Product development flexibility in the aerospace industry

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Abstract

The aerospace industry is facing an ever increasing pressure for efficiency and performance putting the new product development (NPD) at the centre of the firms' competency. Due to low-volume and high resource-intensive nature of this industry, NPD cannot be done with other resources than those of serial production, which adds to the operations' complexity and causes disruption to the production unless new products are fully compatible with the serial production. To better understand efficient and effective product design process, this research offers a high-level model for a sustainable NPD in complex and resource-intensive manufacturing such as the aerospace industry.

Keywords: New Product Development (NPD), Aerospace industry

Introduction

Largest in Europe and ranked second in the world (right after US), is the British aerospace industry, employing just under 130,000 employees in over 3,000 companies and contributing worth of £31b annual turnover to the national economy and shown 30% productivity growth from 2010 to 2015 (Everitt 2016).

However, this industry is under pressure for innovation and performance, which drives for more complex products, processes, materials and technologies (Stolt *et al.* 2015), which ultimately needs higher new product development (NPD) capability, flexibility and efficiency (Vallhagen *et al.* 2013). However, the manufacturing flexibility within product development phase has not yet been extensively studied in this sector (Javadi 2015). Besides, due to high resource and investment intensity and process complexity in this industry, developing new products must be managed alongside the routine production, as firms cannot afford to allocate separate NPD facilities and resources. However, mixing NPD (with its iterative nature) with serial production (with its strive for standardisation and repeatability) can cause large conflicts and disruptions in the entire value chain (Selldin and Olhager 2007). Therefore, this study aims to propose a

holistic model to enhance the manufacturing flexibility at NPD phase within the aerospace industry

Complexity and flexibility in aerospace industry

In the next 20 years the number of aircraft in service is expected to double, with a massive challenge of total 20% weight reduction (Madrid et al. 2016). Besides, the aircraft engine industry needs to show an ever increasing performance in new products (Stolt et al. 2015). Thus, to optimise performance and weight aerospace industry is under a constant pressure to use new materials, complex geometries, and consequently ever complicated technologies which magnitude the level of complexity and variability in this industry, on top of customised demand and market uncertainty (Stolt et al. 2015). Variability, complexity and market uncertainty are latent problems among most manufacturing industries and an even more critical to aerospace manufactures (Vallhagen et al. 2013). Adding to this high level of variability and complexity in this industry, the low production volume nature of aerospace makes its product development a difficult management task, requiring tailored solutions (Javadi 2015).

Jiao et al. (2007), proposing a framework (figure 1) for a platform design and development, categorise new platform design process into four interacting phases of product definition, product design, process design and supply chain design, among which the main two phases of product design and new product introduction (NPI) is accountable for at least 80% of the final structure of the products cost and quality (Singhry et al. 2014). Thus these two stages of a NPD will be the focus of this paper.

Research design

Similar to Mountney at al. (2007), this study deploys a single case method on one of the leading European aeronautical firms. To improve the validity of the results, triangulation approach was employed, and interview, fieldwork data collection, and focus group methods were employed. Eleven managers from different functions (all involved with different aspects NPD) were interviewed first, and transcripts were thematically coded. Fieldwork data collection and statistical data analysis was then conducted to support/reject the interview findings. Finally the results of these two steps were discussed in a one-day focused group study with ten managers with the same functions as interviewees (but different individuals were asked to participate in focused group study for validity-testing purpose).

High-level Conceptual model

Figure 1 shows a high-level conceptual model for this study, which links the abovementioned main three elements that contribute to an effective and efficient NPD.
CE is the centre to the NPD best practice, but it needs process/product design knowledge which must be systematically made available through an effective knowledge management system. The cross-functional team within CE also requires accessibility to information, statistical data and documents from previous design projects through an integrated information system.

To make NPD process a learning and self-enforcement process, when a NPD project is successfully done, there must be a systematic feedback system available to capture design knowledge created in the NPD process (the tacit knowhow) and to feed it back to KMS, and to feedback all recordings, documents and data (explicit knowledge) to the IS. Then linking KMS and IS through constant contact and communications, as well as seeking ways with which KMS can record, upload and share the tacit and implicit knowledge, the T2E process can be initiated, managed and maintained.

