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Concurrent engineering and its consequences

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Abstract

Technology and market changes introduce uncertainty and equivocality in the product development arena, and firms are considering various structural relationships to help them cope with these changes. Concurrent engineering (CE) is a mechanism that can reduce uncertainty and equivocality and improve an organization's competitive capabilities. CE is typically manifested through concurrent work-flows, product development teams, and early involvement of constituents. It enables information to flow through the organization quickly and effectively thereby, reducing uncertainty. At the same time, it enables debate, clarification, and enactment which are essential elements in combating equivocality. CE practices are also purported to have significant effects on product innovation, quality, and premium price capabilities.

This research carefully defines CE and creates a valid and reliable instrument to assess it. It reports on the development and testing of a model that relates CE to some of its most salient consequences. Half of the sample of 244 firms is used for exploratory purposes and half for confirmatory work and hypotheses testing. Results indicate that firms that experience a high technological and product change in their environment are using more CE practices. In addition, results suggest that CE practices have significant direct effects on product innovation. However, only the indirect effects of CE on quality and premium pricing are statistically significant. Firms with higher levels of product innovation have higher levels of quality. Firms with higher levels of product innovation do exhibit premium pricing capabilities but only if they affect quality capabilities. Firms that display elevated quality levels excel in their premium pricing capabilities.

Keywords: Product development; Concurrent engineering; Competitive capabilities; Empirical research; Structural equation modeling

1. Introduction

Customers have grown more sophisticated. They demand new products and features, which has fueled technological change and innovation. Levels of product quality once considered extraordinary are now a minimum requirement for doing business. In many industries, sustained competitive advantage can only be secured by sustained improvements in quality. As customers have grown more sophisticated and demanding, the variety of products has increased dramatically (Wheelwright and Clark, 1992). More and more firms are finding that their competitiveness, indeed their very survival, is determined by the speed and effectiveness of their product development programs. To that effect, there is a number of examples and case studies that have been published and attest to the importance of product development and its effects

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on quality and pricing capabilities (Dumaine, 1989; Nayak, 1990; Clark and Fujimoto, 1991; Clark, 1989; Clark et al., 1988; Hartley, 1992).

Much of this change can be attributed to the insurgence of Japanese products. The rapid introduction of new products along with shorter product life cycles increased uncertainty and equivocality for many organizations. Many firms were poorly equipped to face the realities of this new competition because they were highly bureaucratic with functional structures that inhibited the free flow of information (Liker et al., 1996). These structures were also incapable of dealing with the equivocality that comes from a rapidly changing environment. Firms unable to adjust their organizational design have seen their market shares slip and their dominance recede.

Successful firms employ organizational designs that enable them to reduce uncertainty and equivocality and deal effectively with changes in the competitive environment. These firms have reorganized the product development process from a sequential, 'over the wall', process to a concurrent process where marketing, product engineering, process engineering, manufacturing planning, and sourcing activities overlap (Wheelwright and Clark, 1992; Clark and Fujimoto, 1991; Susman, 1992; Mansfield et al., 1971; Clark, 1989). They involve important constituents early in the product development effort, and those constituents become part of a cross-functional team. This integrated approach has been described as 'concurrent engineering'. Team members coordinate problem solving efforts to improve product innovation, and enhance quality. Improvements in product innovation and quality capabilities are thought to have a determining impact on premium pricing capabilities.

Many companies have been using CE practices but, there is no strong theory for the adoption of CE practices. In general, companies found CE practices useful in their attempts to improve product innovation capabilities and quality. But the question remains as to why the CE practices and not other practices. Do firms in high change environments adopt higher levels of CE practices? Do higher levels of CE practices lead to better product innovation and quality competitive capabilities? In turn, do product innovation and quality lead to premium pricing capability?

While there is keen interest in understanding how to improve product development and competitive capabilities, our knowledge about how to do so is supported by anecdotal evidence (McDonough and Barczak, 1991). Cooper and Kleinschmidt (1994) state that most prescriptions for improving product development capabilities are founded on speculation, opinion, and a handful of case studies. In fact, Gerwin and Susman (1996) report that very little in the form of empirical work has been published. Two recent special journal issues (i.e. IEEE Transactions on Engineering Management 6 (2) (1996); Journal of Operations Management 17 (6) (1999)) have been particularly useful in the body of empirical literature for product development. Trygg (1993) notes that the lack of broad-based research has made it difficult to establish whether the more innovative practices in highly visible companies represent a cultivated movement in industry or merely changes found in a few successful, technology-based companies. Such research requires the development of instruments for measuring product development practices and their consequences.

This manuscript offers an explanation for the selection of CE practices. Essentially, concurrent engineering is conceptualized as an efficient organizational design that tackles both uncertainty and equivocality in the environment leading to improved firm capabilities. This study also presents and tests a hypothesized measurement model and a structural model that relates CE to some of its more pronounced consequences.

2. Theory development

The present product development environment is characterized by rapid change which introduces both uncertainty and equivocality. The work of Daft and Lengel (1986) is indispensable in understanding the effects of uncertainty and equivocality on information requirements and structural design. Based on early work in psychology (Miller and Frick, 1949; Shannon and Weaver, 1949; Garner, 1962), they describe uncertainty as the absence of information. Similarly, Galbraith (1977) defines uncertainty as "the difference between the amount of information required to perform the task and the amount of information already possessed by the organization". Daft and Lengel (1984) citing the prevalent view in organization theory (e.g. Galbraith, 1973, 1977; Tushman, 1978; Tushman and Nadler, 1978), suggest that orga-