Leveraging Technical Interoperability for Design Manufacturing Integration in Low Volume Manufacturing Industry

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Abstract

The low-volume manufacturing industry is facing an ever-increasing competitive market environment, where flexibility, complex products, and short time-to-market are crucial for competitiveness. These market dynamics drive companies to rapidly design and introduce new products, thereby placing greater emphasis on the new product development (NPD) process. The integration of design and manufacturing functions has been identified as a critical enabler for improving the NPD process and reducing product lead times. However, a successful design-manufacturing integration requires the exchange of a substantial amount of data and information between the two functions.

To ensure this exchange, a robust product data infrastructure is necessary, along with the capability for systems to communicate seamlessly. Technical interoperability is essential for enabling data flow, reducing manual interventions, and increasing accessibility to data. Existing literature has primarily focused on technical interoperability within high-volume manufacturing, noting that a lack of technical interoperability can significantly impact the performance of manufacturing processes, including inefficiencies in workflows, data exchanges, and rising costs. However, less emphasis has been placed on technical interoperability within the context of low-volume manufacturing industry.

Against this background, the purpose of this thesis is to leverage technical interoperability to facilitate design-manufacturing integration within the context of low-volume manufacturing industry. This was achieved by performing an in-depth single case study analysing the NPD process of a low-volume manufacturing company. The findings identify current challenges related to low technical interoperability within an NPD process as well as the impacts of inadequate technical interoperability on NPD process efficiency, quality, customer requirement handling, and innovation.

Finally, the findings identify the steps necessary to leverage technical interoperability to facilitate design manufacturing integration. The theoretical contribution of this thesis lies in addressing a notable research gap concerning the role of technical interoperability in facilitating design manufacturing integration. It introduces a novel approach to mapping the product data infrastructure that supports an NPD process, illustrating its levels of technical interoperability and analysing their impacts. The practical contributions of this thesis include a comprehensive understanding of how existing challenges within an NPD process can be addressed by increasing technical interoperability.

Furthermore, it highlights how lacking technical interoperability negatively impacts NPD efficiency and can act as a barrier to innovation. Lastly, this thesis provides a step-by-step approach detailing how technical interoperability can be leveraged and exemplifies the process described herein.

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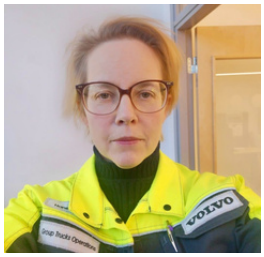

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List of publications in the thesis

Paper A
Sigurjónsson, V., Bruch, J., & Granlund, A. (2023). Exploring Challenges in a Low-Volume Product Industrialization Process – A Railway Case Study, IFIP International Conference on Advances in Production Management Systems, APMS 2023

Paper B
Sigurjónsson, V., Bruch, J., & Granlund, A. (2024). Exploring Manufacturing Design Integration for New Product Development in Low-Volume Manufacturing: An Interoperability Analysis.(Manuscript)

Paper C
Sigurjónsson, V., Bruch, J., & Granlund, A. (2025). Exploring the Potential of Technical Interoperability within Low Volume Manufacturing Design Integration – A Case Study,58th CIRP Conference on Manufacturing Systems, 2025

Biography

Vésteinn is originally from Iceland and graduated with an M.Sc. Degree in Industrial Engineering and Management at Linköping University, where he specialized in Operations Management. He has previously worked as a quality assurance engineer at a consultancy within the digital domain before moving back to academia. Along with that, he has investigated how agile project methods can be applied within production development projects, including coaching and guiding industrial partners. Currently, he is working as an industrial doctoral student at Alstom, where his focus is analysing workflows and identifying improvements via digitalization.

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