SUPERVISOR DECLARATION

"I hereby declare that I have read this thesis and in my opinion this report is sufficient in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering (Design & Innovation)"

Signature: .....

Supervisor: .IR DR Tan Chee Fai

Date: .....

OPTIMIZATION OF VEHICLE STEERING WHEEL IN ACTIVE STEERING SYSTEM

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This report is submitted in partial fulfilment of the requirements for the award of a Bachelor's Degree in Mechanical Engineering (Design and Innovation)

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DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

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Date: .....

Lots of love to my family for the encouragements and supports.

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ABSTRACT

The objective of this project is to design and optimize the vehicle steering wheel in active steering system. Survey on current vehicle steering wheel design and active steering system are conducted to generate consumerism. Analysis of survey involved descriptive analysis that used box plot method while inferential analysis used analysis of variance, ANOVA. This paper demonstrates the optimization techniques that been utilized during the development of the steering wheel to generate an optimal design. In order to design the steering wheels with high safety and comforts using CAE method such CATIA and Quality Function Deployment, QFD. Morphological chart was used as one of the method to generate concept designs. Concept selection method was used to choose the final concept design; example is Pugh method. The final concept design will be analyzed using CATIA method to compare with the existing design of vehicle steering wheel. The outcome of this project is an optimum steering wheel design integrated with active steering system that overcomes several problems that leads to accidents.

ABSTRAK

Objektif projek ini adalah untuk mereka bentuk dan mengoptimumkan stereng kenderaan dalam sistem stereng aktif. Kaji selidik ke atas reka bentuk stering jenderaan yang sedia ada dan sistem stereng aktif yang dijalankan untuk menjana kepenggunaan. Analisis kaji selidik yang terlibat adalah analisis deskriptif yang menggunakan kaedah plot kotak manakala analisis inferens menggunakan analisis varians, ANOVA. Kajian ini menunjukkan teknik-teknik pengoptimuman yang digunakan pada peringkat pembangunan stereng untuk menjana sebuah bentuk optimum. Untuk reka bentuk roda stereng dengan keselamatan yang tinggi dan keselesaan-kebolehan menggunakan kaedah CAE seperti *CATIA* dan *Quality Function Deployment*, QFD. Carta morfologi telah digunakan sebagai salah satu kaedah untuk menghasilkan reka bentuk konsep. Konsep kaedah pemilihan yang digunakan untuk memilih reka bentuk konsep akhir; adalah kaedah *Pugh*. Reka bentuk konsep akhir akan dianalisis menggunakan kaedah CATIA untuk membandingkan dengan reka bentuk yang sedia ada stereng kenderaan. Hasil dari projek ini adalah stereng yang optimum reka bentuk yang bersepadu dengan sistem pemandu aktif yang mengatasi beberapa masalah yang menyebabkan kemalangan.

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CHAPTER 1

INTRODUCTION

1.0 Project Introduction

Steering wheel is a part of steering system that is maneuvered by the driver. The function of steering is to ensure that the wheels are pointing in the desired directions. It also helps improve safety with air bag module and physical design of steering wheel is important as it delivers more comfortable driving.

Most of modern steering wheel allows adjustment by drivers for driving comfort. There are different types of adjustable steering wheels such tilt wheel, telescopic wheel and swing away wheel. The physical design of steering wheel is the most important factor in obtaining driving comfort and safety. When driving, gripping on the steering wheel is important to control the vehicle. Lack of comfort and gripping could cause accident such skidding and car crash.

Active steering system is an alternative for a comfort ride and controllability of vehicle. It is a type of power electric variable gear ratio power steering technology which varies the degree that the wheels turn in response to the steering wheel. As active steering system is different than typical steering system, the steering wheel needs to be optimized along with the advances in technology. The scope of the optimization of

vehicle steering wheel for active steering system is studied and classified for a more focus study and design.

1.1. Problem Statements

According to a statistical data of Polis Diraja Malaysia (PDRM), in 2010 a total of 414,421 accidents are recorded compared to 397,330 accidents in 2009. While according to Jabatan Pengangkutan Jalan, Malaysia (JPJ), the number of serious accidents reach 6000 deaths per year and lead the country lost about RM9 billion each year.(Kementrian Penerangan Malaysia, 2011)

Losing control in controlling steering wheel because of factors such slippery hand and loose gripping in driving are the common cause accident. Steering wheel may look the same for most driver observations. Active steering system is different from the conventional power steering system. Thus to make sure drivers alert that they're driving vehicle equipped with an active steering system, a special steering wheel design is needed. The design of steering wheel and feedback of the active steering system to steering wheel are the main concern the research.

