UNIVERSITI TEKNIKAL MALAYSIA MELAKA

ANALYSIS DESIGN OF VEHICLE FOR OCCUPANT PACKAGING

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

by

AHMAD HAZIM BIN NOR AZMAN

B071610255

940713-14-6895

FACULTY OF MECHANICAL AND MANUFACTURING ENGINEERING TECHNOLOGY

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I hereby, declared this report entitled Analysis Design of Vehicle for Occupant Packaging is the results of my own research except as cited in references.

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

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Supervisor : DR NUR HAZWANI BINTI MOKHTAR

ABSTRAK

Penyelidikan ergonomik kenderaan memperkatakan interaksi fizikal penghuni kenderaan dengan bahagian dalam kenderaan di bawah keadaan operasi biasa. Ini termasuk memahami dimensi badan penghuni dan faktor-faktor reka bentuk dalaman kenderaan itu seperti sikap, kedudukan dan keselesaan pemandu. Pada peringkat pertama untuk projek ini, data tiga jenis kereta dari rantau pengeluar yang berbeza dengan membandingkan dimensi kereta ini dengan dimensi awal telah mengumpulkan dan menganalisis untuk membangunkan rig simulator memandu. Semua pengukuran ini membantu untuk membina simulator memandu sebenar berdasarkan dimensi kereta sebenar. Pada peringkat kedua, struktur rig simulasi telah direka dan dianalisis. Analisis magnitud pemotongan menunjukkan bar yang disokong untuk kerusi pemandu di bawah beban di bawah 150 kg akan membengkok di bawah hanya 0.3 mm sahaja. Analisis tegasan Von Mises telah menunjukkan kawasan yang terjejas di bawah beban berat pemandu adalah tinggi di kawasan tengah bar sokongan kerusi. Analisis faktor keselamatan menunjukkan bahawa rig simulasi ini selamat untuk digunakan kerana nilai lebih daripada satu yang nilai minimum adalah 58.99, dan maksimum ialah 100. Simulator memandu ini akan membantu penyelidik atau pelajar seterusnya menjalankan simulasi dan membangunkan penyelidikan tingkah laku manusia.

ABSTRACT

Vehicle ergonomics research deals with vehicle occupant's physical interaction with the interior of the vehicle under normal operating conditions. It includes understanding the effects of dimensions of the occupant body and factors of interior design of the vehicle as such the posture, position and comfort of the driver. In the first stage for this project, the data of three types of car from different manufacturer region by comparing the dimensions of these cars with initial dimension have been gather and analyze to develop driving simulator rig. All these measurement helps to build real driving simulator based on actual car dimension. In the second stage, the structure of simulation rig has been designed and analyzed. Displacement magnitude analysis shows the supported bar for driver seat under load below of 150 kg will bend below than 0.3 mm only. Von Mises stress analysis has shown area affected under the load of the driver weight is high at the center area of the seat supported bar. Safety factor analysis shows that this simulation rig is safe to use because the value is more than one which is the value for minimum is 58.99, and for maximum is 100. This driving simulator will helps next researcher or student to run any simulation and develop human behavior research.

DEDICATION

I want to dedicate this study to my supervisor, Dr Nur Hazwani Binti Mokhtar, who provides me with additional knowledge to help me in this study, and also to salute my dearest parents for helping me in this project.

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I am very grateful to Dr. Nur Hazwani Binti Mokhtar for her instruction and proper supervision, and also for having sufficient information about the project and also for her assistance in finishing this study. I would also like to thank my parents, family members and friends regardless of their personal support and motivation to support me complete this work. My gratitude and remembrances go also to my colleague who helped me with their expertise.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

1.1 Background

Vehicle Ergonomics research deals with vehicle occupant's physical interaction with the interior of the vehicle under normal operating conditions. It includes studies to understand the effects of dimensions of the occupant body and factors of interior design of the vehicle on the posture, position and comfort of the driver. The objectives of this project are to gather and analysis data of three type vehicles from different manufacturer region by comparing the dimension measurement of these cars with reference dimension, gather and analysis data driver body measurement in driver workspace. All these measurement help to build real dimension in driving simulator based on actual car dimension.

Ergonomics is important in automotive, to develop the best fit between the driver and the vehicle to guarantee the safety, comfort, accommodation, improved execution and proficiency of the driver and diminished exhaustion. The keywords often describing ergonomics are both comfortable and safe environment (Rashid, 2017).

