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Models of the emergence and diffusion of mass customization

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Abstract

Mass customization is a contemporary strategy to satisfy customer needs. The connection of product fit to individual customer needs (specific to the craft production) with price typical for mass production is the assumption of this strategy. The subject of the origin of mass customization strategy was taken in the study. Selected models are discussed in the development of this strategy and the factors supporting its diffusion in various industries. The article is based on literature studies.

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1. Introduction

The strategy of mass customization makes it possible for a company to design, manufacture and provide customers with large quantities of diverse products adapted to the specific needs of customers, within time and price which are typical of mass manufacturers (Tu, Vonderembse, & Ragu-Nathan, 2004). A properly implemented mass customization should combine the best characteristics of unit production with the advantages of mass production. Twenty years have passed from defining and determining the assumptions of this strategy. Throughout this period, it has become a permanent tool applied by companies in competitive fight and is mentioned as one of the major contemporary solutions with regard to the implementation of customers' orders which include the following (Lowson, 2003):

- mass production – manufacturing of standard products in large quantities with the assumption of obtaining the effect of the economies of scale,

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- lean production – consisting in eliminating wastage from any processes implemented in the company,
- mass customization – offering the possibilities of adapting the product to the customer's requirements without a significant increase in price,
- agile approach – a significant adaptation of the product to the customer's needs with a very short order completion time,
- flexible specialization – satisfying the needs of market niches using the combination of traditional forms of handicraft production with contemporary information solutions, reduction in the order completion time takes place as a result of cooperation with small specialized companies,
- simultaneous adaptation of several various action strategies to own supply chains.

Numerous scientific publications have already been published on the theoretical and practical aspects related to mass customization. These which relate to this strategy's origin and its relations with other methods and techniques of organization and management should be considered particularly interesting from the cognitive point of view. This type of studies makes it possible to better understand the essence of the strategy and the mechanisms of its cooperation with other organizational solutions the company.

This study is the continuation of research conducted by the author in previous years. In 2010 the methodology of implementing mass customization in production companies was analyzed. On the other hand, in 2011 the determinants of its implementation in companies became the subject of discussion. The implementation of the abovementioned topics demonstrated the need to undertake work in subsequent directions. On the one hand, the question what solutions and, first of all, organizational methods and techniques are especially helpful when implementing mass customization had to be asked. On the other hand, what characteristics should the company itself and its environment have so that the implementation of mass customization brings the expected results. The questions above indicate the fact that the following are interesting issues, both from the scientific and the practical point of view:

- the origin of mass customization,
- the evolution of operations management systems in companies in which mass customization was created,
- organizational solutions preceding the creation of this strategy which were its primary environment.

Answers to the questions above make it possible to understand both the conditions in which this strategy functions correctly in companies as well as the issue of creating an environment fostering its implementation in companies.

The purpose of this study is to present the origin of mass customization. For this purpose the following models of its formation have been presented: from the point of view of changes in company operation priorities, the development of production system and the evolution of organization and management methods. The basic characteristics of areas in which it was applied has also been presented. The characteristics sheds some light on the diffusion of mass customization. The study was created on the basis of literature studies.

2. Conditions for creation of mass customization – origin of concept

The literature on the subject presents various models for the creation of mass customization. Its origin may be examined from the point of view of changes in priorities observed by companies building their strategies for competing on the market, the development of production systems or the evolution of organization and management methods.

2.1. Creation of mass customization as compared to changes in company priorities

The search for balance between the product's price and the degree of its adaptation to individual customers is a permanent dilemma for manufacturers. On the one hand, mass production means low costs. On the other hand, a better adaptation of the product's characteristics and its functions to the buyer's needs means the possibility of obtaining a higher price. That is why, for example, a luxurious product which is usually characterized by a high degree of adaptation to requirements and an adequate price cannot be a mass product. Mass customization is

supposed to reconcile these extremes, namely make it possible to provide the customer with a product with a high degree of adaptation and a price comparable to a mass product.

