UNIVERSITI TEKNIKAL MALAYSIA MELAKA

DESIGN, ANALYSIS AND FABRICATE THE PROTOTYPE OF FOOD TRUCK BODY

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree in Mechanical Engineering (Automotive Technology) (Hons)

by

MUHAMMAD HAZIM BIN MAZLAN

B071410041

910930-14-6093

FACULTY OF ENGINEERING TECHNOLOGY

2017

DECLARATION

I hereby, declared this report entitled “PSM Title” is the results of my own research except as cited in references.

Signature	:	……
Author’s Name	:	Muhammad Hazim Bin Mazlan
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 Degree in Mechanical Engineering (Automotive Technology) with Honours. The member of the supervisory is as follow:

……

(Mohd Idain Fahmy Bin Rosley)

ABSRAK

Projek ini akan memberi tumpuan lebih kepada badan trak makanan diatas platform kargo Land Rover Defender 110 kerana platform kargo ini akan digunakan sebagai rujukan untuk mereka bentuk badan trak makanan yang baru. Projek ini adalah mengenai kajian alat aerodinamik yang akan digunakan pada reka bentuk badan trak makanan. Trak makanan semasa mempunyai masalah dalam reka bentuk badan yang menyumbang kepada mengheret pekali. Untuk mencapai objektif projek ini, beberapa model trak makanan dibuat dengan peranti yang berbeza pada reka bentuk badan dan akan dianalisis untuk mendapatkan pekali seret. Hasilnya akan digunakan untuk membina prototaip baru badan trak makanan.

ABSTRACT

This project will be more focus on food truck body on Land Rover Defender 110 cargo platform because this cargo platform will used as reference to design a new food truck body. This project is about study the aerodynamics device that will be used on the food truck body design. The current food truck got some problem in body design that contributed to drag coefficient. To achieve this project requirement, some models of food truck are made with different device on the body design and will be analyzed to obtain the drag coefficient. The result will used to fabricate a new prototype of food truck body.

DEDICATION

I would like to dedicate this to my father, Mr. Mazlan bin Zakaria and my mother, Mrs. Che Siti binti Hashim, my supervisor Mr. Mohd Mohd Idain Fahmy bin Rosley, and my friends Shafiq Laili, Husaini Hashim, Azad Abu Bakar, Adi Azri Ngahdiman, Khairul Anwar, Faidhillah Omar, Azmir Zainal, Tarmizi Bahari, Syed Naguib, Safwan Abd. Rahim, Faiz Razali, Azizi Aman and Ikhmal Amran for supporting me from the beginning until the end of this project.

ACKNOWLEDGEMENT

Alhamdulillah. I am sincerely appreciative and grateful to my supervisor Mr. Mohd Idain Fahmy Bin Rosley for giving me chances and opportunity to get involved in this project. A lot of thanks to him for his ideas, guidance, experience sharing, continuous support, and encouragements in making this Final Year Project (FYP) thesis possible.

I also take this opportunity to thanks to my beloved parents, Mr. Mazlan Bin Zakaria and Mrs. Che Siti Binti Hashim who always support me and give me courage since the beginning of this project. Their words have given me the strength to complete this project.

Finally, I also want to express my thanks to everyone who involves directly or indirectly in this project. The commitment and sacrifice that given towards me have helped me to gain knowledge and experience. Without them, this report would have been impossible.

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1.1 Background of Study

A food truck is a truck equipped to cook and sell food. Some of food truck is selling frozen or prepackaged food and others have on-board kitchens to prepare food from scratch for example sandwiches, hamburgers, French fries, and other regional fast food fare. In Malaysia, food truck associate with the pop-up restaurant phenomenon which become particularly popular by offering gourmet cuisine and a variety of specialties and ethnic menus.

Restaurant owner decides either to operate as a food truck, which allows him to serve different locations day to day, or to operate as a brick and mortar restaurant, which ties him to a single location. (Anenberg and Kung, 2015)

With environment that is more relaxed and unpretentious, it has changed the lifestyle of modern society. A well-designed of food truck is important to ensure it is durable and safe. Careful planning in the design will save the money and time during the build-out phase and will increase the profitability of truck. In this research, there will be more focus on food truck body design. Food truck is used as the referral design to create a new design of food truck body. This project aim is to design, analyze, and fabricate body for food truck. The design is referred to food truck that already used now days. It can be adjusted, lightweight and withstand a heavy load. This project is based on the LEGO concept where the body of food truck can be adjusted and produce more space.

