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# The Customer Centric Enterprise

Advances  
in Mass Customization  
and Personalization



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# **Part I: Heading Towards Customer Centric Enterprises**

## **An introduction**

Enterprises in all branches of industry are becoming more customer centric. The increasing interest and effort of business practices heading towards mass customization and personalization is met by an intensified and ongoing study of these approaches in research and academia. Though the oxymoron 'mass customization' was coined in the mid 1980's, research has started to pick up pace only in recent years. The number of papers published on mass customization and personalization has increased threefold in the last decade. With this in mind, the intention of this book is not only to discuss the state of the art of methods and approaches of more customer centric manufacturing, but also to show the obstacles and challenges of mass customization, and to analyze its potentials and capabilities. To open the discussion, the first part of this book gives a brief introduction into mass customization and personalization as key strategies of customer centric enterprises. *Tseng and Piller* comment on their understanding of both terms and illustrate the levels of a mass customization system from a generic perspective. Chapter 1 also presents a framework of the flow of activities in an extended mass customization system and integrates mass customization in the larger framework of supply chain management.

# 1 The Customer Centric Enterprise

## An integrative overview on this book

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*The most creative thing a person will do 20 years from now is to be a very creative consumer... Namely, you'll be sitting there doing things like designing a suit of clothes for yourself or making modifications to a standard design, so the computers can cut one for you by laser and sew it together for you by NC machine...*

Robert H. Anderson, Head Information Systems, RAND Corporation,  
quoted in Alvin Toffler "*Third Wave*" [1], p. 274

## 1.1 Open questions and increasing implementation

More than two decades later, in 2003, this prophecy is still a vision not only in the clothing business but also in most other industries. What causes the renowned futurist miss the mark? Though we have most, if not all, the necessary hardware, software, powerful computing and communication systems, including laser cutting, high performance sewing etc, we are still not really able to meet the special yearning of human beings, that very important feature that sets us apart from animals, i.e. *creativity*. We believe the missing gap is the capacity to put the systems, including organization, process and business models together and make them customer centric. Building a customer centric enterprise that places the demands and wishes of each single customer in the center of value creation implies much more than investing in advanced technologies. Firms have to build not organizations and structures to produce customized services, but organizations and structures for customers. With the customers at the center, human beings can then focus on being creative and be isolated from mundane tasks in order to concentrate on expressing themselves more freely.

Although few enterprises can be truly considered as customer centric today, successful companies have entered their particular market with initiatives and products that break with the paradigm of mass production. In order to be responsive to customers, companies have shortened the product development time dramatically. Taking the automotive industry as an example, the time to market

has been reduced from six years to three months. One of the side effects of time competition in new product development is product proliferation. We witness thousands of new products vying for customers' attention in supermarkets. Even for commodity items such as milk, we have different flavors, fat contents, and types of feeds (organic or ordinary) as factors for differentiation. The main driving force behind the wide spread product proliferation is the expectation of many product managers that somehow one variety will fit with the buying decision of a high enough number of customers. However, variety does not come cheap. The cost of the explosive increase of product variety is tremendous, just consider inventory costs, customer returns (because of buying the wrong items), sales force training, post sale services, and confusion (complexity costs) inside and outside a company.

For these reasons economic forces have led companies to build to order instead of building to stock. This development is made possible by the availability of flexible manufacturing and information technology. The rapid advent of computer and communication technology has enhanced the flexibility not only of shop floor machinery but also on the information system level such as MRP (Manufacturing Resource Planning), ERP (Enterprise Resource Planning) and CRM (Customer Relationship Management). Furthermore, with a more educated workforce, there is an inherent flexibility within companies that has not been fully deployed by the firms. In fact, it has been widely reported that a lot of this new flexibility has been under-utilized in terms of enterprise business. Leading managers have identified the opportunity of applying these under-utilized resources (of flexibility) as an option to better serve customers as individuals instead of just providing variety to the mass. Instead of designing and producing goods to stock for an anonymous market, their companies provide goods and services that are customized and assembled on-demand for each individual customer. Sanjay Choudpouri, former director of mass customization at Levi Strauss, is one example. He foresees that customization in his industry "will become a competitive necessity rather than a nice to have fringe offering" [2].

