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OPTIMIZATION OF STORAGE ALLOCATION USING AN AUTOMATICALLY GENERATED WAREHOUSE SIMULATION MODEL

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ABSTRACT

Classical planning approaches of storage allocation decisions are often conducted iteratively with significant manual effort. Warehouse layouts are generated on the basis of planners' experiences with the target to reduce the operators' travel distances and thereby to increase productivity. By combining optimization and simulation in a software-based planning tool, a multitude of mathematically optimized storage allocation scenarios can be generated and analyzed to improve traditional planning approaches. This paper describes a practical case of a German automotive manufacturer's warehouse allocation problem that is approached using an evolutionary meta-heuristic. The best solutions of the optimization are loaded into a large scale, automatically generated simulation model and evaluated using the company's real-life data.

1 INTRODUCTION

The productivity of warehouse personnel can be decreased through a suboptimal assignment of part numbers to storage locations. Unsuitable storage allocations are a common problem and difficult to identify because of missing IT-supported decision making tools. In the warehouse of a German automotive company, there was no systematic optimization of the allocation of part numbers to the respective storage locations with the objective to improve the efficiency of internal processes. For a given production program, this may pose a risk of increasing time requirements for material handling in the warehouse and ultimately to delays in all intralogistics processes.

This paper describes a practical case in which a real-life storage allocation problem was analyzed using a planning tool that combines optimization and simulation. For the allocation optimization, several objectives have been considered in a genetic algorithm. The simulation model was automatically generated from structural layout data provided by the company. For the purpose of evaluation, actual master data (e.g. material information, storage locations etc.) and transactional data (e.g. materials movements) were loaded into the automatically generated simulation model.

2 SIMULATION MODEL SCOPE AND REQUIREMENTS

To improve current planning practices, the development of a software for the optimization of storage allocations using real-life data was requested by a German automotive company. The first study was conducted in a representative warehouse with approximately 4.000 storage locations to evaluate the suitability of applying the software to other warehouses of the company. Potential productivity improvements in the warehouse had to be evaluated by comparing optimized storage allocations to the current original allocation. For this purpose, two weeks of real-life material movements had to be simulated to analyze the effects of the proposed solutions. To enable a potential application to other warehouses of the company, a generic simulation model that incorporates company-specific processes had to be created, which can be automatically populated with other warehouse-layouts from structural data.

3 TECHNICAL APPROACH

In order to fulfill the aforementioned requirements, a genetic algorithm has been implemented that generated a multitude of solutions with two objectives: First, materials of a high demand frequency should be located at storage locations closest to the respective production line supply areas. Second, materials that are often picked together should be bundled in nearby locations. To categorize materials, historical movement data of six months was used and distances were calculated within the simulation model. A generic warehouse model capturing the company's specifics was developed using SIMIO. These specifics included buffering processes of materials, physical restrictions of materials to certain warehouse areas, shift planning information and the association of materials to the respective line supply areas.

Following the object-oriented modeling approach of SIMIO, simulation model objects, representing specific elements of the real system, such as different shelve types, bulk storage areas and custom forklift objects were created. The specific instances of the modeling elements were then placed into a blank model using a custom built extension to SIMIO. This extension allows to generate entire simulation models by automatically placing, connecting and parameterizing these predefined model objects into a simulation model. The structural data provided by the company was a precondition of the automated generation of a true-to-scale model.

For a valid starting point of the simulation, the current inventory of a specific day was placed inside the model and the warehouse movements were simulated for a timeframe of two weeks. Experiments were conducted for different combinations of storage allocation scenarios and varying scenarios of warehouse personnel numbers to evaluate travel distances, worker utilization and the service level (i.e. timely materials provisioning for the line supply).

Figure 1 shows the warehouse model, consisting of over 4.000 objects, with a maximum of 20.000 concurrent material containers in the system.

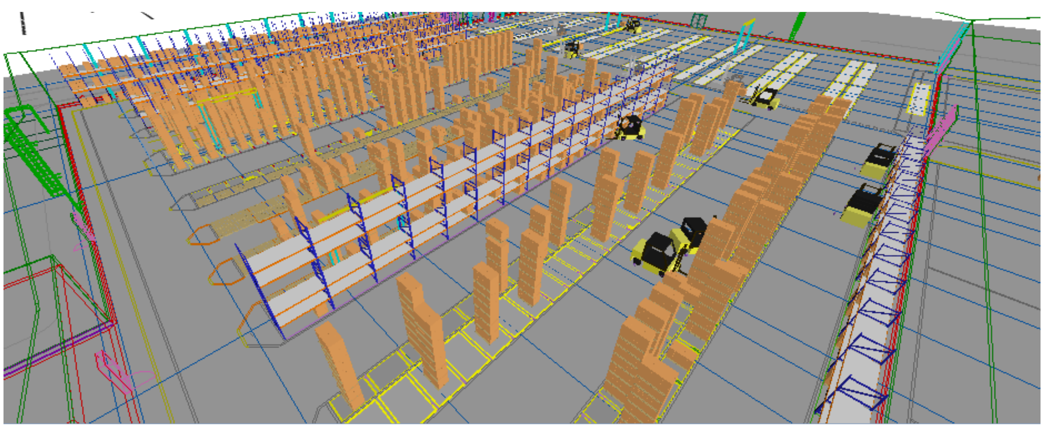

Figure 1: Graphical representation of the warehouse model.

4 RESULTS AND BENEFITS

The ten best solutions of the heuristic optimization were evaluated using the simulation model. Compared to the original allocation, the best solution found by the software lead to a reduction of warehouse distances of 7.63%, decreasing worker utilization by 5.77%, while improving the service level by 8.72%.

Because of the automation of the model generation, the problem solving cycle is significantly reduced compared to the manual creation of simulation models. Furthermore, the process is less error-prone and can be repeated on demand with updated data which confines the model obsolescence problem.