Stakeholder view effects on modularity in configurable products

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Keywords: Configurable Products, Modularity, Concurrent Engineering

Abstract

The basic idea of configurable products is delivering customised products by the means of mass/serial production. This is achieved by designing a configurable product, whose variants cover the needed variation. In this sense a configurable product can be seen as a product family based on same set of modules / building blocks. Although the configurable product paradigm is quite easily defined, it is not so easily utilised in industry. There exist many hindrances and many of them are surprisingly not product related at all. It was found that the differences in opinion between marketing, design and production inside same company were more fundamental than differences between for example designers from different companies.

There is strong stereotypical thinking in stakeholder groups in different companies. Marketing people seem to have their way to think about product modularity and configurable products. Marketing viewpoint could be adapted quite easily to suit configurable product paradigm. The case seems to be different with production viewpoint. Production people seem to have strong idea of modularity, but they want to see modules only as assemblies. This often leads to controversy with marketing and in many cases makes designing configurable products ultimately difficult.

Changing the way of working in a company is always a challenge. In many cases the transition to configurable product paradigm has been considered only as a product upgrade. No doubt this is erroneous thinking. It is important to understand that there exist prejudices and contribution from all stakeholders is needed in making the transition. In this paper some stereotypical opinions of stakeholder groups are presented. Recognising these would help to see the problems by forehand and ease the finding of solutions.

1 Introduction

This paper is based on observations made in research project "Design for Configuration" which was carried out by Tampere University of Technology and Helsinki University of Technology in 1997-1999. In the project the utilisation and prospects of making configurable products was examined in 12 Finnish companies. (Kaso, Hydrovoima, KCI, Tamrock, Tunturipyörä, Valtra, Ponsse, Rocla, Datex-Ohmeda, Neles, Wärtsilä and Kalmar). With four

companies there were co-operation projects in developing tools and methods for supporting design work for configurable products.

In addition to actual development of tools and methods, there were also interesting findings concerning Concurrent Engineering related topics. The attitude towards Configurable Product Paradigm seems to be more affected by a persons own work assignment (eg. whether she/he is working in marketing, designing or production) than any company specific or other factor.

2 Configurable Products Paradigm

Delivering Configurable Products has been chosen in many cases for the means to survive in competition. Delivering customised products by means of mass/serial production is achieved by designing a configurable product, whose variants cover the needed variation. In this sense a configurable product can be seen as a product family based on same sets of modules / building blocks.

As earlier defined [Tiihonen&al98, Pulkkinen&al99] configurable products has the following properties.

- Each delivered product individual is adapted to the needs of an individual customer and is made for order.
- Each product individual is specified as a combination of pre-designed components or modules. Thus, there is no need to design new components as a part of the sales-delivery process.
- The product has a pre-designed general structure and is has been pre-designed to meet a given range of different customer requirements.
- The sales-delivery process requires only systematic variant design, not adaptive or original design in the sense of Pahl and Beitz [Pahl&al96].

Configurable product is defined in *configuration model*. The configuration model represents the available components or modules, rules on their correct combinations, and rules on how to achieve the desired product properties for a customer.

A configuration model is used repeatedly in a *configuration process*, which is a part of sales-delivery process. Configuration processes produce *configurations*, i.e. descriptions of the product individuals to be delivered. Product individuals are *configured*, i.e. adapted to meet given customer requirements, on the basis of the configuration model and the customer requirements. These adaptation activities are referred to as *configuration tasks*. The tasks are sometimes carried out in two phases. In *sales configuration*, the product may be partially specified in terms of functions and attributes. In *engineering configuration,* the result of sales configuration is used as an input that is refined to a technical description of the system. [Tiihonen&al99]

The generalized sales-delivery process of Configurable Products is shown in figure 1.

