Experiences with Product Structuring

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June, 1995

1. Introduction

Industry has, to keep up with his competitors, a strong demand for lower costs, higher efficiency of the processes, shorter lead-times and a higher level of customer satisfaction. Besides those demands the products tends to become more and more complex thus creating a problem in realising the forementioned demands.
Stork Demtec has developed a method for the structuring of product and process related data to support the different stages of the engineering and manufacturing processes. The method gives an opportunity for realising the goals by keeping track of all relevant data.

The method called SIMPEL, Structural Information Models for Product Engineering and Logistics, is based on two different product models:

* A Functional Product Model, describing the functions the product should fulfil for the customer.

* A Modular Product Model, describing the different assembly modules of the physical product.

The models are offering a structure and a carrier for all relevant data, parameters, and documents needed along the primary process.

The method has been used at several companies as a starting point for the creation of product configurators.

The paper will give a short outline of the method used, the results gained in different projects, and the shortcomings of the current method.

2. The Method

The primary process in the mechanical industry is highly influenced by the output of the engineering process. During engineering both the functionality of the product, the costs of manufacturing and the efficiency of the manufacturing processes are determined. So there is a very strong need for a well structured and modular product concept as a basis for an organized workflow and efficient data management in all stages of the primary process.

Every stage in the process has its own needs for specific data be it product related or process related. Relevant data are for instance:

- The functions of the product (input, output, processing, control, etc.).
- Text items for proposals.
- Configuration rules.
- The functions of the process controller.
- The available product variants and options.
- Descriptions of test procedures.
- Descriptions of production processes.
- Assembly structures.
- Etc.

In order to give a better support to the primary process all those data are to be related to the same organizing principles. The principles chosen in the SIMPEL method are a functional and a modular structural product model.

1.1 Functional models

Functional models are describing both the function the product should fulfil for the customer as well as the functions which are needed in doing so. For example a car offers his owner the function of carrying people from one place to another. Functions needed to fulfil this are for instance a carrying function (wheels, carfloor, etc.), a driving function (engine, transmission, prop shaft), a protection function (the body, safety equipment), etc. Furthermore the functional model describes all the available functional product variants in terms of dimensional variants, power variants, process variants, etc. and the building blocks for all those variants and options (different engines, optional equipment, different control units, etc.).
In this way the complete functional model gives a description of the total available alternatives of the product.

Functional models are used in supporting the sales and sales engineering activities during the configuration of a customer specific product based on a pre-defined set of product variants and modules. Parameters and rules are used to specify the wanted solution.

It's not necessarily so that 100 % of the product should be predictable. If one is able to select for instance 80 % of the product the time saved by doing this can be used for the engineering of the remaining 20 %.

1.2 Modular models

Modular models are describing the way the physical product is delivered to the customer. The product is described with all the relevant assemblies, sub-assemblies, modules, and underlying bills of material needed for that customer specific solution.
The modular model forms the basis for the logistic and other processes during the manufacturing of the product carrying all the process data, routings, test spec's, assembly order, installation spec's, etc.

Functional and modular models are strongly interrelated and one should try to match them as far as possible. But this is not always possible for 100 % because some modules of a product are multifunctional and some functions are fulfilled by more than one module. This is not a problem as long as the relations between both models are clearly defined.

2. Product Configurators

Product configurators are a very strong tool in defining the customer specific solution out of the available alternatives. The configurators is mainly based on the functional product model as the main aim is to create the function the customer wants. In case the functional model is not able to cover all the data wanted for the configurator, parts of the modular model can be used.
The set-up of the configurator is done by adding the qualifying parameters to the variants in the models. From the model and the parameters, configuration rules are determined working bottom-up through the model and keeping track of all the relations between the functional blocks of the structure and the exclusions. Rules are written down as for
instance: "IF engine is 1200 cc THEN gearbox is 5V"
or: "IF colour is yellow AND type is glx THEN interior is grey"

In this way a set of rules originates. Arranged in the configurator the rules are setting the different parameters and thus defining the specific solution.

Configurators can be build in different ways using tabular systems, database systems, or rule based systems.

