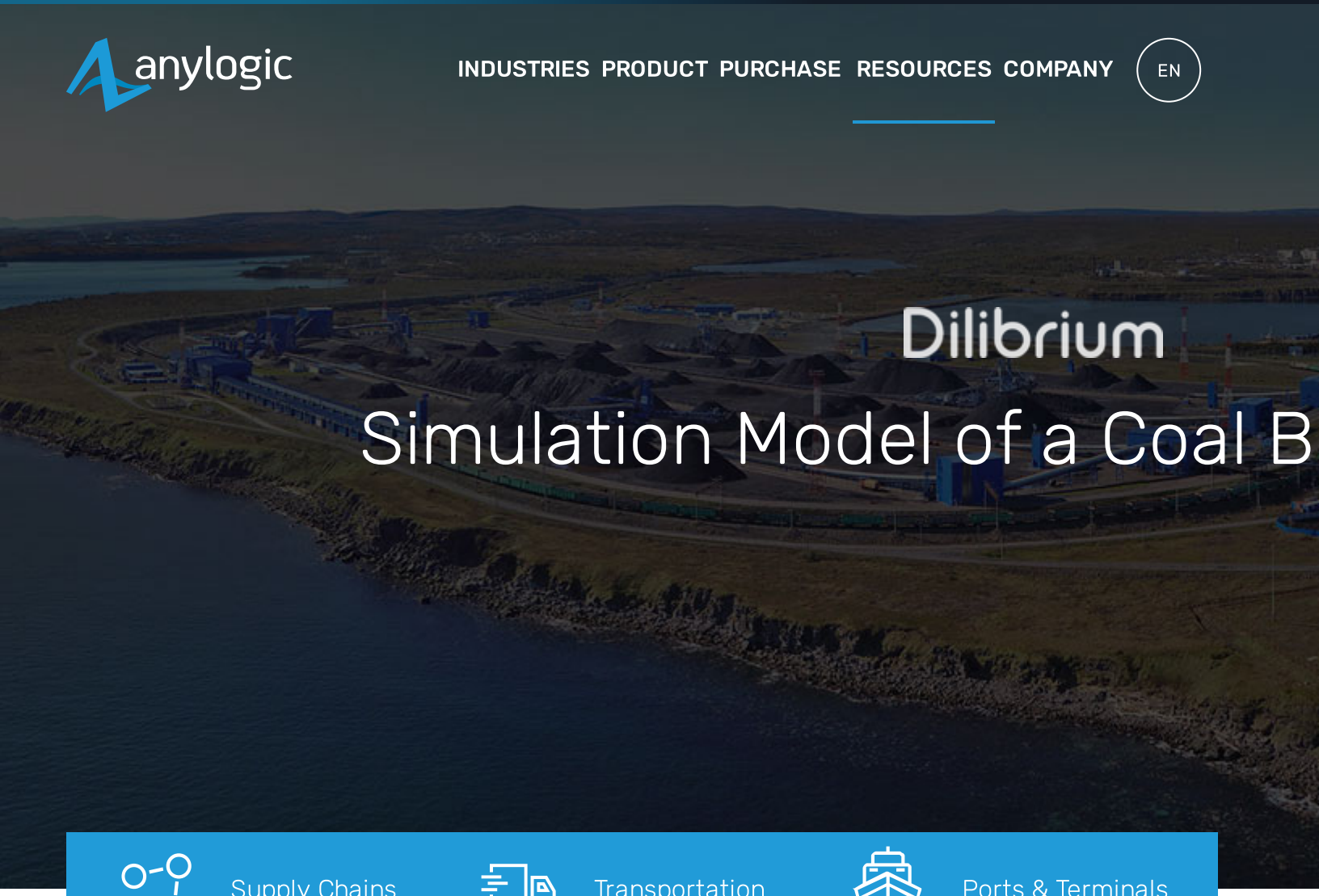


Dilibrium

Simulation Model of a Coal B

Supply Chains | Transportation | Ports & Terminals

Overview

Daltransugol coal terminal, also referred to as the Vanino Bulk Terminal, is located in the deep-water Muchka Bay. It is the most important transshipment point on the way to the markets of the Asia-Pacific region.