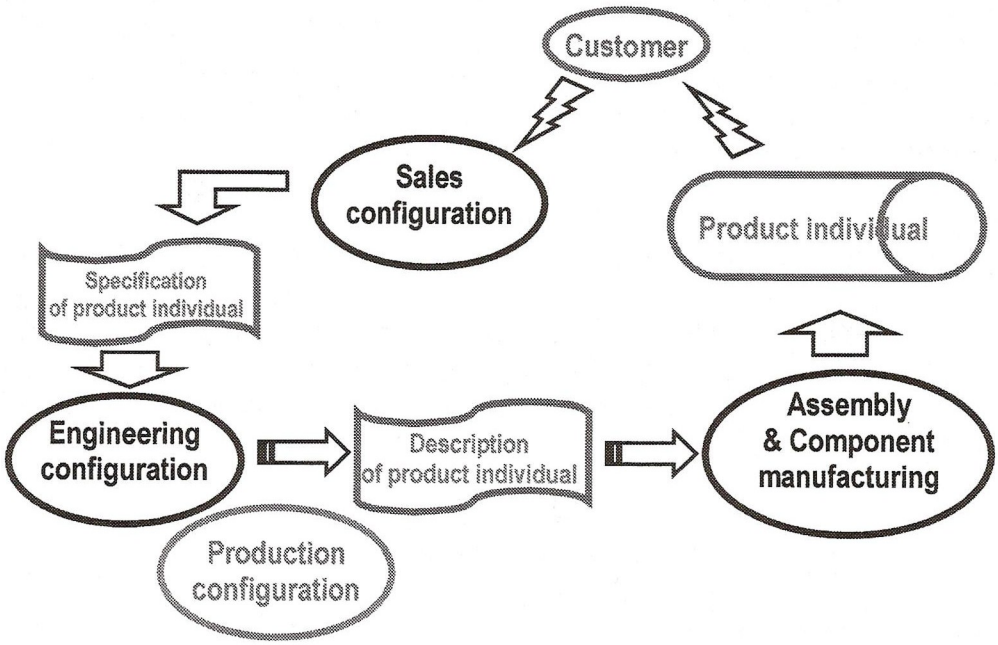

Figure 1: Generalized Sales-delivery-process for configurable products.

3 Approaches to delivering Configurable Products

Delivering configurable products is paradigm in between the mass production and the projecting. Therefore two different transition processes to configurable products are recognised; transition from mass production and transition from one-of-a-kind production. The motivations and goals differ significantly in these two processes [Tiihonen&al98].

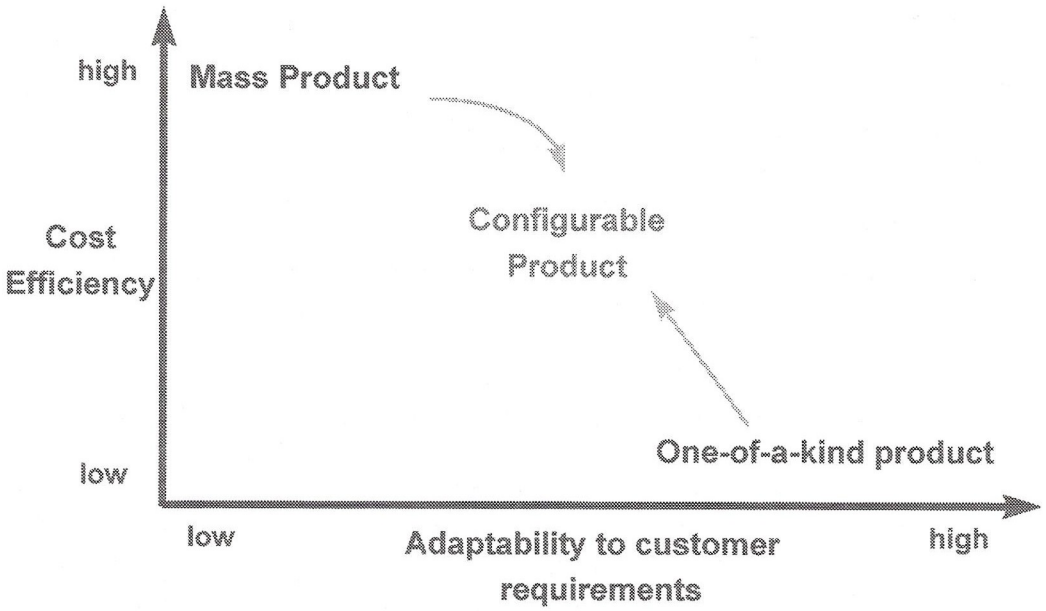

Figure 2. Transition to Configurable Product paradigm is twofold according the company's previous working paradigm.

Delivery processes of one-of-a-kind and configurable products are similar. In both cases the customer requirements are starting points of the process. The most important differences are the limitations set for acceptable customer requirements by the configuration model and the amount of iteration in process. In the configurable product delivery the generated configuration description must be precise because the production should be able to use the specification without any further negotiations with customer.

