Chapter 2
Mass Customization

Abstract The lack of consensus about how mass customization is defined results in a number of disagreements: Is it applicable just to products or also to services, which monetary and time prerequisites need to be fulfilled and at which stage of the manufacturing process should customer preferences be integrated. These questions are answered in different ways by researchers, but most of them share the concept that price and time must be comparable to non customized goods in order to define the customization process of a company as mass customization. Moreover, it is evident that customer preferences should ideally be integrated in the entire design and production process, even though this is rarely the case in practice. With the advent of the WWW individual customer's preferences have become easier to know and to be integrated at least at the assembly stage of the product, thus making the production of the customized good possible at a cost similar to products produced in mass production. Production and delivery times, as well as participation of the customer in the product's design, still remains an open issue.

Keywords Mass customization definition · Production costs · Delivery time · Demonstrative model · Bills of materials

2.1 Different Perspective to Mass Customization

Mass customization seeks, as its goal, to develop, produce, market, and deliver "… affordable goods and services with enough variety and customization [such] that nearly everyone finds exactly what [he/she wants] …".[1]

Despite this definition, many researchers have different understandings of the term mass customization. Various authors have defined mass customization as a concept which should be applied only to products.[2] However, others have applied

[1] Pine (1993).

[2] Ettlie and Ward (1997) and von Hippel (1998).

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Table 2.1 Overview of exemplary definitions of mass customization used in literature

Is mass customization applicable to products and/or services?
Davis (1994, p. 180): ''But mass customization is not restricted to products and services. It also applies to customers and markets.''
Duray (2002, p. 314): ''… offering unique products in a mass-produced, low-cost, high volume production environment.''
Ettlie and Ward (1997, p. 56): ''Mass customization—providing products that are created to the customers' specifications.''
Franke and Piller (2004, p. 403): ''These 'mass customization' methods have enabled custom goods to be produced with near mass production efficiency.''
Hart (1995, p. 36): ''… practical definition: the use of flexible processes and organizational structures to produce varied and often individually customized products and services.''
von Hippel (1998), pp. 631–632: ''Mass customization generally refers to the manufacturing of one-of-a-kind, 'custom' products … One can also logically extend the concept of mass customization to the production of customized services.''
Zipkin (2001, p. 81): ''Mass customization is the capability … to offer individually tailored products or services on a large scale.''

Source Kaplan and Haenlein (2006)

it both to products and to services.[3] For some authors the definition is limited to the manufacturing of goods,[4] whereas others also have used it to describe other value chain activities, such as distribution[5] or marketing. Several authors have included considerations of cost[6] and price[7] into their definition, whilst many others have not mentioned these characteristics.

Table 2.1 gives an overview of the most cited definitions of mass customization and underlines the many different points of view for three basic questions:

1. Is mass customization applicable to products and/or services?
2. Which prerequisites in terms of production cost and monetary price do need to be fulfilled?
3. At which step of the value creation process should the customer preferences be integrated?

Even through mass customization was originally applied to physical products, it can be argued that a similar procedure can be applied to services, those "products" which bear the feature to be consumed in the production moment and in which the customer is part of the production process. Thanks to this last feature there have been many attempts to adapt services offered to a vast public to individual needs. The most emblematic example are insurance contracts for very common risks, such as car crashes or house fire. These contracts are strongly standardized but require to keep into consideration a lot of customer's personal features and

[3] Hart (1995) and Zipkin (2001).

[4] Pine et al. (1995) and Rabinovich et al. (2003).

[5] Åhlström and Westbrook (1999).

[6] Hart (1995) and Lee et al. (2000).

[7] Lau (1995) and Ragsdale and Zobel (2004).

Table 2.2 Overview of exemplary definitions of mass customization used in literature

Which prerequisites in terms of production cost and monetary price do need to be fulfilled?
Fogliatto et al. (2003), p. 1817: ''… at prices similar to mass-produced items.''
Hart (1995, p. 36): ''… at the low cost of a standardized, mass production system.''
von Hippel (2001), p. 256: ''… at near mass-production costs.''
Lau (1995, p. 18): ''… at the price of the comparable mass-produced items.''
Lee et al. (2000), p. 82: ''… with mass-production efficiency and cost.''
Piller and Schoder (1999), p. 1111: ''… at a price which is only marginally higher than that of the standard product.''
Ragsdale and Zobel (2004, p. 84): ''… at an affordable price.''
Da Silveira et al. (2001), p. 1: ''… at reasonably low costs.''

