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## SIMULATION MODEL FOR LIGNITE HANDLING AT THE BOXBERG STOCKYARD

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### 1. Background and objective

Reichwalde opencast mine. At the same time, the new built 675 MW unit R will be put into operation at the Boxberg power plant site of plant IV. The Nochten and Reichwalde opencast mines will then have a production of totally approximately 30 million tonnes of raw lignite, handled via the Boxberg coal stockyard and supplied to the consumers (power plants, briquette factory, combined heat and power plants, and others). Unit Q of the Boxberg power plant IV and the new 675 MW unit R being also supplied by belt conveyors are directly supplied from the coal stockyard by belt conveyors and will then have a total consumption of up to 12 million tonnes of raw lignite per year. The remaining share of raw lignite of approximately 18 million tonnes is transported to the consumers by coal trains of the company's central railway operation (intra-regional coal supply).

To determine the requirements to the design of the equipment and the disposition / operational management of the coal stockyard a quantity despatching system was developed which is specially adjusted to the average daily consumption of the consumers. This quantity concept is the basis for the systems analysis, the draft model and the following simulation of the handling processes at the coal stockyard. The project aimed at modelling the future coal stockyard in sufficient detail and, based on this, proving a reliable operational management over the period of one reference week.

Within the framework of this project GMB was responsible for the technological conception whereas G.E.O.S. developed the simulation model for the coal stockyard and in particular the solution algorithm. Section 2 describes the coal stockyard and the essential elements of it. In the following Section 3 the numerical implementation is explained in detail. Section 4 contains the simulation results and the conclusions resulting from it.

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**Fig. 1.** Target configuration of the Boxberg coal stockyard in 2010

## 2. Description of the System Components

The planned Boxberg coal stockyard is a highly complex logistic handling system. The essential elements are:

- Four coal piles (A to D), each divided into two to three pile sections with different coal qualities. The total pile capacity amounts to maximally 350 kt.
- Four large stacker/reclaimer units with different capacity parameters and scope of functions
  - Ks-S-1815: equipment for partly or fully stacking and/or handling of the incoming coal or alternatively for reclaiming of piles A and B.
  - SR-G 20 and SR-G 40: two machines moving on rails, which can be used for reclaiming of piles B and C.
  - Ks-S-1825: equipment for partly or fully stacking and/or handling of the incoming coal or alternatively for reclaiming of piles C and D.
- Eight belt conveyors being directly connected between each other or via distributors.
- Three distributors enabling the distribution of the coal streams among two belts at a time.
- One collecting bin to homogenize the coal streams in short peak times

In addition to these elements of the coal stockyard, there are the supplying opencast mines as well as the consumers representing the marginal conditions for the logistic processes at the coal stockyard. The whole system is schematically set out in figure 2. The marginal conditions are variably prioritized depending on the operating / fault and consumption condition.

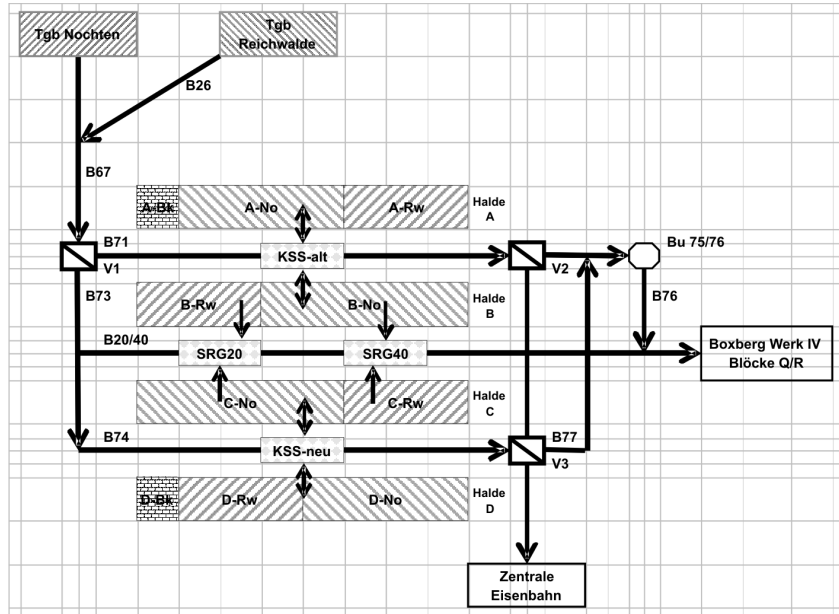


Fig. 2. Schematic overview of the coal stockyard elements

### 3. Numerical implementation

#### 3.1. Software platform

The modelling of the coal stockyard was made with the help of the simulation software GoldSimTM.

