Research on the Customer-Oriented Strategies of Mass Customization*

Zhang Yuhua, Zhang Jiequn
School of Management and Research Institute of Cantonese Merchants, Guangdong University of Foreign Studies, Guangzhou, P.R.China, 510420
(E-mail: zhyh58@163.com, jiequnzhang@126.com)

Abstract Mass customization is the mainstream production mode in the 21st century. This paper researches four basic strategies used by enterprises while implementing mass customization, they are: modularization design, product family design, product development and rapid design, and postponement. During the research, this paper also shows how these strategies are used in mass customization production mode, and analyses what competitive advantage they can bring for the enterprise, so as to support the application and development of the mass customization production mode.
Key words Mass customization; Modularization; Postponement; Product family design

1 Introduction

With the development of human society and the improvement of people's living standard, people's requirement of individuation is becoming higher and higher. When purchasing products, many people expect utilitarian products which can integrate their own wisdom, manifest their own individuality and embody the realizing of self-value fully. Conforming to this trend, mass customization (MC) has become the dominant production mode of the 21st century. In the past, customers just accepted the products passively, however, in MC, they should participate actively, with the requirement for offering satisfactory products in reasonable price and speed. This transition has put forward higher requirement ahead of enterprises inevitably, demanding enterprises to respond quickly to customers' needs in a lower cost. For this, enterprises have to combine the scalization with the customer customizing effectively. The precondition of operating the MC production mode effectively is to reengineer the products and process. The underlying idea lies in transferring all or part of the production of customized products into scale production through product reengineering and process reengineering, and reducing the number of customization components and procedures. Therefore, the basic strategies are: the modularization design strategy, the product family design strategy, the product development and rapid design strategy, the postponement strategy.

2 Strategies for Mass Customization

2.1 Modularization design strategy

In order to provide prompt and contented individualized product to the customer, the enterprise has a pressing need to hold a whole set of interchangeable parts and assembling operation to achieve the goal of resource sharing, cutting down the forming cycle time and the cost of product. Modularization design is an important strategy of MC production mode. It uses some methods to realize product customization, such as configuration, combination, variation and so on. In this way, it can reduce the development cost and the design time, increasing productivity and realizing scale effect by modularized scale production, and increasing quantity and quality of customized product at the same time. The effective combination of product variability and components standardization based on modularized product design technology, and full utility of the impact of scale and scope economics can improve utilization rate of design resource effectively, reduce the cost in assembly, and make it easy for management and maintenance during the whole life cycle of product. What's more, it simplifies design process and promote product update, which is a critical success factor of MC.

In the 1950s, the concept of modularization design was formally put forward in some European and American countries. Then it gained more and more attentions and researches. In Suh's opinion[1], modularization design is a technology to analyze the cause of the result in terms of product, process and system, and meet the predetermined demand. Its method is to choose the right design parameters and realize mapping of function and requirement domains to design parameters domains. Jia Yanlin[2] takes

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modularization design as a design method to satisfy the various demands of market. By selecting and assembling modules, it can make up of the various products. And these function modules are divided and designed after analyzing the function within certain range. These products may have different function, or have the same function but have different performance or specification. Lao Jun[3] considers that modularization design is a systematic method, which considers every system object, categorizes system into several modules with different use and performance according to their functions, calibrates the interfaces, and selects different modules (and design some specific modules) for combination to meet different kinds of requirements quickly. Through different combinations of interchangeable modules and standard modules, a vital role of modularization design is producing a large number of products to meet personalized requirements of customers. Some chief benefits of modularization design are as follow:

1) To satisfy the customers' personalized requirements quickly at a low cost. Because modularization design can produces a large number of variable products by the combinations of a limited number of interchangeable modules and standard modules, product design is quick. Effective use of postponement technique can also support the scale production of modular components, which can finally help to meet the individualized demands quickly at a low cost.

2) Beneficial to the development of new product and the enhancement of competitiveness of the enterprise. Modularization product is beneficial to outsourcing united production. The enterprise can outsource its modular components to external cooperative manufacturing enterprises which have competitive advantage. Then it has the ability to concentrate on the development of new product, product design and markets exploring. The enterprise can set up cooperation partnership with external cooperative enterprises, and develops new products together to enhance competitiveness.

