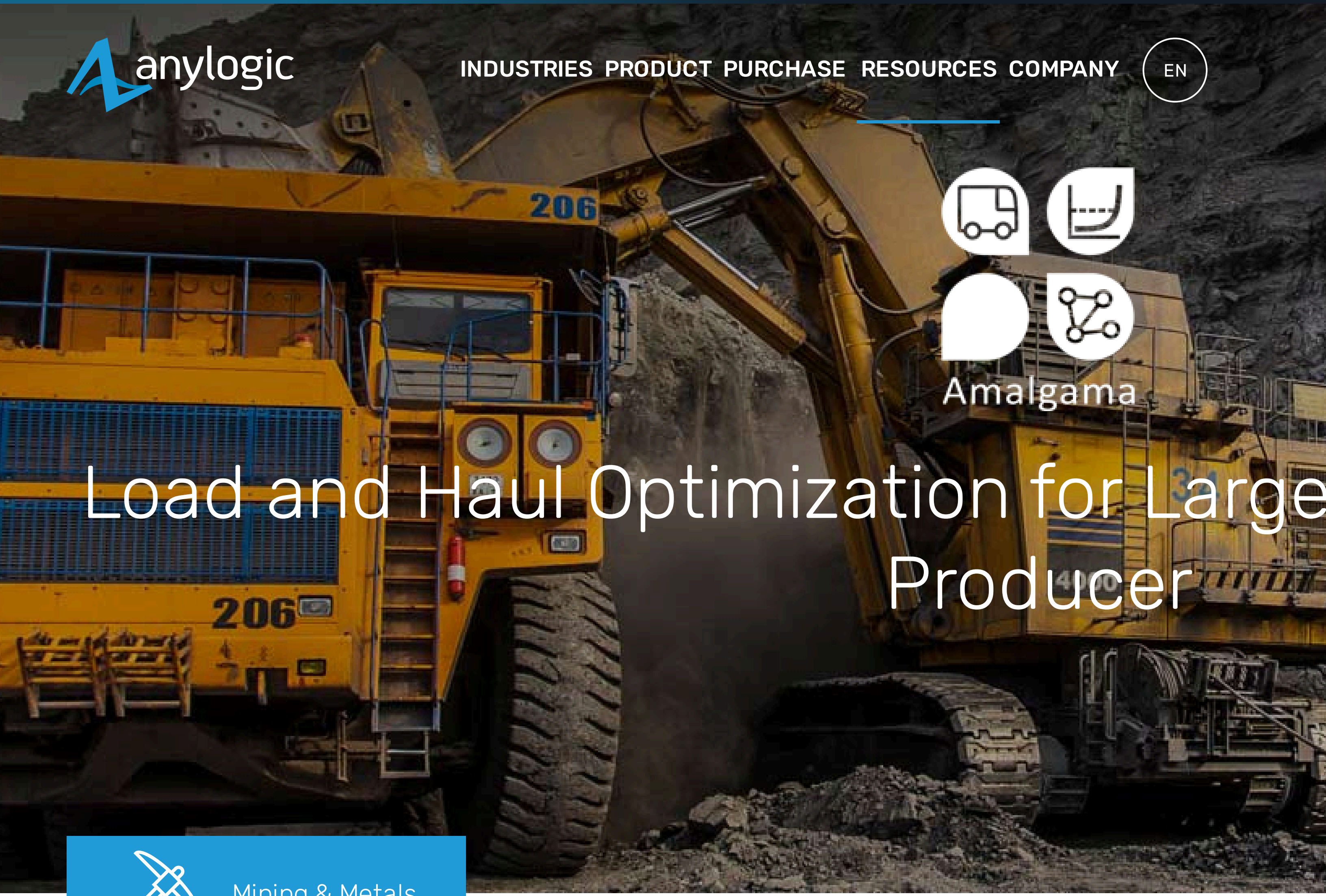


Load and Haul Optimization for Large Producer

Mining & Metals

Problem

Managers and engineers responsible for mining operations regularly face tasks including:

- Determining realistic daily and monthly production volumes.
- Testing mine plan feasibility.
- Evaluating the outcome of operational

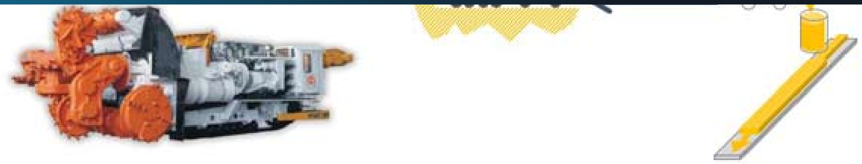
- Many interdependencies and overlapping activities.
- Interaction between equipment units.
- Changing cycle times of processes.
- Spatial limitations, yield and give-way logic of moveable equipment units.
- Complex layouts.
- Limited capacity of bunkers and conveyor systems.

