MINE TWIN

Case studies book

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MINETWIN CASE STUDY #1

MINE RESTART PLAN VALIDATED THROUGH SIMULATION TO SUPPORT CAPITAL AND PRODUCTION PLANNING

THE CHALLENGE

South Crofty, a historic underground tin mine in Cornwall, UK, is being redeveloped. The original restart plan was built using static scheduling tools, which lacked realism. Equipment interactions, queuing, and operational variability were not captured. Management was uncertain around feasibility of ore and waste targets, surface handling capacity, equipment purchases and level-specific equipment placement during the start-up periods.

THE SOLUTION

Developed a MineTwin simulation model based on:

- Full mine layout (stopes, roads, ore passes, crushers, etc.)
- Production schedules and equipment specifications (loaders, horizontal and vertical drills, trucks, chargers, etc.)
- Shift and blasting schedules

We imported Deswik designs and validated the logic with mining experts. Simulated the timeline from start of development to year 5 of production. We included all development and production activities.

THE RESULTS

Simulation uncovered critical bottlenecks:

- 3 additional loaders required in year 2 for waste transport
- 1 more loader needed in year 5 to avoid production delays
- Surface truck–loader–hopper system is insufficient for planned throughput. Usage of bin with automated chutes was recommended

The static plan did not capture idle time caused by equipment mismatches. MineTwin enabled level-specific equipment planning to overcome early connectivity limitations.

THE CLIENTS

tomahee OPTIMISATION THROUGH EXCELLENCE

Tomahee – a mining optimization specialist helping clients transform operations into best-practice systems through deep value chain expertise and integrated planning support.

CornishMetals

Cornish Metals – a mineral exploration company focused on reopening the fully permitted South Crofty tin mine in Cornwall as a low-cost, high-grade underground operation.

The background

South Crofty is a historic underground tin mine in Cornwall being redeveloped by Cornish Metals. To validate the restart plan—which includes shaft rehab, developing underground infrastructure, and a phased ramp-up—Tomahee and Amalgama used MineTwin to simulate the full development timeline. This approach helped identify hidden bottlenecks and ensured the plan was operationally feasible before execution.

The objectives

- **Validate Mine Restart Plan:** Assess the feasibility of South Crofty's ramp-up and full production strategy using dynamic simulation instead of relying solely on static schedules.
- **Identify Operational Constraints:** Detect and quantify system bottlenecks (e.g., loader and surface truck limitations) that could impact production targets across multiple years.
- **Optimize Fleet size and allocation:** Use sensitivity analysis and fleet sizing tools to recommend improvements in loader and truck allocation, especially during ramp up period, and surface handling infrastructure.

Why MineTwin

MineTwin is a simulation tool designed specifically for mining operations. It allows detailed simulation of truck–loader interactions, queuing, haulage delays, and stoppages.

It supports fast, flexible testing of fleet and scheduling scenarios, helping mine planners and top management make informed decisions based on realistic operational behavior.

Analysis of surface operations

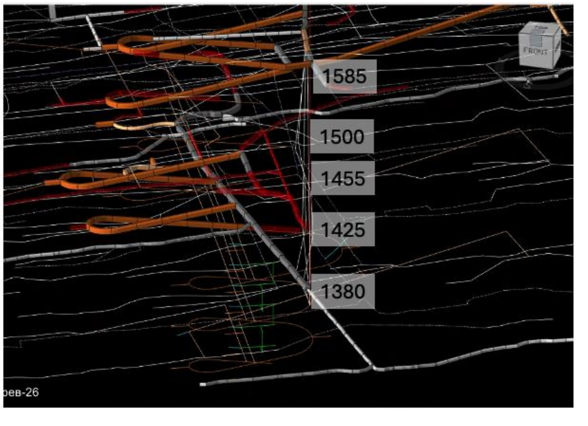
Simulation of surface operations at South Crofty revealed that the planned configuration could not meet daily or annual throughput targets, even under ideal conditions. With surface equipment availability at 85%, daily output fell below target 66% of the time, resulting in annual shortfalls of 9% for ore and 18% for waste.

