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Collaborative knowledge sharing in Composite New Product Development: An aerospace study

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Abstract

New Product Development (NPD) in the commercial aerospace industry focuses on producing products, which reduce operating and service costs, emissions and weights, while increasing operating performance parameters. There is an increasing use of Composite materials in aerospace NPD projects to achieve these goals due to the advantageous properties of increased strength and reduced weight. A key constraint in developing Composite capability in aerospace NPD is the development of appropriate diagnostic and manufacturing capability requiring new knowledge within aerospace organisations. The aim of this paper is to explore the acquisition, embedding and use of new knowledge from multiple sources in Composites NPD using a case analysis of a leading international aerospace prime. In particular, the study focuses on the need for new diagnostic testing capabilities and knowledge within the Composites NPD process as a source of competitive advantage. Data sources include multi-level semi structured interviews ($n = 20$) with internal and external stakeholders involved in the NPD process and focus groups ($n = 5$) comprised of the Composites NPD team members. The findings show that in addition to traditional internal and external knowledge sources, out of sector knowledge (in this case from Healthcare Diagnostics) can be used to inform specialist NPD technologies. Furthermore, it is essential that knowledge from multiple sources is effectively integrated within the NPD process using a designated knowledge portal.

Keywords: New product development; Aerospace; Knowledge; Composites; Interviews; Focus groups

1. Introduction

The current UK Aerospace Statistics (http://europa.eu.int) show that there are 3000 manufacturing organisations employing 150,000 direct staff and 350,000 indirect staff (e.g. suppliers, partners and support services) with a turnover of £18.42 billion (58% civil, 42% military) In civil aircraft, which are the main product of the case organisation used in this paper, the predicted growth rate is 56%. Composites techniques are at the forefront of the evolution in aerospace materials and New Product Development (NPD) to support this growth rate. Within the last two decades, the range of applications that use Composites in civil aircraft construction have steadily expanded, thus contributing considerably to the economic operation of commercial aircraft. For example recent development by Boeing of the 7E7 Dreamliner has a 50% utilisation of Composite structure compared to a 5% utilisation in the MD-80 developed in 1980.

The manufacture of Composites as part of the NPD process utilises individual technologies from research and developmental facilities that provide lower cost and weight alternatives to traditional metal components. Within Composites NPD individual aspects of design and manufacturing process chains are integrated to produce complex products with regard to market drivers, production rates and product integrity. For example, current aerospace manufacturing processes produce new materials, with complex geometrical with highly curved surfaces such as wing components, to increase the performance and efficiency of modern aircraft. This poses problems for manufacture and product integrity, including data acquisition that requires precise control of multi-axis robotic

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systems, data visualisation and anomaly evaluation (Deng et al., 2004).

The need for new knowledge in Composites NPD presents a communications challenge in addition to that of technology development. Davenport and Prusak (2003) and Hurd (2000) have identified effective communication of knowledge both internally and externally through knowledge networks as a key element in transforming organisational NPD.

The aim of this paper is to explore the acquisition, embedding and use of new knowledge from multiple sources in Composites NPD using a case analysis of a leading international aerospace prime. There will be a particular focus on the need to develop appropriate diagnostic testing as a key element of Composites NPD.

2. Knowledge exchange and communication in NPD

Stimulation of innovation amongst national networks in specific fields of technology or business application is paramount (Bach et al., 1999; Preston et al., 2005). For example, the collaboration of prime aerospace manufacturers may provide new industry standards and quality criteria for future development. A number of issues arise from the need for knowledge sharing, including: relationship management including confidentiality agreements, product compliance and competitive advantage issues (Gerwin and Meister, 2002); leveraging previous experiences in new process and product development (Ford et al., 2000; Koners and Goffin, 2007); communication issues between academic and industrial bases (Kodama, 2005) and benchmarking best practice in the industry sector (Cooper et al., 2004).

Contemporary aerospace companies are increasingly using integrated digital engineering and manufacturing, supply chain development, and aftermarket solutions as they transform themselves into e-business on-demand companies that exhibit characteristic responsiveness, variability, focus, and resiliency (Kochan, 1999). Three-dimensional CAD, CAM and computer aided engineering (CAE) software programs reduce time and money constraints in NPD by reducing or eliminating the need for physical mock-ups, expensive wind tunnel testing, allowing for early detection of interferences between components and enabling rapid design iteration that results in product optimisation (Case and Hounsell, 2000). NPD in this environment requires cross-functional internal and external collaboration, with rich, frequent, reciprocal, and early communication of knowledge (Teece, 2000; Lee and Chen, 2007). The capability to recognise, absorb and utilise knowledge and information as part of the NPD process is essential for effective NPD (Abraham et al., 2003). Hence, the benefits of access to external knowledge and establishment of more networks of specific expertise with outside organisations is gaining relevance in comparison to internal R&D linked to NPD (Chesbrough, 2003; Kodama, 2005).

2.1. External knowledge for NPD

While companies increasingly rely on joint R&D projects with other firms, universities are becoming more engaged as active partners in these activities (Hall et al., 2003; Cyert and Goodman, 1997). The fundamental purposes of academic research is to "produce codified theories and models that explain and predict natural reality", while business R&D is concentrated on designing and developing "producible and useful artefacts" (Pavitt, 1998). Distinction between research in universities and companies has become more diffuse. There are both positive and negative outcomes from university and industry collaboration (Hall et al., 2003). Similarly, there are also enhancing and deterring factors related to organising for cooperation (Rappert et al., 1999). Knowledge, information, creative breakthroughs, academic freedom, social change, gaining an outsider's perspective, and flexibility of research are important outputs of collaboration but may pose significant obstacles. Recent studies have shown barriers to knowledge sharing and cooperation while others have produced empirical evidence on the benefits of this kind of arrangement (Meeus et al., 2004; Ottosson, 2006; Behrens and Gray, 2001). Based on these findings and including those of Amabile et al. (2001) and Kramer (2001) among others, the following generic benefits can result from improved collaboration between universities and organisations in relation to knowledge exchange for NPD: knowledge transfer by individuals and organisations, internal organisational renewal, internal renewal of academic curricula, external support from collaboration and establishment of best practice.

Organisations have difficulty in recognising that research work may be abstract, complex and ambiguous, since researchers may be more concerned with concepts and basic sciences as opposed to development of technology and applications (Blackman et al., 2007; Elmquist, 2007). Academia is less subject to radical changes and can have more divergent goals than private sector organisations (Rappert et al., 1999). Similar problems and questions arise with respect to other aspects of collaboration, such as the forms of collaboration (Amabile et al., 2001), scope of collaboration and the quality and applicability of research produced (Anderson et al., 2001).

Restrictions to academic openness may emerge, and accepting funding can lead to issues of ownership and use of intellectual property rights as researchers usually publish their results or utilise them commercially (Behrens and Gray, 2001; Hall and Scott, 2003). The achieved benefits may be insignificant when related to the efforts invested in joint research, and the promised knowledge transfer may not occur. As universities can potentially collaborate with a number of competing companies, unintended flows of knowledge and confidentiality issues within the university may occur, contrary to organisations non-disclosure ideals (Hall et al., 2003). As the understanding of business goals has increased in universities, and universities engage more