

Design Oriented Approaches to Mass Customization in Furniture Industry

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Abstract: The general attitude towards Mass Customization (MC) is positive. It is a key to a better access and satisfaction of the clients needs. The formal research tells us that customization is only one among many options available to firms seeking a competitive advantage [1]. No more do companies that offer mass customization services have to forsake offering standardized products and services; they can integrate both [2].

All the functions of a company should be involved in the customization processes, which associating to three main active roles: marketing, production, and design. The research on customization has been developed mostly follows the perspectives of marketing and production organization. Therefore, we will look into some relevant issues from the design perspective. The streamline of the design research on customization is mainly focused on interaction, where some successful experiences in vehicle and PC sectors are described, and where customization plays an important role in building customer experience.

A basic study of the literature shows that MC is often described in contradiction with Mass Production (MP), generating an inter-functional contrast which can be solved in 3 main ways by using a different organization of production, by using different machinery and by using different design principles in order to control the product architecture. Given this hypothesis, the research informed by this paper focuses on the investigations of some “natural” contradictions, such as which between market and design, and between production and design, in order to describe approaches and design tools which have been generated to facilitate the solution of these contradictions in different industrial sectors.

The research has been done by some case studies in furniture industry, within some European and Asian companies that indicates the interest on MC is expanding in both areas, and particularly the Italian ones have developed an advanced model which is likely shifting to the emerging economies.

Key words: *Mass customization, product configuration, product architecture, design methods*

1. Introduction

1.1 General ideas and definitions, characters of Mass Customization (MC)

In contemporary dynamic economy environment, with full competition and consumer demands power increasing, companies are facing the challenge that their customers are no more satisfied with standard solutions, and require more individual products at an acceptable price and time of delivery.

In his famous 1993 book “Mass Customization: The New Frontier in Business Competition”, Joseph Pine defines MC as a “process by which firms, in different industries, apply technology and management methods to provide product variety and customization through flexibility and quick responsiveness”; building strategic advantage and economic value [3].

The goal of MC is to produce enough variety in products and/or services so that nearly everyone finds exactly what he/she wants at a reasonable price [3]. Some successful examples can be found in a number of industries, including automotive, computers, electronics, consumer goods, fashion, etc. [4]. A review of the literature shows that the performance of MC at least depends on four critical areas: product design, product configuration, production processes, and supply chain operations [5].

Dell considered all these critical areas in applying MC principles in order to eliminate inventories and build quick response to customers, giving them the possibility to personalize their own PC as they need combining standard components. “Dress it up, Drive it out” is the 2007 customization program slogan by Toyota, communicating the possibility to customize the Corolla, one of the world’s most popular cars since its launch in 1966: actually, the customization possibilities given to the customer are the result of the complex combined management of design, production and logistics principles.

1.2 Mass Customization (MC) benefits

In the handicraft industry (pre-industrial) era, everything was customized; in the industrial era, as soon as markets became mature, customers get bored of standard products intended to serve the majority of people. In this kind of competitive environment, MC expresses its potential to meet customers’ needs, providing a close match and new forms of interactions between customers and companies.

Another typical problem in the evolution of market is the progressive shift from the possibility to predict customer needs and behavior to a condition of extreme variety and variability of needs and behaviors. In this kind of competitive environment, the traditional production model which is closely linked with Make-to-Stock (MTS) production systems, represents a serious problem to the companies. MTS systems suffer from the lack of capability in predicting consumer trends, with possible overstock results, but no opportunity to provide a quick response to the changing needs. One of the principles and basic advantages of the mass customization is that in its production model there is no overstock, since the ideal situation of MC is to be linked with Make-to-Order (MTO) production.

Moreover, some studies have showed that in mature markets we normally have positive consequences in integrating MC into the traditional MP systems, giving evidence that the impact of MC on the operations of a company is determined by the level of customization offered and the complexity of the product and processes involved [4]. The successful adoption of MC is proved evidence particularly when we have complex products and production systems, as we can tell by looking at the cases of some major brands such as Dell, Audi, BMW, Adidas, and Nike, etc.