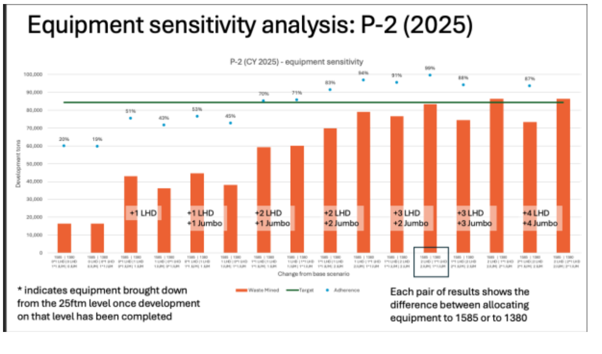
Even at 100% availability, the system could only haul ~1,800 tons per day—below the 1,950 tons per day target. Scenario testing showed that increasing hopper capacity to 200 tons and switching to auto-loading or an 8-tonne loader could close the gap and maintain crusher operation during equipment downtime

Fleet composition and allocation

During the pre-production years at South Crofty, fleet allocation emerged as a critical factor due to limited level connectivity, and the unavailability of ore passes. In the initial year the simulation revealed that the original single-loader plan was inadequate to meet development targets, as all material had to be moved by LHDs without truck support due to height restrictions and incomplete infrastructure. Loaders faced increased competition for access and had to perform long internal hauls to temporary ore and waste storage areas, leading to significant delays.

Equipment sensitivity testing showed that at least three additional LHDs were needed, alongside multiple jumbos, to approach feasibility. By the next year the plan improved, but production was still only achievable under specific equipment assignment strategies—particularly when LHDs were paired with trucks and allowed to dump into ore passes. The analysis confirmed that early-stage fleet competition and isolation—caused by unconnected levels—required both increased equipment and better coordination to avoid idle time and underperformance.





MINETWIN CASE STUDY #2

AUTONOMOUS HAULAGE FOR MINING TRUCKS INCREASES MINE'S NPV BY 7%

THE CHALLENGE

Pronto.AI, an AHS provider, and Whittle Consulting partnered with Amalgama Software Design to evaluate whether smaller autonomous trucks could outperform larger manned trucks economically and operationally.

Traditional approach to LOM calculations uses linear estimations of mining rates that do not consider queuing of trucks at excavators and dumping points as well as decrease of haulage speed due to human factors such as breaks and uneven truck speed.

THE SOLUTION

Created a base case mining operation scenario comprised a North American setting, a simple resource model, a three-phase open pit, a site road network, and a processing plant.

Created 9 scenarios, 3 for each mining stage, with pit vertical distance ranging from 10 to 324 meters.

For every scenario, we varied the number of trucks and excavators. 924 MineTwin simulation experiments were conducted on a server in automated mode.

THE RESULTS

Proved that using autonomous 40-ton trucks improved the mine's NPV by 31% compared to human-driven 100-ton trucks and by 7% over autonomous 100-ton trucks.

Proved significant potential for cost optimizing of surface mining operations using autonomous haulage systems based on smaller vocational trucks.

THE CLIENTS

PRONTO

Pronto.AI – provider of off-road autonomous haulage systems for rugged and remote mining environments.

Whittle Consulting

Whittle Consulting – specialists in integrated strategic mine planning and value chain optimization for mining projects.

The background

Pronto AI, an AHS provider, approached Whittle Consulting to quantify the economic impact over the LOM of implementing AHS. The traditional approach to LOM calculations uses linear estimations of

mining rates that do not consider the following:

- **Queuing of trucks at excavators** due to truck-and-shovel pairing
- **Queuing of trucks at dumping** points due to congestion
- Decrease of haulage speed due to **human factors** such as breaks and **uneven truck speed**

Since this study required an accurate representation of the impact of these factors due to changes in fleet size and composition, a more detailed approach was needed. Whittle Consulting approached Amalgama Software Design to use their MineTwin simulation tool to consider these factors and determine the most optimal trucks and shovel fleet configuration. We tested various fleet configurations on three stages of mining:

- shallow pit (20-68 meters deep),
- medium pit (116-196 meters deep), and
- deep pit (244-324 meters deep).

Why MineTwin

MineTwin is designed specifically for mining operations. It allows detailed simulation of truck–excavator interactions, queuing, haulage delays, and stoppages.

It supports fast, flexible testing of fleet and scheduling scenarios, helping mine planners and top management make informed decisions based on realistic operational behavior.

NPV scenario analysis

The base case mining operation comprised a North American setting, a simple resource model, a three-phase open pit, a site road network and a processing plant.

