DEPARTMENT OF INFORMATICS

TECHNISCHE UNIVERSITÄT MÜNCHEN

Master's Thesis in Informatics

Advanced experiment data collection and analysis for the MaCon approach

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Erweiterte Experiment Datenerfassung und Auswertung für den MaCon Ansatz

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I confirm that this master's thesis in informatics is my own work and I have documented all sources and material used.

Munich, 15 October 2016 Mulenko Tetiana

Acknowledgments

Abstract

Contents

1 Introduction

1.1 Context

In the manufacturing domain, engineers deal with complex system that include components from different disciplines such as mechanics, electrics/electronics, and software. Since software is already the main innovation driver in many industry branches. [Rus13] there is a potential for improvement of the development approach for the projects.

There are software solutions for the industrial engineering that influence the development process and approach of systems design. In this thesis we focus on software-based engineering approaches. Therefore what these solutions offer to the industry is a tool that either supports the traditional engineering project development practice, either offers changes to the process.

Manufacturing and industrial domains are rigid areas in the terms of embracement the new technologies, because of the scope, risks and costs of changes. Thus there should be a strong reasoning in order to start the expensive, risky and complicated process of introducing a new software and project development methodology. This is why it's important to have the means to evaluate the engineering approaches in order to find out whether they are good enough, fit the needs of the industrial enterprise and whether the advantages they claim to provide actually worth the changes.

1.2 Related work

According to [SK98] the typical process of the development of a mechatronic project looks as on the Figure 1.1. Software tools are used on the stages 5 through 9 and help the engineers create, debug and optimize both mathematical and modular models and prototypes of the designed systems [Dev12]. Some examples of these tools are LabVIEW, Simulink/Matlab, Matrix-x, ACSL, Siemens Mechatronics Concept Designer, SimPACK, Hypersignal, and VisSim. These graphical simulation and prototypical tools run on generic platforms such as desktop PC compatible Windows, Linux or Mac OS

operating systems.

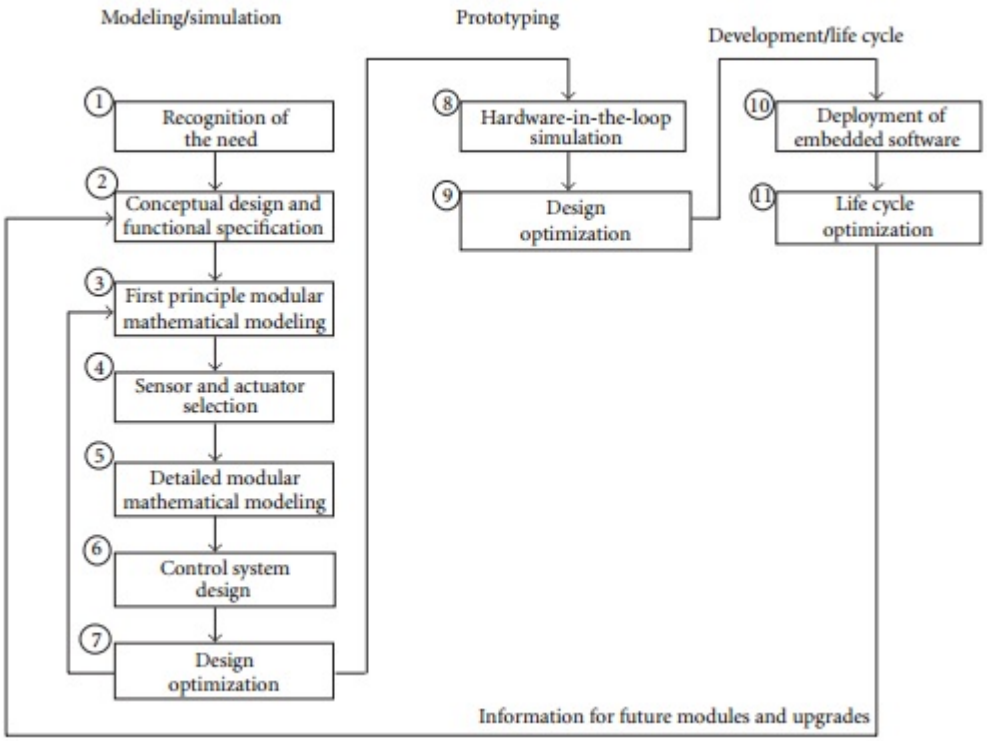

Figure 1.1: Mechatronic design

MaCon is an alternative development approach that offers to shift from mechanically dominated engineering principles to mechatronic development[CZ15]. It provides a model-based method and prototypical tool (called the MaCon workbench) for inter-disciplinary manufacturing system specification as well as continuous syntactic and frequent semantic quality assurance. In particular, the approach promotes top-down and test-driven manufacturing system development.

