

Accelerate Mining Operations Excellence through Integrated Simulation, Training, & Optimization

by Livia K. Wiley, Product Marketing Manager, SimSci by Schneider Electric

Executive summary

The Metals, Minerals & Mining industry has a resource problem — operators that are untrained and subject to a high rate of employee attrition; and plants that operate at less than optimized conditions. To reverse the trend, the industry must promote and accelerate mining operations excellence. It must be done quickly, with little room for uncertainty.

A single integrated set of simulation, training, and optimization technologies can enable the industry to quickly and effectively train operators while running tightly controlled operations safely, profitably, and in compliance with environmental regulations. When coupled together, the realized value of accelerating mining operations excellence will produce maximized returns by improving productivity and efficiencies.

Introduction

According to PricewaterhouseCoopers, the world's top 40 mining companies saw market value drop 23% and profits by 72% in 2013. The cause? Commodity prices plummeted and political challenges hindered global operations. But the report's author notes that the industry isn't standing still during these tough times; instead they are "adjusting to tough times in the short-term with strategies in place to regain confidence."

Many initiatives and offerings that are available, focus directly on production, energy, and yield management, with most involving large expenditures that may not drive results for year or more. Industrial executives are continually searching for new approaches to operations management that are more aligned with the demands of today's business environment.

Current Mining Industry Trends

The commodities Metals, Minerals & Mining business remains volatile. The cyclical nature of ore prices make the market subject to wide swings. The high cost of doing business tops the mining industry trends and predicting future demand is difficult. Cost controls, return on capital, and commodity prices are the industry's biggest concerns.

Trends seem to indicate that companies must maximize returns from existing operations by improving productivity and efficiencies, not by increasing production volumes. Or said differently, look at current operating conditions not at expansion. For example, poor project scoping, integration and performance can leave up to 15% of cost savings on the table. The short supply of skilled labor only amplifies the problem.

To survive, companies must:

- Mitigate risk when investing in and managing capital projects
- Improve performance, efficiency, and operational effectiveness
- Advance sustainability issues
- Promote talent availability and knowledge transfer

...without ignoring compliance with regulatory requirements.

Over the next 15 years, environmental sustainability, rebased globalization, and resource security will shape and drive the direction of the industry. Companies will have to prove they can deliver in good times and bad, and remain a good industry to invest and operate in, well into the future.

Addressing Key Challenges

The Metals, Minerals & Mining industry is plagued with untrained operators that tend to leave after a short time and operations that run at less than optimized conditions. To succeed in today's volatile environment, companies must make both financial and time investments in:

- **Well-trained Operators:** As operators and personnel switch jobs and migrate between various operations, technology holds the key to engaging the next generation of operators. While it takes an operational controller roughly 1 year to be efficiently trained, the industry starts to see the operators switch jobs after 2 years on average. This is where today's technology enabling a reduced training time becomes important by accelerating careers and keeping the next generation of workers more engaged and invested with updated training tools that speed training time. Among the best indicators of the efficiency and success of any organization is the level and depth of its personnel training. Well trained employees perform better and, in turn, create a better performing business and an improved bottom line.

- Optimized Operations:** Extracting minerals from ore is an extremely energy-intensive operation. With the soaring costs and growing demand of construction, along with globalized competition, mineral processing complexes are required to achieve very high throughput rates — all while continually looking for ways to maintain or increase production and reduce energy consumption. Energy has become one of the highest variable costs, and in most facilities, the cost changes significantly in real time. Throughput has emerged as one of the top challenges — specifically, how to maximize production while balancing utilization and availability.

It's all about the economics. Taking immediate action in these two areas simultaneously can turn an unfavorable play into a promising investment. It can drive the market to reexamine the performance of a company and the entire industry.

Accelerating Operations Excellence

Given the current landscape and the unpredictable future of the Metals, Minerals & Mining industry, there has to be a better way to operate. **Figure 1** shows the three views of mining execution — where (i) the Business is interested in how to make money given the volatile nature of the industry, (ii) Production is concerned with throughput, uptime and waste, while (iii) Process metrics focus on plant control, asset utilization, and reliability. These three views must be in sync or one in the same. A single fully-integrated model provides a common interface for planning, managing, and optimizing operations. An end-to-end solution is the only way to reduce costs, maximize profit, and minimize risk.