The development of management sciences in the second half of the 20th century was accompanied by the search for priorities around which effective competitive strategies could be created. Kumar (2004) presents a four-element model of the development of approach regarding operations management which preceded the creation of mass customization (Fig. 1).

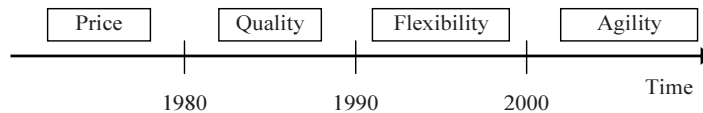


Fig. 1. Changes in operations management priorities in the American industry.
Source: Kumar (2004)

The low price should be considered the first clearly visible priority. It could be obtained only as a result of a radical reduction in production costs. Production systems designed according to it were characterized by high productivity and effectiveness from the point of view of unit costs. However, they had a number of defects including (Kumar, 2004):

- high initial costs (related to the need to purchase highly specialized equipment),
- one-way flow of information (from high management downwards, with a very limited share of feedback),
- sequential placement of positions according to the product's design,
- high level of production automation limiting requirements regarding employee qualifications,
- focus on using the economies of scale.

Nowadays, the strategy above proves correct only on mass markets characterized by high sensitivity to the price.

According to the presented model the American market has been transformed from the middle of the 1970s. The transformation was mainly caused by changes in customer preferences. Consumers began to search for products which were better adapted to their own lifestyle and which had better quality. Instead, they agreed to pay a higher price. The change in situation became particularly visible with regard to the relation manufacturer-customer. Previously mass manufacturers "decided" themselves what was better for the customers. In the new reality the customer wanted to choose a product which suited him best and not necessarily the cheapest one. The new situation became the basis for revising views with regard to operations management, which was particularly severe in the case of companies with very expensive and specialized equipment designed for the needs of mass production.

According to A. Kumar, the next breakthrough moment was the middle of the 1980s. Contrary to general expectations, competitive struggle (at least on the American market) were not focused on product customization and improvement in the flexibility of operation but, in response to the expansion of Japanese companies, the focused on pro-quality activities (Kumar, 2004).

In the next period, in the second half of the 1980s, the set of tools used in competitive struggle by production companies, apart from price and quality, was supplemented by flexibility – understood as the ability to adapt the offer to the customer's expectations as well as the speed of converting ideas into ready-made products (often defined as agility) (Kumar, 2004). At the same time, it was assumed that effective competition requires the selection of one of the strategies above. This resulted from the view that the attempt to use several at the same time will lead, e.g. to an increase in the product's price and, for this reason, its rejection by the market as too expensive.

This belief was present for a short period of time. A clear step towards the rejection of the belief about the need to adhere to one strategy was made by the Japanese. At the end of the 1980s Japanese companies successfully implemented actions aiming at the reconciliation of low unit costs with the offer's flexibility. For this purpose, flexible production systems in combination with robotization and computer assistance production were implemented on a larger scale than before (Kumar, 2004).

A. Kumar believes that Japanese solutions from the end of the 1980s were already very similar to the current definition of mass customization. The deviated from it only in terms of production costs which were radically reduced later on by applying a modular structure of products and technological innovations (Kumar, 2004).

Therefore, American companies were again left behind because their management seemed to be too concentrated on competing with the Japanese by using quality and flexibility. The Americans intended first to obtain the Far Eastern level in both mentioned planes and then win by using modern technologies. However, despite numerous efforts, none of these intentions became successful.

The next step was to check whether it is still possible to simultaneously use all four priorities, namely price, quality, flexibility and agility. In 1990 Ferdows and De Meyer presented "Sand Cone" model. The idea of this model was to present the sequence according to which priorities in operations activities should be selected. The following sequence was considered optimum: quality, dependability of the production system, flexibility of production and cost effectiveness at the end (Fig. 2). Proceeding consistent with the indicated sequence should in assumption system make it possible achieve harmonious benefits from the application of all four priorities as part of one production system.

