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INFORMATION AS A CRITICAL SUCCESS FACTOR FOR MASS CUSTOMIZATION OR: WHY EVEN A CUSTOMIZED SHOE NOT ALWAYS FITS

While the competitive advantage of mass customization has been widely substantiated in management theory, a deficit exists in the empirical examination. Founded on an exploratory case study based research of 100 mass customizers we deploy an information cycle model to demonstrate why adequate information management is the critical success factor of mass customization.

1 Why Mass Customization?

„It is the customer who determines what a business is." In the very sense of Drucker's (1954) analysis, the single customer has come more deeply into the firm's focus than ever. Firms are faced by an uninterrupted trend towards individualization in all areas of life, as new Delphi studies predict. Explanations may be found in the tendency towards an experience economy, the growing number of single households, an orientation towards design and, most importantly, a new awareness of quality and functionality which demands durable and reliable products corresponding exactly to the specific needs of the purchaser. In particular, consumers with great purchasing power are increasingly attempting to express their personality by means of an individual product choice (an example is BMW's new „Individual Program" which emphasizes the fulfillment of individual fittings and equipment). Thus, many suppliers are forced to create product programs with an increasing wealth of variants right down to the production of units of one (differentiation by means of variety). In the final consequence, many companies have to process their customers individually (Glazer, 1999; Kahn, 1998).

Traditionally, the objective of individualizing goods and services is to attain an increased revenue by the ability to charge premium prices derived from the added value of a solution meeting the specific needs of a customer (Porter 1980). However, the present competitive situation of many industries prevents the company from reacting by a strategy of differentiation. The cost-benefit relation alters because buyers demand relatively high standards of quality, service, variety or functionality even when the sales price is favorable or, vice versa, suppliers have to meet additional requirements in pricing when a product is marketed differentiated. Precisely here the objective of mass customization starts. The aim is the production of goods and services for a (relatively) large market which exactly meets the needs of every individual demander with regard to certain product characteristics (differentiation option) at costs roughly corresponding to those of standard mass produced goods (cost option). The information collected in the course of the process of individualization serves to build up a lasting individual relationship with each purchaser.

The practical implementation of mass customization is based on the potential offered by new technologies in manufacturing and information management. New manufacturing technologies (computer-integrated production and flexible manufacturing systems) reduce the trade-off between variety (flexibility) and productivity. The leading literature about Mass Customization is dominated by this manufacturing based point of view (Ahlström/Westbrook, 1999; Anderson, 1997; Kotha, 1995; Oleson, 1998; Pine, 1993; Victor/Boynton, 1998). But as Mass Customization enters more and more consumer markets, new information technologies can be seen as its main enabler. The remaining paper will discuss why modern information technologies are a critical success factor for Mass Customization (section 2). Our research is based on the results of an exploratory study of about 100 mass customizers world wide (section 3). The „best practices" identified by this study concerning the information handling are summarized in a model of an information cycle, which will be explained in section 4. In the last section of the paper, the information cycle is explained by two more detailed real life examples.

2 The Role of Information for Mass Customization

Information can be regarded as the most important factor for the implementation of mass customization. „Being truly customer focused is not possible if the organization is not, first, information intensive" (Blattberg/Glazer 1994). While there are different conceptions to implement mass customization with diverse demands on production (Gilmore/Pine, 1997; Lampel/ Mintzberg, 1996; McCutcheon et al., 1994; Piller/Schoder, 1999; Pine, 1993; Robertson/Ulrich, 1998), all methods lead towards a sharp increase in the amount of information and communication necessitated among those involved. Mass customization is successful only when it can cover this need for information and communication both purposefully *and* efficiently.

