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AN INITIAL EMPIRICAL STUDY OF USING A PRODUCT CONFIGURATOR AS A SUPPORT TOOL FOR DEVELOPING PRODUCT FAMILIES

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1. Introduction

Configurable products are one way to carry out mass-customisation. A *configurable product,* also known as a *product family*, is defined as an artefact that is assembled from instances of a fixed set of well-defined component types and in which components interact with each other in predefined ways [Sabin, 1998]. A configurable product is described with a *configuration model*. If a product is *partially configurable*, some part of a product individual can be configured with a configuration model but customer-specific design is needed in a sales-delivery process [Tiihonen, 1998]. *A product configurator* is an information system for modelling the knowledge in a configuration model and generating automatically or interactively product instances, *configurations,* that are valid with respect to the model [Sabin, 1998]. The task needed to produce a configuration is referred to as *configuration task* [Sabin, 1998].

There are relatively few in-depth research reports investigating the effects of using a product configurator on the operations of the company. Most reports have concentrated on the effects on the sales-delivery process, such as reduced order processing time, reduced staffing and product knowledge consistency checking [e.g. McGuinness, 1998 and Forza, 2002]. To our knowledge, there are no in-depth reports on the use of a product configurator as a support tool in the product development process. The use of the product configurator as a development support tool could be justified even if the variants of the product are not sold in large enough numbers to justify the implementation and maintenance costs of a product configurator in a sales-delivery process.

In this paper we present problems in managing and using the product variety related information during the product development process and some potential benefits and challenges of using a product configurator to manage this information. The results are derived from a case and focus group study in a company that delivers partly configurable products with relatively few orders per year and has no need for a product configurator in the sales-delivery process.

The paper is structured as follows: the case description and the product configurator are described in Section 2, the research methods in Section 3, the results are described in Section 4, discussions and previous work in Section 5 and the conclusions and future work in Section 6.

2. Case Description and Product Configurator

2.1 Patria Vehicles Oy and XA-series Product Family

Patria Vehicles Oy is focused on marketing, product development, manufacture and integration of armoured wheeled vehicles as well as their life cycle service. Customers include defensive forces in many countries. Patria Vehicles Oy is located in Finland and the number of employees is 400.
The case product was the XA-series of armoured wheeled vehicles. Patria Vehicles Oy delivers 5-14 different variants of XA-series every year and the total amount of product individuals is 80-120 per year. Figure 1 is a picture of one individual of XA-series product family. [www.patria.fi]

Figure 1. XA-series product family

2.2 Web Configuration Technology Product Configurator

WeCoTin configurator consists of two components: a graphical modelling environment *Modelling Tool* for modellers and the web-based *WeCoTin Configuration Tool* that supports the configuration task. The modelling method is based on a generic product structure with optional and alternative parts. [Tiihonen, 2003]

The Modelling Tool is a tool for creating and editing configuration models and related information needed to generate a user interface for users. Configuration models are expressed in Product Configuration Modelling Language (PCML). PCML is object-oriented and the main concepts of PCML are *component types*, their *compositional structure*, *properties* of components and *constraints*. Component types are organised in a *class hierarchy*. [Tiihonen, 2003]

A web-based user interface is generated without programming. Each selectable property or part of a component individual being configured generates a question to the User Interface. The modeller can define how the questions are grouped and ordered and he or she can also give display names in different languages to component types, properties, possible values of properties etc. User interface information is stored as XML files. [Tiihonen, 2003]

WeCotin enables users to configure product over the web by using a standard browser. The user interface consists of the following parts: 1) The configuration tree, 2) A status area, 3) A group of questions related to a component individual and derived from the configuration model. The configuration tree gives an overview of the configuration. The configuration tree shows the properties and their values, and also selections already made and selections still to be made. The configuration tree also provides navigation to configure in free order. The status area indicates the status of the configuration. Incompatible alternatives are greyed out. However, the user is free to make the incompatible selections. In this case the user gets information about violated constraints. [Tiihonen, 2003]

There is possible to link documents in HTML format to the different objects of a configuration model. For example document of detailed property information and a picture can be linked to a property or component. User can click the property name and the separate window of the document opens. This allows adding more information of the product to the configuration model.