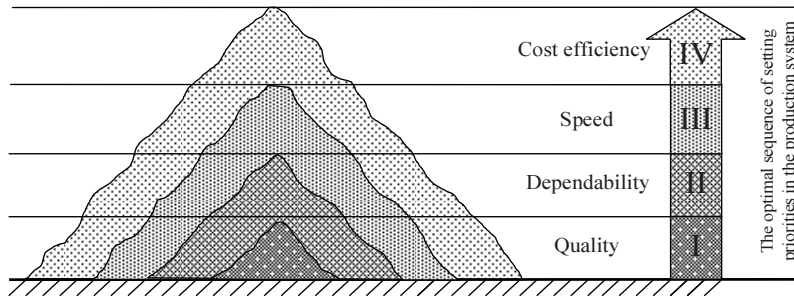


Fig. 2. Sand Cone model.
Source: Ferdows & De Meyer (1990)

At the turn of the 20th and the 21st centuries information technology developed in an accelerated manner. This applied, in particular, to communication with the use of the Internet. According to Kumar entrepreneurs became aware that the period in which it was possible to compete only on the basis of one factor ended. There will always be someone on the global market who will use all four priorities in the struggle and will even add another one which may be, for example, better customer service. The Internet has made it much easier for customers to compare offers. The customer may "demand and receive a high-quality product with a high degree of customization, quick delivery and all this at the lowest price" (Kumar, 2004). Mass customization may be indicated as a solution meeting all the requirements above. On the one hand, this strategy, in assumption, makes it possible to adapt the product to a specific customer, by using relevant communication technologies and the product's structure. On the other hand, it is implemented in the production system which, due to the transition of the evolution above, makes it possible to achieve targets with regard to price and quality.

2.2. Origin of mass customization from the point of view of development of production systems

The creation of mass customization may be considered in the context of the development of production systems. According to Babiarz *et al.* (2008) mass customization was created as a result of the evolution which took place according to the scheme presented in Fig. 3.

Even at the turn of the 19th and 20th centuries numerous goods were made using handicraft methods. These methods have been known to man for thousands of years. They are characterized by high requirements with regard to skills, using simple tools and high labor consumption. Manufactures using this form of production were most often companies consisting of several persons.

The basic changes in the next period included in the model, namely handicraft production, were the increase in the company's size, the use of labor division to a greater extent and the use of machines on a larger scale (Babiarz *et al.*, 2013). In the period of handicraft production, entrepreneurs accepted orders directly from customers and then completed them according to arrangements determined when the contract was concluded. For example, when a customer ordered a car in the 1890s in the company Panhard and Levassor (P&L) he could ask for the driving wheel to be moved from the right to the left side using the standard chassis and engine (Womack, Jones, & Roos, 2008).

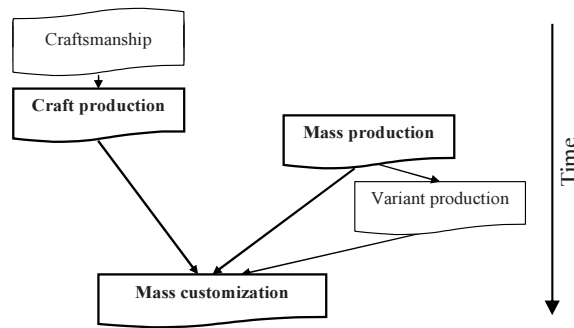


Fig. 3. Creation of mass customization in the context of the development of production systems.

Source: Babiarz *et al.* (2008)

Direct contact between the buyer and the manufacturer in combination with production on a very small scale was made possible by far reaching adaptations of the manufactured product to the customer's wishes. The side effect was the lack of repeatability in production. For example, in the car industry each subsequent copy built in this period differed from others to a larger or smaller extent. The lack of the interchangeability of parts and the necessity to fit them during the assembly was a great problem. The quality of products manufactured in this way was the result of numerous factors, including, among others: the contractor's experience and his diligence when assembling the final product. The inseparable characteristics of handicraft production were: high production costs independent of the quantity of manufactured products, a crude structure having negative impact on the product's reliability, insufficient resources for conducting research and the implementation of new technologies (Womack, Jones, & Roos, 2008). The last factor, in particular, blocked further progress in a number of industries in this period.