In addition to the model file there was produced a so-called Player File for the existing logistic problem. This file contains the whole model logic and can be viewed using the free GoldSim Player. It is also possible to change certain parameters intended for the GoldSim Player via input windows facilitating to run new simulations. The user obtains a flexible tool to check the consistency of the model and to calculate different scenarios.

#### 3.2. Model structure

Based on the elements available in GoldSim it is possible to structure the model hierarchically analogue to the real system. So-called container elements are used for this each representing a handling or storage element, a mass distributor or other general function-relevant elements.

The functionality of each element is implemented via mathematic equations inside the container. It is possible to consider any dependencies from other parameters, sub-systems or conditions.

The model was structured into single containers analogue to the planned coal stockyard. Figure 3 depicts the coal stockyard. The total model also contains some other containers for marginal conditions, graphic illustration of the results, input windows, optimization routine as well as control parameters.

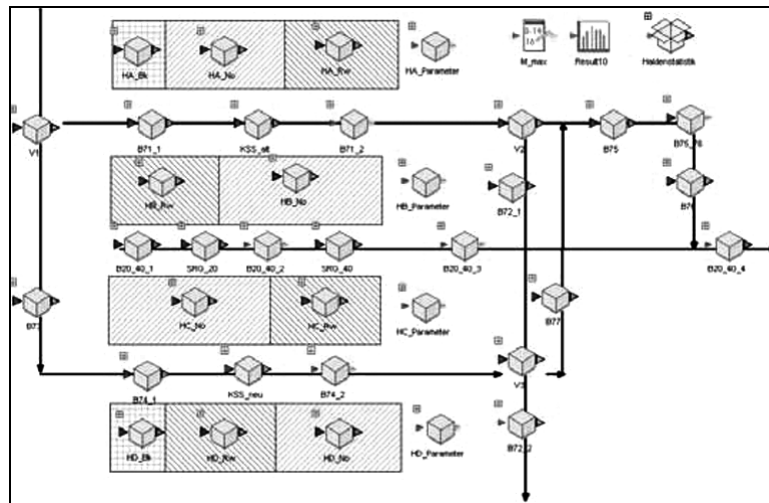


Fig. 3. Container structure of the GoldSim coal stockyard model

The whole model structure is very complex and consists of approximately 1,300 single elements.

### 3.3. Simulation process

The simulation illustrates an integration of the system via time. This is made by simulating changes of all parameters in their interdependencies from timestep to timestep.

In the case under consideration the system condition is determined by so-called equipment conditions and pile conditions. The equipment conditions characterize the possible and logical combinations of working equipment in dependence on the respective marginal conditions. The pile conditions describe the possible combinations of pile sections, where operation can be performed parallel under consideration of collision protection. Considering the marginal conditions (with and without infringement) there were identified 311 equipment conditions and 112 pile conditions.

At the beginning of the simulation the marginal conditions (requirements) are determined and the optimization routine is started. There, a target function is calculated for any possible combination of equipment and pile condition taking into consideration the marginal conditions. In this target function single aspects evaluating the actual combination are integrated. From all possible conditions there is finally selected a condition containing a minimum for the

target function. The system is then simulated under this condition until changeover into a new condition is required.

The target function by which the suitability of the conditions is assessed considers certain aspects by means of relevant mathematic expressions which are included in the target function, each weighted.

All coal streams are balanced via the timestep and the change of coal quantities on the piles, on the belts and in the marginal conditions are calculated.

In addition, the respective transport time of the coal via the coal stockyard is taken into consideration.