How do managers plan mining processes while considering all of the above? Traditionally, they make assumptions that are never close to reality, such as:

- Average haulage distance. The cycle time of haulage is different, point to point and time to time, under the influence of uncontrollable parameters.
- Average dump time. If the system overflows or there are queues in front of the ore passes, then the dump time changes.
- Percentage of time a conveyor is stopped due to overflow. It is never constant, and it cannot be specified by a single number.

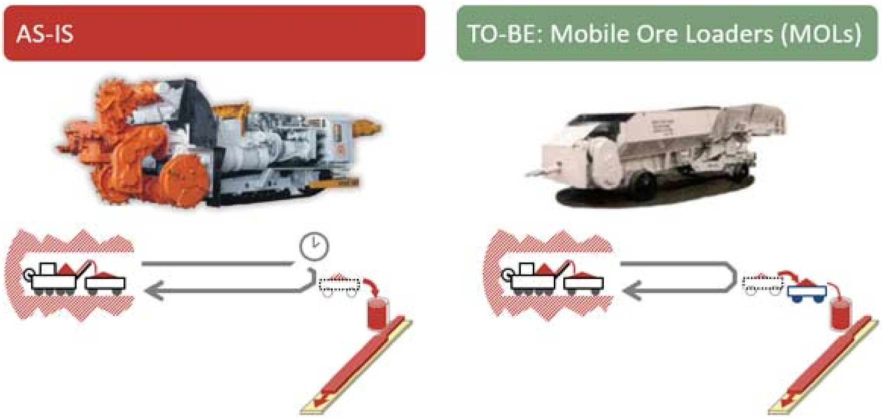
Simulation allows mine planners to model processes as they are and get rid of these assumptions.

As such, the largest European potash producer carried out load and haul optimization. With the help of **Amalgama** and one of the Big Four consulting firms, they created a mining process simulation model using AnyLogic software. A big potash mine is 8 x 8 km in size. 900 thousand tons are mined per month on three underground levels. The mine has 21 km of conveyor belts taking the ore through the system to the skip



20 x (Borer + Dump Truck)

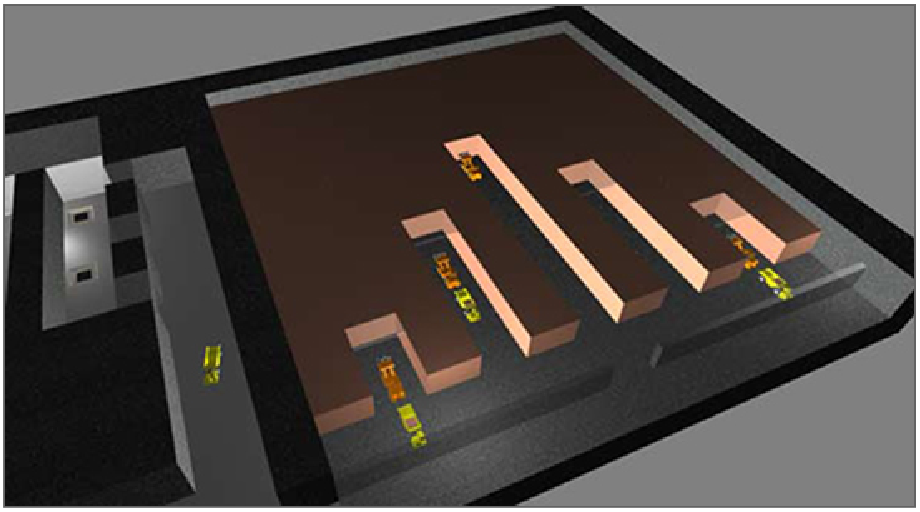
The capacity of an ore pass is three tons, but a dump truck carries 22 tons of ore. After the first three tons, the dumping speed depends on the current load of the conveying system underneath the ore pass. Since the conveyor can already be loaded with ore from other upstream borers, the system may be constrained. To get rid of this constraint, mine planners were going to change the equipment configuration by adding Mobile Ore Loaders, or MOLs. In the TO-BE scenario, MOLs played the role of a buffer between dump trucks and ore passes. The dump truck quickly dumped ore into the MOL and returned to the borer while the MOL continued dumping ore into the conveyor system.



