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Intelligent Production System Planning with Virtual Design Reviews

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Abstract

The conventional way of visualizing the material flow in a production system is to use simulation tools and their integrated symbols and pictograms. By going this way, a good relation to reality does not really exist and thus it is nearly impossible to provide for all contingencies. This paper introduces a procedure which enables a virtual design review of the planned process layout in the HD visualization center at the Heinz Nixdorf Institute. This means that production planners have the opportunity to do a virtual inspection of the production including the visualized material flow. As a result, the planning certainty and the system comprehension of all parties involved significantly increase, so that the presented procedure serves as a valuable decision support. This paper describes the steps to be taken from production-data to an optimized material flow verified in a virtual inspection.

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1. Introduction

Novel approaches for improving production systems have to consider a holistic view on the entire production to avoid isolated optimization of subsections at the expense of the overall system. To manage the resulting complexity in the analysis of all dependencies in the manufacturing process, computer-aided methods in the area of simulation and visualization are suitable [1], [2]. These methods allow to detect weaknesses and bottlenecks without impairing

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the real production processes. Especially in material flow simulation, a conflict inevitably arises between the need for super realistic models on the one hand and unnecessarily complex on the other hand, in order to keep the workload reasonable [3]. In order to resolve this conflict, useful assumptions have to be made which simplify the models but do not weaken their significance [4]. The same holds for the visualization of procedures and facilities which should be designed merely as realistic as necessary, so that the user comprehension improvement is in adequate proportion to the modeling effort [5]. After developing a simulation-capable model, the simulation results have to be processed first to allow an interpretation. Usually this is realized by analyzing the provided data of the production system, for example, by analyzing workload-diagrams and hence identifying possible bottlenecks. The data is normally aggregated to indices and parameters using methods of statistics [6]. Furthermore, the processing of data includes a representation, which is suitable for interpretation, in order to provide a problem-specific and targeted decision support for the user. Here, one particular challenge is to provide simulation parameters and highly aggregated results in a way that the user can interpret them easily and the relevant results remain obvious. Thus, it is appropriate to merge the abstracted results from the material flow simulation by means of the established visualization methods based on the technology virtual reality (VR) with the aim to increase system comprehension of both planners and decision makers.

Conventional simulation tools visualize the results of a material flow simulation based on 2D symbols, pictograms, and plausible 3D representations. This paper introduces a procedure which enables the production planner to discuss questions concerning the planned layout (placement of machines, design of storage areas etc.) of a production system in the course of a virtual design review of the layout in a large-screen visualization facility. For this purpose an interactive visualization of the layout is provided for virtual design review sessions. The interactive visualization of the layout illustrates the spatial localization of the flow of materials in a complex 3D model of a production system and facilitates the understanding of the complex dependencies. The developed procedure supports the assessment of different material flow concepts and consequently plays a part in contributing to increase planning certainty significantly.

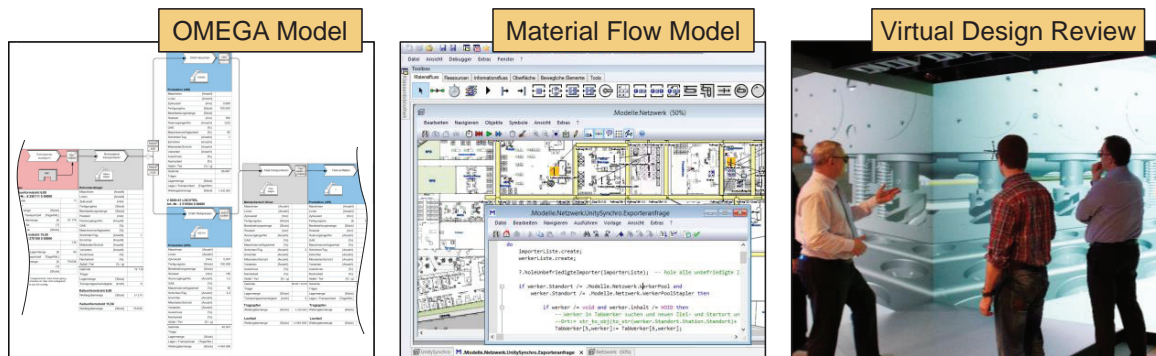


Fig. 1. The steps from production data to a virtual design review

To create an interactive visualization of the production layout, a lot of information is required. First of all, the dimensions of the production area, the machines, and the material flow system are needed. Then, data of the products, e.g. processing steps, time and required transport needs to be provided. Figure 1 shows how the processing of all this information should take place and what basic elements are involved. An OMEGA-model (Object-Oriented Method Strategic Redesign of Business Processes) [7] serves as a detailed and transparent representation of the production processes. From there, the information is transferred to the material flow model in a material flow simulation tool, e.g. Plant Simulation. This material flow model maps the production processes in the form of executable code. The third element is the virtual design review, which is based on the three-dimensional illustration of the material flow model.

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