1.3 The link between production and design perspective

In literature, Mass Customization is often analyzed in terms of contrast with Mass Production. MC processes and methodologies affect both the organizational and cultural aspects of a company as well as its manufacturing strategy and organization. Agility and quick responsiveness to the changes have become mandatory to most companies in view of current levels of market globalization, rapid technological innovations, and intense competition.

Companies are in fact facing a contradiction between the tension towards standardization, as a base for efficiency and economy of scale, and the tension towards fast change, as a base for a proper response to new market needs. This contradiction can be solved in different ways, but if we look at it from a production perspective, companies mainly followed two combined pathways: adopt a different paradigm in the organization and use a different kind of equipment. In literature we have many examples of organization of production leading to a reactive attitude, mostly based on network structures, and combined with the use of different manufacturing systems, such as agile or lean manufacturing. These forms of organization allow the flow of materials and services as needed, between company units or between different companies cooperating in a network, making it possible to produce a wide variety of end products for customers at efficient and cost-effective levels [2]. Looking at the manufacturing solutions, the potential benefits [6] include simplified production planning and scheduling, lower setup and holding costs, lower safety stock, reduction of vendor lead time uncertainty and order quantity economies.

A first level of connection with the design issues is based on the idea of modularity as the keyword for the success of the production approach to customization. All material and information flows have to be flexible, and organized in modular units: modular components, which should be configured easily to be a number of customized products, are the essence of MC manufacture system. Modular product structures also enable the task of differentiating a product for a specific customer to be postponed until the latest possible point in the supply chain [7]. The postponement of product variety results in risk pooling and consequently reduces overall manufacturing, distribution, and inventory costs [8].

The most important consequence from a design point of view is the need to shift progressively from controlling single products to product architectures. In this perspective product architecture, described in literature as the scheme by which the function of a product is allocated to physical components [9], becomes a sort of “meta-product” that will generate a variety of end products. The design of product architecture can be based on the categorization of components, combining production and design issues, such as the cost of variety compared with its results on the perceived value. In complex products this normally leads to divide internal not visible component, which can be standardized, and external visible parts, which should be designed variable in order to obtain different products and different perceptions.

1.4 The link between marketing and design perspective

Buying behavior is a complex issue: dealing with durable goods, customers take time to make decision, comparing many relevant factors which are building different value propositions. Retailers are facing the reality that customers are looking for things which are similar alternatives, but are not presented in their shops, so that they have to take care of presenting a wide range of selection to match what the customers want. Manufactures

face similar problems linked with the product proliferation and overstock production, since mature markets require more choices (variety), and are characterized by fast change in needs (variability).

From a marketing perspective, MC is often described as playing a role in reducing these problems, but it can also be described as a base for a different value proposition perspective, with a particular reference to the progressive shift from a transactional to a relational attitude.

Here we have another important link with the design issues, since shifting from the idea that companies are simply selling things to the idea that they are creating a long-term relation with their customers have important consequences, both in the design of products and in the design of the choice of products.

Literature review indicates that there is a strong tension towards the construction of advanced forms of relation with the customers, leading to their involvement in the process of design (co-design) and in the definition of preferences (co-marketing).

The relational issues are not simply affecting the link between companies and customers, but also the cooperation between companies. Many arguments illustrate the importance of supply chain management in mass customization settings [5], while many authors tell us that the performance of MC is dependent on the capabilities of suppliers with regard to costs, delivery promptness, supply quantities, quality, etc. [3]. Again, modularity is a key solution, since modular sourcing enables the manufacturing firm to achieve the conflicting goals of reducing the level of vertical integration, and simultaneously restricting the extent of the supplier's base. A very popular example in this regard is the SMART car supply chain, which relies on a few module suppliers for the manufacturing of a high variety of cars [5].