#### 4. Results, Summary and Outlook

By means of the described model approach it was possible to map all logistical processes relevant for the coal stockyard and their interdependencies in a technical model. A Player file with an own interface was developed for the model in which parameters can be changed. By way of example, the main menu as well as the visualization for the coal stockyard shall be illustrated. Figure 4 shows the main menu of the Player file by which selected model parameters can be changed, the simulation process controlled and the results visualized.

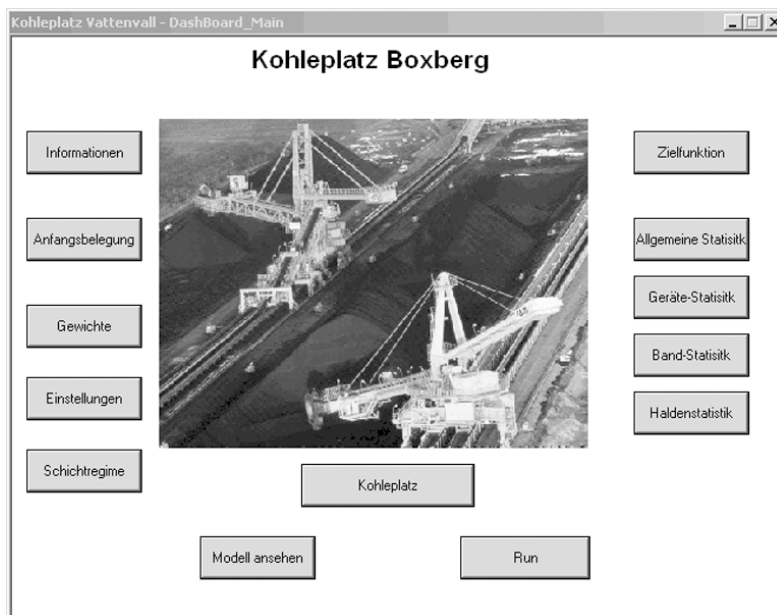


Fig. 4. Main menu of the Player file

Among others, the actual coal streams, pile quantities and activity conditions of the equipment can be visualized (see fig. 5).

