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Developing a Matrix Based Sales Configurator for Modular Product

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Abstract: **-** For several years, the structuring approaches for modular product families have been developed in industry. The modularization leads often to the use of configurator, which is a computer application used to manage the relations of modules, connections and rules between different customer segments. Configurator brings benefits to the whole delivery process, by removing the information gaps from which are needed in the product order. Matrix based sales configurator can make order delivery process to go through faster, and especially help to keep the product knowledge of modules and modular structures of complex products in order as well as to make the updating of them easier by its illustrative user interface. MS Excel was used in the first developed version of the sales configurator prototype and it was found to be good platform for testing configurability in machine industry companies, because of its prevalence. Second development version, the server-client sales configurator expanded the possibilities of the application and improved user safety compared to the MS Excel version of the sales configurator and matrix rule table. The research project described in this paper was started because there was demand for a flexible sales configurator in local heavy machine industry. The paper describes the project where new prototype of sales configurator application was developed in just over a year in cooperation with case company from machine industry.

Keywords :- *Variant products, Configuration knowledge, Product structuring, Modularization, Product development process.*

I. INTRODUCTION

For several years, the structuring approaches for modular product families have been developed in industry. The target of modular structure is to achieve a comprehensive selection of products to fulfill the needs of different customer segments. The modularization makes also the production more simple and standardized. This increases the efficiency of product management and fastens the order-delivery process. To be efficient also the modularized product structure must have similarities with the production. As well this must be an essential part of the product development process starting from the beginning.[1], [2]

The modularization leads often to the use of configurator, which is a computer application used to manage the relations of modules, connections and rules between different customer segments.[3] In many cases matrices have been used to represent product structures and selection criteria of modules and configuration knowledge.[1] Starting to use sales configurator in order-delivery process should be considered after modularization, in order to maintain interchangeability of modules in the product.[4] Benefits of using configurator are i.e. providing delivery time and price instantly, detection of the inconsistencies and dependencies between different options, reduced complexity of specifications and reduced time used for making the specification. Configurator can be used also in co-designing products with customers, where it helps in communication.[5]

Configurator brings benefits to the whole delivery process, by removing the information gaps which are needed in the product order. This is done by forcing the customer to answer to every critical question already when the order specification is made. By using configurator, non-standard products can be identified in the first phase of the sales process and customer can be guided to choose more standard features.[6] The configuration process will typically include at least the clarification of customer's requirements and the selected components,

alongside forming the price, as well as the technical specification. In addition, the configuration process detects the functionality of the configured product.[7] These issues gave aims and restrictions for the research group.

The target of this research was to develop and test a prototype configurator application based on an idea of using the V-matrix representation of configuration rules. After developing and testing the first version of the prototype configurator application, aim was to develop a prototype of client-server version of the sales configurator application.

In order to use configurator efficiently in a company, many times companies' processes needs to be taken into consideration and under development.[7] Because of this it was decided that these aspects will be noticed already in configurator development phase and research and development needs to be done in cooperation with the end users in machine industry. This paper describes how this project was done. Aim was to develop a matrix-based configurator rule table in Excel and to develop a database based client-server configurator application's working prototype for the use of sales departments in machine industry.

II. THE RESEARCH PROCESS

In order to succeed in a difficult new application development project, a case study approach was adopted. Application prototypes were developed as an action type of re-search. Project researchers implemented the project in cooperation with one case company from machine industry. One member of the research team was located in the company, which made continuous collaboration possible with the key processes in the company, considering configurator stakeholders. The empirical research and literature study process of this project can be seen as a systematic combining process. [8]

III. CONFIGURATION RULES AND MATRIXES

The relations between product family modules are guided by rules that in most commercial configurators are in form of "if-then-else" statements. In complicated situations the management of the rule base may become very hard or even impossible. The other option to define the rule base is to use a matrix representation. In it the rule base is easier to update and maintain. The matrix can also be used to visualize the module relations in one view and they represent the configuration knowledge as simple as possible. Matrix also provides the generic product structures for the modular systems.[1]