Thus, Anderson's prediction quoted at the beginning of this chapter may not be accomplished entirely. Putting customers at the center of the enterprise and building its processes and systems towards serving customers as an individual best *and* efficiently has emerged as a profitable business proposition. The basic idea of being customer centric can be considered as achieving the ultimate goal of quality management: meeting individual customers' requirements exactly without a significant increase in production and distribution cost. There are already significant steps towards a new, more customer centric economy. For example, a listed Chinese company reported that by using mass customization technology, it produced more than 500 customized uniforms a day for lawyers, service workers, and policemen. Most people would think that a uniform would have to be uniformly produced. However, due to differences in body measurements, styles in different cities and replacement cycles, production orders require significant amounts of customization. Today's industrial move towards mass customization is an answer to the growing demands in competition. Enterprises in all branches of

industry are being forced to react to the growing individualization of demand and to find ways to manage the increasing product variety. Yet, at the same time, increasing competitive pressure dictates that costs must also continue to decrease. Companies have to adopt strategies that embrace both cost efficiency and a closer reaction to customers' needs. Mass customization and the corresponding approach of personalization have the potential to address competitive market requirements while improving a firm's profitability.

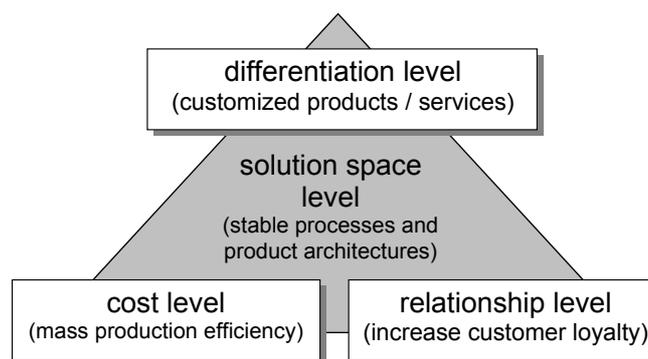
The increasing interest and effort of business practices towards mass customization is met by an intensified and ongoing study of mass customization in research and academia. Though the oxymoron 'mass customization' was coined in the mid 1980's, research has started to pick up pace only in recent years. The number of papers published on mass customization has increased threefold in the last decade. With this in mind, the intention of this book is firstly to discuss the state of the art of methods and approaches of more customer centric manufacturing, and secondly to show the obstacles and challenges of mass customization and personalization, and to analyze their potentials and capabilities.

## 1.2 What is mass customization?

There is a wide variety of understandings and meanings of mass customization and personalization: „Extant literature has not established good conceptual boundaries for mass customization“, state Duray et al. [3, p. 606] after a literature review. The same is true for managers and practitioners who use the term mass customization for many forms of being more customer centric. Davis, who coined the phrase in 1987, refers to mass customization when “the same large number of customers can be reached as in mass markets of the industrial economy, and simultaneously they can be treated individually as in the customized markets of pre-industrial economies“ [4, p. 169]. In order to address the implementation issues of mass customization, a working definition of mass customization was adopted as “the technologies and systems to deliver goods and services that meet *individual* customers' needs with *near* mass production efficiency” [5]. This definition implies that the goal is to detect customers needs first and then to fulfill these needs with efficiency that almost equals that of mass production. Often this definition is supplemented by the requirement that the individualized goods do not carry the price premiums connected traditionally with (craft) customization [4, 6, 7, 8, 9]. However, mass customization practice shows that consumers are frequently willing to pay a price premium for customization to reflect the added value of customer satisfaction due to individualized solutions, i.e. the increment of utility customers gain from a product that better fits to their needs than the best standard product attainable [10, 11, 12]. We consider the value of a solution for the individual customer as the defining element of mass customization. A customer centric enterprise recognizes that customers have alternatives of choice which are reflected through their purchase decisions [13]: Customers can either choose mass customized goods which provide better fit, compromise and buy a

standard product of lesser fit (and price), or purchase a truly customized product with excess features but also at a higher price. Thus, value reflects the price customers are willing to pay for the increase in satisfaction resulting from the better fit of a (customized) solution for their requirements. Mass customization is only applicable to those products for which the value of customization, to the extent that customers are willing to pay for it, exceeds the cost of customizing.

