Mastering Product Variety

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Abstract
Designers continuously strive to be more market oriented. They face a wide range of critical issues as how to design products that fit distinct market segments and use situations, in less time, and at lower cost. Variants support the sales possibilities, but cause additional costs in all other life phases, unless such familiarities are created that the effects of variance are suppressed. The pressure to make new products in a shorter time can also be realised by designing product programs with the possibility to easily divert new variants.

This paper describes a systematic approach to design product variety. A terminology is also suggested.

Keywords
Product programs, variants, familiarities, reuse

1. What is it all about?

1.1 Make familiarities

A lot of companies are expanding their product range, makes variants that fits many use situations, and user specified variants. The sales are increasing, but not the profit. The reason for this is that many variants force higher fixed costs, see Figure 1.

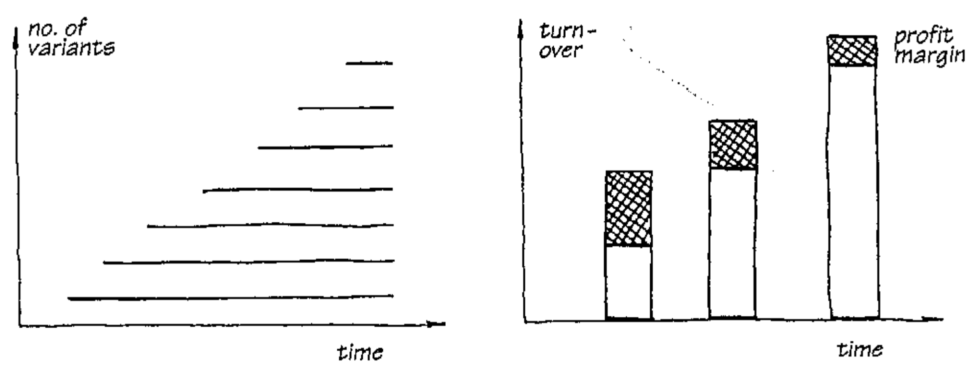


Figure 1 A common consequence of growing product variants is increased turnover, but a reduced profit margin

These costs are very difficult to trace and calculate, and is totally hidden in most companies. A fixed percentage is often used in traditional product cost calculations. To support the calculation of the extra costs in all life phases so called "cost drivers" can be used in addition to traditional cost calculations. Examples of cost drivers are numbers of:

2. Principles to support sales possibilities (big F).

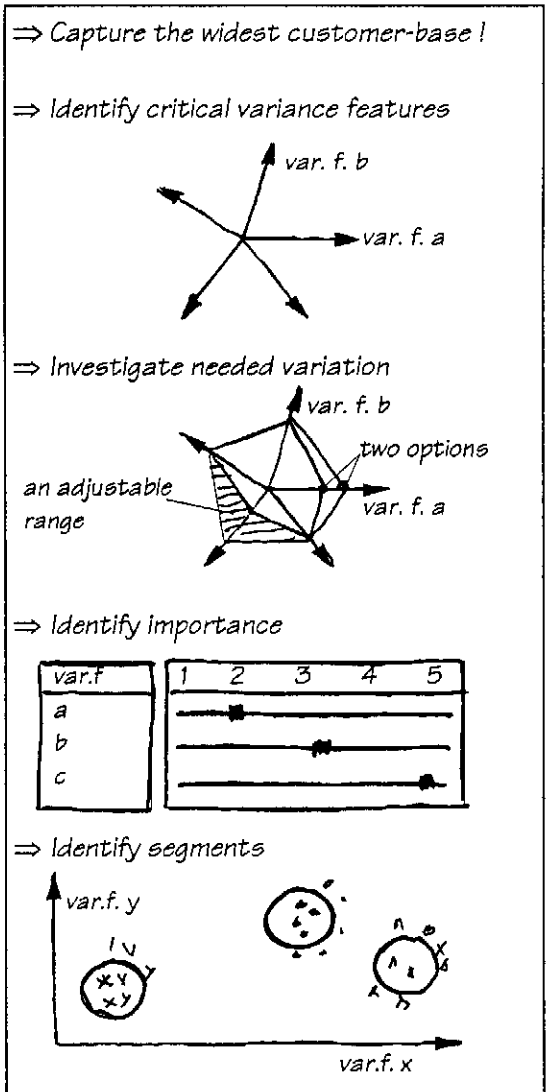


Figure 3 Planning of variance to support sale

⇒ ***Capture the widest customer-base.***

Different market segments and single users have unlike needs. For example, some customers of compact cameras wants a water proof camera, other customers are not interested in this feature. By averaging these needs, a splash proof camera may be made, but who wants splash proof camera? From this simple example we can claim that an average customer does not necessarily exist. It is therefore important to capture the widest customer-base and describe their distinct needs.