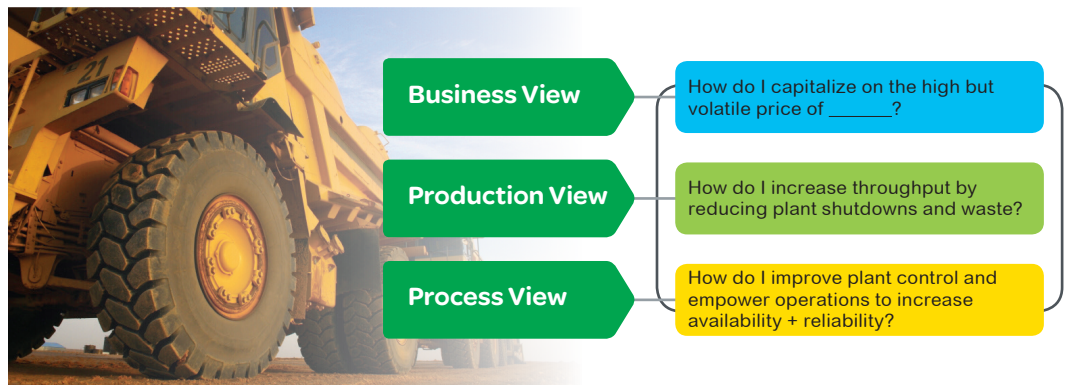


Figure 1
Three Views of Mining Execution

Industry leaders know collaboration between mine, concentrator, smelter and port can help effectively operate and improve productivity and efficiency. Increasing the profitability of minerals processing plant operations is achieved by providing measurable performance improvements in the mills, pyro processes, hydrometallurgy, bulk delivery and port, through the implementation of performance measurements coupled with asset utilization and availability improvements.

Critical Issues

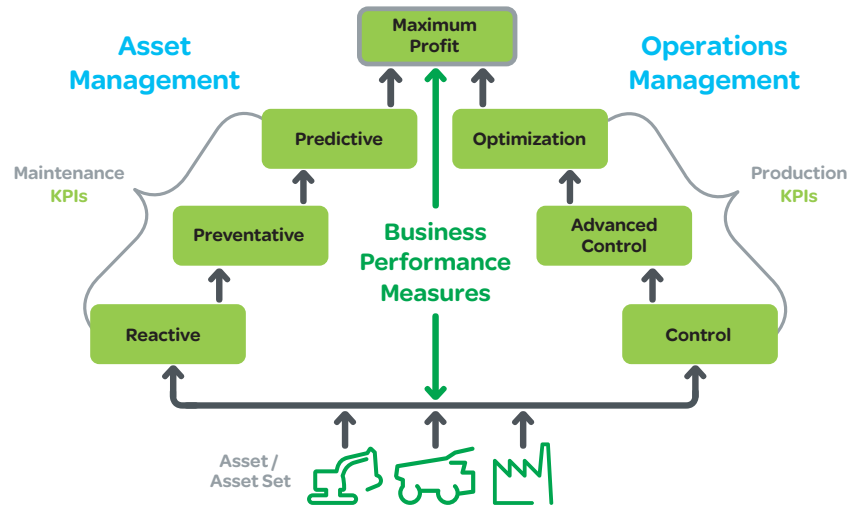
- Lack of actionable asset information
- No feedback to operations/maintenance
- Limited real time decision support
- Too much reactive maintenance
- Inefficient use of subject matter experts
- Lack of site-wide coordination

Untapped Value

- Reduced cost of capital – 20%
- Increased asset life – 25%
- Increased throughput – 10%
- Reduced safety incidents – 20%
- Reduced safety incidents – 20%

As **Figure 2** shows, Business Performance Measures are defined as the actions that can be implemented within an operation to maximize profit.