Figure 2 is shows an example window of XA-series WeCoTin User Interface. The configuration tree is shown on the left-hand side and under the configuration tree is the status area. The selection of the property values can be made on the right-hand side. Also the incompatible selections are seen greyed and struck out and the property NBC has information icon (i) bullet which mean that there is a document link. Below the questions, there are buttons “go forward”, “cancel”, “save”, “ready” “ and “quit”. It is also possible to go forward by clicking properties or property groups in the configuration tree.

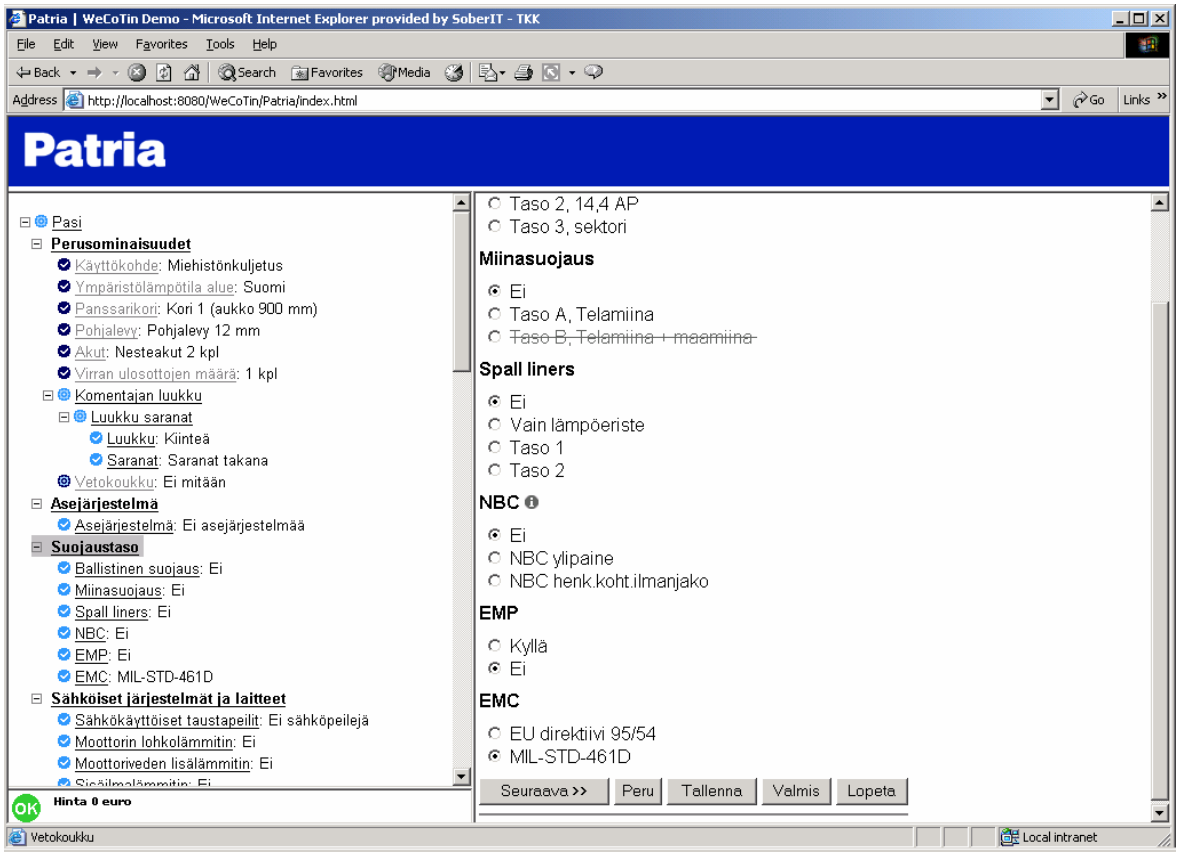

Figure 2. Example window of XA-series WeCoTin User Interface

3. Research Methods

We began with a case study in which we analysed the present state of the product variety related data at Patria Vehicles Oy by studying product documentation and interviewing product designers following the prescriptions suggested by Yin [1994] and Patton [1990]. We studied the existing documentation of the product variety information, then interviewed five designers and documented the knowledge on the product variety they had. Then we analysed the existing problems in managing and using product variety related information.

