



## Alignment of Configuration and Documentation for Highly Engineered Complex Product Configuration Systems: a Demonstration from a Case Study

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# *Alignment of Configuration and Documentation for Highly Engineered Complex Product Configuration Systems: a Demonstration from a Case Study*

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**Abstract** —Adequate documentation is critical for successful implementation, maintenance and further developments of product configuration system (PCS) specially in companies making complex and highly engineered products. This article is based on experience of modelling and utilizing a PCS from an Engineer-To-Order (ETO), where the main focus is on the challenges concerned with the documentation of the PCS, both in the development and production phase. Aligning the development of the PCS with an automatic documentation system creates value. Using the suggested method for documentation facilitates the following activities: (1) iterative testing of the system during the development, (2) communication with domain experts, (3) documentation and maintenance, and finally (4) updates without spending a lot of time and resources. This article is supplemented with a case study from an ETO company where the method for the automatic documentation was developed and tested.

**Keywords**-product configuration system (PCS); documentation; communication

## I. INTRODUCTION

Product configuration encompasses all activities concerned with making customized products from a set of predefined components and according to a set of well- defined constraints [1][2]. PCSs can be applied to support the decisions making process and to illustrate possible product alternatives in order to facilitate the presales and the sales processes [3]. Reliable product documentation without technical errors and mirroring exactly what is included in PCS is vital [4]. Without a documentation system, experience shows that PCSs have been abandoned or rebuilt [5]. Companies utilizing PCS often face challenges as the configuration models are lacking documentation and domain experts without IT background can not understand the models, which leads to difficulties in the maintenance phase [6]. This paper demonstrates the method of modelling and developing PCSs in a practical way where the aim is to generate a automatic documentation system from the configuration model in order to address some of the main challenges when working with PCSs.

Communication can be described as a way to manage relationships between domain experts and IT people [7]. Without a proper communication with the domain experts during the development phase, a considerable amount of

time and resources will be needed for the final debugging of the system, while there is no control of the system's complexity.

## II. METHODOLOGY

The methodology adopted in this research is an investigation through a case study to highlight some of the issues of miscommunication, and lack of documentation and updates for PCSs. Based on this an idea of automatically generation of documentation system from PCS is introduced. A project team was formed in an industrial company included two researchers from the university, software developer and configuration engineer from the company working 50% of their time on the project for six months. Prior to this the architecture of the documentation systems was discussed and outlined through a period of 4 months. In addition, engineers from relevant departments were interviewed during the testing period of the proposed procedure in 6 months.

## III. LITERATURE STUDY

### A. Configuration Frameworks

Nowadays it is expensive for the companies to develop their own reasoning machine. Friedrich et al. [8] describe the modern configuration framework as the systems, which have to provide mechanisms that abstract from the underlying technical representation as far as possible in the modelling phase. Felfernig et al. [9] describes a method for configuration development based on Unified Modelling Language (UML) where the idea is to rely on UML as a graphical notation.

### B. Knowledge Representation Methods

There are number of modelling techniques used for knowledge representation in configuration projects [10][11][12]. For this project it was decided to use Product Variant Master (PVM) and class diagram associated with Class, Responsibility, and Collaboration Cards (CRC), which build on UML [13].

### C. Content Management Systems for Handling Documentation

A content management system (CMS) is a computer application that enables publishing, editing and modifying

the contents as well as maintenance from a central interface [14]. The Groupware platform provides basics functionalities for communication and team or work group publications, structuring, storing, retrieval and distribution of knowledge. Furthermore, the systems contain all the knowledge management systems specifications. Based on these functionalities of these systems with regards to documentation and sharing knowledge, Microsoft SharePoint was chosen as the CMS in this research work.

#### IV. MODELLING AND DOCUMENTING PCS

##### A. Modelling Product Families for PCS

As previously explained the modelling technique for the knowledge representation was chosen as PVM associated with CRC cards. Therefore a commercial configurator is expected to include the PVM and also CRC card structure in a similar way, which can be used for the documentation system. Based on literature study and analysis of the available commercial configuration on the market it was concluded that all of them are able to fulfil the expectations at least on minimum level.

##### B. The suggested method for generating knowledge from the PCS to the documentation system

The present paper suggests a method for the documentation of PCS where the documentation of the product model is generated and maintained within the configuration system automatically.

The standard format generated from the configurator model is an xml format; therefore by renaming the model file extension to .xml the documentation system is able to read/parsed the files. The configurator models are maintained in documents listed in SharePoint called the "Model Workspace", where the Documentation System is able to read the files. The Model Workspace is based on a fairly standard SharePoint Team site, which enables version control of models (minor/major versions) and has check-out/check-in functionalities to lock the models while updating. Furthermore, SharePoint's role based access control is used to secure different user rights e.g. for developers and domain experts. In order to render the model documentation with the required navigation, layout and content syntax and transformation/interpretation of the native configurator XML is needed. In this process the model structure is parsed and transformed into JSON objects, which can be rendered using rich featured JQuery components. In Fig. 1, the interactions between SharePoint and the UI Renderer is illustrated, which is called the Documentation System.

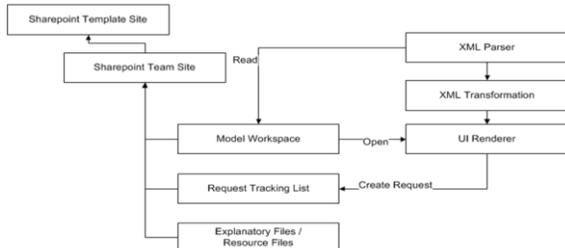


Fig. 1. Interactions between SharePoint and the UI Renderer

#### I. DISCUSSIONS AND CONCLUSION

In companies making highly engineered and complex product there is a great challenge of documentation for the PCSs. In order to address those challenges this paper presents an automatic documentation system for PCS. The system has already been implemented in the case company and where proof of concept has been reached. The first version of the system has provided valuable results. For future work the system has to be further tested and in order to achieve generalization the system will be tested with other commercial configuration systems and in other companies.

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