

Improving an existing product family based on commonality/diversity, modularity, and cost

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As product life cycles become shorter and shorter, stakes are higher in terms of sales and profits, making it an imperative for companies to enhance existing product families as much as possible. In this paper, a methodology using the Design Structure Matrix flow, Value Analysis, and the Commonality versus Diversity Index is proposed to improve an existing family of products. These tools assess and improve commonality/diversity trade-off within the family, feature satisfaction through design, and definition of new modules/components and their interfaces. A case study based on a family of refrigerators is detailed in this paper to demonstrate the methodology.

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Keywords: design method(s), design tools, product design, design management

Companies' success depends mainly on their products' price, quality, competitive positioning, differentiation, etc. In the past companies tended to focus on individual products, but today there is greater attention to product families (Simpson, 2004). While the product family approach facilitates targeting broader market opportunities, it also adds complications as the approach is usually based on a platform shared by several products that are differentiated with specific components targeting specific market niches. Hence, if the platform has a problem, then this problem contaminates every single product that has been derived from it. Another issue is the lack of differentiation of the family of products that can generate catastrophic results on the sales. Lutz (1998) acknowledged the importance of designing a good platform especially in the automotive industry, and, in general, of specifying a good family of products that are differentiated and positioned correctly in the market.

As product life cycles become shorter and shorter, stakes are higher in terms of sales and profits, making it imperative for companies to enhance existing product families. Furthermore, a single improvement in the platform can be leveraged across all of the products in the family. If the necessity to improve an existing family of products is well known, this task is difficult for designers

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www.elsevier.com/locate/destud

0142-694X \$ - see front matter *Design Studies* 28 (2007) 387–409

doi:10.1016/j.destud.2007.01.002

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due to the complexity of platforms. Hence, it is necessary to specify tools identifying improvements to help designers enhance a product family. Redesigning a product family enables designers to use a bottom-up platform approach that utilises designers' experiences with existing products to help specify a common platform (Simpson, 2004). Among others, examples from Black & Decker (Meyer and Lehnerd, 1997) and Nippondenso (Whitney, 1993) highlight the importance of this approach to product family redesign.

A methodology including three tools is proposed in this paper to help identify sources of improvement to support product family redesign. This study focuses on answering the following questions, namely, in this family:

- Is the tradeoff between commonality and diversity resolved in a satisfactory manner for marketing?
- Are the modules correctly defined?
- Are the interfaces specified well?
- Is the number of components satisfying each feature acceptable?

Section 1 below provides the context and discusses the extent of this study. The proposed methodology and its implementation are introduced in Section 2. Section 3 analyses the results of a case study involving three refrigerators and suggests some extensions of the methodology. Finally, closing remarks are made in Section 4.

1 Literature review

A few studies have been done to redesign a family of products focusing on various aspects such as modularity, cost, and commonality/diversity. Hernandez et al. (2003) introduced the Product Platform Constructal Theory Method (PPCTM), a method that proposes a hierarchical organisation of multiple objectives functions to manage product variety. Simpson et al. (2001) proposed the Product Variety Tradeoff Evaluation Method (PVTEM) to assess the tradeoff between commonality and performance within a family of products to provide decision support for designers. Several studies have also introduced methods to redesign individuals products (Taguchi, 1986; Lee, 1996; Holttta and Otto, 2005; Rajan et al., 2005). Very close to this field, many studies have been done on re-engineering the design process. Among them, Kusiak et al. (1994) and Tang et al. (2000) maximised modularity by aggregating activities.

We have identified three categories of tools for redesigning of a *family* of products based on: (1) design specifications, (2) module-interface specifications, and (3) commonality-diversity specifications. These are described as follows.

- (1) *Design specifications* are based on customers' needs; these methods help designers find the best way to address these needs. They include QFD

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