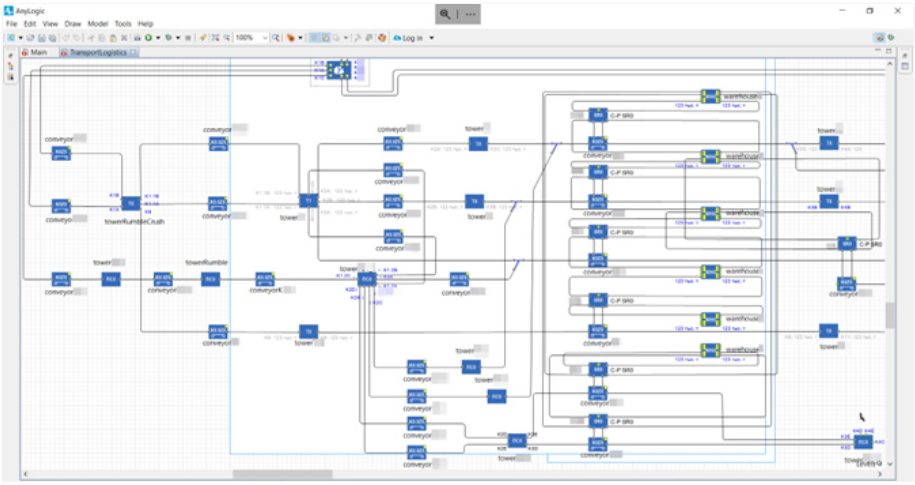
It is situated at the extreme point of the Baikal-Amur

more than 4 km. The length of railway tracks is more than 50 km.

Problem

Daltransugol needed to increase the transshipment capacity of the terminal to 40 million tons of coal per year. At this stage, the specialists of Dilibrium conducted an analysis of the Daltransugol coal terminal.

They specified parameters of the technological process, made full-scale measurements of individual technological operations, conducted interviews with various specialists and terminal services, analyzed historical data on the operation of the terminal, and found statistical patterns. Then they used this information to build a model.



End-to-end business process modeling logic showing transport logistics (click to enlarge)

The entry point was the arrival of laden wagons at the Terminal Reception Park. The exit point was the

the shipment of coal by bulk carriers.
2. The movement of trains at the adjacent station, and internal railway logistics of loaded wagons: arrival, sorting, sawing and defrosting of cargo, and filing for unloading.
3. The unloading of wagons by using an automatic system of wagon dumpers, taking into account the peculiarities of the process at different times of the year and weather conditions.
4. The transportation of goods through the conveyor network, especially the work of a virtual dispatcher for marking a warehouse for unloading coal, and building routes, considering the priorities of cargo, coal grades, season, weather, workload, and degree of operating time of the main technological equipment, etc.
5. The loading of coal onto ships, allowing for their deadweights and restrictions on individual berths for receiving ships, queue priorities, as well as types of vessels for which loading should proceed with different quality control and speed, etc.
6. The movement of empty wagons along the internal railway network, including sorting, rejection of wagons and sending them for repair, and formation of trains for shipment by rail.

Solution

To solve the problem, a simulation model was developed with AnyLogic software. The development process consisted of the following stages:

1. Model design

At this stage, information about the object of modeling

2. Development of the model “AS IS”

First of all, Dilibrium decided to develop the “AS IS” simulation model of the terminal. This was important in order to set accurate values of the parameters of individual agents and algorithms on the constructed and sufficiently detailed model. The purpose was to verify the model in accordance with historical data. As a result of the verification of the terminal simulation model, it was possible to achieve high reliability in comparison with historical data for 2019-2020.

This result became possible due to the high degree of detail of technological processes in the simulation model.

