



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**DESIGN OPTIMISATION OF CAR JACK SYSTEM FOR AN
EMERGENCY USAGE USING PDS**

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

AHMAD NURFAIDHI SADIQ BIN MOHAMMAD SUKERI

B071410389

950308106047

FACULTY OF ENGINEERING TECHNOLOGY

2017

BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: DESIGN OPTIMISATION OF CAR JACK SYSTEM FOR AN EMERGENCY USAGE USING PDS

SESI PENGAJIAN: 2016/17 Semester 1

Saya **AHMAD NURFAIDHI SADIQ BIN MOHAMMAD SUKERI**

mengaku membenarkan Laporan PSM ini disimpan di Perpustakaan Universiti Teknikal Malaysia Melaka (UTeM) dengan syarat-syarat kegunaan seperti berikut:

1. Laporan PSM adalah hak milik Universiti Teknikal Malaysia Melaka dan penulis.
2. Perpustakaan Universiti Teknikal Malaysia Melaka dibenarkan membuat salinan untuk tujuan pengajian sahaja dengan izin penulis.
3. Perpustakaan dibenarkan membuat salinan laporan PSM ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. ****Sila tandakan (✓)**

- SULIT** (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia sebagaimana yang termaktub dalam AKTA RAHSIA RASMI 1972)
- TERHAD** (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
- TIDAK TERHAD**

Disahkan oleh:

Alamat Tetap:

No. 1233 Taman Samudera,

32040 Seri Manjungf, Perak.

Cop Rasmi:

Tarikh: _____

Tarikh: _____

****** Jika Laporan PSM ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh laporan PSM ini perlu dikelaskan sebagai SULIT atau TERHAD.

DECLARATION

I hereby, declared this report entitled “Design Optimisation of Car Jack System for An Emergency Usage Using PDS” is the results of my own research except as cited in references.

Signature :

Author's Name :

Date :

APPROVAL

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

.....

(Project Supervisor)

ABSTRAK

Kajian ini adalah untuk membincangkan pembangunan jack kereta untuk kegunaan semasa kecemasan. Objektif kajian ini adalah untuk mengenal pasti ciri-ciri sistem jack kereta yang mempunyai faktor ergonomik yang baik. Selain itu, untuk mengoptimumkan reka bentuk sistem kereta jack untuk kegunaan kecemasan menggunakan pds. Dengan menggunakan perisian catia untuk membuat lakaran dan untuk analisa dan pengoptimalan menggunakan perisian solidthinking. Reka bentuk itu kemudian direka menggunakan bahan-bahan terpilih yang ada. Proses seperti keratan, kimpalan dan menggerudi dilakukan dalam proses fabrikasi. Model akan dibina dan proses fabrikasi dijalankan di akhir dengan reka bentuk yang terbaik.

ABSTRACT

This study is to discuss the development of car jack for emergency use. The objective of this study is to identify the characteristics of car jack system which has the good ergonomic factor. Besides, to optimize the design of car jack system for an emergency usage using PDS. Using CATIA software to create sketches and for analysis and optimization using the SolidThinking software. The design is then designed using the selected materials available. Processes such as section, welding, and drilling are done in the fabrication process. The model will be constructed, and the fabrication process will run at the end of the best design.

DEDICATION

Special dedication to my beloved father and mother, my brother and sister and to all my friends

ACKNOWLEDGEMENT

This project dedicated to my family who had given a full support along with prayers for the period time of my studies. Thank you for giving the opportunity to further my studies in good conditions.

Sincere thanks to my academic supervisor that is Mr Mohd Idain Fahmy bin Rosley for the guidance, invaluable advice and during the project process and for the course taken. Thanks for their expert suggestions and a constructive advice for this project and my studies.

Finally, I would like to thank Universiti Teknikal Malaysia Melaka (UTeM) for giving me the opportunity to give a course for degree and Perbadanan Tabung Pendidikan Tinggi Nasional (PTPTN) for giving a loan while taking my degree.