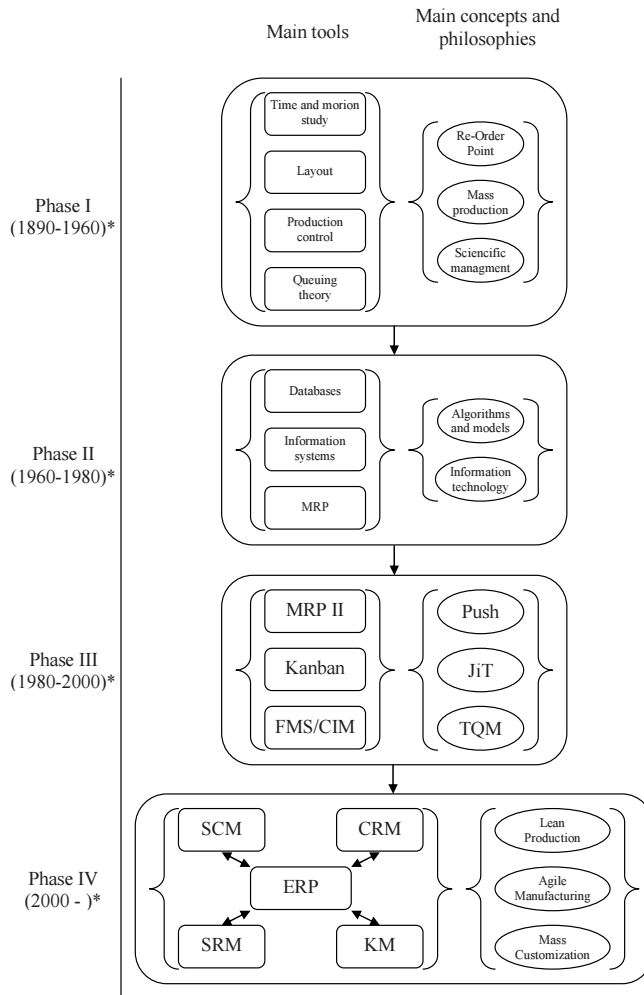
The next stage – mass production, is commonly connected with the start of the model T production in Ford's plants in the second decade of the 20th century. The most important elements distinguishing mass production from handicraft production include: the introduction of specialized machines at a large scale, the use of assembly lines, the effective use of the interchangeability of parts and far reaching specialization of employees. An significant feature was also the introduction of the so-called "production for the warehouse". The previous handicraft forms were dominated by completing orders for specific customers. Using mass production made it possible to substantially reduce unit costs and, at the same time, reduce the product's price which, as a result, became available to a much wider group of customers. This is a significant advantage of this form of production. The second significant advantage is the possibility to achieve high-quality products as a result of a stable process and the possibility to distribute research costs and design for a large number of sold pieces.

The next element placed in the model is variant production consisting in manufacturing numerous variants of the same product. This solution, in assumption, was supposed to limit the main defect of mass production, namely offering the same product to all customers. However, just like mass production, it assumes producing for the warehouse which, in combination with the existence of numerous variants of the product, leads to a complication of the production, warehouse and distribution process. In addition, the risk that part of the production will not be sold increases (Babiarz *et al.*, 2013).

To sum up the model above – mass customization is the effect of the combination of mature solutions regarding handicraft production and mass production along with its later modifications.

2.3. Creation of mass customization in the light of the development of management methods and concepts

The origin of mass customization may be subjected to analysis from the point of view of the development of the widely understood operations management. A complex view has been presented by a team consisting of: Bayraktar, Jothiskankar, Tatoglu and Wu. These authors traced the most significant directions in changes which occurred in management in the 20th century. Their model suggested a division of the analyzed period into the four most significant phases (Fig. 4).