One of the key areas considered by the design engineer when developing the vehicle is ergonomics. Ergonomic factor function is to ensure the vehicles are

harmonized and fulfills customer expectation. The seating position is essential in automotive design. Car seat must be in the comfort position to ensure the driver's health and convenience while driving (Kyung, 2008). Besides car seats, others equipment such as steering wheel position, acceleration and braking pedals position are important to ensure driver comfortness. In comfort position, drivers are able to make an excellent judgment when facing critical condition such as near accident situation.

The interior of the vehicle is designed to maximize accommodation for the target population within the limits of space or cab dimensions. Accommodation means the driver can perform the required task while sitting in a comfortable position. The driver is considered accommodated if the components of the workspace can be reached in the desired position without the limitations of the adjustment range (Rashid, 2017).

The driving simulator is designed to conduct engineering studies on car interiors. In automotive industries, it can help to design and evaluate new vehicles or new advanced driver assistance systems to build in the actual vehicle. Many of scenarios can be run in the simulation which probably too costly, dangerous, time consuming and complicated to test in the real world. However, the affordable driving simulator in the market does not have the criteria to do the simulation based on the actual car driver workspace. Thus, it is necessary to develop driving simulator rig for others benefit to study simulation research related with automotive.

1.2 Objective

The objectives of this project are as follows:

i. To gather and analyze data of three type vehicle from different manufacturer region by comparing the dimension measurement of these cars with reference measurement.

ii. To gather and analyze data driver body measurement in driver workspace.

iii. To develop and analyze structure driving simulator rig.

1.3 Problem statement

Driving simulator in the market are expensive and it more for gaming purpose which are not for real driving situation in the car. Some of their seat is fixed where user cannot adjust the high of headrest, angle of back cushion, high of seat, space between the seat and steering. Structures of the cheaper driving simulator are not solid for the driver and monitor screen.

1.4 Scope

i. Design driving simulator rig using CATIA and SimSolid design software.

ii. Fabricate driving simulator rig

iii. Structure analysis of driving simulator rig

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This part analyzes existing examination writing to set up the establishment and distinguish the exploration in this investigation. The first section is about ergonomic study on driver seating position and driving simulator rig. This includes the SAE guideline, benchmark measurement, references point, and current driving simulator rig. Second section is about driving simulator in the market. The last sections are the previous study of stress analysis on trailer chassis and driving simulator pros and cons. The flowchart of literature review is shown in Figure 2.1.

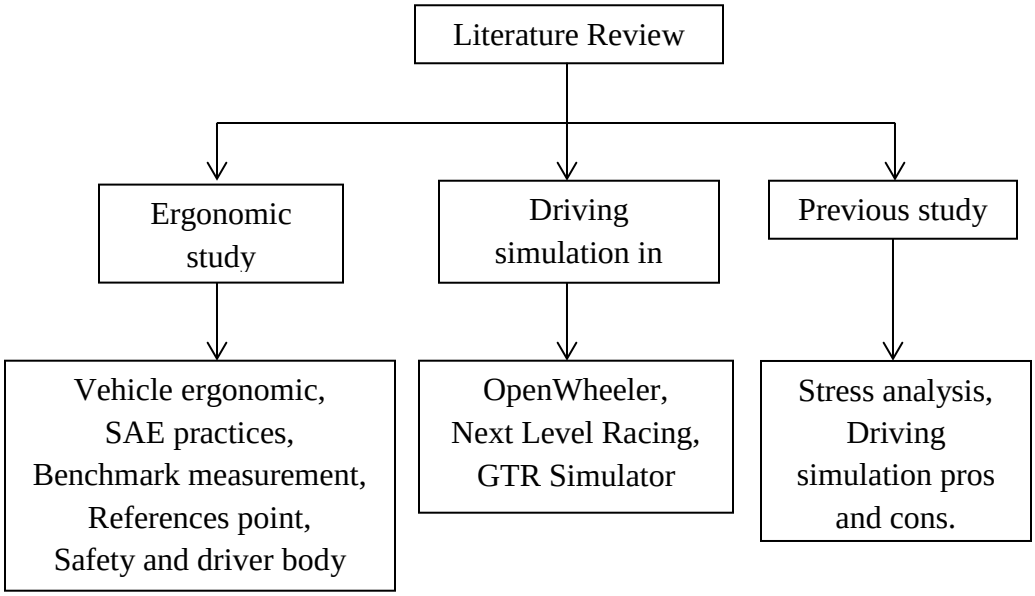

Figure 2.1: Literature review flowchart

2.2 Review of vehicle ergonomic

Ergonomics is a science that utilizes a methodical way to deal with look at the collaborations among individuals and their workplace. It distinguishes potential dangers with tools, equipment, nature and occupation structure that make weight on a person. Ergonomics is a several academic science including fields identifying with data on individuals, for example, physiology, anthropometry and biomechanics. It includes the investigation on human qualities, capacities and confinements and applying this data to plan and assess frameworks and parts for use by the general population.

