

## Case study

# Optimizing from mine to mill to mine with digital twin technology at Newmont Lihir gold mine

In 2023, the Newmont Lihir gold plant in Papua New Guinea advanced its operations by implementing a metallurgical digital twin, Metso's Geminex, aimed at optimizing material flows, managing ore feed variability, and maximizing metallurgical processes. This technology is designed to enhance production throughput, improved mineral recovery, and reduce operational costs while supporting sustainability goals by lowering energy and resource use.

### Why choose metallurgical digital twin technology?

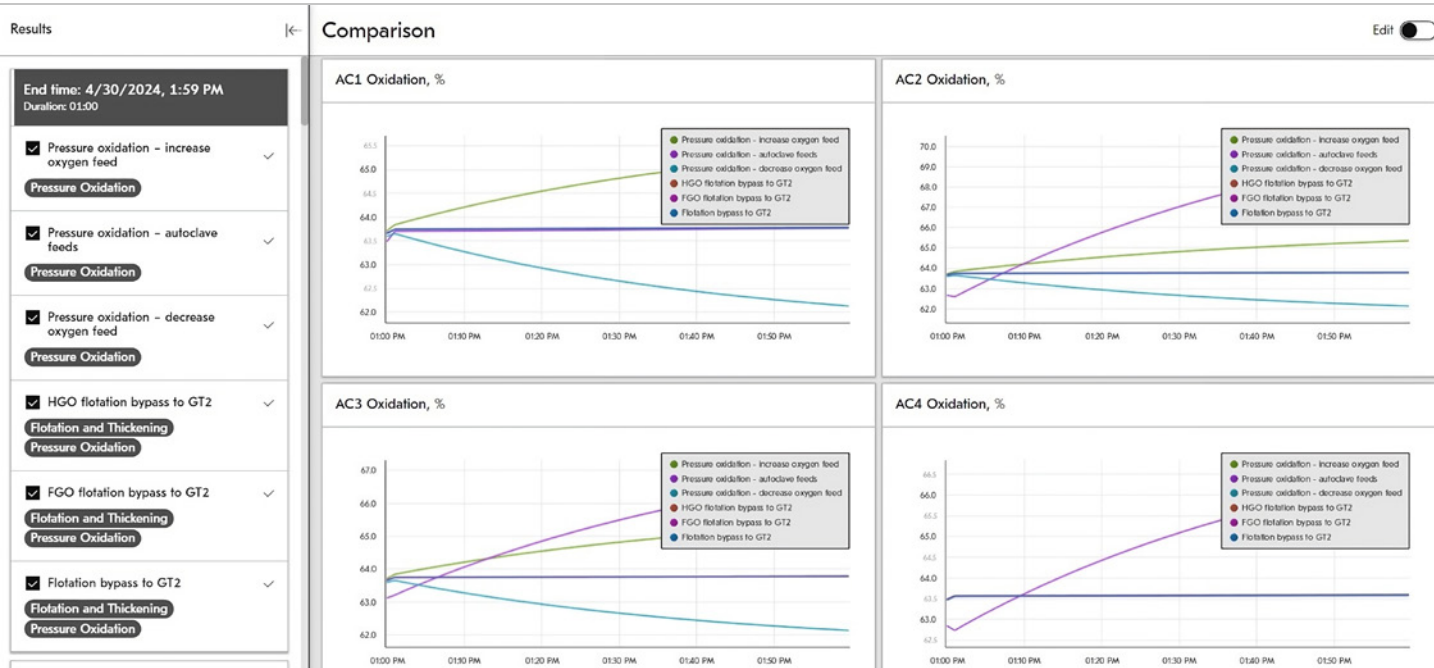
Optimizing material flows in the mine and processing plants is critical for achieving productivity targets. Digital twin technologies provide new insights, enabling better management of the production chain despite variability in ore feed, processes and equipment. Increased situational awareness improves planning, control and mineral recovery, while also optimizing energy, water and chemical use. By simulating process configurations *before* execution, the risk of environmental, financial or safety issues is significantly reduced.

