Summary

Until now, bulk terminals are designed with the aid of rules of thumb. These rules make an estimation reality because they don't account for stochastic aspects of the terminal under design and its' specific properties. By using a simulation model in an early stage of design, more accurate information is gathered which can be used to lay out the terminal. This information can also be used to get a view of how the terminal is going to operate.

In bulk terminals three areas can be distinguished. At first an area which handles incoming flows. Secondly the area which stocks the material before transporting it to the last area. The last, and third, area deals with the outgoing flows. There are many ways of modeling these flows. When designing the model, the focus was on creating a generic simulation model which can be extended with ease and makes it possible to add new functionalities in the future. The used job shop approach has a high level of generality and makes it possible to be extended very far.

The terminal has been modeled according to a modified 'job shop'. In a job shop a number of machines is combined to form production lines. These production lines are defined prior to the actual simulation and are static during runtime. If a task arrives for creating a product, first a production line is chosen. After this choice is made, the task can be assigned to the production line. The production line takes care of every production step by using each piece of equipment in it to create the desired product.

In case of a bulk terminal the same approach can be used. A list of terminal equipment will function as a route throughout the terminal. The first equipment in a production line, better called an equipment line, is the starting point for a batch of bulk material. The last equipment in an equipment line is the destination of a batch. An equipment line transports the batch of material from its' first piece of equipment to its' last piece of equipment.

With the use of two example terminals the model has been validated. The first example terminal is a simple terminal which is able of handling incoming ships, trains and trucks. The second example terminal makes use of double belt conveyors, stackers and reclaimers and thus can fall back on alternative equipment lines when a breakdown occurs. The second example terminal offers redundancy while the first doesn't. It can be concluded the model performs as expected when simulating the example terminals. Both rational expectations and expectation calculations validate the model within an acceptable margin.

Rules of thumb exist that predict the amount of stock space which will be needed for a terminal. The rules say that about 10 to 15 percent of the annual throughput is a suitable stock size. The supply pattern which serves as an input file of the model has been created by a separately developed model. This model is able to generate a supply list and export it to a text file. Simulation results show that the

used supply and demand pattern requires 12% of the annual flow as a stock size. These results are within the range of the rules of thumb.

A generic model that simulates bulk terminal operations has been developed, verified and validated with rules of thumb. The basis of the simulation has been implemented and is available to be extended in the future. The model can be used to determine the required stock space, to get a prediction of service levels and to calculate occupation rates of equipment. It can be used to calculate average waiting times and processing times of transporters too.

It is recommended to extend the model in future updates by adding more detail and implement more functionalities. Besides adding the listed functionalities the model can also be validated with real-life data by simulating an existing bulk terminal and comparing the results with actual available data. This gives a better validation. At the time of writing no – non-confidential – information was available to validate the model any further.