UNIVERSITI TEKNIKAL MALAYSIA MELAKA

INTERIOR PACKAGE DESIGN AND DEVELOPMENT OF ENERGY EFFICIENT SHELL ECO-MARATHON URBAN CAR

This report is submitted in accordance with the requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours.

By

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BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

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Sesi Pengajian: 2019

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APPROVAL

This report has submitted to the Faculty of Mechanical and Manufacturing Engineering Technology of UTeM as partial fulfilment of the requirements for the Bachelor of Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

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ABSTRAK

Rekabentuk pakej dalaman dan pembanggunan kecekapan tenaga kenderaan bandar Shell Eco-Marathon adalah projek untuk mempelajari interaksi manusia terhadap komponen-komponen terlibat didalam kenderaan. Projek ini dijalankan bagi pembanggunan kenderaan yang digunakan dikawasan bandar bertujuan untuk pertandingan iaitu Shell Eco-Marathon Asia 2020. Projek ini fokus dalam mempelajari data antropometrik kepada beberapa jenis populasi. Ianya dijalankan dengan menilai ukuran antropometrik diantara pelajar lelaki Fakulti Teknologi Kejuruteraan Mekanikal dan Pembuantan (UTeM). Data diperolehi kemudiannya dibandingkan dengan pangkalan data SAE J833 yang mewakili populasi rakyat Amerika Utara. Ianya menunjukkan populasi rakyat Amerika Utara tinggi dari segi ukuran badan jika dibandingkan dengan populasi rakyat Malaysia. Selain itu, projek ini juga fokus dalam menganalisa faktor ergonomik didalam kenderaan. Ianya dijalankan menggunakan perisian CATIA V5. Patung yang terdapat didalam perisian ini telah disusun berdasarkan ukuran yang telah ditetapkan. Seterusnya, patung ini telah dianalisis menggunakan "Rapid Upper Limb Assessment (RULA) Analysis". Ia menunjukkan bahawa terdapat perbezaan skor didalam bentuk warna diantara beberapa sampel rekaan. Skor berwarna hijau menunjukkan bahawa bahagian badan berada dalam keadaan baik manakala skor kuning dan merah menunjukkan keputusan yang kurang baik pada bahagian badan seseorang manusia. Berdasarkan keputusan yang telah diperolehi, ianya menunjukkan data diantara populasi rakyat Malaysia dan Amerika Utara mempunyai banyak perbezaan dari segi ukuran badan. Selain itu, kedudukan komponen didalam kenderaan juga memainkan peranan yang penting pada interaksi manusia. Akhir kata, projek ini perlu diteruskan pada masa hadapan bagi memperbaiki interaksi manusia terhadap komponen didalam kenderaan. Untuk memperolehi keputusan yang lebih memberangsangkan, penyiasatan yang lebih mendalam keatas interaksi manusia boleh dilakukan melalui rekaan konsep dalaman kenderaan boleh digunakan oleh manusia itu sendiri, ianya bertujuan untuk memperolehi keputusan di alam nyata dibandingkan keputusan simulasi.

ABSTRACT

The Interior Package Design and Development of The Energy Efficient Shell Eco-Marathon Urban Car is one of the thesis made for studying the human interaction between the component inside the vehicle. This study has been made for the development of the urban type of vehicle which aims for a competition which is Shell Eco-Marathon Asia 2020. This project is focusing on studying anthropometric data on several types of the population that are related to the vehicle package design. The study of anthropometric data is conducted by evaluating the anthropometric measurement between the male student of the Faculty of Mechanical and Manufacturing Engineering Technology (UTeM). The data collected then are compared with the database from SAE J833 which is the population among North American. Based on the analysis, it shows that the measurement of the North American population is higher compared to the Malaysian population. Other than that, this study also focuses on analysing the ergonomics factor inside the occupant cabin. This study was made by using CATIA V5 software. The manikin was organized based on the measurement that has been setup and these manikins were analyse by using Rapid Upper Limb Assessment (RULA) Analysis. The finding of this analysis shows the differences in score among several samples of design which represent in colour code. The green code colour indicated that the body segment is in good condition while the yellow and red colour will resulting in the bad result of a body segment. Based on the resulting gain, this project shows the anthropometric data between the Malaysian population and the North American population has large differences in measurement. Besides that, the position of the component inside the vehicle also plays an important role in human interaction. These projects need to continue in the future for the improvement of human analysis. To obtain better result, a further investigation of human interaction through the real basic concept of interior vehicle in order to get the result in real world compared to the result in the simulation.

