Multi-Agent System for Web-Based Customization

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INTRODUCTION

Web-based customization refers to an e-commerce business model whereby customers can individualize their products via the electronic channel. The success of this business model to a great extent depends on the appropriateness of the information system, which supports online interaction between customer and supplier (Franke & Piller, 2003). For example, computer manufacturers offering their products online enable customers to select the type of components to be built in the final product (e.g., type of processor, motherboards, graphic and sound cards, etc.). This type of interaction is referred to as Web-based product configuration. In order to increase the chances that customers find suitable products, Web-based customization offers large variety. However, due to the limited information processing capacity of humans and lack of technical product knowledge, excessive product variety confuses customers (Piller, Koch, Moeslein, & Schubert, 2003). It triggers decision-making difficulties and uncertainty concerning the suitability of choices. In effect, customers are generally unaware of their needs and not capable of making optimal buying decisions. Furthermore, the support provided by common information systems is more consistency check than real assistance, since their main task is to verify the compatibility of components between each other.

On the other hand, the resulting variety brings about an increasing complexity of operations and manufacturing-related tasks on the supplier's side. The complexity that is perceived by customers during the interaction process is called "external complexity," whereas complexity that is experienced inside manufacturing and operations is referred to as "internal complexity." Therefore, a suitable information system that supports Web-based customization should simultaneously address both challenges. It should provide customers with appropriate assistance during the search for adequate products and support suppliers in managing variety. In the following, an information system that is capable of coping with both types of complexity will be developed.

BACKGROUND

In order to avoid customer confusion in Web-based customization, information systems should be capable of assisting customers through advisory (Blecker, Abdelkafi, Kreutler, & Friedrich, 2004a; Blecker, Friedrich, Kaluza, Abdelkafi, & Kreutler, 2005). They have to capture a customer's preferences and only display via the Internet the subset of product variants that would be interesting for customers. In this manner, external complexity can considerably be reduced because customers have to make decisions out of a few alternatives. In addition, since the product variants proposed to the customer have higher potential to contribute to the supplier's success, they should be retained in the product assortment. The product variants in which customers are not interested rather increase complexity and should be eliminated from the product assortment. Thus, the condition of success is to reach the final subset of product variants presented to the customers. The most successful product variants ensure long existence in the supplier's offer, while "losers," which cannot establish themselves over a period of time, should be discarded.

It can be imagined that the product variants compete against each other in order to be more successful. For the specification of the competition rules, a market mechanism supported by multi-agent technology (e.g., Jennings, 2000; Wooldrige, 2002) is a suitable solution approach. In fact, it is not practical to associate with each product variant an autonomous rational agent because the extent of product assortments can be very large (billions of possible variations). However, it is common in practice that suppliers providing Web-based customization use modular product design in order to manage high variety (e.g., Gilmore & Pine, 2000; Piller, 2003). Modularity enables one to mix and match product building blocks with standard interfaces in order to create many product variations. Thus, the problem can significantly be simplified if an autonomous rational agent is assigned to a module variation. Subsequently, the extent of the multi-agent population can be kept at a low level. Note that a module

variation is an instance of a specific product module (e.g., an engine is a module, while 1.6 Diesel and 2.0 Diesel are two different engine variations). The corresponding agents are referred to as "module agents" and compete against each other for the sake of success, which means formation of product variants with high chances to be proposed to customers.

In industrial practice (e.g., automotive industry, computer industry, etc.), suppliers make use of an additional variety management concept called product platforms in order to alleviate the negative effects of variety on manufacturing performance (Nilles, 2002; Wildemann, 2003). A platform is a basic component (module) that is built into a large number of product variations (e.g., A-Platform of Volkswagen). The corresponding agents are called platform agents, which differ from the module agents in that their lifecycles are much longer. In effect, product platforms are cost intensive and developed to serve as the basic module of a product family for a long period of time. It follows that the platform agents should not compete with each other in order to survive, and the decision about their removal is left to managers.

The multi-agent-based system should dynamically assist users during interaction. It should generate and refine product variants that meet customer requirements. Variety formation refers to the process, by which module agents cooperate with each other in order to form customer-focused product variants. On the other hand, the module agents should provide useful information to support variety steering, which is the process of introducing or eliminating module variants so that variety offer can be optimized.

INFORMATION SYSTEM FRAMEWORK

The module and platform agents require some data that should be provided by other software systems. Therefore, the complete information system additionally includes four other agents (target costing agent, auction agent, product constraints' agent, and validation agent) and two components (an advisory component and a configuration system) as shown by Figure 1. The advisory component is a software system that initiates an interactive dialog (e.g., Meissner, 2002) with customers and captures their requirements in terms of product

Figure 1. Framework supporting the multi-agent system for Web-based customization (Blecker, Abdelkafi, Kreutler, & Kaluza, 2004b)