

Summary

The design of bulk terminals is a costly business. A good way of supporting the design process is by the use of a computer model of the terminal. This model can be used to determine the characteristics of the terminal, like the number of loading stations and their capacity, the storage volume, the capacity of the internal transport system and so on.

The dimensioning of a terminal depends strongly of the annual throughput and the delivery and purchase pattern of the terminal. The goal of this report is to develop and explain a generic computer model to simulate the delivery pattern of a bulk terminal.

The model is kept generic by the use of four input files. The input files are used to enter all the necessary information into the model. The input files are:

1. The Transport input file. This file contains all information about the used transporters (e.a trains, trucks, boats, barges etc):
 - a. The name of each used transporter.
 - b. The capacity of each used transporter.
2. The Bulk input file. This file contains all the information about the bulk materials (dry and liquid) used in the simulation. The information contained in the input file is:
 - a. The Name of the bulk materials
 - b. The Reorder point (or safety stock) of each material.
 - c. The Initial stock. This is the stock on the beginning of the simulation run.
 - d. The Lead time.
 - e. The Density of the bulk material.
3. The LoadStation input file. This file contains the information about the load stations per load station group. The information contained in this file is:
 - a. The transport Modalities each load station group can handle.
 - b. The number of load stations per load station group.
 - c. Per load station its capacity (in tons/hour).
4. The client Input file. This file contains the information on the clients. The information:
 - a. The name of the client.
 - b. The number of transport generators each client has. This generator produces the transporters that arrive at the terminal to pick up the demanded bulk materials.
 - c. Information per transport generator on the arrival pattern of the transporter.
 - d. Information per transport generator on the demand pattern. The arrival and demand pattern of the transporters form the delivery pattern of the terminal.

The names and terms used in the input files must be the same in each file. Before the simulation commences, in the initialization fase, this is checked. When an error occurs during this stage a warning is given and the error is pointed out after which the simulation is stopped.

The key performance indicator (KPI) of the model is the time each transporter has to wait before the loading of that transporter commences. The model is used by comparing the KPI of the model with preset boundary conditions. The model is run several times. By entering different values for the wanted characteristics in the input files, the model can be used to determine those characteristics by trial and error. Two of the characteristics that can be determined that way are:

1. the reorder point of the stock.
2. the number of load stations per transport modality and the capacities of each load station of dry and wet bulk terminal.

In the model input form the run time of the simulation must be entered. Furthermore two graphs can be chosen to be shown at the form. The graphs are:

1. The mean waiting time before a transporter can be helped.
2. The stock versus the time of each bulk material.

The model has been proven to be a useful tool but it is not very elaborate. The terminal is modeled as a black box. The way the bulk material gets into the stock and from the stock into the transporters is not modeled. Besides this detailing of the model there are still a few points that can even further improve the accuracy (if necessary) of the model and the degree of matching with the real world.

1. In the real world a transporter will not just show up at the terminal demanding bulk materials. This is the case at the moment in the model. A client will let the terminal known in advance that the transporter will come and at what time. Furthermore its demand is known as well. Letting the terminal know in advance what to expect can be done by adjusting the program code, but that will not be shown in this report.
2. The transporters at the moment do not have a large number of attributes. To allow for a more accurate representation of the real world, a couple of things can be added. It is important to notice that the implementation of these attributes will seriously complicate the model. So these should not be implemented unless for good reason. To give a few examples of the attributes that can be added:
 - a. Number of compartments in which the bulk material can be stored. This can be important to know when one transporter has to transport several types of bulk material.
 - b. A queue per compartment to store bulk material elements. A boat may have several storage compartments. In each compartment a different type of bulk material can be stored.
 - c. Coordinates of the compartments relative to a specific point (for instance the locomotive of a train). This could determine the time it takes for a loading installation to set up before loading or for the installation to load the transporter.

One very small point of concern remains in the model: the moment of reordering. At the moment the model places an order for new bulk material after the loading of a transporter (if the stock falls below the reorder point) has finished. The model would be more accurate if the order was placed before the loading started, because at the start it is already known that the stock will fall below the reorder point. The necessary adjustment is just a very small one. In comparison, the loading takes about 1 day max, while the lead time of the bulk materials is more in the proximity of 1 month. Nevertheless in future usage of the model it is recommended that this alteration will be made.

In the simulation the clients and their transport generators are coupled to the terminal by the model code. To allow for a more elaborate terminal simulation model the clients and their transport generators have been disconnected from the terminal. The new model created by disconnecting the parts contains the clients and their transport generators. This model produces a list with transporters, their arrival times, transport types and per bulk type a demand in tons. This list can be used as input for the more elaborate terminal model. Just as for the coupled model this model can also be extended to allow for more information in the output file.