DEDICATION

At the end of this project, I dedicated my work to my family, lecturers, and friends that have played an important role in completing my bachelor's degree project. A special appreciation to my family especially my beloved parents, Shamsudin Bin Dobot and Azizah Binti Abdul Rahman that has to give me moral support in the period of completing this project. Also, I dedicate my work to my supervisor En. Mohammad Rafi Bin Omar and my co-supervisor En. Mohd Suffian Bin Ab Razak has guided me from starting until the end of this project. Besides, this appreciation also gives to my friends that always help me and share an idea in completing this project. Finally, this project won't be finished without all the support that has given from them.

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First praise is to Allah (my Lord), the Almighty, on whom ultimately we depend for sustenance and guidance who made me possible in conducting this study and completing this project.

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LIST OF **ABBREVIATIONS**

SAE   -   Society of Automotive

SgRP   -   Seating Reference Point

AHP   -   Accelerator Heel Point

DHM   -   Digital Human Model

CAD   -   Computer Aid Design

RULA   -   Rapid Upper Limb Assessment

CV   -   Coefficient of Variations

SD   -   Standard deviation

CHAPTER 1

INTRODUCTION

1.1 Introduction

Shell Eco-Marathon is one of Energy Efficient Vehicle (EEV) competitions which involves energy saving of the vehicle. Shell Eco-marathon was organized by the company Shell which focused on the minimization of vehicle fuel consumption (Fabian et al., 2017). Interior design inside the passenger cabin of the vehicle has considered as one of the important factors to make sure the vehicle is better energy efficiency. The comfortable of the passenger and driver inside the vehicle also plays an important role in designing the interior. Interior package design has become the main research in this project in order to deliver a good interior for driver and passenger. Vehicle package design is a process of designing the interior of a vehicle according to the predefined standards and its main objective is to achieve the desired purpose especially the comfort environment of the interior vehicle (Parkinson, 2010).

The ergonomics factor has been studying in this research in order to provide a good result. Ergonomics is known as a discipline of science which is focusing on the interaction between humans and applications or elements of the system that are used in daily life such as transport, production processes, agricultural machinery and equipment, traffic system and working environment. Ergonomics role is to increase the efficiency and productivity of production and help improve the health, comfort, and safety of the user. In the automotive field, the ergonomics study is focusing on the prediction and development of passenger space

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inside the vehicle which might impact the mental and physical health of passenger and driver itself. Parameterizing the driver package as shown in figure 1.1 is required. In designing the interior of the vehicle which focusing on ergonomics study, seats that determine the position of the passenger and other component is one of the main factors that need to be the focus. For example, bad seat design will effect the driver and passenger health during long periods of driving (Mačužić, 2017).
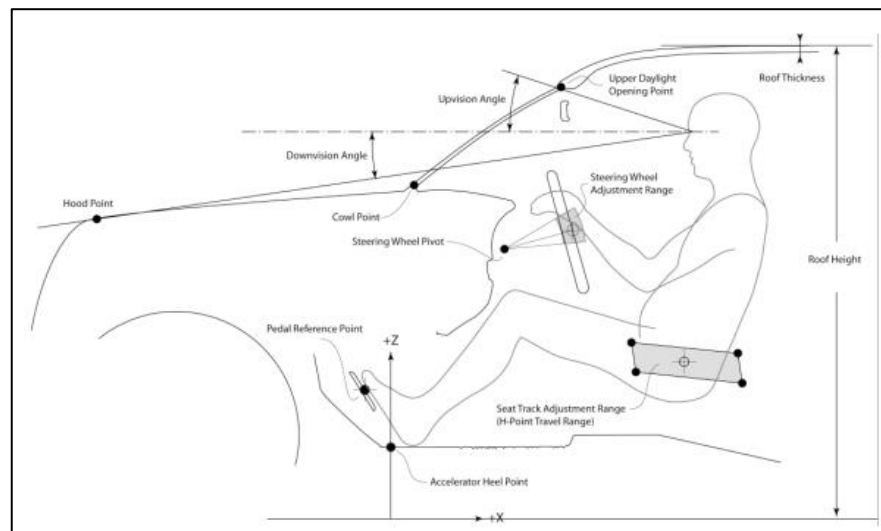
Figure 1.1: Parameterizing the driver optimization inside the vehicle (Parkinson, 2010)