Figure 2
Operations Excellence
KPIs



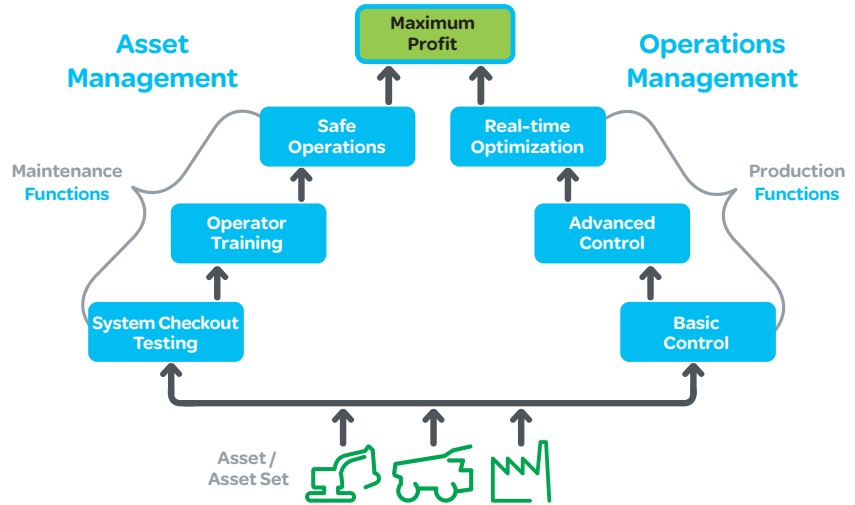
The success of each area — in Asset Management and Operations Management — is tied to specific Key Performance Indicators (KPIs) with the purpose of operating and optimizing a safe and profitable facility.

- The left side of **Figure 2** shows the progression of Asset Management from reactive, through preventative and all the way to predictive maintenance. These KPIs look to address the industry challenge of raising up well-trained and dedicated operators.
- The right side of **Figure 2** shows the Operational progression from basic control, to advanced control, all the way to process optimization. These KPIs are tied to the challenge of running tightly-controlled optimized operations.

With each step, the performance and profitability of the operation improves and the supporting teams are able to make better, collaborative, and timelier decisions. The convergence of these two perspectives provides the maximum combined performance of a facility, as measured through real-time economical and operational metrics.

Translating those steps into executable actions, **Figure 3** on the next page shows the mapping of the individual functions or programs an operator would implement to meet expected KPIs in an existing operation. On the Asset Management side, the Process group (a.k.a. Maintenance) would begin with a program of System Checkout Testing, then develop and implement Operator Training, and finally ensure Safe (and predictable) Operations of the plant. On the Operations Management side, Production would first consider some Basic Control, then implement Advanced Control strategies, and finally, perform Real-time Optimization of its operations.

Figure 3
Operations Excellence
Functions or Programs



Sasol, South Africa

Challenges

- Monitor energy costs/usage to better optimize the coal plant
- Identify energy requirements and minimize impact on the local electrical grid

Solution

- Dynamic performance measurement

Results

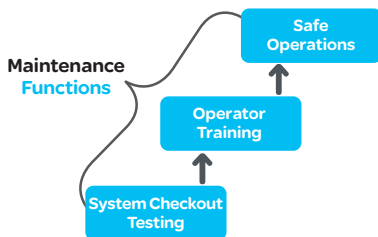
- Saved \$400K in first 2 months; >\$1M in first year
- Over 2% reduction in energy feedstock and electricity costs

Programs, functions, and metrics, however, are only half the consideration. The *only* way to accelerate operations excellence is to use a single set of integrated software tools across the entire supply chain — from mills to pyro processes to hydrometallurgy to bulk delivery to port — starting with the asset modeling through operations, and into optimization.

The first step in the solution is to model the asset. If you can't model your process, you don't understand it. If you don't understand your process, you can't improve it. And if you can't improve your process, you won't stay competitive. Process simulators are extremely effective in modeling any mining process — from minerals processing to metals/logistics processing to end-users / distributors.

Creating dynamic models of the processes allow for design validation, safety and control systems testing, and optimization of capital expenditure by avoiding costly over-design.

