UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Design and Development of Car Gear Knob for Mass Customization

Thesis submitted in accordance with the requirements of the
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Bachelor of Engineering (Honours) Manufacturing (Design)

By

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APPROVAL

This thesis submitted to the senate of UTeM and has been accepted as fulfillment of the
requirement for the Degree of Bachelor of Engineering (Honours)
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The members of the supervisory committee are as follows:

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Mr. Hassan Bin Attan

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ABSTRACT

The title of this project is "Design and Development of Car Gear Knob for Mass Customization". The aim of this project is to design car gear knob, apply "design database" as a tool for mass customization on the design and development of customize gear knob, understand the manufacturing processes involved and to determine its contribution to "Time to Market" of mass customize gear knob. Car gear knob is chosen as a sample product to see whether using design database it can be mass customize. By using this method it can take a shorter time to produce car gear knob compared to the current method today. To fulfill this mission, three aesthetic features of car gear knob named as round, cylindrical and curve knobs are selected. Then, both three aesthetic gear knob is design using the "SolidWorks" software and apply design database method to customize the shapes and sizes through the "design table". Design table is a tool in "SolidWorks" and used to create different configurations or dimensions of a product. This method can also change the dimensions and features of an existing gear knob to create multiple configurations where the configurations control the size and shape of a gear knob. The manufacturing process selected for this gear knob is "Rapid Prototyping" as it can manufacture in shorter time period. The contribution towards "Time to Market" is done by recording the design time and modification of the design by inputting data in the design database. The time collected by this method is compared to conventional method to get the best method in designing customize car gear knob.

ABSTRAK

Tajuk projek ini ialah "Merekacipta dan Membangunkan Tombol Gear Kereta dalam Kuantiti yang Banyak Serta Memenuhi Permintaan Pelanggan". Matlamat projek adalah untuk merekacipta tombol gear kereta mengikut permintaan pelanggan, menggunakan kaedah "design database" sebagai peralatan dalam penciptaan dan pembangunanya, memahami proses pembuatan yang terlibat serta menentukan kesan bantuan kaedah tersebut ke atas masa yang diambil untuk memasarkan tombol gear. Tombol gear kereta dipilih sebagai sampel produk untuk melihat samada dengan menggunakan kaedah "design database", ia boleh dihasilkan dalam kuantiti yang banyak serta memenuhi permintaaan pelanggan. Dengan menggunakan kaedah ini, masa yang diambil untuk membuat tombol gear lebih cepat dibandingkan dengan kaedah yang sedia ada sekarang. Dalam melaksanakan misi ini, tiga bentuk tombol gear iaitu bulat, silinder dan melengkung telah dipilih. Ia kemudiannya dilukis menggunakan "SolidWorks" dan dibangunkan dengan menggunakan kaedah "design database". Kaedah ini digunakan untuk menghasilkan konfigurasi atau dimensi yang berbeza-beza bagi tombol gear. Di samping itu, ia juga dapat mengubah ciri-ciri asal tombol gear secara automatik dalam menghasilkan kepelbagaian tombol kerana konfigurasi ini boleh mengawal saiz dan bentuk sesebuah tombol gear. Proses pembuatan prototaipnya pula ialah dengan menggunakan "Rapid Prototyping" di mana produk dapat dihasilkan dengan pantas. Selain itu, kesan bantuan kaedah ini ke atas masa yang diambil bagi memasarkan tombol gear dikira dengan merekodkan masa untuk merekabentuk serta pengubahsuainya menerusi kaedah "design database". Masa yang diambil menggunakan kaedah tersebut dibandingkan dengan kaedah konvensional bagi menentukan kaedah yang terbaik dalam pembuatan tombol gear kereta.