This study will also cover several topics which are the anthropometric data that represent the percentile required in this study, the sitting posture and the standard or parameter presented by The Society of Automotive Engineer (SAE) which are implemented in designing and arranging the component inside the vehicle to meet the desired purpose. Furthermore, the development of this project is according to established procedures. The research is only focused on the arrangement of the manikin position inside the vehicle by using features on CATIA V5 design software called Rapid Upper Limb Assessment (RULA) Analysis. The position of the component such as steering wheel, seat, gear lever, foot rest, brake pedal and accelerator pedal can be arranged based on this analysis.

1.2 Problem Statement

The vehicle interior design plays an important role between vehicle performance and owner satisfaction. Design that related to interior problems can have a negative impact on the overall satisfaction of the interior and might be effect occupant health. There are several problems faced that need to concerned which is the design of the occupant cabin must be lead to the increasing of energy efficient of the vehicle. The arrangement of the manikin position must be analysed by using a specific method that aims to reduce the poor posture of the occupant inside the cabin while maintaining the comfortable and health of the occupant itself.

To overcome this problem, designing the interior of the vehicle will take several factors that must be concerned. The exterior of this vehicle is designed with low coefficient drag in order to increase energy efficiency which follows the regulation set by the organizer. To maintaining the low coefficient drag, the arrangement of the manikin must be fit the vehicle being designed by reffering the dimension suitable for manikin in this vehicle. The position of manikin can be analysed by using Rapid Upper Limb Assessment (RULA) Analysis in CATIA V5 design software. This analysis will show the correct posture for manikin by presenting the score value as its result. Good score value will be maintaining the occupant's health in good condition.

1.3   Objective

In this project, there are several objectives that need to focus followed as below:

i)   To evaluate the anthropometric data between others population which related to vehicle occupant design.

ii)   To analyse the ergonomics factor inside the occupant cabin of the Shell Eco-Marathon Urban car.

1.4   Scope of Work

There have several scopes of work and limitation which will be followed to complete this project. The work scope of this project is outlined below:

i)   Conducting the anthropometric data of 95th Asian males among 80 samples of male students in the Faculty of Mechanical and Manufacturing Engineering.

ii)   Ensuring the selected manikin is fit enough in the vehicle occupant cabin of the Shell Eco-Marathon Urban Car concept based on vehicle dimensions set by the organizer by referring to the exact value of some kind car posture.

iii)   Analysing the human machine interaction of the manikin inside the occupant cabin by using Rapid Upper Limb Assessment (RULA) Analysis.

iv)   Designing the basic concept of occupant cabin with component (seat, steering wheel, foot rest section, brake, and accelerator pedal section) based on the analysis.

v)   Gathering data between the arrangement of manikin and component involve by plotting the reference line template for further study.