Asset Management



One of the key tasks of Asset Management for Metals, Minerals & Mining is to ensure plant safety while maintaining high economic efficiency. In a typical operation, personnel must deal with a high number of operating limits and operating parameters, which make it impossible to effectively monitor them and take timely actions. Critical operating situations can be missed which can lead to serious safety accidents and loss of productivity.

System Checkout Testing

The pre-testing of control logic in a dynamic simulation environment can reduce commissioning time by several days, and sometimes even weeks. Virtual stimulation software can augment the dynamic model to design, test, and perform system checkout prior to start-up. Because all functions are executed within a dynamic environment, it has the capability to bulk configure tie-back models to aid in training.

Teck Metals, Canada

Business Drivers

- Retain experienced operator knowledge
- Improve new operator training and HS&E

Solution

- Two OTS that mimic real process with identical control system
- Put an operator through a number of scenarios & observe

Benefits

- Real-life operator training without risk
- Improved operator response time, availability, and reliability
- Knowledge transfer; effective operator evaluation tool
- Smoothest startup in 30 years

Operator Training

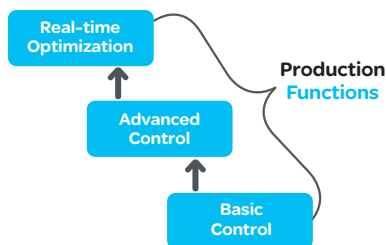
Depending on whether the mining operation contains an acid plant for processing the ore, the complexity of a mining operation varies. Regardless of the complexity, it is important to fully train operators to safely and efficiently operate the process. In recent years, as plants and their operating controls and procedures get more and more complex, a fundamental shift in the workforce has made it necessary for process industry companies to focus on attracting and retaining the kind of workplace operators they require. Workers in the mining industries last in their role for a very short time before moving on to something new. This issue has forced the industry to focus on new, time-efficient training methods, such as Operator Training Simulators (OTS). Reducing the time it takes to properly train an operator is of utmost importance

Safe Operations

Operational integrity has a significant impact on a facility's bottom line. The associated costs of lost production and Health, Safety and Environmental (HSE) incidents can easily justify any expenditure that improves safety, reliability and performance. A solution in this space must produce measurable improvements and benefits, including increased facility utilization, improved equipment reliability, and less downtime. The objective is to reduce maintenance costs while improving safety and environmental compliance, thus creating a safer, more reliable operation of facility assets.

A brilliant strategy may get things started but without flawless execution, sustainable competitive advantage isn't possible. Unfortunately, most companies struggle with implementation of their strategies. To navigate the business through uncertain conditions and steer it towards future growth, Operations Management must focus on synchronizing that strategy and execution in real time.

Operations Management



Basic Control

Basic controls are designed and built with the process itself, to facilitate basic operation, control and automation requirements. The virtual stimulation of DCS or PLC systems, which is built on algorithms and communication infrastructure of industry control processors, can provide an ideal environment for designing superior real-time control software, providing high-quality operator training, and accurately analyzing and troubleshooting control system response and performance. This saves time and resources.

Falcondo, Dominican Republic

Challenges

- Increase throughput while maintaining cost in twelve shaft furnaces

Solution

- Advanced process control

Results

- Modernization, without the downtime
- 6% increase in production
- \$0.45/lb. of nickel decrease in cost

Advanced Control

In today's environment, capital budgets and overhead are constantly being cut. Companies are faced with volatile market swings, soaring energy costs, and an uncertain future. To meet these challenges, operators are forced to optimize operations and make performance improvements that will positively affect their bottom line. Greater visibility into legacy processes is needed, even where basic controls exist, as they are usually insufficient. Advanced Process Control software allows the operation to function much closer to the operating limits by reducing variations in the process. This model-based predictive control can often reduce variability by a standard of deviation of two or greater, thus improving profitability.

Real-time Optimization

Real-time optimization begins with the measurement of throughput, energy, and metallurgical accounting in real time. Key performance indicators at each consumption, production, transfer, import, or export point in the mill can be quantified and reported. This intelligence can empower operators to predict impending events which can deliver 3-6% average reduction in energy consumption and critical production improvements. This same data can be used to reduce unplanned outages to less than 1 per year and increase utilization by more than 2%. Proactive guidance allows users to make informed decisions for conflicts, both in the short-term and long-term.

