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An interactive web system for integrated three-dimensional customization

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Abstract

This paper presents an, interactive, three-dimensional, Web-based and integrated e-Commerce system. This system enforces businesses to implement mass customization, through integration with product design environments on PDM/PLM systems. Through this system, consumers, partners or distributors, can take part in product design and get through their ideas, online and visually, to suppliers. With custom order information, suppliers produce or assembly to meet their customers' demands as precisely and efficiently. We also developed a toolkit to configure the custom product and construct such an interactive website automatically through back PDM/PLM system. Several concerns on this system have been addressed, including its applicable business models, applied techniques, and implementation issues in product data processing, traffic-reduced transportation mechanism of three-dimensional product data, and three-dimensional interaction. A commercial e-Commerce system has been functional and ready for apparel, automobile and mobile phones.

Keywords: Three dimensions; Interactive customization; Integrated e-Commerce system

1. Introduction

Intensive market competition requires manufacturers to learn from and respond to their customers, with as early, precise and efficient as they are able to. A new manufacturing pattern, mass customization [1–5] is emerging to transform customers' requirements agilely to production and meet customers' favorites at as low cost and efficiency as volume production. At its early stage, mass customization emphasized on the flexibility and agility during manufacturing. Appropriate products classification and standardization were the keys to apply mass customization [4]. However, suppliers have seen a power shift from production-centric to consumer-centric in the past few years [6]. Manufacturers are apt to miss or misunderstand consumers' demands when information flows through a long supply chain. Direct distribution is prevalent and competent in a number of industries. For example, Dell Corporation (http://www.dell.com/) has won out by this mode in computer industry. More companies, like IBM Corporation (http://www.IBM.com/) have enhanced customer relationship management by Web-based systems, business intelligence or call centers to get dramatic raise of their revenue. There are plenty of facts that suppliers, including manufacturers, distributors, and retailers, can win out when they are able to get consumers' dynamic demands efficiently and precisely.

To survive this shift of business model from production-driven and market-driven to customer-driven, businesses have to reengineer their business processes and marketing infrastructure with information technologies. The end is to identify and satisfy customers with their favorite features ranging from product functions to appearances and prices. Involved efforts are extensive across the whole enterprise structure. For example, business operation is enforced with tooling systems of marketing analysis, consumers' loyalty analysis and pricing. Employees are enforced with information systems of content and knowledge management, call centers and promotion analysis.

Despite of numerous efforts as mentioned, there is one critical information infrastructure having great potential to be developed, namely three-dimensional and interactive systems. There are plenty of facts that three-dimensional systems are critical for consumer-centric businesses. Three-dimensional systems provide a practical way for consumers to take a part in product design before their assembly or being manufactured. For two-dimensional systems, however, it is not feasible for

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consumers' participation in product design as they may not know what the diagrams and topologies are, and how they relate to products that they want. On the other hand, people for a long time believe that only some kinds of products are appropriate for online businesses, like books (http://www.amazon.com) or those products that is common, standard, well-know or people are familiar with. It is well known that books usually have only a number of standard covers to be optional. What is behind is evident and reasonable. People would never make their mind to buy products that are new and untouchable to them. A number of consumers, especially female consumers, would enjoy touching and sensing their favorite products. We believe most of products would become suitable for online sales if only people have ability to sense products like they do at a store. Three-dimensional systems are one of the key steps to this goal. We have found a number of interactive sites of two-dimensions, however, with no integration with enterprise design and production applications.

This paper presents a three-dimensional, interactive and integrated web system to enforce businesses to implement mass customization. Through this system, consumers, partners or distributors, can take a part in product design and get through their ideas, online and visually, to suppliers. With custom order information, suppliers produce or assembly to satisfy their customers' as precisely and efficiently. Several concerns on this system have been addressed. A commercial system has been developed to provide basic features as mentioned. It is currently functional and ready for implementation in industries like apparel, automobile and mobile phones. Moreover, we have developed a software tool to construct such interactive website automatically. It links the back PDM/PLM system and the front website to greatly enhance the efficiency of publishing the products and shortens the time from design to distribution.

The rest of this paper is organized as follows. Section two provides a survey of related works under virtual reality and collaborative design. Section three describes the proposed system with its applicable businesses and products, applied technique and issues on system implementation. Section 4 demonstrates the system with cases of apparel, automobile and mobile phones. Section 5 concludes the paper.

2. Related works

There are a number of techniques and efforts to exploit user experienced environments and three-dimensional applications. Among them are virtual reality (VR) and Web3D systems. Both of them are prevailing in applications such as collaborative product design and training. VR gives users the sensation of being part of a three-dimensional environment with which they are able to interact. Much interest has arisen for this because of the powerful sensation [7]. For manufacturing industry, VR can be usually used to collision simulation in assembly [8]. There are other applications that allow engineers to design shelves remotely and in three-dimensions (P&G Corporation, http://www.pg.com/). VR is also competent for tutoring and training [9]. Rickel and Johnson were working towards animated agents that can carry on tutorial, task-oriented dialogs with human students. The agent's objective is to help students learn to perform physical, procedural tasks, such as operating and maintaining equipment [10].

Many aspects of a virtual reality system have been developed: the interface devices, system management software and actual virtual world structure [11]. Several specific models and applications have been developed for several specific issues. Benford and Fahlen present a model for supporting group interaction in large-scale virtual worlds [12]. The model provides generic techniques for managing interactions between various objects in such environments including humans and computer artifacts. Zhou et al. worked on collaborative virtual environments and used formal methods to model and analyze environments' real-time behavior and evaluate their network effects and performance [13]. Schwartz et al. describe a shared virtual world with a hospitable environment for users, which examined economic issues related to the design of commercially viable 3D virtual environments and allowed Web-based content [14].

Three-dimensional web techniques and applications have also made progress, especially for multidisciplinary design. Zhang et al. proposes a product information sharing and visualization framework by integrating several state-of-the-art technologies including Web, VRML, and STEP. The objective is to use STEP to establish the product data master model which can support product life cycle and offer a uniform product data space for CAD/CAPP/CAM and ERP systems [15]. Web provides a standard accessing mechanism for product data space. The standard of VRML enables the visualization of the product structure tree in 3D.

The aforementioned works basically focus on three-dimensional collaborative product design and virtual learning. The intended users are product designers and students. With the improvement of the network transport speed and the maturity of computer graphics, especially the combination of the two disciplines, Web3D technology booms. Many application standards emerged, such as VRML (http://www.w3.org/MarkUp/VRML/), Java 3D (http://www.j3d.org/), X3D (http://www.web3d.org/). As the supplier realized that the interaction is the key to hold the customers' interest, there appear a few web systems supporting three-dimensional interaction and product customization [16]. For example, there are a number of websites showing products using three-dimensional animation (http://www.bitmanagement.de/). Other customization sites start to use web3D technology to deploy the interactive digital catalogs [17,18]. What we considered is to utilize the standard international web3d specifications and build automatic website construction tool to publish the commodities online rapidly, and all these integrated with the feature-based design and PDM systems.

This work is to develop a Web-based order system that provides a three-dimensional interactive custom mechanism to get customers' input and enable businesses to implement mass customization. The custom inputs are incorporated through assembly or production to provide customers with products as they demand. To this end, a standardized component, e.g., feature-based product design, feature preprocessing to reduce traffic volume, open, flexible and reusable system architecture,