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Mesoscopic Simulation Models for Logistics Planning Tasks in the Automotive Industry

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Abstract

The paper evaluates mesoscopic simulation models applied to logistics planning tasks in the automotive industry. In terms of level of detail, mesoscopic simulation models fall between object based discrete-event simulation models and flow based continuous simulation models. Mesoscopic models represent logistics flow processes on an aggregated level through piecewise constant flow rates instead of modeling individual flow objects. The results are not obtained by counting individual objects but by using mathematical formulas to calculate the results as continuous quantities in every modeling time step. This leads to a fast model creation and computation. The authors expect that mesoscopic simulation models can help to support decisions on the operational, tactical and strategic level of planning. The paper describes a mesoscopic simulation model of the goods receiving of an assembly plant and compares the simulation results and computation time with a discrete-event model.

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Keywords: automotive industry, logistics planning, production planning, mesoscopic simulation, discrete-rate simulation

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1. Introduction

The usage of simulation in the automotive industry is widely common to evaluate and visualize planning results before the start of production (Schneider, 2008, Haband Wagner, 2010). The discrete-event simulation paradigm (applied for microscopic simulation models) is widely used to model production and logistics systems because of its abilities to represent the original system with a high level of detail and to differentiate between single flow objects in the model. Microscopic discrete-event simulation models can be very complicated and slow and their creation and implementation can be time and labor consuming (Pierreval *et al.*, 2007, Law and Kelton, 2007, Kosturiak and Gregor, 1995, Huber and Dangelmaier, 2009, Scholz-Reiter *et al.*, 2008).This is a disadvantage when simulation results are required to support short-term planning tasks.

The fact that the common simulation approaches do not completely meet the needs of practitioners analyzing and planning logistics systems has motivated the research on new modeling methods for logistics processes. The mesoscopic simulation approach (Reggelin, 2011) proposed by the authors in this paper is situated between continuous and discrete-event approaches in terms of level of modeling detail and required modeling and simulation effort as depicted in Fig. 1. It supports quick and effective execution of analysis and planning tasks related to manufacturing and logistics networks. The principles of mesoscopic simulation of processes in logistics networks described here have been derived from the actual development of several mesoscopic models (Hennies *et al*., 2013, Reggelin *et al*., 2012, Tolujew *et al*., 2010, Schenk *et al.*, 2009, Schenk *et al*., 2008, Savrasov and Tolujew, 2008, Tolujew and Alcala, 2004).

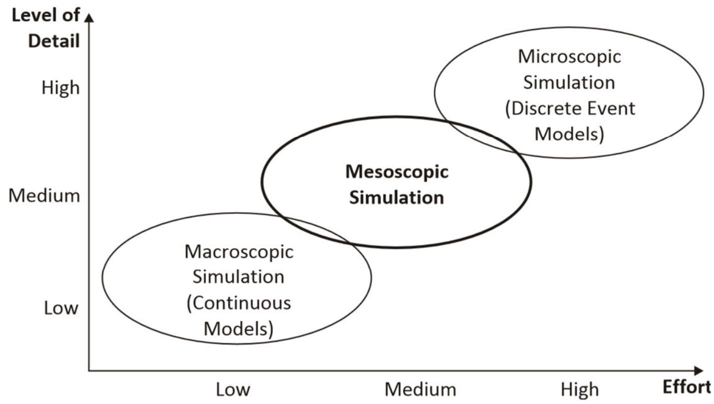

Fig. 1. Microscopic, mesoscopic and macroscopic simulation approaches.

One main objective of this study is to identify typical analyzing and planning tasks in the automotive industry which can be supported with mesoscopic simulation models. A mesoscopic simulation model to support analyzing and planning tasks for the goods receiving of an assembly will be implemented and evaluated. The modeling efforts, results and computational time of the mesoscopic model will be compared with an already existing discrete-event model.

2. Planning Tasks in the Automotive Industry

Simulation is used to analyse the dynamic behaviour of production or logistics systems. Especially in the planning process of a system simulation has a great relevance, but also in other phases of the system lifecycle simulation offers potentials to support decisions (Kuhn and Raabe, 1998). Fig. 2 gives an overview about common tasks of simulation.

Looking on the wide range of production und logistics processes in the automotive industry, it is necessary to define a relevant scope of tasks for which the usage of simulation is relevant. As reported by Schenk *et al.* (2014), planning tasks can be classified according to their time horizon to fulfil. More precisely, planning tasks are