⇒ ***Identify critical variance features (axis of variation).***

Critical variance features can be identified by for example; customer/user interview, focus groups or product use observations. All important external stakeholders should be included in the analysis. We are particular looking for distinctive features that gives the product a specific character that can be used positioning the product relative to competing products. A frequently used way is to include new features or make customer specific features.

The investigation suggested above should involve more than pure measurable features. All of us make chooses about products that are based to some extent on the way that they express the kind of person that we are. Certain products have for example their ability to express status, other makes out as belonging a particular group. Identifying personal identity of single users or user groups gives important input identifying possible variance features.

⇒ ***Investigate needed variation and identify importance.***

To identify the needed variation a broader investigation is needed. A questionnaire can be used. A difficult task is to ask the right questions and control the format of the answers in a way that the needed variance and variation is expressed. In some situations one or more discrete measures may be wanted, in other an adjustable range is wanted. Information about the importance of each variance features gives the designer an understanding needed to make compromise, do optimisations, and avoid unneeded variants. In some situations, the sensitivity of the wanted variation can be useful. This is particular of interest if it is important to minimise the number of variants in a size range.

⇒ ***Identify segments.***

Customer needs depends on culture, climatic, age, etc. This information is crucial in planning of product programs. By plotting the wanted variation in a diagram with two and two important variance features at the time, segments can be identified. Few clear segments indicates that marked needs can be fulfilled by some variants, unclear segments gives preferences to adjustable product or a range of products.

⇒Make benefit of modularization.

The functionality of the product is determined by its structure. Unfortunate changes in complex structures can give negative effects in many life phases. Modularization is an effective technique that reduce this negative effect, particular when a given number of discrete variation possibilities are needed. Variants can for example be made by using alternative modules in a design. By designing each needed variant along an axis of variation in separate modules, similarities can be achieved in many life phases, see also Figure 6.

We recommend to use alternative modules carrying styling and functions that position the product into the market to be able to respond fast on changes in the market and divert new variants. Modularization is also a key to achieve effective reuse in the hole product program.

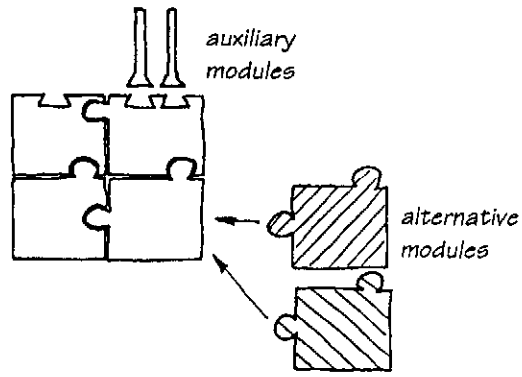


Figure 6 Create variants by using alternative and auxiliary modules.

An another approach is to use auxiliary modules. Auxiliary modules are effective to handle options which is wanted in the product or not in at least one life phase.

⇒Plan carry-overs and diversion of new variants.

Rigid solutions (as part systems, modules or components) that are planned to also be used in future products are named carry-overs. Such solutions are often costly or technology intensive units. As a rule of thumb, update styling and functions that position the product in the market and make use of carry-overs for «heavy parts».

4. Product modelling including familiarities.

4.1 Fitting the product to the life phases in four levels.

Design for product variety can incorporate different levels [2,3,4]. Seen from the sales department, following levels can be used; type of business, product program, product range, and product options. Seen from the production department; task, lines or cells, equipment, and processes can be identified as matching levels. Similar levels can be seen in all life phases. In general, these levels can be roughly classified as at company, department, structure, and component level. See also Figure 7. The setting of the highest level to be used in a actual projects indicates the level of ambition, and is limiting the designers degree of freedom.

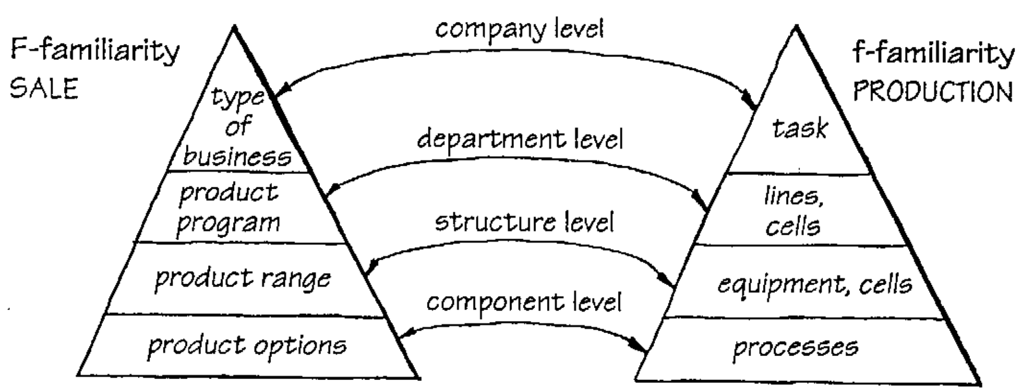


Figure 7 Familiarities defined in four levels

Table 1 Examples of F-familiarity for camera equipment's.

