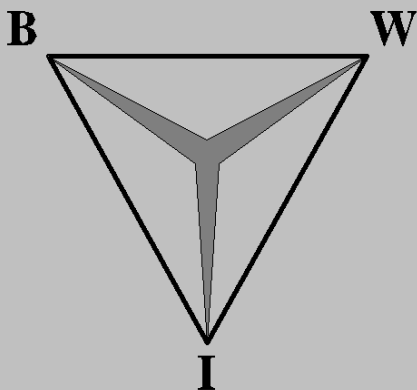


Mass Customization

Will the customer finally be in control?



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1 Preface

“What exactly is Mass Customization?” was the first thought that came up in my mind when I saw this combination of apparent opposite words. Opposite, because clearly there are many differences between customized and mass products. Customized products have been formed to satisfy as many of the customer’s specific desires as possible. For mass products on the other hand, all choices about the design and features of the product are being made by the supplier, which leaves the customer to ‘take it or leave it’. Of course, they do aim to fulfill the wishes of the majority of the people.

Another point of interest, which will be proven in this report, is the apparent versatility of this subject: it is a business economical change, which has been made possible by technological and mathematical developments.

The more time that went by, the more I became interested in this subject. This feeling was intensified during my traineeship at one of the major publishers of the Netherlands, Holdingmaatschappij N.V. Dagblad De Telegraaf. Despite of the little knowledge that I had about mass customization, I began to think about the eventual possibilities that it could offer in this economic segment. This was enhanced by the possibility to discuss about this topic with people from marketing and logistics.

Besides showing gratitude to my former colleagues, I would like to thank Prof. Dr. A.E. Eiben from the Free University, my supervisor during this research, for the time and energy that he has put in this report.

1.1 Goals of the report

The goal of this report can be split into three pieces. First of all, I would like to give a brief analysis of the origin of mass customization, the benefits, the limits, the requirements and last but not least the possibilities that it offers.

My second goal is to determine several economical, mathematical and computer science influences that are related to the development of mass customization.

Thirdly, I want to check whether mass customization is more than just an enormous enthusiasm from suppliers, who are eager to use the slogan that “the customer will be in complete control”. In other words, what are the real benefits that customers can achieve from mass customization?

1.2 Structure of the report

To keep this report in clear order I have divided it into three parts:

- **‘Past’**, the first part, describes the evolution of production methods, including the latest shift from mass production to mass customization.
- In **‘Present’** mass customization will be examined. The different features, possibilities and the requirements will be mentioned first, followed by some practical examples.
- The third part, **‘Future’**, will concern new uses of mass customization that could be expected in the future, in which kind of companies and under which restrictions this will become possible.
At the end of this part, attention will be especially given to the possibilities that mass customization provides to a (online) publisher.

2 Executive Summary

At present producers are in the middle of the successor of the first two Industrial Revolutions. This Third Industrial Revolution differs fundamentally from the previous two revolutions, since it is focused on improving the position of the customer. During the First and Second Industrial Revolution the focus was on machinery, respectively the introduction and the refining of machinery in the production processes.

The theoretical foundation directly emphasizes the benefits for the customer by stating that companies must optimize the degree of customization in their products, while offering them for the same (or lower) price as if they were mass-produced.

Companies can only fulfill these conditions by changing their whole production process dramatically. Among these changes are the introduction of modular product architectures, improved logistics, inclusion of one-to-one marketing and creation of an optimal and effective information flow, that connects all aspects of the company. Many of these features also appear in previous production methods, thus showing the natural evolution of production methods.

According to the theory and prominent economists mass customization is for many companies becoming an inevitable means for survival in the market place. Although the actual realization of mass customization is hard to map, the current state of the digital portals, that companies use for mass customization, does not strengthen the assumption that the practical development is equally extensive as the theoretical one.

The value of Internet for mass customization consists of the possibilities it provides for personalized marketing. The Internet is the best way to achieve interactivity with the customers. Therefore, the poor situation of most websites can be used as an indication that the implementation of mass customization is not yet as successful as it should and could be.

The apparent reluctance towards mass customization is caused by uncertainty. Uncertainty about revenues, while the costs for the initial investments are considerable. The chain reversal, the shift from a push model (with the company in control) to a pull model (with the customer in control), also brings along a needed mentality change in the production process. The uncertainty about the implementation is a pity, since also the companies will benefit of mass customization. In a time when product and price differentiation is more difficult to accomplish, mass customization offers possibilities to gain customer loyalty. By offering the customer products he desires and by personalized attention (marketing) the customer will become less eager to move towards the competition when the quality and price differences remain minimal.

Despite of all the good intentions that mass customization has for customers, they should remain careful. A risk of mass customization for customers is receiving an overkill of variety. The increased influence and power of the customer also obliges them to have more specific knowledge about the desired product. They should finally be careful that companies will not try to withdraw their information function for the customer, since this is essential.

On a more specified level, during this report it turned out that in the next years customized services can be expected from some important Dutch publishers. The Digi-dition concept, which is already in its testing phase, could become an proper realization of mass customization by offering customizable and digitizable news.

Apart from this concept, I am convinced that many other realizations will appear over the next years and will so be clearing the way for achieving the final goal: mass individualism.

Once mass customization (since mass individualism will take a lot of time to develop) will have become the standard for most companies, the customer has finally gone beyond being the final part of the supply chain. He will be involved in the construction of the product from the design phase till the delivery phase as a respected and influential partner, although the companies will always remain to be the final decision maker.

PAST

3 Evolution

Figure 1 shows the evolution of the main production method from 1914 until now. From craft production to mass production, from mass production to lean production and finally to mass customization. This figure, which is based on the American history, will be used as the red line through this chapter. The different models will be discussed briefly and the differences between them will be pointed out.

Although Figure 1 is most characterizing for the situation in the United States of America (USA), it will turn out that the different ideas that laid the foundation for new production methods had a global influence. In fact, for Europe and Japan (the most competitive parties) the same figure is applicable, only with slightly different years.

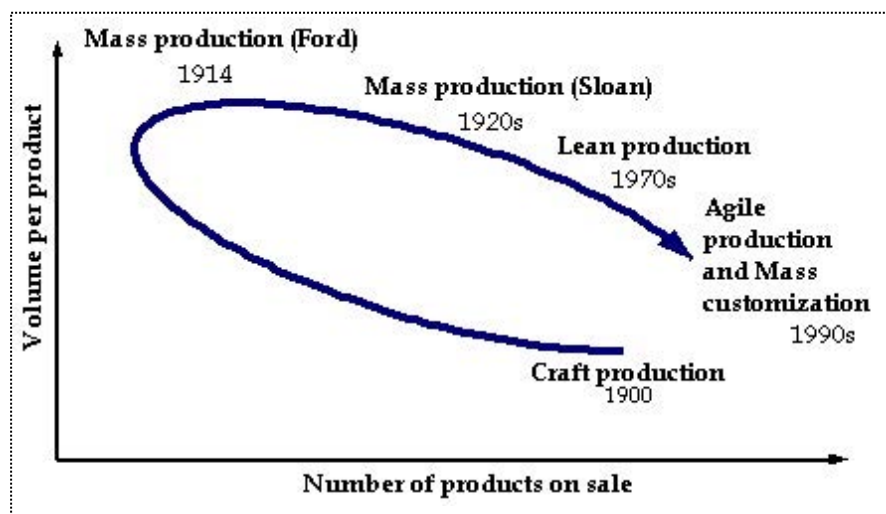


Figure 1. The evolution of production method

(Source: [8])

3.1 Craftsmanship (1750 - 1850)

In the long history that led to the recent mass customization, two industrial revolutions took place. Before both of them, however, there was only one method for producing products: craftsmanship.

