Summary

To compare the terminal performance results of the cross-over model from the study by Duinkerken with the fixed guide path layout (loop, mesh) using Möhrings algorithm for AGV routing, a computer simulation model was created in a previous study with the report title "Comparison of AGV routing strategies in a pre-determined harbour layout".
Möhrings algorithm was introduced to compute the shortest trajectory with respect to costs (costs = transit time + possible waiting time) taking into account given time windows. On this trajectory, which is conflict-free, AGVs can travel between quay- and stacking cranes.
The way to create conflict-free paths, lies in determining which path segments cannot be used at the same time, these data sets were called ConflictSets. The ConflictSets used in the initial simulation program was insufficient to provide simulations with enough realism, e.g. vehicle dimensions were not fully implemented and sharp 90 degree turns were used instead of smooth bends.

The goal of this study was to create a computer tool that would generate conflict set data, giving the simulation the ability to use more realistically shaped bends and the ability to use a wide range of terminal layout designs, including a layout with a finer grid.

To be able to generate these conflict sets, information about the terminal layout (geographical data of arcs and nodes) and the area that the AGV uses (swept path) along a path segment (arc) was needed. These swept paths modelled as polygons, represent the different manoeuvres the AGV performs on the terminal. The AGVs on a typical terminal perform straightforward-, ninety degree bend- and crab manoeuvres (using four wheel steering mainly to change parallel lanes), these types were therefore modelled as a polygon. For every arc on the terminal layout, a polygon is assigned and placed using the two nodes of the arc as a reference point.
With all polygons in place, a pair wise comparison of the polygons to detect overlapping (and thus possible conflicts) using the intersecting line algorithm of Paul Rourke, resulted in conflicts sets required.
To avoid problems with path segments that didn't line up to each other, consequently creating irregular paths, only the arcs pairs (path segments) properly aligned to each other were approved to be used in the simulation. These sets of arc pairs were called OutSets, and were also generated with this tool.
Since no real performance indicators could be used with this tool, an experiment showing the relation between the calculation time of the conflict sets and the level of detail of the swept path polygons was

done. Resulting in an quadratic rise in calculation time when increasing the level of detail. Another experiment was done using the simulation model, showing a higher terminal performance when using the new conflict sets instead of the initial conflict sets.

As a conclusion, it can be stated that calculation time increase is due to the fact that more calculations have to be made when using polygons with a higher number of line segments. Secondly, it can be concluded that the rise of the terminal performance is due to the fact that the smooth turns used in the new conflict sets have a smaller travel length than the old sharp turns. This decreases travelled distance, thus travelled time, and so increasing terminal performance.

In the future, it may be recommended to create different layouts next to the mesh layout, using e.g. 45 degree swept path polygons for travelling diagonally on the terminal area. Also an experiment can be performed on the subject of the influence of the level of detail of the swept path polygons on the size of the conflict set per arc.