The competitive advantage of mass customization is based on combining the efficiency of mass production with the differentiation possibilities of customization. Mass customization is performed on four levels (see Figure 1). While the *differentiation level* of mass customization is based on the additional utility customers gain from a product or service that corresponds better to their needs, the *cost level* demands that this can be done at total costs that will not lead to such a price increase that the customization process implies a switch of market segments [14]. The information collected in the course of individualization serves to build up a lasting individual relationship with each customer and, thus, to increase customer loyalty (*relationship level*). While the first three levels have a customer centric perspective, a fourth level takes an internal view and relates to the fulfillment system of a mass customizing company: Mass customization operations are performed in a fixed *solution space* that represents “the pre-existing capability and degrees of freedom built into a given manufacturer’s production system” [15]. Correspondingly, a successful mass customization system is characterized by *stable* but still flexible and responsive processes that provide a dynamic flow of products [16]. While a traditional (craft) customizer re-invents not only its products but also its processes for each individual customer, a mass customizer uses stable processes to deliver high variety goods. A main enabler of *stable processes* is to modularize goods and services [17, 18]. This provides the capability to efficiently deliver individual modules of customer value within the structure of the modular architecture. Setting the solution space becomes one of the foremost competitive challenges of a mass customization company, as this space determines what universe of benefits an offer is intended to provide to customers, and then within that universe what specific permutations of functionality can be provided [16].



**Figure 1:** The four levels of mass customization

### 1.3 Personalization versus customization

Personalization must not be mixed up with customization. While customization relates to changing, assembling or modifying *product* or *service* components according to customers' needs and desires, personalization involves intense *communication* and *interaction* between two parties, namely customer and supplier. Personalization in general is about selecting or filtering information objects for an individual by using information about the individual (the customer profile) and then negotiating the selection with the individual. Thus, personalization compares strongly to recommendation: From a large set of possibilities, customer specific recommendations are selected [13, 19, 20]. From a technical point of view, automatic personalization or recommendation means matching meta-information of products or information objects against meta-information of customers (stored in the customer profile). Personalization is increasingly considered to be an important ingredient of Web applications. In most cases personalization techniques are used for tailoring information services to personal user needs. In marketing, personalization supports one-to-one marketing [21] which should increase the customer share over a lifetime.

A good example of both customization and personalization is provided by *Land's End*, a catalog retailer. The company has been using a virtual model and recommendation service on its web site since 1999. The system recommends a customized bundle of standard mass products matching each other and the customers' style profile. This service provides customers with a set of coherent outfits rather than with isolated articles of clothing. But each product is still a standard product. In 2001, Land's End also introduced mass customization. Customers can order made-to-measure trousers and shirts. All products are made to order in a specially assigned factory. The company offers a substantial number of design options and varieties. However, this customization process is not supported by personalization. A consumer has to know by herself which style, waistline and length suits her best. The configuration toolkit used by Land's End does not provide any information or consultancy. For this company, personalization as performed for (almost ironically) standard products would only provide real additional benefit for the mass customization operations. Combining personalization with customization would empower a customer without the knowledge of a tailor to customize a product more easily.

Thus, while mass customization and personalization may have different methodological backgrounds and use different instruments, personalization can support mass customization. By presenting, for example, a personalized pre-configuration, the co-design or design by the customer [11] process could be shortened, streamlined and focused on providing real customer value. Instead of starting to combine the core product from scratch with hundreds or millions of options, the customer could concentrate on designing a solution that fits her known needs. Thus, during the configuration process the complexity and burden of choice could be reduced heavily by only presenting options identified as relevant from a customer's profile [22].

