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"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 (Automotive)"

Signature: .....

Supervisor: .....

Date: .....

MULTIPLIER WHEEL NUT WRENCH

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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."

Signature: .....

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Date: 22 JUNE 2012

DEDICATION

Thank to Allah S.W.T for giving me the chance, to my beloved parent for giving me support, my family, my supervisor Dr Ruztamreen Bin Jenal and everybody who involved to accomplishing this report.

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This is the way to exposed myself in the real work environment as well to gain the importance knowledge especial in design process.

Thank you

ABSTRACT

The design has been chosen for this project is multiplier wheel nut wrench. This multiplier is used for wheels vehicles such as car. The purpose of this invention is to reduce the force exerted on the multiplier when loosening the nut on the tire wheel. The multiplier assisted by other hand tools such as ratchet and socket. Normally, car is used a size block socket such as M17, M19 and M21. Multiplier wheel nut wrench capable a high speed that was effectively and variable as the main driver. To build up this multiplier wheel nut wrench, three important processes are used. The process begins with the design of this multiplier by using computational aided design (CAD) such as CATIA software. After finite element analysis (FEA), the process ends with fabrication of the multiplier wheel nut wrench design.

ABSTRAK

Reka bentuk yang telah dipilih untuk projek ini adalah pembuka tayar pengganda. Peralatan ini digunakan untuk kenderaan beroda seperti kereta. Tujuan penciptaan ini adalah untuk mengurangkan daya yang dikenakan pada alat pembuka tayar semasa melonggarkan nat pada tayar dibantu oleh peralatan tangan lain seperti *rachet* dan soket untuk tayar. Kebiasaannya kereta menggunakan saiz nat seperti saiz M17, M19 dan M21. Pembuka tayar pengganda berikut berkebolehan utuk menghasilkan kelajuan yang tinggi secara berkesan dan berubah-ubah sebagai pemacu utama. Untuk membentuk pembuka tayar pengganda ini, tiga proses penting dilakukan untuk menghasilkan alat pembuka tayar pengganda ini. Proses ini bermula dengan mereka bentuk peralatan ini dengan menggunakan *computational-aided design* (CAD) seperti perisian CATIA. Selepas proses analisis seperti *finite element analysis* (FEA), proses berakhir dengan fabrikasi pembuka tayar pengganda.

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F	Force
T	Torque
D	Lever wrench in meter
N	Newton
Nm	Newton meter
m	meter

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

This final year project is associated with the design and analysis of multiplier wheel nut wrench model. This product use a compact planetary gear set to reduce force or torque in effort to remove a wheel nut or lug nut. The review focusing on the multiplier wheel nut wrench design refers to the current product as references model.

Design is an innovative and highly iterative process. In other word is a decision making. The multiplier wheel nut wrench design is made with a little information about it. The process begins with an identification of need, definition of problem, invention of concept, analysis and optimization (mathematical analysis), and evaluation where is the significant phase of the design process.

There are two important method used in mechanical analysis, finite element analysis and statically analysis. The first method of mechanical analysis, finite element analysis (FEA) is used on this project.

1.2 PROBLEM STATEMENT

The current multipliers wheel nut wrench widely used for heavy trucks and vehicle. Due to this problem, the car multiplier wheel nut wrench build up by following some concepts includes specifications, objectives, unique and identity of the product. The model 491 torque multiplier as a reference product is need in order to design a car multiplier wheel nut wrench by using computer-aided design (CAD) such as CATIA software and etc.

1.3 OBJECTIVES

The main objectives are:

1. To design multiplier wheel nut wrench model in effort to reduce force

1.4 SCOPE

The scopes of this project are:

1. Design of multiplier wheel nut wrench by using computer–aided design such as CATIA software.
2. Finite element analysis the main parts of multiplier wheel nut wrench using CATIA.
3. Produce a model of multiplier wheel nut wrench using rapid prototyping

1.5 EXPECTED RESULT

At the ends of this final year project, the design of the multplier wheel nut wrench has been obtained in final year project I. Then, Finite element analysis (FEA) and the model of multiplier wheel nut wrench using rapid prototyping has been obtained in final year project II for this semester.

