# DEVELOPMENT OF CONCEPTUAL AUTOMATIC CAR JACK DESIGN USING TOTAL DESIGN APPROACH

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA
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This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Manufacturing Engineering (Design Engineering)(Hons.)

by

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## BORANG PENGESAHAN STATUS LAPORAN PROJEK SARJANA MUDA

TAJUK: **INVESTIGATION OF FACTORS CAUSING MEASUREMENT ERROR USING GAGE R&R METHOD FOR ENHANCING MEASUREMENT CAPABILITY IN SMALL MEDIUM INDUSTRIES (SMI)**
SESI PENGAJIAN: **2013/14 Semester2**

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I hereby, declared this report entitled "Development of Conceptual Automatic Car Jack Design using Total Design Approach" is the results of my own research except as cited in references.

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# APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Design Engineering) (Hons.). The member of the supervisory is as follow:

……

(Project Supervisor)

# ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious, the Most Merciful. Praise to the Almighty that I have been given strength and with His will, I am able to complete PSM 1 project.

First and foremost, a token of appreciation and gratitude goes to my beloved parents and family for their advice and endless support. My deepest gratitude goes to my supervisor, Dr Hambali for his guidance, advice, concern and help. My heartfelt thanks to all my friends, that with their continuous support and encouragement I am able to complete this project.

# ABSTRAK

Bicu adalah peralatan yang digunakan untuk mengangkat beban yang berat atau memberi tekanan yang tinggi. Bicu menggunakan bebenang skru atau silinder hidraulik yang memberi tekanan linear yang tinggi. Antara bicu yang diguna pakai kebanyakan pemandu adalah bicu yang menggunakan skru untuk berfungsi. Pengguna menghadapi kesulitan dalam menggunakan bicu yang sedia ada kerana masalah ergonomik. Tujuan utama pengubahsuaian adalah kerana masalah sakit belakang yang dihadapi pengguna berikutan kedudukan mencangkung dan membongkokkan badan terlalu lama ketika proses penukaran tayar. Dengan adanya teknologi yang maju, bicu automatik boleh direka bagi membantu mengurangkan masalah lenguh badan atau sakit belakang yang membawa kepada masalah kesihatan yang lain. Konsep bagi bicu kereta automatik boleh dibangunkan dengan menggunakan konsep 'Total Design Approach' iaitu konsep reka bentuk secara total dengan mengaplikasikan kaedah Pugh. Proses pembangunan produk ini berkait rapat dengan keperluan pasaran, spesifikasi produk, konsep rekaan dan rekaan yang terperinci yang melengkapi satu sama lain. Projek ini menggunakan *Total Design Approach* bagi memperolehi rekabentuk akhir bagi rekaan konsep bicu. Analisa dari FEA menunjukkan bahagian atas bagi bicu berada di dalam kawasan selamat. Berdasarkan dari analisa ini, tekanan Von Mises, tekananan dan sesaran bagi bicu telah dapat dikenalpasti

# ABSTRACT

A jack is a mechanical device used as a lifting device to lift heavy loads or apply great forces. Jacks employ a screw thread or hydraulic cylinder to apply very high linear forces. The most common car jack used is screw car jack. The significance purpose of car jack modification is due to health risks especially back ache problems associated with doing work in a bent or squatting position during changing tyres process for a long period of time. With high-end technologies, an automatic car jack should be produced to help reduce body fatigue that lead to health problems. Conceptual automatic car jack can be developed by using total design approach where Pugh's method is fully applied. This product development integrate with market need, product specification, concept design and detail design comply with each other. In this project, final conceptual design of car jack has been developed using total design approach. The result of FEA analysis shows the upper part of the car jack is in safety region. From these analyses, Von Mises Stress, Strain, Stress and Displacement detail of the car jack is determined.

# DEDICATION

Dedicated to my beloved parents, family, supervisor, lecturers and friends.

# ACKNOWLEDGEMENT

In the name of Allah, the Most Gracious, the Most Merciful. Praise to the Almighty that I have been given strength and with His will, I am able to complete PSM 1 project.

First and foremost, a token of appreciation and gratitude goes to my beloved parents and family for their advice and endless support. My deepest gratitude goes to my supervisor, Dr Hambali for his guidance, advice, concern and help. My heartfelt thanks to all my friends, that with their continuous support and encouragement I am able to complete this project.

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| | | |
|---|---|---|
| CAD | - | Computer Aided Design |
| FEA | - | Finite Element Analysis |
| PDP | - | Product Development Process |
| BOM | - | Bill of Material |
| DFE | - | Design for Environment |
| PDS | - | Product Design Specification |

# CHAPTER 1
# INTRODUCTION

This chapter provides background, problem statement, objective as well as scope of the study.

## 1.1 Background Study

A jack is a mechanical device used as a lifting device to lift heavy loads or apply great forces. Jacks employ a screw thread or hydraulic cylinder to apply very high linear forces. The Longman Dictionary defines a jack as a piece of equipment which is used to lift and support a heavy weight, such as a car. The most common car jack used is screw car jack. A screw jack uses a simple theory of gears to get its power. As the screw section is turned, two ends of the jack move closer together. Because the gears of the screw are pushing up the arms, the amount of force being applied is multiplied. It takes a very small amount of force to turn the crank handle, yet that action causes the brace arms to slide across and together. As this happens the arms extend upward. The car's gravitational weight is not enough to prevent the jack from opening or to stop the screw from turning, since it is not applying force directly to it (Smith, 2010).