The mostly used matrix applications are K- and V-matrixes (Fig. 1). In K-matrix the properties and modules are on the different sides of the matrix while in V-matrix the rows and columns are copies of each other. K-matrix is more simple but also more difficult to use.[9] In V-matrix it is possible to set a relation of every module and property to any other modules and properties. The matrix view is clear and no programming skills are needed to manage the rules in it. Matrix structures done in this study was made and tested first in Microsoft Excel, which is an excellent tool to compare and test different matrix applications. It is well known and widely used. These reasons affected when the first phase of the research and development project was started and platform was chosen. It's suitability for this job was also already proved in Nummela's research done about the same subject.[1]

IV. V-MATRIX RULE TABLE

The developed application prototype is based on V-matrix. This is because it was essential to be able to have correlations between sales features of modules. This makes it possible to exclude those features that are not compatible with the selections already made, when using the configurator in a sales situation. While the configuration approaches there is no possibility to make incorrect selections.

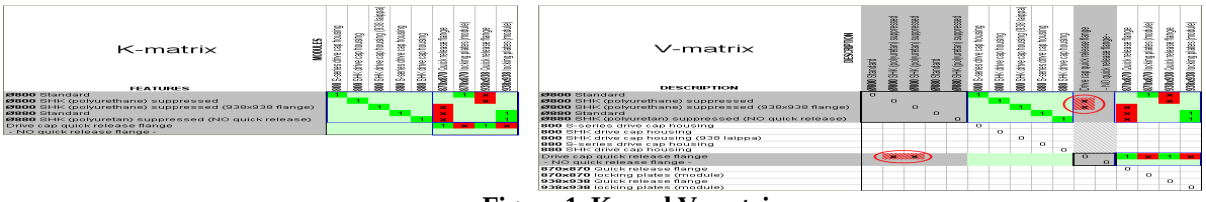

Figure 1. K- and V-matrixes.

In the V-matrix it is possible to make the selections in random order, other than in many commercial configurators using if-then-else rules. This helps in the situation where it is more important for a customer to start from some specific feature of the product con-figured, and not necessarily go through step by step. A configurator which uses if-then-else rules, the configuration order is forced to go only step by step on one path. Because rules are presented in the V-matrix graphically, it is easier to upkeep, comparing to configurator using

if-then-else rules, which needs coding skills from its user. Graphic user interface in V-matrix also shows visually how the change relates to other modules and features.

When using a matrix based configurator it is also possible to use numerical relations between modules and properties. For example, if user wants to select some specific module or feature which demands two pieces of another module, this type of numerical relation is used. Or if the relation number is 0 then selecting a module with numerical relation would exclude the related module or property. These rules can be made by the person who upkeeps the rule table simply by adding the number where appropriate.

In Fig. 2 there is an example of the use of the V-matrix. On the upper left corner there is a column identifier showing the item numbers of modules. Category shows the number of property combo box in user interface. The X-marks shows the restrictions of features. For example selecting the feature 1 from first line would exclude the features 5 and 6 from the combo box 2. Correspondingly selection of the feature 2 would exclude the features 3 and 4. Features 1 and 2 cannot be selected simultaneously because they belong in the same category. If you select for example features 1, 3 and 7, you will get the structure modules 1,2,4,8, and 9.

V. SALES CONFIGURATOR IN MS EXCEL

The first prototype of the configurator application prototype developed through the re-search project presented in this paper, was performed by using an MS Excel spreadsheet and VBA-programming. Result was a V-matrix-based configurator rule table and sales configurator prototype working in MS Excel.