Craftsmanship meant customized production strictly on demand. The price of the product was determined by working time and the raw materials that were needed by the craftsman to fulfill the wishes of the customer. This construction made the price very transparent.

Advantages	Disadvantages
Customized	Expensive
Transparent price	Low volume
Flexibility	Long production process
	No fixed quality

Figure 2. The advantages and disadvantages of craftsmanship

As Figure 2 shows, craftsmanship did not remain to be satisfying and was followed by a new method. Especially the duration of the production process and the related expensiveness led to a change.

This evolution during the First Industrial Revolution (FIR) took place in the nineteenth century and was basically a technological one. It introduced the linking of labor to (steam-driven) machines. The fundamental thought behind the FIR is best described by Piore and Sabel [11]:

Its foundation was the idea that machines and processes could augment the craftsman's skill, allowing the worker to embody his or her knowledge in ever more varied products: the more flexible the machine, the more widely applicable the process, the more it expanded the craftsman's capacity for productive expression.

The FIR and the new way of manufacturing it resulted in had it's origin in Europe. It was later brought to perfection by the USA as the American System of Manufacturers. This would turn out to be the beginning of the worldwide manufacturing dominance of the USA, passing the traditional leader Great Britain.

3.2 American System of Manufacturers (1800 - 1900)

The American System of Manufacturers (ASM) is an improvement of the factory system that appeared in both the USA and Europe after the FIS. The characteristics of the ASM that, according to Nathan Rosenberg [13], distinguished it from the prior methods, are shown in *Figure 3*.

The first two characteristics, 'interchangeable parts' and 'specialized machines', form the fundament of the ASM. Before, a time-consuming effort was needed to create a final product from all different parts. Time-consuming, since there were no standard sizes and no reliable suppliers. The construction and use of these interchangeable parts led to the construction of specialized machines, which all made only one certain part of the final product.

However, not all characteristics that are mentioned had the same importance, but the success of ASM within one firm was dependent of the combination of them. It is curious though, that the social environment in Europe caused that no European company was able to successfully integrate ASM. It proved to be unable to satisfy the last five characteristics of *Figure 3*.

Interchangeable parts
Specialized machines
Reliance on suppliers
Focus on the process of production
Division of labor
Skills of American workers
Flexibility
Continuous technological improvement

Figure 3. Characteristics of the ASM (Source: [8])

3.3 Mass Production (1890 - 1970)

During the beginning of the twentieth century, the ASM could no longer meet the needs of the market. The demand had grown enormously, due to the continuous social development and the rise of towns.

A solution to fulfill the increasing demand was first introduced by Henry Ford in his automobile factory. This took place in 1908, after overcoming much resistance and disbelief against his new idea. In his view the costs of any product could dramatically be reduced by substituting human skill by machinery. This was possible since machinery had become more and more advanced.

This new production process was called 'mass production' since this process was developed to create a standard product that would comply with the requirements of the (majority of the) masses. The relative little group that asked for specific qualities was bluntly denied and had to look for a 'traditional' craftsman.

By focusing on the masses, it was possible to gain high returns on standardized products, since those could be produced against relative low costs. The more standardized the product was, the more efficient and specialized the machines could be.

Since mass production had its origin in the ASM, many characteristics of the ASM also apply for mass production (the first four of *Figure 3*). *Figure 4* shows the additional characteristics that lead the way for the 'revolutionary change' during this Second Industrial Revolution.

Flow
Focus on low costs and low prices
Economies of scale
Product standardization
Degree of specialization
Focus on operational efficiency
Hierarchical organization with professional managers
Vertical integration

Figure 4. Additional characteristics of mass production (Source: [8])

The effect of mass production on the economic world is even today, 94 years later, clearly visible. Although most companies have already understood that pure mass production is not the only answer anymore. The main disadvantage of mass production turned out to be the inflexibility of the production process in both volume and product construction.

3.4 Lean production (1970 - 1990)

In the 1970s a new production method rose, which was based on both craftsmanship and mass production and was first introduced by Taiichi Ohno in the Toyota company. This so-called lean production or Just-in-Time (JIT) method focused on low costs and a high flexibility in products.

Lean production meant producing a large number of variants of a single product. All these variants were made out of selection of the standardized parts. The strength of lean production is that it 'cleans' the production process. Due to an almost perfect organization and tuning between the different process segments and even between cooperating companies, the standardized parts could continuously flow through the complete production process. Since every produced item could be used directly, a lot of money was being saved on stock costs and inefficient machine use.

Although one of the main differences between lean production and mass production was the variety in products, this was also its weakest spot. Since the choice of products was completely made by the producing company, many customers were overwhelmed by the many equivalent products. Companies failed to realize that customers do not want 'everything', they 'only' want the product that fulfills their needs and desires.

As seen with previous production methods, the use and effect of lean production was not equal worldwide. While in Japan the impact was enormous, European and American companies were considerably less capable in implementing lean production. Once again, this was mainly caused by social factors. Particularly the high degree of control proved to be possible in Japanese companies. The less successful usage of lean production outside Japan caused that people now talk about the transition from mass production to mass customization, instead of from lean production.

3.5 Conclusion

Like always, a lot can be learned by looking at the history. From the characteristics of the different production methods it should be concluded that a perfect method does not exist. The 'best' production method however depends on the economical, technological and on the social environment. The first two will be clear since economical and technological elements are the visible parts of any production method. The latter however, may need some explanation.

For example, the Japanese usage of JIT leads to many benefits. European and American companies however, fail to copy the implementation of JIT. Since the economical and technological factors in Europe and USA do not differ from the Japanese factors, the social factors remain. Among these, which differ demographically, are vague terms as mentality, tradition and social state. I use the term vague to indicate the difficulty to 'rate' these factors.

The development of the role of the customer however, is also interesting to follow. His influence first grew when offer increased faster than demand and later when the customer became more mature. Through globalization, he began to know better what could be offered against what price. It is no coincidence that every change in production method was accompanied by a change in customer behavior or state, in fact important changes has been caused by him.

It should also be said that over the years the customer has matured in his knowledge about the market, the products and the price. Unfortunately, it is also still true that all choices concerning the qualifications, price and number of products offered are only being made by companies.