1.3 Problem statement

The manufacturing domain is being offered multiple tool-based engineering approaches and lacks the methodology of evaluation of these approaches.

The importance of the topic lies in the conflict between modern alternative approaches

and conservative methods in manufacturing domain. Nonetheless the modern approaches promise more effective engineering development, the industry tends to stick to the old methods. There should be means to prove the efficiency of the new methods in order for the industry to find it worthy the enormous changes it takes to embrace the new development approach.

This thesis focuses on evaluation the engineering approach on the example of the MaCon approach. Although the approach is a well-thought solution that has a great potential for the industry there are a lot of questions about how good the approach is, how efficient are the tools the MaCon workbench offers, what are the potential weaknesses and ways to improve both approach and the workbench.

Therefore the thesis Therefore we hope the thesis helps to either improve the MaCon approach, either to prove that it's a good solution for the industry.

1.4 Method and outline

The thesis focuses on the experimental methodology for the evaluation of the MaCon approach and the workbench. The goal of the thesis lies in the creation of the needed software and methodology to answer the analytical questions about the MaCon approach. Therefore the thesis includes the following:

1. design of the evaluation approach
2. integration of data collection into the workbench
3. creation of software for experiment data analysis
4. organization of a test experiment
5. analysis of the result of the test experiment

As an outcome thesis should introduce means to perform analysis and evaluation of the MaCon approach regardless of the changes the approach and the workbench might have. Thus the thesis isn't a one-time solution for a current problem, but rather a helper to analyse the experiments and evaluate software and approach development.

In this document we first provide the necessary background information, then describe the approach of how we plan to reach the goal of the thesis. In the *Implementation* chapter

the development of the analysis software is described as well as the integration of the means of data collection for the experiment into the workbench. *Evaluation* chapter describes the experiment, it's results, how good the experiment was conducted and how good is the implemented software for analysis of the gathered data. Subsequently the *Future work* chapter contains predictions for the bigger experiments over the workbench and approach, ways to improve the analysis software and experiment data collection. Finally the *Conclusion* has the summary and outlook of the work and it's results.

2 Background knowledge

2.1 Evaluation of user experience

User experience evaluation refers to a collection of methods, skills and tools utilized to uncover how a person perceives a system (product, service, non-commercial item, or a combination of them) before, during and after interacting with it.[Law+09]

User Research (user study) focuses on understanding user behaviours, needs, and motivations through observation techniques, task analysis, and other feedback methodologies.[Kun12] This field of research aims at improving the usability of products by incorporating experimental and observational research methods to guide the design, development, and refinement of a product. User research is an iterative, cyclical process in which observation identifies a problem space for which solutions are proposed. From these proposals, design solutions are prototyped and then tested with the target user group. This process is repeated as many times as necessary.

There are different types of evaluation studies: [Ler11]

1. Naturalistic observation
2. Case studies, Field Studies and Descriptive studies
3. Action Research
4. Surveys
5. Correlation Studies
6. Measurement Studies
7. Quasi-Experiments
8. Controlled Experiments or Demonstration Studies

During **Naturalistic observation** the researcher studies the participants in their natural behaviour with the system without any intruding. It's a passive research.

Case studies, Field Studies and Descriptive studies are studies where some intervention by researched is incorporated.[Ler11] These studies can answer questions, for example "Why is the system inconvenient for the users?". The goal of the research has to be formulate prior to the experiment. These studies can be combined with Action Research and should be combined with Surveys.

Action-case research or action research uses same approach like case studies, but includes more involvement from the researcher. The research has a goal and gives an opportunity to study difficult questions related to *why* and *how* aspects of the problem. During this experiment, the researcher is less of an observer, but more of an active manager, who leads the study to the situations, that fit the goals of the research.

A **survey** is a list of questions aimed at extracting specific data from a particular group of people. The surveys help to study opinions, thoughts, feelings etc. It's an important part of the study to carefully design the questions of the survey for it to measure what it's claimed the survey measures. A single survey is made of at least a sample (or full population in the case of a census), a method of data collection (e.g., a questionnaire) and individual questions or items that become data that can be analyzed statistically.

A **Correlation study** is a study conducted to find the relations between variables. For example, how does the percentage of successful simulations depend on the quantity of contributors.

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