Source Kaplan and Haenlein (2006)

preferences, forcing insurance companies to develop modularized contracts which can be tailored on the buyer.

On the other hand, authors such as Kaplan and Haenlein[8] argue that the modularization of services is not a technique to increase customization keeping the low cost of mass production but it instead decreases the cost of building an individual contract, which would require expensive risk analysis, given a high personalisation which is mandatory for this kind of products (Table 2.2).

Setting now the focus on production cost and monetary price, we must underline that mass customization means producing keeping the cost-efficiency of mass production. This is not only intrinsic in the concept definition, but also a necessary marketing feature because customers are driven toward personalised products by the desire of possessing their own design object without paying the high prices of craftsman's manufacturing. The price is therefore an essential part of the customer's desire, who would turn towards traditional craftsmanship in case of too high prices. Moreover, when the buyer is involved in the production process, either at design or at assembly stage, he/she invests his/her time and competences in this task and this is already an extra cost in terms of time, which would pile up to any other customization extra cost.

www.plusbrief-individuell.de

Deutsche Post AG is a German postal, logistics and courier company listed on the DAX stock exchange. The company was founded in 1995 and introduced mass customization in 2007. The company offers its customers a choice of 18 customizable envelopes with stamp as base for the customization process. The customer can choose the colour (white, cream white, pearl-effect) and bonding of the envelope and use a predefined picture or upload a picture to design the stamp and an

[8] Kaplan and Haenlein (2006).

additional area on the envelope. The price for 20 customized envelopes including 0.55 € stamp amounts to 36.23 €. The identical non-customized envelopes including stamp of the same company are priced at 13 € (Fig. 2.1).

Fig. 2.1 http://www.plusbrief-individuell.de customization interface (screenshot)

In this case the price of the personalised product is 179% higher than the standard product, probably due to the high cost in printing individual envelopes and stamps. This fact has a strong impact on potential customers which may be willing to buy the standard envelope or to look for other cheaper way of personalizing the product after buying it.

www.mytwinn.com

My Twinn, Inc. is an American company which produces customized dolls. The company was founded in 1994 and introduced mass customization in 1997.

The company offers its customers a choice of four different girl's and one boy's models as base for the customization process. The customer can select the hair length (ear length, chin length, shoulder length, high-back, mid-back, lower-back), hair style (ponytail, pigtails, single braid, double-braids, as shown in uploaded picture), hair texture, skin tone (very fair, fair, olive, light brown, brown), eye colour (nine colours) and hair colour (ten colours). In addition, the customer may request a hand-painted face according to an uploaded picture and give the doll an individual name. The price for a customized doll is equivalent to 129 US$. Similar, non-customized products are priced at approximately US $60 (Fig. 2.2).

