Managing testing activities in sustainable product design and manufacturing

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Project Description:

Currently, manufacturing industries are going through massive transformations in restructuring their products and processes by introducing and adopting new technologies to meet NetZero and sustainability targets. These new technologies enforce product design and manufacturing process changes, especially how these products are tested for quality assurance and validation. Testing plays a significant role in assessing Technology Readiness Levels (TRLs) and in new product development for quality assurance. A significantly increasing number of physical and virtual testing are essential to ensure quality and validate the product, especially for a complex product with many components and subsystems, such as cars or aircraft. For example, the need for enhanced testing of new technologies, including low-carbon hydrogen production and heat recovery, is highlighted in the UK Industrial Decarbonisation Strategy 2021 (Government 2021). A key question arises: when there are uncertainties around the new technology and where the standard process and years of experience are not available, how do companies plan and manage testing activities that provide the optimum balance of quality assurance versus cost and time?

Physical testing is time-consuming and can count up to 30 to 50 per cent of the total development cost in automotive and aerospace industries, for example (Sudol and Mavris 2018, Tahera, Wynn et al. 2019). Therefore, there is an industrial need to reduce physical testing costs and speed up the development process, foster the learning benefits of the testing activity from different stakeholders, and better manage the testing activities (Tahera, Earl et al. 2017). A significant effort goes into virtual testing (i.e. computer-aided engineering (CAE) and modelling and simulation) to assist physical testing. A critical trade-off is how much physical testing can be reduced without compromising the quality, especially for radical emerging technologies requiring comprehensive testing.

Testing strategies can be different for incremental or innovative new product development. Incremental product development perceives minor improvements or simple changes to existing products, so testing focuses on the changes and mostly on verification and validation (Tahera, Wynn et al. 2019). But for the radically new product with major improvements in 'technological capability' or/ and 'product capability', testing also needs to focus on experimentation (Erat and Kavadias 2008), demonstration (Thomke 2007), and refinement (Camburn, Viswanathan et al. 2017), as well as testing the product concept with customers (Cooper 2019). The supplier's product validation testing also plays a significant role in new product testing. Access to supplier testing results and data helps better

understand components' performance and behaviour and dramatically reduces component-level testing in the main company (Tahera 2022). Therefore, a collaborative effort to integrate test plans, analysis results, and corrective action workflows across suppliers, internal teams, and customers is essential.

Testing is based on traditions, standards, and procedures; however, companies must take different strategies when planning testing activities to develop radically new products. There is very limited research in this area, and a pragmatic method of supporting testing strategies for sustainable new product development is needed.

Research methodology:

This research will aim to investigate how testing activities can be managed better for sustainable manufacturing, especially when companies develop a radically new product with new technologies. The research methodology will be based on case studies with manufacturing industries to identify current challenges and opportunities. Data can be collected through semi-structured interviews, observations, and document analysis. The modelling technique could be used to capture and determine how these testing activities are linked with other testing and product development activities from different stakeholders to establish the information flow relationship. This study will help develop testing strategies and effective testing planning methods to reduce product development and manufacturing effort and cost.

About the Supervisors:

Dr Khadija Tahera researches product development, manufacturing and operation management, focusing on improving testing processes through case studies, modelling and simulation in collaboration with industries to establish best practices. Her recent publications and doctoral supervision concentrate on testing new product development and performance measurements for sustainable and resilient supply chains.

Prof Christopher Earl, Emeritus Professor, School of Engineering and Innovation, has researched Design and Manufacturing Processes in several projects, currently co-investigating on EPSRC 'Design Configuration Spaces' (2018-2022) at Leeds University (Schools of Engineering, Business and Computing). Associated work includes research and PhD supervisions in Design Processes (based on industry cases in engineering design), Design Computation and wider issues in design including policy and power.

Dr Bjorn Claes' research interests are Supply Chain Management, Supply Chain Behavior, Management Information Systems, Change Management, and Entrepreneurship.

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