Metallurgical digital twins simulate either the entire mine-to-metal value chain or specific process stages. Their main goal is to align operating parameters – such as feed capacity, target grades and mineral recoveries – with varying ore characteristics and equipment availability. By combining physics-based models with AI-driven machine learning algorithms, Geminex™ continuously adapts to further optimize the plant's operational parameters.

Typically, the metallurgical digital twin operates in tandem with Advanced Process Control (APC) systems or Process Optimizers specific to each process area using real-time data to anticipate the effects of ore blending and setpoint adjustments. Machine learning allows for automatic adaptation of the simulation models, thus maintaining accuracy and maximizing plant performance and productivity.

### Typical Geminex Benefits

- Improved operational efficiency
- Enhanced mineral recovery
- Reduced risks
- Informed decision-making
- Predictive simulations
- Increased sustainability
- Operator training and development



What-if scenario simulations of varying process parameters to oxidation degree in AC1-AC4

**Challenge:** The Newmont Lihir gold mine operates an open pit mine with refractory ore. The plant was looking to address variability in ore feed and improve its metallurgical processes for enhanced mineral recovery, energy efficiency and operational performance. Additionally, eliminating time lags between information updates, ensuring accuracy in assays and minimizing risks during operational adjustments were key focus areas.

### Development process and implementation

The journey towards Geminex™ at Lihir began with a high-level vision of optimizing from the mine to mill and back to the mine. The development of the digital twin was carried out in multiple phases, and the project was managed with a stage gate model. Progress made in each phase was evaluated, and once results met the predefined criteria, the implementation could move on to the subsequent phase. This structured approach facilitated effective communication within the development team, ensuring a well-defined and successful implementation project.

### Accurate calibration: Adapt to ore variability in real-time

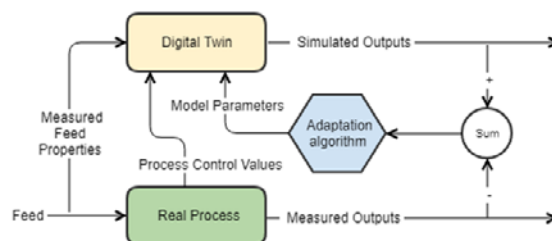
To address the challenge of time varying modelling accuracy due to changing ore types, Metso focused on the calibration of the simulation model to geometallurgical ore types. This calibration ensured that the model would be capable of accurately predicting plant performance under different operational scenarios. By creating dynamic equipment modes specific to different ore types, Geminex™ can respond to changes in ore blends and plant conditions in real-time.

### Automatic adaptation

Additionally, simulation models of a digital twin need continuous monitoring to stay accurate. When discrepancies arise between plant data and simulated outcomes, an automatic adaptation algorithm will dynamically adjust the model parameters. This is a key feature in Geminex™, as the machine learning algorithms adjust the model parameters in response to immediate changes in ore grindability or flotation rate to maintain accuracy.

At Lihir, the digital twin runs as a cloud-based application. Its simulation model is connected to critical plant data such as flow rates, slurry densities and reagent dosages. This integration enables automated adaptation.

Metallurgical twins focus on specific KPIs as their primary adaptation targets, which are carefully selected by simulation metallurgists. Based on HSC Sim simulation models, the data used for adaptation is purposefully pre-selected to suit the specific process, so unnecessary variables have been filtered out.