The reason for this information richness is based – in comparison to the traditional push-system of mass production – on the need for direct interaction between the customer and seller for every single transaction. Every order implies a coordination about the customer specific product design as a result of the divided construction process of mass customization (Hibbard, 1999). While the product architectures and the range of possible variety are fixed during a preliminary design process the second step takes place in close interaction between the customer and the supplier. The individual wishes and needs of each customer have to be transformed to a unique product specification. The costs arising from customization consist largely of information costs. They are accounted for by the investigation and specification of the customers' wishes, the configuration of individual products, the transfer of the specifications to manufacturing, an increased complexity in production planning and control, the coordination with the suppliers involved in the individual prefabrication, and the direct distribution of the goods. All theses activites are characterized by a high information intense compared to traditional mass production. Thus, customer-related value of mass customization added is produced on the information level.

The importance of information processing for mass customization may explain the time lag between the fact that the concept has already been discussed in the literature for more than a decade (e.g. Davis, 1987; Kotler, 1989; Mueller-Heumann, 1992; Pine, 1991; Pine; 1993; in fact, already Toffler, 1970 described the basic idea) and the observation that only in the last few years increased practical implementation of this strategy can been found in business. In former times, firms reduced the information content of their processes in order to reach cost efficient outputs. But today the opposite can be true: An increasing information richness of products and processes guarantees its cost efficient and individualized production. This is possible through the potentials of new information technologies (Wigand/Picot/ Reichwald, 1998).

The role of information technology can be seen on two levels: (1) The substitution of product functions by information activities is in many cases the easiest possibility to customize products efficiently as information richness is a strong indicator for the digitalizationess of goods (Choi/Stahl/Whinston, 1997; Shapiro/Varian, 1998). (2) However, not all products can be transferred to the „info sphere". But for almost all product categories new Internet technologies facilitate the collection and employment of numerous data concerning the individual customer by permitting interaction between economic units connected via electronic networks. Especially Web-based electronic commerce greatly assists in reducing information costs, chiefly by considerably simplifying and increasing the effectiveness of communication relations between customers and producers. Web-based product configurators allows to „outsource" the time- and cost-consuming configuration process to the customer. For low cost consumer goods extensive sales and configuration processes cannot be fulfilled by personal sales in a retail outlet – if one keep the cost option of mass customization in mind.

This process can be assisted by the use of recommendation engines. These software tools allows the simplified identification of individuals and their preferences by recording, comparing, and aggregating former sales, pages views or click rates. They enable the direct presentation of individualized/customized content and lead the customer automatically to her preferred configuration by comparing user profiles and indexes of content – even if an user cannot explicitly express her preferences and wishes (Elofson/Robinson, 1998; Shardanand/ Maes, 1995). These technologies enlarge the range of „configure-it-yourself" to more complex products. As a results, nowadays even complex products like houses can be configured and ordered online with no architect or real estate dealer involved. The saving potential of this process allows German building contractor Streif AG to offer customers an discount of 25 000 € if they configure and order their house online (www.streif.de). But the information tasks do not end at this point. After configuration, customer data have to be transferred into the producer's business application systems. Here standardized interface logs permit transactions beyond company boundaries and interaction between interorganizational operational systems without media discontinuity by using standardized Internet technology (XML-based Web-EDI) instead of proprietary transaction channels (Turowski, 1999).

3 Outline of the Empirical Study

Mass Customization is rapidly becoming a buzzword. Lampel/Mintzberg (1996) identified already in 1996 more than 2000 articles written on Mass Customization (although this is probably misleading since many are press articles in the US). More and more companies enter the market with there very own Mass Customization programs (while writing this paper in Dec. 1999 / Jan. 2000 the three category leaders P&G, Nike and garden.com introduced new Internet based Mass Customization programs). The expression of Sanjay Choudpouri, Director Mass Customization (sic!) at Levi Strauss, can be regarded as typical for many managers: „Customization in the clothing and footwear industry will become a competitive necessity, rather then a nice to have fringe offering" (in an interview with the authors of this paper).

