Reference:	**QSE:CIA**
Topic:	**Change Impact Analysis in an Industry 4.0 Knowledge Graph**
Course Type:	Project, Bakk-/Master Thesis
Start:	As soon as possible
End:	To be defined
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Background

Production systems, such as robot cells in car production (see Figure 1), require maintenance and upgrading, leading to changes to the system. Defects from changes to industrial production, such as imprecise assembly in car manufacturing, may lead to production downtime at the cost of up to 1 Mill. Euro per hour. Therefore, it is crucial to find causes of defects after changes to mitigate this risk.

System parts that are subject to change are linked to other parts of the system or to external systems via *dependencies*. This project aims at annotating knowledge on dependencies of system parts as foundation for defining a smart checklist to check dependencies systematically before and after conducting the change.

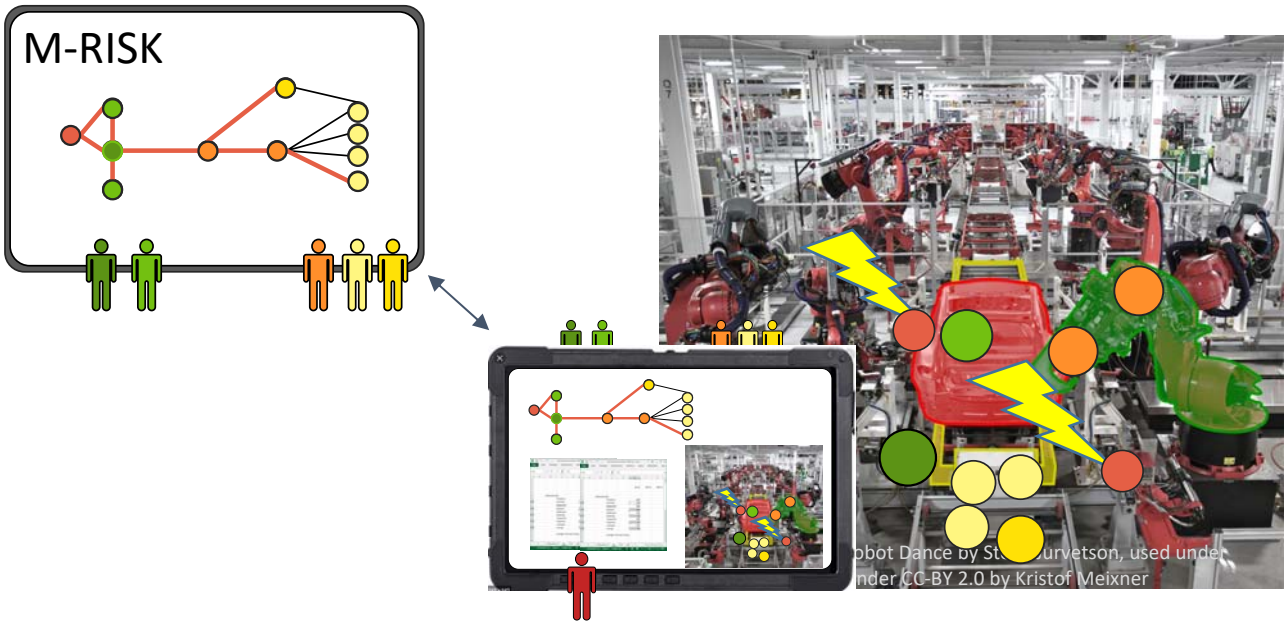

Figure 1: M-Risk cause-effect graph designed by several domain experts and used for change impact analysis.

Figure 2 illustrates a 4-color printing process as a sequence of printing and drying process steps using different colors. Figure 2 shows example system parts, which are subject to change, surrounded by *dotted lasso lines*, e.g., the processes for *printing* and *drying* the first color or the library element of the *printing unit* for printing color x+1. For change impact analysis, a key question is which dependencies cross the system boundary and how risky are these dependencies in case of a change.