Tabular systems can be used for less complex products with a restricted number of variants, parameters, and rules. All the variants to be chosen are organized in a schedule which leads the user to the desired building blocks described by a partnumber or a

drawing number. The schedules can be used on paper or with the aid of word processing software.
The use of the schedules is very simple and the set-up is cheap but a disadvantage is the maintenance of the data. Alterations in the structure or the addition of new variants are rather time consuming and difficult to maintain.

Database and/or rule based systems are the domain for the more complex products with many variants, difficult configuration rules, and with many parameters. The set-up of such systems is expensive as the systems have to be custom build, but the maintenance of rules and data can be carried out very effective with the aid of rule base editors or specific data editors.

Stork Demtec has been involved in several projects were a database or rule based system has been used for the product configurator. These projects were carried out in cooperation with software developers. The main task of Stork Demtec was, in cooperation with the product specialists of the client, providing the different product models, the addition of the parameters and the extraction of the rules. The building of the software was done by the software developers.

Very good results have been gained with such projects. Typical examples are:

- Efficiency improvement sales engineering of 10 - 15 %.
- Reduction order administration: 1 - 2 weeks
- Product cost reduction: 10 %
- Lead time reduction: 25 %
- Reduction of the number of parts: 25 %

The last example is very remarkable as the reduction was only the result of a critical look at how the product variants were engineered and it may be clear that this job was not done very successfully.

A problem often confronted with, during the execution of projects on configurators, is that the product itself has to be redesigned in order to suit the task. In many cases it's not possible to draw up workable models of the existing product because of the fact that functions are not isolated in specific modules. So the boundaries of the module have to be redrawn which often leads to a re-design.

3. Problems encountered

During the different projects that were executed Stork Demtec has gained a lot of experience with the use of the SIMPEL method. From these experiences the following problems came to light:

- There isn't a one and only good model structure for a specific product. A structure is good or bad depending from the use that will be made of the model. So it's better to speak in terms of workable or not-workable.

- The process of drawing up a workable product structure is more or less try and error and ask for a lot of experience.

- Defining structures asks often for a re-design of the product or some of the modules of the product as has been dealt with in the previous chapter.

- Drawing up models, parameter assignment, extracting rules, etc., is a very time consuming activity and asks for a very thorough knowledge of the products, knowledge on the deciding parameters (will model X do the job, or should we use the bigger one?), and knowledge of the way the products are used.

* Product Development up till now is not supported. At the moment Stork Demtec is working out how the method could be used during the product development as well. With respect to this item the problem is that during product development the product model change very often due to design changes. Keeping track of these changes is necessarily

* Configurators are asking for sophisticated methods for design data management especially during product development as stated above.

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Contents:

2. The Stork Method on Product Structuring

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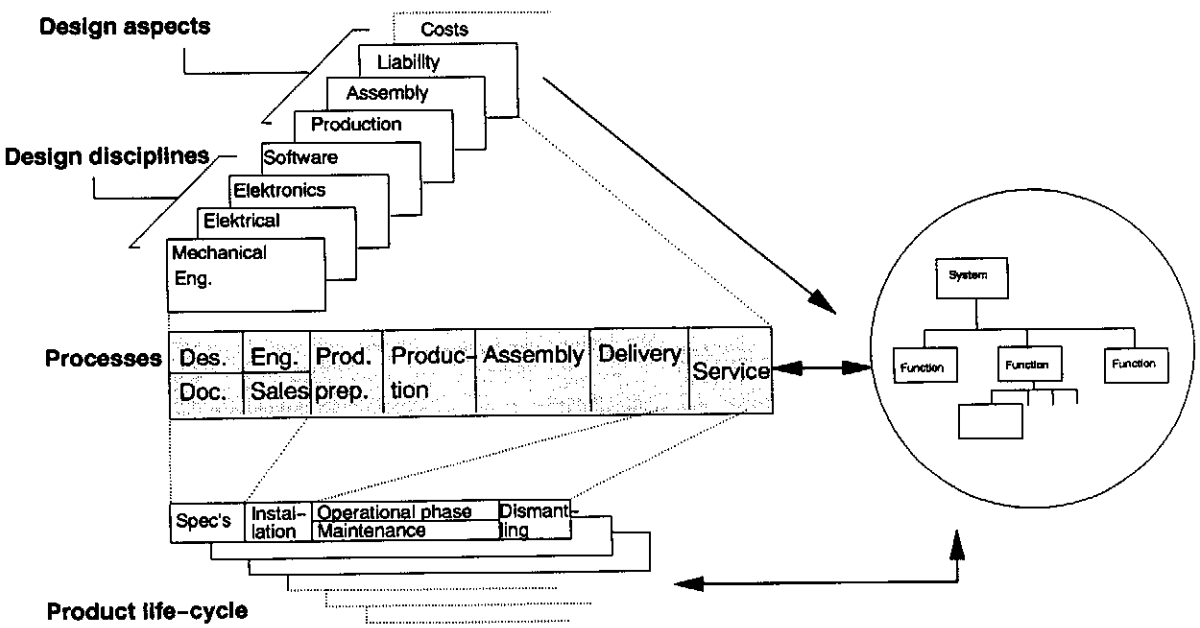