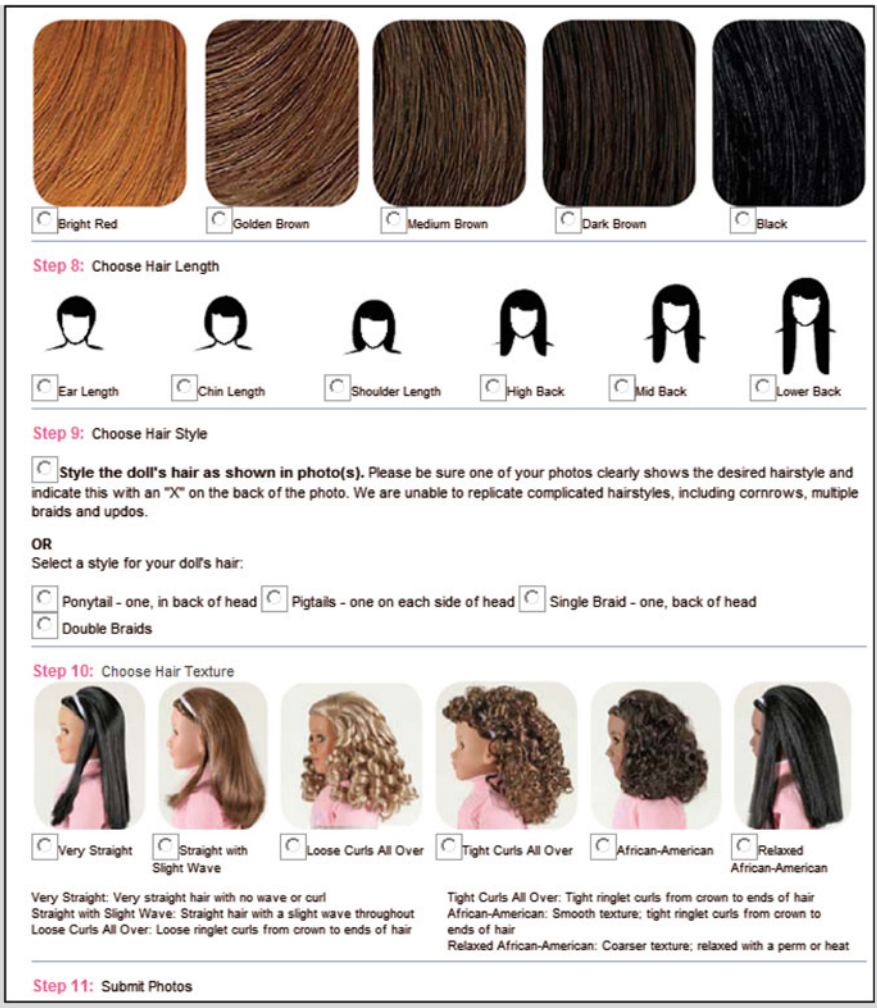

Fig. 2.2 http://www.mytwinn.com customization web interface (screenshot)

Also in this case the personalised price is much higher than the standard one, namely 115%, but the customization's added value is not a mere aesthetic change. The core aspect of the product is changed, together with its main use, and it can be adapted to the potential buyer in a way which is impossible to achieve through other tools or with post-buying changes.

We can here easily conclude that costs, and for internal efficiency also production costs, must be kept at the level of standard mass produced goods. There may be even some cases in which costs are even smaller: in markets with high volatility in buyer's preferences it is cheaper to avoid stocking products and

Table 2.3 Overview of exemplary definitions of mass customization used in literature

At which step of the value creation process should the customer preferences be integrated?
Åhlström and Westbrook (1999, p. 262): ''Mass customization is a term first coined to describe a trend towards the production and distribution of individually customized goods and services for a mass market.''
Glazer (1999, p. 63): ''… is usually associated with flexible manufacturing and operations, it can also refer to strategies based on flexible marketing methods.''
Lavidge (1999, p. 72): "… to making mass customization of advertising practical.''
Pine et al. (1995), p. 105: ''Customization means manufacturing a product or delivering a service in response to a particular customer's needs, and mass customization means doing it in a cost-effective way.''
Rabinovich et al. (2003), p. 66: ''These product design and manufacturing policies have been grouped under the term 'mass customization."
Sheth (1992, p. 61): ''… is the practice of mass customization in which each element of the marketing mix … is based on standard platforms or architecture.''

Source Kaplan and Haenlein (2006)

whenever the customer expresses its preferences it is giving precious information for the producer's marketing department which is traditionally acquired through expensive surveys.

Another important issue strictly connected to extra costs is extra time. Standardized products, whether mass produced or handmade, are immediately available and customers have become used to zero waiting time. A personalised product not only needs the time of the buyer to express its preferences, but might also require more time to be produced and to reach its final destination. This issue must be seriously considered because, while for some products immediate availability is not strictly necessary, for others buyers would give up customization if confronted with too long waiting time (Table 2.3).

Mass customization integrates the buyer's preferences as product's specifications into the production chain. Kaplan and Haenlein use Porter's value chain to show the different steps at which mass customization can be integrated (see Fig. 2.3). The choice of which step of the chain to select has a strong impact on the level and quality of personalisation and, in the opposite direction, on the extra producer's costs.

The visionary answer would be to let the user participate into the product's design without imposing any restriction. This, however, would make the producer lose all the benefits of mass production since it requires for each customer a complete expensive change in the technology of the production chain with, probably, also a restructure of the firm infrastructure. Moreover, it is also too costly for the buyer itself since it needs time and competences typical of product's designers.

