



**UNIVERSITI TEKNIKAL MALAYSIA MELAKA**

**RAPID TOOLING STRATEGIES FOR PRODUCT  
CUSTOMIZATION**

This report submitted in accordance with requirement of University Technical Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Manufacturing Design) with Honours.

by

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# UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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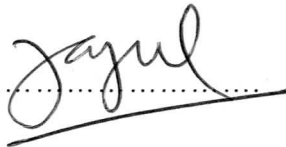
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## APPROVAL

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## **ABSTRACT**

Modernization had created customer that always seek out for products that can be customized according to their desires. This situation somehow had challenge the manufacturer to come out with a new product that can be tailored according to customers desires but still bring the company high profit with the minimum cost and at the shortest lead time. The pressure to fulfill those challenges can become unbearable for the manufacturer if they don't have suitable and appropriate technologies to keep up with the demand. Through this report, the author had tried to show to what extend that the technology of rapid tooling which had been recognized as one of the latest method in manufacturing can help in application of customization to a product. A simple product that can signify the concept of customization had been selected before one of the methods from customization be taken and applied. After that, several types of rapid tooling strategies available in UTEM had been used to the product to verify the connection of customization and rapid tooling. This practical session is a mini case study that had been done in order to understand more and verify the finding. At the end of the laboratory sessions and based on the analysis done, the result had shown that provided on certain condition, the methods of rapid tooling used is not directly connected to customization in term of modularization.

## ABSTRAK

Pemodenan telah menghasilkan golongan pelanggan yang menginginkan kepada penghasilan produk yang dihasilkan berdasarkan kehendak mereka. Keadaan ini telah memberikan satu cabaran kepada pihak pengeluar untuk menghasilkan barangan yang mengikut kehendak pelanggan dengan kos pengeluaran yang paling minimum serta jaminan produk tersebut dapat diedarkan dalam pasaran secepat mungkin. Tekanan untuk menyahut cabaran ini menjadi semakin sukar sekiranya tiada teknologi pembuatan yang dapat membantu dalam menyelesaikan masalah ini. Oleh yang demikian, laporan projek ini bertujuan untuk mengkaji dan menunjukkan sejauh mana salah satu teknologi pembuatan yang terhangat masa kini iaitu 'Rapid Tooling' boleh membantu pengeluar dalam menghasilkan produk yang menepati cita rasa pengguna. Bagi membantu mencapai objektif tersebut, satu produk yang boleh menggambarkan konsep pengelasan akan dipilih sebelum cara yang tertentu dari teknik-teknik pengelasan diaplikasikan keatas model produk tersebut. Seterusnya, kaedah kaedah 'Rapid Tooling' yang terdapat di UTeM ini akan dijalankan keatas model produk tersebut . Melalui kajian mini praktikal ini perkaitan antara kedua-dua teori dapat dilihat dengan lebih jelas. Di akhir kajian, berdasarkan hasil praktikal dan analisis yang dilakukan, maka dapat disimpulkan bahawa dengan berpegang pada syarat-syarat tertentu, teknik-teknik 'Rapid Tooling' tidak berkait secara langsung dengan pengaplikasian kaedah modularasi secara khusus dn pengelasan secara amnya.

## **DEDICATION**

For my dearest parent that had never failed to give me unconditional love and supports.

Also for teachers, lecturers and friends that had always give me chances to learn and improve.

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## LIST OF ABBREVIATIONS

RP	-	Rapid Prototyping
RT	-	Rapid Tooling
CAD	-	Computer Aided Design
MP	-	Mass Production
MC	-	Mass Customization
PD	-	Product Design
FDM	-	Fused Deposited Modeling
SLS	-	Selective Laser Sintering
BPM	-	Ballistic Particle Manufacturing
CNC	-	Computer Numerical Control
EDM	-	Electrical Discharge Machining
RTM	-	Rapid Tool Making
DSPC	-	Direct Shell Production Casting
PSM	-	Projek Sarjana Muda
MFD	-	Modular Function Deployment
MIM	-	Module Indication Matrix
RTV	-	Room temperature Vulcanization

# **CHAPTER 1**

## **INTRODUCTION**

This chapter presents the objectives and general information regarding to the title of the research.