Therefore, the conclusion up till now (at the beginning of mass customization) should be that the customer is not king, not even by a long shot, but at least companies have learned to consider him as a full partner, instead of an anonymous buyer.

PRESENT

4 Introduction to Mass Customization

The 19th century French poet Alphonse Karr wrote, while referring to the immutability of human nature during social and technological change:

'Plus a change, plus c'est la m'me chose.'

(The more it changes, the more it is the same)

Although the last twenty years have probably been the most technological, social and economical changeable years Karr's words still apply. The goal of the customer has not changed a bit since the first craftsmanship products: customers still want the product that fulfills as many of their desires for a transparent (preferably low) price.

Like other methods, this is exactly the goal of mass customization. However, mass customization seems to be the first one that could actually establish it. Since the concept has now been mentioned more than once, I will first give some of the most common definitions or descriptions.

Mass customization ... :

- ... is the ability to design and manufacture niche market or customized products at (better than) mass production efficiency and speed [8].
- ... means the production of goods and services for a (relative) large market that exactly meets the needs of every individual demander with regard to certain product characteristics at costs roughly corresponding to those of standard mass-produced goods [7].
- ... can offer service, accomplish greater levels of customer satisfaction and loyalty, gather advance information on market trends, and reduce inventory levels.

Since a real definition always consists of the descriptions of the different features, this and the next chapter will give an more detailed overview of the exact changes that have occurred, the features and the limits of mass customization. In this chapter a brought outline will be given of the preconditions of mass customization, while in chapter 5 the focus will be on the core features.

4.1 Fundamental change

In the 1990s some important changes occurred in common business strategies. These were pointed out by the Gartner Group, a globally respected company for identifying and analyzing trends and technologies that make a difference to business, and are shown in *Figure 5*.

Fundamental Shifts in Business Strategy	
<i>Paradigm for 1990s</i>	<i>Paradigm for 2000s</i>
- Efficiency, focus on cost reduction - Mass production of goods	- Agility, focus on customer responsiveness - Mass customization of goods, services and information
- IT drives standardization - Minimum integration with the supply chain	- IT drives market differentiation - Maximum integration with the supply chain

Figure 5. Recent change in paradigms

(Source: Gartner Group)

The most striking shift is the apparent decreased importance of cost reduction and the growing realization that customers do not mind to pay a bit more, when the received product or service is significantly better. It must be noted however, that the higher degree of integration with the supply chain will lead to lower costs, since primarily storage and maintenance costs will decrease.

Another important shift is the increasing acceptance to consider '*Think global, but act local*' as the new success formula. Advantages of global organized mass production combined with local customized features is at present being seen as the best.

4.2 Other influential changes

Besides the shifts in business strategy, there are more changes that have had an important influence on the evolution towards mass customization:

Growing heterogeneous demand

Since the recent customer has much more common (including economical) knowledge than its predecessor, companies will have to put a greater effort in convincing them not to go to the competition. As a logical result, more attention will go to specific desires, brought forward by the customer.

This differentiation in products is enhanced by the decreasing equality in income distribution, which leads to corresponding disparities in needs and desires [8].

A satisfied market

In contrary with the past, companies have to operate much more at satisfied markets, although new markets will be found eternally. This results in an extra need to meet the specific desires, since price differentiation is becoming more difficult to accomplish and the customer has to be convinced to switch from their current product. These desires can concern quality, services as well as features.

Demographical equality

With previous production methods the demographical position turned out to be of considerable importance. At present, this importance is swiftly minimizing. This is caused by the worldwide globalization and the rise of internet (especially e-commerce).

Although more changes have occurred in the last years, especially the equal possibilities for (international) companies and the growing power of the customer are responsible for the shift to mass customization.

4.3 Some Key Features

Although the next chapter will be about the most important aspects of mass customization, some other key features will be mentioned already:

- **Chain reversal**
With mass production the value chain model, which shows how a product goes through the different companies until it reaches the final customer, was a push-model. This means that the company 'pushes' products towards the customer, and thus has complete control about what and how much is produced. The ideal form of mass customization is a demand-driven pull model. Production is activated by specific demand. Up until now however, an exact implementation of this model has proved to be an utopia for most companies.
- **Responsiveness**
The ability to introduce flexibility into the production process. The goal is to reach zero lead-times in the whole process. For instance, stock costs will diminish, machines will work more efficient and, last but certainly not least, customers will be more satisfied.
- **Interactivity**
To reach customization it is necessary to know what the customer desires. Interactivity, achieving a dialogue between the company and the customer, is essential. The impossibility to achieve (sufficient) interactivity has been an important obstacle for a long time. With Internet and related new technologies this barrier has been taken away.

- **Networking**
Most production processes involve different companies. To reach optimal customization and zero lead-times, demand-specific cooperation must occur to accomplish the necessary synergy between the companies involved.
- **Digitizability**
Digitizability measures to which degree desirable features can be fulfilled with information technology only. Internet, probably the most relevant aspect of this technology, is the best, sometimes even the only way, to respond correctly and quickly to customer's wishes.
- **Modular production**
Without modular design, which means splitting the product into different standardized pieces, the demand required static costs cannot be guaranteed.
Modular production however does not imply the same price for different customized products. The additional features that a customized product contains, beside the static priced set of standardized parts, do result in a higher price.
For instance, nobody expects the same price for a standard version and a full-option (e.g. including audio-system or GPS-system) version, as long as the additional costs are transparent. The use of standardized parts also makes it possible to view the exact product you buy, before it is even produced.

Figure 6 shows the differences between the most important previous production methods and mass customization, based on the features above. For every method it is shown whether the features in the far left column can be fulfilled or not.

	<i>Craft Production</i>	<i>Mass Production</i>	<i>Lean Production</i>	<i>Mass Customization</i>
Anybody ... can get it	No	Yes	Yes	Yes
Anything (any product, any design) ... can be made	Yes	No	No	Yes
It can be made ... Anywhere	No	Yes	Yes	Yes
It can be made at... Any time	No	Yes	Yes	Yes
Any volume ... can be made	No	No	Yes	Yes

Figure 6. Features of the different production methods

(source: [15])

4.4 Degree of penetration

In Chapter 3 it was mentioned that much can and should be learned by looking at the history. The major learning point that comes clearly forward, is not to consider mass customization directly as the one and only solution to all economical problems or as the only possibility to survive for a company.

Just like mass production its influences will be widespread, but not for every sector it will have an equal effect. For some segments the lack of it will have negative consequences in comparison with their competition, for other it is not worth the investment to change.

Since the alteration in the production process will surely be radical, the question whether a manufacturer really needs to change towards a very agile manufacturing environment, has become very serious. This consideration should include the realization that the changes will be at all parts of the value chain, like development, production, marketing, and delivery.

Pine's Market Turbulence Mapping System (Figure 7) measures the amount of uncertainty, instability, and lack of control in a certain segment. According to Pine this analytical tool helps managers to take a fresh view of their firms and industries to determine if mass customization is, indeed, the direction to take.

