Int. J. Production Economics 114 (2008) 313–332

Contents lists available at ScienceDirect

Int. J. Production Economics

journal homepage: www.elsevier.com/locate/ijpe

Lean product development: Maximizing the customer perceived value through design change (redesign)

Naveen Gautam[a,*], Nanua Singh[b]

[a] Hella India Electronics, Plot P-46, Rajeev Gandhi Infotech Park Phase I, Hinjewadi, Pune, Maharashtra 411057, India
[b] Department of Industrial and Manufacturing Engineering, Wayne State University, Detroit, MI 48202, USA

ARTICLE INFO

Article history:
Received 20 November 2004
Accepted 28 December 2006
Available online 18 March 2008

Keywords:
Lean product development
Customer perceived value
Design change
Decision making
Optimization

ABSTRACT

With the incremental product development, one of the main objectives is to make it more attractive and valuable for the customer, which leads to increased sales and higher profit. When existing product design is modified to improve its perceived value, each change needs resource commitment. It is important to identify and pursue only those changes, which give maximum improvement in the perceived value. In this paper a mathematical model is presented for perceived value and step-by-step methodology is provided to capture the optimized design changes with cost implications. With the help of a case study on automotive vehicle development, we show how proposed model and method can be used for highest value added change selection. Application of optimization model for perceived value and change trade-off in general is presented along with some special policy cases for different scenarios.

1. Introduction

Any company can stay in market if and only if it makes profit and keeps its customer excited about its products. Therefore, product improvement by incremental development is the heart of any sustained business venture (Gilvan et al., 2004; Morgan et al., 2001). With product improvement, we here imply bringing the new features, technologies, attractive designs and improved quality to the market. However, this is possible generally by introducing changes in the existing product. In this study our scope is limited to the products being developed based on existing products such as automotives, computers, and printers, etc.

This evolutionary product development for such products needs decision as, what to change and what to reuse. If changes are too many, product development may be too expensive and development time may be too long. On the other hand, if changes are too few, customer may not be able to see the differences from the last product and unable to get excited (Kosonen and Buhanist, 1995; Lindstedt and Burenius, 2003; Mallik and Chhajed, 2006; Rainey, 2005). However, with aggressive marketing strategy some gains can be made which do not last longer (McAdam and Leonard, 2004). Art of sharing the changes and change cost across several product line is outlined by number of researchers (Dahan and Hauser, 2002; Gilmore and Pine, 1997; Meyer and Lehnerd, 1997; Pine, 1999; Richards, 2000). The key to successful product development is to pursue the changes for which customer cares, while minimizing the overall changes to reduce development time, cost and risk involved due to these changes. Fisher et al. (1999) presented key costs related optimization model for component sharing and tradeoffs for variety and use of over designed parts. In their study, they did not consider impact of customer perception on sharing or reuse of the components across products. Samson and Wacker (1998) provided a broad and general understanding on maximizing the benefits per dollar to the customer. In their study on automobile industry, they provided a good comparison of various players in industry and emphasized the need for focusing more on the

* Corresponding author. Tel.: +91 2066730700/800.
E-mail address: navgau@gmail.com (N. Gautam).

0925-5273/$ - see front matter
doi:10.1016/j.ijpe.2006.12.070

customer as a new organizational cultural, but did not give any theoretical model or step by step process to support their study. Value of a global product was analyzed and compared in cultural context by Boztepe (2007) and Matsui et al. (2007). However, their focus was on localization and standardization of the product. Marketing aspects of customer perceived value has been extensively reported in literature (Tam, 2004; Ulaga and Chacour, 2001), but during product development customer perceived value still needs more attention.