## 1.4 Placing customers at the centre of the enterprise

While mass customization has been addressed in literature as a promising approach to meeting today's market demands, some authors have recently discussed its limits and concerns (e.g., [23, 24, 25, 26, 27]). One limitation of mass customization is that excess variety may result in an external complexity that Pine defined as "mass confusion" [28]. The number of choices could overwhelm customers during product configuration [24, 29]. However, this challenge of mass customization can also serve as the source of its competitive advantage. The interaction with each single customer and their integration in the supplier's value chain is the prerequisite for delivering a customized solution. Essentially, by making customers the center of an enterprise, every transaction implies information gathering about each customer's specific product design requirement. Thus, a *two stage process of development of product offerings* bestows the foundation for customer centric enterprise and is the basis of mass customization:

(1) Product architectures and the range of possible variety are fixed during a preliminary design stage linking the overall company strategy to the available capabilities including manufacturing, logistics and service capacity. During this step, the 'solution space' of a mass customization system is set.

(2) The second design and development stage takes place in close interaction between the customer and the enterprise. Here, the capabilities of the solution space from stage 1 are turned through adequate configuration tools into a specific customer order. This process is called the *elicitation* of a mass customization system [27]. The enterprise has to interact with its customers to obtain specific information in order to define and translate the customers' needs and desires into a concrete product specification.

Elicitation during the course of configuration and the process of co-development results in customer integration. The customer is integrated into the firm's value creating activities. Customer integration can be defined as a form of industrial value creation where "the consumers take part in activities and processes which used to be seen as the domain of the companies" [30, p. 360]. The customer becomes a 'co-producer' respectively 'prosumer' [31]. The result is a system of co-production, i.e. an interaction of supplier and customer for the purpose of attaining added value [32, 33]. The customer can be seen from the firm's perspective as a production factor fulfilling tasks that in a mass production system are done internally [34]. As in a mass customization system the main part of the interaction with the customer takes place during the configuration and therefore the design of a customer specific product, it seems appropriate to call the customer more a *co-designer* than a co-producer. Customer co-design describes a process that allows customers to express their product requirements and carry out product realization processes by mapping the requirements into the physical domain of the product [35, 36, 37]. While a personalization system is often able to provide individualized communication with a client without any explicit interaction between both parties (if the information for personalization can be based on existing information about this client), mass

customization requires the active participation of each customer. Here, the organization's primary thrust is to identify and fulfill the individual wants and needs of each and every customer [16, 38].

## 1.5 Linking mass customization and supply chain management

Interacting with customers and enabling them to become co-designers and part of value creation is an important capability of a customer centric firm. Another is to deliver the results of the configuration process, to finally produce customized products and services. While specific means and approaches of flexible manufacturing are addressed in many chapters of this book, we want to place mass customization here in the larger framework of *supply chain management*. In many ways supply chain management and mass customization are important building blocks for a customer centric enterprise. However, supply chain management addresses production management from the inside out, particularly from the manufacturers' point of view, while mass customization approaches from the outside (i.e. customer requirements) towards the production and distribution systems. Finding synergies between these two approaches may open up new avenues to better serve the end customers, particularly the creative ones. Here are areas where we believe the synergy between supply chain management and mass customization can be built upon [39]:

*Product design as an integral part of the supply chain:* In supply chain management, the product design is often taken as given. By considering products at the SKU level, the emphasis of supply chain management is on the synchronization of material, financial and information flows. In mass customization, customers can actively participate in the value chain by making informed trade offs not only regarding cost and delivery schedules, but also with regard to product design features and functionality. Thus, expanding the three flows in supply chain management to include the customers' choices on product design could provide a new dimension for synchronization. For example, customers may be persuaded to buy a specialized design to alleviate the shortage of certain components.

*Bring customers into the value chain:* In supply chain management, customers are an integral part of the value chain. In many cases, they are at the initiation point of the value chain. Consequently, mass customization has been working on issues such as getting customers to explore the possibilities, identify what they want and getting information about the capability of producers, and hence the delivery schedule, without laborious searches. The idea of helping customers to articulate their needs, negotiate and make informed decisions could be useful to leverage on supply chain management information flow. Efficiency of the supply chain can be improved because the customers and producers are able to share information about material availability and customer preference in a direct, non-

intrusive, and *in situ* mode. For example, customers and enterprise can negotiate the price, features, and delivery simultaneously so that best value can be provided to the customers at that time.