The body design of food truck is built with various option of material. Material selection is important because requirement for the design must be simple, low cost, easy to fabricate at the same time light weight. The example of the materials is fiberglass, aluminum sheet and mild steel sheet that is similar to developed boat body. **Figure 1** are the example of standard food truck body.

Figure 1 : Standards of food truck body

1.2 Problem Statements

Current design of food truck body already made is not enough space inside the food truck. The body design almost made from heavy material and has high load to carry. The current food truck needed design with modular unit, low cost, compact, and low drag body.

The bodywork conveys the essential identity and aesthetic appeal of the Vehicle the drab functionality of utility vehicles, the actual material from which it is fabricated has until recently attracted relatively little interest. (Prabu, Vinoth and Senthilkumar, 2016)

Current food truck body fix and buyer need to buy additional vehicle as a supply truck. The design of food truck body must be durable, light weight and using land rover HCPU as based vehicle. But there are some criteria that are considered which are materials used, functionality and the building process.

Selection of materials for the fabrication is an important to ensure the vehicle is durable, easy to set up and to do maintenance work or repairs when damage. (Hassan, Razali and Halid, 2013)

1.3 Project Objectives

The objective of the present research is:

1) To develop a new design of food truck body.
2) To analyse the aerodynamics of food truck body.
3) To fabricate a low drag food truck body prototype.

1.4 Project Scope

The scope of the present research is:

1) Design a food truck body using SolidWorks Software.
2) To study the analysis of the food truck body aerodynamics design using Virtual Wind Tunnel by HyperWork Software.
3) To study the fabrication process of food truck body on Land Rover Defender HCPU Malaysian Army cargo base platform.

CHAPTER 2
LITERATURE REVIEW

2.1 Introduction

This chapter will discuss and explains about the fundamentals, theories and concepts of this project. This chapter also review about the perspective, materials and process handling that will be used in this project.

2.2 Food Truck

The food truck market currently experiencing a rapid growth over the past several years, driven by the emergence of the 'gourmet food truck'. According to the National Restaurant Association in 2011, food trucks are the single fastest growing sector of the restaurant industry. The benefit to being able to serve different locations is that consumers have a taste for variety in their day to day food consumption. The food truck can avoid customers which have already been served recently. The cost to be a food truck is that there is uncertainty as to whether a location will be accessible on any given day. For example, all the parking spots at a location may be taken before the food truck arrive. (Anenberg and Kung, 2015)

2.3 Characteristic Key on Food Truck Body Design

Vehicle body design is one of the significant aspects of the performance of a vehicle. When the vehicle across a medium at high velocity, the medium will act along the vehicle body in term of resistance. Air is one of them that provide resistance when a vehicle traveling at high speed due to air space densities. This contributes to the fuel consumption of the vehicles. Besides that, the purpose of the vehicle body should hold an aura of attraction design in terms of creativity and esthetic value. (Hassan, Razali and Halid, 2013)

Normal or typically food truck body has bulk and boxy design that produce drag from front and turbulence at back may require high fuel consumption. A lightweight design contributes to the fuel efficiency of the vehicle. (Yusop *et al.*, 2014)

2.3.1 Center of Gravity

Center of gravity, also known as center of mass, is that point at which a system or body behaves as if all its mass were centered at that point. It's also to define the weight, and also all accelerative forces of acceleration, braking and cornering act through it.

Performing a weight distribution analysis can prevent building trucks that are overloaded in normal use, causing problems for users and the equipment installer. Overloads can shorten the live of a vehicle and its components. Overloads can also prevent compliance with weight laws and federal safety standards.

