



Productivity Improvement of Mining Haulage System Simulation



Mining & Metals

Overview

SPb-Giproshaht is a consulting company that operates internationally and carries out design, procurement, and construction projects for the mining industry. Their flagship project in this domain is a haulage system optimization project for the mining company Medvezhy Ruchey, one of the largest miners of copper-nickel sulfide ores. Medvezhy Ruchey partnered with SPb-

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To date, mineral deposits near the surface of the earth are practically exhausted. Therefore, mining companies are forced to create enterprises of greater depth and productivity. Approximately 90% of the raw minerals extracted in open pits are excavated from mines which are more than 500 meters deep.

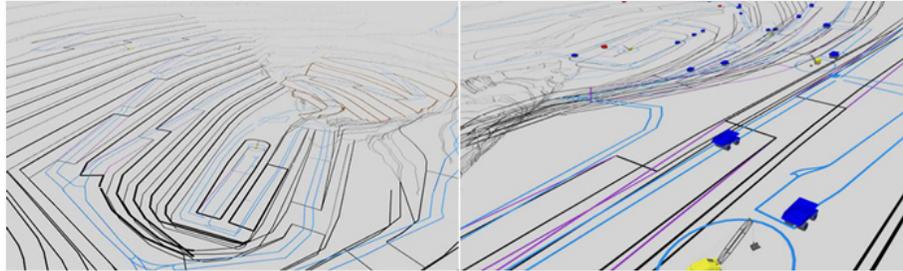
Increasing the depth of open pits has made raw material extraction more complicated, which in turn, has required the building of haulage systems consisting of various mining and transportation vehicles. Such systems cover all operations of the production process. At the same time, transportation costs have escalated: for deep open pits they account for 60-75% of the cost of the raw materials.

In order to optimize mining operations and transportation processes, Medvezhy Ruchey commissioned SPb-Giproshaht to build simulation models of the Medvezhy Ruchey open pit mine and the Zapolyarny mine. In both cases, a mining simulation model was required to address the following logistical challenges:

- Evaluate mine transportation network throughput.
- Verify the equipment required to haul the rock mass.
- Develop recommendations on equipment selection and its quantity.
- Confirm the specified production capacity with the given equipment fleet is being met.

The SPb-Giproshaht team applied AnyLogic mine modeling software to develop two separate simulation

concurrent application of several modeling approaches when building a model. In this case, a model was developed using the agent-based and discrete event approaches.



A fragment of the load and haul optimization model in 3D

In the model, excavators are used for unearthing ore and overburden (natural rock and soil that sits above and around the ore body), and dump trucks are used to transport the ore and remove the overburden. Ore is carried to a processing plant or to the crushing and hauling facility located in the Medvezhy Ruchey open pit, and overburden is taken to dumps. Ore dumper unloading is carried out successively, while overburden dump unloading from different trucks can be carried out simultaneously.

The input data for the mining optimization model came from the maximum transport load period of the open pit and the maximum production capacity: the 7th, 8th, and 9th years of mine operation.

The transport network was based on the site layout plans for the open pit. The 3D situational plan was set up according to the mining operations database loaded from the Micromine and Geovia Surpac software applications.

The model has 2D and 3D modes. The transportation

experiment.

The simple experiment runs a model with predefined parameters. At model startup, such parameters like the year of mining, the ore dumping spot, and the amount of equipment are set. The mining simulation model also enables the setting of additional parameters, including dump capacity, vehicle speed, and the duration of loading and unloading. At model startup, the rock transportation process is displayed. The results are presented in graphs, diagrams, and dynamic text: the number of vehicles involved, the total ore and overburden excavated (during shifts and for the entire simulation period), and other characteristics of the transportation process.

The parameter variation experiment enables the user to evaluate the type and the degree of influence of certain parameters on model behavior. Users choose the parameters needed and set the number of automatic simulation runs for which to vary the values of the selected parameters. The experiment results are displayed in diagrams showing the dependency of model efficiency on the varied parameter. For example, this experiment provided insights on how the transported overburden volume is related to the number of dump trucks. It helped define the minimum quantity of dump trucks needed to provide the required performance.

Result

The open pit optimization model allowed engineers to:

- Calculate traffic flows and the maximum capacity of the open pit road network in order to prevent

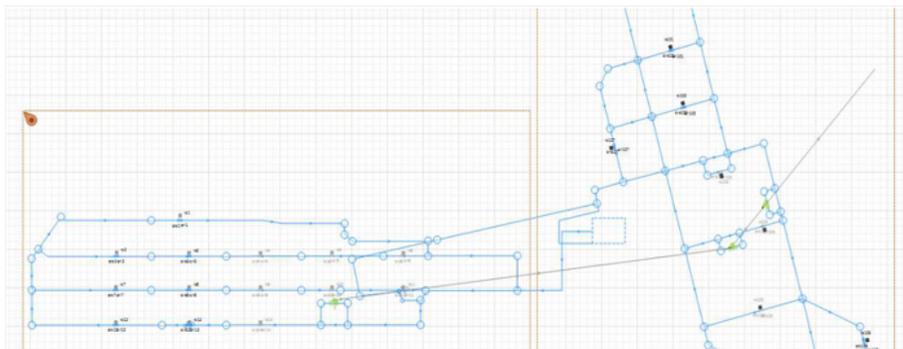
rock mass and total quarrying time.

Zapolyarny underground mine simulation model

Solution

Mining processes in the Zapolyarny underground mine are characterized by a number of features. For example, the mining operations generating the spoil tip operate on a closed transportation network and dump trucks inevitably interfere with each other when navigating the network. Also, with advancing field development, the position of spoil tips changes along with the locations of the raw material extraction. As a result, at various development stages, the dump trucks should be loaded in different places, which results in numerous haulage routes.

These features make the rock mass transportation process non-linear. When developing the model, a discrete event approach was chosen to reflect the listed features. The AnyLogic Material Handling Library provided components that reflected how vehicles moving in a transportation network could influence each other.



loading and unloading points are situated. The simulation and the parameter variation experiments are also available in this model.

When conducting the simulation experiment, the mining productivity improvement model runs with parameters that determine dump truck operations during one working shift. The minimum time interval of the transport network operation is one calendar month. Each month corresponds to a certain area of mining operations, while the process of the rock mass transportation remains unchanged. The model requests information from the database about the areas where the operations are being performed for the specified date and activates the corresponding loading points in the transportation network. Taking this data into account, the routes for the dump trucks are built and accidents are monitored and eliminated.

For the parameter variation experiment, the year and the month are set as variables, while the following settings act as parameters:

- The number of dump trucks
- The weight of the rock mass transported per trip
- The speed of the dump truck (loaded and empty)
- The loading and unloading duration
- The dump truck working times during the shift

Results are displayed in a histogram that shows the ore production volume for each month of the given time frame.

Results

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