TABLE OF CONTENTS

Abstrak	i
Abstract	ii
Dedication	iii
Acknowledgement	iv
Table of content	v
List of Tables	vi
List of Figures	vii

CHAPTER 1: INTRODUCTION

1.1	Background of Study	1
1.2	Problem Statement	3
1.3	Objective	3
1.4	Scope	3

CHAPTER 2: LITERATURE REVIEW

2.0	Introduction	5
2.1	Overview of Car Jack System	5
2.2	Types of Car Jack System	5
2.2.1	External Power/Power Assist	6
2.2.1.1	Overview	6
2.2.1.2	Post Lift	6
2.2.1.3	Electric Car Scissor Jack	9
2.2.1.4	Hydraulic Floor Jack	11
2.2.1.5	Exhaust Jack	12
2.2.2	Fully Mechanism	13

2.2.2.1	Overview	14
2.2.2.2	Scissors Jack	14
2.2.2.3	Hi-Lift Jack	15
2.2.2.4	Jack Stand	17
2.2.2.5	Car Ramp	18
2.3	Product Design Specification (PDS)	20
2.3.1	Overview	20
2.3.2	PDS Checklist	21
2.3.3	Concept Selection Method	22
2.3.4	Morphological Chart	23
2.3.5	Concept Screening	24
2.3.6	Concept Scoring	25
2.4	Previous Research	26
2.4.1	Automated Car Jack	26
2.4.2	Analysis and Fabrication of Remote Control Lifting Jack	27
2.4.3	Development of A Foot Operated Hydraulic Lifter for Automobile Workshops	28
2.4.4	Solar Car Lift Jack	29
2.4.5	Design of Pneumatic Operated Jack for Four Wheelers.	31

CHAPTER 3: RESEARCH METHODOLOGY

3.0	Introduction	33
3.1	Catia Software Application	33
3.2	Design Flow Chart	34
3.3	Product Design Specification (PDS)	35
3.4	List of Body Designs and Ideas	35
3.4.1	Design 1	35
3.4.2	Design 2	36
3.4.3	Design 3	36
3.4.4	Design 4	37

3.5	Selection Method	37
3.5.1	Morphological Chart	37
3.5.2	Scoring Method	39
3.5.3	Screening Method	40
3.6	Experimental Work	41
3.6.1	Project Design	41
3.6.1.1	Master Support Leg Without Wheel	41
3.6.1.2	Jack Handle	42
3.6.1.3	Arm Bracket	43
3.6.1.4	Jack Wheel	44
3.6.1.5	Full Assembly	45
3.6.2	Research Material & Instrument	45
3.6.2.1	Mild Steel	46
3.6.2.2	Advantages of Mild Steel	46
3.6.2.3	Disadvantages of Mild Steel	47
3.6.3	Fabrication	47
3.7	Operational Framework	49
3.8	Expected Outcomes	50
3.8.1	Project Time Plan	51

CHAPTER 4: ANALYSIS AND FABRICATION

4.0	Introduction	52
4.1	SolidThinking Inspire Application	52
4.2	Design Analysis and Optimized	53
4.2.1	Conceptual Design	53
4.2.2	Topology Optimized Process	54
4.2.3	New Design	57
4.2.4	Analysis for New Design	58
4.3	Fabrication Process	62
4.3.1	Fabrication Flow Chart	62

4.3.2	Safety Measure	63
4.3.3	Measuring Process	64
4.3.4	Cutting Process	65
4.3.5	Joining Process	67
4.3.6	Drilling Process	69
4.3.7	Finishing and Touch Up Process	70
4.3.8	Completely Fabrication	72
CHAPTER 5: SUMMARY AND FUTURE WORK		
5.0	Project Summary	76
5.1	Future Work	77
SUMMARY		78
APPENDIXES		80