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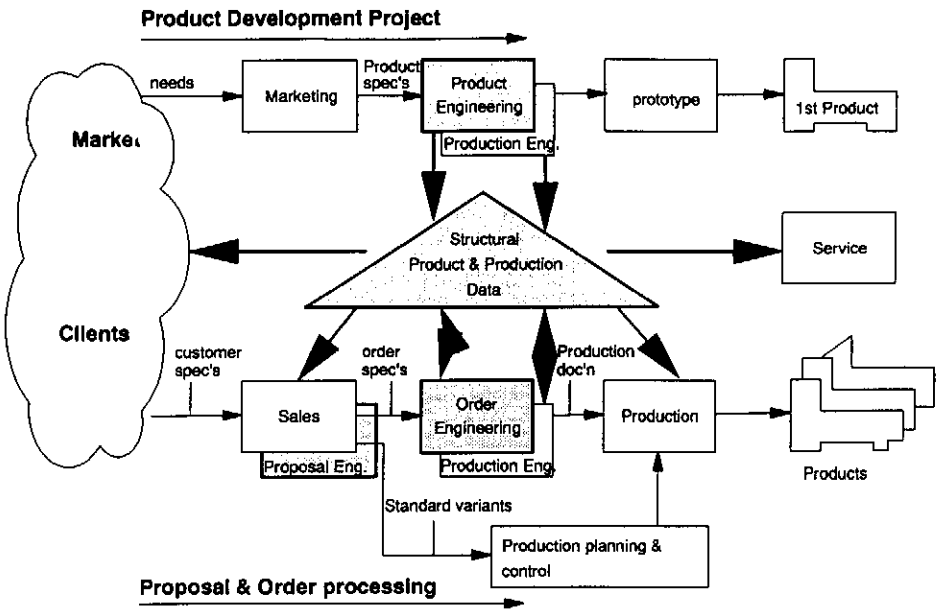

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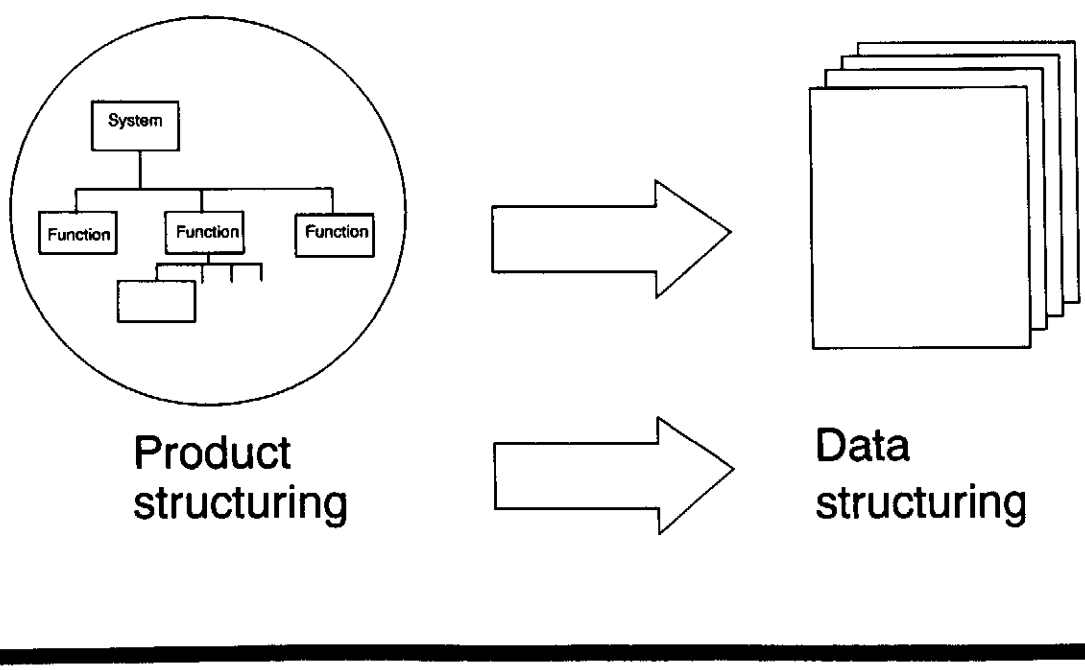