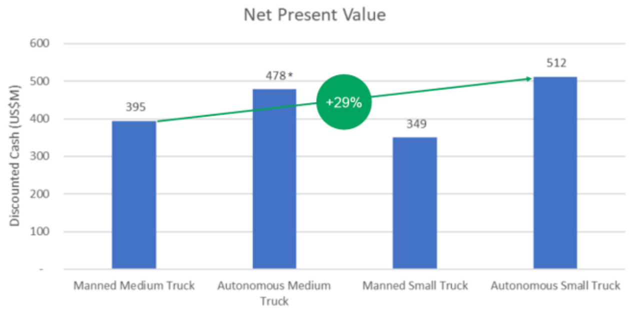
For each scenario, we identified the optimal combination of trucks and shovels that minimized time losses due to queuing and congestion, while keeping to the target tons output. The optimal fleet size was then used in the LOM calculations, and the following results were observed.

Scenario 1 (baseline): The baseline scenario with human-driven 100-ton trucks provided the reference point for NPV comparison.

Scenario 2 (autonomous 100-ton Trucks): Implementing autonomy in 100-ton trucks resulted in a 23% increase in NPV. The improvement was driven by higher truck utilization and reduced labor costs.

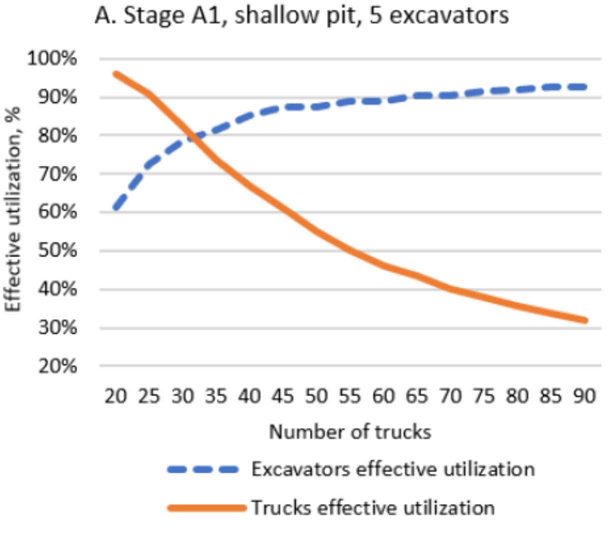
Scenario 3 (human-driven 40-ton Trucks): Using smaller trucks without autonomy led to a decrease in NPV by 9%, largely due to increased labor costs and congestion, which offset the lower capital and maintenance costs.

Scenario 4 (autonomous 40-ton Trucks): This scenario produced the highest NPV, with a 31% increase over the baseline. The autonomy significantly reduced labor costs, improved haul speeds, and minimized congestion, making smaller trucks economically viable.



Fleet composition analysis

MineTwin was used to test 924 fleet scenarios across varying pit depths, identifying truck–excavator combinations that met haul targets while minimizing queuing and delays. Results showed optimal fleet sizes differed by depth and truck type, emphasizing the need for simulation in fleet planning.



MINETWIN CASE STUDY #3

OPTIMIZING STOCKPILE AND FLEET CONFIGURATION AT A SOUTH AFRICAN COAL MINE

THE CHALLENGE

Determine whether a buffer stockpile is needed in front of the conveyor—and, if so, define its optimal size

Identify the minimum number of trucks, dozers, and excavators required to reliably meet production targets after the mine's expansion

Evaluate plan fulfillment rates under real-world equipment availability constraints

THE SOLUTION

MineTwin was used to build a detailed digital model of the mine's production cycle, including:

- Realistic replication of mining sequences, haul distances (0.8–3.5 km), and equipment cycle times
- Simulation of operations with and without intermediate stockpiles
- Scenario testing to evaluate multiple fleet configurations

THE RESULTS

Simulation confirmed that a 10 kt ex-pit stockpile improves operational stability and reduces the probability of plan shortfall by 90%

The model identified optimal fleet sizes needed to achieve high fulfillment rates under constrained availability

It was determined that an additional 7 dozers and 6 trucks will be needed to sustain operations after the mine's extension

THE CLIENT

One of South Africa's largest open-cast strip coal mines

Client and Project Context

The study was conducted at one of the largest open-cast coal strip mines in South Africa, characterized by haul distances ranging from 0.8 km to 3.5 km.

The mine operates with a truck–shovel–conveyor system, and its managers sought a simulation-based approach to improve fleet planning and evaluate buffering strategies at the conveyor intake.

