



UNIVERSITI TEKNIKAL MALAYSIA MELAKA

**A NEW DESIGN CONCEPT OF LIGHTWEIGHT
KNUCKLE FOR B-SEGMENT PASSENGER 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) with Honours.

by

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I hereby, declared this report A New Design Concept of Lightweight Knuckle For B-segment Passenger Car is result of my own research except as cited in references

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APPROVAL

This report is submitted to the Faculty of Engineering Technology Mechanical in Manufacturing as a partial fulfilment of the requirements for the Bachelor of Engineering Technology in Mechanical (Automotive) with Hons. The member of supervisor is as follow:

.....
(Mohd Hafizi bin Abdul Rahman)

ABSTRAK

Buku jari kemudi adalah komponen yang bergabung pada kemudi dan sistem brek, hub roda kepada casis dan penggantungan. Ia adalah komponen yang sangat kritikal dan memerlukan kualiti yang tinggi, ketahanan dan ketepatan. Di dalam automotif industri, masalah yang utama adalah berat komponen untuk meningkatkan ciri-ciri keselamatan di sesebuah kenderaan. Pengurangan jisim komponen kenderaan sangat penting kerana ia akan menyumbang kepada pengurangan jisim kenderaan dan seterusnya akan meningkatkan penggunaan tenaga dan kuasa yang berkesan. Jadi, objektif utama penyelidikan ini adalah untuk mencadangkan sebuah konsep reka bentuk yang baru dengan menggunakan bahan yang berbeza dan pengurangan berat untuk sesebuah buku jejari kemudi yang telah sedia ada dengan menggunakan kaedah pengoptimuman. Untuk proses mereka semula, perisian CATIA V5 akan digunakan dan perisian Solid Thinking akan digunakan untuk proses pengoptimuman dan proses analisis kekuatan. Untuk proses pengoptimuman, berat hendaklah berkurang sebanyak 20% minimum daripada berat komponen asal yang sedia ada tanpa menjejaskan kekuatan komponen dengan faktor keselamatan hendaklah di atas 1.2. Akhir sekali, keputusan yang diperolehi adalah tekanan maksimum tidak melebihi kekuatan hasil bagi kes beban lurus dan kekuatan tegangan muktamad bagi kes beban tidak lurus.

ABSTRACT

Steering knuckle is a component that attached to the steering and braking system, wheel hub to the chassis and suspension. It is a very critical component and requires high quality, durability and precision. In automotive industry, the main issue of this component is weightiness due to increasing safety features on a vehicle. It is so important to reduce mass of vehicle component that will automatically contribute to the reduction of the vehicle's mass and this will improve the energy consumption and power efficiency. So, the main objective of this research is to propose a new concept design by using different material and reduce weight of the existing steering knuckle by applying topology optimization technique. For redesign process, CATIA V5 will be used and solid thinking will be used for optimization process and strength analysis process. For optimization process, the weight must be reducing at least 20% from the original component and not compromising the strength of the component which is the safety factor must be above 1.2. At the end, the maximum stress does not exceed yield stress and ultimate tensile strength for linear and nonlinear loadcases respectively.

DEDICATION

I dedicate this report to both of my lovely parents Mr Mohamad Daud bin Harun and Mdm Fazilah binti Senan. my supervisor Mr Mohd Hafizi bin Abdul Rahman.

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CHAPTER 1

INTRODUCTION

1.1 Background

Steering knuckle is a component that attaches between steering system and braking system, suspension to a wheel hub. The function of this component is to convert linear motion into angular motion and vice versa. So, this component will experience various type of loads depend on different conditions. For example, during turning and steering condition this component will experience a high tension loads and due to rotation of wheel, steering knuckle also experience high torsional load. To experience these conditions, steering knuckle must be very sturdy, stiff and light. It is a very critical component and requires high quality, durability and precision.