CHAPTER 2

LITERATURE REVIEW

2.1 OVERVIEW

This chapter begins with a review of the multiplier wheel nut wrench background associated with description of the multiplier wheel nut wrench, theory of the design and finite element analysis (FEA) process.

2.2 MULTIPLIER WHEEL NUT WRENCH

Multiplier wheel nut wrench is a device is used a compact planetary gear set to gain mechanical advantage. The toque increases that can be applied by an operator because the power output is not exceed the power input. The number of output revolutions which be lower than number of input revolutions. The large output torque also can be produce by inputting less force.

Where:

Toque (Nm) x RPM = Power (W)

Multiplier wheel nut wrench is an effort to remove and tighten a wheel nut or lug nut using reduction gear. It is also adopts high efficiency planetary shifting as a main drive. Mostly the present multiplier wheel nut wrench is widely used to assemble and disassemble the tires of the heavy trucks and vehicle.

Figure 2.1: Multiplier Wheel Nut Wrench

The multiplier wheel nut wrench has a great variety of purposes. At first, this tool is used to loosen lug nut on the wheel of car. It is also loosening on pipe (high pressure joints) and to turning the crankshaft.

The variously company tent to produce a version of multiplier wheel nut wrench with the variety range starting from 960 pounds of force and up to 73500 pounds. This is considered more powerful than what the average of person posses. For example Highway man HT3 shown in figure 2.1 is good model that used to change of truck tire. Neiko is one the example company that make multiplier wheel nut wrench with the reaction bar where attached to the main piece. So the user has to absorb some of the reactionary force. The output of this multiplier less than 1000 pounds (not huge issue).

The reaction bar is function to sustain the opposite force where created in multiplier wheel nut wrench. By using principle of Newton's law states which that every action has an equal and opposite reaction. Thus, the torque is applied to the object, there is going to be an opposite reaction to it. The reaction plate is used to absorb this opposite reaction. Also included is a reaction bar. The reaction bar is what the user holds to apply the initial force. It attaches to the main part of the torque multiplier and works the same way a ratchet.

2.2.1 Multiplier Wheel Nut Wrench Calculations

Mostly multiplier wheel nut wrench application the force relationship expressed by following equation:

Force (F) x Distance (D) = Torque (T)

Where:

F is turning force in Newton applied by operator.
D is lever wrench in meter
T is total force applied to wrench head in Newton meter.

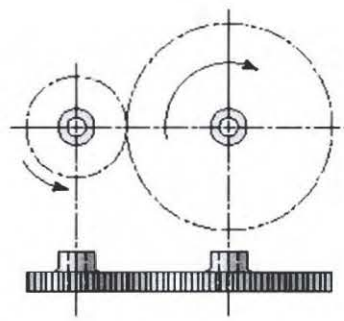
2.2.2 Gear Theory

The basic gears theories which the main parts of multiplier wheel nut wrench as a final year project. The multiplier wheel nut wrench used spur gear type ass a system. The information of the spur gear will be used as a guide line to build up the parts of the multiplier wheel nut wrench product.

By creating assestment, the multiplier wheel nut wrench used four quantity of the spur gears as a significant parts.

Spur gear:

a) Type



- ✓ Teeth is parallel to axis of rotation
- ✓ Can transmit power from one shaft to another parallel shaft.