Business Questions

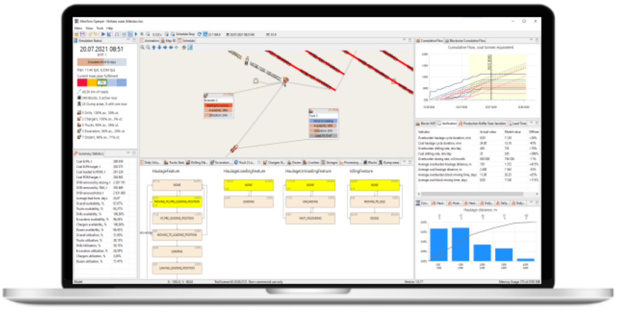
The study was initiated to answer several interdependent planning questions:

Buffering: Is a stockpile required in front of the conveyor system? If so, what should its optimal capacity be?

Fleet Sizing:

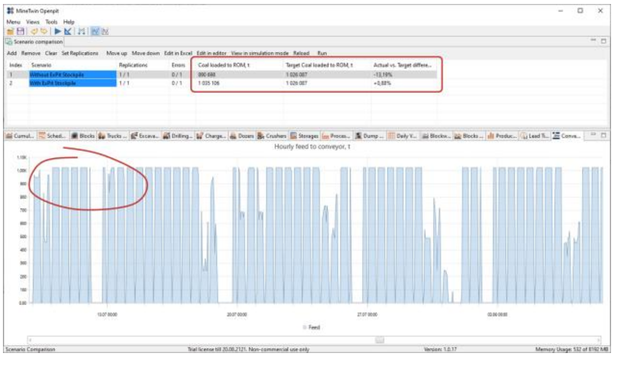
- How many trucks are needed to meet the plan?
- How many dozers are required to maintain dumping and cleanup operations?
- What is the minimum number of excavators required to consistently hit daily targets?

All scenarios were evaluated under 95% equipment availability, reflecting real-world maintenance and reliability expectations.



Stockpile Buffering Impact

Buffering Impact. Introducing a 10 kt buffer ahead of the conveyor significantly reduced system delays and allowed for smoother operation, especially under fluctuating haul cycle times.



Fleet Optimization

MineTwin identified right-sized fleets that could meet production targets with minimal redundancy:

- Overestimating fleet size did not proportionally improve throughput.
- Undersized fleets quickly led to plan shortfalls, even with high availability.
- Determined that additional 7 dozers and 6 trucks will be required to sustain the operations after the mine's extension

		Dozers count			
		4	5	6	7
Trucks count	4	-35,19%	-23,80%	-9,37%	-5,81%
	5	-36,64%	-19,20%	-4,53%	-1,66%
	6	-33,39%	-17,73%	-5,99%	0,61%
	7	-33,52%	-16,71%	-1,73%	0,54%

Why MineTwin?

MineTwin is purpose-built for mining. Unlike generic simulation or planning tools, MineTwin is designed specifically to replicate the operational realities of both open-pit and underground mines. It models detailed interactions between equipment, including truck–shovel coordination, queuing delays, and haulage cycles. This level of specificity allows it to capture non-linear constraints and cyclical dependencies that are typically overlooked by spreadsheets or linear programming models.

MineTwin bridges strategy and execution. Its simulation-based approach allows planners to test the feasibility of mine plans under realistic conditions, accounting for equipment availability, geological uncertainty, and process interdependencies. This makes it an effective link between high-level mine planning and on-the-ground operational decisions.

MineTwin is scalable, configurable, and in-house friendly. MineTwin enables mining companies to build internal competence centers that support multiple sites with a single modeling platform. It is flexible enough to adapt to different mine layouts, workflows, and business rules. Once deployed, MineTwin empowers mine planners to independently run scenario analyses, optimize fleet configurations, and evaluate operational changes—supporting continuous improvement and better investment decisions.

USING SIMULATION TO EVALUATE IMPROVEMENT OPPORTUNITIES AT COMPLEX UNDERGROUND MINE

THE CHALLENGE

A complex underground mining operation in North America, with multiple ore bodies, development areas, and shared infrastructure needed a way to evaluate different improvement opportunities. Traditional planning approaches, relying on static schedules and spreadsheets, struggled to account for:

- Dynamic equipment interactions
- Resource competition across levels
- Surface infrastructure constraints

THE SOLUTION

We developed a MineTwin simulation model based on:

- Full mine layout, including stopes, headings, muck bays, ore passes, rail infrastructure, and surface logistics
- Equipment interactions for mucking, drilling, hauling, and mill feed operations
- Multiple ore production zones with dedicated crew and fleet

We imported Deswik designs and validated the simulation logic with mining personnel.

THE RESULTS

Simulation provided answers and insights on all initiatives tested:

- Adding additional ore passes did not improve throughput, but yielded 13% efficiency gains (less travel, reduced fuel consumption)
- Additional crew in 3 of the production zones resulted in 20% increase of the mine's throughput
- Drilling capacity is the bottleneck: + 1 Drill rig = +10% throughput
- Muck haul becomes constraint when mining both SLE and MCF

THE CLIENTS

MOSIMTEC
future proof your business.

