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The mechanisms of construction of generic product configuration with the help of business object and delay differentiation

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Abstract

Product configuration has a central role in PLM application. The generic product configuration which factories the similarities between the product types, may be used to facilitate the production by permitting the delay differentiation.

In this research, the role of business object in the construction of generic product configuration is studied. Then the rules which are used in the procedure of structuring the generic and specific product configuration are presented. These rules are based on the "variability points" method. The principal concept of this method is identifying the major variability's of different products by finding the dependencies of their properties.

The industrial case is used to develop and validate the results is the culinary articles. In this case, the generic product configuration is constructed by this method.

Keywords:

Product Lifecycle Management, Product Structure Model, Delay Differentiation, Genericity in product configuration

1. INTRODUCTION

Implementation of a PLM system within an enterprise is an opportunity to improve its information management and rationalize its document structure, since it preliminary requires structuring plenty of product information. Product informations to be structured in a PLM are essentially the documents and the configuration. Structuring of product configuration is studied in this research. [Rangan 05]

Analyzing some industrial cases of PLM deployment, shows that the management of product configuration in the many cases is about to construct the configuration for each commercialized product, independently to the configuration of other similar products in the same production line. Therefore the amount of information to be managed is relatively huge. This manner of configuration management, can make some difficulties concerning to the creation and possible future modification of configurations.

It's obvious that many of commercialized products fabricated by an enterprise belong to a family of product, more explicit, a production line. Therefore, it's frequent that some of their properties are similar and common. This commonality is not already been taken to account in many of industrial cases; each product configuration is constructed independently to the configuration of the other similar product. This

procedure, make the system so huge and difficult to manage, mostly its modification.

So, in order to avoid from this problem, it seems that it suit to factorize the common information of whole products of a production line (from their configurations), and create one product configuration which represent the "generic product configuration", in opposite of "specific product configurations", that are constructed separately for all products. [Mannisto 01]

It should be noticed that the specific product configuration is created based on two logics (or viewpoints), design or fabrication. [Jiao 99] Therefore, two type of configuration may be managed in PLM systems, "as-designed" and "as-built". These two types of specific configuration can correspond to two type of generic configuration. The generic configuration "as-designed" is more known because the generic configuration usually created for the design-based purposes.

This research is aimed to propose a mechanism which leads to construct the generic product configuration "as-built" as well as "as-designed", in the way that creation and mostly modification of specific configurations became more easily and straightforward.

The basic issues of generic product configuration, the type "as-designed" and "as-built" are studied and presented in the first section. In the second

section, the construction rules of generic product configuration with the “as-designed” viewpoint are discussed and validated by the industrial case. Then in the later section, the construction of generic product configuration with the “as-built” viewpoint is under analysis. It is done by using the delay differentiation exigencies. The article is then finished by the conclusion and perspective.

2. GENERIC PRODUCT CONFIGURATION

Generic configuration has been proposed with the aim to regroup all of the properties of the products in the same production line. So it contains all options and variables possible of these products. [Gzara 03] Here some important properties are presented:

Like other configurations, the generic configuration is composed essentially by two different relationships, the composition relationship and specialization relationship.

- Abstraction:

All the objects (document, components etc) in the generic product configuration are abstracted, means virtual. This is because the generic configuration should cover all the similar product of a same type. So there are several parameters without values. Going from generic configuration to specific one is done by allocating values to these parameters. The values of these parameters can be optional or variable.

Heritage

Within the product configuration, the specialized objects (variant objects that are assigned to a generic object) inherit the properties of their generic object. It means that if a decomposition schema is defined for a generic composed object, all of the objects which are the specialization of this generic object obey this decomposition schema. This is one of the advantages of using the concepts of object-oriented theory in the product configuration context. This is shown in figure 1