Figure 2.2 Terminology of spur gear

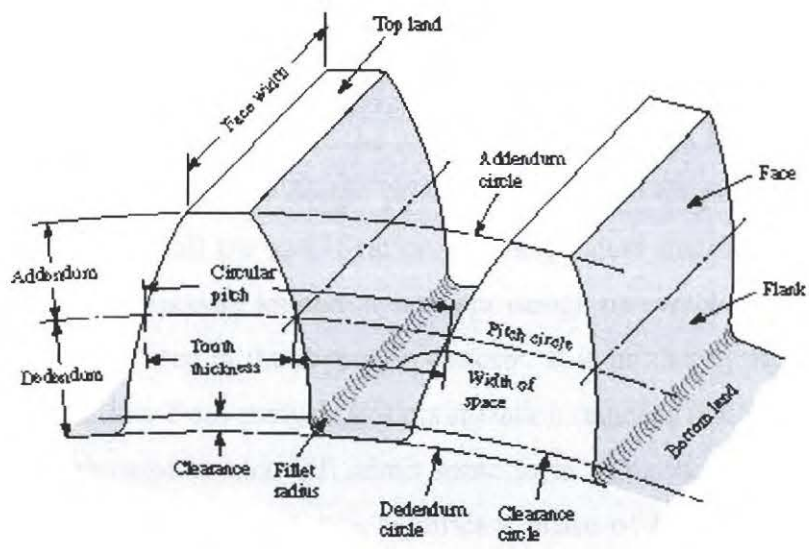


Figure 2.3 Nomenclature of spur gear teeth

Module : Ratios if diametral pitch and number of teeth, m = d/N [mm]

Face Width : width of the tooth

Addendum : distance between top face of the tooth to pitch circle

dedendum : distance between pitch diameters to bottom of the gear

2.3 DESIGN

The design is a complex, requiring many skill extensive relationships need to be subdivided into a series tasks. To design is either to formulate a plan for satisfaction of a specified need or to solve a specific problem. In mechanical design, other considerations include dimension, tolerance units and calculation.

2.3.1 Phase of the Design Process

The complete design process, from start to finish is often shown in figure 2.4 the process begins with an identification of need and the decision to do something about the design. The process ends with the presentation of the plan for satisfying the need. This is the final step in the design process. The definition problem is more specific and must include all the specification for the product that is to be design. Invention of the concept is also known as concept design or synthesis. This is the first and most important step in the invention concept. It is intimately related to the analysis and optimization. Both analysis and optimization required that is constructed abstract models of the system that will admit some form of mathematical analysis. As indicate in figure 2.4, evaluation is a significant phase of total design process. Evaluation is the final proof of a successful design.

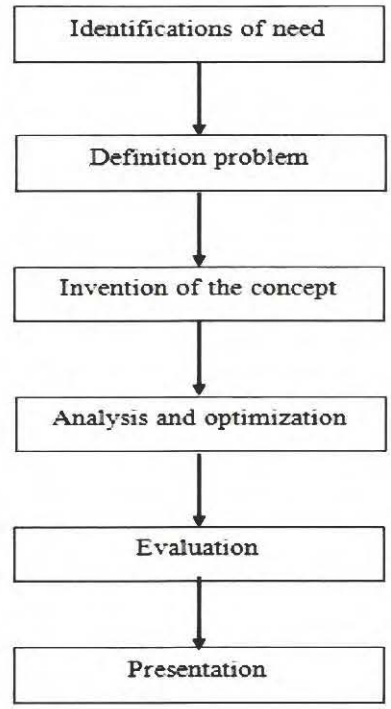


Figure 2.4: Phase of the design process.

2.3.2 Computational Tools

Computer-aided design (CAD) software allows the development of the three dimensional (3-D) design from which conventional orthographic views with automatic dimensioning can be produced. There are a great many CAD software package available such as AutoCAD, CATIA, Solid Work and etc. Some computer software packages perform specific engineering analysis and simulation task, but it is not considered a tool for the creation of the CAD design. Such software is categories into two are engineering based and non engineering specific. Software that might also be integrated within CAD system where is include finite element analysis (FEA) program for analysis of stress and deflection.

2.4 THE FINITE ELEMENT ANALYSIS

The finite element analysis (FEA) is integrated well with Computer-aided design (CAD).