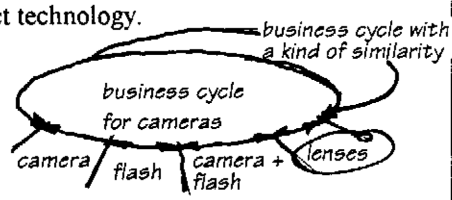
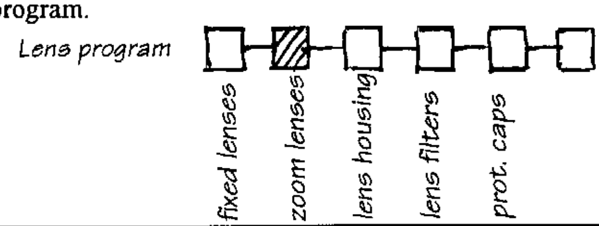
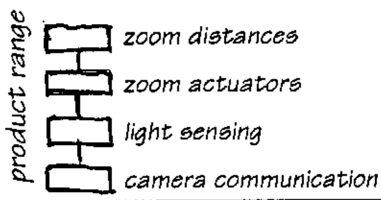
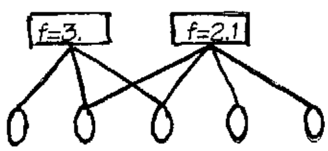
Level	F-familiarity	Examples
company level	Familiarity at the company level is related to the type of business or product technology. 	❐ *stand alone flashes adaptable to all mass produced cameras (above 200$)* ❐ *lenses adaptable to all mass produced cameras (above 200$) that have replaceable lenses.* ❐ *built in flashes for Canon cameras*
department level	Familiarity at the department level is related to the product program. 	*Lenses:* ❐ *fixed lenses* ❐ *zoom lenses, manual* ❐ *zoom lenses, autofocus*
structure level	Familiarity at the structure level is related to the product range 	*Autofocus zoom lenses:* ❐ *28-70 mm zoom lens* ❐ *60-110 mm zoom lens* ❐ *120-200 mm zoom lens* ❐ *200-400 mm zoom lens*
component	Familiarity at the component level is related to product options. 	*28-70 mm zoom lens:* ❐ *f = 2.1 and 3.2* ❐ *adaptable to Nikon, Pentax, Canon* ❐ *connection possibilities for protection caps* ❐ *connection possibilities to auxiliary glasses*

Table 2 Examples of f-familiarity for camera equipment's

Level	f-familiarity	Examples
company	Familiarity at the company level is related to the type of production technology to master and be no. 1 in, and what to order from suppliers.	❐ *light measuring sensors* ❐ *flash power control electronics* ❐ *mirror production technology and machines*
department	Familiarity at the department level is related to the production lines or complex production cells. It is wanted that all parts or modules can be produced efficiently in the production line without costly adjustments.	*Lenses:* ❐ *similar lens glasses production technology in manual and automatic lenses* ❐ *one type of lens electronics in al autofocus lenses*
structure	Familiarity at the structure level is related to the production equipment or small production cell units.	*Autofocus zoom lenses:* ❐ *similar actuators to drive and control all zoom lenses* ❐ *identical mechanisms to guide lens glass movements* ❐ *assembly of all lenses in one assembly cell*
comp.	Familiarity at the component level is related to the single processes.	*28-70 mm zoom lens:* ❐ *adaptation to different cameras by a module to be assembled* ❐ *identical assembly sequence as the 70-210 lens*

4.5 Familiarity superimposed in to the physical structure.

We have seen from the previous sections that it is necessary to see the variants and familiarities from all life phases to be able to optimise the product. To model this, the physical structure shall be superimposed by principle for familiarities seen from the product life cycle activities [7]. Figure 11 shows an illustration of this concept.