* – due to the special character of the creation and development of management tools, the dates should be treated conventionally. Their function is to signal the time intervals discussed in the study in the figure.

Fig. 4. Evolution of operations management.
Source: Bayraktar *et al.* (2007)

Phase I is the turn of the 19th and the 20th centuries and the first half of the 20th century. The authors of the model referred to it as ROP (Re-Order Point). This phase should be identified with the achievements of management pioneers and precursors. The main problem in this period was increasing the efficiency of workers. For this purpose, the following organizational tools have been developed: time and motion study, placement optimization methods, control methods, the theory of queues, classified as achievements of the so-called scientific management (Bayraktar *et al.*, 2007). From the end of World War II until the 1960s, a number of models and algorithms which were supposed to optimize the functioning of selected areas in companies were created. Mass production developed in this period made it possible to achieve the economies of scale and struggle with the competition using low prices. The main idea for solutions from phase I was an efficient supplementation of the stock of ready-made products.

The authors of the model connect the beginning of phase II with the first use of computer science in management (the 1960s) and the later development of MRP class systems (the 1970s) namely the computerization of control over production processes. As a consequence of the development of information technology and related fast decrease in the costs of constructing IT systems integrated management systems appeared. They automated a number of actions

related to planning, implementation and the control of activities in companies. Therefore, solutions based on the push philosophy were consolidated. This phase is also the creation of flexible manufacturing systems (FMS) and computer integrated manufacturing (CIM).

Entering phase III took place in the early 1980s and is related to the successes of Japanese products on global markets. Increasing competition resulted in the growing interest in such solutions as TQM, JiT and MRP and the decreasing rank of traditional organizational tools coming from the period of the engineering school (Bayraktar *et al.*, 2007). In addition, the Japanese proved that effective competition on the market does not require complicated and expensive integrated management systems. In phase III the evolution proceeded from searching for the possibilities of reducing cost to quality improvement. This effect was obtained combining achievements related to computer science with the leaning philosophy. This is also a period of opposing push solutions – typical of American and European companies, and the pull approach – typical of the Japanese organizational culture. Phase III is also the time of increasing interest in consumers, as one of the stakeholder groups in companies, and hence increased attention towards their needs (Bayraktar *et al.*, 2007).

Phase IV which began at the turn of the 20th and the 21st centuries are far reaching changes on markets related to their globalization and the development of the Internet. After the period in which the cost and quality were considered the most significant competition factors, markets became focused on satisfying more and more variable customer needs. The most significant priorities for companies became the cost, quality, time of delivery and flexibility of operations at the same time. As a result, a new action strategy defined as mass customization emerged (Bayraktar *et al.*, 2007). In order to use mass customization in practice, a far reaching integration of all functions in the company turned out to be necessary. This task is partly completed by contemporary IT management systems of which the following have been highlighted in the model:

- SCM (Supply Chain Management) – supply chain management with emphasis on an effective transfer of both materials and information between various links of the logistic chain (when all competing companies use similar solutions regarding the organization of production and the efficiency of logistic systems becomes more and more significant),
- SRM (Supplier Relationship Management) – a complex depiction of relations with all suppliers and not only, as it was often the case, with the largest partners (this system is supposed to create long-term cooperation relations inside the value chain),
- CRM (Customer Relationship Management) – in assumption, supports the process of creating strong relations with customers (this objective is used, among others, by the use of all available communication channels in contacts as well as the automated process of acquiring information about customer behavior and needs),
- KM (Knowledge Management) – solutions aimed at increasing the level of using knowledge available in the company and thus its transformation into a true learning organization,
- ERP (Enterprise Resource Planning) – a central element of the IT management infrastructure integrating the functioning of the remaining systems.