1.2. Objective

The main objective of this project is to design and optimize the feedback of a vehicle steering for active steering system.

1.3. Project Scopes

Throughout this project, there are several guidelines must be followed in order to make the project flows within the scopes. The scopes of this project are:

i. State of the art review on the vehicle steering and active steering system.
ii. Survey on driving behaviour based on current steering wheels.
iii. Design and development of a vehicle steering wheel for active steering system using total design method.
iv. Optimization of vehicle steering design using CAE method such as DFMA
v. Fabrication of vehicle steering prototype(s).
vi. Evaluation of a vehicle steering wheel
vii. Analysis of the evaluation result.

1.4. Methodology

1.4.1. Project Planning

- For a better understanding and information regarding the project, consultation session with supervisor, Ir Dr Tan Chee Fai at least once a week is needed.
- Prepare Gantt chart for guidelines and progress report.

1.4.2. Literature Reviews

- Study and understand about steering wheel and active steering system.
- Detailed information gained by referring through journals, reference books and supervisor's point of views.

1.4.3. Design Process

- Physical design of steering wheel will focus on the shape, size and material used.
- System feedback design will focus on the feedback of the active steering system will give to the steering wheel.
- Dassault System CATIA will be used in designing the vehicle steering wheel.

1.5. Outline of Report

1.5.1. Chapter 1 – Introduction

This chapter contains the background, objective, scopes and problem statement of the project. This chapter also reviews generally about the methods used in this project.

1.5.2. Chapter 2 – Literature Review

In this chapter, the details of subjects cover in this project from studies done will be review. Main concern of this chapter consists of the history of steering wheel, vehicle steering wheel design, ergonomics study, overview of active steering system, and last but not least, research on driving behaviour.

1.5.3. Chapter 3 – Methodology

This chapter contains the methods used in this project such as method for data collecting, analysis method and design method. The flow chart of this project is included in this phase and the details of each methods used is discussed.

1.5.4. Chapter 4 – Concept Design

This chapter will conclude the findings and progress that have been completed until end of this semester. The remaining process for this project also discussed in this section.

1.5.5. Chapter 5 – Detail Design & Material Selection

This chapter will conclude the details design and material used for the steering wheel. The product design specification also included.

1.5.6. Chapter 6 – Result & Discussion

This chapter will discuss about the results of data that been obtained throughout the research. Processing and analyzing data involves a number of closely related operations which are performed with the purpose of summarizing the collected data and organizing these in a manner that relevant.

1.5.7. Chapter 7 – Conclusion

This chapter will discuss about overall outcome from this research.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter is representing the literature review about the paper which has done. This chapter consists of the history of steering wheel, vehicle steering wheel design, ergonomics study, overview of active steering system, and last but not least, research on driving behaviour.

2.1. History of Steering Wheel

The first cars were guided using a tiller-like device similar to bicycle handle and it looked more like a joystick as shown in Figure 2.1. In 1894, a Frenchman named Alfred Vacheron became the first tinkerer to adapt what he called "wheel steering" for his race car use in the famous Paris-Rouen-Race. He use a 1893 Panhard 4hp model fitted with a "wheel steering" and named his car "Vacheron" which later won several high-profile competitions. He borrowed the idea of a steering wheel from big sailing ships and it proved to offer range of motion than the tiller design. Although the race was won by a De Dion-Bouton Steam-mobile and Vacheron became 11th, his idea of adapting a steering wheel from big sailing ships proved that steering wheel offer high range of motion than the tiller design. (Duncan, 1927)

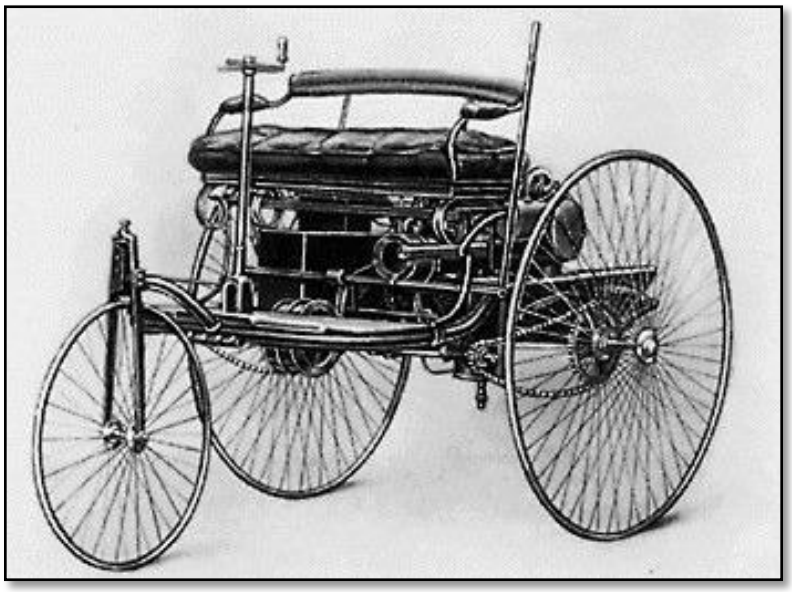

Figure 2. 1: 1885 Benz Patent Motorwagen that use tiller as handle

(Photograph reprinted from Benz Patent Motorwagen)

