Conceptual Design and Simulation of an Automotive Body Shop Assembly Line

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Keywords: Conceptual design, assembly line, modeling, simulation, automotive body shop.

In most industrial organization, simulation based analysis is recognized as an essential tool for designing manufacturing systems. Improving the assembly line design process and analyzing performance at early stage of a project is still a major challenge. The objective is to support decision process on strategical choices regarding the future system configuration. Indeed, early design decisions typically lack formal preliminary analysis for making good decisions based on incomplete or unreliable information.

In this context, simulation and digital factory concept represents tools and related methodologies to support manufacturing design process, taking into account the whole system lifecycle (Kühn, 2006). However, these model based approaches usually focus on detailed design and less on conceptual design where key decisions are made based on few information (Robinson, 2012). This research work deals with several assembly line architectures assessment which can be declined under various configurations.

An original approach combining Business process modeling and simulation is proposed to analyze several scenarios of process layout and structures. Indeed, for each simulation project conceptual models of an assembly line are first defined to support designer's choice and solution analysis. Many practitioners have used hierarchical, modular or functional modeling concepts in conceptual design to handle the complexity of the system (Schuh and Brussel, 2003). Such best practices are however not well applied in practical and there's a need to reduce the gap between industrial practices and research. Therefore, most of actual

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P.-J. Benghozi et al. (eds.), *Digital Enterprise Design & Management*,
Advances in Intelligent Systems and Computing 261,
DOI: 10.1007/978-3-319-04313-5_14,

simulation tools are technical solution modeling oriented and dismiss functional aspects that can be implemented by several possible solutions. The limitations of the identified approaches are shown to be determined by the capabilities of the simulation modeling tools (Pierreval and Paris, 2001).

Our methodological approach identifies five steps involving (1) system description, (2) preliminary analysis, (3) conceptual modeling, (4) detailed design, and (5) simulation. On the one hand, three pull control assembly line representing batch and single part flows are modeled using business process modeling notation. These models are used to decide the adequate architecture to fulfill the demand. A batch flow control has been identified to fit the mixed model demand. On the other hand, a U and L shaped assembly line are described as possible configurations corresponding to the chosen assembly line architecture. The last step consists in running simulation analysis for each configuration and performing multi-criteria analysis to compare each alternative based on cost, delay, quality and flexibility. This approach enables us to formalize the design process of assembly systems from conceptual to detailed design.