The quality of accommodation will determine the percentage of fit of the potential user population to the vehicle, and ensuring adequate clearance of the body to fit the driver workspace. The field of ergonomics or human components

building in car item improvement include working with a few vehicle configuration groups, for example, the groups from venture the executives, exterior and interior styling configuration, design package, and the engineering design group (Bhise, V. 2011).

2.3 Society Automotive Engineers Recommended practices

The Society Automotive Engineers (SAE) is an expert association for portability building experts in the aviation, car, and business vehicle enterprises. SAE is a principles advancement association for the building requirements of different of vehicle including cars, trucks, boats, airplane, and others. SAE has established a number of standards commonly used in the automotive industry especially by the automotive Original Equipment Manufacturer (OEM).

SAE Recommended Practices have been utilized in the improvement of a mixture of institutionalized instrument to speak to the conduct of occupants, especially in the vehicle driver workspace. It was at first created in 1950s and is respected a principal reference for the plan of inside space in the vehicle design package. Despite the fact that organizations may have their very own in-house structure rules and methodology, the SAE Recommended Practices still structure the reason for some basic plan strategy. Table 2.3 shows a selection of the SAE Recommended Practice for automotive interior design. Location area of SAE recommended practice code in occupant packaging is shown in Figure 2.2 (Reed, Roe, Manary, Flannagan, & Schneider, 1999).

Table 2.1: SAE Standard Practices for automotive interior design

SAE Standard Code	Standard Name
J182	Motor Vehicle Fiducial Marks
J287	Driver Hand Control Reach
J826	Device for Use in Defining and Measuring Vehicle Seating Accommodation
J833	Human Physical Dimension
J941	Motor Vehicle Driver's Eye Location
J1050	Describing and Measuring the Driver's Field of View
J1052	Motor Vehicle Driver and Passenger Head Position
J1100	Motor Vehicle Dimension
J1516	Accommodation Tool Reference Point
J1517	Driver Selected Seat Position
J2731	Motor Vehicle Seat Dimension
J4004	Positioning the H-Point Design Tool- Seating Reference Point and Seat Track Length

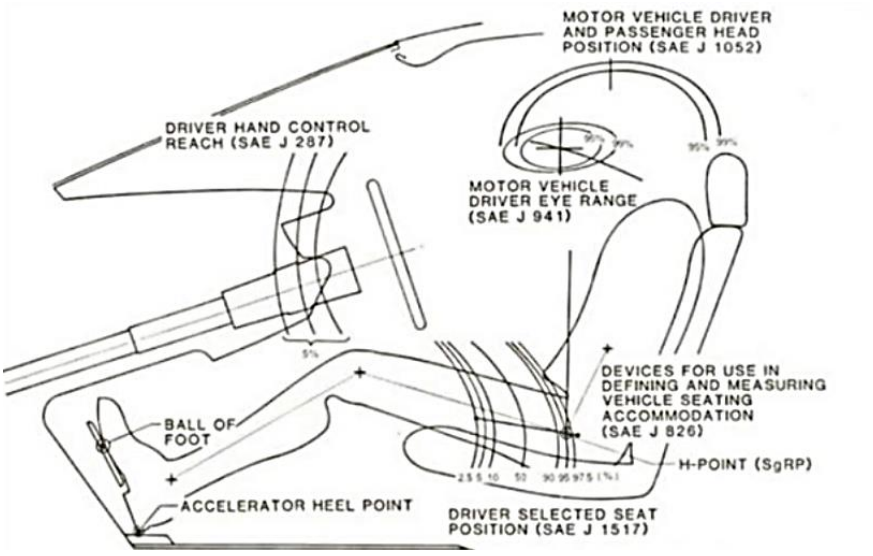

Figure 2.2: Location of SAE recommended practice for occupant packaging

2.4 Benchmark for measurement

Some benchmark point like Hip point (HP), ball of foot (BOF) and accelerator heel point (AHP) are used as standard point to state driver's position. Hip point also call hip pivot is the line's midpoint that connects two hip joints. Ball of foot is point that foot and pedal are touch. Accelerator heel point is the heel position while on the pedal of the accelerator. These benchmarks of measurement (Figure 2.3) contribute to indoor vehicle components such as floor, seat and pedal. Ball of foot and accelerator heel point is related to foot, whereas hip point location are related to shoulder width, hip and elbow. (Sivaraman, 2016)