Delivery process with mass-produced products differs from configurable product delivery. In mass production the way of working often involves predicting the future sales, manufacturing products to stock and selling the already made production. Taking this background into account the transition to configurable products requires more profound changes in the delivery process. Because the cost efficiency with configurable products is often poorer than with mass production, there should be very important arguments to make transition to configurable products feasible.

4 Different types of modularity in configurable products

In research community the concept modularity has been defined with different ways. For example Ulrich defines modularity as a property of product structure and defines 5 types of modular structure (sharing, swapping, cut-to-fit, bus and sectional modularity). In American research modules are not always defined at all but instead a work "chunck" is used to describe not precisely defined part or subassembly of a product for eg. [Ullrich&al95].

Erixon lists 12 reasons or motivations, which he call Module Drivers, to form a module. These are Carry over, Technology push, Planned change, Variance, Styling, Common unit, Process/Organisation, Separate testing, Black box, Service/maintenance, Upgrading and Recycling [Erixon98]. If we take more abstract view on these motivations, we found six groups of motivation; Component-sharing and re-use, long term product management, life-time maintenance of individual delivered products, organisational production oriented reasons, recycling and product variance.

The actual module itself is quite seldom defined. In DFC-project [Pulkkinen&al00] a module was defined by following axioms. This more focused definition of module can be referred as m-modularity.

Part or sub-assembly of a product is a module when
1. It has defined interface, which determines its connection to other modules.
2. It is a member of set of parts/subassemblies, which forms a modular system.

In this definition, system is considered as a modular system, when there exists some or all of those structural variations, which were defined by Ullrich to be types of modularity.

In addition to previous axioms, there is a requirement that module system must be defined on one level only in concrete presentation (eg. part-domain). In other words this means that no module should include or consist of other modules of same module system. If this is allowed, the interfaces of modules could no longer be defined unambiguously and modules could no longer be handled as undividable black boxes.

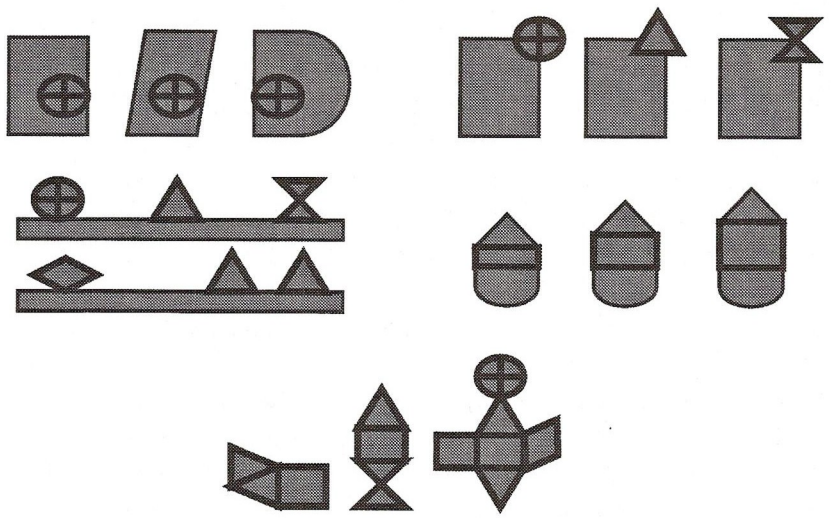

Figure 3. Types of modularity according Ullrich [Ullrich&al91].

In figure 4 an example of different structures is shown. First drawing shows "ad-hoc" integral structure of a Dv12-locomotive. Second drawing shows assembly oriented modular structure where compressor cabinet has a separate frame. The third drawing shows effects of function based modularity, where compressor unit is one module and parts belonging to other functional modules (headlight, upper fuel tank and covers) are separated. For clarity sake, all pictures are drawn according a locomotive model drawn in sixties, although this model was never manufactured in modular form.