The far reaching integration of IT and production systems is the basic element distinguishing mass customization solutions from previous approaches taking into account the possibility to adapt the product to the customer's needs (Bardakci & Whitelock, 2003). Apart from the above mentioned IT systems, the model emphasizes the three most significant concepts/strategies for phase IV: lean production, agile manufacturing and mass customization. Lean production is a concept commonly known and the most significant effects achieved with its use include the elimination of wastage from processes, the focus on values and the formation of the habit of continuous improvement among people (kaizen). On the contrary, the essence of the agile approach in production has been described by H.M. Hormozi as follows: this is a new manufacturing method making it possible to obtain competitive advantage. Companies which have implemented it "produce high-quality and defect-free products with a short time of marketing (Hormozi, 2009). (...) The purpose of the agile approach is the delivery of products which fully satisfy the customer's requirements and needs".

Despite the fact that mass customization in the presented model has been placed on equal terms with the lean and agile approach it appears that this strategy requires the company to be at least "lean", "agile" to a significant extent

and well computerized in order to function effectively. Only in such configuration will the company be able to effectively provide customers with customized products.

3. Conditions for diffusion of mass customization

Mass customization is not a completely universal strategy which proves in all conditions in which companies function on markets. Specified conditions need to be met for its effective operation. First of all, there needs to be a specified combination of the production scale for a particular product and the nature of the processes in which it is manufactured (Fig. 5).

The discussed strategy will not prove correct both in the case of typical mass products and in specialized unit production. In addition, the process which is supposed to provide customized production should constitute a combination of a certain number of invariable (standard) operations – repeated for each item of the product – with operations which may be shaped as necessary.

The literature on the subject has numerous studies the authors of which indicate the conditions for success when implementing mass customization. And thus, for example, Chandra and Grabis classify the following as factors which determine the emergence and the development of mass customization on a given market (2004):

- the customer's tendency to bear additional costs and involvement in the customization process, as well as the readiness to wait for the delivery of the product,
- susceptibility of the product and processes to customization,
- competitive market characterized by a high variability of customer requirements,
- the readiness of companies operating on the analyzed market to adapt new solutions and undertake competitive struggle, as well as to share knowledge inside own chains of creating value.

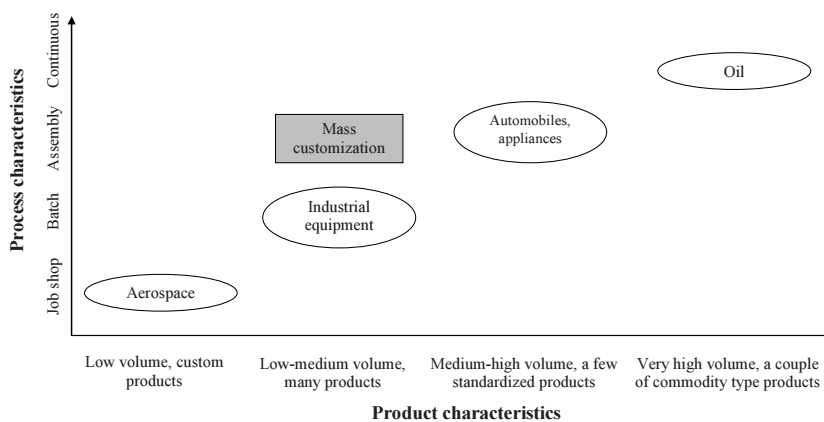


Fig. 5. Scope of application of mass customization in product-process arrangement.

Source: Chandra, & Grabis (2004)

Factors fostering the introduction and the development of mass customization may be divided into, according to J. Broekhuizen & Alsem (2002):

- internal – resulting from the company's characteristics,
- external – connected with the organization's environment – which included: the customer, the product, the market and the trade¹.

¹ Widely, these factors are discussed in the paper: (Walczak, 2011).