LIST OF TABLES

2.3.3	The concept selection method example of decision matrices	23
2.3.4	Example of Morphological Chart table	23
2.3.5	The concept screening example of screening matrix	25
2.3.6	Sample of the concept scoring table	25
3.3	PDS Table	35
3.5.1	Morphological Chart	37
3.5.2	Scoring Method	39
3.5.3	Screening Method	40
3.8.1	Gantt Chart	51
4.2.2	The Comparison of Weight Before and After Topology Process	56
4.2.4	Data analysis differences between old designs and new designs.	59

LIST OF FIGURES

2.2.1.2	1-Post Lift	6
2.2.1.2	2-Post Lift	7
2.2.1.2	4-Post Lift	7
2.2.1.3	Electric Car Jack	9
2.2.1.4	Hydraulic Floor Jack	11
2.2.1.5	Exhaust Jack	12
2.2.2.2	Scissor Jack	14
2.2.2.3	Hi-Lift Jack	16
2.2.2.4	Jack Stand	17
2.2.2.5	Car Ramp	19
3.1	Catia Software Logo	33
3.2	Design flow chart	34
3.4.1	Design 1	35
3.4.2	Design 2	36
3.4.3	Design 3	36
3.4.4	Design 4	37
3.6.1.1	Master support leg	41
3.6.1.2	Jack Handle	42
3.6.1.3	Top Bracket	43
3.6.1.4	Jack Wheel	44
3.6.1.5	Overview full assembly	45
3.6.3	Example of Support Bracket Design	49
4.1	SolidThinking Inspire Logo	52
4.2.1	Concept Model	54
4.2.2(a)	The Objective Type of Optimization	55
4.2.2(b)	Topology Optimization Result	56

4.2.3(a)	Topology Optimization in CATIA software	57
4.2.3(b)	New design for car jack system	57
4.2.3(c)	Direction of Movement	58
4.3.1	Fabrication Flow Chart	61
4.3.2(a)	Example of Clothing and Safety Equipment Throughout the Workshop	63
4.3.2(b)	Examples of Appropriate Clothing and Equipment When Welding Process	64
4.3.2	Measuring tools	64
4.3.3(a)	Steel Cut-Off Saw, Or Chop Saw	65
4.3.3(b)	Steel Plate Were Clamped By G-Clamp	65
4.3.3(c)	Cutting Proses with Using Grinder	66
4.3.3(d)	Cutting Proses with Using Top Handle Jig Saw	66
4.3.4(a)	MiG (Metal Inert Gas) Welding Machine	67
4.3.4(b)	Measure The Angle Using By L-Square	68
4.3.4(c)	Workpiece Clamp At Bench Vise	68
4.3.6	Workpieces Are Fastened and Do Drill Process	69
4.3.7	Wash and Clean the Workpiece	70
4.3.7(b)	Painting master support	71
4.3.7(c)	Painting jack handle and top bracket	71
4.3.7	Clear Coat Using 1k Clear Samurai	72
4.3.8(a)	Top View	73
4.3.8(b)	Front view	73
4.3.8(c)	Side View	74
4.3.8(d)	Overall View	74
4.3.8(e)	View from Outside the Car Boot (Vertical Arrangement)	75
4.3.8(f)	View from Outside the Car Boot (Horizontal Arrangement)	75

CHAPTER 1

INTRODUCTION

1.1 Background of Study

Most family cars today are equipped with spare tire in the boot. It can be used in case of emergency, such as if the tire is in low pressure or with a flat tire. Either man or woman with basic knowledge on changing tire still can perform the process. The problem occurs in the tire changing process is how much a space between tire and road surface that suitable for tires removed from its place. To get the free space between the tire and the ground, the vehicle should be lifted by using lifting equipment or lifting system. It will make it easier for the tire to be removed from the wheel hub.

Each vehicle that exist in the world especially family vehicle, have been supplies with a set of car jacks to be use on an emergency if the problem goes wrong. Car jack is a mechanical device used to lift the car. With the car jack, the vehicle user does not need to wait long for help to arrive. In addition, the process of using the car jack is very easy and can save time for us to reach a destination that we want to go.