DEDICATION

Firstly, thank to Allah S.W.T for the opportunity to finish this project. I owe this project
and my true happiness to my beloved parent. Since the day I started joining this
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Muhd Amran Abdullah

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

TTM	-	Time to Market
CAD	-	Computer Aided Design
MIN	-	Minute
AVG	-	Average
IEA	-	International Ergonomic Association
DFMA	-	Design for Manufacturing and Assembly

CHAPTER 1
INTRODUCTION

1.1   Introduction

The objective of this project is to train student to work independently to design, fabricate, analyze, collect data and solve the problem by investigation using available facilities including library, laboratory equipment, internet and software. Apart from that, student can improve their knowledge on engineering, science and mathematics in solving the problems.

The title of this project is "Design and Development of Car Gear Knob for Mass Customization" where student need to create a flexible or modular design database, make some analysis and then produce mockup of a car gear knob. This study will focus to design and develop an existing car gear knob which already available in the market. There are many types and shape of car gear knob but for this study, the most common ones are selected to test its flexibility for mass customization.

To design this gear knob, SolidWorks software is used. Using this software, some analysis on gear knob can be done before transferring to Rapid Prototyping machine for producing mockup. The project will focus on determining the current problems occur and evaluate the factors that might produces limitations for the product to be customize. Brief explanation of the theory will be provided in the second chapter forwarded.

1.2   Objectives

The objectives of this project are:

   i.   To design car gear knob.

  ii.   To apply necessary tools for mass customization on the design.

 iii.   To develop customize gear knob and understand the manufacturing process.

 iv.   To determine the contribution to 'Time to Market' of mass customize gear knob.

1.3   Scope Of Project

The scopes of this project are:

   i.   To create a flexible or modular design database of car gear knob.

  ii.   Utilization of 3D modeling software in design and analysis.

 iii.   Utilization of rapid prototyping technology as a tool for mockup.

1.4   Problem Statements

Generally, mass customization is the new frontier in business competition. In this new frontier, a wealth of variety and customization is available to consumers and business through the flexibility and responsiveness of companies practicing this new system of management (Pine II, 1993).

To change market perspective especially car gear knob from mass production to mass customization by customize a customer requirements may face some problem because mass customization is a new approach in manufacturing field. Basically, manufacturer did not take any risk to try this approach because needs a high cost for introduce to customer includes to train employee about mass customization.

This project will attempt to identify the difficulties and the effectiveness in mass customization of gear knob design start from design until producing mockup by applying all necessary tools available.

CHAPTER 2
LITERITURE REVIEW

2.1   Introduction

This chapter will introduce gear knob which includes definition and types of gear knob available in the current market. This chapter will also describe in detail about mass customization and findings about it by scholars and researchers from their journal and article. Mass customization is the use of flexible computer-aided manufacturing systems to produce customizes output. Those systems combine the low unit costs of mass production processes with the flexibility of individual customization (Pine II & Gilmore, 1997).

Details of 'Time to Market' (TTM) will also be discuss in this chapter where TTM define as the length of time it takes from a product being conceived until its being available for sale (Kahn, 2004). Measuring of TTM and their types will be discussed in detail. Besides, this chapter will also discuss about ergonomic factor, modularity, analysis and process in designing a car gear knob.

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2.2   Gear Knob

2.2.1   Definition of Gear Knob

The car gear knob or shifter knob is at the end of the gear stick. It forms the handle of the gear stick. Typically the gear knob includes a diagram of the shift pattern of the gear selection system such the positions to which the gear sticks should be moved when selecting a gear (Nemoto, 2002).

A typical manual transmission vehicle, with five forward gears, will have seven possible positions includes the five forwards gears, reverse gear, and a central "neutral" position. Some vehicles have a special button to prevent accidental engagement of reverse. Others require that the lever be lifted, pressed down, or moved with extra force to engage reverse (Nemoto, 2002).

Figure 2.1: Five Speed Shift Stick of a Manual Transmission Car

Many automatic transmission vehicles have extra controls on the gear stick or very close by which modify the choices made by the transmission system depending on engine and road speed. For example, sports or economy modes which will broadly speaking allow, respectively, for higher and lower revolutions per gear, before changing up. Some

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specialist vehicles have controls for other functions on the gear stick. The Land Rover Freelander introduced a button for that company's hill descent control feature, which uses the brakes to simulate the function of a low-ratio gearbox in steep descents (Nemoto, 2002).