At the same time, the company is subject to influences coming both from the inside and the outside (Onken, 2011). The temptation to acquire additional customers and, at the same time, benefit from the advantages of mass production appears inside the organization. The following phenomena intensify on the outside:

1. The company's search for ways of increasing customer satisfaction. In the case of mass customization, new technologies in many cases make it possible for customers to design their product on their own.
2. Globalization – disappearing barriers in cooperation of companies from all over the world. On the one hand, globalization creates new possibilities. On the other hand, it stimulates competition. The pressure to reduce costs, which may be achieved by using the economies of scale, still intensifies. On the other hand, increasing the volume of production forces the acquisition of new markets characterized by other preferences and customer requirements and thus requiring adapted products.
3. Technology. Technical progress with regard to information-communication systems, flexible manufacturing systems and logistics is of special significance for the development and dissemination of mass customization. IT systems, first of all those based on Internet communication, simplify the gathering of information necessary to prepare the order, control warehouses, production and transport not only with respect to one company but globally in the entire chain of value creation. Flexible production systems make it possible to modify the production process even to complete a single piece without a significant increase in the costs. On the contrary, modern logistic solutions greatly reduce the time and expenses incurred between placing the order and delivering the finished product to the customer, even when the production actually took place in a distant geographic location.

Mass customization thus proves the companies' response to the combination of numerous factors which gradually but systematically affected the change in relations between market participants.

4. Areas of application of mass customization in practice

The literature lists numerous implementations of mass customization. Sigala widely describes the mobile telephone industry (Sigala, 2006), Onken – the sports clothes manufacturer – the company Nike (Onken, 2011). Kumar (2004), referring to other authors, lists: Dell Computer Corporation – regarding the production of PC computers, McGraw Hill (financial and educational services) – regarding the print of academic books in the JiT system, Lenscrafters (opticians) – making glasses within one hour, Motorola (telecommunications electronics) – the production of pagers, Hertz (car rentals) – the delivery of a car consistent with the customer's preferences (at an attractive price, service available only for holders of the gold card), Cemex (cement plants) – the preparation of cement with parameters compliant with the customer's requirements within two hours. Among the remaining described applications: Amazon (online stores), Yahoo (Internet content), Acumins (the production of multivitamins), ChemStation (chemistry, detergents), Lands' End (clothes), Lutro Electronics (lighting systems), Procter & Gamble (cosmetic products), TaylorMade (golf clubs), Ultra Pac (plastic containers), Yankee Handle (candles), Microsoft, IBM, SAP, Oracle (IT industry) – the creation of modular software, TC2 (clothes) – adapting sizes to the customer's figure, Ford, GM, Chrysler, BMW (automotive industry) – the form of product delivery to the customer, attempts at application when designing (Kumar, 2004).

The large variety in terms of trades in which mass customization was used makes it possible to believe that this strategy is highly universal. On the other hand, studies about its application in services are not as numerous. This condition is related to the specific character of services. The production of a service in many cases directly precedes or is even linked to its consumption and, as a consequence, this is a good which cannot be stored. In addition, the service is most often conducted on the basis of direct agreements with the customer. Therefore, the very nature of the service has a high degree of adaptation to the customer's requirements.

5. Conclusion

One of the first authors indicating the need to manufacture products adapted to the customer's individual needs on a large scale was the futurist A. Toffler. In 1970 he contained his reflections in the book entitled "Future shock"

(Aurand, 2004). However, the interest in this type of approach in the world literature began in the middle of the 1990s. It was preceded by a number of transformations of the approach of companies to the order completion problem as well as changes in customer awareness. The analyzed models, in this paper, try to demonstrate the sequence of these transformations indicating, at the same time, the most significant factors affecting the creation of mass customization.

In the context of further research and from a scientific point of view, it seems to be interesting to investigate the diffusion of mass customization issues and problems related to its use in practice. With regard to diffusion, the analysis should be focused on the first records of implementation of the strategy in different sectors. In regard to the identification of problems during the practical application of mass customization, analysis should be devoted to case studies, especially those where a failure or only a partial benefit have appeared.

In the future, we should expect a further development and diffusion of mass customization in subsequent trades. This will be fostered not only by factors which have so far resulted in its creation and evolution. In the case of production, an increasing role will be played by fully robotized systems with ever greater flexibility. The 3D printing technology seems to be very promising in this aspect. On the other hand, regarding the identification of the customer's requirements, IT systems gathering information from numerous distributed sources and then analyzing them and searching for patterns in the behavior of particular customers will play an increasing role.

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