Kaplan and Haenlein[9] give therefore two definitions of mass customization: a visionary one and a working one which applies personalisation at fabrication/assembly stage.

Mass customization (working definition): "Mass customization is a strategy that creates value by some form of company-customer interaction at the fabrication/

[9] Kaplan and Haenlein (2006).

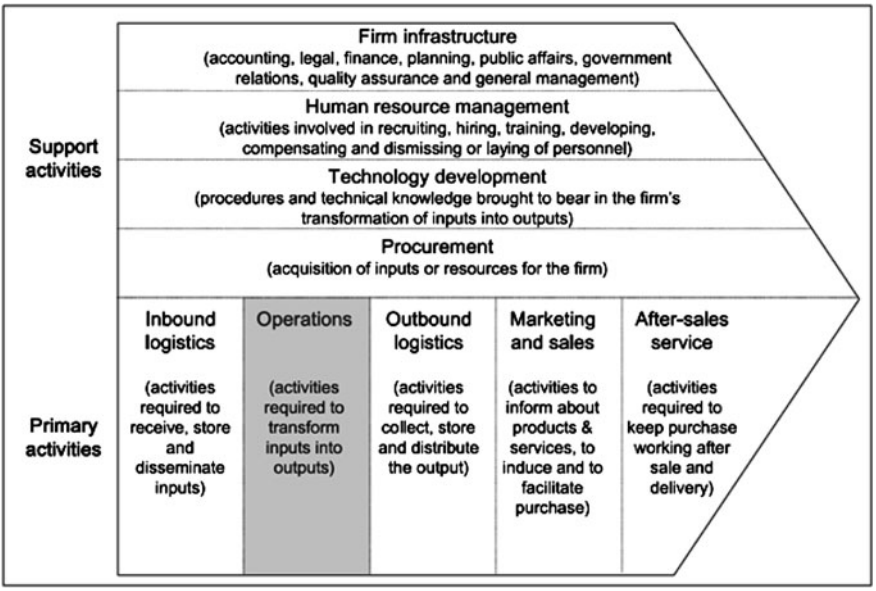

Fig. 2.3 Porter value chain for mass customization [Porter (1985) modified by Kaplan and Haenlein (2006)]

assembly stage of the operations level to create customized products with production cost and monetary price similar to those of mass-produced products".

Mass customization (visionary definition): "Mass customization is a strategy that creates value by some form of company-customer interaction at the design stage of the operations level to create customized products, following a hybrid strategy combining cost leadership and differentiation".

2.2 Electronic Mass Customization

The advent of the Internet, and in particular the graphical interactive World Wide Web, marks an important turning point in mass customization. Web interfaces are the ideal tool to dialoguing with the potential customer providing the necessary information about the product and collecting its preferences in a totally automatic way. This reduces considerably the time and costs for the first step of product's customization and can turn the buyers work into a pleasant experience which can further induct the need for a personalised object. Choice of the interface is clearly a crucial one, since it must be at the same time easy to use, complete and offer all the possibilities, and with good defaults choices.

An *easy to use* interface avoids frustrating a not-expert customer and keeps it from judging the personalisation task too difficult and thus leaving it.

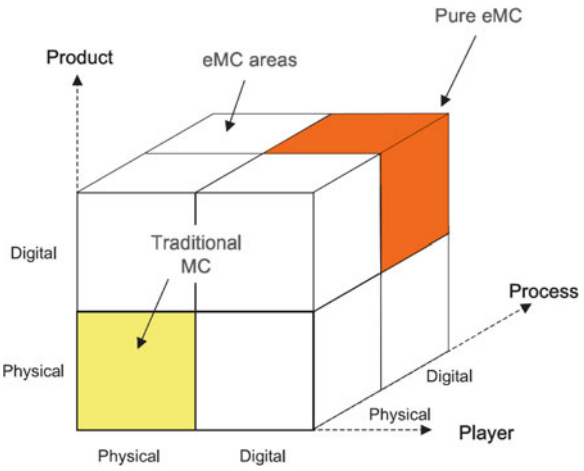

Fig. 2.4 Choi, Stahl and Whinstone model as modified by Kaplan and Haenlein [Kaplan and Haenlein (2006)]

An interface must be *complete*, in the sense that it must present to the user all the possibilities and each one with a clear indication of the impact on the final result. This is usually achieved through a product's picture which dynamically changes when the customers changes parameters, even through this solution works only for customization in the assembly stage.