Normally, we can see that the car is stranded roadside vehicle suffered a tire puncture or leak. However, the driver just sat in the car waiting for help to arrive. The possibility that the driver does not know how to use the lifter jack to change the tire. Majority gender in these circumstances is from women above reason. There are also of men who do not know how to use this tool lifter jack, but usually the elderly or disabled. Although the existing car jack in the boot of our car it is easy to use, but it is still difficult for most people and requires little time to spare to lift the vehicle

Technology is increasingly developing and becoming more sophisticated. Technology will always try and keep trying to reduce human labour and indirectly all kinds of human labour will be assist by technology. Car jack lifter is not immune to

contact with trace technology is constantly developing. The market now, there are many different types of car jack, how it works and more technology that has changed the car lifter jack to become a better product.

Which type of car jack of choice for automotive vehicle manufacturers put on every boot of the vehicle is a type of scissor jack. Among the factors to be preferred, it is low cost, small size, lightweight and does not use any power source. There is also the type of jack of choice for luxury cars generated by the electric power, hydraulic and much better than scissor jack. The size and strength of a car jack depending on the type of vehicle as well, so it is suitable for use in future emergencies.

In the last 5 years, maybe we will use a car jack found in car boot once. This is because the tire for leaks and punctures rare to happen. However, the car jack is very useful if it is need in an emergency. The scissor jack has different size and weight but the shape and the way it works is the same depending on the size of the vehicle. For vehicles of segments a, b and c usually has a scissor jack the same in size and weight. However, for vehicle pickup or 4x4 size scissor jack to two times the size and twice as heavy. It has created to be that way because it needs to function smoothly to lift vehicle that weighs nearly two tons or more.

A scissor jack has four main pieces of metal and two base ends. The four-metal piece have all connected at the corners with a bolt that allows the corners to swivel. A screw thread runs across this assembly and through the corners. As the screw thread is turned, the jack arms travel across it and collapse or come together, forming a straight line when closed. Then, moving back the other way, they raise and come together. When opened, the four-metal arms contract together, coming together at the middle, raising the jack. When closed, the arms spread back apart, and the jack closes or flattens out again.

1.2 Problem Statement

The existing car jack in the market is difficult to handle for the elderly and female due to the weight and size. In addition, to handle the car jack, users need to lower the body to reach to the jack. This means, to operate the jack which is not ergonomic to human body, it will give physical problems in course of time. Furthermore, available car jack has a screw thread. When that user rotates the screw thread, the jack can lift a vehicle that is several thousand kilograms.

The problem is if the screw thread, users will hard to rotate and need more force to overcome friction at the screw thread and load of the vehicle. The purpose of this project is to overcome all the problems faced with the existing car jack. Using the mechanism of the Formula 1 jack, the new design of car jack will be developed. Users need give a less energy without do a lot of movement for a long period to lift the vehicle.

1.3 Objective

- i. To identify the characteristics of car jack system which not use any power source to operate for an emergency usage.
- ii. To optimize design of car jack system using PDS.
- iii. To fabricate the prototype of car jack model based on the selected design.

1.4 Scope

The project is about the designing, analysis and fabricating the car jack. The type of car jack system is fully mechanism, no external power supply used for this system. Users need do a simple movement to lift the vehicle. To develop a new concept of the car jack, some research will be done specially to identify, optimize and do some material testing to make sure it can function properly.

The scope of this project is lifting capacity for this car jack only 300-kilogram minimum. The car jack was designing to be use for cars that weight 1300kg and below.