MOSIMTEC empowers businesses to make better decisions amid constant change -- from climate shifts to supply chain disruptions, automation, and global events. By guiding organizations along the simulation modeling and digital twin continuum, MOSIMTEC helps them not just prepare for change, but embrace it.

The mining client – Due to the sensitive nature of the project the final client will remain anonymous, and all the data presented here is sanitized from any identifying information. Screenshots are from a similar but different mine.

The background

The mining operation was under pressure to improve throughput while keeping costs under control. Although several improvement initiatives had been identified, ranging from equipment changes to crew reallocation, the team lacked the time, resources, and capital to test each one in the real world. They needed a safe, risk-free way to evaluate these ideas, quantify their potential impact, and prioritize the most effective strategies due to limited budget and time. To achieve this, they partnered with MOSIMTEC to develop a simulation-based digital twin of the operation.

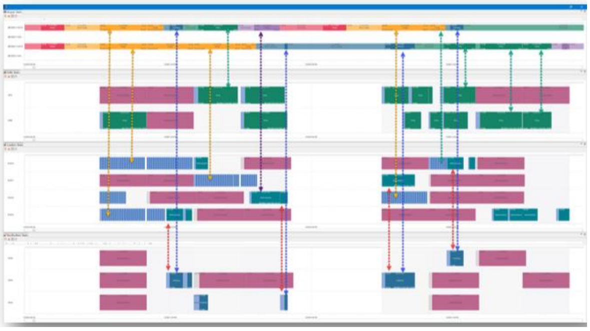
The objectives

- **Evaluate improvement initiatives** in a risk-free environment by simulating operational changes without disrupting real-world activities.
- **Quantify the impact** of proposed changes on throughput, efficiency, and cost to support data-driven decision-making.
- **Prioritize initiatives** based on ROI and feasibility, ensuring limited time and capital are focused on the most effective strategies.

Why MineTwin

MineTwin is a simulation tool designed specifically for mining operations. It allows detailed simulation of drill, charge, blast, mucking and loading operations. This includes scheduling, truck and loader interactions, queuing, haulage delays, and stoppages.

It supports fast, flexible testing of fleet size and scheduling scenarios, helping mine planners and top management make informed decisions based on realistic operational behavior.



Determining benefit of additional infrastructure

One of the major initiatives tested in the simulation was the addition of more ore passes throughout the underground mine. Operations had long believed that increasing the number of dumping points between levels would ease material flow, reduce wait times, and ultimately increase overall production throughput.

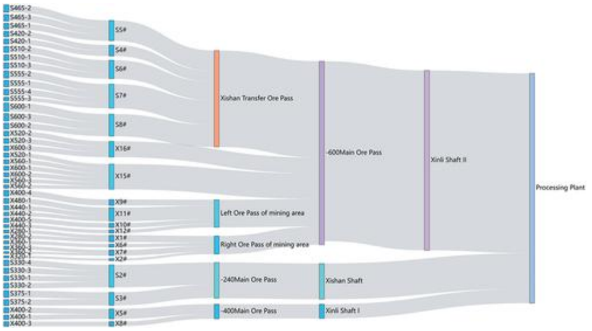
However, the MineTwin simulation revealed a surprising result: ore hauling was not the limiting factor in the system. The model showed a 13% gain in logistical efficiency, with total loaded travel distance decreasing, leading to a modest drop in fuel consumption – not higher throughput.

This counterintuitive insight proved critical. Without simulation, the team was prepared to invest heavily in new infrastructure, believing it was a key to unlocking capacity. By validating this through data, the operation avoided a multi-million-dollar capital expenditure and was able to redirect focus to changes that truly improved performance.

Analysis of mining cycle

Using MineTwin's reporting and Gantt chart visualizations, the team analyzed the full mining cycle to identify bottlenecks. A key finding was that drilling was the bottleneck during most of the simulated period. Unlike other equipment, drills could not move independently and required loaders (LHDs) and crew to be repositioned between headings, which makes static calculations to determine the exact bottleneck almost impossible.

The simulation revealed there were enough LHDs, but not enough drills to keep stopes ready. Scenario testing showed that the biggest gains came from adding both drills and crew, with crew availability delivering the highest overall impact.