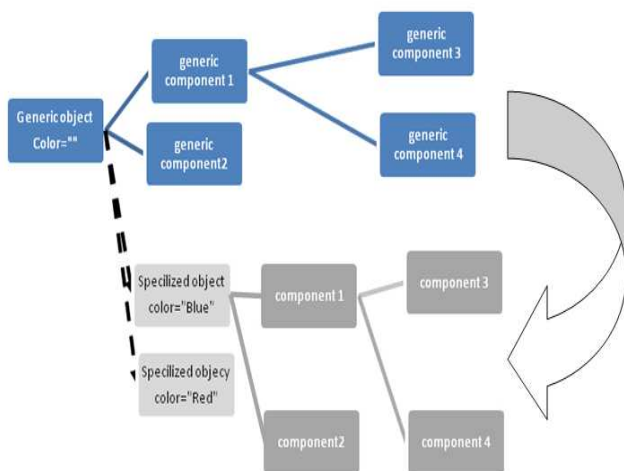


Figure 1: the heritage of composition within the specialization

With the help of that, the amount of information to be stocked in the system decrease as all the common knowledge are transferred to the generic level and saved only one time. Moreover the evolution of this system is much easier, because a modification in the generic product configuration will be implemented automatically in all of its specialized specific product configuration.

The fact to be noticed here is the continuity of this heritage. The heritage may be applied only in the beginning of specific configuration structuring, which means the saved specific configuration is not more dependent on the generic product configuration. But the better strategy is that this heritage will continue during the lifecycle of the specific product configuration. In this case the specific product configuration is reconstructed by the pattern of generic product configuration, each time that is used.

2.2 As-Built vs As-Designed

The product configuration is based on the business viewpoint of the user. It means that the configuration that is done for a manufacturing or fabrication is different with the configuration of the same product but structured for design phase.

The configuration for design viewpoint is more conceptual and functional structure, whereas the one with a fabrication viewpoint is more based on the process and procedures of manufacturing. [Gzara 03].

3. THE CONSTRUCTION RULES FOR “AS-DESIGNED” GENERIC PRODUCT CONFIGURATION AND CENTRAL ROLE OF BUSINESS OBJECT

3.1 The definition of basics of method.

The properties of generic configuration are already discussed. The genericity of product should be conserved. This means that the as-designed generic configuration must represent the variety of specific product designed by a company. The heritage is one of the most important relations in the product configuration. A specific product inherits the properties and relationships of its father (generic product). If the generic configuration can not support this, then it's not appropriate.

The as-designed generic configuration depends also on the enterprise's process of design. For example the circumstance of codification of the components of a product and its order may Influence on the generic configuration. In the other case, the organization of the design department and their logics influence on the configuration.

Our proposed method of structuring of the as-designed generic configuration is based on the variability point technique. In this technique, all of the variety of specific products are studied and compared in order to find the whole set of proprieties making them different. Then this set of

variability points is analyzed in order to find the points on which the other points mostly depend. These points are then considered as the properties that should be valued, even in the generic configuration. The other properties can be regarded as the generic parameters. (Without value)

In order to illustrating this method, an industrial case study will be elaborated in the next section.

3.2 The industrial case

The case that has been chosen to validate the proposed method of generic product configuration construction is a frying pan. The different parts of a frying pan are presented in figure 2.

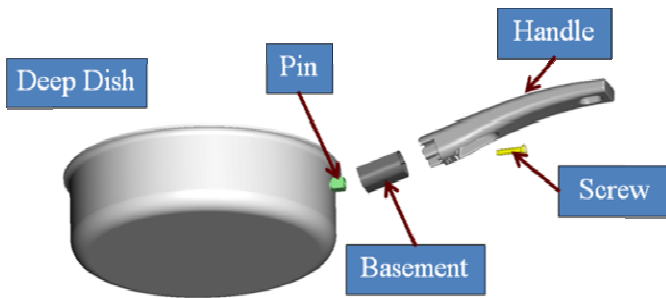


Figure 2, the decomposition of a frying pan

The initial decomposition of the specific product configuration of a frying pan is shown in the figure 3.

As it's shown, the objects presented on the product configuration, are not only the components of a product, but also the tools and the documents associated to the components.

Table 1 lists the different properties of the product configuration which cover the variability points.

The Object	The properties
Frying pan (whole product)	Dimension of Product
	Family of Product
Deep Dish	Dimension DD
	Family DD
Pressed Disk	Diameter PD
	Tools DDD
	Thickness
All of the equipments	Diameter
	Family
Lid	Diameter L
	Tool L

Table 1, the different properties determining a frying pan.

