Preface

During product development, in particular when it no longer focuses on a single area, but, like Mechatronics, takes place in an interdisciplinary environment, on the one hand the product developer needs knowledge of the area of application and product behavior in sufficient quantity and appropriate forms for decision-making, that should be made available in a timely manner, especially since he/she creates comprehensive knowledge on his/her own. It should not only be "producible" and be "manageable" at reasonable cost, but it must be possible to also be incorporated with a similar effort to the existing knowledge landscape. On the other hand, he/she needs such frameworks for his/her interdisciplinary development work that not only aim at creation and acquisition of knowledge, but also provide support for the actual development activities. This is point at which the present dissertation of Mr. Neumann starts.

At first, the reader will find a compact historical and technical introduction to Mechatronics. Thereby, mechatronic product development (MPD) is described as interdisciplinary collaboration between the involved domains, characterized by a high degree of parallelization of activities and the extensive use of models (and related interfaces). In the following, knowledge is considered a *polymorphic* concept, i.e. a concept that cannot be defined by a classical definition comprehensively describing their specific traits. Therefore, the definition of knowledge requires a specific context, which at the same time constitutes the area of validity for this definition.

For the context of interdisciplinary product development, the author emphasizes the dichotomy of tacit knowledge (subjective, experienced) and explicit knowledge (can be objectified and externalized). The interdisciplinary development work is perceived as interplay of individual and collective processes. The author developed a descriptive model of knowledge creation for the associated continuous conversions between tacit and explicit knowledge-as well as a suitable analysis and modeling method. The application of this method to MPD allows the build-up of a library of mechatronic process elements, contributing significantly to an improved ability to model these activities as well as to greater transparency of the activities. By combining these analysis results with the vast potentials of semantic technologies, the author developed a design support system in MPD. Thereby, the knowledge embedded in the utilized models may be captured, extracted, and stored by means of common vocabularies.

Although the author is not a native English speaker, he has written his thesis in fluent and well readable English. The reader may thereby benefit not only from the presentation of the scientific content, but also from the appealing English of this dissertation.

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Abstract

Based on the understanding of Mechatronic Product Development (MPD) as an interdisciplinary activity, both individual and collective activities in product development have to be considered when conceiving design support for MPD. Consequently, the thesis focuses on a first step of establishing a theoretical basis that allows a description of the interplay between individual and collective processes in product development and the sources of knowledge applied within these activities. For this purpose, the integrated descriptive model of knowledge creation is introduced as the first constituent of the overall research framework. It employs a model of cognitive activities in design for explaining the patterns of knowledge application and creation within individuals, whereas it adopts a model of organizational knowledge creation to describe collective processes. For the integration of these approaches, the integrated descriptive model of knowledge creation in interdisciplinary product development follows an approach that merges the two models based on their common conceptual elements. As a second part of the research framework, an analysis and modeling method is proposed that captures the various knowledge conversion activities described by the integrated descriptive model of knowledge creation.

Subsequently, the research framework is applied to the analysis of knowledge characteristics of MPD, whereby the development process is represented by common process elements compiled from various procedure models of MPD. For the first steps of this analysis process, the process and activity views are established for a set of representative process elements. Based on these views, the knowledge characteristics of the process elements are extracted and documented.

Next, the results gained from the previous research steps are used within a design support system that aims at improving the creation, storage, distribution, and context-sensitive provisioning of information and knowledge throughout MPD. In particular, the previously determined characteristics of common process elements for MPD are included within the design support system as a ready-to-use library of common process elements that provides the basis for context-dependent provisioning of information and knowledge objects. In addition, common vocabularies are applied for the semantic enrichment of models used in MPD. They allow extraction of information and knowledge embedded in these models and make them accessible to applications sharing the same vocabularies.

Finally, a system architecture for the design support system is developed that conforms to Linked Data principles (cf. section 8.2.1) and the architectural style called Representational State Transfer (REST). It aims at federating the information and knowledge resources contained in the models published in the course of the development activities in MPD.

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