

Optimising container terminals using simulation and emulation methodology: Part 2

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Determination of a container terminal capacity

A system working on the lowest level of detail does not consider the operation system the terminal uses. The capacity of a container terminal is limited by the capacity of the container stacking area and the quay. The latter is limited by its length and by the capacity of the ship-to-shore cranes available. The aim of such a system is to surmise the current point at which the terminal bottlenecks. With this, the user can determine how much throughput the terminal handles through use of the existing facilities, as well as the maximum possible capacity of a planned terminal. Does the bottleneck occur by the quay respective of the number or type of ship-to-shore cranes? Or does it take place in the stacking area? And how much throughput can a terminal handle with its existing capacity?

CAPS (see Figure 1) is one example for the above explained proceedings: In the input module, the model asks for general information, land side and quay side information. For simulation the system needs information on both the yearly throughput, which has to be investigated, and its distribution over the year, in order to simulate peak times. The number of container slots available has to be entered as well as the container dwell times regarding individual container types. Among other features, CAPS provides the options to develop several vessel types for the quayside definition, to design the quay in any desired configuration and to distribute the ship-to-shore cranes along the quay.

After simulation, such a model evaluates the quay as well as the stacking area and provides information about the utilisation of the quay and the crane performance. The user is informed, e.g. if the quay length fits to handle a definite container volume and how many ship-to-shore cranes are necessary to serve the arriving vessels. For the area evaluation, the model ideally distinguishes various area types (e.g. areas to stack standard, reefer, dangerous, and empty containers) and it provides an indication of the sufficient number of stacking slots.

The CAPS system has been in operational use since the end of 2001. Since then, several consultancy projects have been carried out with the aid of this system. During these projects the software was enhanced and verified according to real operations, i.e. together with the terminal operators a simulation scenario of the current situation of the terminal was defined and the simulation results were compared with the real data of the terminal.

Simulation and analysis of container unit handling systems

The simulation of the operation system used supports the user to investigate the planning and design of container terminals. The design comprises the layout and the deployment of equipment. The interdependence of these two factors is a focal point of the model, i.e. it investigates which areas are available and which equipment types and handling system should be deployed best.

The evaluation of the simulated container terminal is carried out with regard to economic and technical aspects. The target variables' output, measured against each other and interpreted, are the costs incurred and the handling volumes achieved.

