Product Configuration Systems

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INTRODUCTION

Product configuration systems are considered to be important enablers of the mass-customization strategy. They are the most successful applications of e-technologies and artificial intelligence in e-business, particularly in customer interaction. Product configuration systems support the acquisition of the customers' requirements while automating the order-taking process, and they allow customers to configure their products by specifying their technical requirements.

In this article, the state of the art is explained and the different product configuration systems are classified in a morphological box. The analysis of the criteria according to which configurators are designed thus far reveals a neglect of the front-end perspective. Therefore, necessary enhancements and development directions toward a comprehensive tool for customer interaction in mass customization are analyzed.

BACKGROUND

Product configuration systems or configurators are important enablers of the mass-customization (Pine, 1993) paradigm. Configurators are information tools that allow the automation of the order-taking process by automatically capturing customers' requirements without involving human intermediaries. Therefore, a configurator has additional relevance because it may be one of the few information systems with which the customer directly interacts in e-business (Bramham & MacCarthy, 2003).

Configurators can be implemented at the interface between a supplier and its customers over the Internet. Its principle task is to support customers in the self-configuration of their products according to individual requirements. For example, customers can be provided with the possibility to alter a basic product and also to graphically visualize the effects of these changes (e.g., http://www.customatix.com/).

Configurators support the configuration process that requires one to accurately understand the customer's needs and to create a complete description of a product variant that meets those needs. Given a set of customer requirements and a product family description, the task of configuration is to find a valid and completely specified product structure among the alternatives that the generic structure describes (Sabin & Weigel, 1998).

Product configurators have been employed in one form or another for many years. Freuder (1998) notes that Lucent Technologies has used product configurators for more than 20 years. Configurators support the configuration task, which is defined as the process of designing a product using a set of predefined components while taking into account a set of restrictions on how the components can be combined (Soininen, Tiihonen, Männistö, & Sulonen, 1998).

STATE OF THE ART AND TYPES OF PRODUCT CONFIGURATION SYSTEMS

Based on heterogeneous application scenarios and solution approaches, the technical literature discusses many types of product configurators. In the following, different classification criteria for product configurators are presented (Blecker, Friedrich, Kaluza, Abdelkafi, & Kreutler, 2005).

Knowledge Base

The representation of the domain knowledge may rely on different ontologies: (a) rule-based, (b) model-based, and (c) case-based approaches. Rule-based configurators work by executing rules with the following form: "if condition then consequence." The product solutions are derived in a forward-chaining manner. At each step, the system examines the entire set of rules and considers only the set of rules that can be executed next. The most important model-based representation types are logic-based, resource-based, and constraint-based approaches (Sabin & Weigel, 1998). Logic-based approaches are often based on description logic. Description logics are formalisms for representing and reasoning with knowledge. The inference mechanism is based on subsumption. However, resource-based systems are based upon a producer-consumer model of the configuration task. Each technical entity is characterized by the amount of resources it supplies, uses, and consumes. In constraint-based reasoning, components are defined by a set of properties and a set of connection ports. Constraints among compo-

nents restrict the ways components can be combined (Tsang, 1993). The case-based approach relies on the assumption that similar problems have similar solutions. The knowledge necessary for reasoning consists of cases that record a set of product configurations sold to previous customers. The configuration problem is solved by finding and adapting a previous solution to a similar problem.

Strategy

From the point of view of mass customization, three main strategies with different requirements for configurators are distinguished, namely, assemble to order, fabricate to order, and engineer to order. The assemble-to-order concept enables customers to configure a product by combining a finite number of standard modules. However, the fabricate-to-order and engineer-to-order concepts may assume an infinite number of configuration possibilities. The technical realization of configurators for fabricate to order and engineer to order is more demanding than those for assemble to order because a parameterization of component dimensions should be made possible.

Organization

The organization of a configurator can be either central or distributed. A central configurator works locally and its configuration knowledge is completely stored in one unique system. All potential product instances that may represent a solution to the customer configuration problem are derived from these local data. However, the knowledge base of a distributed configurator is locally incomplete. It is integrated with other configurators (e.g., suppliers' configurators) in order to generate consistent product instances for specific customer requirements.

Internal vs. External

Internal configurators are only implemented for a company's internal use. For example, internal configurators support sales experts in capturing a customer's requirements and translating them into technical features without errors. External configurators are designed to provide customers with direct assistance during product configuration. They are equipped with front-end interfaces to facilitate the configuration task for customers.

Interaction Nature

The nature of interaction can be either off line or online. Off-line configurators work independently from networks.

The necessary data for configuration are stored on a data carrier such as a floppy disk, CD-ROM, or DVD-ROM. After product configuration, customers can send the specifications via, for example, e-mail or fax. However, today, mainly online configurators are applied. They enable communication with customers over the Web. The configuration knowledge is stored on a central Web server. Online configurators can be further divided into two categories: online configurators with central data processing and online configurators with local data processing. Online configurators with local data processing require the loading of the configuration application (Java applets, full Java applications) onto the customer's local unit.

Update Execution

The update execution can be either push or pull based. A push mode is realized when the supplier's central unit containing the product configuration logic communicates product updates to the customer's local unit. In this mode, the central unit imposes the updates that have to be accepted by the local unit. In contrast, one speaks about a pull mode when the local unit retrieves the updates if required.

Scope of Use

Configurators can be categorized as single-purpose or general-purpose systems. A single-purpose system is developed to support the sales-delivery process of a product or a set of products of only one company or business field. Single-purpose configurators are called special-purpose configurators and may be designed for a particular industry such as, for example, the window and door industry. However, general-purpose systems are used to configure diverse product types in different companies (Tiihonen & Soininen, 1997).

Complexity

Tiihonen and Soininen (1997) distinguish between primitive, interactive, and automatic configurators. Primitive configurators are the simplest ones. They merely record the configuration decisions made by the user without checking the validity of the decisions. Interactive configurators are capable of checking as to whether the configuration decisions are valid. They also guide users in making all of the necessary decisions. In addition to the functionalities of interactive configurators, automatic ones are able to provide full support and to automatically generate parts of configurations or even entire configurations.

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