The ease of operation shown in the 1894 race meant that by 1898, when all Panhard et Levassor cars came equipped as standard with steering wheels. The principle quickly caught on and similar systems sparked across the world. In Britain, Charles Stewart Rolls bought a Panhard from France and implemented the steering wheel into his designs. By 1899, the steering wheel expanded to the US, where Packard introduced the steering wheel on one of its models. As Packard Model T arrived, the steering wheel became essential part of car. Packard Model T as shown in Figure 2.2 success had given a big impact to the automobile with the usage of steering wheel as main controller.

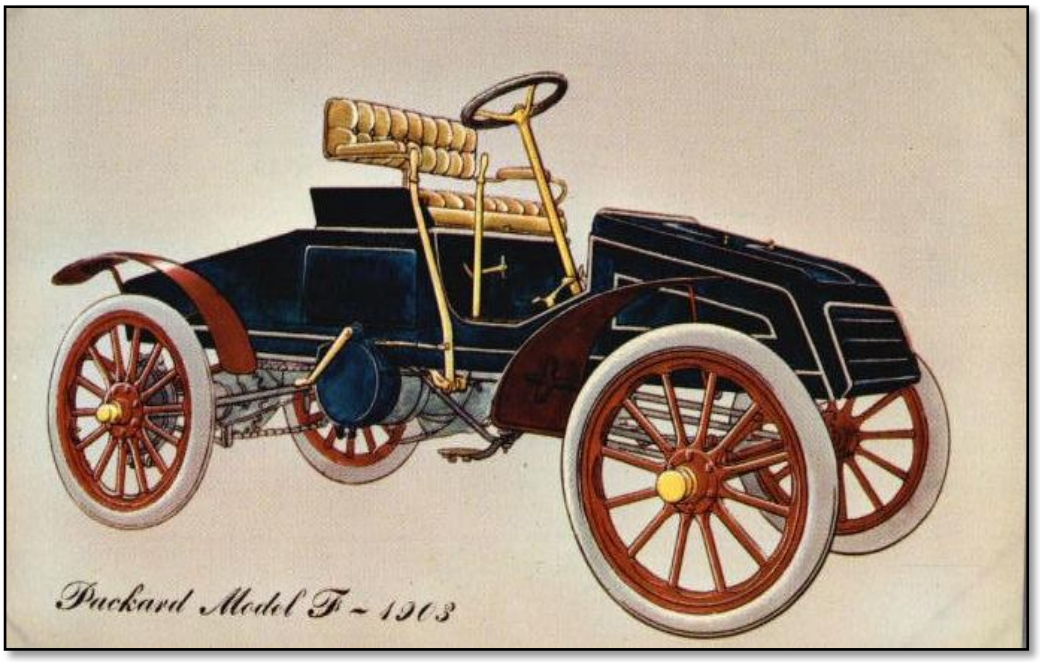

Figure 2. 2: Packard Model T

(Photograph reprinted from Postcard-1903-Packard-Model-T-Ford-Museum-Dearborn-MI)

After that moment, the steering wheel stuck with the car, with its most common shape, which is a circle, unchanged for more than a century now. As humanity crawls its way through the 21th century, the steering wheel is quickly leaving behind its established role of vehicle controller and becomes command hub for the entire vehicle.

