Reference:	**QSE:RACE**
Topic:	**Risk Analysis based on a Cause-Effect Knowledge Graph**
Course Type:	Project, Bakk-/Master Thesis
Start:	As soon as possible
End:	To be defined
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Background

Defects in industrial production, such as imprecise assembly in car manufacturing (see Figure 1), 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 fast to mitigate this risk.

Important effects depend on causes that come from (1) production processes, (2) the production system that automates the processes, and (3) the production environment. This project aims at annotating knowledge on risk for selected effects to a cause-effect graph that links relevant effects to typical causes as a foundation for deriving a *smart checklist* to find the selected effects fast and at low cost.

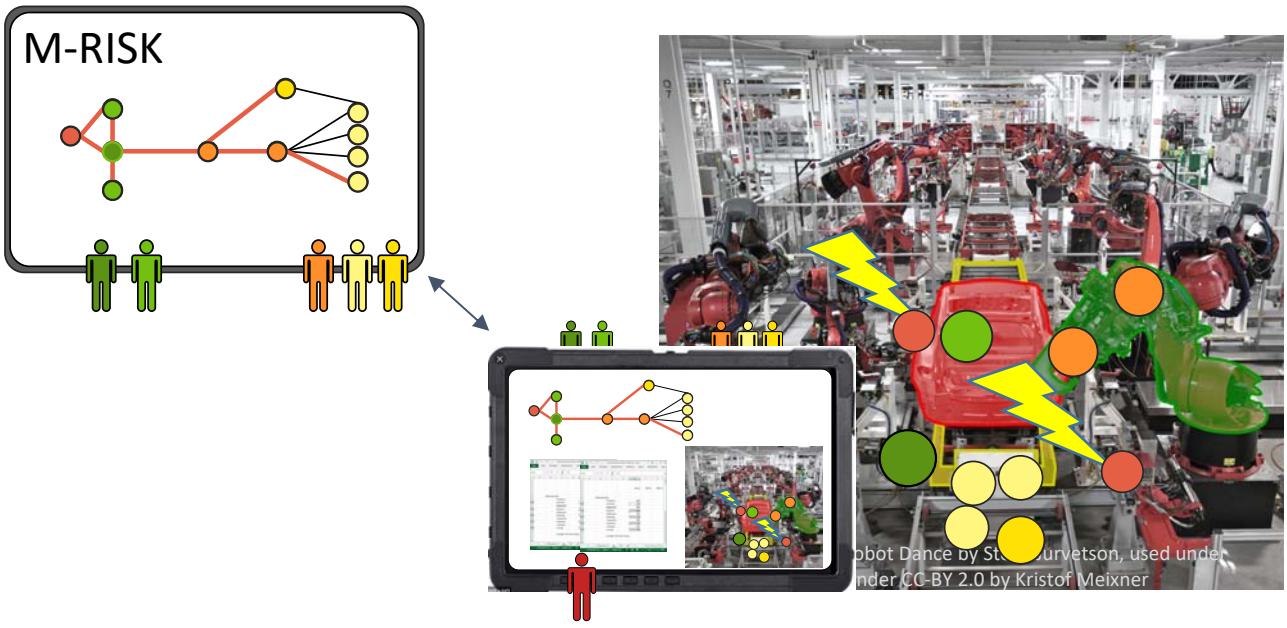

Figure 1: M-Risk cause-effect graph designed by several domain experts and used during production for risk analysis.

The performance of production processes, such as 4-color printing, depends on correct contributions by a *cyber-physical production system* (CPPS) that automates these processes. Figure 2 illustrates a 4-color printing process as a sequence of printing and drying process steps using different colors. The product quality Color Clarity depends on the process performance that in turn depends on functions that the production resources, such as printers and their components, provide. Figure 2 shows an example

cause-effect network, as *red lines*, starting from the effect *Color Clarity,* and leading to potential causes with a *Drive* or a *Dryer* (annotated with a letter C in a blue circle).

