

Agility evaluation of mass customization product manufacturing

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Abstract

Based on the characteristics of mass customization (MC) product manufacturing and the requirement of agile manufacturing, an MC product manufacturing agility evaluation index system is established through studying MC enterprise's organization management agility evaluation, MC products design agility evaluation, and MC manufacture agility evaluation. Also, with the Xi Dian Casting Limited Company as an example, the multi-grade fuzzy assessment method is used to evaluate its agility.

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1. Introduction

Mass customization (MC) is a kind of production mode for customized products supplied to the individual customer in random quantity, or to multi-variate small batch markets, based on mass-production with high efficiency, via the recombination of product structures and manufacturing process, using a series of modern information technology, advanced manufacture technology and modern management technology with the cost and speed of mass-production. MC has combined the advantages of mass-production with those of customized products to satisfy the customers' demand so that it is progressively becomes one of the important enterprise production modes in the information age [1]. At present, competence of manufacture is more than just in quality, price, date of delivery and service of products; what is even more important is that the enterprises are response to the markets at speed. Accordingly, agile manufacturing has been one of major strategies of modern enterprises. In the environment of the market continuing to vary with a high speed, MC enterprise is required to strengthen its ability of controlling future markets by improving its "agility of product manufacturing". Combining with modern management technology and advanced manufacture technology, MC product manufacturing is aimed at the objectives of agile response to customer demand, market change and market opportunities, combining advanced management technology with advanced manufacturing technology, adopting the development model of design for a product

family and technology concurrently, so as to make the components and technology universal and designing modularization into the product, in order to launch products rapidly [2]. As far as MC agile product development is concerned, Americans David M. Anderson and B. Joseph Pine II have made some relatively systematic research. In recent years, there has also been relevant research carried out in China. Wu and Mahave studied an enterprise's agility evaluation, but little has been done on systematic research about the agility evaluation of MC product manufacturing. This paper discusses this question in detail.

2. Design of the agility evaluation of MC product manufacturing index system

Based on the rapid obtaining of MC demanded information from the consumers, and market changing information, MC product agile manufacture is to develop new products in responding to the consumers' demands and to guide the markets via agile organization management, agile design and manufacturing. Accordingly, MC enterprises are required to possess the abilities of agile organization management, product design and product manufacturing. For this reason, it is necessary to synthesize these three aspects for carrying out the evaluation of MC product manufacturing.

2.1. Assessment index of MC enterprise organization management agility

As viewed from the enterprise organization management's thought, Amos et al. used five such indexes as

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Table 1
CIPME indexes

Communication paconnectivity	Enterprise information unblockedness, network connection extensiveness, communication systematic utilization rate
Inter-organizational participativity	Inter-enterprise cooperative level, VE, confidence between enterprise
Produce flexibility	Produce promptness, productivity, produce control ability
Management relativity	Resource distribution rationality, organization management ability, enterprise technical innovation
Employee enability	Employee quality, authorize level, innovation consciousness, the speed of building team

communication paconnectivity (C), inter-organizational participativity (I), production flexibility (P), management relativity (M) and employee enability (E) to assess the agility of an enterprise, which is known as CIPME (as shown in Table 1). CIPME is a set of static agility assessment indexes, which involve each aspect of enterprise construction [3] (such as people, organization, production system and infrastructure, etc.), and also can offer a guide to common enterprises to realize their agile organization management. However, as mentioned previously, MC enterprise is different from other manufacture enterprises. Accordingly, CIPME cannot be completely adaptable to the agility evaluation of MC enterprises' organization management. In addition, if quantization analysis is applied to the organization management agility of MC enterprises, the five indexes of CIPME will be too fussy to be determined. In order to adapt the characteristics of MC enterprises production, the three indexes designed in this paper are shown in Table 3.

2.2. Assessment indexes of MC enterprise products design agility

The three indexes, which including information-obtaining agility by the customers' demands, the speed of product design and the flexibility of product design, are used to assess the product design agility of MC enterprises.

The accurate and rapid information-obtaining agility by customer's demands and the product designing speed are the pre-requisite conditions for product agile design of MC enterprises on a large scale. The demanded information of an industrial product is directly obtained by communicating with customers, and that of customer goods is obtained mainly by market forecast. Therefore, it is necessary to use a rational method to analyze the demanded information systematically and then to communicate with major customers, so that agile and accurate obtaining of the customers' demand information can be made. The agility of obtaining customers' demand information can be measured by the

channels of how to gain demand information and the processing time of demand information as a proportion of the period of a product; and the speed of product design can be measured by the period of product design and its proportion in the period of a product.

Flexible design is a kind of product designing technique of the manufacturing company, and it is required that the schemes designed by the designers are not only in agreement with the present demands by the customers, but also are able to vary with the corresponding demand changes by the customers, however, this change can mainly be realized through second design or repeated design. Flexible design is similar to the thought of modularization design, but it is required that there should be a certain correlation relationship among the designed schemes. Namely, that there is the same or a similar module (it can be called the key part). When the customer's demand is changed, the designer can re-use some former design module to revise and add in order to satisfy the customer's new demands. Largely owing to the adaptation of the former design plans without being re-designed, the speed of product design has been improved greatly. Therefore, three indexes of the seriation degree of products; the similarity degree of a product's structure, and the universalization degree of the parts, can be used to assess a product's design flexibility.

2.3. Assessment index of MC manufacture agility

Dove has adopted re-configurable, re-usable and scalable norms to assess the agility of an enterprises' manufacture system [4]. In order to enable an enterprise to operate it easier, Dove sub-divided RRS into 10 norms (as shown in Table 2). He considered that an enterprises manufacture system should be designed by these 10 norms. On the basis of the characteristics of an MC product, some improvements have been made to RRS and their 10 indexes and the three principles, totaling eight indexes, for the assessment of MC enterprise's manufacture agility are suggested in this paper, as shown in Table 2.

Table 2
RRS indexes

Re-configurable	Integrated unit modular, displacement compatibility, displacement of assist tool
Re-usable	Negotiate across level, development hysteresis unite volume, controlling mechanism and information system distributed, autonomy relation
Scalable	Stretch out and drawback scope, redundant unit, expand frame architecture

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