### **1.1 Background**

In keeping up with the modernization world of 21<sup>st</sup> century, the industries had shifted their production from the last era of mass production to the ‘time-to-market’ race, in order to stay and compete in the global market (Rosochowski and Matuszak, 2000). It had been a complete winning package for the industries if they can produce high quality and reliable products, in shorter time at lower cost compared to their competitive. Due to the highly competitive market, most companies started to redefine the way their business operate and expand and later had try to implement new techniques and skills suitable in various departments of their production (Felferning, 2007).

Then the leading companies discover in case of a new products, the sooner the product hits the market, the chances the company gain the customer’s loyalty to their products will be even much higher. Furthermore, customer nowadays had been even more demanding and seeks for a high quality but low cost products which are relevant to their specific needs (Ho et al, 2005). In fact, it had been estimated that 60% of total profit are often reduced because of the company’s incapability to deliver the products to the market in time (Hannula and Yang, 2007). This situation had shown that the customer really play an important part in this new business world.



Customer seems to be looking for items and products that suit their specific need which perhaps can be tailor-made to satisfy their constantly changing requirements (Lau et al, 2004). Russel (1993) had mentioned that today generations of consumers has a strong sense of individualism that will lead them to seek and later approved of customized and personalized products. As to that, it's obvious that the traditional mass production techniques which first applied in most industries around the year of 18th years (Pine, 1997) had evolved into mass customization which had been seen to be representing the trends more (Goldsmith and Freiden, 2004).

As said by Alexander (1999), customization is nonetheless to traces its ability to reduce inventory and working capital cost, allowing customized products to be supported at the same or lower cost than those which had been mass-produced. After all, customization can provide a strong relationship between customers and the company which spell out to more satisfaction, transaction and of course higher margin in the long run (Goldsmith and Freiden, 2004).

As the customer demand for quality products that are tailored made to their desires with the lowest price to be available in the market at the shortest time, the manufacturers somehow find the situation could become difficult to fulfill without the help from proper manufacturing technologies. This situation had encouraged the technologies such as Rapid Tooling (RT), a rapid prototyping (RP) based tooling to be well developed (Nagahanumaiah et al, 2007). This technology had reduced the prospect of spending a lot of time, energy and cost in order to develop the complex geometry and high quality dies and moulds (Hannula & Yang, 2007).

Nagahanumaiah et al (2000) had defined rapid tooling process as developing a mold by using RP based processes in one or more steps. It had been proven to reduce the tooling development time by 50% or more. The same authors also believed that there are more than 25 rapid tooling processes are available and can be categorized based on their expected mold life (number of parts that can be produced). Many renowned companies

and universities are directly and indirectly involved in the research of further development and new application of RT from time to time.

## **1.2 Objective**

There are a few objectives this final year project report wants to reach along the research:

- (1) To develop a mini case study that can support the concepts of customization and Rapid Tooling strategies.
- (2) To investigate the method of customization that can be apply to the case study's product model.
- (3) To try out available method of Rapid Tooling Strategies to the product selected for the case study.
- (4) To study to what extend the rapid tooling strategies can support the concept of product customization.

## **1.3 Scope**

The scope of this project will be two major sectors which are the customization and of course the rapid tooling methods. Both sectors are regards as the new methodologies that have been known to be under continuous study and had been believed to be among the techniques that can brings more income to the companies if it is well applied. Nonetheless, both topics cover a wide series of subtopic under their wings. Though for this research, the author needs to cover the application of customization in term of product design. Then, the author needs to identify the varieties of RT methods that are available in the market nowadays before later choose the methods that can be practiced in the university laboratories for the mini case study. The case study is an observation of methods that are available to produce the mould of the selected products. However, the

mould will be based on a master pattern of a product that beforehand had been undergone the modularization method of customization. The recorded data and the observation done during the experimental sessions were supposed to answer the objective of the research.