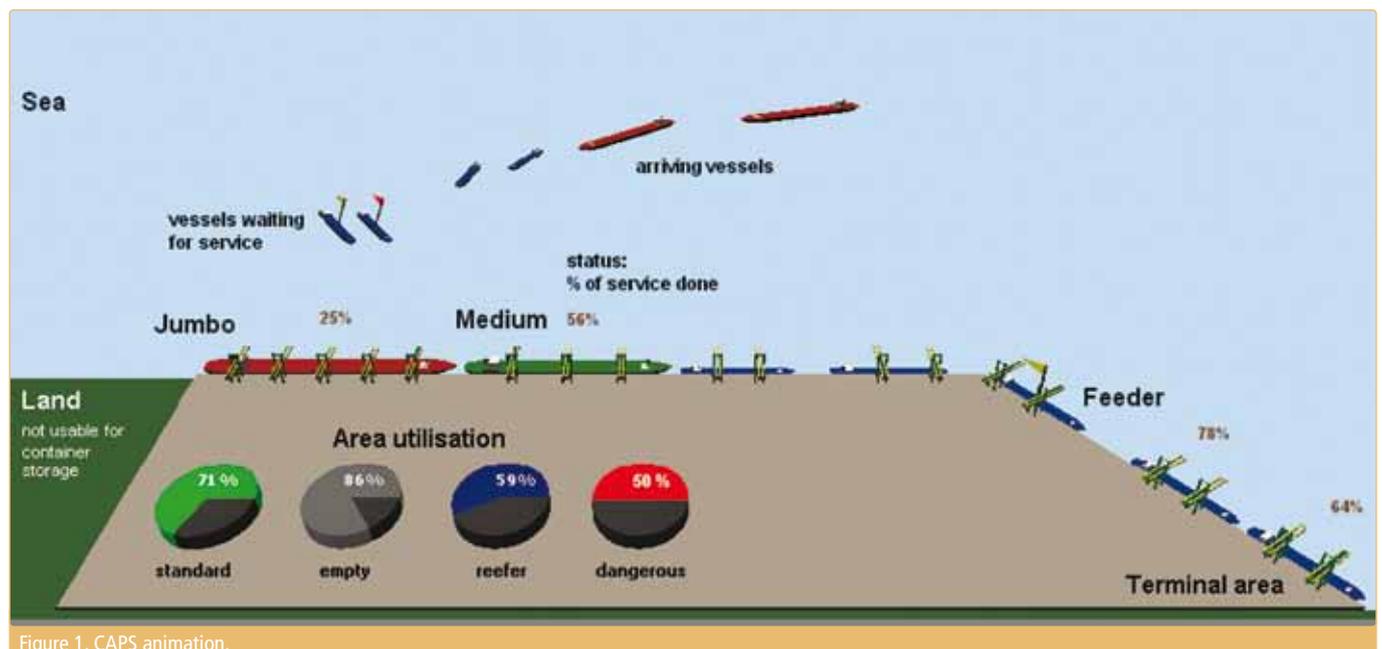


Figure 1. CAPS animation.

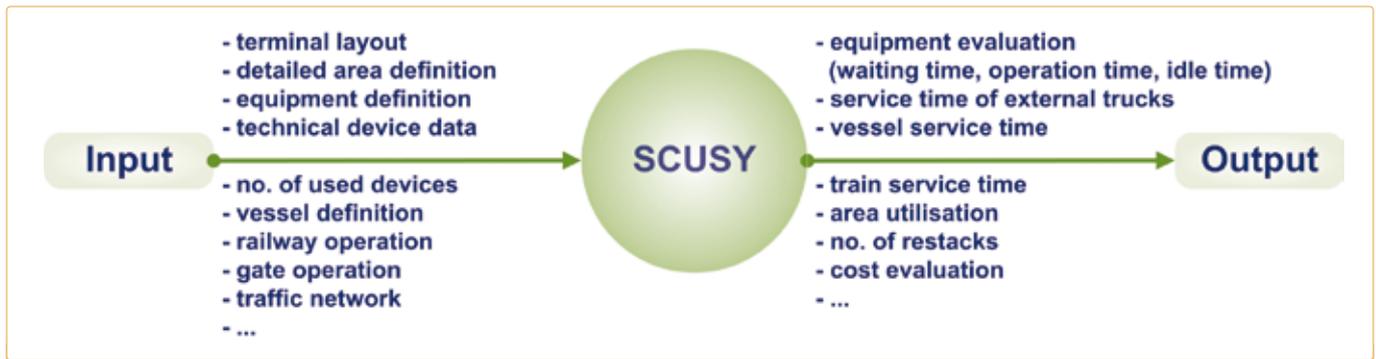


Figure 2. SCUSY: Input and output parameters.

SCUSY can be used for such an investigation. SCUSY (see Figure 2) has been developed as a tool for decision-making at the strategic planning and design level. This medium-term level covers the planning of new terminals, the expansion of existing ones and changes in organisational structures that extend beyond short-term deployment planning (operational level). This model does not simulate the individual containers in isolation, but instead, the behaviour of the whole system 'container terminal'.

The software provides the necessary flexibility for taking new concepts of the system interfaces waterside, gate and railway into consideration. With the results of the simulation the user can calculate the operation costs for each terminal operation system. In the end, a technical and economical evaluation of all analysed terminal systems will be executed.



Figure 3. CRASY animation.