2. Main body: Theories proposal

2.1 From Mass Production to Mass Customization

MP is successful in stable business environments, in which the supply side is more powerful than the demand side. The mass customization paradigm can be regarded as a response of industry to the high dynamics of the competitive environment and change of power in the supplier-customer relationship [5].

The evolution from MP to MC in advanced economies lasted a couple of decades, which can be traced from the market dominated time, when firms started striving to improve processes of lean/agile manufactory, and stepped gradually into flexibility, quick responsiveness, reconfigurable processes.

If we look at the marketing, design and production perspectives, this process of evolution leads to some inter-functional contradictions.

2.2 Contradictions between marketing, design and production

Market demands more variety and variability to meet different target groups and segments, to offer more choices, and to be able to follow the unpredictable change of market needs. On the other hand production is typically demanding to remain stable and reduce the product proliferation, in order to reduce costs and increase efficiency. And at the same time, the increased role of design in companies is linked with the idea of continuous innovation as a competitive attitude, and leads to a natural tension towards a much faster change of product portfolios, which is again a factor of friction with the organization of production, demanding volume and continuity.

If we look at MC from a customer point of view, we also have to understand that the unlimited expansion of the choice possibilities is not always a positive factor, since it might lead to what F. Piller calls “mass confusion”, which means that an excess of variety could easily bring to a difficulty in choosing the right solution.

Analyzing the contradictions, we can say that the typical evolution of MC normally passes through some excesses before getting to a balanced situation that we would call Advanced MC, where we have a balance between MP and MC, correct inter-functional relations, and a balance between a wide variety and easy choice.

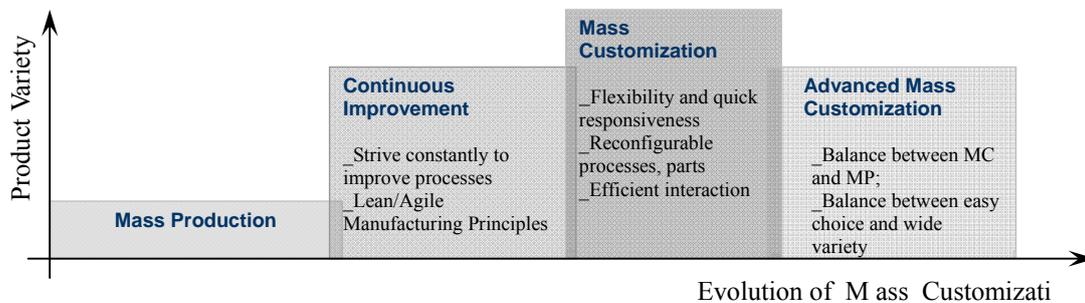


Figure.1 Evolution of Mass Customization

The thesis of this paper is dual:

- On one side, MC can not be described in an absolutely positive way, but it has to be linked with the competitive environment companies which are surrounded by;
- On the other side, MC has to be approached from an inter-functional perspective, where design plays an important role as a pre-requisite, and as a mean of relation between functions, and between company and customers.

Design plays a significant role in getting to this balanced situation, since it is essential in “the four critical areas of MC, which are product design, product configuration, production processes, and supply chain operations” [5]. Pine argues that the best method to achieve MC is to develop modular products [3]. Product design constitutes the specification of design parameters, the determination of precedence relations in the assembly, and the detail design of the components (including material and process selection) [5], acting as a sort of prerequisite of MC feasibility, directly related to production organization.

On the other hand, design plays a relevant role in balancing the need to enrich customer experiences, which leads to new forms of physical or digital relation, like the advanced configuration systems with many possibilities of choice and a “rich” interface; and the need to perform an easy choice by looking at the relevant issues. In fact, on one side customers are expecting a large product variety to meet individual needs, but definitely in many cases the reality is that customers find it difficult to make a decision if there are too many alternatives, and “customers often do not know what solution might meet their needs” [10], which is evidenced in many studies.