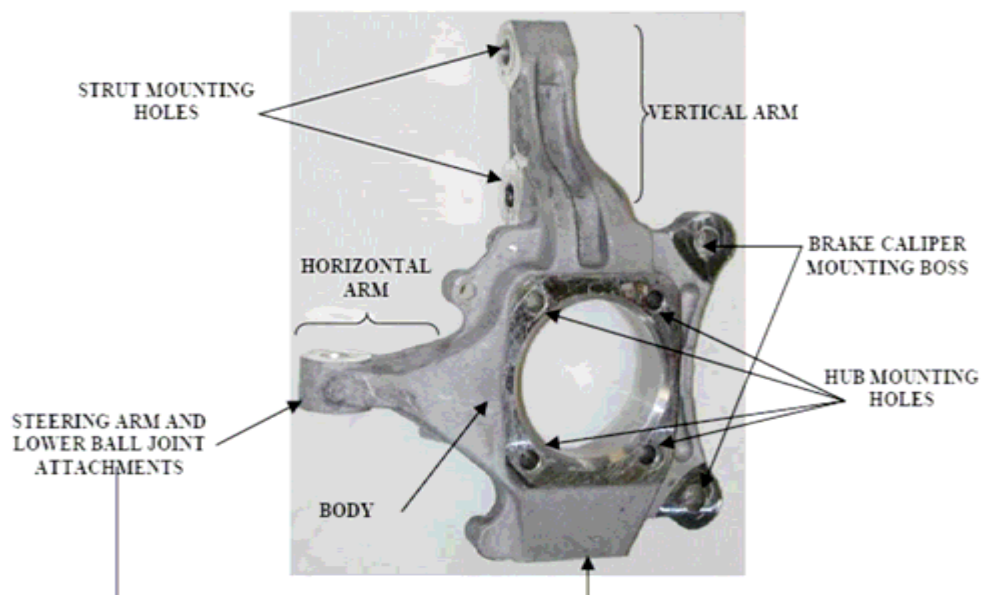


Figure 1.1: Photo of Steering Knuckle

For automotive application, normally steering knuckle manufactured either by forging or casting. A part from that, castings usually could have blow-holes which are can affect durability compared to forgings process which are free blow-hole (B.Babu, 2015). In fact, forging is more suitable manufactured process compared to castings. But at certain part especially critical part such as hole to install wheel bearing, it used CNC machine to drill that hole. This is because CNC machine can control tolerance either clearance fit, transition fit or interference fit. Usually to install the bearing part must be set into interference fit. This is important to make sure that the wheel bearing cannot easily come out.

In automotive industry, the main issue of this component is weightiness due to increasing safety features on a vehicle. It is so important to reduce mass of vehicle component that will automatically contribute to the reduction of the vehicle's mass and this will improve the energy and power efficiency. So, the main objective of this research is to propose a new concept design by using different material and reduce weight of the existing steering knuckle by applying optimization technique. For redesign process, CATIA V5 will be used to design and Solid Thinking will be used for optimization process. For strength analysis process, finite element software which is Hyperwork will be used to achieve this objective.

1.2 Problem Statement

Nowadays, most of automotive manufacturers are investing a lot in reduction of vehicle's weight. Based on previous studied stated that for typical front wheel drive vehicle distribute 60% of the weight on front axle while 40% of the weight are distribute on rear axle. This can lead to emission, fuel efficiency and environment problems. So, to solve the 60% of weight distribution on the front axle, the component on that particular area must go through weight reduction process. One of the components is steering knuckle(Gore, 2017).

Besides, in order to improve fuel efficiency, emission and save environment, weight reduction has been the main aim of manufacturers. This is because the lighter steering knuckle will affect greater power and less vibration cause by less inertia. It also will improve handling performance of the vehicle (B.Babu, 2015).

So, these are the main problems statement in this research:

- i. How to design a new concept of lightweight steering knuckle?
- ii. What is the best material that can lead to weight reduction without compromise the strength of the component?
- iii. What is the best fabrication process to develop lightweight steering knuckle?

1.3 Objective

The main objectives of this project are:

- i. To design a new concept of lightweight steering knuckle
- ii. To reduce 20% of weight of steering knuckles by using topology optimization and strength analysis methods without affecting its strength.

1.4 Work Scope

The scopes of this project are as follow:

- i. Design the 3D model of steering knuckle by using CATIA V5.
- ii. The concept design process is based on benchmark products that already in market
- iii. For topology optimization and strength analysis processes are by using Solid Thinking Inspire
- iv. The actual material for fabrication process applies on analysis process only.
- v. Fabricate the prototype steering knuckle by using 3D printer.