Figure 7 shows that companies producing products in (very) turbulent markets should seriously consider transforming to mass customization. That this is not without risks is shown by the low number

of present successful implementations. This discouraging fact should however not be a measurement for correct use of mass customization, since it is the correct use that is still lacking.

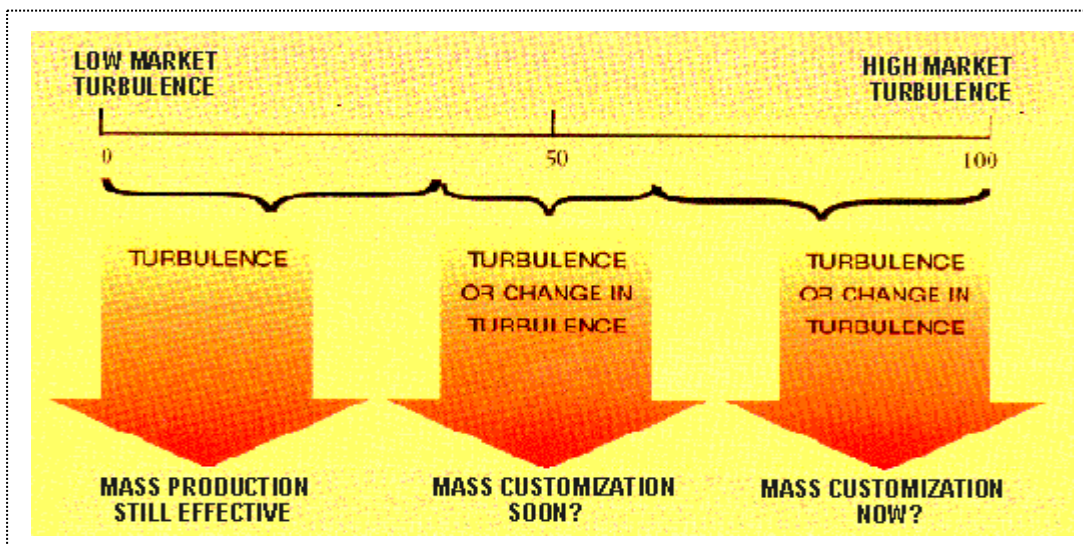


Figure 7. Simplified version of Pine's market turbulence map

(source: [9])

A final result of Pine's figure is that it once more shows that mass production will not disappear. Especially in markets with new, incomparable products. The degree of appearance will however decrease.

4.5 Products

It is difficult to say what kind of products are suitable for mass customization. The two major reasons for this are:

- It is a relatively young method. Although mass customization was first mentioned in 1987 by Stan Davis, only the last years the first successful implementations followed. Therefore it is too early to have a clear vision and can only be stated that every product has the potential to be successfully mass customized.
- As will turn out in the next chapter (*Paragraph 5.1*) there are different forms of mass customization, each with a different level of customization. Some of them are more like the 'defined' mass customization, while others correspond more with former methods. The distinction becomes thus harder to make.

The first implementations did show a preference for digitizable services, like banking and online information. But now, producers of tangible products are also making the change.

The intended target group the companies aim for is extensive. Both the business-to-consumer as the business-to-business market (primarily) offers many possibilities.

4.6 Disadvantages

Although the goal of mass customization is commendable, some disadvantages for both customer and company do occur.

Customers are overwhelmed with the enormous offer of many, slightly varied products. Customization is one thing, losing oversight of the possible choices is another. Since many of the individual customers have unique desires, it is no solution to decrease the offer again. Decreasing the number of selectable options is linked with a decrease of the percentage of satisfied customers. A substantial number of customers is boldly confronted with the fact that they have overestimated their knowledge. Especially with more complex products the company remains a necessary information

source for them. This information involves both the set of standardized parts and (more important) the additional options, which could lead to an higher price.

The main disadvantage for companies up till now is their unfamiliarity with mass customization, combined with the enormous initial investment that comes with it. The revenues mass customization will result in are uncertain, but to implement mass customization within a company the whole production process will have to alter. It is not just the purchase of a software-package or some hardware, but it covers every aspect of the supply chain from customer contact through manufacturing until distribution.

This point is becoming more crucial, due to the economical bad climate many companies have to face.

Besides the possible negative effect that wide customization have for customers, companies are not too eager about it also. The more varied options are offered, the more changes has to be done to the production process. As a result of this and of the current economical situation, many companies use a strategy that includes initial manufacturing of general products, after which the personal configuration takes place later in the process. Or as H. LeHong, research director at Gartner G2, defines it in [5]: "Companies will pluck out products when they are half-finished and add the customer's options." Although this strategy does not correspond completely with the mass customization concept, the numerous common grounds make it the best possible intervening period towards real mass customization.

5 Core Aspects

In this chapter different aspects of mass customization will be described in more detail.

5.1 Customization

Customization is without any doubt the main feature of mass customization. That this has to do with fulfilling specific desires of a customer will not come as a surprise. Less obvious will be that there are (at least) five degrees of customization, or that a different degree can lead to a whole different business strategy.

In [3] five variations are identified:

- (1) *Pure standardization* produces identical products and customers have no individual influence. It is equal to mass production.
E.g. paper-clips, T-Ford.
- (2) *Segmented standardization* produces different variations of one product. There is no direct influence of the customer on the process, but there is a certain variety in production and distribution.
E.g. shoes, milk.
- (3) *Customized standardization* produces products composed of standardized and mass-produced parts. Customers have influence on the assembly and distribution of the final product, but not on the different parts itself.
E.g. Ferrari, insurances.
- (4) *Tailored customization* offers variation in fabrication, assembly and distribution. A product consists of a large number of individual choices. The different selectable options are determined by the company.
E.g. ties, shoes, suits.
- (5) *Pure customization* is the situation where the customer has control in every part of the production process.
E.g. the construction of a custom-built house.

Some products appear in more than one variation (cars and shoes are named twice). The difference then exists in quality and exclusiveness. When a suit, for instance, is handmade it belongs to tailored customization and could be quite expensive. Suits can also be offered as segmented standardization, but in this case exclusiveness will be non-existing, while quality is in most cases less.

Important in these variations is the point where the customization begins. With (1) and (2) the customer comes into the process after the production, with (3) he joins before the assembly and with (4) he is involved during the whole process of producing. With (5) finally everything begins and ends with the customer.

The influence the customer has, is also of importance for the differences. Up to (4) he can only choose from the options the company offers. This is not necessary a disadvantage, because customers are not seeking many options, but their preferred option. Of course, with a higher level of customization the chance to offer their desired product increases. The only method that offers complete control to customers is (5), but successful realizations are still in the minority.

Among other subdivisions of customization an important one that occurs in literature is **soft** and **hard** customization. Soft customization is based on fully standardized manufacturing processes and corresponds with (3) and to a lesser degree with (2). The last two, (4) and (5), correspond with hard customization, which means that the customization starts within the manufacturing process.