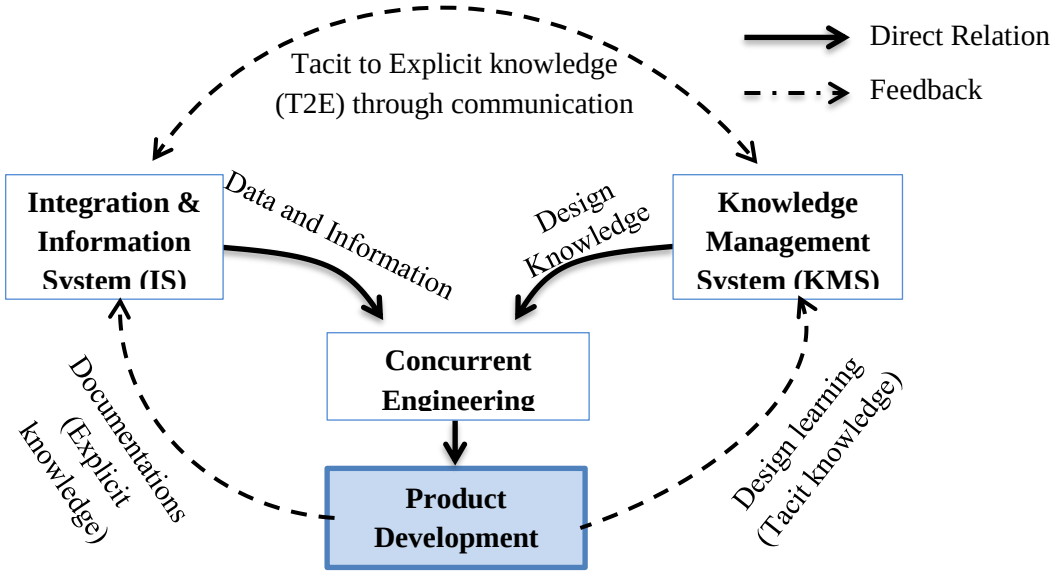

Figure 1: high-level model of enhancing flexibility in new product development

Results

The focused group, fed with the coding result of the interview, defined manufacturing flexibility in new product introduction phase within aerospace as "*how best a new component can be introduced to the production line, for an efficient, agile and fault-free production, with a minimum disruption to the serial production*". To enhance this flexibility, the interview coding results led to development of a holistic framework to enhance manufacturing flexibility in NPD phase in the aerospace industry, as shown in figure 2. This model and other findings will be discussed in detail in the extended paper.

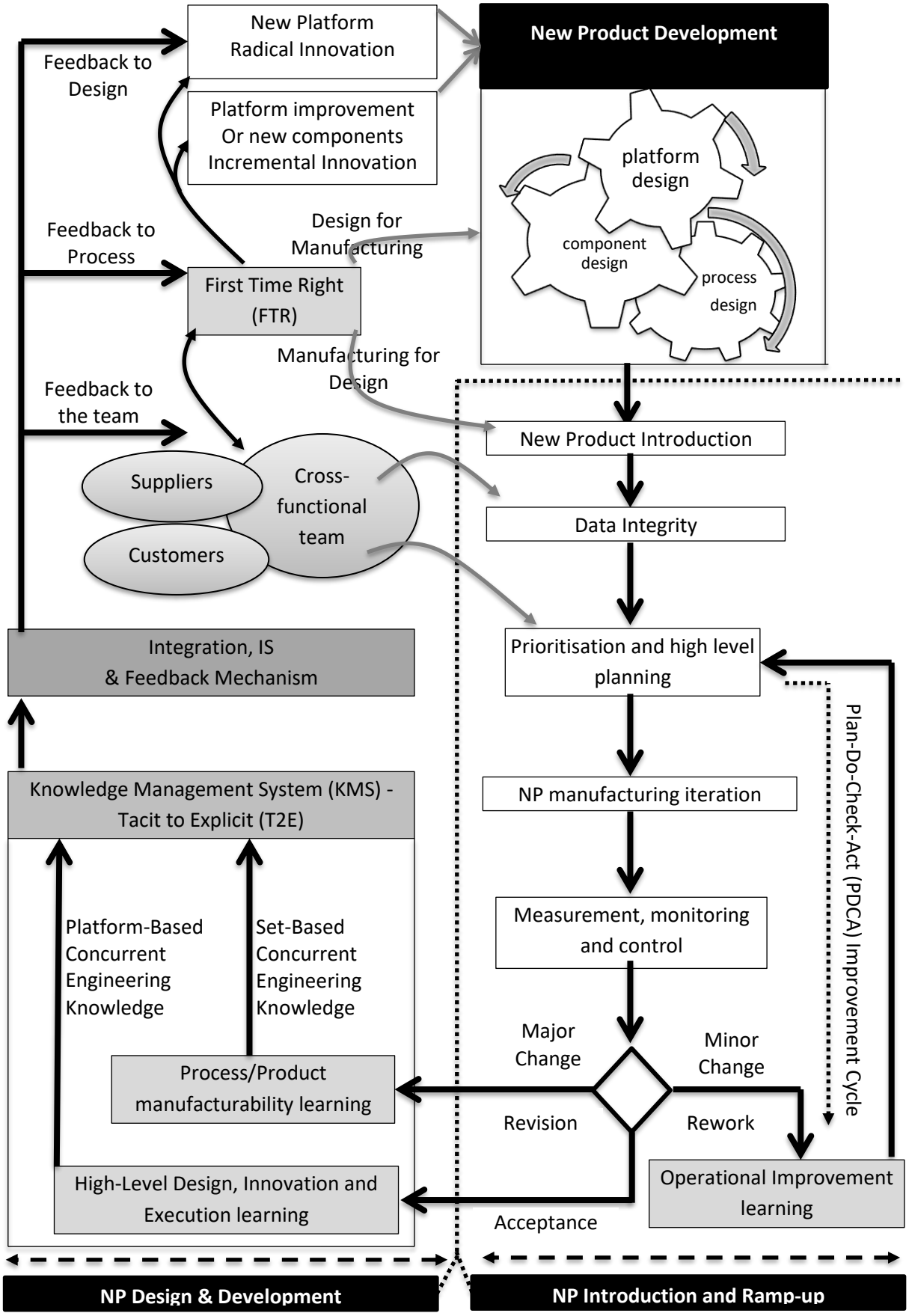

Figure 2: The holistic framework to enhance the product development flexibility in the aerospace industry

Conclusion

This research contributes to the state of knowledge in management process of NPD in aerospace industry, by identifying what manufacturing flexibility entails in the new product introduction in this industry, and how to enhance it by implementing an integrated information system, a knowledge management system and an effective concurrent engineering practice. The result shows rooms for 15 to 20% mid-term NPD improvement (in development cost and lead-time), which translates to millions of dollars/pounds of saving in the scale of this industry. The wider relevance and contribution of this research will be discussed in the full paper.

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