Focus to car at segment a and segment b. The design of this car jack is need a car that have a small or medium luggage room to store it.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

The literature review is a summary of the scientific papers, including current or past knowledge, and comprise of theory and methodology for a topic. Literature review is a secondary source. Most often associated with academic-oriented literature, a literature review is found in academic journals, and is not to be confused with the review books can also appear in the same publication. Review literature is the basis for research in almost every academic area. With a literature review, we can find and make an assessment related to the topic or find a solution to a problem. Graduate and post-graduate students often do research literature to be use as part of the work in creating a final year project or thesis.

2.1 Overview of Car Jack System

Car jack system is a system used to lift vehicles especially cars. It will have used a mechanical device to lift heavy loads or to apply great force. The purpose of lifting the car is allowing the work to change a tire or do some maintenance and repairing.

2.2 Types of Car Jack System

There are two type of car jack system, using external power and fully mechanism.

2.2.1 External Power/Power Assist

2.2.1.1 Overview

In chapter 2.2.1, it will explain and list some examples of the car jack that were using external power as a power source for the system to function.

2.2.1.2 Post Lift

Post lift are design to lift the vehicle to easy for mechanics to make inspection, repair or change the tire. There is any type of post lift. Which is 1-post lift, 2-post lift, and 4-apost lift. They are similar in terms of design and it function. However, the difference is the numbers on each name. These numbers indicate the number of columns or pillars.



Figure 2.2.1.2(1): 1-Post Lift



Figure 2.2.1.2(2): 2-Post Lift



Figure 2.2.1.2(3): 4-Post Lift

Nevertheless, more popularly used in every car workshop is type 2-post lift. Post lift jack operated using hydraulic fluid as a medium for power transfer. When a button on are pressed, the hydraulic power unit will deliver a pressurized fluid to the hydraulic cylinder contained in each column. Hydraulic cylinder will push up the carriage assembly, which is connect with four adjustable

arms. The pressure of the hydraulic fluid is regulating by the factory preset pump valve.

Among the advantages of using this machine can lift the weight of the car up to 4000kg. We already know the hydraulic power capable of providing high power. Therefore, it can lift the weight of the car is great. Besides, the advantage of using this engine it can lift the four wheels of the car, which means it can lift the whole car. Therefore, we do not need to change the position of the car in the garage when repairs in progress.

Furthermore, we do not have to lie on the floor to get under the car if we want to make a check something on the bottom. This machine is also suitable for large conditioned service, such as pull down the gearbox or pull down the overall engine. Obvious advantages of this machine can see where it can lift the vehicle up to 1.8 meters high, and this advantage is not available on any other type of car jack. With these advantages, this machine gives plenty of space to mechanics, so they are easy to move when making inspections on each side of the vehicle.

However, there is also a disadvantage on the post lift machine. The first is very expensive by its type of material used and it requires technology and engineering expertise to build this machine. In addition, the size is quite large compared to another hydraulic powered jack. For small and medium-sized the workshop so hard to put into it because it requires a large clearance space in the workshop because this machine moves down and up. After all, this machine operates using electric power to move the hydraulic motor, if the electricity supply disconnected or blackout, then this machine cannot be use.

However, not all situations we have to use this machine to change the tire. This machine is suitable for use by mechanics who has his own workshop. It is not suitable for use in an emergency, while driving the highway, it is impossible to keep the machines in the car boot for use in future emergencies. Caused by this machine is installed

and bolted down on the floor, it cannot go everywhere to raise the car if you want to change. It always is in place it is install. As a safety precaution, this machine can only be used by adults and very dangerous if incorrectly used.

2.2.1.3 Electric Car Scissor Jack

Electric car jack is the one product that innovate from the scissors jack which is the scissors jack only using human power for it to operate, while the electric car jack which is added to an electric motor in place of a human hand to rotate the drive screw so that Jack can rise above or down. Electric car jack can plug into car's 12V DC power outlet which is most cars in this world has a 12v socket has a 12v socket. We can control the car jack up or down using a switch that has been provide.



Figure 2.2.1.3: Electric Car Jack

Electric car jack advantage is that it is a convenient tool that added external power to operate it, meaning they are relatively