Screw car jack is the simplest design among its class. By adding automatic value on this car jack, a new car jack is designed. The Merriam-Webster online dictionary defines automatic as having controls that allow something to work or happen without being directly controlled by a person. The current design of automatic car jack add component as motor that generate power to lift up the car. A mechanical jack is a device which lifts heavy equipment and vehicles so that maintenance can be carried out underneath (Budynas, and Nisbett, 2008). In terms of ergonomic prospect, doing

work in a bent or squatting position for a period of time is not ergonomic to human body. It gives back ache problem in due of time. This requires new modification for the mechanical car jack. Automatic car jack may consist of motorised screw by connecting it to the motor that help to regulate the lifting and lowering process.

The new ideas of conceptual automatic car jack design require some serious design works. This can be achieved through several designing method such as Total Design approach. Total design concept consist of three elements (1) functionality, which arises from the product's features and related benefits for customers, (2) aesthetics, comprising the product's sensorial characteristics, including, its appearance, touch, smell, taste and sound, and (3) meaning, involving the associations of the product in the minds of its customers (Srinivasan *et al*., 2008). Total Design is a systematic methodology to achieve integration of the technological as well as nontechnological subject material with the goal of creating successful products and processes (Pugh, 1990).

By designing the new car jack design that emphasize more on the conceptual automatic car jack, this study will be deployed on the development of conceptual automatic car jack using total design approach.

## 1.1 Problem statement

Based on few studies that has been done before, the conventional design of mechanical car jack can be upgraded more in comply to performance of the jack itself when it is automated. Users faced difficulties in using the conventional car jack. The significance purpose of car jack modification is due to health risks especially back ache problems associated with doing work in a bent or squatting position for a long period of time (Akinwomi and Mohamed, 2012). Due to the limitations stated above, modification needs to be made for the conventional mechanical car jack. It is important for consumer researchers to adopt a conceptualization of design that acknowledges the different aspects of product design such as functional, communicative, and aesthetics (Veryzer, 1995). Thus, new conceptual automatic car jack design should be developed by using total design approach. By incorporating these techniques into the new design, a visible

operational structure is constructed thus help in product design integration where market need, product specification, concept design, and detail design act in accordance with each other (Pugh, 1990).

## 1.2 Objectives of study

The aim of this study is to design a new conceptual automatic car jack using total design approach. The specific objectives for this project are listed as below:

a) To design car jack that is safe, reliable and are able to be raised and lowered in height level.
b) To use engineering decision-making approach for developing conceptual automatic car jack.
c) To develop a car jack powered by internal car power and fully automated using limit switch.

## 1.3 Scope of Project

This research study is about the designing of the new conceptual automatic car jack. Ergonomic factor is seriously taken into main concern for this new car jack. The scopes of research cover conceptual design of the automatic car jack by using total design approach. Design method used is Pugh's method which involves market investigation, product design specification, conceptual and detail design. For conceptual and detail design, drawing will be done by using CAD to draw out each part of automatic car jack design. Deformation, von misses stress and factor of safety of car jack will be analysed using Finite Element Analysis (FEA) software.

# CHAPTER 2
# LITERATURE REVIEW

A review on previous research work in several areas relevant to this research is presented in this chapter.

## 2.1 Introduction

Product development process (PDP) are the procedures and methods used by companies use to design new products and sell to the market (Unger and Eppinger, 2009). A product development process is the sequence steps of activities that an enterprise employs to conceive, design, and commercialize a product (Ulrich, 2012). Acknowledgement of process development is relatively new because a traditional, staged process dominated US industry for almost 30 years (Smith and Reinersten 1992, McConnell, 1996). Through the development of various PDP model prepare many choices for the companies as they changed from staged process to speed the design process and reduce costs (Lim *et al*., 2006). Studies suggest that technical innovation accounts for more than 80% of long term economic improvement (Solow, 1957). By applying engineering design practice can result in valuable progress.

This chapter covers on design method by Pugh, Pahl and Beitz, Cross, Ulrich and Eppinger, Otto and Wood and French. It also covers advantage and disadvantages of total design, comparison of design method and existing car jack review.

## 2.2 Existing Car Jack

There are two most common used car jacks in market nowadays, hydraulic car jack and screw car jack. A jackscrew as shown in Figure 2.1 is a type of jack operated just by turning the lead screw.

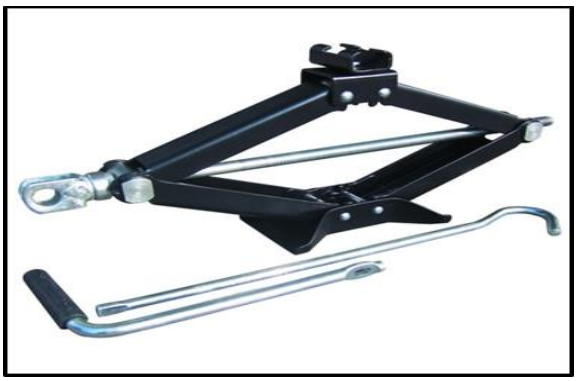

**Figure 2.1:** Screw car jack (Source: Harbour Freight Tools,2014)

A small force amount of force is applied in the horizontal plane that is used to raise lower large load (Khurmi and Gupta, 2005). Screw jacks designed to be able to withstand both tensile and compressive force. Mechanism of screw jack consists of lead screw and mating nut. Lead screw applies tension force for the screw jack to obtain compressive force. For this reason, usually an acme thread is used. This thread is very strong as it can resist the large loads enforced by car which is approximately 1000N and not weakened by wear over many rotations made when operating. Its larger thread contact area enables the load capacity to be much higher and higher friction prevent back-driving. In addition, the mating nut helps to tighten the engagement of the screw and not allowing backlash to develop (Rajput, 2007). Figure 2.1 shows various model of lead screw available in the market.

Figure 2.2: Various model of lead screw (Source: Designatronics Inc., 2011)