Chapter 9
Domain Specific Simulation Modeling with SysML and Model-to-Model Transformation for Discrete Processes

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ABSTRACT

In this chapter, the authors present an approach for developing a simulation-tool-independent description of manufacturing systems and how to convert such a general model into simulation-tool-specific models. They show why we need standards for these discrete processes, what the state of the art is, why SysML has the chance to become a standard in modeling discrete systems, and how to use it. The authors present SysML and explain how to model discrete systems with it. For that, they explain the concept of domain-specific modeling in detail. They furthermore have a look at model-to-model transformations and its validation and verification. Finally, the authors examine different SysML modeling tools and how to improve the usability of SysML tools for engineers.

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INTRODUCTION

Production and logistic systems provide a diverse world of simulation applications with all kinds of systems and challenges to master. It ranges from small businesses employing only a few people over large manufacturing facilities with hundreds of workers to whole supply chains containing numerous businesses; from productions based on traditional craftsmanship to fully automated factories with robots doing most of the work. There are resources to be scheduled, assigned, and planned from groups of workers with different qualifications to machines capable of performing a number of completely different work steps; even the pure empty spaces in a manufacturing system sometimes need to be considered valuable resources, providing room to move or store large work pieces. On one hand, we see shipyards which sometimes build only a hand full of ships in a year; on the other hand, there are semiconductor facilities churning out thousands of chips every single day.

Simulation is used in a lot of these companies for numerous applications and purposes. Research to tap even more potentials with the help of simulation has been done for years and will continue for years to come. Fields of application range from asserting aerodynamic properties of new car designs to determining the course of etching processes on silicon wafers. Our interest focuses on simulation based optimization of the very production systems. We are analyzing the material flow within these highly dynamic discrete and sometimes continuous manufacturing environments, devising and testing strategies and approaches to improve them based on key performance indicators (e.g., work in progress, due date adherence, throughput, and cycle times). Furthermore, we work on optimizing resource assignments, maintenance schedules, and lot scheduling to improve the overall factory performance. Sometimes just providing a glimpse into the future is an invaluable advantage for decision makers.

Nowadays this work is mainly done by companies offering simulation consultants and universities; larger companies even have their own simulation departments utilizing the possibilities provided by discrete event simulation. Common to most of them is the use of simulation packages which are mostly bought off the shelf, and sometimes customized to a certain company or branch. Most of these tools base their modeling approach on their own proprietary languages. Files from one tool are not only incompatible with other tools; in some cases there are even major problems with loading files from different versions of the same simulation package. For companies using simulation as basis for their decision, these incompatibilities pose a significant economic thread.

Simulation based decision support systems rely on the manually created models or model generation systems. Creating these models and building infrastructures for automated model generation is an expensive and time consuming endeavor, one which

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