Not all kind of products lend themselves for the same degree of customization. For books, the content is fixed, but the design and shape of the book is not. Sport shoes, on the other hand, can be customized from scratch till end. Therefore the product itself should be seriously considered, when looking for a realization of mass customization.

5.2 Customer Relationship Management

Successful mass customizing companies “build an integrated information flow that not only covers one transaction but improves the knowledge base of the whole company by information gathered during the fulfillment of a customer-specific order” [6].

Creating better and lasting communication and interactivity between company and customer is also exactly the goal of customer relationship management (CRM), which has been introduced in most companies nowadays. CRM includes concern wide accessibility to customer files, central entry for customers and ‘learning’ from the customer’s information.

That proper CRM is thus inevitable for successful mass customization is shown by the three different sides of mass customization (*Figure 8*). The differentiation and cost option has been mentioned before. The relationship however is equally necessary, although it is more difficult to understand.

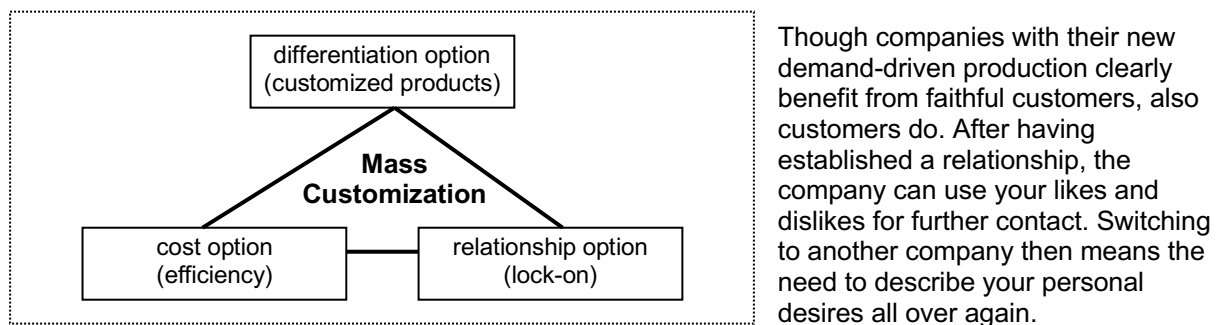


Figure 8. Three levels of mass customization

An important issue with CRM is the ability for the customer to contact a company. Internet has turned out to be of additional value for this one-to-one marketing initiated by the company, which becomes more and more part of the marketing.

However, “being truly customer focused is not possible if the organization is not, first, information intensive” [7].

5.3 Role of Information

Information should be seen as oil that makes the whole mass customized production process run smoothly. The importance of information within companies is rising enormously over the last years. Even that much that it is being called the ‘third wave’ of the technological development. After the arrival of the computer, the first wave took place concerning the improvement of hardware. The second led to impressive improvements for software.

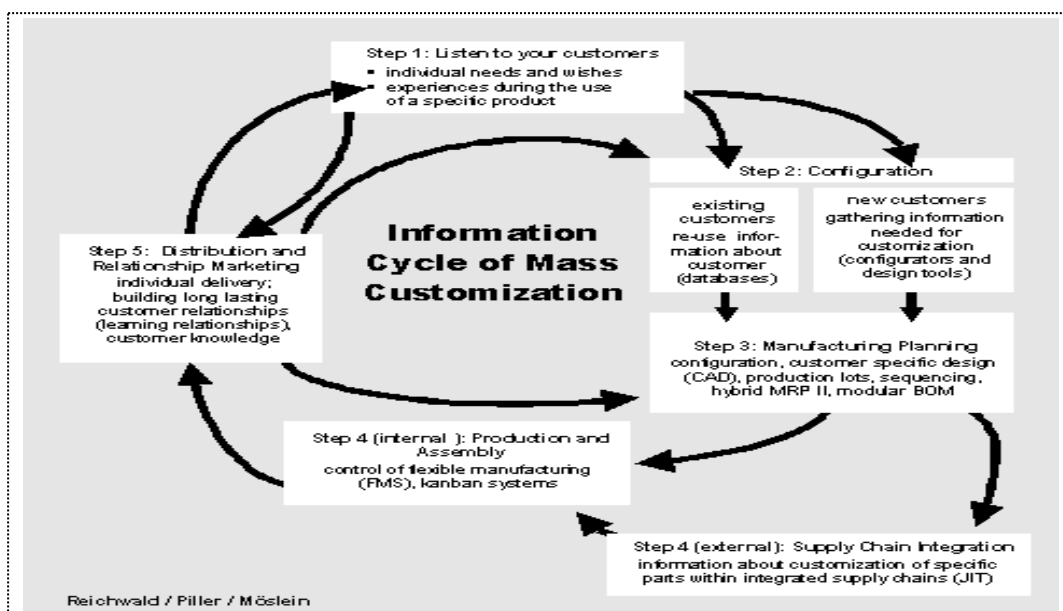


Figure 9. The information cycle of mass customization

(Source: [8])

Figure 9 shows the information flows within the (ideal) mass customizing company. Piller distinguishes five consecutive steps [7]:

1. *Listen to your customers.* Although the architecture and possible variety of a new product is still defined by the company, to make the product successful they must use information about the desires of the determined target group. Part of this step is thorough research in customer information, to determine the size and financial state of the expected target groups for new products.
2. *Configuration.* For achieving customer loyalty this is the main step. During this phase the customer's information is transferred in concrete product specifications. For old clients this means that their old profile can be re-used, thereby avoiding to create a new profile again.
3. *Manufacturing planning.* To schedule the manufacturing process, the specific dates of delivery for individual customers is needed. After that, the production tasks are being transferred to the different process units and suppliers.
4. *Production and supply chain integration.* When actual production starts, all produced modular units should be monitored until they are used. The better the information flows between the different product applications, the more speed and cost advantages can be accomplished.
5. *Relationship management.* After actual delivery, the relationship with the customer must be maintained. One-to-one marketing, where the known information of the customer is used, is the most common option. At this part, also information about the production process has to be examined, to gain future efficiency and quality improvements.

Information costs have become the main costs within mass customized companies, instead of future demand planning for mass production. This is not awkward, since information represents the actual link with the customer.

5.4 Logistics

The shift from mass production to mass customization has made the role of logistics far more important. Chain reversal and responsiveness, both have been labeled as a feature in *Paragraph 3.3*, require drastic changes in the logistics of the company. Currently, these logistics are for a great part focused on cost reduction, quality control and (internal) just-in-time delivery. These will have to be replaced by minimizing the lead-times and maximizing the flexibility of the production process.

Another reason for the increased role of logistics is the uncertainty it contains. Companies do not know what they have to deliver until the next order arrives, but then the product must be delivered as soon as possible and against low costs. The complexity of mass customization makes precise coordination during the entire supply chain essential. To achieve this purpose logistics is the most logical choice.

The best way to describe the role of logistics for mass customization has been done by A. Brown: "In a mass customization environment logistics is like an air-traffic controller, making sure everything is synchronized up and down the supply chain."