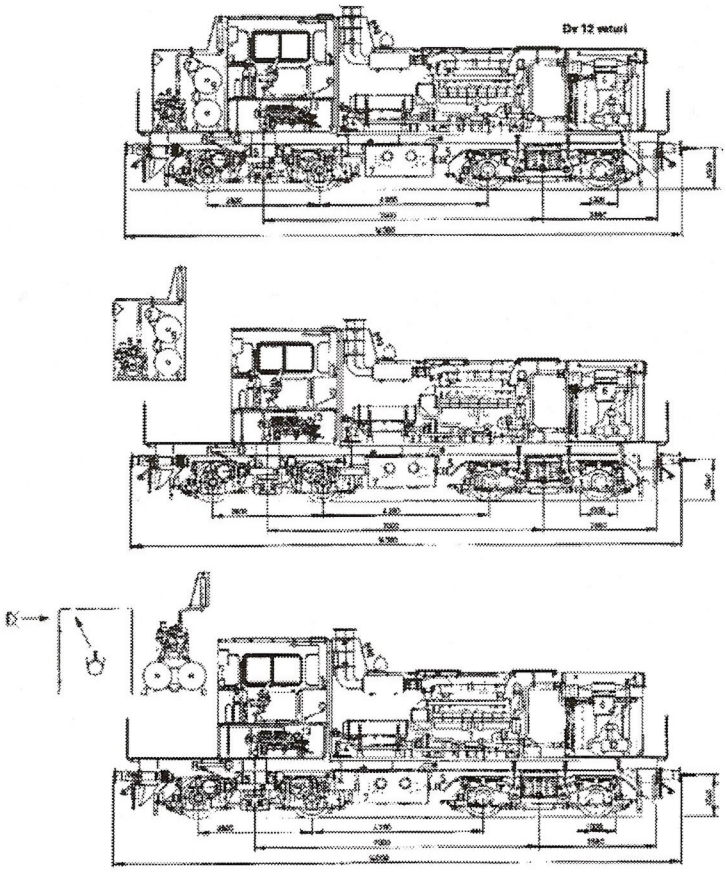

Figure 4. Locomotive production development in Transtech Tampere from sixties to nineties. The effects of different modular structures on compressor cabinet are shown.

In M-Modularity definition it was not purposely defined according how the modules should be composed. The widely accepted idea is that modules should be composed according the functional structure of the product. However, for example majority of Erixon's module drivers are not related to product functionality. Besides, many successful modular products are divided according to assembly structure rather than functional structure.

In this paper we focus on configurable products and in this case the preference is clear. The core of the paradigm is answering to customer requirements in rational and systematic way. Thus the handling of requirements is the key point and normally the requirements are more or less related with functions. The assembly based modular structure could be used only, when product assembly structure resembles the functional structure (or customer's idea of functional structure, which is case for example highway truck -business). So whether it is difficult to achieve or not, configurable products normally require function based modular structure.

If there are many viewpoints of modularity in academia, the situation is even more mixed in industry. This must be taken in account when making interviews in companies. All participating companies in the Konsta-research were producing physical products, i.e. a kind of hardware. There was only one company from electronics industry. In this kind of sampling, pure modular products seemed to be rare. Instead there actually seems to be "chuncks", which are blocks of a product, but don't have clear interface between them and other parts of the product. Because these blocks or sub-assemblies don't have defined interfaces, they are not readily changeable with other type of block from the product assortment. Thus, we cannot speak about modular systems by definition. However, companies themselves often consider their product as a modular product.

Figure 5. In some product areas modular product structures are used successful and almost without difficulty. One such product area is highway truck. It seems to be due the fact that customer's idea of functional structure is similar to assembly structure. For example Finnish-made self-supporting aluminium tank truck was not accepted by market, which expected separate chassis. So despite unequalled weight/load ratio (20 % increase in payload!) and superb riding qualities, the Hollming-truck flopped in the market.

5 Sales prospects and problems

Sales people are most frequently in direct contact with customers. So they are normally more than willing to accept the idea of adapting product to individual customer requirements. However the actual effect of modular configurable product depends on the company's earlier

way of working. If the company has earlier made standard products, configurable products truly add the possibility to satisfy individual customer requirements and thus this change would be welcomed in among the sales people.

Among those companies who had earlier made standard products, the possible problems with sales work were considered as a minor factor. The identified possible problems were the increased complexity of sales work, obscure relations between variable features in the product and problems with cost estimating/prizing and decreasing of profits. The increased complexity of sales work was thought to be compensated with better and more detailed invoice forms or with some special made simple configurators. The latter kind of sales support tools were developed with three companies and results have been earlier presented in ProductModeller98 and NordDesign2000 [Lehtonen&al98, Lehtonen&al00].

