In order to generate product variants not only by customized assembly of standard parts but by individual manufacturing processes, an innovative production control is necessary. In this chapter, the methodology of the Segmented Adaptive Production Control is presented to perform this task. The approach combines the two basic control principles push and pull. Using the mass-production character of the pull principle and merging it with the customer-oriented push principle, the basic approach of mass customization is applied to production control. The sophisticated system allows controlling the manufacturing of both, parts manufactured in mass production as well as customized parts, at the same work stations.

21.1 Customer orientation – a rising challenge without control?

In recent years, customer orientation became more and more important for the manufacturing industry. Especially, enterprises with mass production are obliged to put strong emphasis on customizing their products by variable production concepts. Obviously, the fundamental aim of efficient production of high volumes has still to be considered. Otherwise, efficient cost reduction could hardly be combined with the manufacturing of high-quality products. Nevertheless, the crucial challenge for modern companies is to satisfy individual customer orders and varying customer needs. This trend might have been satisfied by designing modular product concepts in the last years. In the future, it will be an additional challenge in matching customer demands by individualizing strongly the production processes. Pursuing the two objectives – customer orientation and efficient mass production – two main approaches have to be considered: First, flexibility can be increased by reengineering and designing flexible work stations and machines, jigs and fixtures. Second, mass customization principles can be supported by pure organizational changes within the manufacturing process: modifying the logistics by inventing innovative principles of production control.

Implementing principles of mass customization into production control, classic systems of production control reach their limits. Offering customized manufactured products in short delivery times leads to an increasing number of variant-
specific buffers and to raising inventory costs on the one hand. On the other hand, the higher product variance decreases the single order volume and, by this, the manufacturing lot sizes. The time slice of set-up processes increases. This chapter proposes an innovative way of agile and adaptive production control, to avoid raising costs and allow a high logistic performance in terms of low inventory levels, short delivery times and high delivery reliability. The system presented is developed at the Institute of Production Systems and Logistics, Hanover, Germany. Our research was funded by the Deutsche Forschungsgemeinschaft (DFG), the central public funding organization for academic research in Germany.

21.2 Production control for mass customization

21.2.1 Fundamental organizational structures

Basically, mass customization requires high flexibility of the production and the production organization. Companies can ensure market success only with flexible reactions to customer demands, to fluctuation of quantities and to new competitive products. Analyzing production organization and designing suitable production control systems under these pre-conditions, two main organizational options must be distinguished (see Figure 1). Each alternative determines directly the basic draft of the production control system.

On the one hand, one can divide the production into segments for standardized high-volume production and segments for customer-individual low-volume production (segmentation). On the other hand, the process chain can be split into anonymous pre-production and customer-specific end-production (separation). Additionally, a mixed form of these possibilities can be identified: Dividing only the pre-production into a customer-specific segment and an anonymous segment. To investigate whether the organizational structure is able to support mass customization, the two main options are briefly be analyzed.

(1) The principle of segmentation: The main idea of segmentation is to define parallel working production areas. A criterion for this segmentation is for example the order volume. The objective of mass customization can be supported by practicing mass production and customer-specific production in parallel – one segment for mass production and a second segment for customer-specific production. For this, it is necessary to duplicate every process step and to provide all machines in both segments. As well, the product range has to be designed for its allocation to different segments – a high-volume standard program and a low-volume product program for customization. With this realization of mass customization the satisfaction of customer demand on individualized products is limited without additional investment in flexible manufacturing technology. Trying to avoid both, the necessity of double investments and the limitation of customer-specific quantities, there is a need to enable mass customization via production control.