#### **1.4 Problem Statement**

Globalization had opened the world of manufacturing to a new level of standard and somehow had redefined the way companies conduct their business (Felferning, 2007). It had become the challenge for the industries to produce quality products with the minimum cost but at the same time still try to meet the customer's demand in the shortest time possible (Nagahanumaiah et al, 2007). Furthermore, Goldsmith and Freiden (2004) mentioned that customer nowadays has a strong sense of individualism that leads them to seek customization and personalized products to satisfy their desires. This situation had had created smaller segmented market that need to be satisfy. To produce mass customization products, Pine (1997) agreed that new technologies are playing the key roles. He also said that advances in the speed, capacity, effectiveness, efficiency and usability of information are crucial to allow the company to respond quickly to changes in fulfilling customer demands. But the question to know which technology would deliver the greatest impact to the application of customization remains to be revealed through various researches improving the already available answer.

## **CHAPTER 2**

### **LITERATURE REVIEW**

This chapter will present the background studies of previous research that related to the title of the project. The sources for the information and facts that are shared together in this chapter mostly come from journals, books and online trusted websites.

#### **A) CUSTOMIZATION**

##### **2.1 Introduction**

Manufacturing companies are all different with respect to the way they meet the market demands. Some companies fulfilled the customer's demand and deliver end product from their inventory (make-to-stock). However producing finished product to order, does not necessarily mean that the manufactured item is tailored to a specific customer's requirements. Furthermore, product customization which involves the supplier value chain necessarily assumes the delay of some activities of the value chain until the customer puts in an order (Blecker et al, 2004).

Blecker et al (2004) also agreed that the trends toward product customization nowadays are the result of many changes in the business environment. These changes have enforced many suppliers to revise their production strategies and management concepts. Many literatures contribution emphasize that mass production (MP) as a successful management paradigm but only under specific condition. Otherwise, it fails.

MP provides a mass market with goods at a consistent quality and affordable prices. It builds upon main principals that include among others economies of scale, product standardization, specialization, division of labor, hierarchical organization and vertical integration. The main goal is to develop, manufacture, market and deliver goods and services at prices which are low enough to where nearly everyone is able to afford them. Mass production provided low cost but at the expense of uniformity (Managing Change, 2004).

Customization is intended to add customer perceived value to a product since a customized product can fulfill the need of the customer better (c.f. Blecker et al, 2004). In order to define customization, it is relevant to include the product perspective which can be a physical good or a service. Thus product customization can be defined as producing a physical goods or a service that is tailored to a particular customer's requirements.

In this context, customer involvement is an important issue because customer dictates what the manufactures have to produce (Blecker et al, 2004). In case of physical goods, product customization can occur after manufacturing by the retailer or the customers themselves. Today, new interactive technologies like the Internet would allow customers to interact with a company and specify their unique requirements which are then manufactured by automated systems (Managing Change, 2004).

"Competitive advantage fundamentally grows out of the value a firm is able to create for its buyers that exceeds the firm's cost of creating it. Value is what buyers are willing to pay and superior value streams from offering lower prices than competitors for equivalent benefits or providing unique benefits that more than offset a higher price" ((Porter, 1998) c.f. Blecker et al, 2004)

Porter (c,f Blecker et al, 2004) emphasizes that the value offered to the customer as the most important factors, which determines the extent of competitive advantage. In this context, capability to produced goods that are tailored to customer's need can be marketed as the differentiating and distinctive that provides customers with the superior

value (Blecker et al, 2004). Therefore, product design (PD) can be considered as a feature to differentiate goods from other competitors.

When the products are customized, the features that customers undesired hardly exist and they just need to pay for products that have the configuration that satisfies their requirements. Customization enables suppliers to consider both basic types of competitive advantage that are identified by Porter (c,f Blecker et al, 2004).

## **2.2 Concept of Customization**

Silviera et al (2001) had agreed that customization can be defined either broadly or narrowly. Davis (c.f. Silviera et al, 2001) had a broad definition of customization as the ability to provide individually designed products and services to every customer through high process agility, flexibility and integration. Davis also had agreed that mass customization may thus reach customers as in the mass market economy but treat them individually as in the pre-industrial economies.

