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VARIANT DESIGN BASED ON PRODUCT PLATFORM

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1. Introduction

Within many trades and product areas there has been a development toward more and more customer-adopted products during the last couple of decades. For complex products it is a common practise to purchase a product that is not on the warehouse. Instead, the customer's order defines the product and demands. Since, customers are different with different needs and criteria of choice, this means that it has become more and more necessary to offer a spectrum of product variants to satisfy customers demands [Aasland 2001]. Therefore, companies worldwide need to design product variants in shortened time periods and within tight resource constraints. One common approach to solve this problem is to adopt product families to share a common platform (functional, physical) [Gonzalez-Zugasti 1999], which lead to reduction in:

- Design costs (through design reuse),
- Manufacturing costs (through economies of scale),
- Administrative costs,
- Maintenance costs (through standardization).

This approach can also contribute to shorten lead times to market and higher product variety and reliability. There are many examples of the success of this approach in diverse industries: automotive, consumer electronics, aerospace. E. g. Sony™ has used three platforms to support hundreds of different personal portable stereo products in its Walkman line, a Black & Decker® built a line of products around a scalable motor platform, [Gonzalez-Zugasti 2001]. Audi, Volkswagen, Seat and Skoda are based on only four platforms from which the different product models are built. Though, the common approach is relevant for all types of product platform, we will present an approach for design a product variants based on the scalable product platforms, called scalable product variants.
The structure of this paper is as follows. Section 2 presents a short overview of the terms in product variety with our interpretation of product family term. In section 3, is given a case study of design a scalable product variants. It is proposed information models of the product platform in section 4. Conclusion and further research are addressed at section 5.

2. A short overview of the terms in product variety

The product is competitive on the market if it is able to satisfy a varying range of customer needs. By looking at related products on the market one might observe that they might differ according to [Liedholm 1998]:

- variation of size,
- market variety (laws, standards, culture, language),
- variation of performance,
- variation of functionality,

- aesthetical variations.

Much research has been done in the field of product variety, but there is not universally agreed-upon definition for variety. However, in literature exists two main terms in the area of product variety: *product family* and *product platform*.

[Tichem 1999] defined a *product family* as a set of related products, product variants. Relations between them can be explained in terms of the structure of these products. The structure of a product describes the components the product consist of and their relations from a certain perspective e.g. functionality or assembly. According to the [Simpson 2001] *product family* is a group of related products that share common features, components, and subsystems; and satisfy a variety of market niches. The distinctive aspects between individual product variants are the difference in their structure, i. e. the elements and relations they do not share.

A *product platform* can be defined as a set of agreements on the components and relations out of which a product variant will be composed [Tichem 1999]. A *product platform* is a set of a subsystem and interfaces that form a common structure from which a stream of derivate products can be efficiently developed and produced [Meyer 1997]. Often, the product platform is defined in terms of physical components, but the product platform can be defined in other domains as well. The product platform is the basis for developing new product variants.

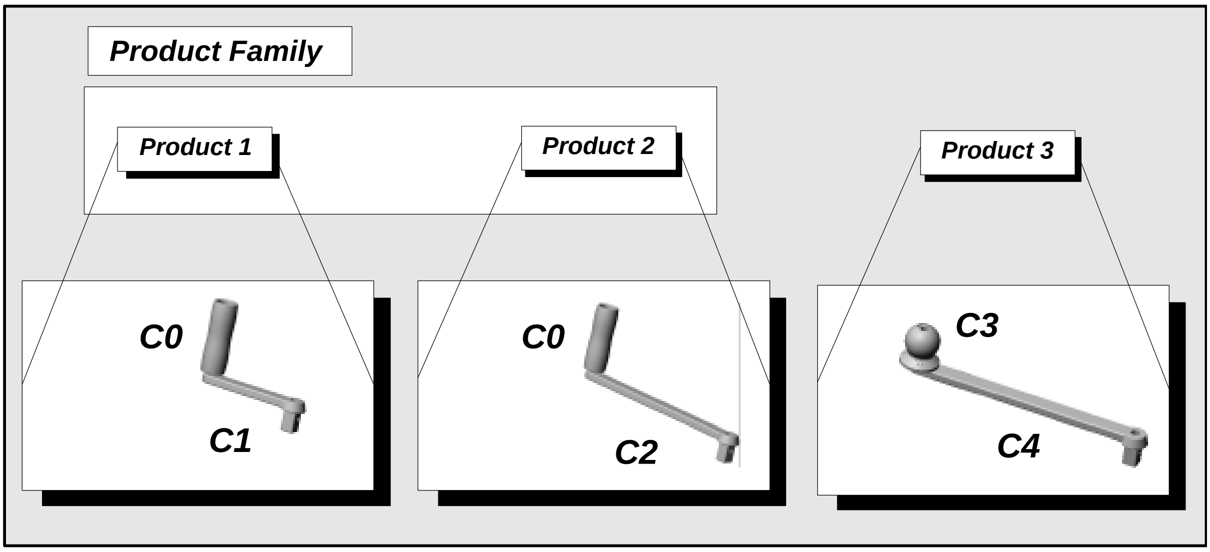

Figure 1. Example of product variants

In this paper, the term product family will be used for describing a scalable product variants, which are mostly, composed from the components with equivalent shapes in all variants and the difference between them is just in the scale of the particular dimension. The scalability refers to the capability of product to be "scaled" or "stretched" by varying one or more of its design parameters in order to satisfy different customer or market requirements.