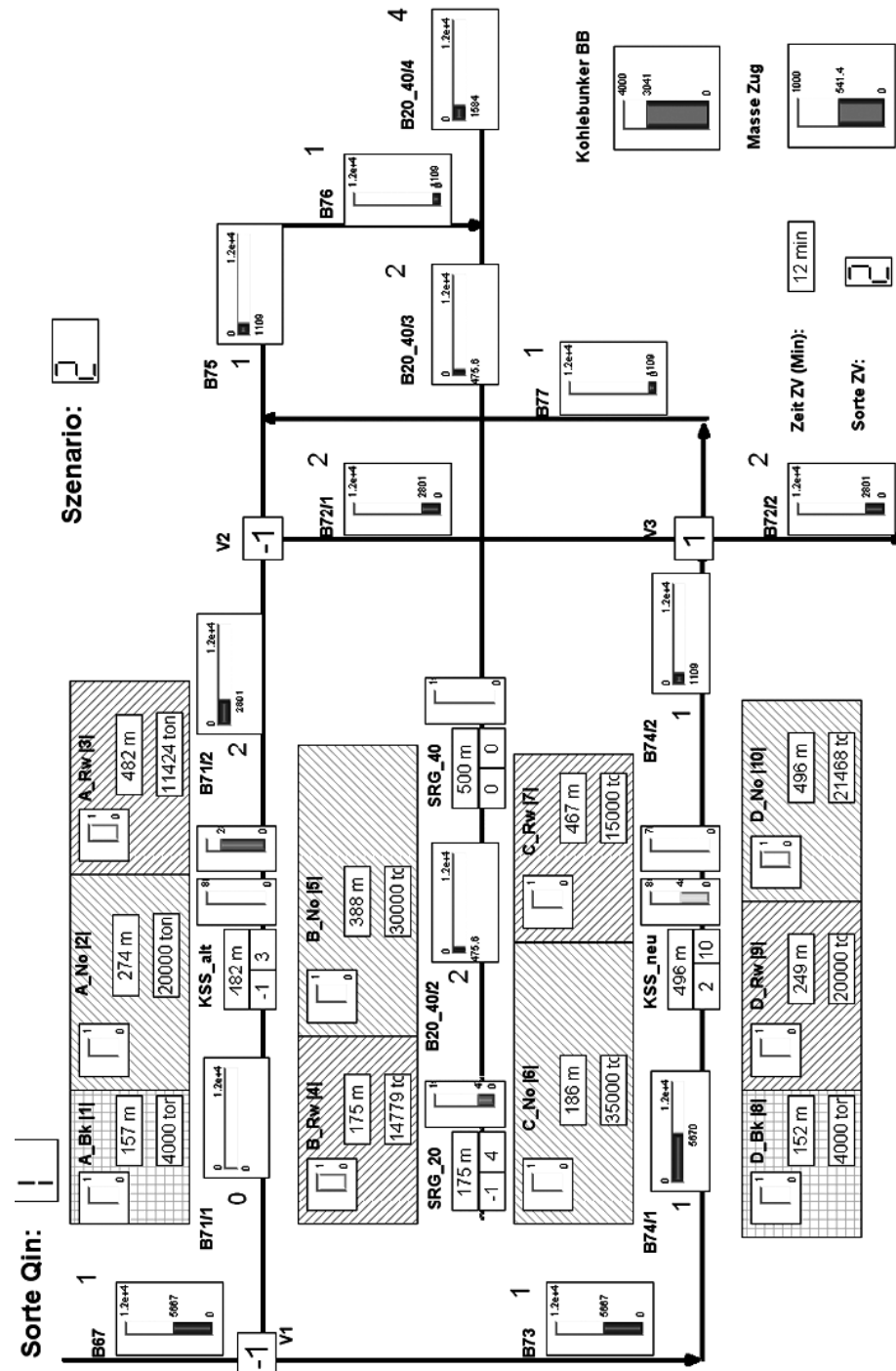


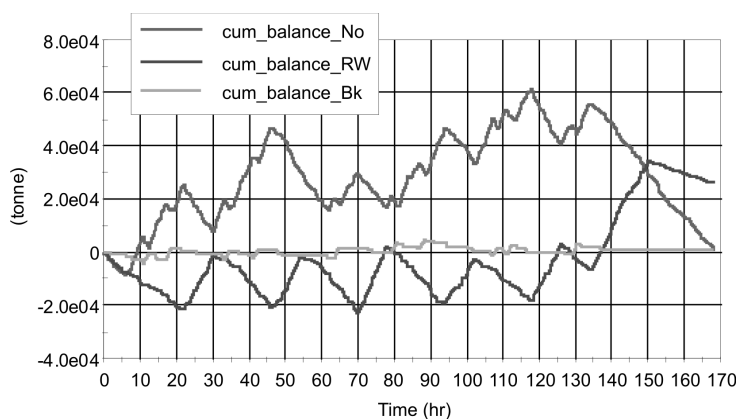
Fig. 5. Window for visualization of the coal stockyard processes

Based on the model simulation, it could be proven that the currently envisaged plant-technical planning variant for the coal stockyard is capable to undertake coal handling with an equalized balance within the reference time under consideration of the given marginal conditions.

**Below, some simulation results are illustrated by example**

Figure 6 shows the total balance of the coal stockyard supplies over a period of one week broken down by individual coal grades.

In the illustrated simulation case, there are reserves of boiler coal from Reichwalde. In reality, this constitutes an optimization reserve, because for example it might be possible to stop operation for one shift.



**Fig. 6.** Total balance of the coal stockyard supplies

The existing model implementation based on GoldSim was used iteratively with varying marginal conditions allowing to determine both capacity reserves and weak points of the plant-technical and logistic system.

However, the calculation time of the simulator (on state-of-the-art standard PCs) is considerable due to the high model complexity. The ratio of simulation time to real time currently amounts to 1:100 (simulation time for one week corresponds to 2 hours).

Therefore, the simulator is currently not suited for further applications e.g. as operative tool with online process data acquisition for the coal stockyard dispatcher, where necessary even with interaction in the equipment system.

A further increase in the simulation speed by a factor of approx. 100 will be possible by optimization of the existing algorithms and consideration of all ad hoc information currently known. This could facilitate to develop the above-mentioned process-oriented applications for the realization of an automatic operation of the whole coal stockyard system in the future.