses to various mine related or market conditions.

A recent pilot project at a platinum producer employed spatial visualization to inspect, analyze and animate each design to verify feasibility. This methodology demonstrated that with feasible design options, the typical eight-week design and schedule process can be reduced to days. This is because each design option can be immediately available for evaluation, allowing scheduling to be optimized as required. In addition, the resulting design and scheduling options can be shared over the web for validation—enabling transparency and improved efficiency.

Productivity in optimal resource allocation and scheduling decisions

The second step to enhancing agility and productivity is to create an optimized schedule to develop and operate the actual mine. This schedule should be adaptable to changing market conditions and interruptions to the mine plan when required.

Flexibility in mine scheduling: An underground mining example

Since underground optimization deals are extremely complex due to the volume of activities, intricacies and constraints involved in the mining process, they provide an ideal example of how optimized scheduling can improve agility and productivity. Let's take a closer look.

In an underground mining environment, the total number of distinct mining activities to be planned can easily exceed 40,000 activities, and the time to complete all of them can take 25-to-30 years (the life of the mine).

Additionally, underground optimization can impose major constraints, such as activity precedence constraints, hoisting and tramming capacities, ventilation and rock engineering considerations, crew allocation and equipment deployment.

Without these constraints, the problem is simply one of project scheduling, which can be solved through specific, fast mathematical algorithms. But adding the practical mining constraints changes the difficulty level and requires specialized heuristics to provide solid scheduling solutions in a reasonable amount of time.

Mine planning for the life-of-mine horizon can yield a viable strategy, but this initial plan is one that needs to be modified frequently. In mining, things rarely go according to plan, and schedules may need to be adjusted for variables such as industrial action, geological faults, significant economic swings, equipment breakdowns and market demands.

The old approach to mine planning entailed optimizing the operational activity schedule according to the mine design and constraints. This approach, however, was static and often did not allow agile responses to demand in real time. The new "Mine on demand" approach requires knowledge of the market demand first, as opposed to merely the mine design and constraints. Thus, this strategy can facilitate the redesign and optimization of mining schedules as demand changes—which simultaneously addresses the challenges of improving agility and productivity.

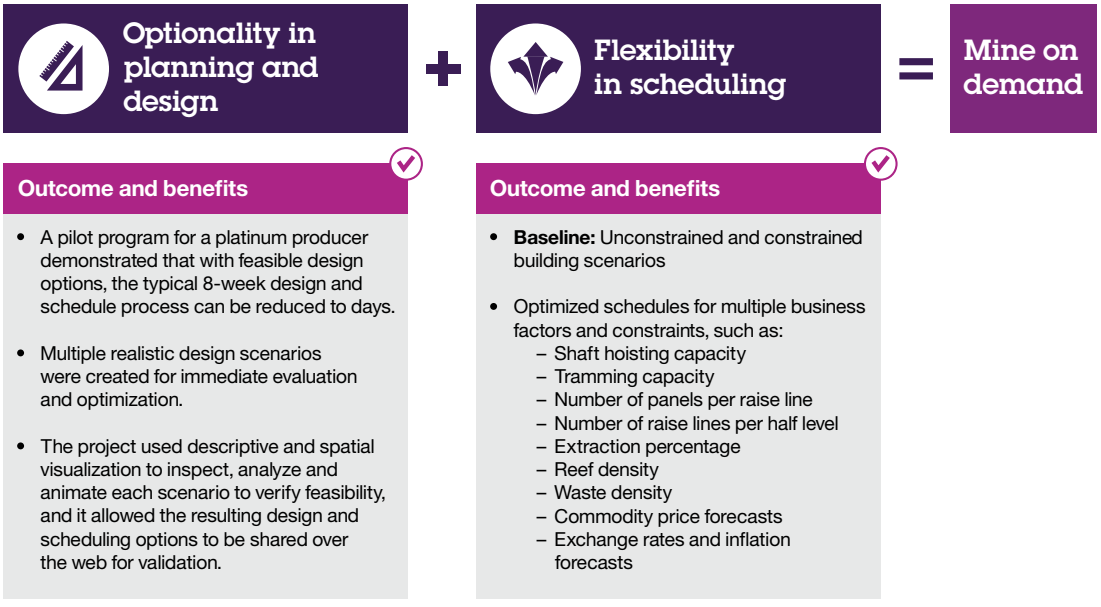

Figure 2. "Mine on demand" optimizes mine design planning and scheduling to improve business productivity and agility.

Conclusion

Big data, analytics and integrated enterprise systems, combined with effective business processes, can enable mining companies to more rapidly evaluate multiple mine designs and optimize execution schedules to improve decision making and meet demand objectives. This paper demonstrates that the "on demand" principle that has been implemented in other industries can be implemented effectively in mining.

Providing the optionality in the design and scheduling phases of mine planning can result in improved productivity and the flexibility to respond in a timelier manner to changing market and operational conditions.

For more information

To learn more about Mine on demand, please contact dirk.a.claessens@be.ibm.com General Manager Metals and Mining IBM or Pieter Nel, CEO MineRP pnel@minerp.com.

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About the authors

IBM

- Dirk Claessens, General Manager Industrial Products - Industry Academy Member
- Jose Favilla, Director, WW Industry Solutions for Industrial Products, Member of IBM Industry Academy
- Kizhanatham N Srikanth, Senior Solutions Consultant
- Magda Honey, IBM Sales & Distribution, Enterprise - IBM - South Africa Operations
- Louis Schlebusch, IBM Sales & Distribution, Enterprise - IBM - South Africa Operations

MineRP

- Pieter Nel, President, MineRP Global
- John Megannon, Vice President, Technology
- Empie Strydom, Vice President, Marketing
- Mike Woodhall, Vice President, Growth

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Route 100
Somers, NY 10589

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