After the case study, a configuration model was created with the WeCoTin product configurator and the model was extended and validated on the basis of additional interviews with the designers from the design department who participated in the case study. The configuration model was not a fully complete description of a product; some properties, property values and constraints were not modelled. The basic idea was to create a configuration model and use all the available functionality that the product configurator offers.

When the configuration model was ready, we used the focus group method to evaluate the configuration model, the tool supporting it and the potential benefits and challenges in using a product configurator as a design support tool for developing product families. We decided to use the focus group method because it is a highly efficient qualitative data collection technique, it provides some quality controls on data collection in that participants tend to provide checks and balances on each other that weed out false or extreme views, the group's dynamics typically contribute to focusing on the most important topics and it tends to be highly enjoyable to participants [Patton, 1990]. There are also some weaknesses in the focus group method. For example, the sample size is small and therefore it is difficult to generalise the results [Judd, 1991], and when the participants know each other, the unexpected diversions may occur: conflict may arise, power struggles may be played out, and status differences may become a factor [Patton, 1990].

Table 1. Job descriptions and departments of the participants in focus group sessions

Job description	Department
First session:	
Development Manager	Product Development
Manager, Engineering Support	Product Development
Configuration Manager	Product Development
Quality Manager	Product Development
Designer, Engineering Support	Product Development
Project Engineer	Process Development
Director, Customer Projects	Customer Projects
Second session:	
Design Team Leader	Product Development
Purchasing Director	Logictics
Export Director	Marketing
ILS System Administrator	Integrated Logistics Support
Project Manager	Process Development
Project Manager	Process Development
Designer, Engineering Support	Product Development
Project Manager	Product Development
Material Manager	Logictics
Design Engineer	Product Development

There were two groups of people from different departments related to product data creation and usage. The job descriptions and the departments of the participants in both sessions are described in Table 1. In the sessions, we first presented the configuration model and explained how to configure product individuals. Then we discussed the use of product configurator as a design support tool. The results are a summary of the potential benefits and challenges as seen by the participants. The presentations and the structure of the sessions were the same in both sessions.

To ensure that all the relevant data was considered during the analysis, we recorded the interviews and discussions and collected the necessary documented product data. After the interviews and discussions, we listened to the recordings and took notes of the most important information.

4. Results

In Section 4.1, we describe the present state and problems managing and using the product variety related information that led us to the configurator approach. In Section 4.2, we describe the results of the focus group study on the potential benefits and challenges of using a product configurator to manage product variety related information during the development phase.

4.1 Present State Case Study

The product variety related data were mainly managed with tables in the Excel format. The main properties of a product were listed in the tables that were saved in the local directories. The tables also contained note fields with the most important constraints between the properties. The tables were not complete descriptions of a product. In fact, no overall and complete description of a product variety existed. Much of the information was tacit. For example most of the constraints and some properties that were not sold regularly were not documented at all.

The developers did not have access to local directories of other designers, and if they took own copies to their own local directories, they were not informed if the original data was changed. There were many local copies of the same file. Outdated product variety related information was used in other documents such as marketing documents.

We learned that the main problems were caused by the fact that the existing Excel tables were the only documented product variety related information. The overall and completed description of a product variety related information was missing. The properties of a product can be described in the Excel tables but it is difficult to describe the constraints between the properties or property values. Insufficient product variety related information means that the users do not have the common understanding of a product and the information is not available for everyone.

4.2 Configurator Managing the Product Variety Related Information

The configuration model of XA-series consisted of 13 property groups that were *basic features, weapon systems, protection levels, electrical systems, fire suppressions, wheels, external connections, accessories, communication systems, optical systems, navigation systems, detectors* and *ambulance equipment*, and the total amount of different properties was 76. There were 13 constraints between the properties in the configuration model. We also created a few examples of how to link documents (e.g., marketing documents, quality documents and spare part information) to the objects of the configuration model. Modelling the product took 4 hours and extending and validating the model took 3 hours. Adding the document links took 3 hours.