3) Beneficial to the parallel tasks and quick response to customers' requirements. The standardization of modules and interfaces between them helps to reduce the coupling between product design and production task, and lower the complexities in related tasks, which is convenient for the parallel tasks. So the duration of production cycle decreased greatly.

4) Beneficial to the alteration of modules, and enable the enterprise to supply diverse products for the market. As module uses standard interface and independent from each other, the change of one module will not affect other modules' function. Therefore, it's easy to alter the modules and enable the enterprise to supply diverse products for the market.

5) Beneficial to the improvement of the quality and reliability of goods. Modules are some relatively independent units that being careful designed. Previous to becoming general modules, the modules should experience a long trial, testing, and repeated modification and demonstration. Reuse of composite module makes it easy for experience summary, optimal design and improvement on the quality. With respect of reliability, design, manufacturing, assembly, environmental factors and so on, may all cause the invalidation of product. Because that the reliability has been deeply verified, we just need to verify the reliability of new modules when adopting modules stereotype embraced.

6) Provide great convenience for update and upgrade, maintenance, scrapping and recycling of product. Because that product is made up of related modules, users just need to update individual modules when upgrading his product. Maintenance just needs to replace the related module. Thus, it can not only save user's expenditure, but also help economize on raw material and reduce waste.

2.2 Product family design strategy

In mass production, many enterprises design single product to meet public demand. Some enterprises build product family based on requirement discrepancy on product function and performance. But the product family is formed by doing some partial and/or easy alterations or variations on the current products of the company, and then making some categorization. Without systematic planning, it's easy to cause the increment of the quantity of altered component, the abusive using of resource, difficulty in management and cost-controlling, and making great waste to the enterprise. In MC production mode, on the basic of fully grasping customers' demands, the enterprise defines several groups of customer demands according to the difference and similarity of customers' demands, and customizes subdivision market product with different functions, specifications and patterns for each customer demand group. The subdivided product will form a product family that will be planned and designed by the enterprise. Customer-needs-oriented product family design, on the one hand, satisfies the difference among customers' demands in the market, in order to gain more market share and realize scope economy; on the other hand, maximizes the generality among subdivision market products and helps to achieve scale economy. Product family is the critical technique of MC. Its basic idea is to design product platform and corresponding product series, under the guidance of product platform strategy, and addressing demands of different customer groups in segmentation market, in order to meet

customers' individual demands in low price and fast development cycle.

Product family design refers to something that categorizing products with similar function into one family on the basic of normative components and modules, through similarity analysis of existing customer requirements, market research and forecasting. After considering fully about the reuse of design knowledge and quick derivative product model, it structures a configurable model for each product family, and do the customized design according to order on the basic of product model. Through the sharing component parts of the product platform and manufacturing process, the enterprise is able to develop differential products effectively; improve the flexibility of manufacturing process and response speed; meet the market demands of cost, speed and individuation; occupy the market at a maximum; improve competitiveness for enterprise. The basic idea of product family design is to utilize the general mature product platform, design related product series on the basic of product platform according to demands of different customer groups from subdivision market, meet different customers' individual demands in low price and fast development cycle. The technology to realize product family design including three aspects as follow: ①define the product family that is being considered to develop and its technical indicators, by the transition of customer demands and the analysis of product family. ② meet individual demand of customized product by structuring a product model which can covers a class of product specification and type changes, and instantiate the customization according to customer's order. ③construct design resource database that is connected to the product model, which helps to realize the fast searching and use of current resource, thus raise the reuse rate. Generalization, modularization and standardization are the cores of product family design. Product family design strategy of the MC product mode has obvious advantages:

1) The adoption of a great deal of standard modules and interchangeable parts helps to keep the low production cost and high quality.

2) A reasonable product family makes it easy to derive a series of products, diversify its range of product, fit the demands from different subdivision market market or rapidly changing market, decrease the uncertainty of market.