Taken this growing implementation efforts and the long academic discussion into account, it is surprising that, with few exceptions (Pine, 1991; Ahlström/Westbrook, 1999; Piller/Schoder, 1999) there is almost no large scale empirical research about mass customization. The literature argues more or less based on some case studies describing successful mass customization programs. We agree with Bettis (1991) and Kotha (1995) that researchers in strategic management should employ more unstructured and exploratory research instead of the dominating multivariate statistical methodology in order to suggest prescriptions that are

relevant and practical for managers. However, most authors following this recommendation concentrate on few examples (Kotha, 1995; Oleson, 1998; Victor/Boynton, 1998). But to cover a field characterized by a heterogeneous population of firms and strong growth rates only the combination of research looking on a large group of cases with an in-depth study of some exceptional examples seems sufficient. Therefore, we constructed a long-term exploratory study to identify best practices and success factors for Mass Customization. Data was gathered by secondary sources like database and Internet research and primary sources like interviews and company visits alike. Some important characteristics of our study are outlined in Table 1.

Table 1: Key characteristics of our empirical research

Research time	June 1997 – June 1999	
Cases covered	103 (plus 80 additional cases not covered in this evaluation)	
Market focus	Business-to-consumer (b-to-c)	68
	Business-to-business (b-to-b)	29
	Hybrid	6
Origin and main target market	United States and Canada	57
	Germany	37
	Europe (without Germany)	4
	Japan	5
Mass Customization concept (Piller/Schoder, 1999; for other systematologies see Gilmore/ Pine, 1997; Lampel/Mintzberg, 1996; McCutcheon et al., 1994; Pine, 1993; Robertson/Ulrich, 1998) *(if two concepts were mixed, the dominating one was counted)*	Modular product architectures	54
	Service customization (customized services around standardized products)	17
	Customization-standardization-mix (customize either the first or the last activities of the value chain, while keeping the others standardized)	13
	Flexible customization (flexible manufacturing systems used in constant, controlled processes)	12
	Point-of-delivery customization	4
	Self customization (customizable products / services)	3
Interaction channel with customers	Traditional retail channels	54 (26 b-t-c, 28 b-to-b)
	Internet	43 (39 b-t-c, 4 b-to-b)
	Hybrid channels	6 (4 b-t-c, 2 b-to-b)

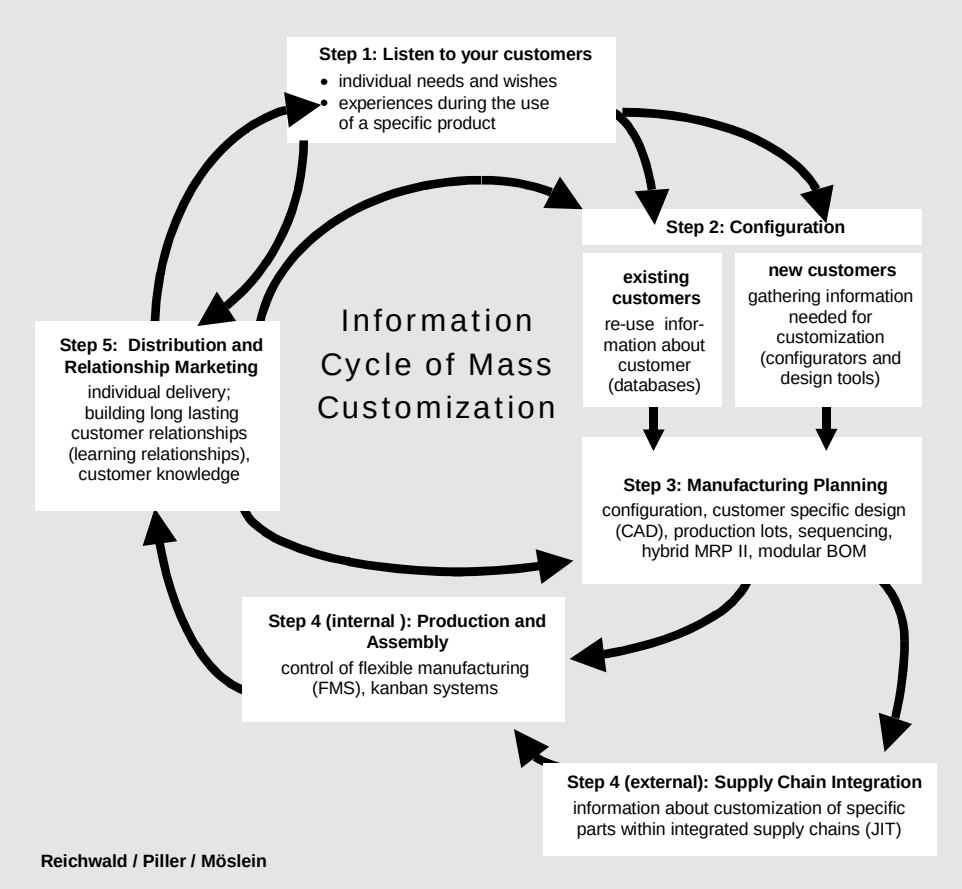
In our study most consumer good companies with high-ranked Mass Customization programs (based on a score evaluating their fulfillment of different tasks) entered the market within the last two years. However, in the business-to-business sector, many mass customization programs already started in the early 1990s – without any modern information technologies on