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Product Structuring

Provides the basis for data structures for:

* **The support of Sales by a Product Configurator based on Functional Structures**
* **The support of Engineering by Modular Structures and a Product Data Book**
* **The support of Logistic and Assembly processes by Modular Structures**

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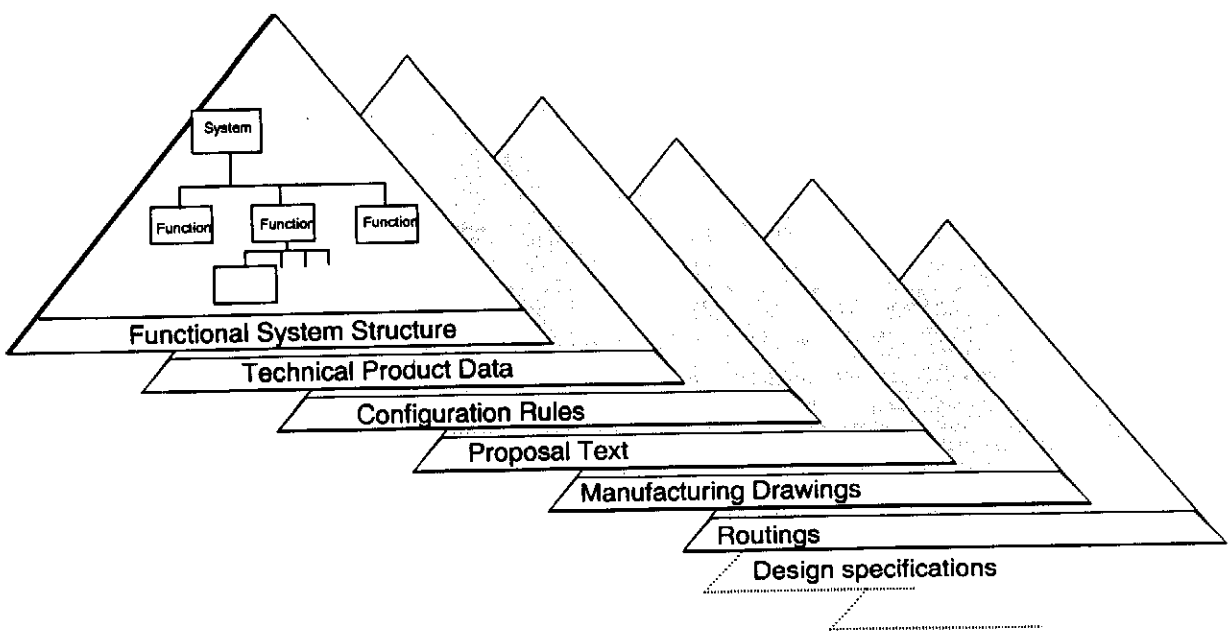

The different layers behind the functional system structure

Functional versus Modular Structures

* The Functional Structure gives a description of the functions a product should fulfil for the customer.
* The Modular Structure gives a description of the physical assembly of the product by modules, assembly units, parts, etc.
* Both structures are not necessarily 1:1
* The choice is depending from the application.