In fact, the complexity in buying process is mostly described as a result of the three following factors:

- 1) the limited information about product [11];
- 2) the limited inscience of needs [12];
- 3) too many options to compare and choose.

The case of the furniture sector tells us that, even if we look at a global market, we discover important differences in the approaches of companies coming from different cultural/geographical areas.

In the furniture sector, the advanced application of MC leads to the combination of physical store with the virtual environment (of either an Internet configuration system or a configuration software used by retailers). The basic

idea is to involve customers in an advanced process of choice, where they imagine acting as co-designers [13]. For instance, the individual product configuration can be co-created by the customer and sale staff, which might turn in an exciting experience. But if we look at the same issue from the inter-functional perspective, we easily discover that the first task of the configuration systems is to link the point of sale with manufacture. In fact, while customers imagine acting as designers of their own solution, the real designers have pre-arranged a simplified number of options that will allow and ensure the customers to be able to make decision easily. In this case, MC is offering a sort of basic co-design solution capability, not a product. A felicitous and successful configuration process will therefore have an impact both on process and product satisfaction, requiring a corresponding communication and marketing strategy [10].

2.3 Furniture firms categories in a customization perspective

We have described an advanced relation with the customer, but looking at the furniture industry in general from a customization perspective, furniture firms can be classified into three main categories: Non-Customized (MP), Customized and Fully Customized. In fact, their attitudes toward customization are not only the result of a general trend of change in markets and customers needs, but also the result of some specific cultural and geographical conditions.

Category	Non Customized (MP)		Customized		Fully Customized by configuration
	Bundle of products	Single product pieces	Combination of modules + finishing	Combination of modules + finishing + accessories	
Product sort	Bundle of products	Single product pieces	Combination of modules + finishing	Combination of modules + finishing + accessories	Variable products based on platform
Production organization	Make To Stock (MTS) Simple Stocking		Modular Make To Stock (MTS) Complex Stocking		Make To Order (MTO) JIT (Just In Time)
Product Architecture	No architecture		Modular architecture		Platform
Market	Early markets Mid or Low-end markets		Mid-developed markets; Mid or High-end markets		Mature markets; High-end markets
Example	Asian Model (E.g. Hinglee, Kuka)		Scandinavian Model (E.g. BoConcept)		Italian Model (E.g. Poliform, Flou)

Table 1. Furniture firms categories in a customization perspective

This means that we cannot describe the “Fully-customized” solutions in terms of univocal competitive advantage. For instance, while the advanced configuration systems play an important role in the local market competition, they do not work properly in serving distant markets, basically because those markets cannot be easily served with a JIT production, unless companies move production units close to the geographical areas that have to be served. This means that the three attitudes we present are just a part of the evolutionary scheme, while in part they might be seen as possible alternatives that can be chosen to match with particular competitive conditions.

Non-Customized approach is based on the idea of producing and selling fixed products in bundles or in single pieces, which are simply stocking in factories, warehouses or points of sale. This is the typical approach companies have in early industrial contexts, such as in Asia, South America and some other developing countries, where companies mainly serve the low-end furniture market where people care about the price more than design and quality. Companies operating in this situation face the risk of overstock, and occasionally get to product proliferation in their effort to meet more needs from market.

Customized approach is based on the idea to better meet the customer needs by designing, producing and selling a combination of “Modules+Finishing” or a combination of “Modules+Finishing+Accessories”. In this approach the stocking is obviously more complex, since we have to deal with a larger number of end products and with the need of defining possible combinations between modular components to obtain different end products. The main problems in managing this approach are to define:

- how a limited number of modules may result in a large number of final products [14];
- if the final assembly of the product (from the modules) will start when an actual order is received or not [4],
- where to manage the assembly, ranging from the factory to the point of sale.

This approach is significantly represented by the Scandinavian firms that are mainly working in the middle level market.