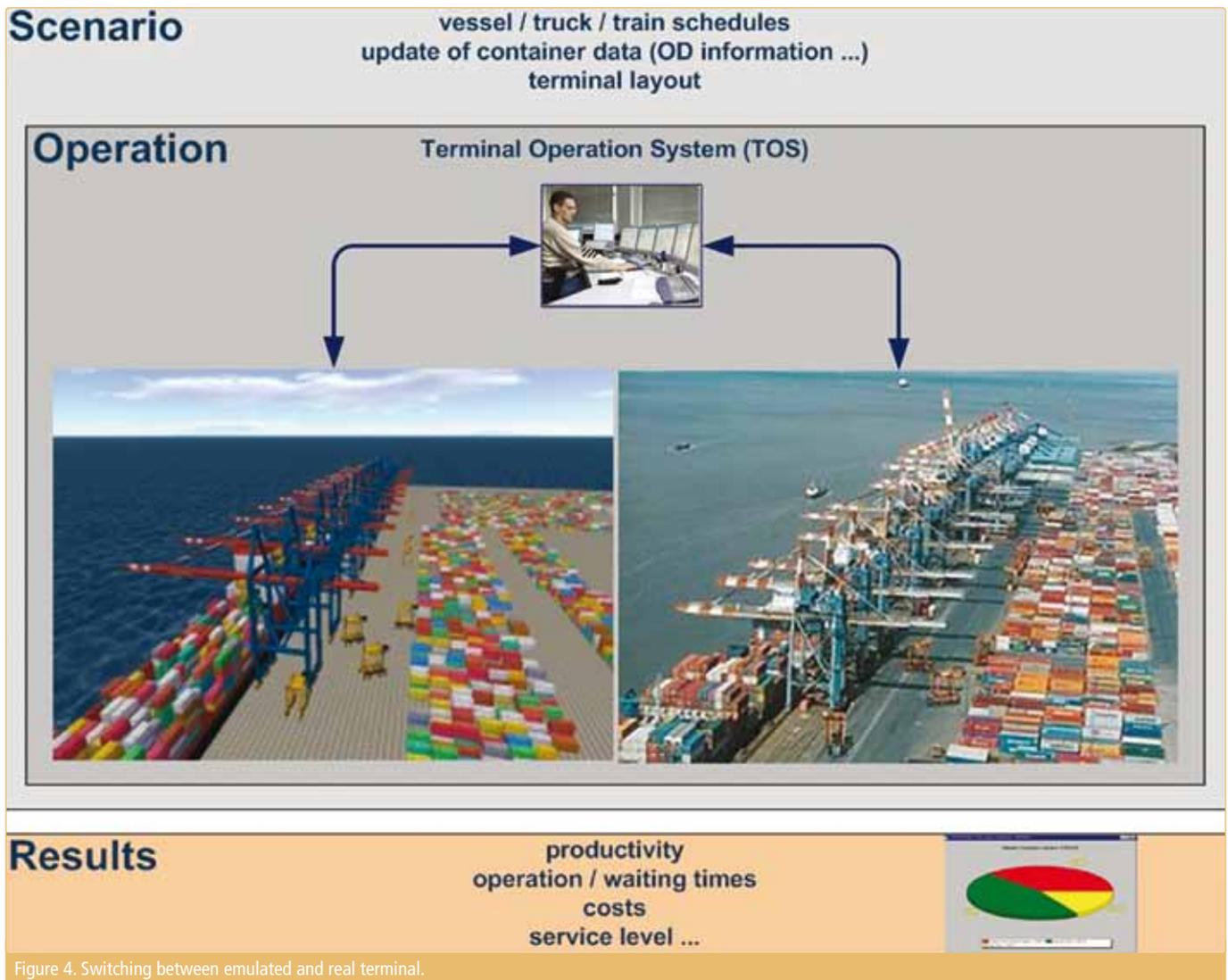


Figure 4. Switching between emulated and real terminal.

In this way the whole terminal operation may be analysed and optimised. Key production indicators (KPI) or costs per move can be used to compare different operation systems (e.g. Straddle carrier, RMG combined with AGV or shuttle carrier, RTG combined with chassis or multi-trailer). The layout may be optimised regarding the size (length, width and height) of the stacking blocks, the traffic control (one way tracks, priority handling). Furthermore the strategies (pooling transport equipment, twin or tandem operation, stacking algorithms) may be analysed and optimised with systems of this level of detail.

Furthermore ecological impacts may be analysed with this system. The latest module of SCUSY combines the simulation of the terminal operation with noise emission parameters. Using transmission formulas, the noise impact of a terminal at any point in the surrounding area may be calculated. In this way the terminal planner is able to evaluate these impacts in the very early planning phase, long before the licensing procedure forces him to do so. In this phase a re-planning is much cheaper than it will be later on. In a similar way the carbon footprint of the terminal may be calculated by assigning emission parameters to the device types in use.

Evaluation of vessel operation with ship-to-shore cranes

In the previous phases quay crane productivity was the input parameter for the simulation scenarios. But which type of crane will guarantee this productivity? Not any quay crane is suitable to serve any type of vessel. Nor does the vessel service work trouble-free with any type of crane or any desired number of allocated cranes. Here, simulation tools for the quay crane analysis provide support.

CRASY (see Figure 3) was developed to make such investigations possible. With the CRASY software it is not only

possible to simulate the vessel service by one or more cranes, but also to simulate the unloading and loading process of a particular bay by an individual crane. Different crane types such as single hoist and double hoist cranes can be modelled and any vessel with its dimensions, slots and hatches can be integrated. The stowing plans for vessels can either be entered or imported by the user or automatically generated by the system.