Finally, the web interface must have *default choices* which speed up those potential buyers who do not need a deep personalisation or who do not have enough competences neither time to go through all the possible options. Clearly, the choice of these defaults must be very precise and possibly dynamically based on other individual customer's preferences or choices obtained through user profiling techniques.

Choi, Stahl and Whinstone[10] have suggested a three dimensional model for electronic commerce, which can be easily extended to electronic mass customization. The three dimensions (see Fig. 2.4) are the product dimension, which states how much digital is the sold object, the player dimension which defines the way the buyer interacts with the producer and the process dimension which distinguishes different ways for controlling the production process. Kaplan and Haenlein make the clear example of a customized newspaper: as long as it is printed on paper (physical product), assembled with a direct interaction with the clerk (physical process) based on user preferences expressed to an employee (physical player), it is an example of traditional mass customization. However, each of these three dimensions can be digitalized: the preferences gathering process can be transferred to a web interface, the assembling stage can be fully automated with the help of an appropriate program while the newspaper itself can become a digital electronic newspaper.

Although most companies offer their products for a similar price as the same, non customizable products, there is one decisive critical point in electronic mass

[10] Choi et al. (1997).

www.lanyman.com

Textil & Offsetdruck is a German textile printing company. The company was founded in 1984 and introduced mass customization in 2003.

The company offers customization of lanyard keychains. The customer can choose the colour (nine colours) of the lanyard keychain and add a personal text (2 lines with up to 30 characters each), choosing the font (15 fonts) and colour of the text (14 colours) as well as adding one of the 110 predefined symbols. The price of a customized lanyard keychain amounts to 8.90 €. One piece of a similar, non-customized product is priced approximately the same.

Table 2.4 lanyman.com shipping and handling conditions

Country	Cost (€)	Free shipping and handling from	Waiting time in days
Belgium	7.20	150 items	6–8
Bosnia-Herzegovina	9.65	150 items	9–12
Bulgaria	9.65	150 items	9–12
Germany	4.60	60 items	5–7
Denmark	8.60	150 items	7–9
Finland	24.70	150 items	10–13
France	13.50	150 items	8–10
Greece	7.60	150 items	11–19
Great Britain	7.60	150 items	7–9
Ireland	28.50	150 items	9–11

Even though lanyman offers customized products for the same price, as can be seen in Table 2.4 the extra costs boost the final price by 325% for Ireland, 152% for France and 52% for Germany, the country where the item is manufactured. Under these conditions many potential small customers will opt for other ways of personalizing the keychains.

Waiting time is instead fully acceptable for a personalised product, while it is absolutely not comparable to a buy of a standard keychain in a physical shop.

customization. As the customized products have to be dispatched the customer has to add additional costs for shipping and handling. Especially for low-cost articles shipping and handling cost can be more than the price of the article itself.

Thus, it would be favourably for companies to find convenient solutions regarding this matter in the short run, since this represent extra cost for the buyer and, as we have seen before, it is a crucial point for an effective mass customization. In the medium run, shipping and handling must approximate zero. This will increase competitiveness both to mass customizing and mass producing

companies and attract even customers which are not specifically searching for customizable products.

There are currently many solutions which can be borrowed from standard electronic commerce, which have exactly the same problems.

Intensive cooperation with dispatchers as well as with other companies is recommended. An increasing number of customers will reduce costs additionally and would make the customer feel he/she is saving money if several orders can be combined together reducing shipping costs. Free shipping and handling is not an impossible challenge, as the book industry shows: Amazon offers free shipping and handling for all new books with shipping destination in Germany, Austria, Belgium, Liechtenstein, Luxembourg, the Netherlands and Switzerland.[11] The book itself is offered to the same price customers have to pay in traditional bookshop.

Another possible solution is cooperation with shop chains which have many points of sale, possibly adding also local independent shop which can act simply as distributors to this network. With this solution shipping costs for the manufacturer can be drastically reduced, since orders to the same point can be combined together and at the same time customers would have the advantage of a personal dispatch from a physical reference person who represents the producer.

