A function-oriented approach for vehicle development from an HTO perspective

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Abstract. The automotive industry commonly adopts a component-oriented approach in the development process, where the focus lies on the components. However, due to the current challenges in the industry, this approach is no longer sufficient to fulfill customer requirements. By shifting the focus to functions instead of components, the enterprise can adapt more easily to changing requirements and manage the increasing complexity. Successful implementation and long-term success of this approach require attention not only to technological aspects but also to human and organizational factors affecting the development process. The research aim is to conceptualize a holistic, function-oriented development approach regarding the technological, human, and organizational factors.

Motivation & Research Goal

The automotive industry currently faces several challenges due to the emergence of new technologies that cause fundamental changes in the product. To tackle these challenges, there is a need for an evolution in the vehicle architecture design. Modern vehicles are mechatronic products with mechanical, electronic, and software components that are equally integral, which leads to increased complexity. Consequently, the development process must evolve as well. A promising step in this direction can be function-oriented development (FOD), a mindset where product functions are the core of the development. This approach offers a more comprehensive view of the product, enhancing communication between disciplines through the explicit definition of product functions. As a result, customer requirements can be addressed more effectively. While various FOD methods have been explored, the introduction and implementation of such an approach have not yet been fully understood (Uhri & Isenhardt 2023a). The successful implementation depends not only on the technological solution but also on the human and organizational factors. Therefore, the research goal is to design a FOD approach considering the relevant technological, human, and organizational (HTO) factors to ensure its successful implementation within established organizations.

Methodology

For this research, the FOD framework is based on the RFLP (requirements, functions, logic, product) approach of model-based systems engineering (MBSE) (Jacobs et al. 2022). Thus, a human systems integration (HSI) approach is suitable as an overarching methodology, as the focus on functions can be seen as declarative knowledge (instead of procedural) in design activities. Human-centered design (HCD) (ISO 2019) was utilized to capture the human perspective and derive user requirements through a user study where vehicle designers developed a system using the framework (Uhri et al. 2024). The OSTO (open, socio-technical, economic) system model (Rieckmann & Weissengruber 1990) was used to analyze the organizational factors regarding knowledge management to derive redesign measures for the organization (Uhri, Matz & Isenhardt 2023b). The output of this research shall include guidelines to construct a standardized and central data model, an accompanying procedure model, and an implementation strategy for FOD.

Preliminary Results & Next Steps

The most significant (incomplete) findings of the studies conducted thus far are shown in Figure 1, which illustrates the most relevant HTO factors for implementing the FOD framework.

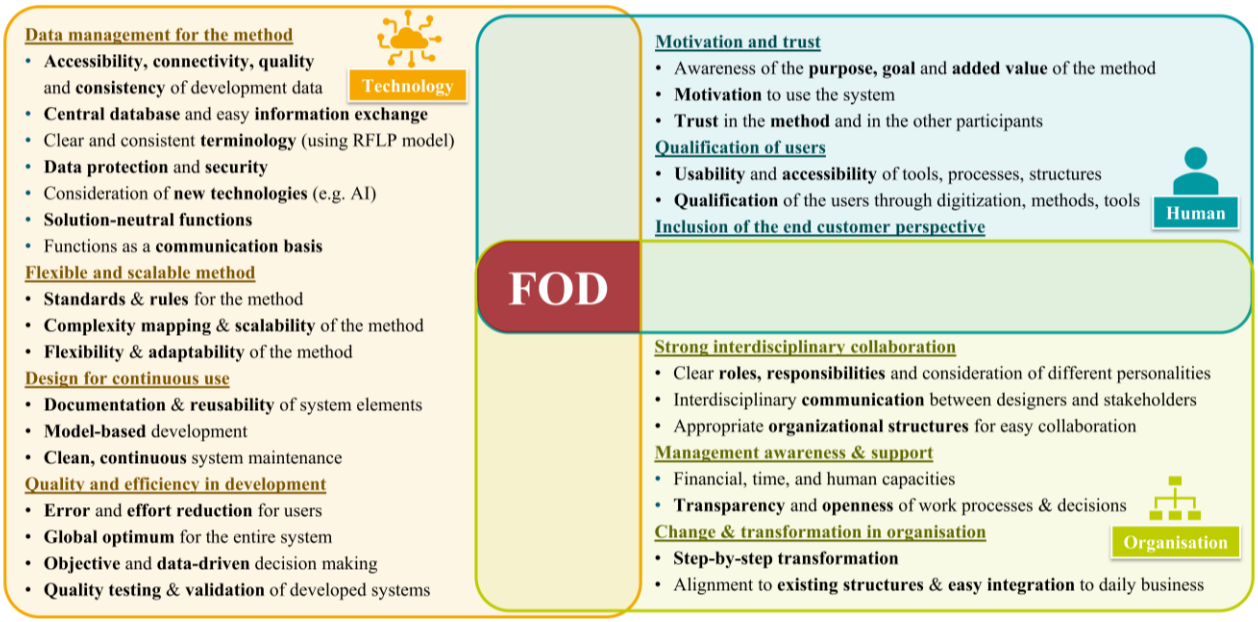

Figure 1: The most significant HTO factors to consider for the FOD framework (Uhri & Isenhardt 2023a, Uhri, Matz & Isenhardt 2023b, Uhri et al. 2024).

The study results will be consolidated and prioritized to design an FOD framework, which will subsequently be validated via empirical studies. The research outcomes shall provide valuable findings for practitioners (specifically in vehicle development) who want to implement the framework, and for researchers who develop MBSE methodologies.

Acknowledgments

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Biography

Ekin Uhri, M.Sc. Ekin Uhri is a PhD candidate at the Chair of Intelligence in Quality Sensing (WZL-IQS) at RWTH Aachen University, in collaboration with BMW Group. Her research centers on the adoption and implementation of function-oriented, model-based development of complex industrial products in established organizations. She employs socio-technical systems thinking, knowledge management, and engineering design approaches to advance her research.

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