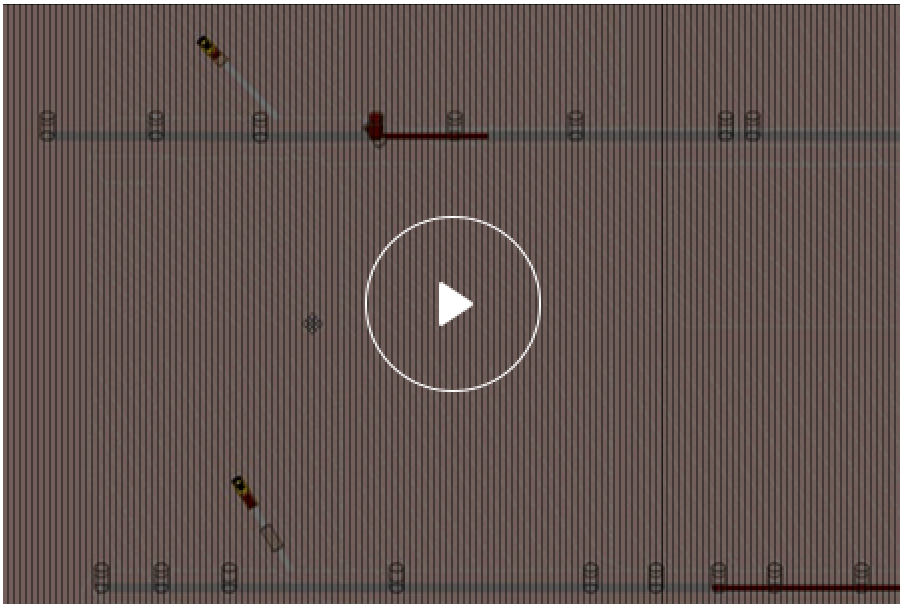
Adding Mobile Ore Loaders

By adding buffering capacity, mine planners hoped to lower the dump truck cycle time. The main question was whether usage of MOLs would allow them to get rid of one borer while keeping the production volume.

Amalgama's simulation developers created an AnyLogic mining simulation model to answer these questions. This mining simulator included the whole mining process from drilling to hoisting, precisely as the plant was laid out.



Load and Haul Optimization Model in 3D



Simulation model of the mine

The first experiment with the model was how the mine system would behave if the external constraint of conveyor speed was removed. This experiment helped find three borers that had a production rate limited by internal constraints such as their own performance, maintenance intervals, buffer size, etc.

As a result, three borers were chosen to be candidates for removal with minimum influence on the mine production rate, since MOLs would only remove constraints caused by the speed and capacity of conveyors.

Borer	Scenario 1. No Borer #65	Scenario 2. No Borer #105	Scenario 3. No Borer #150
Borer #012 + MOL	54 003	54 003	54 003
Borer #145 + MOL	36 329	35 183	34 550
Borer #65 + MOL	0	44 089	44 126
Borer #77 + MOL	45 434	45 434	45 642
Borer #82 + MOL	50 125	51 363	51 339
Borer #143 + MOL	39 079	38 543	38 591
Borer #150 + MOL	46 114	46 114	0
Borer #99 + MOL	50 293	50 293	50 293
Borer #123 + MOL	46 467	45 413	45 168
Borer #147 + MOL	48 471	50 175	50 468
Borer #011 + MOL	60 792	60 912	61 056
Borer #62 + MOL	50 651	47 895	47 482
Borer #53 + MOL	48 782	49 262	49 190
Borer #113 + MOL	40 088	39 434	39 561
Borer #144 + MOL	40 153	40 106	39 864
Borer #89 + MOL	45 567	45 882	45 761
Borer #95 + MOL	47 568	49 019	47 786
Borer #96 + MOL	48 832	51 024	52 681
Borer #105 + MOL	45 316	0	45 594
Borer #104 + MOL	45 412	44 972	44 605
Total:	889 476	889 117	887 761

The effect of removing each of three borers

The effect of removing each of these three borers was studied with simulation. These experiments showed that removing borer #65 reduced production the least.

Then several scenarios were run to determine where to send the five MOLs to maximize ore production. Five borers were chosen to send the MOLs to. This scenario showed only a 1.02% decrease in production volume, which was negligible. At the same time, this scenario showed a significant decrease of OPEX, since one borer had been removed from the mine.

Outcome

The simulation model of the underground mine changes.

Project presentation by Andrey Malykhanov, Amalgama

Similar case studies

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