Figure 1. shows three products, product 1, product 2 and product 3. Each of these products consists of two components: C0 – C1, C0 – C2 and C3 – C4. Products 1 and 2 are the variants of the same product family. Product 3 doesn't belong to the family, because the shape of the component C3 is different form the shape of component C0. Component C3 can be combined with the components C1, C2 and make another product family, but it is not possible to replace a component C0 with the component C3 in the context of the scalable product variants (it is not the issue of this paper). This limitation to make arbitrary combinations of components reduces the number of product variants, but increase the stability and optimisation [Erens 1996].

The product platform model is described by two information models. The first information model is focused on the product structure information and it is linked with the information model which is focused on geometric information of product. More about that will be considered in next sections.

3. Case study

This research is continuation of the implementation of the CAX system in SMsE and is directed to the solving of implementation problems. The main disadvantage, came from the implementation, is the lack of integration of two separate systems [Pavlic, 2000], [Žeželj, 2001]. It is not supported a changing of the 3D component model through the product component structures.

New approach [Figure 2] in support of design a scalable product variants is tied with the system managing of:

- Product structure information
- Geometric information of 3D model.

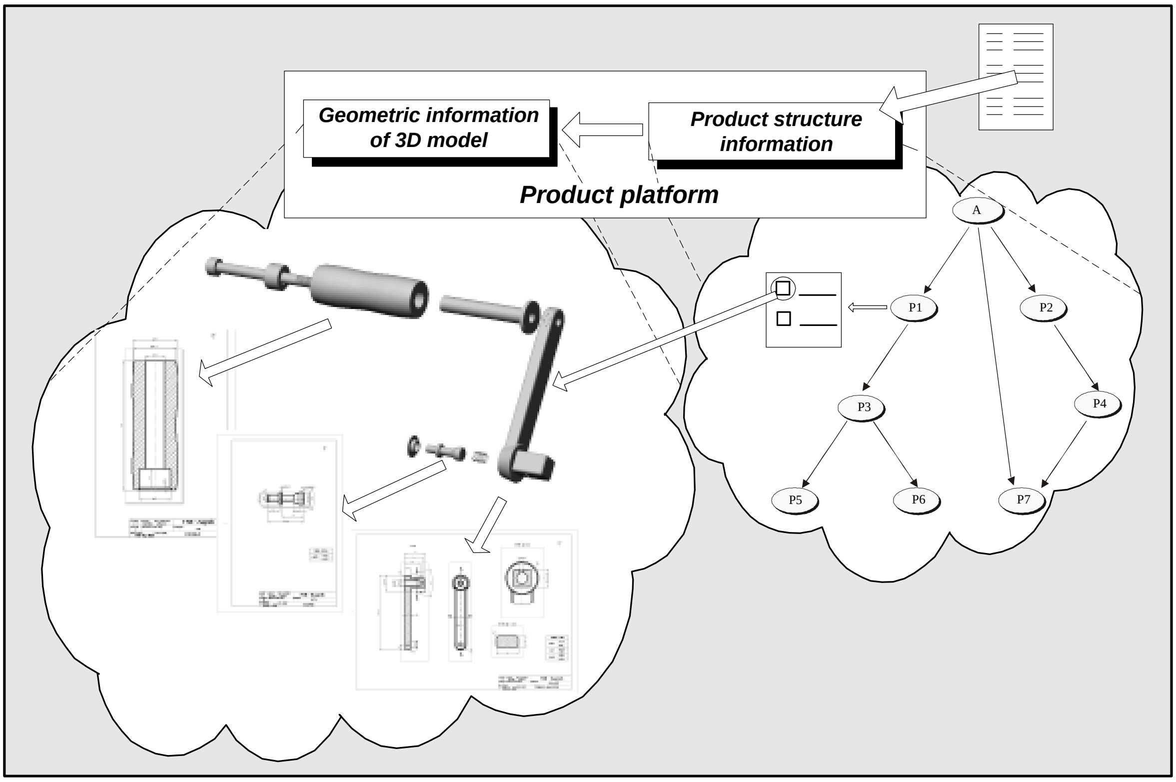

Figure 2. The management of product structure and geometric information

The management of product structure information and geometric information is performing through the one direction link. Namely, geometric information of 3D model is managed through the design parameters, which are included in the product structure information. A request for the changing of design parameters comes from the customer demands. Changing the design parameter of particular component will influence the changing of 3D component model and technical documentations. Topological data (geometrical relations and constraints) in 3D model will than influence the changing of other 3D components, which are connected with the changeable model. That is the way in which new product variant is created. Product structure information can be further used in production and others tasks.