2.2. Vehicle Steering Wheel Design

Steering wheel basically consists of round wheel that nowadays coated by absorbent material. By referring to Figure 2.3 below, the cross-section view of basic steering wheel is shown. The basic layout of a typical steering wheel assembly is comprised of a metal insert, a steel hub, and a layer of material or molding to cover part of the insert where shown by Figures 2.4. (Yang *et al*., 2005)

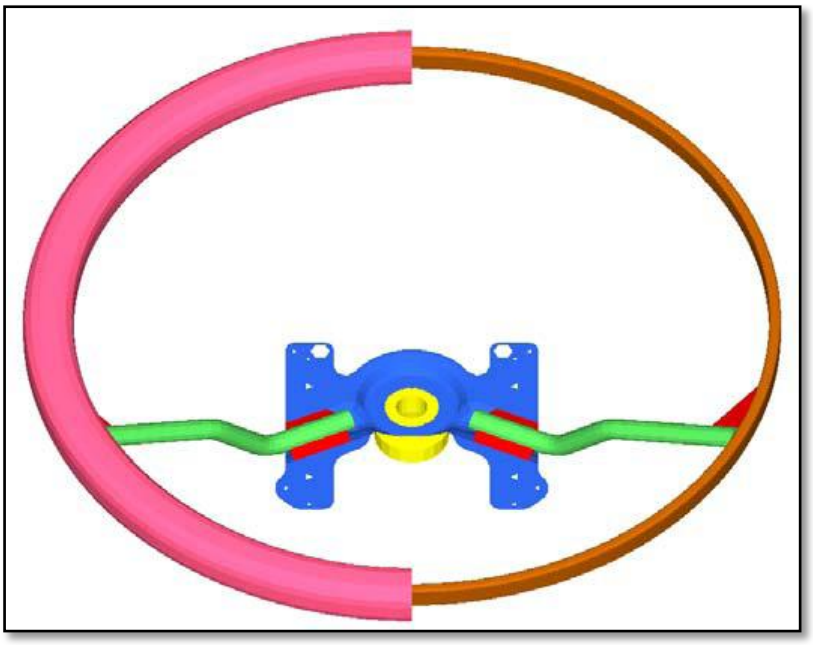

Figure 2. 3: A steering wheel at design stage

(Photograph reprinted from Yang *et al*. 2005)

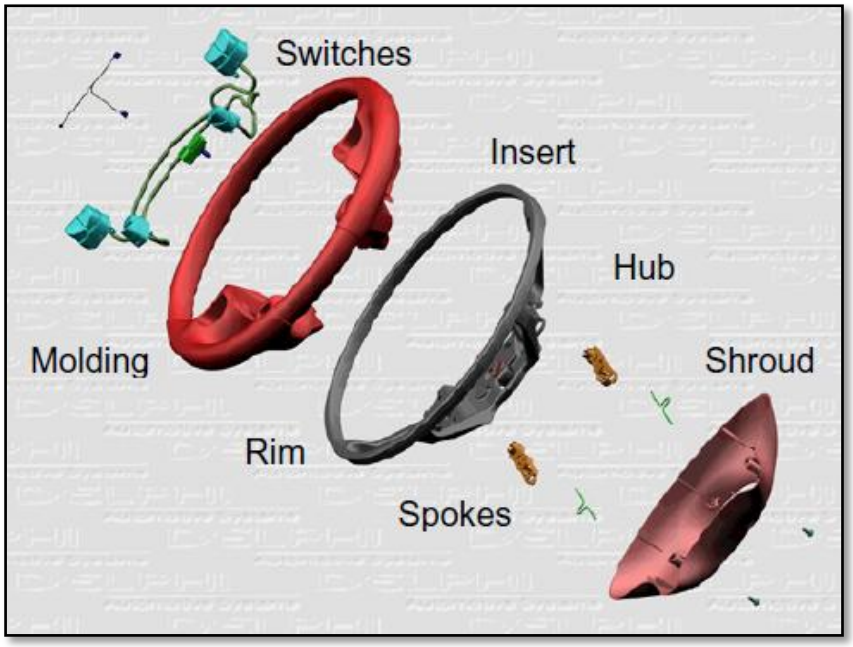

Figure 2. 4: Components of a typical steering wheel

(Photograph reprinted from Yang *et al*. 2005)

For the structure wise of a steering wheel, it may have 1, 2, 3, or 4 spokes as shown in Figure 2.5. The cross-sections of the spokes and rim could be solid, tubular or u-channel depends on design criteria. Insert materials for steering wheel that commonly being used includes magnesium, aluminium and steel. And for the cover material can be urethane, leather, wood, or a combination thereof.

Figure 2. 5: Various steering wheel styles

The steering wheel allows driver to move steering linkage to steer the vehicle. Steering wheels on manual steering systems are larger in diameter than the ones used on a power-steering system. This gives the driver some mechanical advantage during low-speed steering. The horn control button and air bag are located within the steering wheel. Some newer vehicles have switches for cruise control and other accessories on the steering wheel. (Owen, 2011)

To makes the design process much more efficient, incorporation of structural optimization in the initial stages of design phase of automotive components are needed. The increases of the possibility of achieving the maximum performance of the final design also considered. Various shapes are created in the steering wheel by considering