3) Realize the reuse and transfer of technology by using product family, which can help to decrease cost and risk of development new product, shorten product development cycle.

4) Realize a complete product chain through a complete product family, to cover every demand of market and shape a good image of both product and enterprise.

The process of product family designing including five levels, namely, division of customer demand groups, transition of customer demand, product family planning, establishment of product family model-base, product combination and configuration. Firstly, categorize customer demands on the basic of intensive analysis on customer demands and the existing system; extract common requirement and individual requirement from customer demand and transform it into design requirements of product family; plan the product family according to market research and forecast; build the function model of product family, the process is as follows: map each function unit through function-principle mapping unit, then constitute the principle model of the product family; aiming at every principle node of the function-principle tree, analyze the structure that realize the required function related to each principle node and extract variant parameter based on dynamic product family, then define range of customization for product family and form the model-base of product family gradually; and lastly, based on product family series, design the product configuration that leads to product having practical value.

2.3 Product development and rapid design strategy

Diversity and complexity of product requirement, shortening of product life cycle, and the globalization of market, all raise the urgent demand for the product design and manufacturing enterprise to respond to market changes with a maximum speed, the highest quality, the lowest cost and the best service. In accord with such a request, modern product design is being with the trends of digitization, modularization, networking and intelligent increasingly. One of the key factors contribute to the success of MC is to build the support system that is oriented to product development and rapid design of MC. It enables the enterprise to quickly respond to clients' customization demands with the cost and efficiency of mass production. The rapid design based on MC improves the flexibility of product design and manufacturing; enhances the nimbleness for adapting to market change; characterize the enterprise as reconfigurable, reusable and extensible; improves self-adaptive range of the company; enables the enterprise build process beyond predetermined requirement; increases creative ability.

Product rapid design is also called rapid response design or agile design. There is no generally accepted definition at present. Teng Qi[4] thought that rapid design is a whole of all design technology

and method aiming at shortening the development cycle. The process of rapid design can be described as: put forward functional demands according to client requirement; restricted by time, quantity cost and so on; adjust structure and parameter on the basic of existing product; get a design result to meet clients' requirements quickly; to organize production, sales, distribution, after service in product value chain as soon as possible; satisfy clients' customizing requirements with the right product and reasonable price[5]. The product rapid design in MC falls into two phases: development of product rapid design system and realizing rapid design. In product development, enterprise locates customer group, analyzes the existing customer demands, summarizes the existing design knowledge, forecasts potential customer demands; divides product function based on the analysis and forecasting above; then establishes a dynamic product model-base(including product family model-base and modules model-base) covering the whole market demand; forms product rapid design mechanism; supplies foundation of rapid design for quick response to individual demands. In product rapid design phase, dynamic product model-base is employed to perform approximate matching for individual demands. By making full use of existing design resource, taking the configurator as main tool to configure product quickly, or providing customers with individual products by variant or innovation design of partial or total product, it realizes the organic combination of mass production and customization production.

2.4 Postponement strategy

The greatest challenges of MC production mode are cost and speed. Firstly, client customization adds product complexity, makes it more difficult to design, manufacture and manage, in this way, it raises customization costs. How to keep a low customization cost while meeting customers' individual demands is the first issue need to be solved by MC Company. Secondly, in MC manufacturing, customization is carried on after having received clients' requirements. How can the MC company gives fast response in clients' customization demands, and supply customized products or service, is the second issue must be solved by MC Company. There's trade-off conflict between cost and speed. That is, if you want to response to customers' individual demands quickly, it may increase customizing costs; but if no increase of customizing costs, it may also affect the customizing speed. Thus, how to appease the conflict between costs and speed in MC production, and fully take the advantage of MC production, is the key to the implementation of MC production mode. Postponement strategy is the right strategy to solve the contradiction of MC. It applies the concept of postponement to MC production mode. By looking for disparate points of different product and delaying the time of production, assembly and distribution of disparate points as much as possible, it maximizes the same production procedure shared by different product demands, and postpones the variation procedure of customizing demands (the part reflects individual demands). In these ways, it makes the utmost possible effort to solve the costs and speed problem in MC production. Thus, while controlling the total cost, it diversifies its products and satisfies customers' individual demands. Postponement strategy increases the flexibility of enterprise in dealing with changes of demands from different subdivision market. It reduces and controls the requirement uncertainty, helps the enterprise to enhance competitiveness both in time and cost. As one of the most effective way to realize the MC production mode, both domestic and international enterprises have paid much attention to postponement strategy. It will certainly become an important strategy of the MC production mode in this century.

