4th WDK Workshop on Product Structuring
October 22-23, 1998
Delft University of Technology
The Netherlands

THE CHART OF MODULAR FUNCTION DEPLOYMENT

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DFX, modularity, modules, design methodology, design theory, flexibility, design for variety

Abstract

The deployment and use of a design method is dependent on the availability of the method. Easy available tools, largely increases its usefulness. Simplicity and clearness together with an easy understanding of the inputs required and the resulting outputs for the different steps of the method itself is also vital. The Modular Function Deployment (MFD) method and procedure has been implemented in a graphical chart in order to increase the clearness of the method. This chart comprises the main phases of the MFD-method and allows the user to manage the entirety of the modularization work. The chart and the method make it easy to detect and correct omissions made in the modularization process. The transparency of the chart visualises the connections inside the MFD-method, from customer demands via *module drivers* to the designed modules, helping the user to test different solutions to a design task. Thus, the context of the complete work will be clear from the chart. This chart will support platform management, as well. Platform here means: "the total set of modules from which all required product variants can be derived".

1 Introduction

Earlier research has shown that product modularity based on the concept of *module drivers* gives high product flexibility and allows effective re-engineering of product and factory [1]. The concept of *module drivers* has also formed the basis for the Modular Function Deployment (MFD) method [2] (see figure 1).
The method has been used in several modularization projects in real industrial cases of which some have been reported in [1]. Experiences from these cases have been generally positive, but some deficiencies have also become clear. The deficiencies have mainly concerned the possibilities to learn and understand the complete MFD-process, in itself. Thus, the difficulty to transform from an "ad hoc" to a systematic and disciplined design process, to link the steps in the process together and to determine the status of the project.

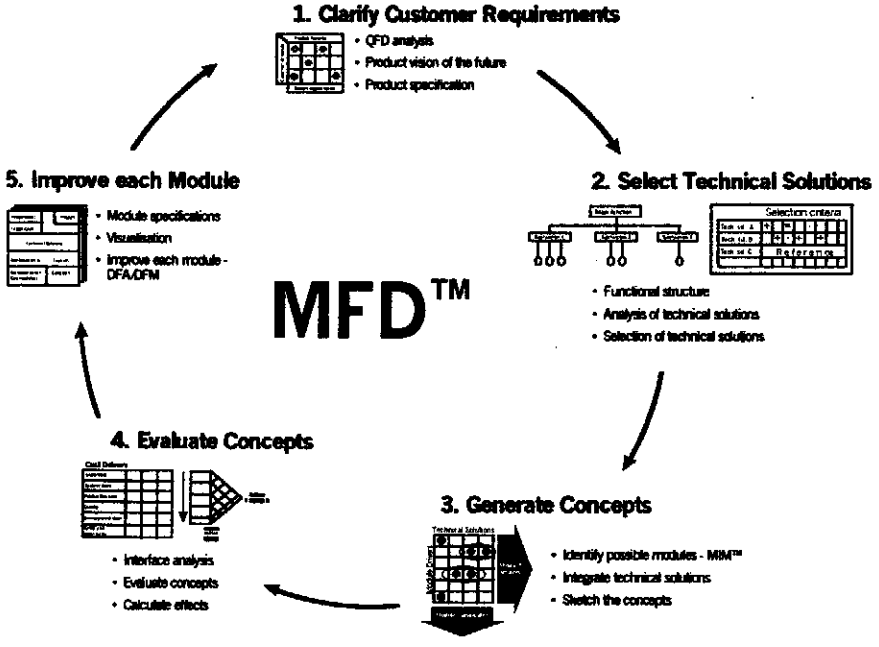

Figure 1. The MFD-method

To resolve some shortcomings the MFD-method has been, partly, implemented in a graphical tool, *the chart of modular function deployment* (*The Chart*). The long term goal is to comprise the complete method, into *The Chart,* thus, present a holistic view of the foregoing process to the users, in order to ease the management of the process. The detection of errors made during the process will be facilitated, as well.

It has to be pointed out that, at this stage of the research so far, only some phases of the MFD-method are incorporated in *The Chart*. A complete description of the MFD-metod can be found in [4].

The primary objective of *The Chart* is to view the information flow and refinement from customer demands via *module drivers* to the designed modules. At this stage of the research the QFD [3] matrix and the Module-Indication-Matrix (MIM) [2] are linked together with a new developed "connection matrix".