The first developed prototype in Excel can be used as a sales configurator that finally produces the bill of material (BOM-structure) of the configured product and guides the sales person when choosing the features for the customer order. With the guidance pro-vided by the rule table, inappropriate module relations can be avoided. Application also gives the price and weight information based on the selected modules. The BOM item numbers are similar to the item numbers in PDM-system, so the BOM can be directly transferred into it for further processing.

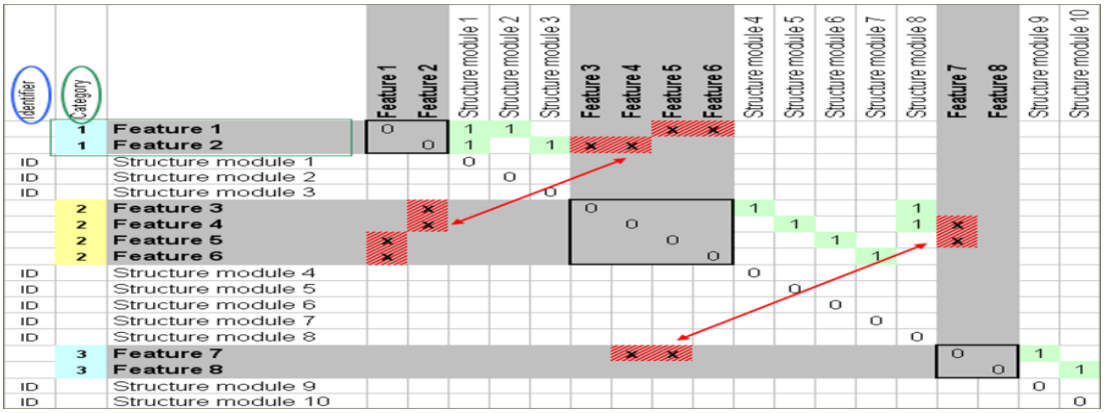

Figure 2. Example of the use of V-matrix.

As a benefit for different departments in a machine industry company, it was seen that V-matrix presentation gave a common language for different departments and most importantly, it made possible to see all modules and possible combinations available for the machine in one sheet. This brings benefits for example for the design department and situations where module changes are discussed with sales, because the dependencies of the modules and technical features can be seen immediately.

Excel does, however, have some disadvantages that make its use difficult in real production situations. One of the worst is that the spreadsheet is just one file. It would be very difficult to control its use and updating. When modifications and updates are made to the spreadsheet which consist all configuration data, it needs high level of attention because it can be possible that the change is done to wrong field or for wrong item by mistake. Depending on the amount of dependencies of features, one mistake can lead to numerous wrong non-functional modules and products, or leave out choices what should have been possible to make.

VI. SERVER-CLIENT SALES CONFIGURATOR

The second phase was started alongside with the rule table development in Excel. In this phase researchers started to develop database-based client-server configurator application's working prototype for the use of sales departments. This was also done in cooperation with the case company and end users of the configurator. Aim of the configurator application development in the second phase, was to design it to work in

larger scale with more configurable machines and data, and with use of sales persons anywhere in the world, as well as make it possible to communicate with other systems used in the factories. Architecture for the second phase prototype can be seen in Fig. 3.

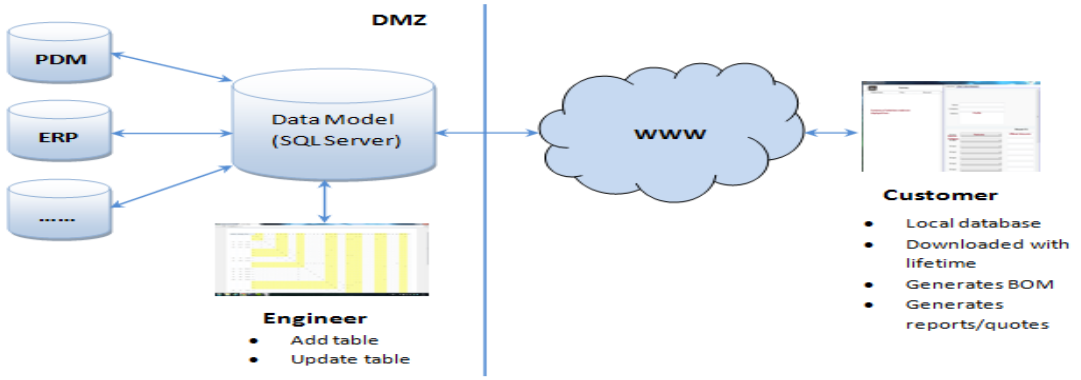

Figure 3. Sales configurator architecture.