An important issue when designing vehicles with high gravity center is a phase of preparation and examination of a virtual vehicle prototype in view of the analysis of its dynamics. The vehicles with high gravity center are more prone to roll over. (Tengler and Harlecki, 2012)

A variety of methods have been proposed to realize accurate estimation of the CG position of vehicles, and each approach has its merits. Basically, most methods are divided into three groups based on different dynamic models which is vertical dynamics model-based methods, roll/yaw dynamics model-based methods and longitudinal dynamics model-based methods. In terms of estimation theory, a lot of methods have been employed for the CG position, such as recursive least squares (RLS), transfer function methods, linear/nonlinear Kalman filters. (Lin *et al.*, 2016)

2.3.2 Vehicle Aerodynamics

Aerodynamics is the way objects move through air. The rules of aerodynamics explain how an airplane is able to fly. Anything that moves through air is affected by aerodynamics, from a rocket blasting off, to a kite flying. Since they are surrounded by air, even vehicles are affected by aerodynamics. "Aerodynamics" is a branch of fluid dynamics concerned with studying the motion of air, particularly when it interacts with a moving object. (Mustafa, 2012)

The flow around road vehicle (car, buses, trucks) under normal operating condition is principally turbulent. It is typically characterized by large-scale separation and recirculation regions, a complex wake flow, long trailing vortices and interaction of boundary layer flow on vehicle and ground. In developing new road vehicle, it is essential for the designer to understand thoroughly the structure of flow around the vehicle. This will have influence on such principal feature as the shape of vehicle, aerodynamic drag, fuel consumption, noise production and

road handling. Traditionally, vehicle designer have gained their understanding of the air flow around a vehicle through extensive wind tunnel testing. (Khan and Umale, 2014)

All the aerodynamic forces acting on a body is due to the distribution of pressure on the surface of the body and the distribution of shear stress on the surface of the body. The pressure, P acts perpendicular to the surface, while the stress τ is tangential to the surface. This strain appears as a result of friction between the body and the fluid. The distribution of P and τ over the entire surface result in one equivalent force, F and moment, M. (Quezada-Larriva, 2015)

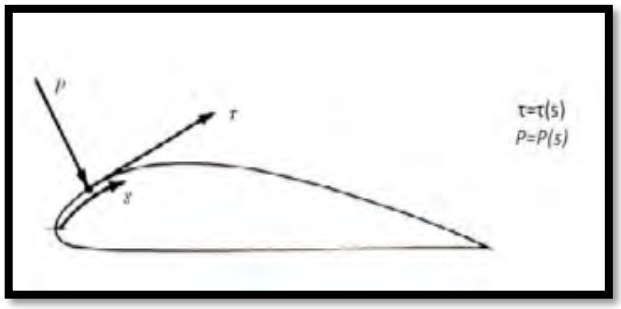

Figure 2 : Pressure and shear over a surface.

2.3.3 Aerodynamics Drag

Drag is the aerodynamic force that opposes a vehicle's motion through the air. Drag is a mechanical force generated by the interaction and contact of a solid body with a fluid. It is very important in design of vehicles because the higher this force is, the higher the power needed to move the vehicle. (Quezada-Larriva, 2015)

To obtain the values of Drag Force, the equations is used is the following:

$$D = C_D \times \rho \times S \times \frac{v^2}{2}$$

Where:

C_D = drag coefficient, ρ = air density (1.225Kg/m³), v = speed (m/s,) S = projected section

2.3.4 Drag Coefficient

This coefficient is a dimensionless value that allows to quantify the drag resistance of an object. When this value is low indicates that the object has less aerodynamic drag. The drag coefficient depends with the shape and position of the object (projected area) and the properties of fluid (kind of fluid, density, speed). There are some examples of the CD depending on the shape or vehicle shapes. (Quezada-Larriva, 2015)

The equation to obtain this value is:

$$C_D = \frac{D}{(½ \times \rho \times v^2 \times S)}$$

Where:

D = Drag Resistance, ρ = air density (1.225Kg/m³), v = speed (m/s), S = projected section

2.3.5 Drag Reduction

Drag reduction is of paramount importance in the transportation field. A major part of the fuel in commercial (aerial/ground/marine) vehicles is spent on overcoming aerodynamic drag from one of the main contributors to overall drag. Heavy vehicles due to their large frontal area and bluff shapes are aerodynamically inefficient to overcome drag**.** (Altaf, Omar and Asrar, 2014)