Full customized approach is based on the idea that the design is not dealing with single end-products, but with an abstract solution, where the product itself - if we look at it as a single physical artifact or as a set of combinable modules - does not exist anymore. In fact, in a Full customized approach, product can be described as a platform which generates variable personalized products, meeting different customer's needs. The production is normally based on “Just In Time” (JIT) principles in a “Make To Order” (MTO) organization, which enables managing a wide diversity with a pre-design architecture [15]. The Italian furniture industry is applying this approach, mostly serving the mid-high to high-end market.

2.4 From furniture to interior design

One more problem in managing the configuration of pieces of furniture, which brings with itself a great differential with other industrial products, is that furniture “lives” inside an environment, which will be able to influence the customers' perception and choice of the product itself.

“Furniture companies such as Ethan Allen, Pottery Barn are successful not because they present a sofa, but because they create a look.” [16]

The relation with space is both a technical problem and a perception issue. For these reasons, buying a piece of furniture is a complex decision. Will it fit my room? Does it suit the rest of the furniture?

This actually leads to a further problem in the customization process, which is linking the single product with an environment and with other existing products or ones that can be combined with others from the portfolio of the same company. This actually leads to some advanced solutions that most of the other sectors do not need, such as the progressive transformation of product configurators in space planners, with many consequences in terms of cognitive relation that has to be built with the customer.

3. Case studies

Hinglee is a furniture company based in Hong Kong, with production units in Shenzhen (China). Founded in the early 1990's as a single brand, and now carrying around 10 sub-brands, some of which aim to quite similar target markets. Hinglee is a typical Chinese furniture company, whose strategy is to provide abundant product range to convince their clients that whatever is the demand, there must be a solution in its offer. As a result, Hinglee is facing the problem of creating product collections with an increasing number of variants, which is leading to a sort of hysteric attitude towards the development of new products (the company currently develops around 10 beds and 20 sofas per month). Therefore, high overstock becomes an increasing risk and challenge, sometimes

leading to large discounts to empty out some space for the new product collections. Furniture retailers are facing the same problems, since they carry a wide range of products in a limited space, resulting in the costs of holding huge inventories.



BoConcept was established in Denmark in 1952, and is today an international retail-oriented concept holder with a coordinated product range comprising design furniture and lifestyle products for private homes.

The common mission of BoConcept is to make modern design furniture and accessories available to the urban-minded shopper. The BoConcept collections focus on meeting customers' needs with a complete product range, by means of different colors, materials and sizes. The furniture can be customized to match the needs of the customer.

Compare with the advanced solutions using by some Italian companies, the customized model of BoConcept is based on the combination of modular parts, finishing and accessories. Some snapshots of the configuration process of a relatively simple product as a table are presented as following. This gives a limited range of choices. Of course a key point in customization is the cost/price, while in this case, the cost is exactly the same standard as the modular parts were produced industrially, and the end price is simply depends on the customer's choice.

Step 1. Tabletops: Different sizes and shapes are available to fit tastes and needs.



Figure.2 BoConcept table tops

Step 2. Surface: Tabletops come in a range of materials and colors.

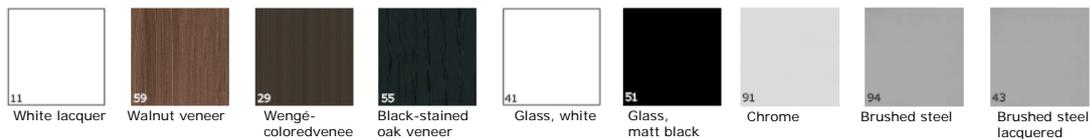


Figure.3 BoConcept table surface

Step 3. Legs: Legs in different shapes, colors and heights are available to complete the table.

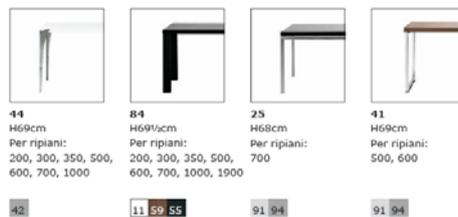


Figure.4 BoConcept table legs

Step 4. Result: Some of the possibilities of customized tables' combination.