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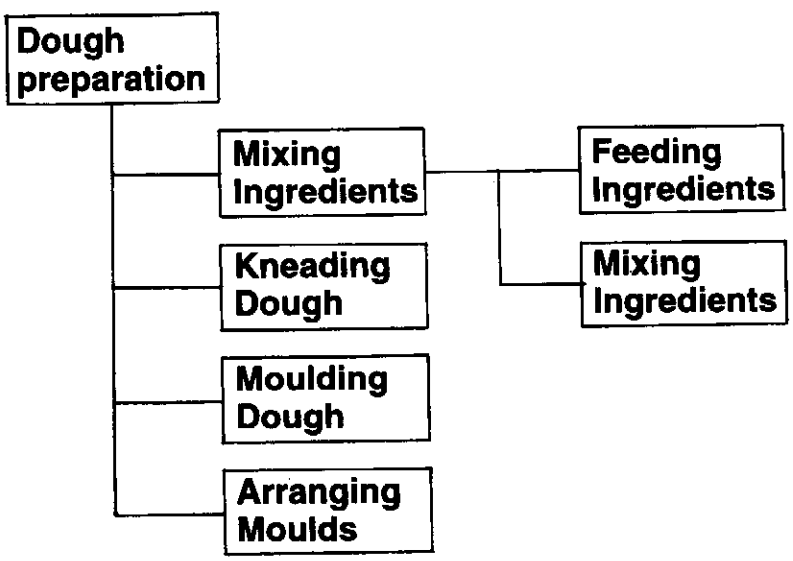
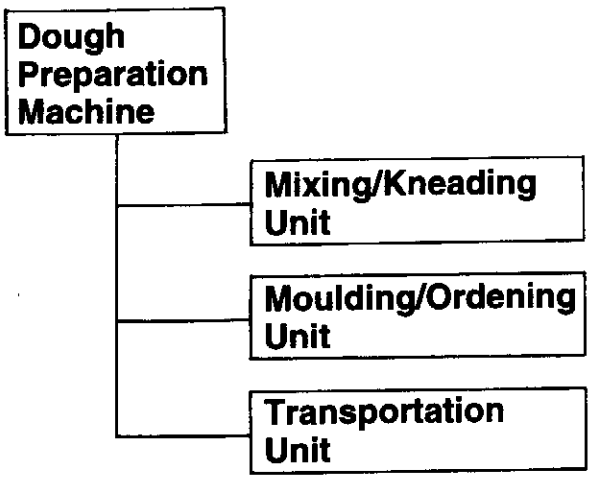
Example of a Functional Structure



Example of a Modular Structure



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3. Product Configurators

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Data recording

* **Structures are the basic organizing principal**
  - **Configuration Data are organized according to the Functional Structures.**
  - **Engineering Data are organized according to the Modular Structures.**

