Collaboration Barriers in the Implementation of Design for Environment

Case Studies from Small and Medium UK Enterprises

This paper considers product development interaction and collaboration issues in the implementation of design for environment (DfE). The research used a multiple case study methodology to investigate collaboration and relationships within product development teams. Interviews within a multiple case study research were used to identify the links between poor adoption of DfE principles, communication, collaboration and knowledge management. The study was carried out across the product development teams of twenty British small and medium sized companies. The paper presents an overview of the preliminary findings drawn from an ongoing comparative analysis of these case studies to highlight the impacts of organisational factors on DfE implementation within product development teams. It is argued that further research should focus on how knowledge acquisition and transfer within small and medium enterprises can better support the necessary collaboration in DfE.

Keywords: Design for Environment, Product Development, Collaboration, Knowledge Management, Case Study

Organisational structure and Design for Environment

Design for Environment (DfE) is mainly concerned with lowering the environmental impacts of products or services through the pursuit of reduced carbon footprint, increased recyclable content, weight reduction, etc... (House of Lords, Science and Technology Committee 2008). Much of the research in this area has focused on the development of eco-tools: *"finding ways of describing environmental aspects of material selection and generalised ways of dealing with environmental information"* (Baumann et al. 2002, p.415). Other research concentrates on the use of case studies to illustrate the potential of these tools and other DfE applications to industry.

While DfE has received much attention over the last two decades (Baumann et al. 2002; Boks 2008), the role of organisational factors on DfE success appears to be seldom explored. Baumann et al. (2002) add that research presents *"a fragmented approach to the issue"*, lacks a business focus and has few references that *"deal with the integration of management issues, environmental issues and product development activities."* (p.415). Although the need for DfE to focus on organisational capabilities is not new, as mentioned in 1997 by Bras; Karlsson and Luttropp (2006) explain that researchers seem more interested in the introduction of new tools than evaluating or enhancing existing ones. Boks and McAloone (2009) also agree but add that research has since the review by Baumann et al. (2002) started to look at organisational issues and to diverge from the creation of eco-tools.

Meanwhile in industry, the take up of DfE is limited (Tukker et al. 2001; Boks & McAloone 2009). The DfE scene has evolved considerably academically but DfE implementation in industry is still lagging. It is thought this research can start to address this problem by reporting on the up-to-date DfE practices and perceptions of British design teams and helping us further understand the possible success factors and barriers of DfE implementation.

Developing a better understanding of DfE organisational success factors
The research undertaken and presented in this paper is interested in the organisational factors that influence the implementation of DfE within British product development teams. It aims to investigate the links between the low take up of DfE principles and factors such as communication, collaboration and knowledge management.

Methodology
This research uses a multiple case study of in house design teams and design consultancies, and was undertaken through semi-structured interviews. Over 80% of product design consultancies in terms of British market share were interviewed (Relph-Knight 2011, p.39)**.** Twenty small and medium enterprises took part, resulting in 65 interviews with 55 interviewees. Interviews were undertaken where possible with designers, engineers, production managers and managing directors on their current and recent DfE projects. These projects are defined by DfE intent in which environmental criteria are part of the brief.

Cases	Design Consultancies	In-House Design Teams	Total
Number of Interviews	18	47	65
Number of Cases	7	13	20

Table 1: Cases and interviews spread.

This multiple case study design enabled the gathering of a greater variety of findings. Moreover, the use of a larger sample size and of comparative cases from different settings enabled this research to corroborate patterns of association and therefore to offer potential for contextualised generalisation and theory building. Multiple case studies also allow a high generation of findings and to reach data

saturation without using too much resource from each case participant in an industry where time is very precious.

The interviews provided a rich and personalised picture of distinctive cases. Each participant offered an account with its own perspective resulting from their different background and position in the company. They were guided by the researcher through the introduction of broad topics which allowed the participants more freedom to express views (Bryman 2008). The topics included 'design process', 'DfE views and approach', 'communication', 'collaboration', etc... These views were then compared, looking at company, sector or job type as variables.

This descriptive research is ongoing through the real time tracking of projects, and the purpose of this paper is to provide researchers and practitioners with the latest insights and to create a dialogue on the issues raised. Further collection of data and analysis is underway, which will complete this research and fine-tune its results along with the feedback from both industry and the academic world.