VALIDATION OF ALTERNATIVE RAILVEYOR IMPLEMENTATION SCENARIOS

THE OBJECTIVE

To simulate and validate the **technical design** of a project implementing a flexible autonomous rail haulage system (Railveyor®).

Tasks included:

- Calculating **mine productivity** for various stages of life of mine using the Railveyor system
- Identifying **bottlenecks** for different haulage configurations (dead-end, looped, etc.)
- Determining the **optimal number** and technical parameters of Railveyor trains
- Evaluating overall **mining efficiency** after implementation of Railveyor system

THE CLIENT

A research and engineering company specializing in mining.

THE SOLUTION

Simulation scenarios were created **for key stages of life of mine**.

The model replicated Railveyor **dispatching and scheduling** logic along multiple routes, accounting for:

- Train interactions at **passing loops**
- Movement in **loading and unloading areas**
- Different **routing schemes**

Optimization studies determined the **best capacity** and **fleet size** for Railveyor trains.

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

THE RESULTS

- **The initial Railveyor layout was refined**. At later stages of mine development, an additional branch track was required for bypassing.
- **Technical parameters** of the Railveyor trains were **simulated and verified** to support future design justification.

PROJECT CONTEXT

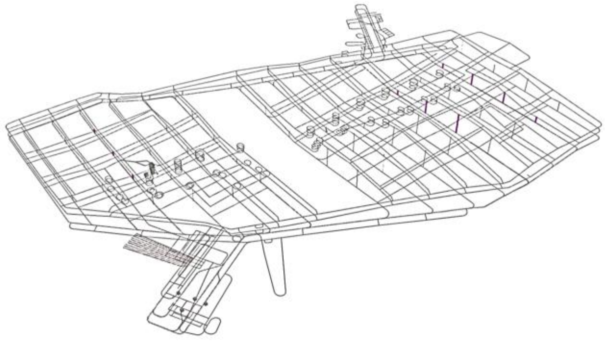
The project involved modeling the mine infrastructure and Railveyor operations for multiple stages of life of mine.

Each stage included:

- Validation of design assumptions and fleet sizing based on productivity and availability criteria
- Simulation of Railveyor movement considering:
    - Haulage speed on mainlines
    - Speed during loading/unloading
    - Train and wagon parameters
    - Individual route layouts
    - Interaction at passing points
    - Speed reduction on curves and acceleration on straight sections
- Scenario-based study using simulation modeling and interpretation of results
- Detailed performance analysis with 2D and 3D visualization of Railveyor operation

Additionally:

- MineTwin was integrated with the mine's geological information system to enable automated scenario generation.



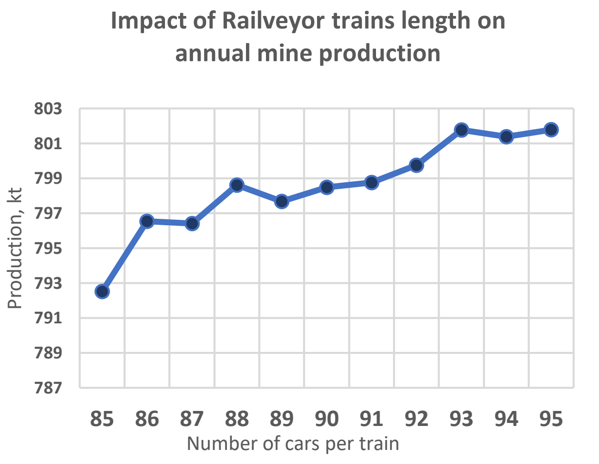
KEY QUESTIONS

Simulation in MineTwin was aimed to answer:

- Are the design assumptions valid?
- What Railveyor fleet is optimal for achieving production targets?
- How many trains are needed at each stage of mine development?
- Is the overall haulage system capacity sufficient?

STUDY MODE

MineTwin's "Study" mode and fleet analysis helped identify operational patterns for production improvement, such as automatic calculation of Railveyor train parameters and their impact on productivity.



WHY MINETWIN

Designed specifically for mining:

Unlike generic simulation tools, it accurately reproduces operations of both open-pit and underground mines.

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

Bridging strategic planning and operational control:

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

Scalable and adaptable:

It enables creation of an internal competence center to develop models for multiple mines on a unified platform.

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

After implementation, internal teams can independently run scenario analyses, optimize fleet configurations, and evaluate operational changes — supporting continuous improvement and well-grounded investment decisions.

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.

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.

MINETWIN CASE STUDY #7

MINETWIN SIMULATION OF 6 UNDERGROUND MINES UNCOVERS $262M IN COST SAVINGS

THE CHALLENGE

Head office cannot check the number of equipment units requested by the mines. Mines complain that they do not have enough equipment to meet the plan.