The participants of this study clearly indicated that a configuration model could strengthen the product policy. They said that it is easy to see the properties and property values of a product and the allowable variants. Especially people from Marketing, Process Development, Integrated Logistics Support and Logistics departments, who are not designers and do not work intensively with the product variety related information, saw that configuration model could increase their knowledge of the product.

Especially designers thought that a configuration model could serve as a blueprint in product design and it visualises the product better than the Excel tables. Participants also thought that a configuration model could support the communication between employees from different departments and it could be also a good tool for training and communicating with new employees and subcontractors. A product configurator can be used as an electronic product catalogue.

The participants were mainly concerned about the increasing amount of work in product design. The extra work consists of modelling product with the configurator, creating the rules and adding the documents into the model. Also the discussions and decision-making process of properties and property values that company want to sell might increase.

5. Discussions and Previous Work

The present state case study illustrated that there are there are no comprehensive methods for managing the product variety related information in the product development phase in the case company. The results based on the focus group study give us to assume that product configurator could probably benefit a company that has a partially configurable product with few orders per year and that does not need a product configurator to support the sales-delivery process. A product configurator seems to be a feasible tool to manage product variety related information during the development phase because a product configurator is an information system for modelling the product families and generating automatically or interactively product instances.

The configuration tree in the product configurator user interface would give an overview of the configuration and shows the properties and their values of a product. Every user could use one up-to-date model instead of many local files. Linking additional product information documents to the objects of a configuration model, a configuration model could thus be used as an electronic product catalogue. It could support the communication between employees from different departments and help training new employees. A configuration model could strengthen the product policy because it allows the different departments and high-level managers of the company to have a common view of the product they want to sell.

Product data can be created and updated easily and consistently in a configuration model because the product configurator has a practical modelling environment and tool for creating product instances, and the modelling method was deemed comprehensible to model the case product. The configuration model was created by the first author, who has previous experience with the WeCoTin product configurator. Although it would probably have taken more time for a beginner to create the model, modelling with the WeCoTin product configurator is quite straightforward and would not have taken weeks or months. During the modelling there was no bugs. Generally, it seems that product configurator modelling method helps to bring out the variation of product visually.

Although some participants were concerned about extra work. To some extent the extra work is explained by the fact that a product configurator makes it possible to have a complete description of a product family. Earlier the product documentation did not provide such description at all.

As mentioned in introduction there are relatively few in-depth research reports investigating the effects of using a product configurator on the operations of the company. Most of these have concentrated on the effects on the sales-delivery process. Some reports on product configurators consider the benefits in the product development phase. For example, if consistent product variety related information is available online, the new engineers do not have to rely on local, incomplete and probably inconsistent copies of the data [McGuinness, 1998]. Our study confirms these considerations.

6. Conclusions and Future Work

We present problems managing and using the product variety related information during the product development phase and some potential benefits and challenges of using a product configurator to manage product variety related data during the development phase.

The results are derived from a case and focus group studies. We first carried out a case study of the present state of product variety related data and its usage. We then developed a configuration model on the basis of the product variety related data using the product configurator. Finally we evaluated the configuration model and the use of the product configurator as a support tool using the focus group method.

The overall and completed description of a product variety related information was missing. The properties of a product were documented, but it was difficult to describe the constraints between the properties or property values. Common understanding of a product was missing and the information was not available for everyone. We found that the product configurator could probably benefit a company that has a partially configurable product with few orders per year. A product configurator seems to be a good tool for creating and maintaining overall and complete description of the product variety, which is available for every user up-to-date, and for helping the communication and training in the product development phase.

This study was the first approach of investigating the use of a product configurator as a support tool in the product development process. We modelled a real product with a product configurator. Research methods we used were sufficient for the first approach of this topic and these initial results are based on a relatively large number of focus group participants from various departments with the broad range of viewpoints. However, the results should be further validated and strengthened with more case studies that try to apply a product configurator as a support tool managing the product variety related information in product development in real operations. Also more case studies in different companies with different products should be carried out.

This research will progress in this direction in the beginning of the year 2004 with the same case company. We will start with a pilot project where a pilot group of people from different departments will use the product configurator and configuration model in a real working environment. The case product will be the AMV armoured wheeled product family and the goal is to further investigate the product development phase and also consider the potential benefits and challenges for other departments.

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