CHAPTER 2

LITERATURE REVIEW

2.1   Background

In this chapter, information about Vehicle Package Design will be described. The ergonomics in the automotive design process, ergonomics factor that related to energy efficient of a vehicle, history of interior design and the development of the vehicle will be presented. The flow of the literature review is shown in Figure 2.1.
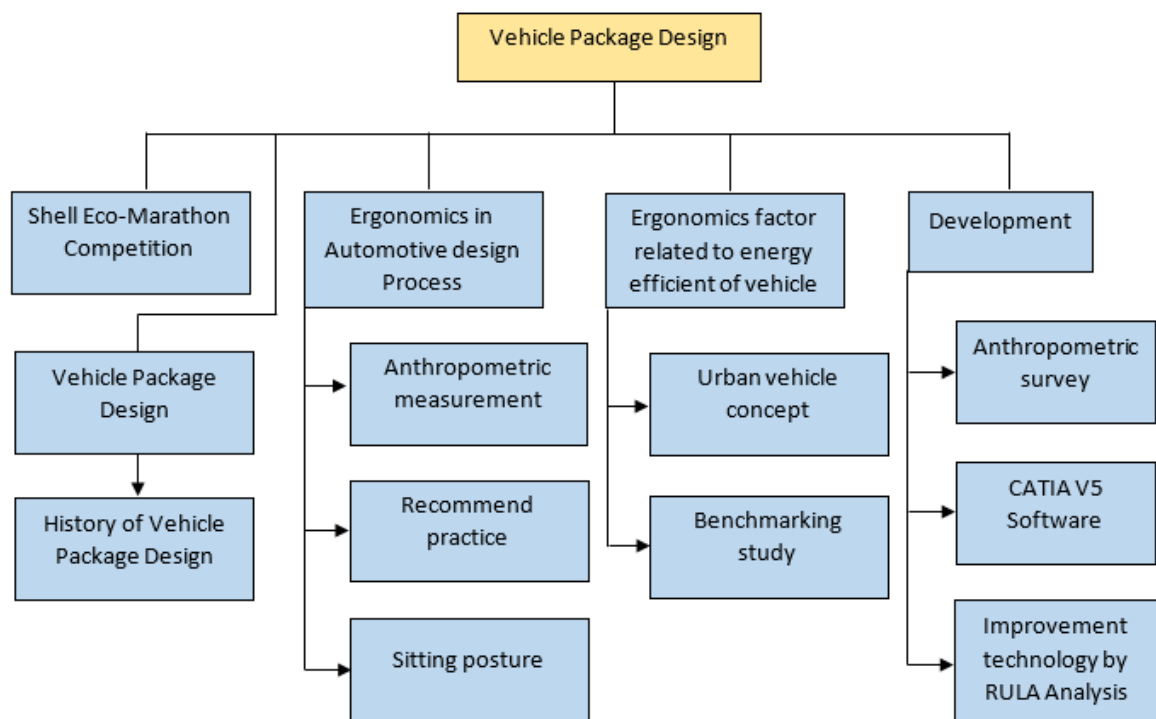

Figure 2.1: Flow Chart of the Literature Review

2.2   Shell Eco-Marathon Competition

Shell Eco-Marathon is an international competition organised by the company Shell. This competition focuses on minimizing the fuel consumption of vehicles by allows the competitor to design their own vehicle construction along with the combustion engine innovations. The vehicle is designed by using CATIA V5 Design Software. The experimental vehicle's 3D model created must be optimized aerodynamically with airflow simulation. Based on the Shell Eco-Marathon 2016 that has been organised on a circuit in London. This competition set a length of the circuit about 2240 metres and the racing vehicles need to pass this distance 8-times with one litre of fuel below 43 min (Fabian, 2017).

2.3   Vehicle Package Design

Vehicle package design or vehicle occupant packaging is known as a process of designing the interior of the vehicle aims to achieve the desired purpose which is comfort, reliability, durability, and safety for the occupant inside the vehicle cabin. In this vehicle occupant packaging, the first thing that the designer needs to focus on is the driver workstation. The component arrangement inside the driver workstation needs to be positioned correctly based on ergonomics study to avoid the accident occur. The driver package refers to the pedal locations and adjustment ranges of the steering wheel and seat (Parkinson, 2010).

2.3.1 History of Vehicle Package Design

Ergonomics science seems to have been placed in the context of Ancient Greece's culture. It can prove that they used ergonomic principles during the Hellenic Civilization of the 5th century in the design of tools, jobs, and workplaces. The term ergonomics comes from the Greek words "ergon" meaning work whereas "nomos" means natural laws. In the 19th century, Frederick Winslow Taylor founded the "Scientific Management" method to propose a way on optimization of carrying out a given task. In early 1900, Frank and Lillian Gilbreth continue the Taylor method and expand "Time and Motion Studies" to improve efficiency by eliminating unnecessary steps and actions. Crash of the fully functional aircraft due to decision-making attention, situational awareness and hand-eye coordination of the machine during World War II has inspired Alphonse Chapanis, a lieutenant in the U.S Army to introduce the "Pilot Error". Ergonomics has continued after decades since the war. The Space Age created new human factors related to weightlessness and extreme g-forces (Gkikas, 2012).

2.4 Ergonomics in Automotive Design Process

Bubb & Spanner-Ulmer (2009) said that Ergonomics or human factor is the term that are emphases between human and their interaction with machines, materials, information, procedures, and environments that are used in their daily life. Ergonomics study needed in the design process because it aims to study human behaviour, capabilities, and limitations before its applied to the design of products and machines for productive, safety, comfort, and human efficiency in applying it. The ergonomics purpose in product design is to ensure that the efficiency and productivity of production is increase. Ergonomics also improve certain elements such as health, safety, and comfort of the person in their workplace. There have several scientific disciplines practiced in ergonomics study which are physiology,

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