ROI of new mining and ore transportation technologies is hard to estimate due to multiple moving constraints and non-linear dependencies of the underground mines.

THE SOLUTION

Check the feasibility of mine plan and evaluate impact of new technologies with simulation models.

Perform scenario analysis in MineTwin to determine the required number of equipment unit to purchase each year.

THE RESULTS

Savings of $262M due to equipment fleet optimization.

MineTwin ROI exceeds 800% due to more optimal scheduling and redistribution of equipment between mines.

Determined ROI of 10 innovative initiatives, including using fast borers, railveyors, hot-seat shift changes, and others.

THE CLIENT

One of the world's largest producers of refined nickel and palladium, operating complex underground mining assets in Eurasia.

Client and Context

A leading global producer of nickel and palladium, implemented a simulation-based decision support system (MineTwin) to improve planning and coordination across six of its underground mining operations. The model has been in continuous use for over three years and is managed by a dedicated three-person team within the company's headquarters.

Objective

The goal was to enhance the accuracy and efficiency of operational planning and to bridge the gap between long-term mine strategy and short-term equipment scheduling. Traditional planning tools lacked the ability to account for complex resource interactions and operational constraints—particularly those involving equipment coordination and shift-level execution.

Solution

A high-fidelity simulation model was developed to replicate the real-world operations of six underground mines. The model captures shift-level planning rules and intra-shift coordination of crews and equipment. It includes logic for key operational constraints, such as:

- Loader–truck interactions (e.g., LHDs and haul trucks)
- Equipment availability and relocation
- Production targets across daily, decadal, and monthly horizons
- Geotechnical and geological limits

MineTwin's model became a vital link between strategic life-of-mine planning and real-time execution, enabling planners to validate whether annual, monthly, and daily plans are feasible under real-world constraints.

Implementation Results

- More than **10 types of technological equipment** have been modeled
- Simulation **covers over 500 units of equipment**
- Auxiliary equipment **fleet sizing** is performed using the simulation model
- The company's main equipment **fleet has been optimized** using the simulation model
- The system allows various business cases to be modeled using the company's internal resources

Key Benefits of MineTwin

Transparency: Improves visibility into mine operations, enabling structured analysis of key KPIs.

Planning Accuracy: Supports execution-level planning with realistic resource and process logic.

Scalability: One model and team supports six mines, reducing overhead and ensuring consistency.

Foundation for Digital Twin: The simulation logic lays the groundwork for full digital twin development by integrating planning, coordination, and execution.

MineTwin Competence Center

A dedicated MineTwin competence center was established within the client's technical division to support simulation-driven planning across six underground mines.

Staffed by 3–5 trained specialists, the center develops and maintains MineTwin models, ensuring consistent application in fleet sizing, equipment scheduling, and scenario analysis. The in-house team enables rapid iteration, internal knowledge growth, and reduced reliance on external vendors, forming a core component of the client's digital mine planning framework

MINETWIN: FROM STRATEGIC DECISION SUPPORT TO VERIFYING QUARTERLY AND ANNUAL MINE PLANS

THE CHALLENGE

The underground fluorite mine faced significant complexity due to unpredictable geology and a complicated haulage network. To support a production increase, the company needed clear answers to two key questions:

- Would the planned capacity upgrade of a shaft ensure sufficient mining and haulage throughput?
- How many additional trucks and loaders were required for the planned production growth?

After MineTwin provided reliable answers, the client continued using it to validate quarterly and annual plans, foresee bottlenecks, and guide equipment-purchase decisions.

THE SOLUTION

We developed a MineTwin simulation model based on:

- Full mine layout, including stopes of 2 different mining methods, headings, muck bays, ore passes, and skip hoists.
- Equipment interactions for mucking, drilling, hauling operations.
- Geology unpredictability in the form of random variable distributions of drilling durations, fragmentation rates and blasted ore quantities.

We imported Vulcan designs and validated the simulation logic.

THE RESULTS

Simulation provided insights across all tested initiatives and:

- Improved annual planning accuracy by 10%
- Confirmed that the shaft capacity upgrade could deliver a 3% increase in mine throughput
- Determined the required number of loaders and trucks for the mine's future state

THE CLIENT

The client operates one of the leading underground fluorite mines in the Americas.

Due to the sensitive nature of the project, the company will remain anonymous, and all data shown has been fully sanitized to remove any identifying information. The screenshots included are illustrative examples taken from a comparable, but different, mine.