* **All Data, Rules, Spec's, etc. are recorded in a Product Data Book.**

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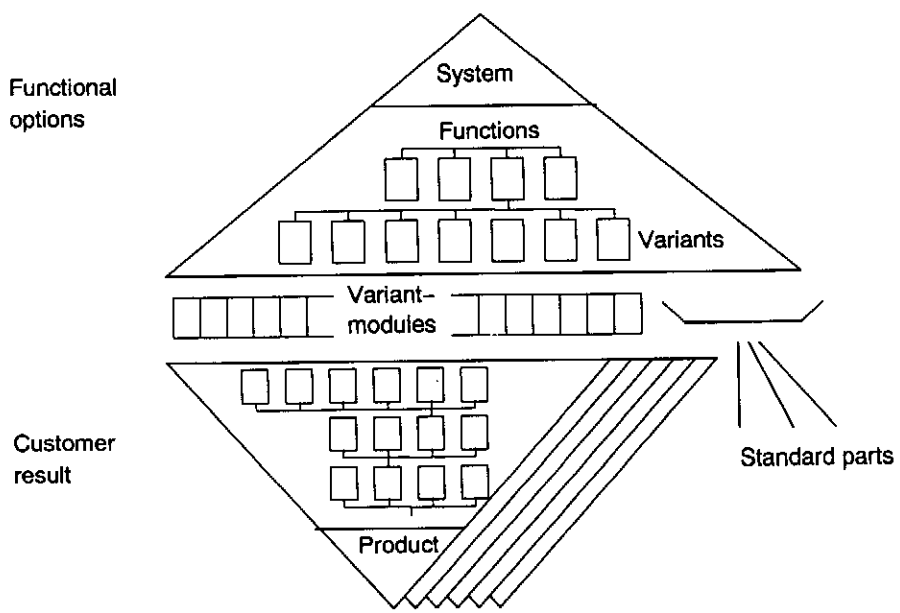
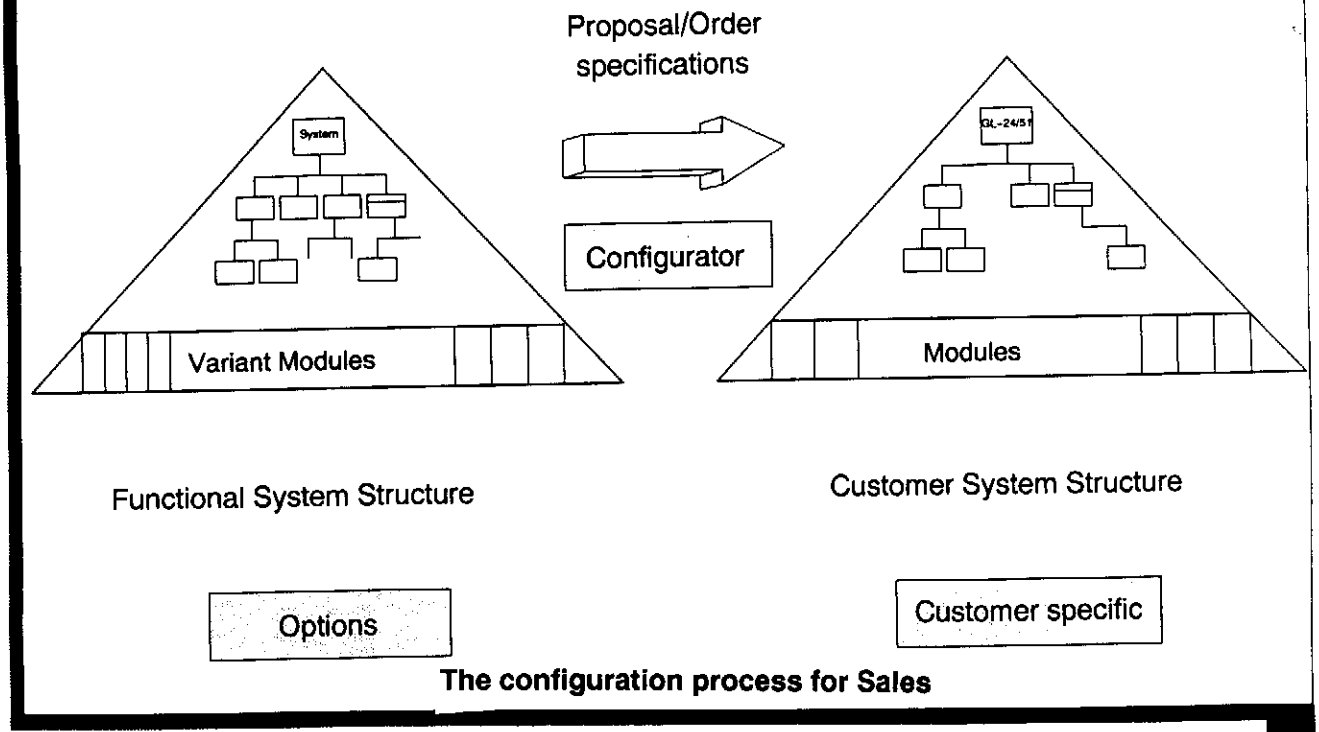