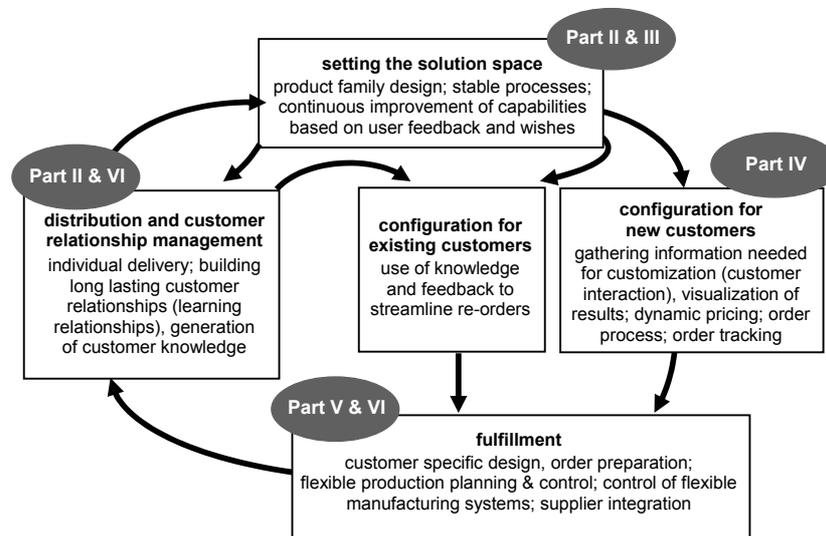
*Measure value chain performance directly:* By considering each customer as an individual, value contribution of the supply chain moves beyond traditional metrics of inventory and delivery performance. Direct links between customer preference and the supply chain provide the possibility of measuring value contribution directly including metrics such as customer loyalty and gross margin. Furthermore, pushing accountability closer to the value contributors could create flexibility to utilize more economical production capabilities such as electronic cottage industry and global division of works.

*Structure product family to achieve efficiency in high-variety low-volume production:* Recognizing the individual differences among customers while still achieving economies of scale as well as product family, modularity and commonality are important techniques for implementing mass customization. Much has been learned in mass customization about the importance of structuring product families that are both easy for customers to comprehend and conducive for organizing repetition in high variety production. These techniques will be very useful for supply chain management to streamline not only various processes but also increase the scale of economy in operation.

## **1.6 The knowledge circle of mass customization: A survey of this book**

Mass customization and customer integration create a customer centric enterprise system that transcends the traditional manufacturing enterprise. In essence, the scope of a customer centric enterprise is not limited to producing its products, it also applies the capabilities to detect customers' needs, to proactively satisfy them, and to strategically position the enterprise capabilities around the customers' future requirements. Companies no longer design, make and then sell products; instead, companies will sell capabilities, get orders, and then fulfill these requests. Consequently, their success depends very much on the ability to manage knowledge – that not only covers one transaction but uses information gathered during the fulfillment of a customer-specific order to improve the knowledge base of the whole company [14, 27, 40, 41]. The representation of these processes in a knowledge loop model stresses the importance of an interconnected and integrated flow of information (Figure 2). The four premier activities of a mass customization system [14, 42, 43] link together to form a loop that serves as the backbone of a customer centric enterprise. These four activity bundles are the design of the solution space, configuration and customer interaction, fulfillment of customized manufacturing, and customer relationship management. These activities have to be delivered in an integrated, streamlined way, starting from the point of interaction where information required for customization is surveyed, then on to processing

this information for fulfillment and providing the customized offer, and finally activities that deepen the customer relationships and create customer loyalty. The knowledge generated during serving one customer has to be stored to serve this customer even better, faster, and more efficiently when a second order is placed. Furthermore, information acquired during the output process must be saved, assessed and employed to continuously improve the solution space and foster efficiency and quality enhancement in follow-up business. By doing so, both new and old customers can be served better. Supply chain management can also be improved continuously (e.g. with a given amount of inventory, the customer service level can be optimized).