Achieving Operations Excellence

While solely looking at Asset or Operations Management provide a base level of improvement, the benefits of an integrated model are numerous. They include:

- ✓ Refined process and control system designs
- ✓ Shorter plant commissioning schedules
- ✓ Lower capital and operating costs
- ✓ Faster, equivalent on-the-job training
- ✓ Better operator effectiveness and agility
- ✓ Increased operational safety
- ✓ Reduced equipment damage
- ✓ Document regulatory compliance
- ✓ Optimized control during transients
- ✓ Higher plant performance efficiency
- ✓ Enhanced quality
- ✓ Increased throughput
- ✓ Reduced energy usage
- ✓ Maximum sustainable plant performance
- ✓ Improved process profitability
- ✓ Lower market risk

Codelco, Chile

Challenges

- Reduce time for controls checkout at startup for smelter processes
- Provide efficient operator training

Solution

- 14 APC projects and three OTS projects

Results

- Rapid controls checkout ROI
 - 6.5 days reduced time for controls checkout at startup
 - \$2.9M actual project savings
- Reduced training time for 36 operators
- Justification to apply technology at all sites
 - \$370+M identified;
 - \$50+M already realized

To achieve true operations excellence, a single set of integrated software tools must be used to execute these functions or programs throughout the lifecycle of an asset. The solution must deliver a common interface for fulfilling what's important to all three views of mining execution (**Figure 1**); a single model for asset design, simulation, and optimization. A common base of tightly integrated products ensures a moderate learning curve, transferable skills, and optimized workflow.

A rigorous dynamic simulator can be used during the design stage of a project to execute process design, control strategy validation, and risk analysis studies. The investment made in these dynamic simulation models is preserved throughout the later stages of the asset's lifecycle. For example, the model can be turned over to Maintenance for meeting safety and training KPIs and/or to Production for achieving control and optimization metrics.

Maintenance uses the validated dynamic model to test system checkout for start-up, conduct operator training, and safely operate the facility. An OTS integrated with a plant's real control system graphical interface, is used to allow the operator trainee to become familiar with all aspects of operating a facility from a familiar yet totally risk-free environment. Operators can practice plant operation under normal circumstances, as well as those instances where certain variables are changed, a mechanical breakdown occurs, or a new standard operating procedure is implemented.

Production uses the validated dynamic model to advance control system design and troubleshooting, hooking in control systems as required. Then, real-time optimization together with advanced process control are used to determine the optimal operating parameters for a process to deliver targeted operational results within the context of changing economic and plant needs and environmental constraints. This combined optimization solution automatically, and in real time, optimizes a site's energy usage and provides a balanced approach to energy cost management across the entire operation.

Conclusion

SimSci™ offers the Mining, Minerals, and Metals industry a best-in-class solution based on generating economic value by providing measurable advancements through patented processes, an excellent portfolio, and continuous improvements. It provides operators a single continuous view of their assets along the entire supply chain—from extraction to delivery—and empowers them to plan, manage, and optimize performance. This fully-integrated model provides a common interface for driving simulation, training, and optimization initiatives within a facility.

Effective operator training is essential for engaging operators, limiting attrition, and promoting careers, all while doing so quickly and efficiently. This drives performance and improves the bottom line. With the rising cost of energy, companies are increasingly focused on optimizing energy management and improving efficiency out of financial and environmental considerations. The successful implementation of the SimSci integrated solution has been shown to maximize returns from existing operations by improving productivity and efficiencies, reducing costs, and mitigating risk.



About the author

Livia K. Wiley is the Product Marketing Manager for SimSci software at Schneider Electric. She is responsible for expanding SimSci brand awareness and marketing of its design, simulation, training, advanced control, and optimization software. She has more than 17 years of experience in process simulation; assisting clients model, troubleshoot, and optimize their processes through technical and economic studies. She holds a B.Sc. in Chemical Engineering from Queen's University, and an M.Eng in Chemical Engineering from the University of Houston.

Footnote: Client references represent content entirely volunteered by the customer.