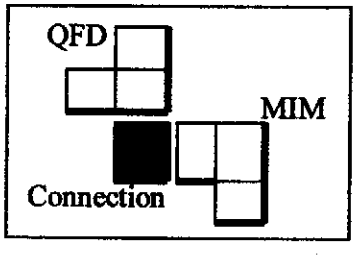

Figure 2. The connection matrix in The chart.

This connection matrix makes it possible to establish an unbroken information chain from customer demands in the QFD, to Design Requirements, onto technical solutions and finally the proposed modules in the MIM.
Before the technical solutions can be incorporated in *The Chart* a technical view of the product concept must be created. That is, all functions needed have to be mapped against selected technical solutions. This part of the MFD-method is not yet incorporated in the chart.
In the development of a product family, varying demands, wishes and weights from different market segments has to be accounted for. That is, different design values or a range of design values has to be taken into account. The varying design values, mapped onto the carrying Technical Solution respectively, may then serve as the foundation for the, later arriving, *module driver* judgement, e.g. Variance vs. Common Unit. In addition, a design value not possible to reach at the first product launch indicates a possible development module (Technology Push or Product Planning).

2 Illustration

The Chart has yet been applied in a few test cases of which one is described here for the illustration of how the tool operates. A team of engineers at a small company had the task to design a modularised product platform for cellular telephones using the MFD-method. The telephones were supposed to be used in rescue and fire-fighting missions.

The first step in MFD is to clarify customers demands and or wishes on the products with the help of a simplified QFD (see figure 2). QFD is used in simplified form because, here, there should be no seeking for the one and only product filled with numerous features to fulfil every single wish. Thus, here the objective is to create a flexible, modular, product platform from which a variety of products can be derived. This also means that minor deficiencies in the firstly launched product variant, step-by-step, can be erected. QFD transforms the "Customers Voice" (interpretation of wishes and/or demands from different segments of the market) into the "Engineers Voice" (Design Requirements). The Engineers voice should be expressed in measurable Design Requirements in order to facilitate the control that a proposed design fulfils the design requirements. As mentioned before, the design of product families often requires ranges of design values.

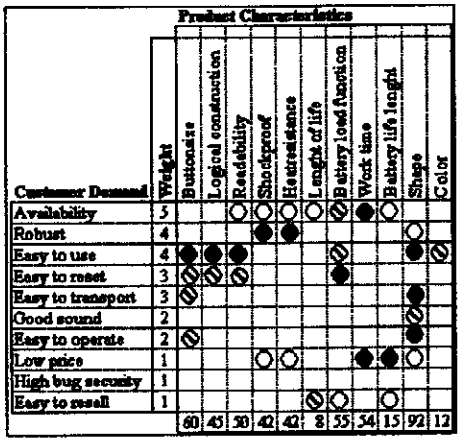

Figure 3. QFD for cellular telephones

Before entering Technical Solutions to The Chart, a functional decomposition of the product was performed (second step in MFD)

Next step (step 3) of the MFD involves an assessment of every function carrier (technical solution) one by one against the *module drivers*, for each column vertically down through the so called MIM matrix. The *module candidates* (Technical Solutions viewing numerous reasons to become modules) can be picked out and the grouping or integration of other function carriers to the module candidates can be executed; the software implementation supports this activity. The result will be a concept for a modular product design, where each module can be concurrently worked on.