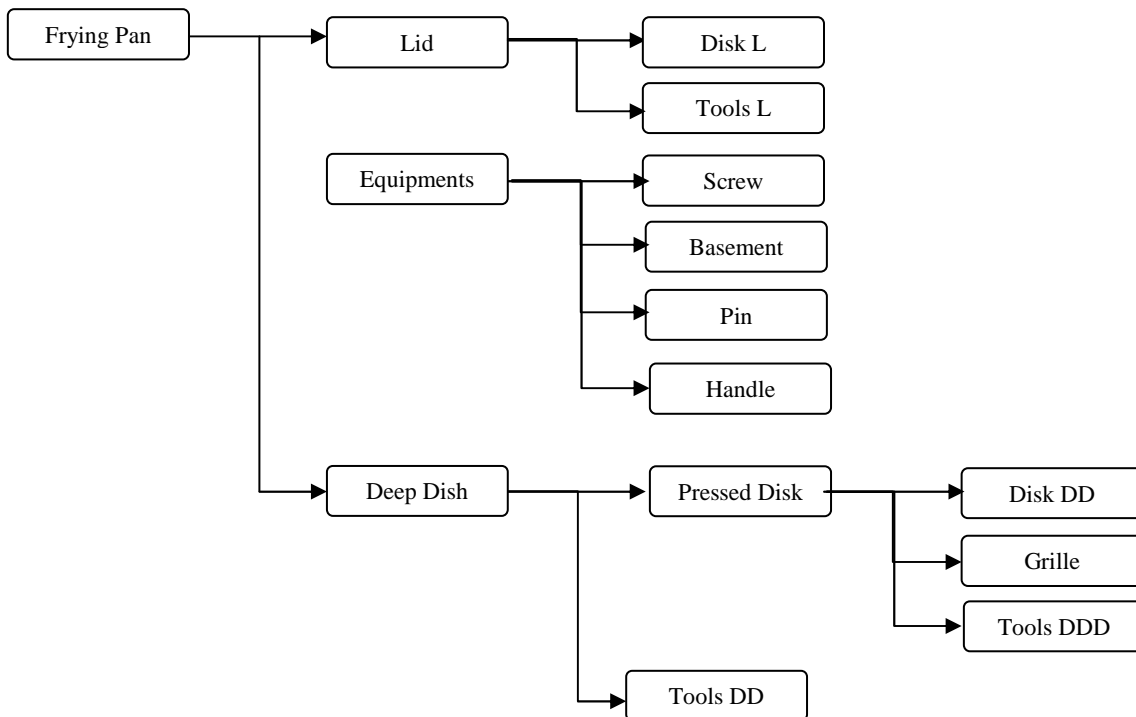


Figure 3 the decomposition of a frying pan

Table 2 presents the extracted list of dependencies between variability points:

The Parameters	The dependencies
Dimension DD	Dimension of product
Family DD	Family of product
Dimension PD	Dimension of product
Tools DDD	Dimension of product
Dimension related to the equipments	Dimension of product
Family related to the equipments	Family of product
Diameter L	Dimension of product
Tool L	Dimension of product

Table 2 , the dependencies.

These dependencies are found via the business rules and experiences and obtained from the discussion meeting with the technical sector members of the industrial partner.

It's shown here that the determining variables are "diameter of product" and "family of product". Therefore the constant parameters in the generic frying pan are these variables. So the generic frying pan is defined like that:

Generic Fraying Pan of 20 and the Family of Best Cuisine.

This will be a starting point of specialization of the product.

4. THE CONSTRUCTION RULES OF "AS-BUILT" GENERIC CONFIGURATION AND THE CENTRAL ROLE OF DELAY DIFFERENTIATION

As the generic configuration "as-built" is related to the manufacturing process its construction is based on the genericity in the fabrication. One of the subjects that analyze the genericity in the fabrication line is delay differentiation. Delay differentiation is a strategy of the production line design for the high variety production or huge customization product. The concept of delay differentiation is how to maintain the genericity of a product during its fabrication. [Agard 02] [Ghiassi 03] The production line consists of several stations. In each station, one of the production activities is done. The starting product has uncompleted configuration. During the fabrication, its configuration evolves and enriched. This evolution is done, by specifying or determining the values of the parameters. This means whether choosing an option or a component or valorizing a value (such as color). So the evolution of product configuration is considered as a key concept in this study. This evolution is similar with the evolution of generic configuration to exemplary configuration via several specific configurations.

Delay differentiation will be done by elimination of intermediary products, and construction of a generic intermediary product. Figure 4 shows the simple example of delay differentiation.

Therefore the delay differentiation is to retard the differentiation point of product or process within the production line. At the differentiation point, different specific products obtain their own valued properties, identities or codification.