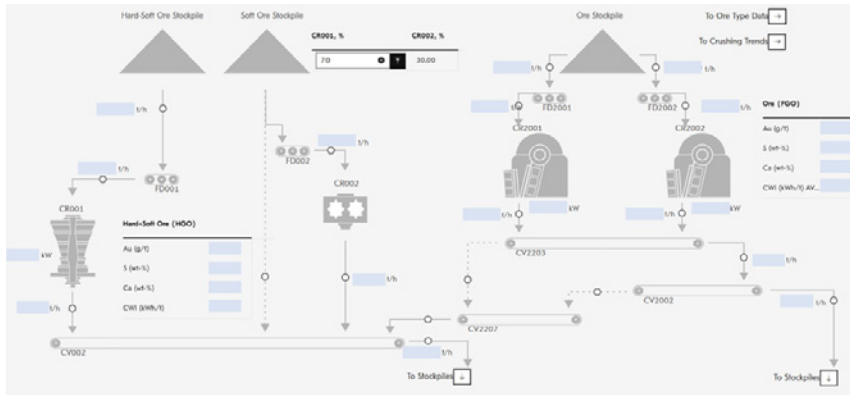


Adaptation of a digital twin simulation to real process operation

# Increased efficiency, sustainability and cost savings

The integration of the digital twin into advanced process control (APC) systems provides operators with a comprehensive tool for managing plant operations more efficiently. By anticipating the effects of various operational changes, such as altering the ore blend or adjusting process setpoints, the plant is better equipped to respond to challenges and improve its overall performance.

Additionally, Geminex™ creates value by promoting more sustainable operations. By matching processing recipes to different ore types, the system reduced the plant's energy and water consumption and optimized the use of chemicals. This capability is particularly useful for life cycle assessment (LCA), a method used to evaluate the environmental impacts associated with all the stages of a product's life. The ability to simulate life cycle scenarios contributes to both cost savings and further enhances the plant's ability to plan for long-term sustainability.



Flowsheet display example of process areas. Picture from crushing and conveying.

## User-friendly interface

The user interface was specifically designed to be intuitive for operators and metallurgists. It features flowsheet views for each process area, providing detailed information for process monitoring with soft sensors.

It also includes scenario analysis views, where users can create simulation scenarios and compare results. This feature allows for a deep understanding of the processes and facilitates effective decision-making, ensuring users can effectively interact with Geminex™.

## Cybersecurity integration to protect sensitive data

Digital twins handle confidential data, which may encompass information about current operations and plans, making cybersecurity essential. To ensure data protection, the optimal approach is to fully integrate the digital twin and its connectivity within the end user's corporate IT policies and practices, where cybersecurity design principles are already in place. At the Lihir gold mine, Geminex™ operates on Microsoft Azure, interfacing with data through a secure data lake. This communication architecture aligns with the corporate cybersecurity policy and was implemented smoothly. Access is controlled via Single Sign-On (SSO) authentication, ensuring only authorized users can manage and access the data, thus maintaining its security and integrity.

## Laying the foundation for long-term operational excellence

A strong commitment by Lihir, backed by a compelling vision, carried the project to a fully functional digital twin at Lihir. Although the technical deployment of the digital twin has been completed, full operational commissioning is still in progress due to recent personnel changes at the plant. These key users play a crucial role in the successful adoption and expected benefits.

In the short term, next steps include completing auto integration of crusher feed characteristics to enable use and testing of the stockpile model, confirming all equipment running tags are working correctly to ensure accurate reflection of the plant, review the data supply process, as well as develop and test the auto-optimising algorithm and recommended plant settings.

Looking ahead, there are plans to expand the system's capabilities for automated value chain optimization which leverages the communication interface with mine planning and ore tracking systems. This expansion will result in improved feed material considering the full production value chain and its constraints. This holistic approach will enable informed decision-making, helping to ensure that resources are allocated efficiently and that production remains optimized over the long term.

In addition to its operational benefits, the digital twin can serve as a valuable training tool for plant operators. By simulating both normal and abnormal operating conditions, Geminex™ allows operators to practice handling various scenarios, helping them build the skills needed to manage the plant even when digital tools are unavailable. This continuous training leads to a workforce that remains proficient and capable of handling unexpected challenges.

By combining real-time data analysis, advanced process control and predictive modeling, Geminex™ can give operations the ability to make informed decisions, reduce resource consumption and drive greater efficiency throughout the plant. The completion of the technical deployment at Newmont's Lihir gold plant has set a good basis for further work in both short-term and long-term, supporting Newmont's goals for operational excellence and sustainability.

This is an abbreviation of the paper "Mine to mill and back to the mine at Newmont Lihir gold mine" (Moilanen, J.) at the 2024 AusIMM Mill Operators conference held in Perth, Australia.

Metso is a frontrunner in providing sustainable technologies, end-to-end solutions and services for the aggregates, minerals processing and metals refining industries globally. By helping our customers increase their productivity, improve their energy and water efficiency and environmental performance with our process and product expertise, we are the **partner for positive change**.

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