USING SIMULATION TO COMPARE ALTERNATIVE HAULAGE DESIGNS OF AN OPEN-PIT MINE

OBJECTIVE

To validate technical design decisions and assess mine performance at years 1, 7, 15, and 25 of operation.

Tasks included:
- Accounting for equipment downtime caused by weather conditions
- Evaluating the efficiency of a conveyor-truck hybrid haulage system
- Determining the optimal equipment fleet (including tailings transport from the processing plant)

SOLUTION

Simulation scenarios were developed for key stages of life of mine.

The model accounted for:
- Seasonality of equipment units' downtimes
- Transportation of tailings from the processing plant

Performed scenario analysis (CAPEX, OPEX).

Integration with the mine's geological information system enabled automated scenario setup.

RESULTS

- The project layout was updated — the processing plant was relocated closer to the pit.
- Haulage technologies for ore and waste were compared.
- Optimal fleet sizes were determined, and production bottlenecks were identified.

Quantitative Effects:
- Adding one 20 m^3 shovel increased production by +1.48 Mt of ore and +2.3 Mt of waste.
- Optimized bulldozer fleet: 8 instead of 9 (saving ≈ USD 300–400K).
- A conveyor system for tailings transportation proved to be over 2 times more efficient than 130-t trucks.

CLIENT

A greenfield open-pit iron ore deposit located in a sub-arctic region.

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Project Context

The project simulated the mine's operation and processing plant for multiple stages (years 1, 7, 15, 25).

Each stage included:
- Comparison of overburden haulage options: trucks, conveyor-based haulage, or a combined system
- Consideration of seasonal effects (low temperatures) causing downtime and reduced productivity
- Validation of engineering design and fleet sizing based on performance and availability criteria
- Scenario-based analysis using discrete-event simulation and interpretation of results

Additionally:

Integration with the geological information system automated block creation for ore and waste, accelerating scenario preparation.

Key Questions

Modeling with MineTwin was used to answer:
- Are the design assumptions for the plant and fleet valid?
- What fleet configuration is optimal for achieving ore and waste targets?
- How many bulldozers are required for dumps, cleaning, and ore stockpiles?
- When does the conveyor-based haulage system become economically justified?
- What is more efficient — conveyor or truck transport of tailings?
- How does weather affect mining productivity?

Fleet Calculations

Bulldozer fleet optimization:

Optimal: 8 instead of 9 units → saving USD 300-400K
Confirmed requirement: 10 units at 260–300 t/h productivity

Excavator fleet (year 7):

Adding one 20 m^3 shovel →
- +1.48 Mt ore,
- +2.3 Mt overburden

Plant-Related Findings

- The conveyor system for tailings transport was more than twice as efficient as 130-t trucks.
- Simulation confirmed the need to relocate the processing plant closer to the pit to reduce haul distance and improve profitability.

Why MineTwin

Designed specifically for mining:

Unlike general-purpose tools, MineTwin accurately reproduces both open-pit and underground operations.

It models detailed equipment interactions, including cyclic-continuous haulage systems, capturing nonlinear constraints and dependencies invisible in Excel or linear programming.

Bridging strategic planning and operations:

MineTwin validates plan feasibility while considering equipment availability, geological conditions, and operational constraints.

Scalable and adaptable:

It enables creation of an internal competence center capable of building models for multiple mines on a single platform.

MineTwin is flexible enough to adapt to different mine layouts and process configurations.

After implementation, internal teams can independently perform scenario analyses, fleet optimization, and operational assessments — supporting continuous improvement and data-driven investment decisions.
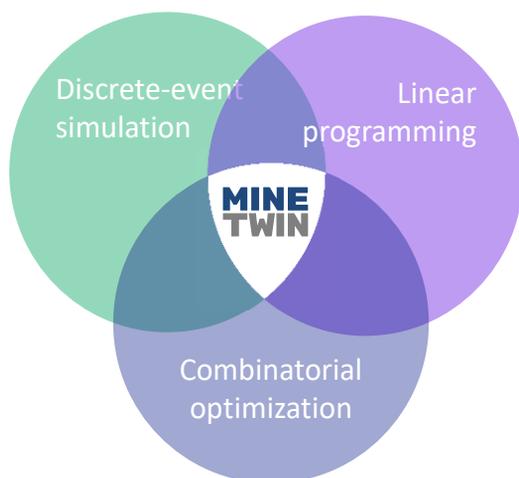
What Is MineTwin?

MineTwin is a configurable, simulation-based decision support tool designed for both underground and open-pit mines. It captures the majority of operational constraints and interdependencies found in real-world mining environments.

How MineTwin Works

MineTwin builds a simulation model—a high-fidelity digital representation of an actual mine's operations.

It is the only platform on the market that integrates discrete-event simulation with linear programming and combinatorial optimization, enabling the creation of realistic digital twins of mines.

What Tasks Is MineTwin Best For?

Check the **feasibility of mining plans** and evaluates the impact of improvement initiatives by using a dynamic model of mining operations. Able to capture non-linear factors like queuing, dynamic ore pass stocks, coordination standby delays, etc.

Provide the means for **comparison of several potential future states** of an existing or future mine. Estimates the operational and financial KPIs of every option.

Provides the scenario analysis functionality for determining **equipment fleet configuration and size**.

Allows mine planners to verify and adjust plans and schedules based on **foreseen bottlenecks** (lack of mining fronts to work in, insufficient blasting frequency, ore and waste flows imbalance, insufficient backfill rate).

Learn More

Visit us at https://minetwin.com

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