

Collaborative Engineering - Main features and challenges of cross-company collaboration in engineering of products and services

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Abstract — Though methodologies will change engineering, it will stay crucial for the economic success of products and services. However, the success criteria are changing increasingly. Not only the price, quality and functionality are key factors, rather the prerequisites for future business models are increasingly being created by providing accompanying services and novel possibilities for product enhancement. Strictly speaking, engineering has to prepare the basics for such business models.

In a forecast study on behalf of the German Ministry of Economics the authors asked for trends, opportunities and challenges in future engineering. Based on literature analysis and expert interviews success factors and upcoming trends were identified. Collaborative work was identified as a key element in future engineering. Collaboration currently exists widely in the field of research and development, i.e. in the more pre-competitive field. This is often described by the keyword open innovation. The model of collaboration is aligned with equality. Regional innovation clusters provide e.g. such an ecosystem geared towards equality and long-term strategic cooperation, which has proven economically successful in recent decades. Bringing all these methodologies together - engineering accompanying the whole life cycle, collaboration along the value-added chain, and new information-driven business models - this results in a new culture of cross-company collaborative engineering as a key enabler.

It turned out that it is still too early for a detailed strategic roadmap for the concrete implementation of cross-company collaborative engineering. Nevertheless, the status quo and foreseeable steps to create the precondition for successful cross-company collaborative engineering can be well described. Thus, the extended digital twin becomes the key element of success for the widespread use of cross-company collaborative engineering. The digital twin will only be able to fulfil its key function as a virtual image for the engineering by means of an extension in order to bring together all the levels and not only the technical ones.

Keywords — *engineering, collaboration, cross-company, business model, law, labor organization, enhanced digital twin*

I. INTRODUCTION

At the basis, cooperative and collaborative work requires two or more participants to share and exchange a shared pool of content to create something new. However, a serial execution of sub-tasks including definable hand-overs which participants can agree on in advance is only possible in cooperation. In collaborations a more intense interaction among partners is required due to the high complexity of tasks. According to [1] collaborative engineering is a concept for optimizing engineering processes with the goals of better product quality, shorter lead times in manufacturing, more competitive costs, and higher customer satisfaction. At present, collaborative engineering is widely used within companies, but far less across company-borders. Despite the common use of software tools for design, construction, simulation, testing, product data management, and technical documentation, there are considerable challenges concerning e.g. the semantic integration of data across the entire engineering process and the interoperability of corresponding tools.

Furthermore, the engineering changed from a one-time creation process at the beginning of the product life cycle to a permanent accompanying process during the last decades. Of course, the amount of work invested in the initial product development is greater than in the later phases, while at the same time changes and redesigns, such as reconfigurations or retrofits, are becoming increasingly important. This reflects changed framework conditions or new business models as well as the different typical lifetime of components especially in complex systems (industrial software: 1 to 5 years, electronics hardware: 2 to 8 years, mechanics: up to 50 years).

With cross-company collaboration, the requirements for collaborative engineering increase. On the technical level the heterogeneity of the software systems involved is growing significantly and different ways of working and processes must be taken into account. More challenging are the non-technical aspects: diverse company strategies and cultures, different cost and ROI-structures and undefined property rights to name only a few.

The aim of the study was to assess the current situation in technology, business and framework conditions, to analyse