J.C. Paro *Minimizing crane moves by smart stacking of containers*
Computer program, Report 2006.TL.7097, Transport Engineering and Logistics.

The transport of containers all over the world consists of only few steps. To optimize this process only several steps can be considered. One of those steps is the stacking of containers which takes place in harbors and at the ships. This research investigates several methods to stack containers more efficiently. This will overall lead to less crane movements for picking up all the containers. The goal is to investigate the relation between the amount of departure time information available and the amount of restacks needed.

A model has been made in TOMAS to compare four different stacking methods. A stacking lane of 6 x 40 containers and maximum pile height of 4 containers is used (960 containers total). The first stacking method resembles random stacking. Containers are stacked at the lowest pile available. The second method chooses the lowest pile and then also considers the departure time of both containers. The smallest time difference is preferred as long as the container to be placed is picked up first. The third method is based on a procedure called the Remaining Stack Capacity (RSC) described by Duinkerken [M.B. Duinkerken, J.J.M. Evers, J.A. Ottjes "A Simulation Model for Integrating Quay Transport and Stacking Policies on Automated Container Terminals", Proceedings of the 15th European Simulation Multiconference (ESM2001), June 2001, Prague [SCS], ISBN 1-56555-225-3]. This is a cost-reduction method which considers both pile height and departure times and calculates the reduction of the RSC. The pile with the smallest reduction of the RSC is preferred. The method uses time windows to compare departure times. Method 4 is an improvement of Method 3. In this method the same calculations are made as with Method 3, but containers with equal time windows are not allowed to be placed on top of each other. The main parameters that can be changed in the model are the maximum allowable difference between the planned departure time and the real departure time (time deviation) and the rate of containers with this information. The output of the model provides the total amount of restacks and the amount of containers that could not be placed according to the chosen method. Method 1 is used as a reference when no particular stacking method is used. (the Random method)

The main experiment in this report is the analysis of the relation for every method between the restacks needed and the rate of containers with departure information. Next to this the influence of the occupancy, the time deviation (difference between real and planned departure time) and the overall departure distribution is investigated.

Conclusions
Method 4 performs the best of all methods. The relation between the amount of restacks and the rate of containers with departure information is almost linear and show the best result. Also the standard deviation of this method outperforms Method 2 and 3. The result of all Methods is shown in Figure 1 for a time deviation of 3 hours and an occupancy of 90% of the total stack capacity.

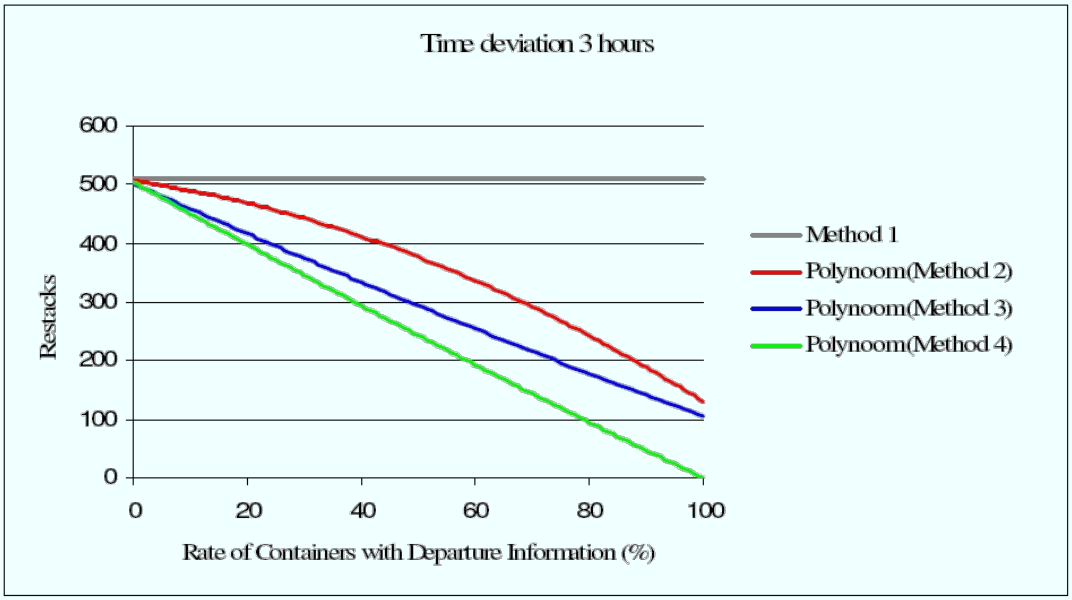

Figure 1. Results