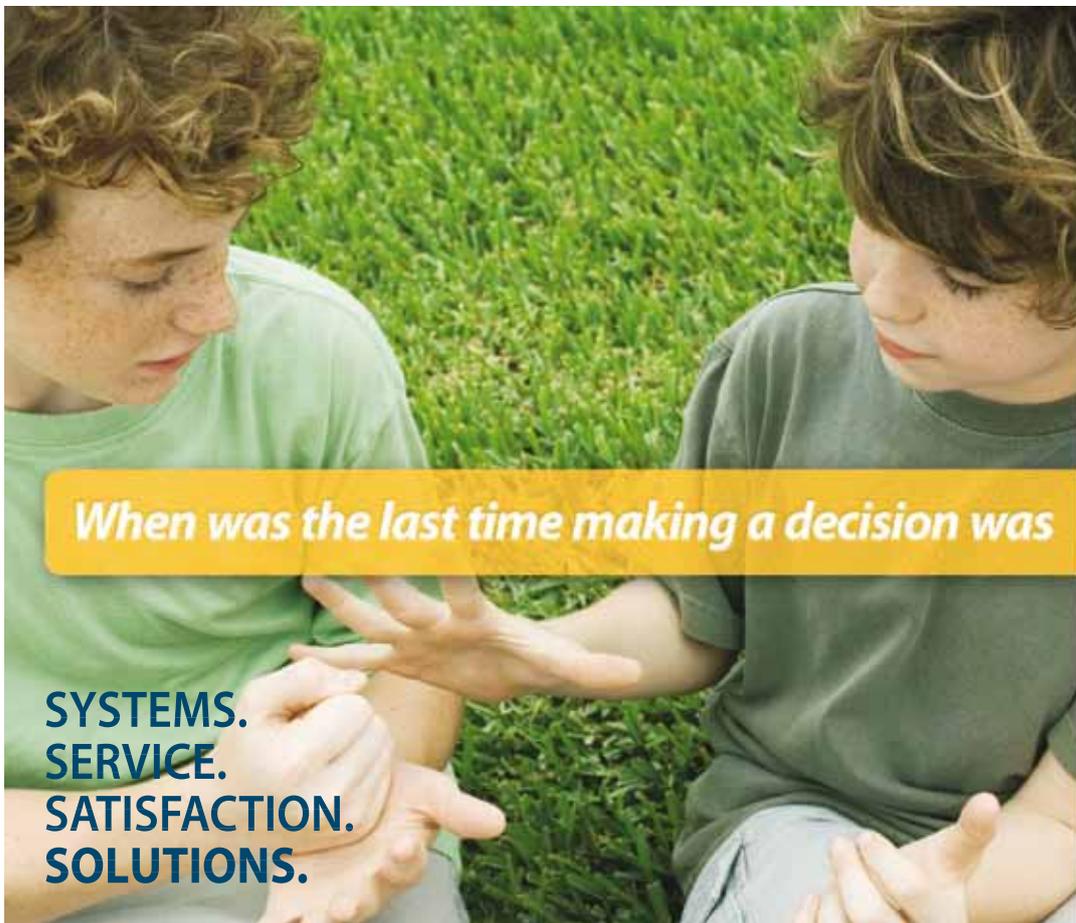
The crane performance depends on its technical performance and further on the terminal operation system responsible for transporting the unloaded containers from the vessel to the stacking area and vice versa.

With several simulation scenarios it is possible to find out which is the best type of quay crane to operate a special vessel and which is the optimum number of cranes operating this vessel simultaneously.

Terminal start up and optimisation

While the above-mentioned simulation systems are used for terminal planning purposes, the start up of a terminal and the optimisation of the Terminal Operating System (TOS-Software) may be supported using emulation methodology. In contrast to simulation, an emulator clones the functionality of the target system. The emulated system receives identical data, works in the same manner and produces identical results like the original system, i.e. the emulated system imitates the original one (see Figure 4).

In the case of container terminals this may be done by using the devices from the simulation models and connecting them to the terminal's real TOS. In this way a test bed for the TOS is generated. Each TOS new release may be checked and accepted using this test bed. Furthermore, by evaluating various parameter combinations using the emulation, one can optimise the strategies