2.3 Mass Customization Strategies

In 2000, Spring and Dalrymple developed a mass customization typology from case study research and identified different roles of customization from four case studies.

Companies do not always use mass customization as a profitable business strategy but also as a way of forcing themselves to develop new capabilities.[12] According to Spring and Dalrymple, mass customization may be a vehicle for learning or a symbol to the industry and, moreover, it can be used to build an entry barrier to new competitors. Table 2.5 provides an overview of a strategies' typology.

This typology has more practical than academic relevance due to the limited number of underlying case studies. In 2007, Moser extended this typology and revealed three other roles of mass customization (see Sect. 1.3.2) from 14 case studies for a total of seven mass customization strategies (Table 2.6):

Table 2.7 gives an overview of the classification of case studies presented in this book according to Moser typology.[13]

As described in Sect. 1.3 and graphically shown in Fig. 1.8 a product can be defined as customized when at least one of the operational activities of design,

[11] http://www.amazon.de

[12] Spring and Dalrymple (2000).

[13] Moser (2007).

Table 2.5 Mass customization typology

Strategy	Rationale	Time of benefit	Costing philosophy	Volume required	Possible manufacturing issues
Entry barrier	Product may be unprofitable, but will keep competition out	Medium-term	Cost of account?	Depends on balance of potential loss of revenue and cumulative effect on manufacturing costs	Identify all costs; develop shared understanding of rationale
Vehicle for learning	Product may be unprofitable, but new organizational or technological capabilities will be learned	Very long-term	Indirect costs as product line overhead	Enough in various/demanding applications to accelerate learning	Capture learning and involve potential disseminators
Symbol to industry	Product may be unprofitable, but, if suitably communicated, it will enhance standing/brand in industry	Long-term	Indirect costs as general overhead	Minimum to achieve effect	Develop shared understanding of rationale
Profit-taker	Product attracts high price and makes profit in its own right	Immediate	Indirect costs charged to customer per product	Any profitable	

Source Spring and Dalrymple (2000)

Table 2.6 The seven mass customization strategies

Strategy	Rationale	Volume required
Sustainable mass customization business		
Profit-taker	Customized product attracts high price and makes profits in its own right	Any profitable
Vehicle for market entry	Offering a customized product attracts customers when other differentiation factors are missing for a market entry	Enough to attract a sufficient share of the market, create a profitable business and become a profit-taker
Path to mass producer	The basic principles and competencies for mass customization are applied to generate a superior mass production organization	Enough to be able to implement the basic mass customization competencies, pursue a profitable business today (profit-taker) and create a profitable mass production business in the future
Support of a non-mass customized business		
Entry barrier	Product may be unprofitable, but will keep competition out	Depends on balance of potential loss of revenue and cumulative effect on manufacturing costs
Symbol to industry	Product may be unprofitable, but suitably communicated, will enhance standing/brand in industry	Minimum to achieve effect
Vehicle for learning	Product may be unprofitable, but new organizational or technological capabilities will be learned. Focus on learning: marketing data	Enough in various/demanding applications to accelerate learning
Vehicle for increasing operational efficiency	Product may be unprofitable, but organization is able to capture data for improving operational efficiency	Enough in various/demanding applications to accelerate learning

Source Moser (2007)

Table 2.7 Classification of mass customization case studies according to the Moser typology (strategy)

Company name	Mass customization strategies
BMW (MINI)	Profit-taker
Dell, Inc.	Vehicle for market entry (in the past), profit-taker, entry barrier
Deutsche Post AG	Symbol to industry, vehicle for increasing operational efficiency
Edelwiser ski	Vehicle for market entry, profit taker
Gaspo Sportartikel GmbH	Vehicle for market entry, vehicle for increasing operational efficiency, profit-taker (future)
Jones Soda Co.	Entry barrier, symbol to industry
K-Swiss, Inc.	Symbol to industry, vehicle for learning
Mars, Inc.	Symbol to industry, vehicle for increasing operational efficiency
My Twinn, Inc.	Vehicle for market entry (in the past), profit-taker
PersonalNOVEL	Vehicle for market entry (in the past), profit-taker
Tastebook, Inc.	Vehicle for market entry, path to mass producer
Textil & Offsetdruck	Symbol to industry, vehicle for increasing operational efficiency, profit-taker
Timbuk2 Designs, Inc.	Vehicle for market entry (in the past), profit-taker

fabrication, assembly or distribution is carried out according to the customer's specifications. The level of customization depends on the technology used by the enterprise. The following section presents a simple but versatile mass customization model to demonstrate customized (see Sect. 1.3) using a simple LEGO™ car.

www.mykswiss.com

K-Swiss, Inc. is an American footwear company listed on the NASDAQ stock exchange. The company was founded in 1966 and introduced mass customization in 2005.

