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INTEGRATION OF DISCRETE-EVENT SIMULATION IN THE PLANNING OF A HYDROGEN ELECTROLYZER PRODUCTION FACILITY

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ABSTRACT

In the context of production and factory planning, the expansion of the factory must already be taken into account during initial planning. This leads to an increase in planning complexity since planners involved need to know the expansion stages of the factory in the different time periods and need to evaluate concept modifications across all time periods. This paper presents an idea for a planning tool, that takes expansion stages into account. The data model contains all relevant information to generate a simulation model of the factory almost automatically. The goal is to enable factory planners to quickly investigate concept changes with the help of simulation, for example, to identify bottlenecks.

1 INTRODUCTION

According to Wappler et. al, global demand for hydrogen will increase from 135 Mt/a in 2030 to more than 500 Mt/a in 2050. A comparison with the production capacities for hydrogen shows a considerable need to catch up, especially in the area of green hydrogen (produced from regenerative energies by water electrolysis), since less than 1% of the hydrogen produced today can be classified as green. (Wappler et al.) Demand for hydrogen electrolysers is expected to grow rapidly in the coming years. The first manufacturers are expanding production capacities, but experience with industrial series production of electrolyzers has yet to be gained. (BMBF 2022) A new type of electrolyzer is being developed as part of the "Stack Revolution" research project. The production and logistics concepts required for large-scale production are also being investigated. One challenge is to ensure that the factory can handle rapid growth. For this purpose, the individual expansion stages of the factory are already taken into account during factory planning. This leads to a significant increase in planning complexity, as it must be ensured that the planned production volume can be achieved in each expansion stage. A planning tool is being developed to support this planning process. This tool makes it possible to generate discrete-event simulation models for different stages of the factory with little effort, to investigate the interactions between the individual production steps. This is intended to safeguard planning and identify bottlenecks at an earlier planning phase. Typically, simulation is used to evaluate the final planning version at a late stage in the planning process, as the possibilities for adjustments at this stage are limited.

2 CONCEPTUAL MODEL

Figure 1 shows the planned architecture for the planning tool. The essential element of this tool is the database, in which the relevant information about the products as well as the production and logistics processes is collected. The information is submitted by the engineers and involved planners via a web frontend or via the API directly using custom applications. Functions in the frontend and backend ensure that planners specify all the required information and store the data in the desired manner. These tight specifications are necessary in order to implement software functions that support the planner.

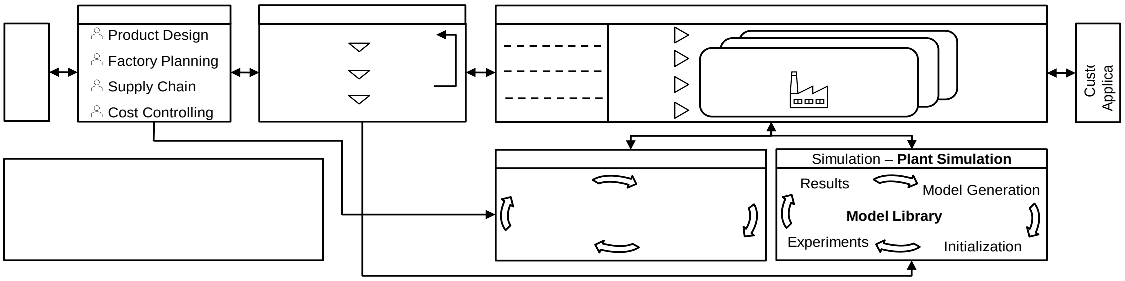

Figure 1: Design of the planning tool.

One of the most important support functions for the planner will be the generation of simulation models to investigate the dynamic system behavior directly in the planning process. The goal is the automatic generation of executable simulation models for sections or the entire factory. The necessary information for parameterization and connection of the simulation modules is stored in the database. The planner describes individual segments (e.g. a production step) via the web frontend. Information on dimensions, function, process times and costs must be provided. With the help of the information about the product (manufacturing BOM), the required input materials and the output (assembly) can be described. In the further course of planning, information on internal logistics is also provided. The factory planner develops suitable layouts in which the segments are arranged in a grid. Furthermore, the transport network of the factory is also formally described with the help of the data model. In order to consider the information flow (production control) in the simulation model, predefined replenishment strategies can be specified for material provision locations and buffers. Based on all this information and the developed simulation modules (classes), executable simulation models are generated in the simulation software Plant Simulation. These models can be adjusted as needed, such as when replenishment strategies change.

3 CONCLUSION AND FUTURE WORK

A key success factor for factory planning is a planning database and documentation that is transparent and up-to-date for all parties involved. Consolidating the essential information in a central location can improve communication between the stakeholders. By formalizing the description of planning results, planning tools can be better integrated into the process. Currently, the database and the frontend are in the development phase, with the development of the "product twin" already completed and being tested by the project partners. The data model for factory planning is currently being validated with the help of case studies and subsequently implemented. The case studies also form the basis for the development of initial simulation modules.

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