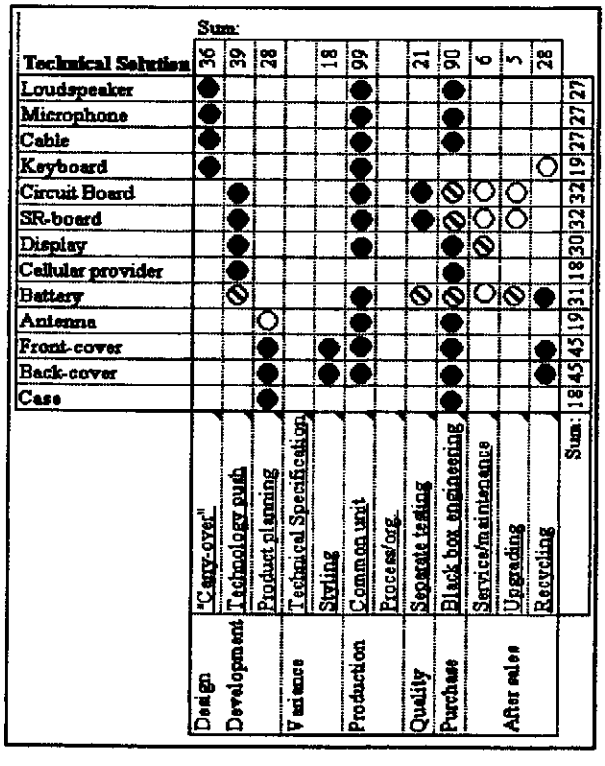

Figure 4. MIM of cellular telephones

3 The Chart

QFD and MIM linked together with the connection matrix shows the chart of MFD for the cellular telephone. An examination of *The Chart* indicates, e.g. the following:

A relation: the connection matrix makes it feasible to test different solution to a given task. As can be seen in figure 5, it is also possible to perform *what/if* simulations, e.g. how is customer demand influenced if the technical solution "Display" is changed. The answer is that the customers demand "Easy to use" is likely to be affected. The other direction (customer demand – technical solution) is also very interesting. If there will be changes in customer demand, which technical solution will it affect and how?

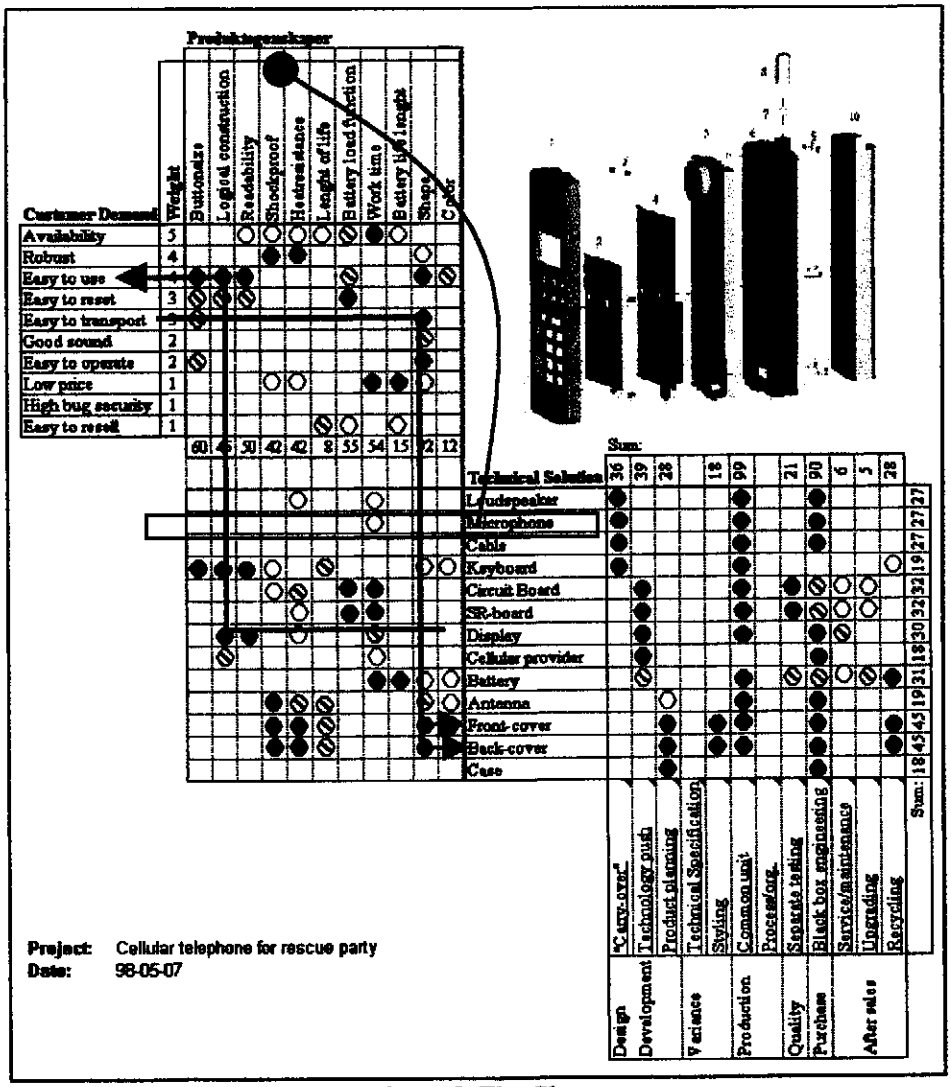

Figure 5. The Chart

Miss match: mistakes, as having technical solution without any corresponding product characteristic is also evident from studying *The Chart*. For example, the technical solution "microphone" actually does not have any corresponding Design Requirement value! In this case, customers have shown little appreciation for the microphone itself; "as long as it is there". Either the design team has missed one design value, or otherwise, the microphone means little to the final design and might be integrated into a Common Unit Module.