Figure 2.2: Shift Stick of an Automatic Transmission Car

2.2.2   Types of Car Gear Knob

Nowadays, there are various types of car gear knob in market. Differentiation between gear knobs can be identified through their design and material selection to manufacture. Figure 2.3 are aesthetics examples of car gear knob commonly available in market.

Curve knob	Round knob	Cylindrical knob

Figure 2.3: Existing Gear Knob in Market Following Category

2.3   Mass Customization

2.3.1   Definition of Mass Customization

Mass customization, in marketing, manufacturing, and management, is the use of flexible computer-aided manufacturing systems to produce customizes output. Those systems combine the low unit costs of mass production processes with the flexibility of individual customization (Pine II & Gilmore, 1997).

Tseng and Jiao define mass customization as "producing goods and services to meet individual customer's needs with near mass production efficiency" (Tseng & Jiao, 2001).

Kaplan and Haenlein define mass customization as "a strategy that creates value by some form of company-customer interaction at the fabrication or assembly stage of the operations level to create customized products with production cost and monetary price similar to those of mass-produced products" (Kaplan & Haenlein, 2006).

Joseph Pine II described this paradigm at the beginning of the 90s. Pine suggested a business model that he called the 8-figure-path which describes the process from invention to mass production to continuous improvement to mass customization and back to invention (Pine II, 1993).

2.3.2 Types of Mass Customization

Mass customization is divided in four types (Pine II & Gilmore, 1997):

    i. *Collaborative customization* - firms talk to individual customers to determine the precise product offering that best serves the customer needs. This information is then used to specify and manufacture a product that suits that specific customer. For example, some clothing companies will manufacture blue jeans to fit an individual customer.

    ii. *Adaptive customization* - firms produce a standardized product, but this product is customizable in the hands of the end-user (the customers alter the product themselves)

    iii. *Transparent customization* - firms provide individual customers with unique products, without explicitly telling them that the products are customized. In this case there is a need to accurately assess customer needs.

    iv. *Cosmetic customization* - firms produce a standardized physical product, but market it to different customers in unique ways.

2.3.3 Implementation of Mass Customization

Many implementations of mass customization are operational today, such as software-based product configurations which make it possible to add or change functionalities of a core product or to build fully custom enclosures from scratch. This degree of mass customization has only seen limited adoption, however. If an enterprise marketing department offers individual products (atomic market fragmentation) it does not often mean that a product is produced individually, but rather that similar variants of the same mass produced item are available (Pine II, 1993).

Companies which have succeeded with mass customization business models tend to supply purely electronic products. However, these are not true 'mass customizes' in the

original sense, since they do not offer an alternative to mass production of material goods. Companies in which the production of tangible goods and services is immediately directed by customer demand include (Pine II, 1993):

    i. Dell's famous 'build-to-order' model facilitated its rise to dominance in the PC direct-purchase industry.

    ii. The Architectural Skylight Company is a Maine firm that uses CAD to automate the production of windows to architect specifications.

    iii. Companies throughout the tourism industry have been offering package holiday alternatives through mass customization.

    iv. Most mass customization applications, however, are still in business-to-business industries.

2.3.4 Mass Customization in Automotive Perception

Approaches for mass customization are reviewed to identify three distinct strategies for the automotive industry (Alford, Sackett & Nelder, 2000):

    i. *Core customization*: involving the customer with the design process of the vehicle occurs in low volume, specialist vehicles. Where the vehicle is designed to meet a specific market requirement, there may be a limited scope for the customer to request changes that affect the core design of the product.

    ii. *Optional customization*: allows the customer to choose their vehicle from a plethora of options, though the design of the vehicle may not be changed in any way. The customer is integrated into the manufacturing process as vehicles are assembled to their requirements, based on the decisions they make.

    iii. This is one aspect of *form customization* where changing the form of the standard product at the distributor. In addition to limited changes or enhancements to the actual vehicle, *form customization* includes the

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