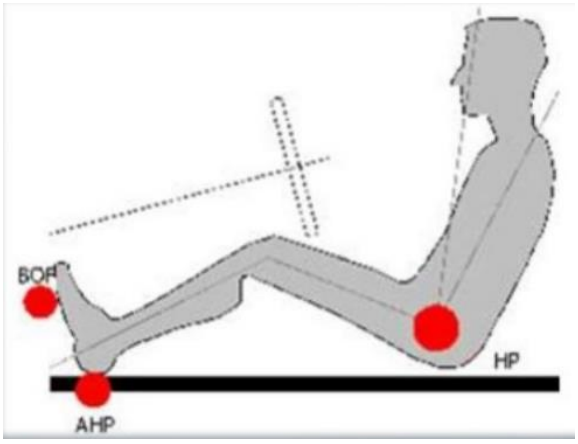

Figure 2.3: Benchmark for measurement (Sivaraman, 2016)

2.5 References point and dimension used in driver workspace

Driver workspace is the main focus in occupant packaging. The driver workspace commonly refers to the places and adjustment distances of the steering

wheel and seat with respect to the pedals, but also includes the controls and displays physical locations with which the driver interacts. Analysis of both direct and indirect internal and external vision driver zones is often generally considered aspect of the packaging practice. The reference measurement in the Table 2.2 is used to optimizing driver workspace. The references points of the dimension are shown in Figure 2.4. The analysis is carried out in two dimensions (side view). Accelerator heel point (AHP) is measure from ground clearance below AHP. Steering wheel pivot, upper day light opening, cowl point are measure from AHP as starting point. The height of the roof is measure from ground. (Parkinson & Reed, 2010)

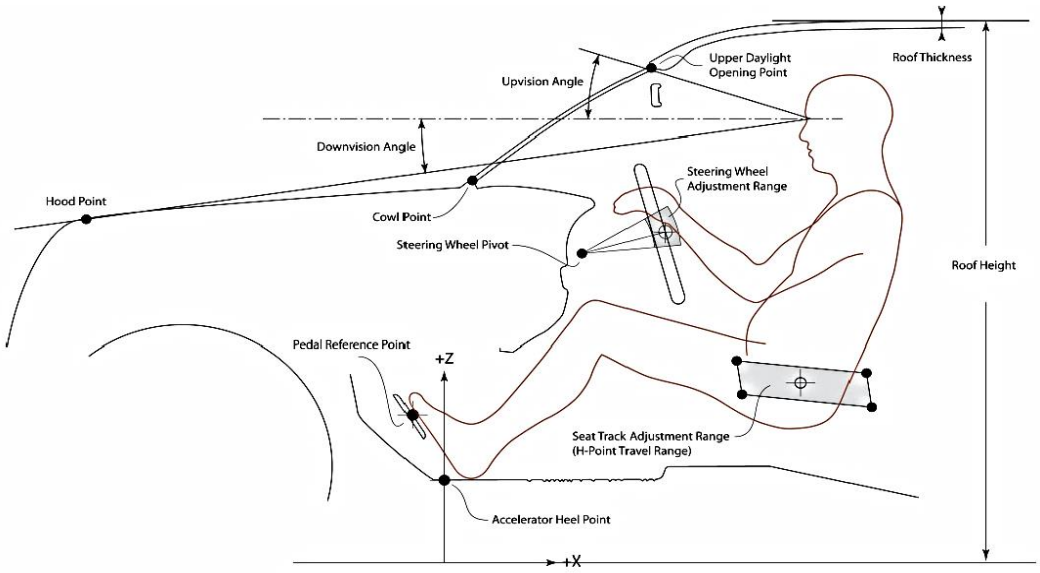

Figure 2.4: References point and dimension used in optimize driver workspace (Parkinson & Reed, 2010)