

## Chapter 8

# **PRODUCT MODULARITY IN MASS CUSTOMIZATION**

Up to now we have only dealt with product modularity as the ability to configure product variants by mixing and matching components within a modular product architecture. Product modularity enables the manufacturing of a large number of product configurations by simultaneously taking the advantage of the economies of scale and scope. In fact, the concept of modularity has played a decisive role in the development of the mass customization paradigm. It enables not only the ability to put the “mass” in mass customization, but also to configure the products according to the customer’s requirements. Whereas the advances realized in the field of information technology can be considered as an important enabler of mass customization, product modularity is considered to be a necessary requirement. Furthermore, modularity is not restricted to the product level by combining modules in order to create many variations. “Modularity refers to an ability to “decompose” technological and organizational systems such that the internal functioning of one subsystem does not significantly affect the functioning of the others in the short term” (Garud/Kumaraswamy 2003, p. 68). Thus, product modularity involves additional implications on the organization itself and on the way to conduct business. Due to all of the depicted reasons, it is important to deal in more detail with this concept and to discuss some relevant related aspects.

In this chapter, we will discuss the benefits as well as drawbacks of product modularity. Then we will deal with the relevant managerial implications of product modularity in mass customization. Finally, we will present some selected methods from the technical literature for a systematic development of modular product architectures. These methods deal with the

main question of how to implement modularity into the design of product families with several product variations.

## 1. PRODUCT MODULARITY

In the previous chapters of this book we have used a definition of product modules as building blocks that enable the configuration of a large number of product variations. This definition was sufficient and adequate for the development of the already presented ideas, especially those relating to the multi-agent system concept for variety formation and steering in mass customization. However, it is generally argued that there is no standard definition for the terms module, modular architecture, modularity and modularization (e.g. Ericsson/Erixon 1999, p. 19; Nilles 2001, p. 123).

In the following, we will provide definitions identified in the technical literature that are consistent with our understanding of the corresponding terms. But before that, it is relevant to define the term product architecture. It is "... the scheme by which the function of a product is allocated to physical components" (Ulrich 1995, p. 420). The main purpose of a product architecture is to define the product building blocks by specifying what they do and how they interface with each other. The choice of a product architecture plays an important role and to a great extent affects the performance of the manufacturing firm.

Nilles (2001, p. 127) points out that a product module is characterized by the following properties:

- A product module is a subsystem with lower complexity than the overall system of which the module is a part.
- A module is a closed functional unit.
- A module is a spatially closed unit.
- A module has well-defined and obvious interfaces.

Ulrich (1995, p. 422) mentions that a "...modular architecture includes a one-to-one mapping from functional elements in the function structure to the physical components of the product, and specifies the decoupled interfaces between components."

Ericsson/Erixon (1999, p. 19) define product modularity as "...having two characteristics: 1) similarity between the physical and functional architecture of the design, and 2) minimization of the degree of interaction between physical components." Baldwin/Clark (2003a, p. 149) include the process perspective in their definition of modularity. Modularity refers to "... building a complex product or process from smaller subsystems that can