Figure.5 Some of BoConcept table solutions

Poliform Poliform was founded in 1942 as a small artisan's shop in the Brianza area in Northern Italy, is today a global furniture brand internationally recognized.

Poliform's comprehensive production range is based on the design idea of a "Poliform home" with stylistically compatible component parts: a "global project" for each architectural situation thanks to the exceptional versatility of its systems. Actually, Poliform portfolio strategy is based on a limited number of products, which are characterized by a platform that gives the possibility to obtain an infinite number of configurations, and to develop different proposals every year following trends. In fact, some of the products presenting in the today's portfolio are the constant evolution of the ones introduced during the early 1980's. Surveying the relation between customization and value proposition, the key competitive factor of the company is to combine the capability to maintain solutions through time (leading to efficiency), and to reset products according to new needs and lifestyles, and to offer the highest possible level of customization.

Similar as the previous model, the cost of production is almost same while the end price is depend on the final co-designed product, as well as the material and finishing.



Figure.6 Poliform wardrobes open system

Flou Flou is a prominent Italian furniture brand founded in 1978, specialized in what the company calls the "culture of sleeping", or else producing beds and bedroom furniture in general. The company invested in a customization approach from the beginning of the nineties, building an advanced customization system, based on a very effective configurator that gives customer the possibility to combine many possible choices in a guided process that can be performed by the internet (before going to the shop) or in the point of sale, where configurators are directly linked to the production.

This advanced solution leads to the possibility for the customer of having a customized bed that can be delivered in 2-4 weeks, depending on the distance.

In order to better understand the process, we report some frames of the "choose your bed" section of the Flou site.

By following a guided process (Figure.7):

Dimension/typology/Base/Bed/Measure/Mattress/Mattress/cover/Pillow/Duvet/Linens, customers can select and combine all the elements of the bed and create their own solution.



Figure.7 Flou bed selection



Figure.8 Flou 3D view of bed finishing

Request for an estimate		CLOSE	
Model:	Mattelleh21	Name:	xlalabo
Base:	Orthopedic base	Surname:	qlm
Typology:	Leather	Dom:	01 01 1980
Cover:	Relie 112	Sex:	<input type="radio"/> M <input type="radio"/> F
Measure:	160x210	Road/Street:	Via darondo 38/A
Bed codes:	LE19	Zip code:	20158
Bedlinens:	Andy 6222	State:	ITALIA
Mattress:	7 axes/6 axes mattress medium <input type="radio"/> individual (BONDI) <input checked="" type="radio"/> Double (160x210)	Province:	MILANO
Mattress cover:	Sponge mattress cover	City:	Milano
Pillow:	Wash	Telephone number:	+39022395664
Duvet:	Goose down 4 seasons	E-mail:	qlm@xlabo118@gmail.cc
		Profession:	Dottorista
		Married:	<input type="radio"/> Yes <input checked="" type="radio"/> No
		Children:	<input type="radio"/> Yes <input checked="" type="radio"/> No
		Privacy Authorization:	<input type="radio"/> No <input checked="" type="radio"/> Yes
			<input type="radio"/> No <input checked="" type="radio"/> Yes
			* Required fields
			Continue

Figure.9 Flou Request list for an estimate

A plug-in will automatically upload, providing a 3D view of the bed (Figure.8). The customer can ask for an estimate enquiry, giving the opportunity to suggest a visit to the closest point of sale (Figure.9).

4. Challenge of MC in the furniture industry

As many other sectors, furniture industry is facing contrasting challenges, as the need to reduce cost, maintain high quality standards, serve faraway markets as well as geographically proximal ones.

An effective insight in MC approach can be helpful, giving the possibility to define the correct balance between contrasting needs, and to build a better response to customers and market needs.

Design can be seen as a key factor in reaching these goals, not just for its traditionally strong role in the furniture sector, but also as an inter-functional link and as the most important factor in building an experiential relation with the customer.

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