CHAPTER 2

LITERATURE REVIEW

2.1 Background

This chapter consist of all the information regarding design and development of steering knuckle from previous articles, journals and books. All the information will be presented according to the flow chart.

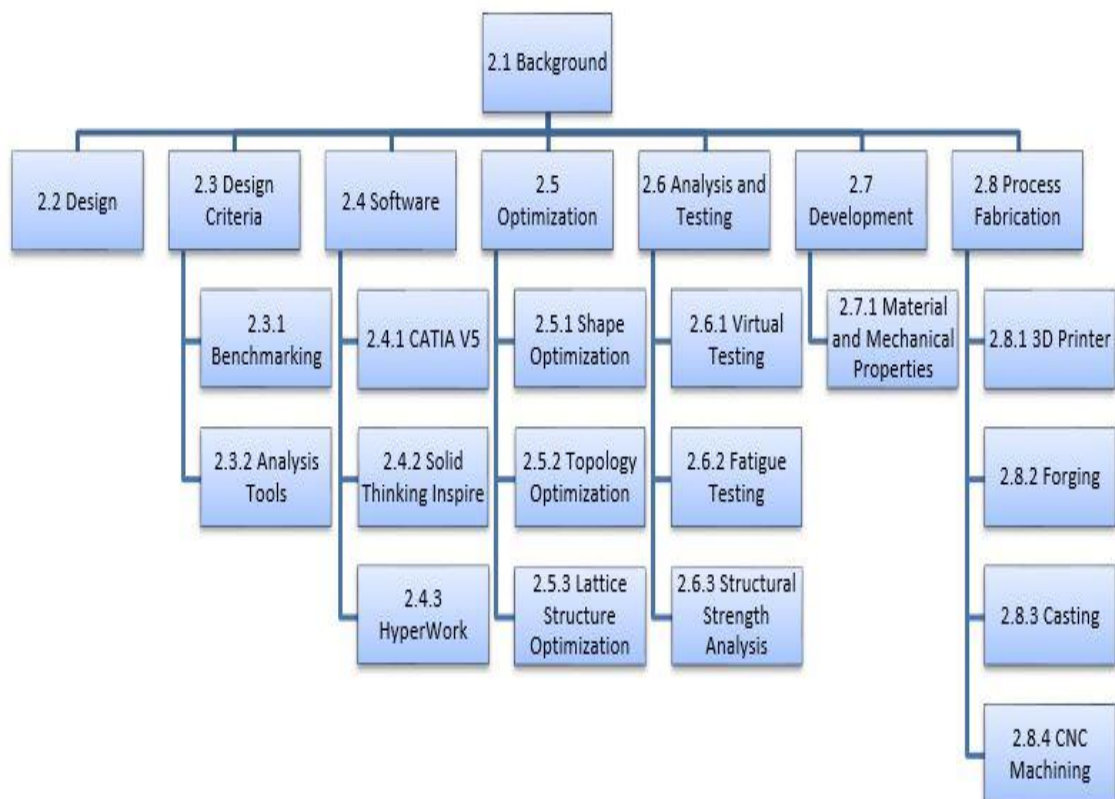


Figure 2.1: K-Chart for Literature Review

2.2 Design

The definition of design is a set of decision-making process that used to determine the form and function to fulfil the customer requirement. It can be divided into many phases which involved many forms of sketching, drawing and technical drawing. Sometimes the idea can be triggered by observe the problem that people may experience. Then the product designer will try to solve the problem through their sketching and drawing.

2.3 Design Criteria

In order to declare this research to be successful, there are certain designs criteria that must be fulfil. These criteria come from various sources such as customer, related designs and analysis method. For customer, the information can be extract from their feedback through surveys and marketing data. Besides, the criteria also can be determined from previous design specification that related to the component. Next, information from previous technical report, journals and books also can set criteria for this research.

The design criteria for steering knuckle are as follows:

- i. A new design concepts
- ii. Lightweight product
- iii. Minimum 20% of weight reduction