However, the situation and attitudes for Configurable Products in sales department seem to become quite different if the company has previously made one-of-a-kind deliveries. Now Configurable Product Paradigm probably means the narrowing of possibilities to satisfy exactly customer's wishes. Earlier the product has been adapted to customers wishes, but now the customers should adapt themselves to new more strict product policy. In this situation the possible benefits should be underlined. These could be shortened delivery time, better delivery reliability and increased quality (products are less prototypes than they used to be when they were engineered to order).

In earlier chapter two different approaches for determining of modular structure was discussed. The viewpoint of sales people is (and should be) near the viewpoint of customer. So they understand the customer's process where the product is utilised. Function based modularity is thus a natural way of thinking in sales department. This could lead to disagreement with production department, when pure functional modular structure is not achieved in product for technological or manufacturing related reasons.

6 Possible gains in design office

Configurable products could lead to remarkable savings by design reuse. However this is a challenge, if design work has earlier made *ad-hoc* for a single delivery only. The enhancement level of design work will rise, due "scratch building" is no longer possible. Instead, some kind of product master plan is needed to cope with variety and maintain compatibility between modules in different product versions. Also the requirements for documentation will rise, due to the life span of a solution will became longer (as it is no longer used only in a single product). Thus a better life-cycle management is needed.

As a whole, the Configurable Products Paradigm reduces the work needed in routine design. As a side effect also new product development differentiate from delivery projects, when design work is no longer a part of delivery process. As a conclusion could be said that designer's common attitude against configuring is neutral. More definite is whether the idea of starting configurable product deliveries is originating from the design department or it has came outside. In these cases the NIH-phenomena (Not Invented Here) is seemingly present.

7 Threats of production

The effects on production differ significantly whether the company has previously produced standard products or is it changing configurable products from project deliveries. If the company has previously made project deliveries, the usual cause for changing the paradigm is trying to improve the profitability by rationalising the production. In this kind of situation the company has already the capability to produce customer variant products and thus delivering configurable products is by no means a problem. However, if the way of work in production does not actually change and configurable products are made same way as the project deliveries earlier, there will be no actual improvement in profitability. The gain the advantages of configurable products, the production should be rationalised and for some extend the methods of serial production should be used. These changes probably make production less flexible, because ordering and manufacturing of parts in bigger series, needs more planning and prediction of production. If the need for production re-arrangement is not realised or it is not possible for example due for product design or market situation, the production personnel may feel there is no point in delivering configurable products.

If the company has earlier made standard deliveries, the effects of configurable products in production could be even drastic. When every product made earlier in masses became actual product individual with predestined customer, totally new methods for material management and production control could be needed. This normally causes increasing complexity and also increasing production cost. This is not normally a problem, because no sensible company would start delivering configurable products instead of standard products, if there is no possibility to get something extra in the market. Only one exception to this can be seen; those business areas where logistical expenses and the cost of storing up ready-made production are very high compared to the value of products.

The point of view of production people on modularity is of course very production oriented. The production deals with actual products so part structure of the products is the viewpoint they understand. Function based modularity often requires modules with are not assemblies. This is sometimes very difficult for production people to accept.

For reasons above, the production personnel seldom sees configurable products as a desirable objective. Although configurable products in some cases could solve problems in production, which earlier has been making project deliveries, often the change brings new or increased demands. In addition to this, often company's production management system is simultaneously altered to suit better for delivering configurable products and a market oriented module structure is taken in use. In most extreme cases there is no actual positive effects on production - only indifferent or negative impacts. One should not underestimate the effort needed in convincing the production people of the virtues of configurable products for the whole company's business.

8 Conclusion

There seem to be strong stereotypical thinking in stakeholder groups in different companies. Marketing people seem to have their way to think about product modularity and configurable products. Marketing viewpoint could quite easily be adapted to suit configurable product paradigm. The designers' attitudes are most effective, if they have been initiators by themselves. If not, there is a danger that they see configurable products as an extra burden and restriction to innovations. The case seems to be different with the production viewpoint.

Production people seem to have strong idea of modularity, but they want to see modules only as assemblies. This often leads to controversy with marketing and in many cases makes designing configurable products ultimately difficult.

Changing the way of working in a company is always a challenge. In many cases the transition to configurable product paradigm has been considered only as a product upgrade. No doubt this is erroneous thinking. It is important to understand that there exist prejudices and contribution from all stakeholders is needed in making the transition. Our experience suggests that the product development should follow the guidelines of Integrated Product Development by [Andreasen&al87].

Acknowledgements

The writers acknowledge the co-operation of the companies and the support from the Finnish Technology Development Centre (TEKES).

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