Cumulative Dissertation
“Improving Engineering Processes and Quality Assurance in Heterogeneous Engineering Environments”

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Reviewer:
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Abstract.
In context of the Christian Doppler Laboratory on “Software Engineering Integration for Flexible Automation Systems” (CDL-Flex), the cumulative dissertation summarizes my work as key researcher for the Research Area “Quality Management” (QM) and “Engineering Process Analysis & Improvement” (EPA&I).

Industrie 4.0 initiatives and multi-disciplinary engineering environments, such as Automation Systems, include a heterogeneous group of stakeholders that have to collaborate and exchange data. Individual experts use a variety of specific tools and related data models with strong limitations regarding interoperability and data exchange that hinder efficient data exchange and collaboration. Thus, projects become more risky and error prone. The improvement of engineering processes in multi-disciplinary engineering environments requires efficient data exchange mechanisms and integrated data models, efficient and effective quality assurance methods for early defect detection, and engineering process improvement approaches to improve product, process, and project quality. The VDI 3695 guideline provides a valuable framework for addressing the research challenges for (a) *Quality Management (QM)* and (b) *Engineering Process Analysis and Improvement (EPA&I).*

In context of this work, *Quality Mangement* (QM) refers to early defect detection and the avoidance of recurring defects in future projects. Main results include a bundle of *ASE Defect Detection Methods* that allow engineers and project managers to improve product, process, and project quality. Based on Semantic Web technologies, integrated data represent the foundation for quality assurance in multi-disciplinary engineering environments. Needs and requirements coming from multi-disciplinary engineering communities have been addressed by applying adapted approaches from Business Informatics. Main results include (a) Focussed inspections to analyse changes and defects efficient and effective; (b) Integration and system tests (i.e., End-to-End test) that enables automated tests across disciplines and domain

borders; and (c) the Multi-Model Dashboard Process that enables an efficient elicitation and observation of success-critical process and project constraints.

Engineering Process Analysis & Improvement (EPA&I) focuses on process modelling, validation, and monitoring of selected engineering workflows, e.g., the change management process, and the support of researchers to transfer research results into industry. Main results include a bundle of *ASE Engineering Process Analysis & Improvement Methods* that allows (a) project managers to monitor projects and the project progress, (b) process mangers to define and evaluate workflows, and (c) innovators and researchers to transfer research results into industry. EPA&I contributes to Multi-Disciplinary Engineering communities by eliciting needs and use cases and providing solution concepts and prototypes. Semantic Web communities provide concepts to generate integrated data, receive real-world application scenarios, and test data. Business Informatics communities provide established approaches from Software Engineering and receive real-world application scenarios and adapted EPA&I methods that support multi-disciplinary engineering.

Key research contributions of QM and EPA&I are

1. Adapted quality assurance methods on project level in Multi-Disciplinary Engineering environments to (a) identify defects early and efficient, (b) avoid recurring similar defects in future projects, and (c) the efficient definition and observation of critical project and process parameters.
2. Mechanisms for Engineering Process Analysis and Improvement in Multi-Disciplinary Engineering environments on team and organizational level to (a) efficiently observe engineering projects and the project progress, (b) efficiently define and validate engineering workflows, and (c) efficiently support research and industry projects and to transfer research results into industry.

Individual use cases have been evaluated in real-world test scenarios coming from multi-disciplinary engineering communities. Main result was that the bundle of ASE Defect Detection Methods and ASE Engineering Process Analysis & Improvement Methods were found useful in the evaluation context and showed promising results for improving product, process, and project quality in Multi-Disciplinary Engineering environments.