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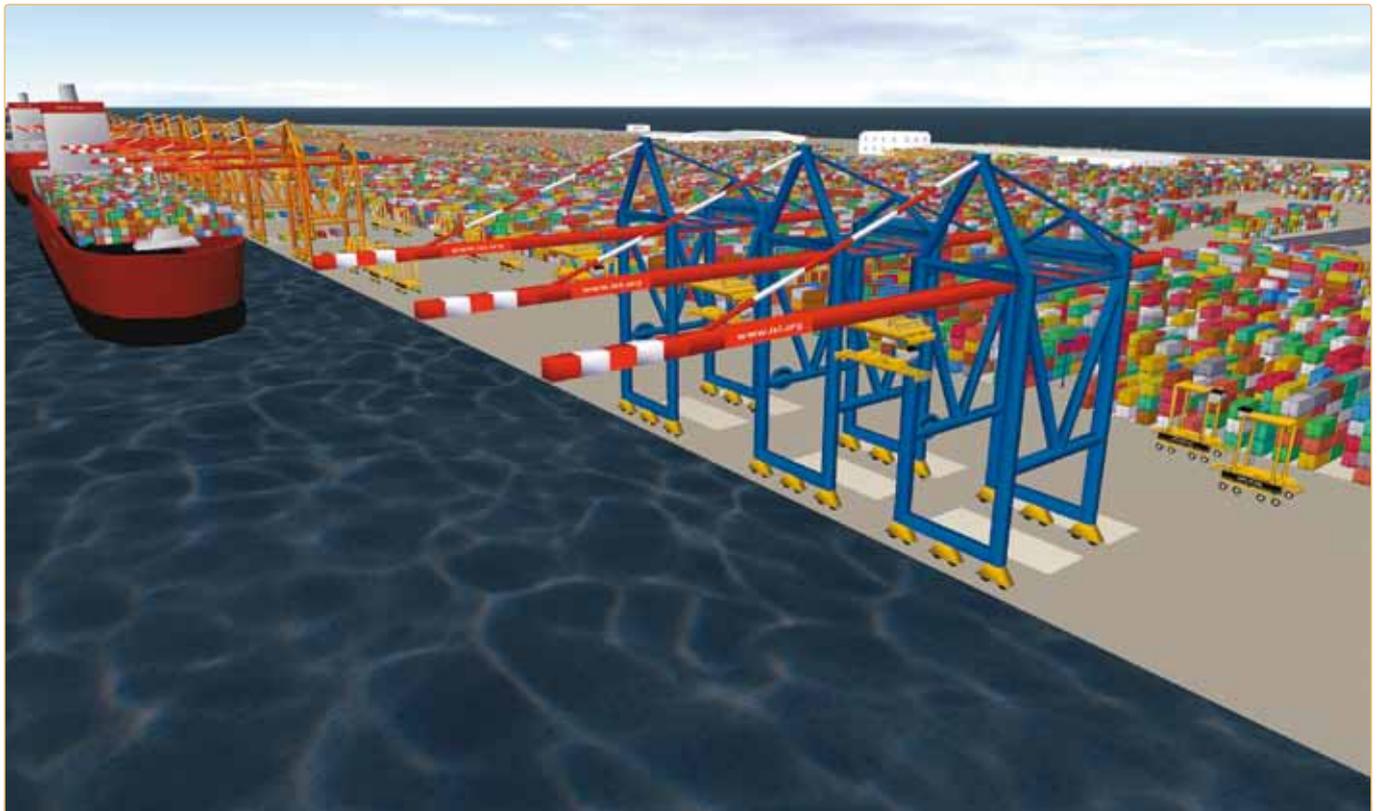


Figure 5. Emulation of Eurogate's Container Terminal Bremerhaven.

used within the TOS. The emulation system can also be used as a training camp to train the terminal supervisor staff.

This methodology has been used for planning and start-up, and is still in operation at the fully automated Container Terminal Altenwerder (CTA) in Hamburg. Each software release is still tested against the emulators before going live at the terminal. Currently Eurogate IT Services GmbH is under contract with ISL to use their ViTO (Virtual Terminal Optimising) for optimising and emulating Eurogate group terminals (see Figure 5).

Conclusion

Currently, there are a large range of simulation tools which are mostly used in the planning phase of new (greenfield)

terminals or for reorganisation and optimisation of existing ones. Increasingly, simulation technology is being used in the implementation phase and will be used in the operational phase as well. In this case (called emulation), interfaces between the simulation model and the TOS are necessary to combine the material flow of the simulation models with the information flow (strategies used) of the TOS.

By making simulation technology accessible to logisticians and management, numerous software solutions have helped simulation technology find its way into logistics and help support planning new terminals, optimising processes, and implementing new strategies, thus contributing to major cost savings and quality improvements in the industry.

ABOUT THE AUTHOR



Dr.-Ing Holger Schütt is the head of the competence centre 'Optimisation and Simulation' in the department 'Information Logistics' at ISL in Bremerhaven. He manages various simulation projects with topics in logistics.

Prior to this he worked in simulation for a major container terminal operator in Hamburg and was responsible for the simulation assistance during the whole planning and implementation phase of the automated Container Terminal Altenwerder (Hamburg).

He is member of the ASIM (German Simulation Society) and has written various articles and papers in the field of simulation applications.

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