5.5 Software

Sound software and hardware are other requirements for proper mass customization. Although hardware will not be further mentioned, it must be realized that software is of no use without hardware.

To show the versatility and differentiation *Appendix A* contains a survey of related software including their providers. The technology differs from CRM-software, production and logistics systems, till specific software like foot scanners, which clearly have a more limited use.

The requirements that all these technologies must fulfill are given by Maskell [4] and shown in *Figure 10*.

- **Integration.** Systems must be fully integrated so information is entered only once, and is up-to-date and accurate.
- **Simplicity.** Programs, screens, and reports must be designed to be simple and easy to use.
- **Flexibility.** Users must be able to introduce new techniques in one area while retaining an old approach in others.
- **Openness.** Software must lend itself to easy interfacing with other systems and networking. Typically these interfaces will involve real-time quality control, CAD/CAM, shop-floor data collection, and automated warehousing systems.
- **Accessibility.** Information must be readily accessible to users of the everything from creating performance measures to ad-hoc analysis reports.

Figure 10. Maskell's Characteristics of Agile Software

(Source: [9])

If the technology was not as sophisticated as it is today, the enormous number of communications and flexibilities within the supply chain could not be controlled, which would cause an impossibility for achieving mass customization.

5.6 Mathematics

Mathematics was of considerable importance for mass production. Since the production process was not very flexible, there had to be sufficient initial knowledge about the volume and characteristics of the product. Mathematical models were used for this goal.

With mass customization, mathematics is of the same importance, although the focus has altered. No longer lays the emphasis on future demand estimation, but the demand-driven process requires additional flexibility. This has made the whole process so complex that marketing and logistical mathematics are indispensable.

Marketing related mathematics:

- Stochastic equations to extract passive information from the customer database or verifying hypotheses about possible segmentations of the target group.
- Keeping track of the costs versus the effectiveness of certain marketing activities. Personalized commercials bring at certain product areas such additional revenues that it justifies the additional costs. Although it is true that personalized commercials are much more often done electronically, in which way costs are in fact decreasing.

Logistical related mathematics:

- Storage control is redundant in a demand-driven process and the mathematical focus has shift to the planning of logistics and distribution. Stronger time-pressure makes cooperating and effective networks necessary in which products are being moved. They must cover the whole supply chain from beginning to end. Because of this classical mathematical models from operational research still prove their worth. Network analysis and dynamic programming [14], for instance, still have a significant value for companies.
- Another important use of mathematics within mass customizing companies has to do with the waiting time theory. It has been stated before that the relationship with the customer is very important (as the rise of CRM confirms), therefore the abilities for the customer to contact the company must be as perfect as it can be. It requires complex mathematical equations of the average number of customers, the average length of a contact and more, to make sure the call center (first contact) and the rest of the company handle customer support well. Since differentiation between companies is getting harder and harder to reach, service is the main thing to distinguish yourself from the competition.

5.7 Conclusion

Chapter 4 and 5 have proved that the theoretical foundations of the mass customization concept are clear and consistent. It has been defined around only two rules:

- Desires of customers are properly being handled, no matter “whatever, whenever, wherever” the customer prefers.
- The same speed and costs as mass production must be presented.

The first rule forms the difference with mass production and the second one with craftsmanship. Besides these differences mass customization shares many commonalities with other production strategies, such as personalized production agile manufacturing and virtual enterprise (Chapter 3).

For both rules certain footnotes must be made. The customization component has turned out to be less obvious and explanatory than possibly expected. Many different diversities can be recognized. The cost stability is fixed only to certain extent. The costs should not change when exact the same product architecture (collection of modular parts) is being used. Additional features are a valid cause for an increase in costs.

The modest core does not imply simplicity of the concept. Many different aspects have turned out to be essential. Even more than any previous change in production, the shift towards mass customization affects every part of the company. The enormous investment this wide range of consequences leads to, is the main obstruction for actual realization of mass customization.

The demand-driven push-model, which is linked with mass customization, requires more control and flexibility in logistics, marketing and manufacturing than any previous production method. This is only possible with faultless use of current technological and mathematical improvements and an optimal information flow throughout the whole company.

It can be concluded that at least the theory behind mass customization is sound and preferable for customers. The ideal situation, based on this concept, offer customers more variety and influence in manufacture, assembly and distribution aspects, with transparent and static prices. Furthermore, in order to make the right choices, companies offer personalized and optimized service through several ways of contact.

6 A Practical View

Over the last years more and more companies claim to have transformed their production process into a mass customizing production process. The many possible variations of customization, with each different advantages and possibilities for customers, become clear in actual practice. In this chapter online portals for mass customizing companies will be described briefly. Subsequently, the results of a empirical study of mass customization projects will be further examined.

6.1 Online Portals

The web offers the most direct and fast possibilities for customization and is therefore frequently being used as the main contact point for customers. A quick review of some of the better rated sites leads to a number of conclusions. First of all, the main difficulty appeared to be in distinguishing the basic product and the additional features. This separation is important since only then it becomes controllable whether the results of the same structured modular production cost equally. This regulation is part of the definition of mass customization.

A website that, in my vision, really is a proper portal towards a mass customizing company is www.NikeID.com (Nike). Through a very user-friendly user-interface and clear information, it makes the customization process well-organized. Directly when the basic model has been chosen, before any customizing option, the price appears in the screen. Apart from a single exception, the different customization choices that can then be made, have no effect on the price. During the whole process of customization the result up to that point is shown at the screen.

The absence of cost-increasing additional features is pleasant. Especially in contrast with multiple websites where the final product can cost many times the initial price. Although the customer himself chooses these features, it could cause a feeling of deception.

Of course, for completely customized products, where modular production is absent, the above statement is not valid. The website www.diamond.com offers the possibility to design a ring all the way from a single jewel, where many different options can be selected. In this case it would be a (positive) surprise if the price remains fixed during the whole customization process.

Besides the possible price instability, also an earlier mentioned disadvantage came forward. The increased need to have specialized knowledge can be recognized at many sites. On www.spinlife.com numerous wheel chairs can be purchased. After choosing the type of wheel chair, a surprisingly long list of options (with additional costs) is presented. The lack of information about the different options can lead into two results. Either the customer is pushed away towards the competition that offers more (personal) service or somebody ends up with a product that was not exactly what he was looking for. In both cases the customer is lost for the company. The information and its presentation are essential for the digital contact of the company with his customers.

Although many digital portals claim to offer mass customization, only few have actually realized it. Most companies use their website either as a digital display of their mass-produced products or to offer custom-made craftsmanship.

6.2 Empirical study to characterize mass customization

The last paragraph showed that at least two different categories of customers (with or without detailed knowledge of the desired product) can be distinguished. The suspicion that there are more differences between the implementations, considering the different types of customization (*Paragraph 4.1*), was confirmed by an empirical study done by Piller and Reichwald [7]. The key characteristics of this study are shown below, followed by the main derivations of this study.