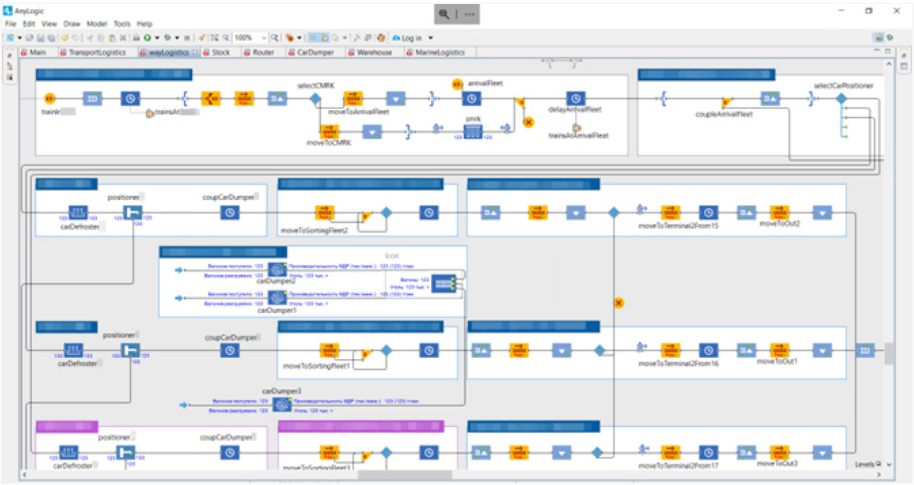
To simulate technological processes and change the state or behavior of model objects, the following simulation approaches were applied:

- A method of agent-based simulation to implement the behavior of individual agents.
- A discrete-event method for modeling the technological processes of the terminal.

3. Refinement of the model with “TO BE” scenarios

Several experiments were added to the verified “AS IS” simulation model with fine-tuned processes and parameters to test hypotheses for calculating the maximum throughput of the terminal. These included modified terminal spatial planning, a new layout, and new types of main technological equipment. In total, five different options for the configuration of warehouses and sets of basic technological equipment were implemented in the model. They corresponded to

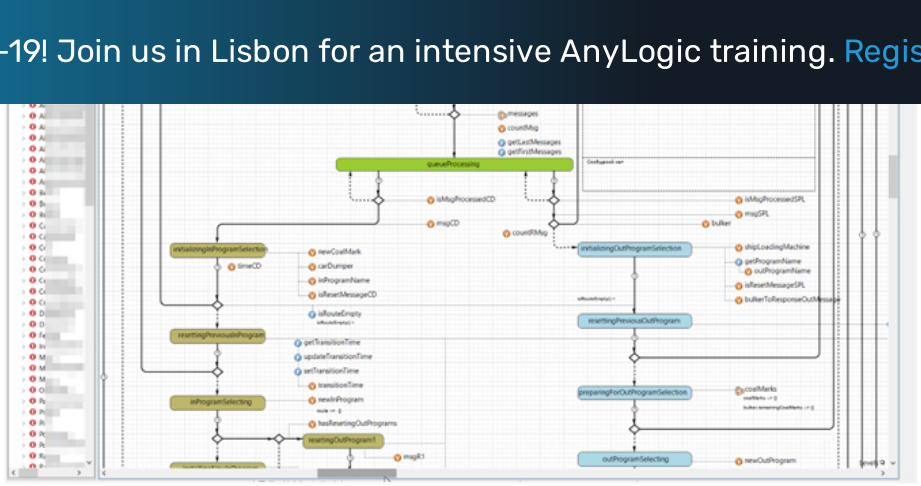
modeled using Java code.



End-to-end business process modeling logic showing railway logistics (click to enlarge)

In addition to modeling railway and conveyor logistics, there was a difficult task to develop a cargo routing algorithm taking into account warehouse planning. In order to select and build a route, a large number of interrelated conditions and parameters had to be considered:

1. The stage of modernization chosen before the simulation.
2. Weather conditions (modeled according to historical data and with specified coefficients of deviations).
3. Season.
4. Availability of each key unit: equipment (more than 80 units), employment on the line, maintenance and repair, breakdown.
5. Current order from the dispatcher for unloading or loading.
6. Volume and types of cargo in wagons at the terminal and in transit.



The algorithm was developed using the AnyLogic statecharts (click to enlarge)

The model simulated a full calendar year, including seasonality and weather conditions. During this period, both operational data and statistics by year/month/day for all major processes and pieces of equipment were collected in virtual time mode. At the end of the simulation, the outputs were uploaded to a separate Excel file for further analysis of the results of the experiments.

Stochastics were implemented into the model, for example, random deviations from statistical data on breakdowns, weather conditions, and the coefficient of errors or inconsistencies when submitting trains and ships to the terminal. Conventionally, a ship could come to the pier, at which not all of the required grades of coal were in stock and the rest was still delayed on the way to the terminal.

Results

The simulation model was verified through the “AS IS” stage. Dilibrium obtained extensive statistics for maximum productivity and for the indicators of each

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