The company offers its customers the possibility to choose from three different men's and two different women's models as a base for the customization process. Depending on the selected model, the customer can choose between a palette of 19 different colours for 3–6 parts of the sneaker (base colour, outsole, stripe colour, overlay colour, shield colour, laces colour). Additionally, the customer may add a personal text composed of one to eight letters or numbers for which he may also choose the colour. The prices for the different models of sneakers range from US$ 65 to US$ 95. The identical non-customized product is priced at US$ 5 below the customizable product (Fig. 2.5).

Fig. 2.5 mykswiss.com customization process (screenshot)

Mykswiss offers personalised shoes for 6% more than standard shoes. Considering that the customization process allows for many variants which are not normally on sell and includes a name written on the back, which clearly cannot be pre-produced on stock, we can suppose that the production cost for K-Swiss is considerably higher than a standard product. This is therefore an example of a company which enters mass customization business to enforce its symbol among its customers (see Table 2.6).

2.3.1 A Demonstrative Model for Customized Assembly

The model[14] in this section demonstrates how a customized assembly strategy (see Sect. 1.3) works. This approach for mass customization has been selected because it is most widely followed by companies in many industries.

A simple LEGO™ car with a total of 30 components demonstrates this approach to mass customization. The LEGO™ blocks are ideal to demonstrate customized assembly since all components are pre-fabricated and customer involvement only takes place at the assembly stage (see Fig. 1.8).

The first level of customization of the car is offered by size variation, enabling customers to select between small, medium or large cars. Further customization is offered by colour selection for six parts in the car (steering-wheel, driver's seat,

[14] Basic idea adopted by Metta et al. (2007).

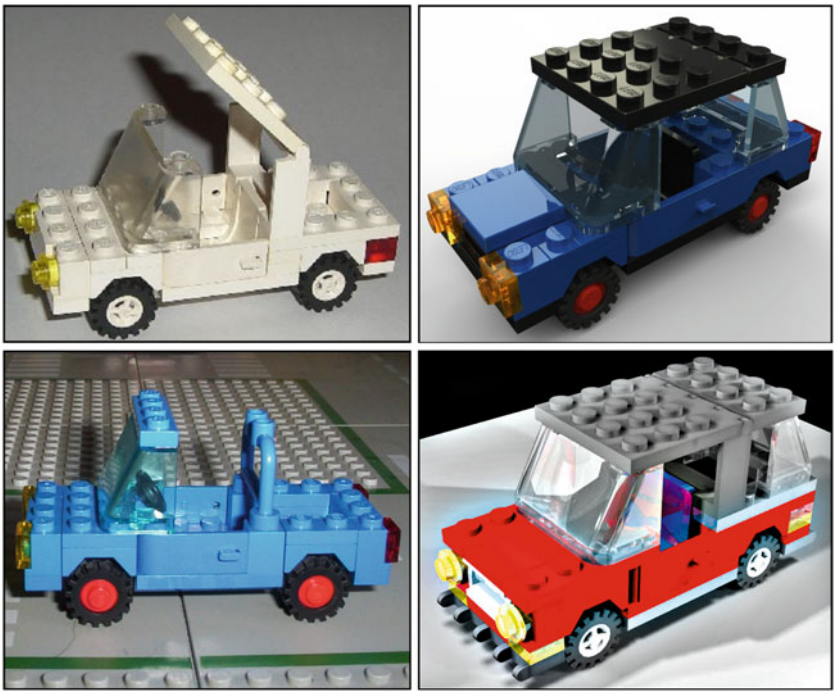

Fig. 2.6 LEGO™ car models

sunroof, car doors, headlights and tyres including rims). A number of eight different colours is available for each part. Considering all the colour and size options, the total car variants are equal to 786,432. The car model designed is shown in Fig. 2.6. Figure 2.7 shows the bill of materials (BOM) for the car indicating the customizable parts.