The advantages of this approach are to achieve:

- the visualization of product structure information
- the support to build up and to visualize relations between different components
- a linkage between product structure information and geometric information of 3D model
- management design parameters of the of 3D model as a part of product structure information
- design a new product variants based on the existent components

4. Proposed information models of the product platform

The product platform model, as a basis for developing scalable product variants, is adopted from the product structure model [Jovic 1998]. The basic entity of the model is a **Part.** Such a **Part** can be the piece that cannot be disassembled (named **Simple Pa**rt) or the piece composed from two or more other pieces (named **Assembled Part**) with defined relations between them (named **Assembly Relationship)**. Components that are the building blocks for the assembly can be assemblies as well, so relatively simple recursive algorithm through the tree structure of the whole product definition could be reached. On the figure 3., the product platform model is present by the two different but interrelated information models:

- Product structure model with the non-geometrical module (dashed line) describes a part of product platform model which is used for management a product structure information,
- Product structure model with the geometrical module (continuous line) describes a part of product platform model which is used for management geometric information of 3D model

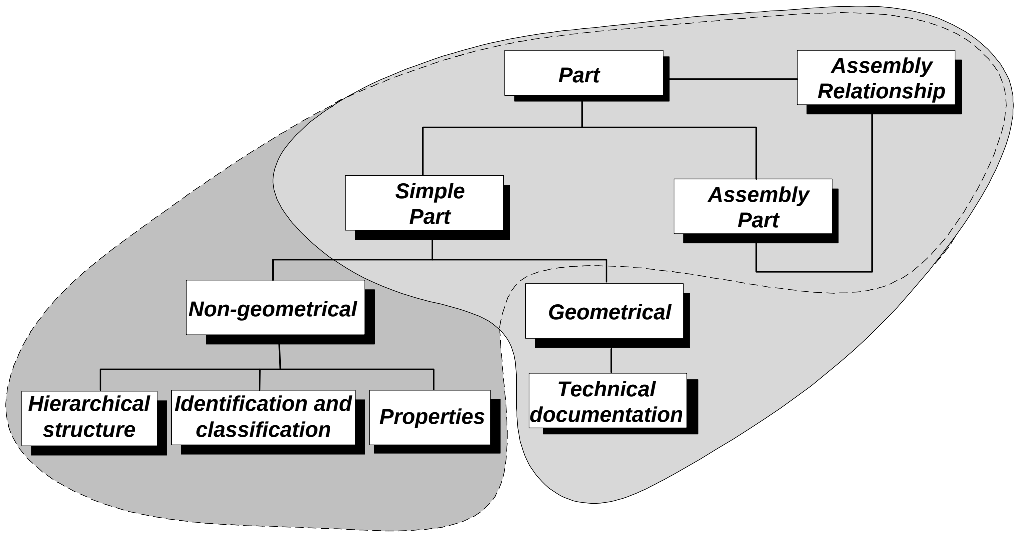

Figure 3. Information models of the product platform

4.1 Information model for management product structure information

According to the proposed product structure model, a part of product platform model for management product structure information is presented. The following entities of that information model are explained more detailed in figure 4.:

- *Entities for identification and classification of product physical components* - identification and classification are achieved according to a fundamental STEP interpretation of 'Part as a Product'. The identified component may represent part or assembly. The identification of components is achieved through the product_context entity, which identifies the engineering discipline's point of view from which the components are being presented. The classification of components is achieved by dividing the components into the category.
- *Entities for describing the product component proprieties* – a property is the definition of a special quality and may reflect physics or arbitrary user defined measurement. There are also a number of pre-defined property type names, proposed for the use: recyclability property, mass property, quality property, cost property, duration property. A special case of component properties is that of the component shape property – a representation of the geometrical shape model of the product components.
- *Entities for defining the hierarchical structure and relationship between components* – explicit hierarchical structure represents complex components and the constituents of those components. Relationships between constituent definitions are the principle entities used to

structure an explicit configuration of complex components (either physical parts of product or structured documents). In addition, relationships could characterize explicit alternates and substitutes for the each component.