**Figure 2:** The enterprise knowledge loop and the structure of this book

We will use the knowledge loop model to briefly give an overview of the subsequent parts and chapters of this book. However, before starting with the first activity of the knowledge loop, readers will be introduced with the fundamentals of being customer centric. Thus, Part II of this book provides an introduction to principles, concepts, demarcations, and business models for mass customization and personalization. In Chapter 2, *MacCarthy, Brabazon and Branham* present an introduction into the scope of mass customization principles in industry. Correspondingly, *Franke and Mertens* discuss the use of personalization in industry and public administration (Chapter 6). Does mass customization and personalization pay? Both *Riemer and Totz* (Chapter 3) and *Reichwald, Piller, Jäger and Zanner* (Chapter 4) evaluate this question from an economic perspective in two different settings. *Thoben* contributes to the understanding of the nature of mass customization by comparing this approach with (traditional) customer driven manufacturing (Chapter 5). Part II concludes with a new perspective: individualization and

personalization are characteristics of art, as *Gros* discusses in Chapter 7. After this introduction, the structure of the book follows the activity sequence of the knowledge loop (see Figure 2 above):

*Design of the solution space:* Before a single customer can interact within a mass customization system, the solution space has to be defined. As described above, building the solution space consists of developing the basic product architectures and families, setting the number of customization options for one component, and defining the pricing schemes for each selection. This activity cluster further includes the development and implementation of the fulfillment processes in manufacturing. These design activities are addressed in Part III of our book. Here, *Du, Jiao and Tseng* (Chapter 8) provide an introduction into the product family approach for mass customization, followed by *Siddique and Rosen's* discussion of common platform architectures to identify a set of similar products (Chapter 9). The development of reconfigurable models and products is an important means of increasing productivity in the product development process, as *Cox, Roach and Teare* show (Chapter 10). Cost-Based Reasoning and TRIZ are significant methodologies that, although not developed originally in a mass customization setting, can improve the design of customization systems considerably, as *Wongvasu, Kamarthi and Zeid* (Chapter 11) and *Mann and Dmoch* (Chapter 12), respectively, demonstrate.

*Configuration* means to transfer customers' wishes into concrete product specifications. While the solution space is set up at the enterprise level, elicitation activities take place with every single customer's order. For new customers, first a general profile of their desires and wishes has to be built up. This profile is transformed into a concrete product specification and order. For re-orders made by regular customers their particular existing profiles have to be used. The old configuration may be presented and customers just asked for variations. The objective is to make subsequent orders of an existing customer as easy, efficient and fast as possible – an important means of increasing customer loyalty. Part IV comprises the discussion of configuration methodologies and modes for customer interaction. *Khalid and Helander* give an introduction into web-based configuration approaches (Chapter 13), an issue that is elaborated by *Oon and Khalid* in Chapter 15. How consumers behave in such an environment is discussed by *Kurniawan, Tseng and So* (Chapter 14). Afterwards, *Porcar, Such, Alcantara, Garcia and Page* show how consumer expectations can be captured by the Kansei Engineering methodology (Chapter 16). *Hvam and Malis* present a documentation tool for configuration processes to foster knowledge based product configuration (Chapter 17). Part IV concludes with *Svensson and Jensen's* plea that the customer should always be at the final frontier of mass customization (Chapter 18).

*Fulfillment:* After an order has been placed, it is transferred into specific manufacturing tasks. Scheduling activities follow, whereby suppliers may be integrated in the customization of some parts, too. Often in a segmented production layout, the order is fulfilled. Part V analyses how such manufacturing operations are set up and performed. *Urbani, Molinari-Tosatti, Bosani and Pierpaoli* present an analytical approach on system flexibility and reconfigurabil-

ity for mass customization (Chapter 19). Flow systems can enable mass customization, as *Tsigkas, de Jongh, Papantoniou and Loumos* explore in Chapter 20. An adaptive system for production planning and control for customized manufacturing is discussed by *Lopitsch and Wiendahl* (Chapter 21). *Schenk and Seelmann-Eggebert* take a broader view on customized manufacturing including training activities in Chapter 22. *Hansen, Jensen and Mortensen* explain how modularization in manufacturing is implemented in industry (Chapter 23). Finally, *Mchunu, de Alwis and Efstathiou* introduce a framework to select the best fitting mass customization strategy for a specific manufacturing task (Chapter 24).