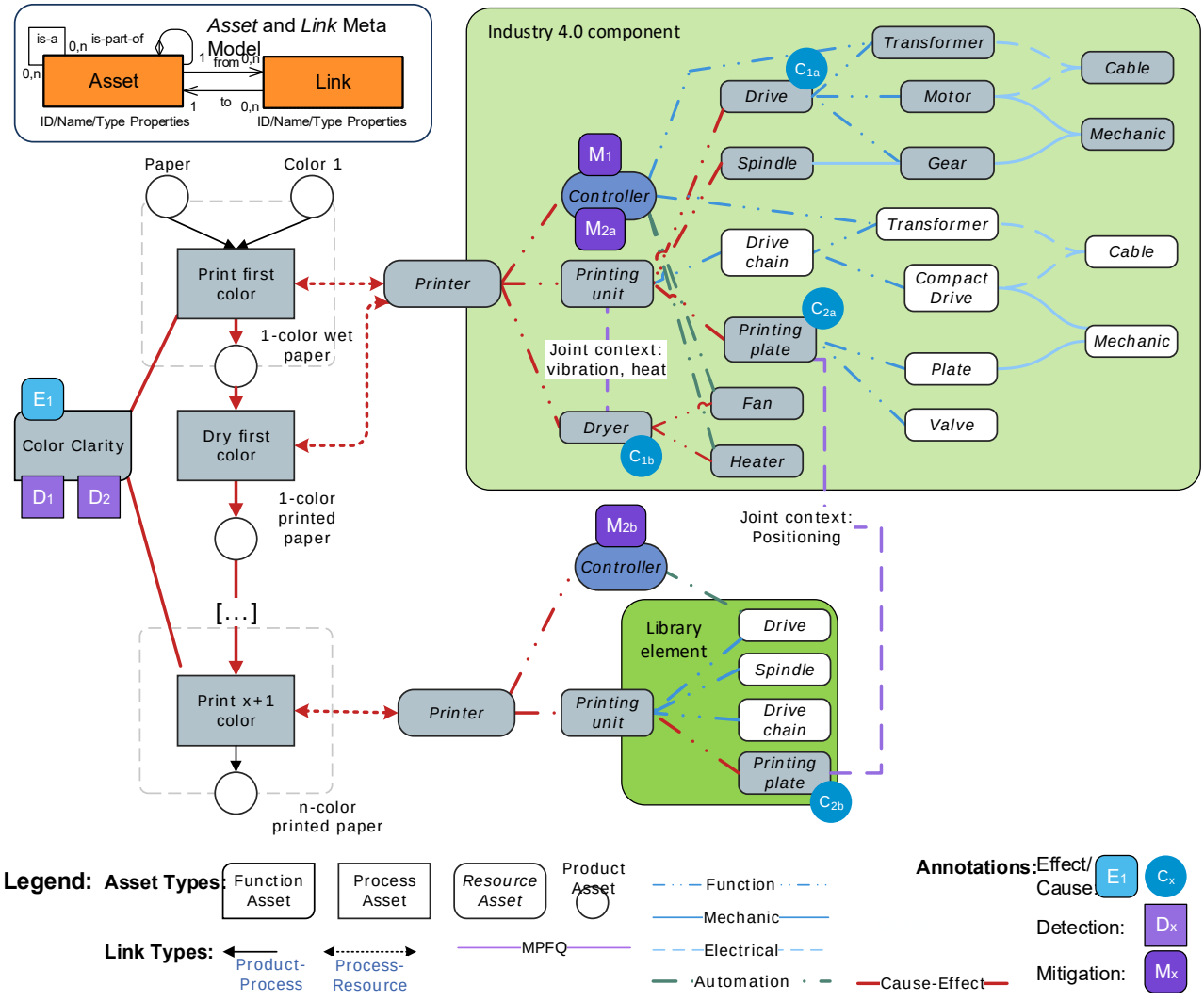

Figure 2: 4-color printing process with risk analysis regarding the risky effect *Color Clarity*.

Goal of this project is to develop a web-based application for facilitating *risk analysis*: (1) collecting risk analysis data from several sources as a knowledge graph; (2) annotating a cause-effect path; and (3) providing the cause-effect knowledge graph via a graph database as a foundation for advanced functions, such as deriving a *smart checklist* or adding evidence from designing or using 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 risk and issue 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.
- Selection of graph databases based on the risk analysis requirements.
- Prototype implementation and evaluation of risk and issue analysis functions.
- Design and implementation of benchmarks for risk and issue 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/