In the sales-client application prototype, the V-matrix serves as the admin tool to visualize the relationships between the tables in the database in a compatibility matrix. Changes can be made to the database from this matrix view, which is developed as a web page using the MVC (Model-View-Controller) model approach.

As safety in use was one important aspect in the research and development of the configurator prototype, many features of the second version of the application were auto-mated, so that use of it would be easier and safer. For example additional features and modules can be created by clicking on the provided links on the V-matrix web page. Colors are used to distinguish between the features and the modules i.e. yellow color for the features, white color for the modules.

Changes made to the number of modules belonging to a particular row of features by typing the desired numerical value or changes made to the compatibilities by typing "x" in the appropriate cell on the matrix table, can all be saved into the database by clicking on the "Submit" button at the foot of the page. Before saving the data, application shows the user all data to be changed and asks approval for it. These functions are important benefits when second prototype is compared to first version of the configurator prototype.

The sales configurator is a client's user interface consisting of combo boxes which contains features. Configurations can be set by selecting different features from the available combo boxes. The combo boxes in this user interface are all generated at runtime i.e. it is generic, and works even if the database is modified. The sales configurator was developed using WPF (Windows Presentation Form), with C# as the coding language.

To help sales persons working in different countries, the client's sales configurator can be downloaded from a secured address, with the right username and password. The software can then be installed on a personal computer running Windows XP, Vista or 7. When the program is started for the first time, the sales configurator software downloads the database via a provided web service address and populates the combo box items with features from this database. At other times after the first launch, it checks for any update and if it finds one, it makes a request to update its local database. If the request is granted, it will update the local database with the most recent data. And if otherwise request is denied, it will continue using the current local database until its specified lifetime ends. Lifetime prevents sales using outdated product data in new orders, which might lead to difficulties in the production.

VII. CONCLUSIONS

Because of the flexibility of Excel based configurator, it is easy to use with any modular product families. It is a cheap way to find out how configurable the products are. Matrix based rule table and Excel configurator is a light way to test configurability of the modular products in the machine companies, because expensive investments are not needed and the first step towards configurator and configurable products is very easy to take.

However, the modular product structure must be first well defined for all product families which are configured with the application. Also the investigation of product sales features has to be done before the configurator development may begin. The maintenance and update of big matrix rule base is not easy task. It demands deep knowledge of product structure and the functional properties of modules.

When the products come more complex and the number of configured product families grows, a database solution is the safest way to handle all product related data. It makes it easier and safer to have everything up to date, as well as it is updated immediately to configurator when changes occur. And when the configurator is used by multiple sales persons in the same time, the server-client sales configurator makes it easy to force everyone to use the same most up to date data. Also the security aspects are better, because the configuration files have many times secret company specific information and connectivity to other company systems are easier to implement than in the first version of the sales configurator prototype in Excel, which needed filter applications for transfer-ring the data.

When developing a configurator application it is important to take into account the demands of continuous update and maintenance of configuration knowledge. This is because the product structure is under continuous development and the configurator that does not correspond to the product is useless.

As from the research project view point, dividing the development project in two phases, using different software for finding the best solution and doing the development work from scratch with the end user companies, was found very efficient in terms of finding as many problems as fast as possible. This way the companies can have faster an application what they really want, which works and they can use efficiently..

VIII. ACKNOWLEDGEMENTS

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