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Research on E-product development (ePD) for mass customization

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Abstract

Electronic product development directly connects multiple customers and suppliers throughout the entire value chain. This alleviates much of the inefficiency in current product development and supply chain practices. It integrates different facets of product design, process design, order processing, and order fulfillment in a cohesive manner. This capability becomes a critical factor in global competition. This paper presents an on-going research program of e-product development (ePD) for mass customization. The program aims at investigating fundamental issues and enabling techniques for applying the Internet to re-engineering manufacturing companies towards mass customization. The ultimate goal is to assist industries to upgrade to become high value-added businesses.

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1. Introduction

Facing the buyers' market, many industries are now shifting from mass production to mass customization (Pine, 1993). Once homogenous markets have turned fragmented and heterogeneous, where customers may express their individual needs. Product life cycles and development cycles are constantly reduced. With the increasing flexibility in manufacturing systems and the high speed of information exchange, mass customization may satisfy the requirements of individual customers with near mass-production efficiency. Such a new manufacturing paradigm enables higher profit margins for designers and manufacturers, better and improved customer satisfaction, as well as high-value added business opportunities (Tseng and Jiao, 1996).

The Internet provides a pervasive communication infrastructure as well as immense business opportunities and information resources. E-commerce is expected to reach a turnover of US\$100 billion by 2000 (Van Poel and Leunis, 1999) and will exceed US\$1 trillion by 2003 (IDC, 2000). E-commerce has much potential to transform industries in terms of core activities such as design, resource planning, factory automation, and supply chain

management. These processes can be re-engineered to utilize Internet technologies, leading to significant cost savings and reduction in lead times (Huang and Mak, 2001a).

In light of new capabilities brought by e-commerce, customers will be able to directly input and interact with the design, manufacturing and service providers. The providers will have to respond to a high variety of requirements and orders within the constraints of cost, schedule and quality. Therefore, e-commerce will be a major driving force, and an important enabler as well, for shaping the future roadmap of mass customization (Economist, 2000).

Web-based product development and design have received worldwide attention over the last decade or so. A number of major initiatives and projects recently launched in America (i.e. MADE and ReDEO, AIMS, TEAM) and Europe (i.e. GEN, PRODNET), involving government, academic and industrial institutions, have adopted the Internet/web technology as the common development infrastructure (Huang et al., 2000). The Web-based approach is particularly suitable for customer requirement management or market research (Muller et al., 1996; Anton and Liang, 1996). From a wider perspective of supply chain management, the web technology also has a great potential (Minis et al., 1995). A detailed review of web applications in product development is given by Huang and Mak (2001a,b).

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While e-commerce and mass customization have recently attracted tremendous interests from both academia and industry, there is hardly any research devoted to re-engineering design, manufacturing and logistics systems in order to best integrate with e-commerce. One of the current obstacles for industries to realize e-commerce is the lack of knowledge in supporting product development and manufacturing capabilities as well as marketing expertise in the Internet-connected environment.

Motivated by these initiatives, this paper presents an on-going research program of electronic product development (ePD) for mass customization. The program is chartered to investigate fundamental issues and techniques of applying the Internet to re-engineering design and manufacturing companies towards mass customization.

2. Implications of ePD-enabled mass customization

Mass customization offers the opportunity to perceive and capture latent market niches and subsequently to develop technical capabilities to meet the diverse needs of target customers. Therefore, we approach mass customization from a product development perspective. Essentially, the strategy is to include customers in the product development life cycle by proactively connecting customer needs to the capabilities of a company. One consideration is to elevate the current practice of designing individual products to designing product families. Another concern is to extend the traditional boundaries of product design to encompass a larger scope spanning from sales and marketing to distribution and services through the employment of the Internet technology. Fig. 1 summarizes these conceptual implications of ePD.

There are three pillars underlying ePD, namely the integrated product lifecycle, mass customization, and supply chain management. The integrated product lifecycle incorporates marketing/sales, design, manufacturing, assembly, and logistics. Using the Internet, some of these activities may be handed over to the supply chain.

There may also be “service” companies that supply so-called “business-to-service” functions.

With the communication and interactivity brought about by the Internet, the physical locations of companies may no longer be important. The typical company that engages in design, manufacturing and logistics will become less common. Manufacturing, as well as design and logistics, may be conducted by outside service companies. As a result, supply chain and service companies will be flourishing.

The company can sell products to distributors and/or directly to customers through customer-to-business e-commerce. In some cases, products may be designed by the customer him/her-self. This is related to as mass customization. Customer needs are then captured directly through the customers’ preferences—customers understand what they want and can submit their preferred design electronically. A well-known example is Dell Computer, where customers can select the elements that constitute a computer according to their own preferences.

Usually information about customer needs may be delivered by sales and marketing. Typically they rely on analyses of customer feedback and predictions for the future. These remain important sources of information for new product development. From this kind of information, the company may redesign the products or decide to develop new ones. The design effort has to take place “concurrently” with many experts involved representing the various expertise and parties that collaborate through the system. The supply chain companies may also participate if this is deemed necessary. In addition, in order to manufacture the product, parts (and other services) may be bought from the supply chain and delivered just-in-time to the manufacturing facility. These constitute typical business-to-business e-commerce.

Fig. 1 also illustrates a systems approach to design and manufacturing. It is a dynamic system with feedback. For each new product or product customization, one must “go around the loop”. The purpose is to obtain information from marketing and other sources to esti-

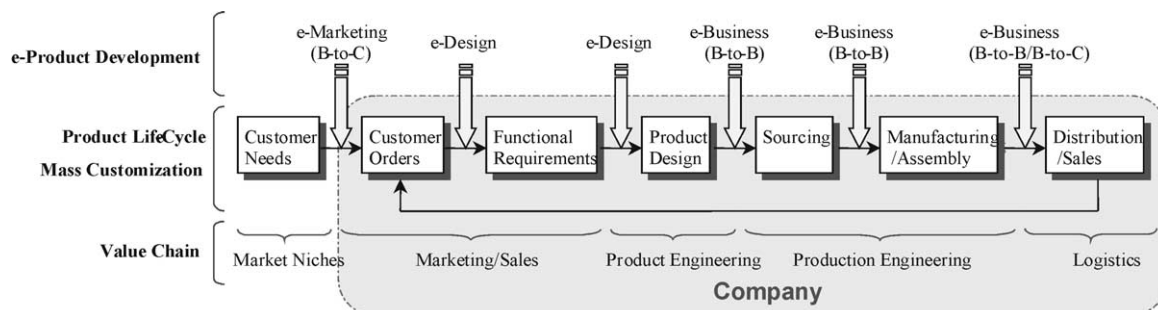


Fig. 1. Implications of ePD for mass customization—from customer needs to sales.

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