Comparative analysis
While the research is still ongoing, the data collected has been through an initial stage of comparative analysis that this paper presents below. The findings have been segmented into themes that have so far emerged from the analysis. These also facilitate the presentation of this paper. The themes are 'Adoption' (regarding the take on of DfE), 'Views' (the perception of DfE), 'Approaches' (the way DfE is implemented), 'Objectives' (the types of environmental objectives pursued), 'Knowledge' (its level and structure in DfE) and 'Communication and Collaboration' in DfE.

Adoption:
Across all cases, there were no projects driven by DfE principles. There were very few projects where the implementation of DfE principles was considered. Moreover, the cases that consciously looked at DfE were primarily driven by hopes that there would be a cost benefit. Only if it made financial sense would the DfE principles be taken on. Interviewees also expressed, that although based on cost, some of their brief's criteria did relate to DfE and were considered in that respect, typically saving on material, minimising packaging or housing of components, reducing weight, increasing recyclability, etc...

Views:
According to a majority of interviewees, DfE is seen as a discipline with conflicting opinions. There is confusion as to why different environmental alternatives and strategies seem sometimes to contradict each other. There is a general lack in confidence and sometimes, even trust with DfE, in particular regarding products' environmental claims and DfE implementation methods such as eco-tools and software. In some cases, there is also a belief or concern that DfE alternatives will hinder the products' functions, properties or another part of the design.

Approaches:
In terms of methods of implementation, the research identified there was a total lack of use of eco-design tools. In only one case had a large design consultancy developed a spreadsheet linking environmental impact data to a bill of materials. Within this company, one person was fully aware and able to use the tool. In other cases, designers would follow principles of DfE without any methods of environmental impact measurement but rules of thumb and peers' advice.

As for investing in DfE, both in-house teams and consultancies expressed their uncertainty regarding the types of investment to make and doubts regarding the potential return on investment. Senior level staff thought that DfE was not asked for enough by clients to be worthy of investment. Few

knew what they would do next if they had to develop this part of their offer and would have to look into it further at that time if the need arose.

Objectives:
Environmental objectives found in project briefs are typically associated with those relating to reducing weight or energy use, increasing the recyclable contents of materials, looking at more environmentally friendly materials, etc... But in all cases, as mentioned earlier, the cost constraints are placed higher in priority than the environmental ones. Moreover, in almost all cases, the environmental objectives are pursued in the knowledge that they have potential in lowering costs or at least keeping costs at the same level.

On another level, there is a clear lack of cohesion between briefs' environmental objectives and overall company environmental objectives. The interviewees directly involved in product development are usually not aware of the environmental objectives set by the companies selling the products nor do they appear in the briefs. If their briefs include environmental objectives, these are again usually set without any knowledge of the environmental management teams. In effect, it seems companies' overall environmental strategies are not driven down to product briefs and design teams.

Knowledge:
A key element found within this research concerns the individualistic nature of DfE knowledge. Whilst those interviewees most interested in DfE, spend some of their time looking at the DfE field, none declared that they had received professional training on DfE. The gathering of information and learning is in most cases self-driven and regarded as commendable by senior management. However, this knowledge development process offers very little opportunity for knowledge transfer as it is driven by individual interest and not by management. Because DfE is not encountered in many projects and learning about it does not appear to be critical; both knowledge development and transfer appear weak. The interviewees' time is not accounted towards expanding DfE knowledge in any of the cases. Most feel they are not given the time, do not have the time or do not bear the responsibility to gather knowledge on DfE. This in turn, creates a problem of knowledge retention. Employees interested in DfE, motivated and able to dedicate time towards knowledge development in the area, explain they only transfer small amounts of knowledge to their team. In some cases, they or their teams do not feel the need to gather knowledge, let alone transfer it. When DfE savvy employees leave their company, their knowledge goes with them since there are in most cases no systems in place to transfer knowledge to the product development team or company. This problem of knowledge retention was experienced by the majority of cases. This lack of communication regarding DfE knowledge offers an interesting parallel with the findings above regarding the lack of communication in environmental strategies across product development chains.

Communication and Collaboration:
Most interviewees observe a general lack of cohesion across the product development chain in terms of DfE strategy. The interviewees have generally a low engagement with suppliers and in most cases no engagement over environmental strategies. Gathering knowledge from suppliers on their processes and material use for example is difficult. This in turn makes it difficult to develop environmental impact assessment of existing products and new concepts. However, in a majority of cases, it is not seen by the interviewees to be their job to investigate these issues. It also seems difficult at a product development level to work with suppliers in adopting greener approaches.