As for authors like Hart, Kay, Kotha, Ross and Joneja and Lee (c.f. Silviera et al, 2001), they agreed the definition of customization is similar but narrower, more practical concepts. They said that customization in term of mass situation as a system that uses information technology, flexible processes and organizational structures to deliver a wide range of products and services that meet specific needs of individual customers at a cost near that of masses produced items.

According to Silviera et al (2001) in short, the justification for the development of mass customization is based on three main ideas which is first, a new flexible manufacturing and information technologies enable production system to deliver higher variety at lower cost. Second, an increasing demand for product variety and customization had been available. Last but not least, the shortening of product life cycles and expanding

industrial competition has led to breakdown of many mass industries which later had increased the need for the production strategies to focus on individual customers.

In technical literature, there is no consistent or uniform definition for customization in related to mass condition precisely. This may be because the term is a paradigm. Another reason is that the work on mass customization involves many researchers from different fields of science, for example business administration and mechanical engineering (Blecker et al 2005 c.f. Kaskela, 2007). The requirements for products are specified more according to customer specifications than in traditional mass production (Grieves, 2006 c.f. Kaskela, 2007).

Mass customization can also be divided in a triangle of parties involved. Mass customization is the interaction of customer, manufacturer and product. The product adapts to the needs of the customer, and the customization is an outcome of customer-product interaction. The adaptability, however, has in most cases limits, and producer-customer interaction is needed in customizing the product. (Mäkipää et al 2005 c.f. Kaskela, 2007). The goal of mass customization is to combine the two approaches, to enable mass production with a high variety of products customized to the customer's needs.

### **2.3 Methods of Customization**

Extracting from books written by Pine (1997), he agreed that customization can be obtained by using these five fundamental methods which are:

- Customized services around standardized products and services.
- Create customizable products and services
- Provide point of delivery customization
- Provide quick response throughout the value chain
- Modularize components to customize end products and services

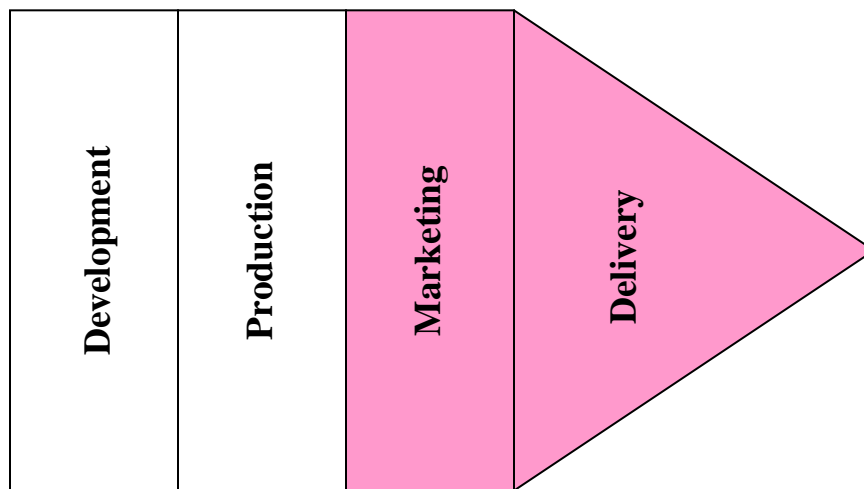
Though, he mentioned that all the methods that he suggested cannot be run exclusively as in practice all those strategies often overlap, combine or perhaps mix altogether for application. He also said that the organization itself should be ready with a tool of

flexible technology and quick responsiveness along with the flexible strategies so that their goals can be achieved.

### 2.3.1 Customized services around standardized products and services

Pine (1997) said that this type of customization involved the people from marketing and development by using the complete standardized products. This method would not affect the development and production as shown in Figure X. This kind of customization allowed the marketing and distribution team to change, add features or combine with other products plus provide services that would allow customers to feel their individual need had been attend.

The obvious example for this kind of customization is the hotel rooms and the airlines seats. The customer would have a chance to choose according to their preferences based on what the company had produced and can offer. This method, sell the services value to the customer rather than the technology.



**Figure 2.1:** Changes in Value Chain to Customize Services around Standardized Products and Services (Pine, 1997).