In order to produce the LEGO™ car according to the customer's specifications, preferences are expressed using a web-based interface. The customer navigates autonomously and configures the product. At first, the customer decides the size of the car. Then, the colour for the six customizable parts and finally the customer is asked to approve the visually shown car and to enter billing and shipping information.

When a company offers mass customization using customized assembly strategy the single parts are already fabricated at the moment when the customer places the order. The customer has therefore no possibility to design the single parts or to influence the fabrication process. The product is assembled after the customer orders it according to the requested specifications. In practice, most practical mass customization operations, as in this model, entail filling in a web form which sends an e-mail to the manufacturing plant where the product is produced by manual labour and then sent by mail to the customer. This represents the most widely used strategy at present.

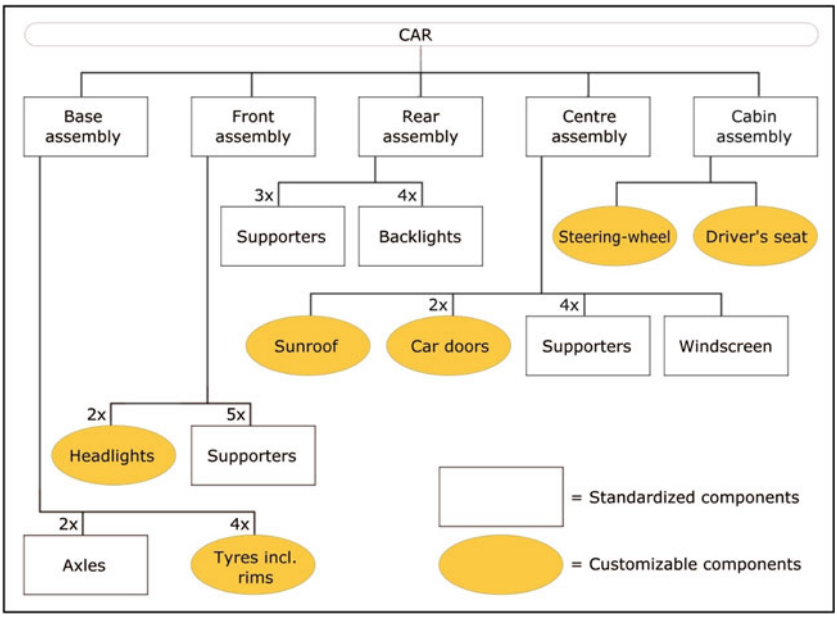

Fig. 2.7 Bill of materials (BOM) for car model

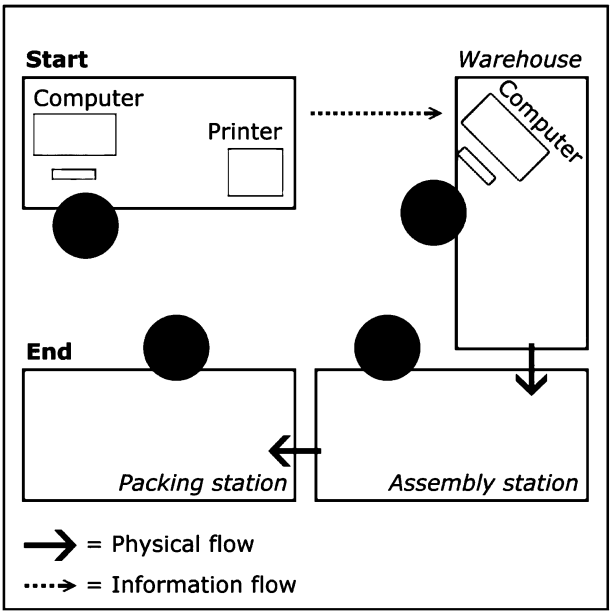

Fig. 2.8 Manufacturing plant organization

In the model, the customer places an order and the system sends the customized BOM to the manufacturing plant as shown in Fig. 2.8 where it is analyzed and forwarded to the warehouse. The warehouse is responsible for supplying the assembly station with the necessary parts according to the BOM. At the assembly station the product is composed using the individual parts. Finally, the finished product is passed on to the packing station where it is packed and sent by mail to the customer.

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