Ulrich and Eppinger (2004) provided steps for identifying customer needs and establishing their relative importance, but did not provide method for selecting vital few needs based on their perceived value and practical constraints like budget, development time, risk due to change, etc. Several researchers (e.g. Hauser and Clausing, 1988; Ulrich and Eppinger, 2004; Wheelwright and Clark, 1992) emphasized the need to first establish critical customer attributes for the product using QFD approach. These attributes become the rows of the central matrix of the house of quality. Kansei Engineering (Nagamachi, 1989, 1995, 2002) has been developed and successfully applied (Hsiao and Chen, 1997; Ishihara et al., 1995; Jindo and Hirasago, 1997; Lai et al., 2006; Yang et al., 1999) as "translating technology of a consumer's feeling (Kansei in Japanese) and image of a product into design elements". Han et al. (2004) prioritized customer attributes and engineering characteristics in QFD with incomplete information using linear partial ordering approach and Fung et al. (2006) helped in establishing functional relation using fuzzy regression. However, they did not study the cost implications and impact of changes required to implement the prioritized characteristics. Studies of Burke (1992) and Gilvan et al. (2004) were primarily based on optimization of development life cycle at the program level. In his study, Burke (1992) did not bring the analysis at the component level. Lin et al. (2008) proposed dynamic development process model, for managing overlapped iterative product development. Ozer (2007) emphasized the need of reducing demand uncertainties by predicting cluster-based methodologies for customer opinions. Whereas, Sobek (1997) and Sobek and Ford (2005) emphasized the need of knowledge-based product development for any effective and efficient design reuse, but did not discuss how reuse impact the customer perception. Ryan (2004) developed multiple models based on goal programming for generalized economies of scale. Ulrich (1995) presented the role of the product architecture by which function of a product is allocated to a physical component. He tried to conceptualize the linkages between product architecture and key areas like product change, product variety, component standardization, product performance and product development management. Krishnan and Ulrich (2001) presented an extensive review of literature on product development decisions. Sousa and Voss (2002) provided review and agenda for future research on multidimensional quality management and there is evidence of multidimensional quality construct (Stone-Romero et al., 1997) including customer perceived quality. However, not much has been reported on perceived value based product design change.

Unlike the existing literature, in this paper we are proposing a method of feature selection during incremental product development to maximize the customer perceived value for the changes. In our analysis we included cost of change in the form of development cost, tooling cost, per piece cost and increased warranty cost due to increased risk. We also consider the role of coupled product architecture and undesired changes on customer perceived value and change cost. Based on binary integer optimization, we came out with maximized perceived value within the given budgetary constraints. Our results also provide analytical support that perceived value of the new product is largely depend on part/feature correlation and part complexity within the given budget, but it can be significantly improved with resource reallocation based on policies and product strategy.

2. Reasons for a new component design and its impact

There may be several possible reasons for change in the product. However, we classified the changes here in three major categories describes in sub-sections. As shown in Fig. 1, existing product can be transformed into a new product by bringing in these three types of changes. In the following sub-sections, we will detail out each category of change.

2.1. Bringing innovation

Innovations can be brought into the product in different forms such as new feature/function, new look/feel or new technologies. *New features* are the main source of keeping the customer excited about the product results in maintaining or increasing market share (Kosonen and Buhanist, 1995; Mallik and Chhajed, 2006; Rainey, 2005). New feature demand is often driven by change in customer life style. Use of computer mouse and keyboard, creates similar expectation from programmable features in the cars. Similarly remote operations in the home electronics triggers demand for remote functions in car. In business, often it is felt that customer may be ready to pay for increased comfort or safety in the product but they have not yet learnt to articulate these features (Ottosson, 2004). These features need extensive market research, marketing and through demographic study of the market. We can call these as push type of innovations. Rain sensitive wipe, enhanced accident response or adaptive cruse control are some of the examples to this category for automobile industry.

Look and feel is another important attribute of value judgment for most of the products. To create excitement and unique feeling in the end user, new aesthetic features are introduced. This can be a change in exposed components and themes from look/feel and color perspective, even though the design functionality stays the same (Hsiao and Chen, 1997; Ishihara et al., 1995; Jindo and Hirasago, 1997; Lai et al., 2006; Person et al., 2008). Body style, door profile, interior trim style and color, distinct combinations of multi-theme interiors in car are some of the example of this category.