When referring to postponement strategy, it means delaying customizing activity in supply chain until having received the order, i.e., postponing customizing activity both in time and space, so as to realize seamless connection between customizing demands and products/ services, and improve enterprise's flexibility and customer value. Postponement is a comprehensive application of delay. The essence of postponement strategy is to postpone the customizing activity in supply chain until having received determined an order or more accurate information, help to realize seamless connection between customizing demands and products/ services.

Postponement strategy divides product production and processes in supply chain into two phases, namely, generalization and customization. It maximizes the generalization phase, so as to manufacture standard components with generality. Enterprise is able to finish differentiation process and delivery process of product as fast as possible when receive customer order. In this way, the enterprise is able to cut down the lead time of product delivery and reduce uncertainty of supply chain operation. Postponement strategy under MC is a powerful means for enterprise to gain competitive advantage in the new market circumstances. It is also a better way to realize customization. To implement it, there are some indispensable terms:

1) Modularization production of product. The product should be able to be decomposed into limited modules. By assembly or simple processing, these modules can form diverse products. Product may also

consist of general basic products, which, by certain post-processing procedures, can be provided wider selection range to customers.

2) Standardization and interchangeability of components. Product modularization is just a prior condition, standardization and interchangeability is more important. Just after having these characteristics, can the enterprise completely divide operation process of product into stages of generalization and customization in time and space, and keep the completeness of final product. At the same time, because of these characteristics of every module, the enterprise can outsource some of its modules and components with low technology and weak capabilities of adding value. It produces others which have higher technology content and added value capabilities. Thus, it improves core competitiveness of supply chain.

3) Easy to implement final processing. The production of semi-finished product was separated from that of final product in postponed manufacturing. The manufacturing of final product can be finished in logistics stronghold near the customer. So the processing and manufacturing of final product should be of low degree of technical complexity, with a small processing range, without necessity of tremendous manpower and resources, but of easy operation.

4) Proper delivery lead-time. Too short a delivery lead-time goes against the implement of postponed manufacturing, due to the required time of the production and processing of final product for customizing process. But too long a lead time will result in no necessity of implementing the postponement strategy.

5) Intensive cooperation among multiple agencies and organization. Usually, the postponement strategy is realized by the product and procedure design. It calls for cooperation among workers of relevant departments within the enterprise. The manufacturing of modules and components may be outsourced to other companies. The formation of final product may also need some helps from the Third Party Logistics Enterprise and the retail corporation. All these require that the enterprise must cooperate fully with its cooperative partners in its supply chain, and seek for design proposal that brings it back opportunities of postponed operation.

In addition, if the enterprise wants to make full use the advantage of postponement strategy, it should first redesign its product structures and manufacturing process. When designing product, it should use the technologies of standardization, modularization, interchangeability and so on for; and divide the divide the manufacturing process into stages of interchangeability and customization, which can be separated completely both in time and spatial.

3 Conclusion

The product family design, product development and rapid design are all blent with the ideas of modularization and standardization. The product family design, product development and rapid design, and the modularization design are the design that product structure-oriented. They have given expression for the MC enterprise making full use of the scale economy and the scope economy. The postponement strategy is the design process-oriented, expressing the process reengineering concept that MC-oriented. The modularization and standardization have provides foundation for the postponement strategy. Without the standardized modules and components, the customizing firms can hardly delay customers' requirements to the downstream in its supply chain, and cannot give the rapid response to the customers' demands. Only after having combined the strategies of product family design, product development and rapid design, modularization design with postponement, can it fully produce the advantage of MC production. By using the MC strategy aiming at individual needs, it can give support to the application and development of the MC production mode. Therefore, it has an expansive application prospect.

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