the customer end (but often strong internal use of information technology in manufacturing and construction). This may be explained by the fact that in business-to-business markets personal sales are very common and that the higher order volumes justify a personal configuration process (see Table 1) – unbelievable with a consumer product with a retail value of 5 € (like the personalized chocolate bar by CyberChocky), where Web-based electronic commerce has to take this part.

4 The Information Cycle of Mass Customization

Our research showed that companies pursuing mass customization successfully integrate a variety of important tasks. They build an integrated information flow – that not only covers one transaction but uses information gathered during the fulfillment of a customer-specific order to improve their knowledge base. The representation of these processes and of the tasks described before in an information cycle model shall stress the importance of an interconnected and integrated flow of information (Figure 1). The model is directed to managers implementing or supervising a mass customization concept. But like the value chain model it may also show academic readers important fields for further research and shall help to structure the discussion by integrating some distinguish tasks described below.

Figure 1: The information cycle of mass customization



1. Listen to your customers: The cycle starts with the individual needs of each customer. The center of each mass customization program has to be information about the desires of a customer group regarding the product. Although a major meaning of mass customization is that a mass customizer doesn't fulfill every wish of its customers (that would be traditional customization at premier prices), it is important to listen carefully to prospective customers to design a set of product variants and individualization options that on the one hand side has enough possibilities for customization, but that on the other hand is as easy as possible in order to reduce complexity – a main cost driver of mass customization.

2. Configuration: Here the task is to transfer the customers' wishes in concrete product specifications. This is one of the most critical parts of any mass customization business. It's important to differentiate between old and new customers. For new customers, first a general profile of their desires and wishes has to be built up. This profile is transformed into a product specification. At this stage new technologies like recommendation engines provide help. For the configuration for regular customers the existing customer profile has to be used. The old configuration may be presented and customers just asked for variations. The second and all following sales have to be as easy (time- and money-saving) as possible. This is one of the major possibilities to built-up customer loyalty. Leading companies have implemented strong instruments to build trust and show reliability in order to reduce the risk seen by prospective customers in mass customization processes („configure your own design, pay first, wait, and then hope, that our product fit", a sales manager described the transaction process from a customer's point of view). New research by Mandel/Johnson (1999) demonstrates strong possibilties to influence the users of a web site by screen design. These findings have to be used to develop „trust-full" web sites.

3. Manufacturing planning: Often already during step 2 the configuration is checked in production planning to get customer specific dates for delivery. After an order is placed, it is transferred into specific manufacturing tasks. Scheduling activities follow. The production tasks are transferred to the responsible process units, whereby suppliers may be integrated in the customization of some parts, too. Note that there shall be no step back to the configuration process after the order was placed. This time- and money-consuming iterative re-configuration has to be eliminated in a successful mass customization concept.

4. Production and supply chain integration: Up to this point, the mass customization process is on the information level only. Now manufacturing activities starts. Often in a segmented production layout (one production segment is responsible for some modular product components) the order is fulfilled. During this step information management has to take care that the right specification details of an order are at the right work places. In an advanced mass customization concept external suppliers may be integrated into the customization process. The result may be an extension of the economically possible degree of individualization, a speeding up of the processes, and cost savings due to specialization and faster learning effects. Here, too, information activities are in the center. Integrated information flows and shared applications are required to transfer the specific customer information between the factories.