<i>Research time</i>	June 1997 – June 1999	
<i>Cases covered</i>	103	
<i>Market focus</i>	Business-to-consumer (b-t-c)	68
	Business to business (b-t-b)	29
	Hybrid	6
<i>Origin and main target market</i>	United States and Canada	57
	Germany	37
	Europe (without Germany)	4
	Japan	5
<i>Mass Customization concept</i>	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 process)	12
	Point-of-delivery customization	4
	Self customization (customizable products / services)	3
<i>Interaction channel with customers</i>	Traditional retail channels	54 (26 b-t-c, 28 b-t-b)
	Internet	43 (39 b-t-c, 4 b-t-b)
	Hybrid channels	6 (4 b-t-c, 2 b-t-b)

Figure 11. Key characteristics of empirical research

(Source: [7])

- Most projects up till now are business-to-consumer oriented. This is not surprising because in the past customized production orders were not unusual, as the volume justified the additional costs.
- In Chapter 3, social factors were concluded to be of importance to determine the most appropriate production method. It was stated that these differ demographically. The results of the study confirm this idea, since there is one overwhelming centralization in the USA and Germany. Although it would be a valuable research the determine the reasons behind this specific centralization, it will not be part of this report.
- Like the examples of *Paragraph 5.1*, the results demonstrate the variety in mass customizing production methods. The negativity this brings to the customer, the increasing difficulty to estimate in advance the service and quality, is caused by the lack of standards.
- The number of projects without any linking to the Internet was higher than expected. It does strengthen the value of digitizability of products for the preferred strategy. A large number of products are so unsuited for digitization that Internet just does not add anything significantly. In present time, with the Internet hype on its top, this seems to be forgotten a bit.

6.3 Conclusion

Although www.digichoice.com shows numerous ‘mass customizable’ opportunities for every kind of products, most realizations lack both additional value and correct interpretation of the mass customization concept. Several websites lure customers with a promise for mass customization, while in the end all they offer is their range of products. The ‘customizable’ part is then strictly restricted to the possibility for a more refined search through their catalogue.

Digital contact further proved to be valuable for a selected group of customers. Precise knowledge about the desired product is needed, since the information function of companies is apparently more complicated too digitalize.

The impurities of digital contact strengthens the need to have several possible ways to contact the company. The more complex and versatile the product is, the more important becomes this need.

The broader range of varied products the theory promises customers can be recognized in practice, although it has a different origin. The increased offer is in most cases independent of an eventual integration of mass customization in the company.

The increased influence the theory further promises is even less represented. The selections are defined by the company and only a few websites offer customization different from the selections. The linking of the buy-order with the production system (essential in real mass customization) is if possible even less implemented.

All in all, the viewed websites show that the possibilities of mass customization are currently not being used by many companies. In order to speak of mass customization as the new standard still much will have to change.

FUTURE

7 What can we expect?

It is mentioned before that companies already know *WHAT* they have to do, *WHY* they have to do it and *HOW* they have to do it. The last thing that seems to be missing is to actually do it. In the first years from now mass customization will surely become much more standard than now. More actual realizations of mass customization will provide helpful information, which can be used for further development of the concept.

7.1 Mass individualism

Mass individualism is frequently used as a synonym for mass customization. Wrongly, in my vision, since the difference lays in the point of the supply chain where customization is introduced. *Figure 12* shows that with mass individualism the customer is involved much earlier in the process than with mass customization.

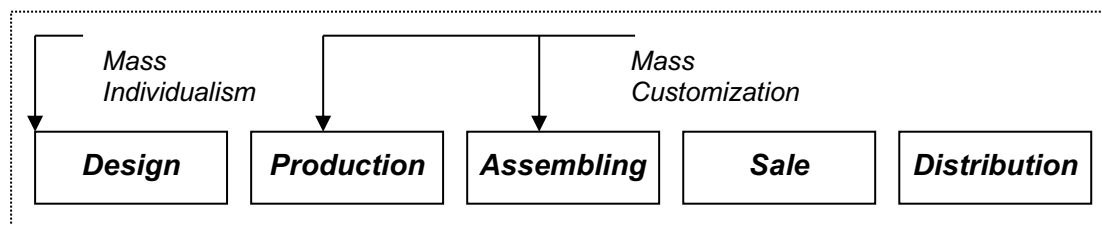


Figure 12. Introduction points of customization

It turned out before that mass customization includes widely variable products and a demand-driven production. The design however, is independent of direct customer influences. Mass individualism can be seen as the optimization of mass customization. With the involvement of the customer starting at the design, the most pure form of customization is being accomplished. A necessity for mass individualism, however, is just like mass customization that there cannot be additional costs connected to this differentiation.

The apparent slight difference between both methods is of importance. The recent technology is in my vision not advanced enough to successfully pursue mass individualism. I consider mass customization as a temporary, but necessary intermediate towards mass individualism.

7.2 Conclusion

This very brief prediction already covers a long time lapse. Currently mass customization cannot be recognized in many digital portals of companies. Assuming that it becomes standard once, it remains questionable in what degree this development will turn out positive for customers. Only then more can be said about the eventual successor.

It must be kept in mind that many times it has proved to be impossible to determine future possibilities. The reason for this is that with the knowledge of present technologies future possibilities are being examined. Technological changes nowadays occur that often that no useful prediction can be made.

8 Possibilities for a publishing company

During my traineeship at one of the Dutch publishers, Holdingmaatschappij N.V. Dagblad De Telegraaf (HDDT), I worked within the team of architects. Their function was to develop models (for both business and software) for the future. Since future possibilities were part of their area of interest, those formed the subject of many conversations.

8.1 Initial dilemmas

Publishers were initially skeptical about an online newspaper. They did not doubt whether technological improvements had made it possible, nor the professional measures to provide this service. Their main dilemma was the apparent impossibility to make it a profitable activity. Every newspaper already had its own website, but for all of them the additional revenues were only a fraction of the costs. Together they have spent millions and millions of Euros over the last years, but not one of them has successful online activities.

The reason for this, however, is an old economical law. It is impossible to sell something, if at the same time you give it away for free. I believe that the main dilemma for creating profitable online news-activities is the presence of free news-websites. Ironically, many of them are even hosted by the publishers themselves. The disappearance of these websites will be a logical result once a profitable concept for e-commerce has been found.

Another, mainly Dutch, 'dilemma' is the tradition of delivering a newspaper at home. Because of this, a major advantage of online publishing in other countries does not count here. In those countries it is an enormous improvement to be able to read the newspaper without having to leave your home.

8.2 Present activities

Two companies must be given the credit for 'waking' up the publishers. NewspaperDirect as well as PEPC has shown that profitable online news-services are possible. PEPC introduced the PressPoint, which is a nicely designed combination of a computer, an A3-printer and a modem. From airports and hotels their target group, mainly international businessmen, has access to the most current edition of their favorite newspapers. Their power: speed and around ninety possible newspapers.