Internally and in most cases, communication and collaboration on DfE is said to happen through emails and few meetings but more usually by "bumping into" and around an impromptu "cup of

tea". Other than these means, the vast majority of cases seem to lack communication and collaboration tools, especially in terms of DfE.

It is interesting to denote that the only case using an eco-tool (a design consultancy) is also the one using the most communication or collaboration tools. This company uses forums on their internal computer network to share information and interests, ask questions to peers and diffuse knowledge. However, even in this lone case where systems are in place for communication and knowledge transfer, the actual use is low in the area of DfE. Interviewees talk about communication and collaboration examples relating to industry sectors or more general product design aspects, but only a few meetings take place on the subject of DfE. Knowledge of internal DfE resources is also very limited. Contrary to the majority, they feel very satisfied by their communication and collaboration tools. However, the use of those in terms of DfE still remains relatively very low.

There is a level of frustration, mostly from designers in more junior positions regarding communication and collaboration. They are in many cases negative about the ability of their company to learn from previous projects and to transfer knowledge and information. They are also negative about the lack of collaboration and communication within projects. They explain that internally within the design team, information filters down with loss from senior levels and from the client companies. Externally, they also experience difficulties (such as time constraints and retention of information) in gathering information from the supply chain. Comparing the views from the different job types, it does seem that environmental criteria are much more affected by this hierarchical loss of information. Overall, it seems that the companies' environmental strategies as well as the products environmental objectives are not communicated effectively down to the design team.

The problem of communication and collaboration affecting interviewees is not confined to DfE oriented projects but apply to all project types at certain levels. However, in DfE oriented projects, interviewees express how more hindering these problems become and how it affects their capacity to achieve best performance. In many cases, interviewees reflecting on their practices explain that lack of information, communication and collaboration makes it often impossible to achieve the desired environmental objectives.

Conclusions and future research
Although DfE has received a lot of attention from the academic world, especially in the last twenty years, the take up in industry is still far from being at the same level.

This paper uncovered obstacles in the DfE process relating to a lack of information, communication and collaboration. While these issues are not seen to be unique to DfE they are thought to be key drivers in the advancement and success of DfE. The research also shows that these obstacles emanate from various parts of the product development chain and that they are not confined to small groups or individuals. Knowledge development and management have also shown to play an important part in the implementation and success of DfE.

These findings finally show how the drive of some motivated interviewees to develop their DfE knowledge is restricted by the lack of knowledge transfer and collaboration processes within product development. This could in turn challenge the concept of 'green champions' often cited in literature (Baumann et al., 2002).

Further research should focus on looking at how the identified difficulties could be overcome in different parts of product development and throughout the wider context of operations management. So far, this research has highlighted the importance of focusing on the development

of collaboration, knowledge management methods and sustaining knowledge acquisition in DfE as well as understanding how to develop systemic knowledge and knowledge transfer at the level of design team, company and product development chain.

References

Baumann, H., Boons, F. & Bragd, A., 2002. Mapping the green product development field: engineering, policy and business perspectives. *Journal of Cleaner Production*, 10(5), pp.p.409–425.

Boks, C., 2008. New academic research topics to further ecodesign implementation: an overview. *International Journal of Product Development*, 6(3/4), pp.p.420–430.

Boks, C. & McAloone, T.C., 2009. Transitions in sustainable product design research. *International Journal of Product Development*, 9(4), pp.p.429–449.

Bryman, A., 2008. *Social Research Methods* 3rd ed., Oxford: Oxford University Press.

House of Lords, Science and Technology Committee, 2008. *Waste Reduction*, London: the Authority of the House of Lords.

Karlsson, R. & Luttropp, C., 2006. EcoDesign: what's happening? An overview of the subject area of EcoDesign and of the papers in this special issue. *Journal of Cleaner Production*, 14(15-16), pp.1291–1298.

Relph-Knight, L., 2011. The Top 100, Consultancy Survey 2011. *Design Week*.

Tukker, A. et al., 2001. Eco-design: The State of Implementation in Europe – Conclusions of a State of the Art Study for IPTS. *The journal of sustainable product design*, 1(3), pp.p.147–161.