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# Towards Life Cycle Management for Product and System Configurations: Required Improvements in Business Processes and Information Systems

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**Abstract**

Current market trends force component manufacturers to offer not only separate products or components but also whole integrated solutions. However, efficient management of product life cycle for such solutions requires significant changes both in business processes and in information systems. The paper presents major findings in this area aimed at improving life cycle support for configurable products and systems. The findings are results of ongoing research and IT optimization projects carried out in the company Festo AG & Co KG. However, the results can give significant input to achieve benefits for component manufacturers that tend to become system vendors in general.


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*Keywords:* System; application; customer view; configuration.

## 1. Introduction

Changing market requirements cause companies to modify their business strategies [1], [2]. An analysis of the business and information management processes related to the automation equipment producer Festo AG & Co KG showed that instead of offering separate products, the company tends to offer complex products (which may consist of several other products), whole integrated systems and also software units using different services [3], [4].

This is a reaction on market challenge: the component market is highly competitive and for most companies it is hard to compete with cheap production from low-wage countries. A good way to create new customer value is to provide the customer with system configurations. The components are not used individually but in a greater context at the customer's site, for example a sensor, an actor and a control unit combined with cables. Hence, for customers who are not experts in the product domain communicating values based on a combined set of components enables and improves finding a matching solution for a given application problem.

The considered company produces pneumatic, electronic automation equipment as well as products for the process industry and has more than 300 000 customers in 176 countries supported by more than 52 companies worldwide with more than 250 branch offices and authorized agencies in further 36 countries.

In the considered company, these changes caused an appearance of another view to the product lifecycle, defined as "a new integrated business model that, using new ICT technologies, implements an integrated cooperative and collaborative management of product related data along the entire product lifecycle." [5]. Product lifecycle management can provide a shared platform for creation, organisation and dissemination of product related knowledge across the business processes and information systems related to the product lifecycle. The company has to elaborate more accurate and reactive plans in order to be able to keep up with the economic challenges. Together with changes in the product lifecycle


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concept and developing information technologies, this led to a significant field for a number of projects .

One of the first projects related to this problem was launched in 2010 [6]. It was aimed at modification of work and information flows related to configuration of product combinations.

The business process reorganization started with setting up a product ontology originally aimed at product codification (order code scheme) [7]. The resulting ontology consists of more than 1000 classes organized into a four level taxonomy, which is based on the VDMA classification [8]. Taxonomical relationships support inheritance that makes it possible to define more common attributes for higher level classes and inherit them for lower level subclasses. The same taxonomy is now used in the company's PDM and ERP systems. For each product family (class) a set of properties (attributes) is defined, and for each property, its possible values and their codes are defined as well. The lexicon of properties is ontology-wide, and as a result, the values can be reused for different product families. This is a key enabler for modular product structures achieved by the ability to compare product components and their descriptions.

Then, based on the developed ontology, the complex product modelling design and system has been implemented. Complex product configuration models consist of two major parts: product components and rules. Complex product components can be the following: simple products, other complex products, and application data. The set of characteristics of the complex product is a union of characteristics of its components. The rules of the complex products are union of the rules of its components plus extra rules. Application data is an auxiliary component, which is used for introduction of some additional characteristics and requirements to the product (for example, operating temperatures, certification, electrical connection, etc.). They affect availability and compatibility of certain components and features via defined rules.

Based on the configuration model the process of complex product or solution configuration in accordance with given requirements can be automated. A pilot research project aimed at developing a tool called CONFig was aimed at testing this possibility. The tool supported the configuration process in terms used within the company (company's knowledge level). In reality, the customers are used to operate different terminology (customer level), which doesn't correspond "one to one" to that used within the company. Besides, customers from different industries can also operate different terms. As a result, there is a need to create configuration tools that can map customers' requirements to those used in the company taking into account the context (customer's industry segment, history of customer's orders, etc.).

Although some significant results have been achieved in the area of complex product and system configuration, still a lot has to been done to support the whole life cycle of this type of products. We see the most apparent open issues in this context not in the run-time, i.e. configuration and order creation applications, but in the build-time, i.e. setting up and maintaining the required product master data, configuration rules, and application data, and so on. This is one of the goals of the future research.

In this paper, we share our vision of required improvements in business processes and information systems at the considered company related to life cycle management for product and system configurations. Though the research results are based on the analysis of one company, the presented work can give significant input to achieve benefits for component manufacturers that tend to become system vendors in general.

The remainder of this paper is organized as follows. Chapter 2 presents impacts that the introduction of complex configurable products and systems has on general PLM concepts. Chapter 3 describes how a company should react on these impacts by introducing changes to the configuration-related business processes and information systems. Chapter 4 presents a case study showing currently ongoing implementation of these changes at Festo AG & Co KG. Finally, Chapter 5 summarizes and concludes this paper.

## 2. Product Lifecycle Support for Product and System Configurations

PLM encompasses the processes needed to launch new products, manage changes to existing products and retire products at the end of their life. In this sense, typical product life cycle stages are development, introduction, growth, maturity and decline [9]. The development stage is when new products are conceived and prepared for manufacturing. For variant-rich products, the stages introduction and growth as well as the maturity are typically supported with product configurators. The decline stage, in contrast to previous ones, is the latest stage at which either a considered product is completely phased out or well-suited successor products are sought.

We distinguish the development stage from the introduction and following stages in the sense that development deals with setting up product master data, structures and configuration rules. The stages from introduction to maturity use this data for effective sales supported by product configuration.

Product lifecycle support for complex products and systems differs from that for simple products. Major differences arise from the point of view to the products.

The complex product/system view comes from the application side (table 1). After defining of the application area, configuration rules and constraints to the product are defined. They are followed by characteristics and product structure definition. Finally, the apps (software applications) enriching the product functionality or improving its reliability and maintenance are defined. The same applies to the sales stage.