System alternatives and customer specific solutions



The configuration process for Sales

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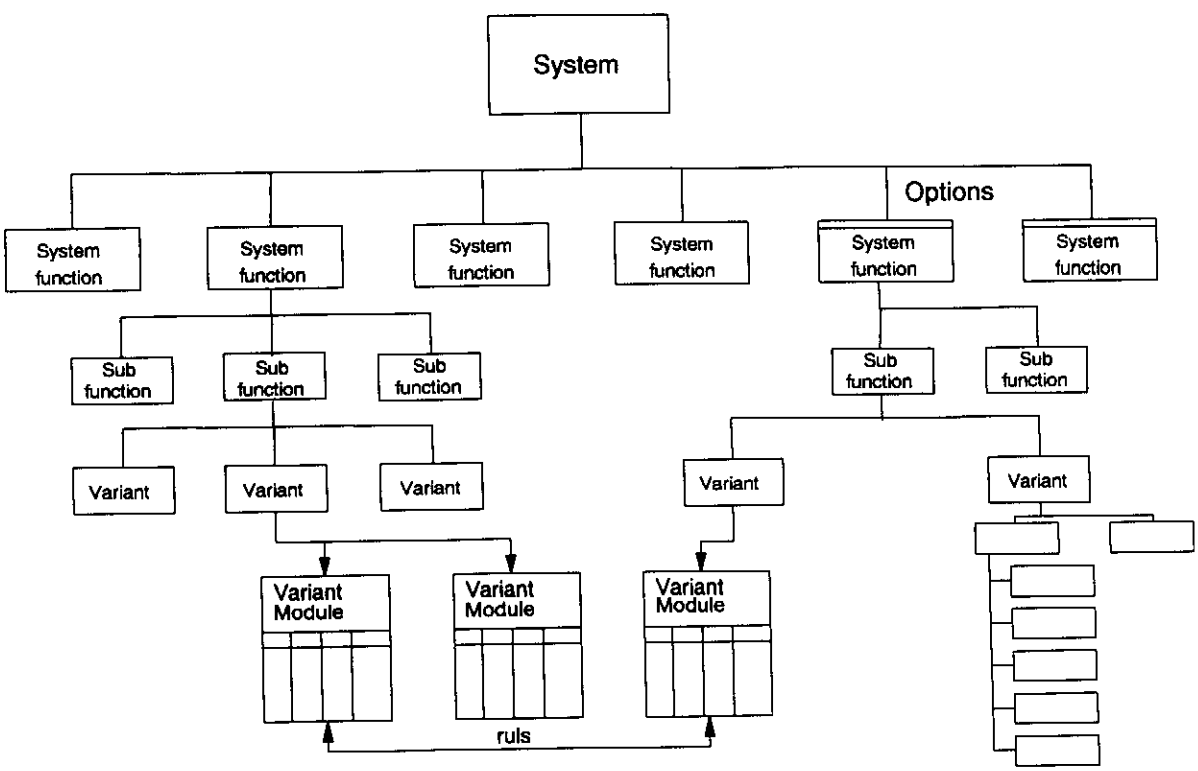

The Functional System Structure

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Configuration Rules, the basis for the Product configurator

* Captured Design Data
* Captured Design Knowledge
* Captured Product Knowledge
* Captured Customer Demands
* Captured History

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Realised Product Configurators by Stork Demtec

- Tabular Configurators (on paper)
  * Linden Machines
    Industrial grinding and sanding machines
  * Stork Bepak
    Filling and packing equipment
  * Nooteboom
    Trailers and semi-trailers
    (Computer Application in preparation)
- Database Oriented Configurators
  * Fri-Jado
    Cooling furniture for shops and restaurants
  * Stork Pompen
    Large customer specific pumps

Continued

* Stork Brabant
  Textile printing equipment

■ Knowledge based Configurators

* Grasso Products
  Refrigerator Compressor Packages

Applications

* Complex Products or Systems with many pre-defined variants.
  - Many parts
  - Many parameters (Stork Pompen 80 for one part!)
  - Complex rules with many cross-influences

* Products are Custom Specific configurated.

Some results (not all in one company!)

* Efficiency improvement Sales Engineering: 10 - 15 %
* Reduction order administration: 1 - 2 weeks
* Product cost reduction: 10 %
* Lead time reduction: 25 %
* Reduction of number of parts: 25 %

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4. Problems encountered

Problems

* There isn't a one and only good structure. The process of drawing up a workable product structure is more or less try and error.
* Defining structures asks often for a re-design of the product.
* Drawing up structures, parameter assignment, extracting rules, etc., is a very time consuming activity.
* Product Development is up till now not supported.
* Configurators are asking for a refined method for Data Management.

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Wishes

* Support during:
  - Defining structures,
  - Parameter assignment,
  - Rule extraction.
* Support during the Product Development stage.
  - Decision support,
  - Design History,
  - Design considerations,
  - Dynamical update of different product structures.