5. Relationship management: After distribution, the relationship building continued that started with the configuration process. Further knowledge about the customers has to be acquired. The information cycle also shows that not only information about the customer but the production process itself has to be collected in an knowledge base to improve efficiency and quality in follow-up business (Peppers/Rogers, 1997). By doing so, not only new and old customers can be served better. Also production planning can be improved continuously (e.g. by better forecasts for the prefabrication of modular components).

5 How to make the shoe fit – the information cycle applied

To demonstrate how the information cycle may be applied we briefly provide two in-depth case studies from the shoe industry. The shoe industry is one of the industries profiting most from Mass Customization in consumer markets. As market research shows, purchasing decisions of women and men alike often suffers from the need to compromise between a good fit and a fashionable design. As a fashion orientated market, the industry suffers, too, from the increasing speed-to-market needs, decreasing collection and order cycles, an ever faster pace of change of fashion trends, the move to individuality, and the huge planning complexity resulting from theses changes. Additionally, the price war becomes harder as new competitors like Wal-Mart or Tesco enter the markets. And from an didactic point of view an – on the first view – not really information based business may demonstrate the importance of information better than information rich products like PCs, books or electronic devices.

Custom Foot was one of the leading pioneers of the mass customization scene. Featured in cover stories of the New York Times, Forbes or Fortune (Holusha, 1996; Martin, 1997; McHugh, 1996) and described in long case studies in business bestsellers (for example Peppers/Rogers, 1997) the customized shoe maker from Westport, CT, seemed to show a whole industry new ways of doing business: Custom-made Italian shoes, delivered in about three weeks, at off the shelf prices. But after a glorious start Custom Foot went finally out of business and closed its operations in summer 1998. Another case probes Creo Interactive, a fast growing German shoe pioneer. Creo reacts to the competitive challenges of the industry with an innovative business model. The shoes are sold only via the Internet, each pair custom made. Visiting the homepage (www.creointeractive.com) one will recognize the main difference from traditional online-shoe-stores: No shoes are presented! It is the customer who first has to design and to configure her very own shoe. But before this virtual shoe fits to her future owner's feet, some important steps have to be fulfilled successfully – most of them on the information level. Exactly at this point the business models of Custom Foot and Creo are different: in the way how they handle the information connected with mass customization.

What were the reasons for the failure of Custom Foot? Marketing and customer relationship management were both excellent best practices solutions. Also, customer demand was very strong. The bad side started after customers placed their orders and the shoes finally arrived: Often the shoes doesn't fit! Or they came in a wrong color. And often it took them months to be delivered. Although Custom Foot used sophisticated technology like foot scanners and latest design software to configure the products and to transfer the customers' data to the Italian shoe plants, the information cycle wasn't complete. The company managed steps 1, 2 and 5 of the information cycle very well but missed the equally important steps 3 and 4. When the order crossed the „Italian border", the information flow broke. Italian shoemakers are well known for their skills, but the factories of the subcontractors that got the order by the Italian based broker of Custom Foot were not able to fulfill the requests in time – they were used to much long order cycles of the traditional „customer push" system. The distance between the United States and Italy was not only an ocean but based on a deep cultural misunderstanding, too. The workmen couldn't imagine why it finally should matter if a shoe is a little bit more or less wide. They were skilled factory workers of the old mass production system, but couldn't manage the complexity and new tasks connected with made-to-order production.

Another reason of failure was a wrong product concept. Custom Foot tried to make shoes the traditional way, consisting of a wide variety of parts and needing plenty of working steps (about 150 to 300). Further, the possible variety was too large forcing the plants to have huge stocks of raw material. The limitations Custom Foot made, were not enough. To blend mass production and customization, the company set limits: 670 sizes and about 10,000 variations in

women's shoes and 7,800 in men's. But the whole system couldn't handle the enormous complexity of the process. In our opinion, two things were missing: A strong modular product system and a fully integrated information flow.