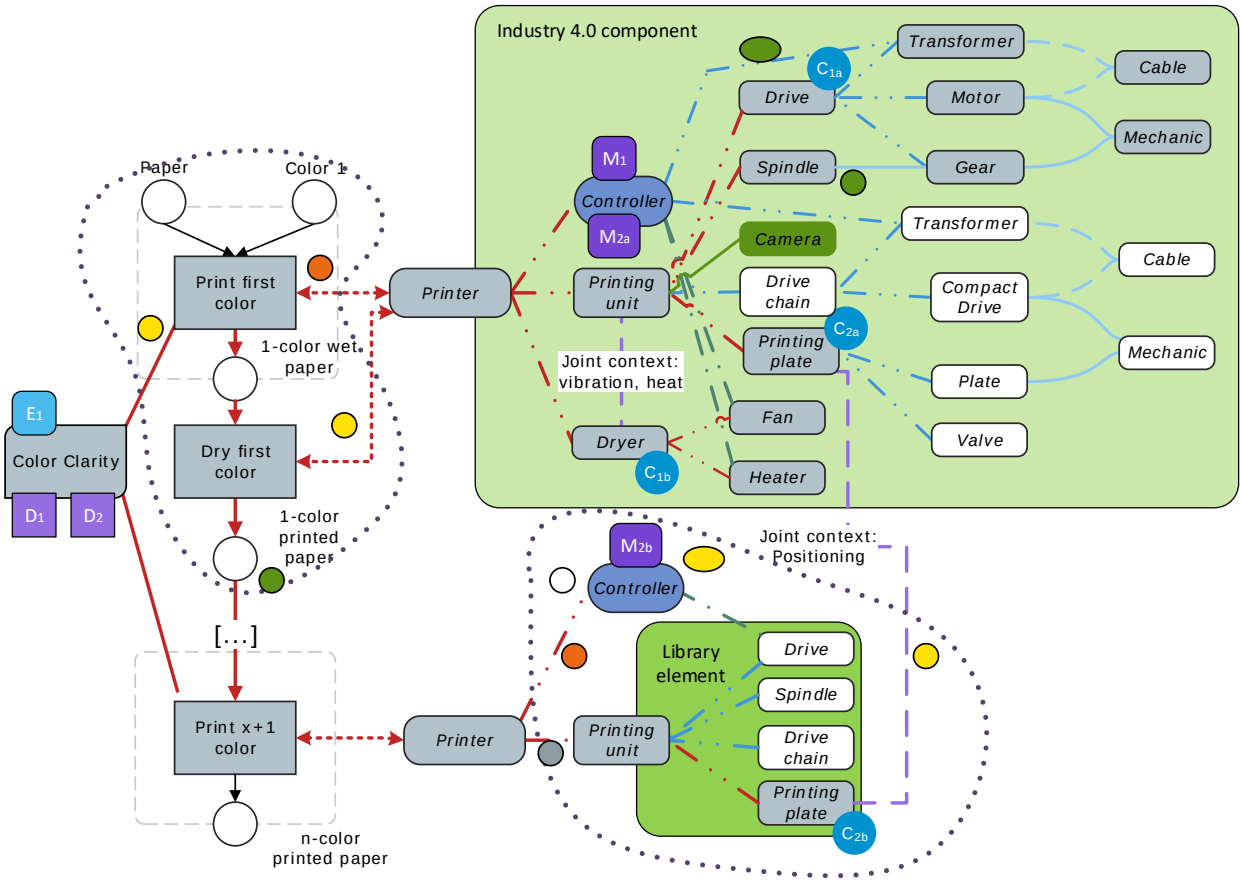

Figure 2: 4-color printing process with change impact analysis regarding a *printing unit*.

Goal of this project is to develop a web-based application for facilitating *change impact analysis*: (1) collecting change impact analysis data from several sources as a knowledge graph; (2) annotating dependencies between system parts; and (3) providing the dependency knowledge graph via a graph database as foundation for advanced functions, such as deriving a *smart checklist* or adding evidence from designing and conducting changes to the production system.

This topic is provided and supervised in cooperation with our industrial/academic partner *TU Wien Pilot Factory*.

Tasks

- Detailed requirements analysis for change impact analysis functions.
- Design of a web-based application based on the MDRE Platform, a front-end platform that provides functions on graph manipulation for connected models to efficiently collect several views on the system into a common graph.
- Design of basic graph placement for adding elements to the common graph.
- Selection of graph databases based on change impact analysis requirements.
- Prototype implementation and evaluation of change impact analysis functions.
- Design and implementation of benchmarks for change impact analysis queries.
- Empirical evaluation of measurement data regarding criteria for the strengths and limitations of the graph databases.

Expertise

For this topic a set of skills is recommended (at least two are mandatory).

- Java programming skills
- Graph database skills, e.g., Neo4J/Cypher.
- Data modeling
- Empirical evaluation, e.g. case study, pre/post comparison.

References

Biffl, S., Lüder, A., & Gerhard, D. (Eds.). (2017). Multi-Disciplinary Engineering for Cyber-Physical Production Systems: Data Models and Software Solutions for Handling Complex Engineering Projects. Springer.

Biffl Stefan, Arndt Lüder, Kristof Meixner, Felix Rinker, Matthias Eckhart, and Dietmar Winkler. Multi-View-Model Risk Assessment in Cyber-Physical Production Systems Engineering. In Slimane Hammoudi and Luís Ferreira, editors, Proceedings of the 8th International Conference onModel-Driven Engineering and Software Development, MODELSWARD 2021, online, February 8-10,2021, pages 1–8. SciTePress, 2021.

Biffl Stefan, Arndt Lüder, Kristof Meixner, Felix Rinker, Matthias Eckhart, and Dietmar Winkler. Multi-View-Model Risk Assessment in Cyber-Physical Production Systems Engineering. Technical Report CDL-SQI-2020-05, CDL-SQI, Institute for Information Systems Engineering, TU Wien, November 2020.https://qse.ifs.tuwien.ac.at/cdl-sqi-2020-05/