2.3.6 Drag Reduction Features

Vehicle parameters alone do not affect total drag, but the operational parameters have a large effect as well. It was found that using aerodynamics devices is optimal when these vehicles travel at high speeds on long haul driving cycles as weight does not have any direct effect on drag. Driving through urban areas utilizes most fuel for acceleration and deceleration. These factors are important because every part of a truck contributes, positively or negatively, to the total drag of the truck. (Altaf, Omar and Asrar, 2014)

Below are the technics to reduce drag:

1. Flaps/Deflectors - The coefficient of drag, was reduced with the increasing flap length. By deduced the flap displaced the flow attachment enabling more downwash, hence reducing the reverse flow in the wake. With the increase in downward angle, there was an increase in drag reduction. (Altaf, Omar and Asrar, 2014)

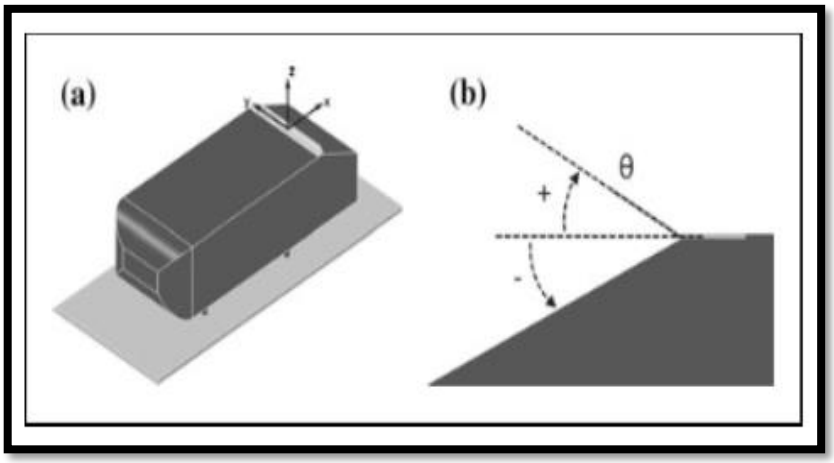

Figure 3 : (a) Deflection overview and (b) Deflection angle, θ

2. Splitter Plates - Drag reduction was achieved by eliminating longitudinal vortices, reducing wake cross section and minimizing pressure loss. (Altaf, Omar and Asrar, 2014)
3. Boat Tails - Adding boat-tail flaps at the back of truck can reduce the drag by increased the pressure over the base area, hence reducing the aerodynamic drag. (Altaf, Omar and Asrar, 2014)

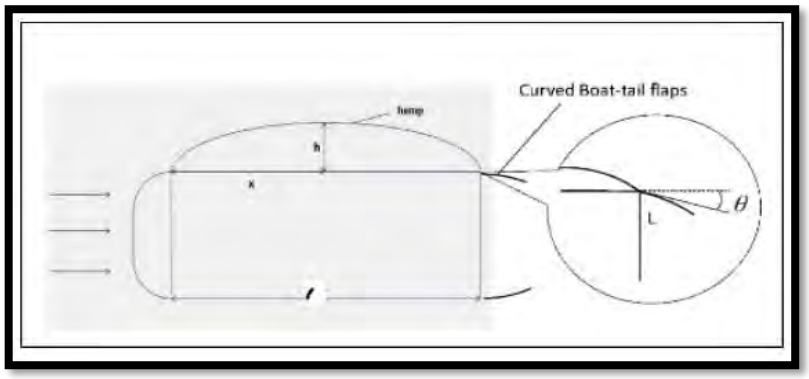

Figure 4 : Hump and curved boat tail flaps geometry

2.4 Material

2.4.1 Fiberglass

Fiberglass is a type of fiber-reinforced plastic where the reinforcement fiber is specifically glass fiber. The glass fiber may be randomly arranged, flattened into a sheet (called a chopped strand mat), or woven into a fabric. The plastic matrix is often a thermoset polymer matrix based on thermosetting polymers such as epoxy, polyester resin, or thermoplastic.