That's exactly were Creo Interactive starts. Founder Jo Steuerwald designed a totally new shoe, based on a modular concept of mainly three parts: the sole, the main body (shaft) and the tongue. All parts were constructed compatible to the last, which is responsible for the fitting and technical configuration of a shoe. So his shoes can be produced in just 83 working steps (compared to the 150 to 300 of Custom Foot) – minimizing not only possible failures but labor costs, too. This is important as the shoes are produced in Germany, being a country with some of the highest wage levels worldwide. To control variety, Creo learned from the famous SWATCH watch which based it's success on limited editions of special styles. Creo offers a limited choice of colors and patters at one time (about 100 styling options simultaneously for one model), but changes these possibilities often to attract customers to buy once they designed their own shoe. But while watches comes in „one size fits all", shoes have to be produced in at least 24 different sizes. So this ever changing design process can only made possible economically by using virtual products on the Internet – imagine the huge and expansive logistics expenditure to change shoe designs in normal stores every single week. Also, the 75 € Creo asks for its shoes would not cover a long configuration process of the shoes between a salesperson and a customer (the average customer „invests" about 30 minutes to design her favorite shoe). After configuration, the order is transferred directly to the shoe plant where trained workers finish the shoe in a special line.

Figure 2: The information cycle in practice

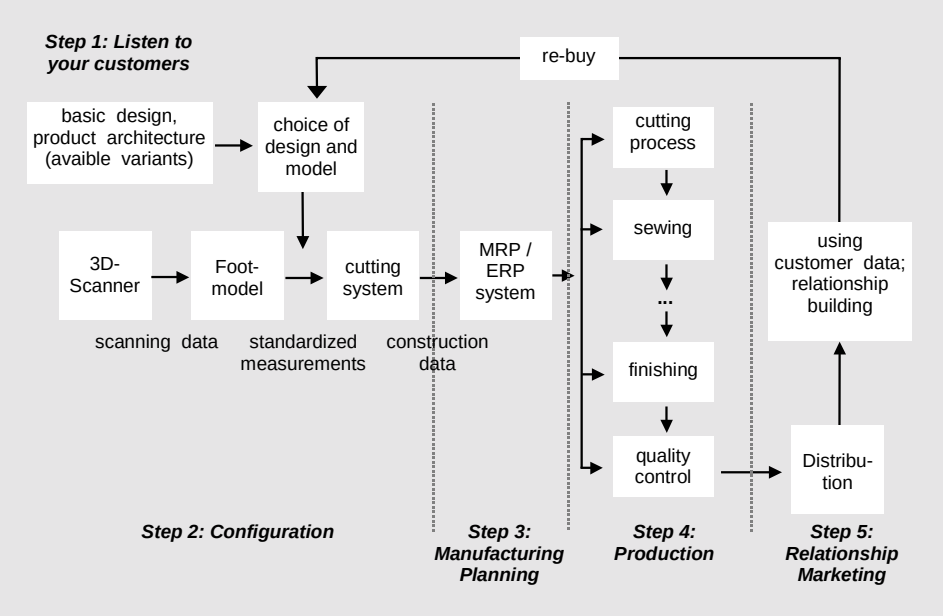


Figure 2 shows how the information cycle is modified for the shoe industry. The configuration process here is separated into two phases: The measurement and the choose of design. Here Custom Foot showed a good solution: The customer's feet were scanned by a three-dimensional scanner. Next, these raw data have to be transformed (and reduced in

complexity) to a generic foot model (CAD model) of the customer. This is the starting point for the design process. The generic model is matched with the designs, styles and colors, and size options available. These information have to be transformed automatically into production data, cutting information in this case. Further, a connection to the production planning system has to check (and reserve) capacities in order to get a customer specific delivery date. After the order is accepted it has to be placed automatically into the production planning system that controls the single manufacturing steps. After manufacturing, the feet data are stored for further sales and to build up a learning relationship with each individual customer. And hopefully, the new shoes fit perfectly.

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