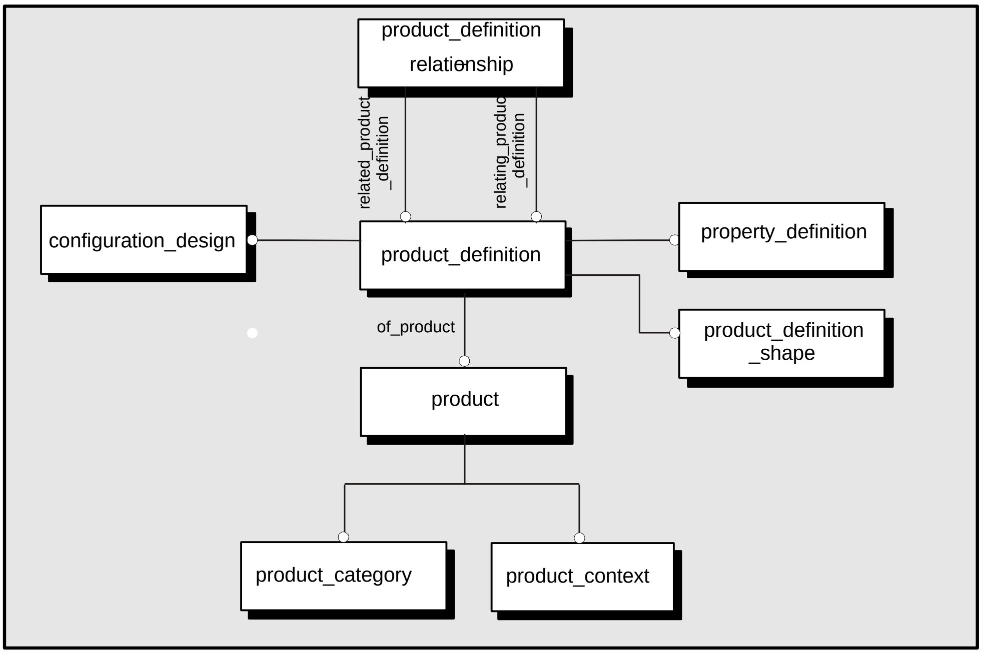

Figure 4. Product platform model for management product structure information

4.2 Information model for management geometric information of 3D model

Figure 5. presents a part of product platform model for management geometric information of 3D model. It consists from the feature-based geometric and parametric model created together with the technical documentation. The link on the model from the previous information model is by the design parameters which are correlated with dimensions of the model. The value of design parameters is contained in information model for management product structure information. Dimensions and relations are mutually connected.

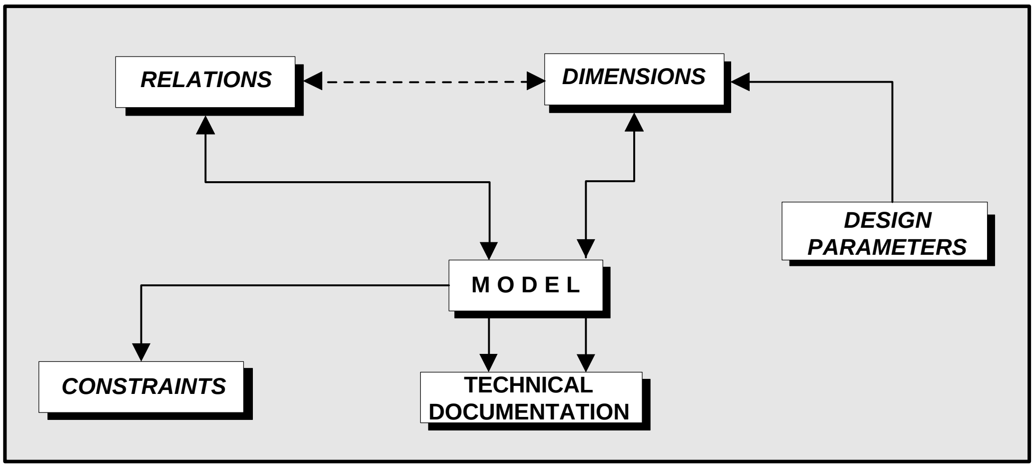

Figure 5. Product platform model for management geometric information of 3D model

Changing the dimensions of particular model component through design parameters will influence the changing the rest of the model components, and the new model variant is created.

5. Conclusion

The presented approach can be viewed as a beginning or basis for the variant design of scalable product variants. The aim of this approach is to constitute a product platform from which the scalable product variants will be created, instead to design scalable variants every time from the beginning. The reason, why design scalable variants every time from the beginning, is in non-existence records of already designed product variants [Pavlic, 2000] so the information cannot be retrieved for further use. The existence of only 3D models with the technical documentation does not satisfies the needs. Therefore, it is necessary to restore the information model for management product structure information. That information model will also make possible to search through the existent information of designed product variants, generating the BOM and access to the information in other departments. The further research should be directed to the development of computer-aided support for implementation of product platform model.

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