*Customer relationship management:* Increasing customer loyalty is one of the foremost objectives of companies going into mass customization. Mass customization has especially pronounced capabilities to intensify the relationship between a supplier and its customers and, thus, to increase customer loyalty. Customer loyalty can be seen as a result of switching costs, opportunity costs, and sunk costs based on technological, contractual, and psychological obligations faced by a customer [44]. All sources of switching, sunk, and opportunity costs are positively influenced in a mass customization system during the course of customer integration, as *Riemer/Totz* present in Chapter 3. Corresponding activities are also discussed in various other chapters of this book (e.g., *Reichwald et al.* in Chapter 4, *Franke and Mertens* in Chapter 6, *Svensson and Jensen* in Chapter 18, *Gurtzki and Hinderer* in Chapter 27, and *Piller and Tseng* in Chapter 30).

How the different activities of the knowledge loop of mass customization are connected and applied in an industry model is the theme of Part VI. Five chapters present lessons learned from the apparel and footwear industry and give an insight into some specific challenges of mass customization. We have chosen this industry as a premier example as here many experiments, pilot studies and business implementations of mass customization principles have already taken place. *Bullinger, Wagner, Kürümlüoglu and Bröckner* open this part and substantiate the knowledge loop model for the footwear industry by presenting a framework for an extended user oriented shoe enterprise (Chapter 25). Issues of retail and customer interaction are addressed by *Taylor, Harwood, Wyatt and Rouse* in Chapter 26 and *Gurtzki and Hinderer* in Chapter 27. Special issues of customization in the footwear sector are illustrated with regard to measurement and fit by *Luximon, Goonetilleke and Tsui* (Chapter 28), and with regard to design and manufacturing by *Sacco, Viganò and Paris* (Chapter 29).

Even with all the references to the state-of-the-art of mass customization research in Parts II to VI, there are still many unanswered questions. Thus, we share our view about the future of the customer centric enterprise, mass customization, customer integration, and personalization in Part VII. We also comment on business opportunities and fields for further research where it is necessary to develop new processes, tools and programs for integrating the customer into value creating activities, both on the technological and the operational process side.

But despite open questions and demand for further research, many companies have proved that it is already possible today to identify specific (perhaps

sometimes still narrow) customer centric niches as a successful business opportunity. These are the companies which took serious investments and business risks to identify major factors for differentiation in order to create economic value and precipitate enablers for increasing customer loyalty.

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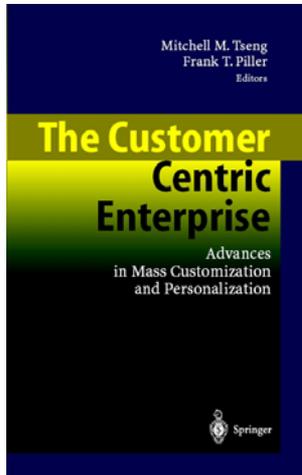
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Companies are being forced to react to the growing individualization of demand. At the same time, cost management remains of paramount importance due to the competitive pressure in global markets. Thus, making enterprises more customer centric efficiently is a top management priority in most industries. Mass customization and personalization are key strategies to meet this challenge. Companies like Procter&Gamble, Lego, Nike, Adidas, Land's End, BMW, or Levi Strauss, among others, have started large-scale mass customization programs. This book provides insight into the different aspects of building a customer centric enterprise. Following an interdisciplinary approach, leading scientists and practitioners share their findings, concepts, and strategies from the perspective of design, production engineering, logistics, technology and innovation management, customer behavior, as well as marketing.

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