The background

The client operates a large underground fluorite mine, characterized by complex production processes, variable geology, and shared use of critical equipment such as LHDs and mining trucks. The mine relies on multiple extraction methods, several transfer points, and two skip shafts, making the haulage system highly interdependent and sensitive to bottlenecks.

Because production performance depends non-linearly on equipment allocation and the movement of mining fronts, the mine required a more reliable way to assess operational constraints and plan for a future production increase.

The objectives

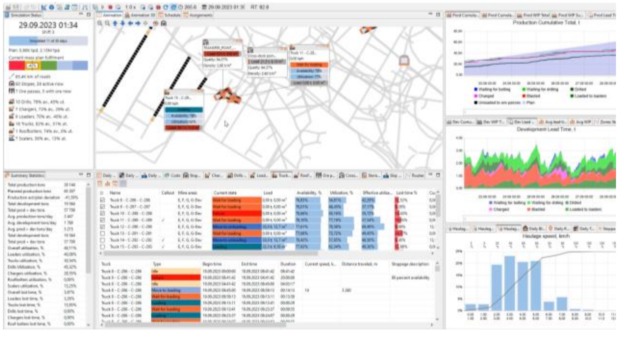
The project aimed to introduce a simulation-based decision-support tool capable of validating medium-term mine plans (1–12 months) and answering several critical production-increase questions, including:

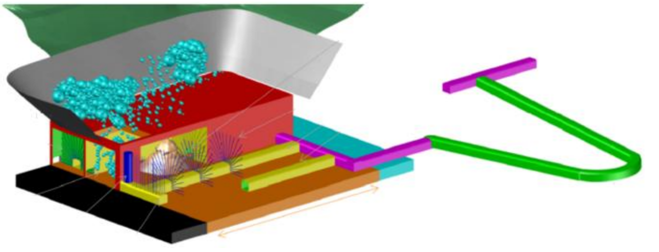
- Whether improvements to one of the shafts' availability would ensure the haulage system could support the first stage of production growth.
- How many additional mine trucks would be needed to meet the planned production targets.
- How changes in crew schedules would affect overall productivity.
- Whether constructing an additional skip shaft could reduce the truck fleet size by shortening haul distances.

A long-term goal was to establish a center of competence enabling the client to continuously apply simulation for strategic and mid-term planning.

Why MineTwin

MineTwin was selected because it provides a high-fidelity simulation of underground mining operations, capturing equipment interactions, haulage routes, delays, and the dynamic behavior of the mine. Compared with Excel or industry standard planning tools, MineTwin offered superior customization, accuracy, integration potential, and rapid simulation speed, allowing the model to reflect the unique conditions and constraints of this specific mine.

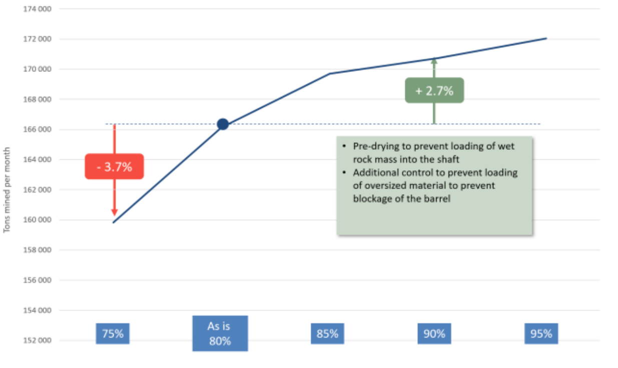




Determining benefit of additional infrastructure

MineTwin simulations evaluated whether measures to increase shaft's availability — from 80% to 95% — would effectively raise mine's throughput. The model showed that at higher shaft availability levels, mine output could increase by up to 2.7%, confirming that the planned capacity upgrade was justified.

The model also assessed the effect of adding more mining trucks. Scenarios ranging from +1 to +5 trucks were tested, allowing the mine to determine the optimal fleet size required to support the planned production increase and avoid unnecessary capital expenditures.



Supporting ongoing planning

After receiving clear, data-driven answers to the strategic questions, the client expanded the use of MineTwin as a core tool for ongoing planning. The simulation model now supports:

- Validation of quarterly and annual production plans
- Early identification of bottlenecks across extraction, haulage, and hoisting
- Optimization of equipment fleets for both short- and long-term horizons
- More accurate decision-making and forecasting at all operational levels

The project was completed in four months, resulting in the creation of an internal competence center that enables the mining company to independently use MineTwin for continuous decision support.

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://mine-twin.com

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