The proposed concept here is like the variability points technique used in the previous section, but the variability relates to the production process. Therefore the procedure is similar to the previous one, but here the parameters of product that are related to the fabrication are considered. It's obvious that the product configuration extracted from this mechanism is different with the previous one. Here, the decomposition of product is done based on fabrication conditions.

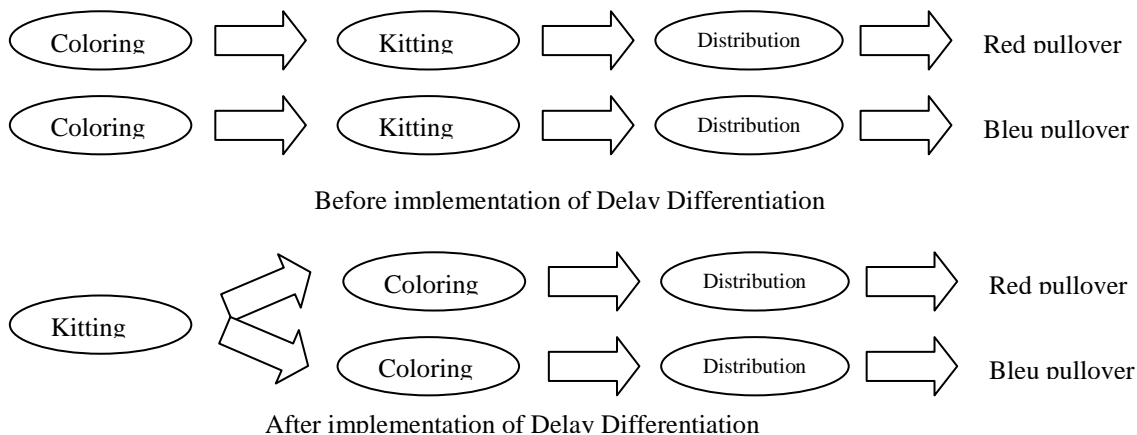


Figure 4, the concept of product differentiation

The first stage is to find the parameters and variables¹ that specify a product and then categorize these parameters and variables with fabrication viewpoint. This is done by analyzing the different specific product configurations "as-built". Then the different stations of production line are studied in order to determine in each station, which parameter of product is specified. For example in the case of frying pan, in a station that coloration is done, the color of product becomes fixed or in the press station, the family and dimension of product take values.

Next stage is to find the dependencies of stations, which means the obligatory order of fabrication. These are considered like the constraints of fabrication. For example, a coloring or coating station can not be placed before the pressing station.

Then finally the stations are ordered from the most dependent station, and will continue until the most independent, in order to fulfill the delay differentiation exigencies. The corresponding generic product configuration is then constructed based on this proposed order. For example the generic configuration "as-built" is a product in the first stage, but each station specialize one or more properties of it.

5. CONCLUSION

The generic product configuration is considered as one of the most important structure in the PLM systems. In the other hand, there is a variety of configurations made for each type of fabricated product. This diversity of products which is a source of the huge quantity of different configurations to be managed in the system obligates us to take in to account the concept of genericity in product configuration and search to find this genericity within all types of a product line. So in the context of structuring the product configuration, which is done with the design viewpoint, the genericity is inevitable.

Moreover in the fabrication process, in order to reduce the cost, delay differentiation has been introduced. This method of ordering the production line is used with the objective of preserving the genericity of product as long as possible during the production. This genericity may be represented in the form of generic product configuration as-built.

In this study, we construct the generic product configuration as-designed from the basics of design process and variability points. This "as-designed" generic configuration must be capable to facilitate the design process, the development of product, the evolution of configuration, etc. Subsequently, the generic product configuration as-built is extracted from delay differentiation exigencies. It means the

generic configuration and delay differentiation are considered like high relevant concepts.

The generic configuration as-designed is more about the static genericity in the designed product, whereas the generic configuration as-built, as well as delay differentiation are the dynamic one; they are about the genericity of a fabricating product during its fabrication process.

In this research, the genericity of configuration within PLM systems was studied. The other important subject to be study is the genericity in the documentation. The other subject that should be analyzed in the future is the relationship between the two generic configurations, as-built and as-designed. The mechanism of transforming between these configurations as well as the coherence that should be maintained between them are the interesting to be studied.

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¹ The parameter may have a fixed value, but the variable is not valued.