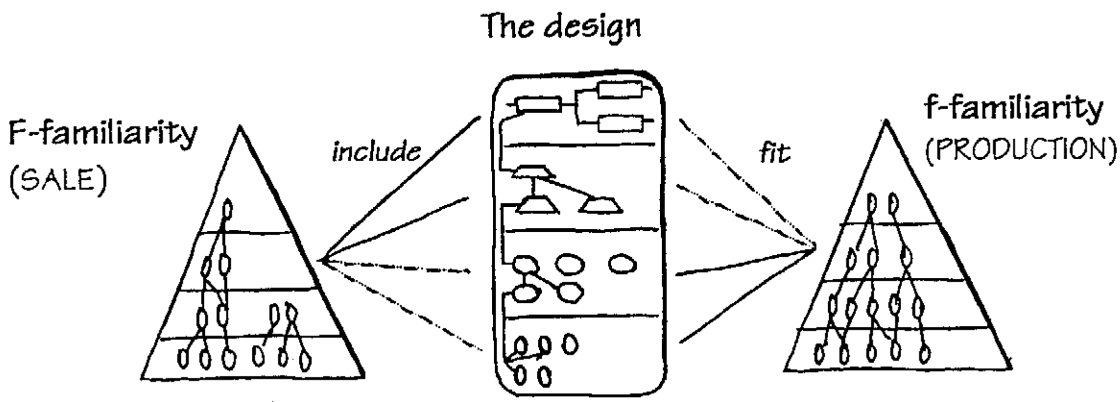


Figure 11 Superimposed structures from all life phases by principles of variance and familiarities

The pyramid pattern describing familiarities do not correspond to the views in the domain model. A family relation in one level in one of the life phases can affect any of the four systems in the domain model. Some familiarity aspects can easily be modelled in one domain system other aspects in other systems, and so on. As a simple guideline, the F-familiarity will mostly affect the process and function system, and the f-familiarity will mainly affect the organ and part system. This is also indicated in Figure 11.

The familiarity principles described in earlier sections can be used along many axes or design degrees of freedom. Table 3 includes a more precise description of the design degree of freedom that typically can be affected by familiarities.

Sizing provide a rationalisation of design and production procedures. Geometric familiarities ensures simplicity and clarity of design. Several authors have suggested methods for optimum step sizes based on market and production demands. See [8,9] for further reading.

Selection of approach is based on balancing of many conflicting arguments. Rather then offer recommendations for how to select design strategy, contrasting arguments will be discussed. It is a good reason for paying attention to design principles in design for variety. Principles are helpful to widen the solution space and do optimisation.

5.1 A multi-functional product versus a product program.

Need for continuous adjustment or a large number of adjustment possibilities gives preferences for a multi-functional product. Making advantage of the information technology make it possible to create multi-functional products at a low cost. Such mechatronic products can have many advantages compared to traditional mechanical products (like easy to use, self diagnostics, flexibility etc.). When a company has started to use functionality is often increasing [10], this phenomena is illustrated as S-curves in Figure 12. This simplicity of making variance can cause to many options and unneeded possibilities is built in to the product. Information technology in their mechanical products, their possibility and appetite for new

A multi-functional product is often an integrated product, i.e. many functions are implemented in a module. A modular design is considered to be a design in which each module execute one or a restricted number of functions.

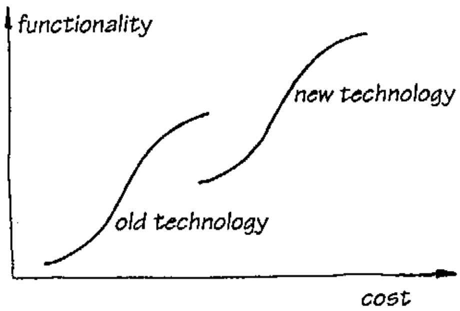


Figure 12 The effect of using new technology

Need for a few discrete variation possibilities gives preferences to make a product program. Modularization is a key to design many variants at a low cost. It is possible to make product program members that fits distinct market segments, and use situations without many unneeded features. Members of a product program can therefore often be significantly cheaper than a multi-functional product. It can also be easier to divert new variants or fit new trends.

The product program philosophy can also be effective to force the customer to continue buying products from a program by offering attractive reuse, standardised interfaces etc.

5.2 Independent products versus a product program

If it is beneficial to reduced the fixed costs, a product program with familiarities in all life phases have preferences.

Industrial design can be regarded as a kind of language. Certain shapes, colours, surface finishes suggest a particular meaning. They can be combined to create products that can convey many meanings. In fact, with mass produced products, these are clues that give a product a identity. The designer can design products that looks as they all come from the same program, or which express particular characteristics. Such identity can be very powerful to position the product in the market in competition with other products.

On the other hand, if the fixed costs are negligible compared to the variable cost like materials, independent products have preferences. Each product can then be sub optimised without any limitations caused by making familiarities. For example weight optimisation.