2.4.1 The Element Method

The modern development of the finite-element method began in the 1940s in the field of structural mechanics with the work of Hrennikoff, Mc Henry and Newmark who used a lattice of line elements (rod and beam) for the solution of stresses in continuous solid. But the expression finite element is first attributed to Clough. Since the early beginning, a great deal of effort has been expended the development of this method in formulations and computer implementation of the entire solution process.

2.4.2 Element Geometries

Many geometry shape of the element are used in finite element analysis (FEA) for specific applications. The various element used is a general purpose commercial FEM software code constitute what is referred to as the element library of the code. The element can be placed in the following categories:

1. Line element
2. surface elements
3. Solid elements
4. Special purposes element

CHAPTER 3

DESIGN OF MULTIPLIER WHEEL NUT WRENCH

3.1 OVERVIEW

This chapter adresses multiplier wheel nut wrench design process sequences in order to cearte a drawing of multiplier wheel nut wrench product. The process begin with skething and dimension part of multiplier wheel nut wrench. The drawing of multiplier will nut wrench create in CATIA. The drawing of multiplier of Multiplier wheel nut wrench provide the significant information such as dimension of parts in order to build of this multiplier wheel nut wrench model. Catia modelling tools is a very usefull in the design of thi multiplier wheel nut wrench. After many step, the process ends with the assemble of the product for satifying the need based on this final year project. The process will be introduce here with the design process of the multiplier wheel nut wrench design includes reseach of parts such as gear and the datail drawing of the product.

3.2 PRODUCT DESIGN

To design is to solve a specific problem and formulate a plan for satisfied of the final year project. In creation of this product, commonly the product must be functional, safe, reliable, useable and competitive.

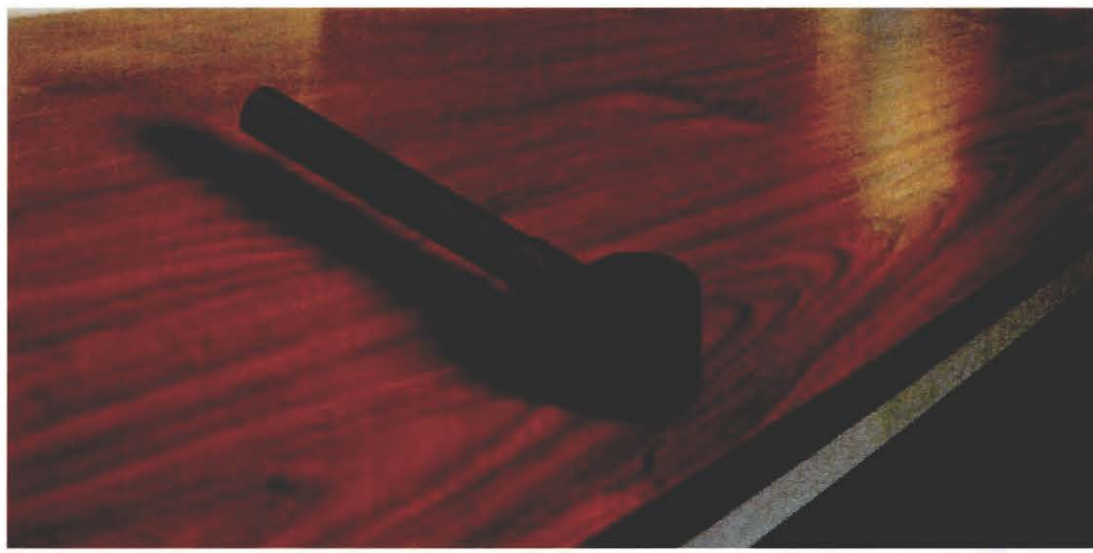


Figure 3.1: Multiplier Wheel Nut Wrench

The figure above show the assembly of multiplier wheel nut wrench product create in CATIA include photo studio easy tool process in CATIA after assembly design process of the multiplier wheel nut wrench.

3.2.1 Specification

The specifications of multiplier wheel nut wrench product more to the input and output quantities, characteristic and all the limitation on these quantities. The