NewspaperDirect offers their digital newspapers to specific groups. They provide certain cruise ships, but also the Dutch community in Thailand.

Also a few publishers themselves have begun with introducing digital newspapers. Although only some weeks ago in the Netherlands the first online version of the "Nederlands Dagblad" could be purchased, in other countries this is much more common. Especially the German 'Rhein Zeitung' (www.rheinzeitung.de) shows that Dutch publishers are well behind on the digital level.

A breakthrough that could close this gap is a development by the HDDT, called Digi-dition. Digi-dition is the successor of the e-paper, in the definition of an online version of a newspaper.

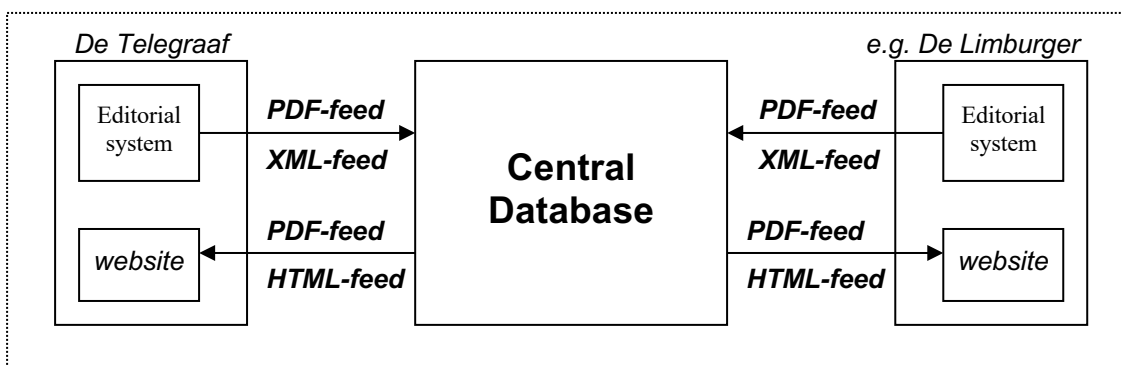


Figure 13. The structure of Digi-dition

According to this concept (*Figure 13*) every evening when the first paper edition is being printed, a feed of files in Portable Document Format (PDF) and a feed of files in eXtensible Markup Language (XML) are being transferred to a central database. There the graphical (PDF) and textual (XML) parts are combined, after which two feeds occur in opposite direction. Through an HTML-feed and a PDF-feed the central database provides the Telegraaf website with the digital version of the newspaper. The HTML-files provide quick access (because of the low download-time), while the PDF-files provide the graphical equivalence of the original newspaper.

Although at first sight this might seem an unnecessary complicated structure, there are four things that make it a profitable concept:

- **Reproducibility**
Besides the national paper, the HDDT also publishes many magazines and regional papers (e.g. De Limburger). If the technology for this concept functions for one paper, it can be copied for the rest. Therefore, no longer all individual newspapers will need to invest in their own solutions. Certainly with regard to the current reluctance to invest in e-business, it is an important advantage and it meant the last push that the HDDT needed.
- **External commercializing**
The central database will be managed by a new firm, of which the HDDT owns a certain part. This company will also be responsible for a large part of the commercializing of the digital content. This could include delivering news for local networks (at the moment such a test takes place with the Dutch Ministry of Justice). In this way, the publisher can concentrate on their traditional work: creating a newspaper.
- **Deep-archiving**
An important service of Digi-dition is the possibility for deep-archiving. Digitalizing more than 150 years of newspapers offers an enormous digital archive. Combining several digital archives provides customers with an unimaginable and customizable collection of news.
- **'One-stop-shopping'**
The idea behind one-stop-shop is the preference of centralizing different services, to give better access to the customer. A portal could be made, containing not only the Telegraaf and their regional newspaper, but also competing newspapers. The main obstacle for the cooperation between newspapers, their independence, is removed because of the new company.
In the ideal situation customers will become able to search and read through all possible Dutch newspapers at one place.

Although the concept will be in the advantage of the customer, it does not offer much customization yet. This is accomplished by special features on the several websites. Abilities to create a personal paper which only contains news about personally selected subjects, to access photo-databases selected on news-category or to receive live news-feeds (on demand) on mobile devices like PDA's or mobile telephones, makes it possible for the customer to customize their collection of news.

Providing these features will mainly cost an initial investment, but can then be eternally copied. Since the number of customers has no significant impact on the costs, both main criteria for mass customization have been met.

Of course, during the development of Digi-dition different problems were encountered. These were of economical (reluctance to invest), technical (reliable payment software) and social (uncertain demand) origin. The success rate, however, can only be determined once it is realized.

8.3 Conclusion

The moment the publishers finally realized that their content had a large financial value, meant the changing point for online services. Except for the services mentioned in this chapter, it is as good as impossible to predict what future technologies will make possible. I-mode and UMTS, the first new technologies, already will offer the possibility of a whole new range of products. Live news-feed on mobile telephones or computers, both textual and graphical will then become realizable.

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Appendix A List of mass customization technology

Product Line	Technology Provider
Product Configurators	<ul style="list-style-type: none"> • Calico • Selectica • EKS Systems • CSS&C LLC
Collaborative filtering software/service	<ul style="list-style-type: none"> • Net Genesis • Kana • Alladvantage • Accrue
Collaborative manufacturing software	<ul style="list-style-type: none"> • Agilesoft • i2 Technologies • Technomatix
CRM and Sales Force Automation	<ul style="list-style-type: none"> • Oracle • Siebel • PeopleSoft • Lily Software
Software for Request for Quotation	<ul style="list-style-type: none"> • Ariba • Right Works
Decision-making software for personalizing financial services	<ul style="list-style-type: none"> • Keystroke
3D Photography	<ul style="list-style-type: none"> • Dimension 3 • Geomagic • Geometrix • i3DX
3D Ergonomic Tools	<ul style="list-style-type: none"> • TechMath
Technologies for manufacturing electronic parts	<ul style="list-style-type: none"> • AgileSoft
Technologies for thermosetting composites	<ul style="list-style-type: none"> • VEC Technology
Powder metallurgy systems for any shape	<ul style="list-style-type: none"> • MII Technologies

Technologies for apparel manufacturing	<ul style="list-style-type: none"> • Gerber Technology • Edgewise Technologies • [TC²]
Whole body scanners and body measurement systems	<ul style="list-style-type: none"> • CCR • SYMCAD's Turbo Flash 3D • VITUS 3D Body Scanner • [TC²] • National Security Division • Wicks and Wilson Ltd.
Foot scanners	<ul style="list-style-type: none"> • ShapeGrabber's Foot Scanner • TechMath's Pedus
Web personalization	<ul style="list-style-type: none"> • Vignette • Allaire • Blue Martini • Broad Vision
Technology for ERP, supply chain and logistics	<ul style="list-style-type: none"> • IBM • I2 • JD Edwards • Manugistics • Oracle • SAP • PeopleSoft • Trilogy