Elements: labels in the connection matrix can be used to represent corporate strategy, as well. Questions like, "Does this relation represent what we want our product to stand for", "Does the representation explain the strategy of the company , or does it only show the present correlation between technical solution and Design Requirements?" can be answered.

4 Computer implementation

In order to further assist the work a software application using Visual Basic has been developed. The interface consists of seven "UserForms" of which the customer demand form is shown in figure 6. Navigation between the different forms is performed by clicking the proper icon in the navigation box.

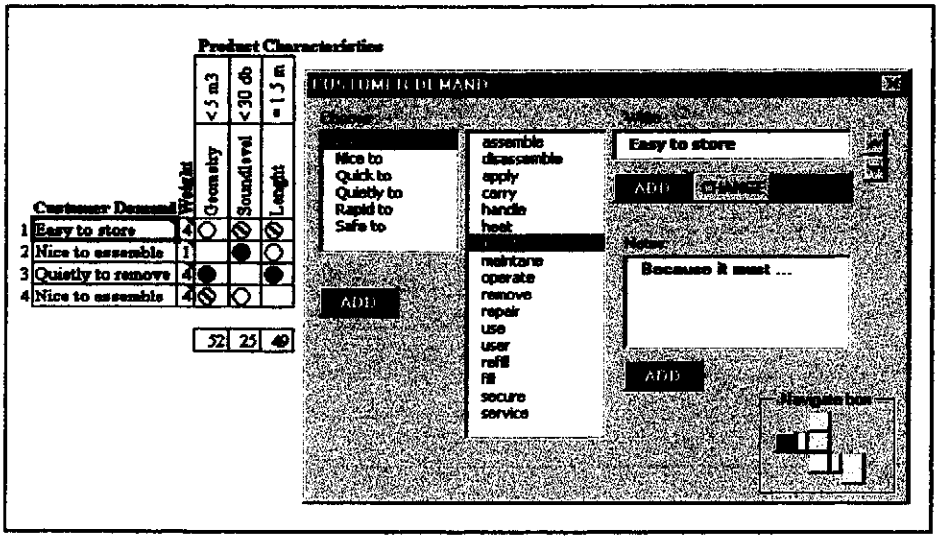

Figure 6. Software user interface. Example "Customer Demand"

5 Concluding remarks

The plans are to extend *The Chart* also with the missing steps in MFD (functional decomposition and selection of technical solutions). In addition, all matrices will be equipped with an intelligent computerised analysing method, helping the user to evaluate them. For example, this help is assumed to detect errors, like a missing connection between Design Requirements and technical solutions, or to find excessive connections, indicating, i.e. that present characteristic(s) probably ought to be split in sub characteristics.

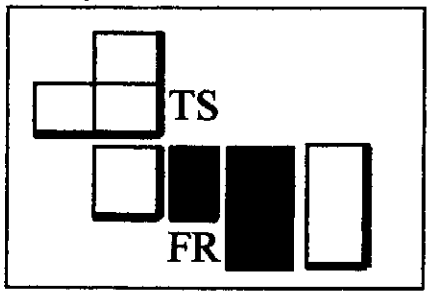

Figure 7. The Chart with the missing part "functional requirements"

We also believe that the software tool has to be equipped with guidelines and case examples to support the work. Additionally, a standardised information structure must be implemented, taking advantage of neutral information transfer protocols, such as STEP. The chart will also be part of

the PreCAD Toolbox™ , which supports the documentation, storage, analysis and visualisation of product related information derived during the early phases (conceptual design) of the product development process.

5 References

[1] Erixon, G. "Modular Function Deployment (MFD) – Industrial Experiences", The 3rd WDK Workshop on Product Structuring, Delft, June 26-27, 1997.

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[4] Erixon, G. "Modular Function Deployment (MFD) – A Methode for Product Modularisation, Doctorial Thesis, KTH, Stockholm, 1998.

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