FV MALAYSIA RACE CAR - BODYWORK DESIGN AND ANALYSIS

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Draft Final Report
Projek Sarjana Muda II

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DECLARATION

I declare that this project report entitled "FV MALAYSIA RACE CAR – BODYWORK DESIGN AND ANALYSIS" is the result of my own work except as cited in the references

Signature	:	....
Name	:	NAQIUDDIN BIN NASIRIN
Date	:	....

APPROVAL

I hereby declare that I have read this project report 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 :. ....

Name of Supervisor :<u>DR. MOHD AZMAN BIN ABDULLAH</u>

Date : ....

DEDICATION

In the name (of) Allah, The Most Gracious, The Most Merciful.

Dedicated to my beloved mother and father.

ABSTRACT

The purpose of this study is to identify aerodynamics properties of the race car. Aerodynamic is the main factor on how well performance of the car itself. Car with good aerodynamics properties will have better fuel economy and performance. Failure to have better aerodynamics properties will make the vehicle lose stability during high speed maneuvering. The aerodynamics properties include coefficient of drag, coefficient of lift, and effect on different speed travelling. This study use Formula Varsity race car model that designed by using CATIA software. Then, it was been analyzed by using ANSYS Fluent software. Result from the analysis can be used to find the coefficient of drag and coefficient of lift. It is also shown that coefficient of lift and drags on vehicle may be difference on different meshing size. The experiment is repeated by using several different speeds in order to see difference performance of vehicle. The finding may be useful in optimizing the aerodynamic properties of bodywork for future use.

ABSTRAK

Tujuan utama kajian ini adalah untuk mencari ciri-ciri Aerodinamik pada sesebuah jentera perlumbaan. Aerodinamik merupakan salah satu faktor yang penting dalam mengukur prestasi sesebuah kenderaan tersebut. Kenderaan yang mempunyai ciri-ciri aerodinamik baik mampu mempunyai kadar eknomi bahan api dan prestasi yang bagus. kegagalan mempunyai kadar aerodinamik yang bagus mampu menyebabkan hilang kestabilan semasa pemanduan di kelajuan yang tinggi.Ciri-ciri aerodinamik yang termasuk adalah pekali daya seretan, pekali daya angkatan dan kesanyna terhadap kelajuan yang berbeza. Kajian ini telah menggunakan model jentera perlumbaan FV Malaysia yang direka menggunakan perisian CATIA. Kemudian, model tersebut telah dianalisa menggunakan perisian ANSYS Fluent. Keputusan kajian dapat digunakan untuk mencari pekali daya seretan dan angkatan. Selain itu, ia daya pekali seretan dan angkat akan berubah apabila mempunyai saiz meshing yang berbeza. Kajian ini diulang menggunakan kelajuan yang berbeza dalam mencari perbezaan prestasi jentera. Hasil kajian amat berguna dalam mengoptimumkan diri-ciri aerodinamik pada jentera masa hadapan.dingkan.

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LIST OF ABBEREVATIONS

ANSYS	American Computer-aided engineering software
CFD	Computational Fluid Dynamic
CATIA	Computer Aided Three-dimensional Interactive Application
FV	Formula Varsity
FSAE	Formula Society of Automotive Engineers

LIST OF SYMBOL

C_D	= Coefficient of Drag
C_L	= Coefficient of Lift
A	= Frontal Area of Vehicle (m^2)
ρ	= Density of Air (kg/m^3)
V	= Velocity of vehicle (ms^{-2})
T	= Temperature (°C)
P	= Pressure (kPa)
R	= Gas Constant Value

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

The numerical analysis on aerodynamic properties using Computational Fluid Dynamic has become more effective way compare to conventional way. Ability to have major changing on design during fundamental designing can save time used in constructing prototype thus, reduces cost for prototyping. Analysis using wind tunnels are very expensive and demand large amount of equipment and skilled personnel.

The aim of this study is to increase the performance of open-wheel race car of FV Malaysia by manipulating several aerodynamic factors on the bodywork. The coefficient of drag and the coefficient of lift are being analyzed using fluid analysis. This project conducted by using ANSYS, CATIA and CFD software that provided by the faculty of mechanical engineering.

Aerodynamic is the main factor when designing an open-wheel race car. The shape of the vehicle is often the main factor that contributes to aerodynamic performance. Aerodynamic can be defined as the study on how fluid or air properties move whenever interact with solid object. To have the stability on open-wheel race car, aerodynamic drag and aerodynamic lift need to be considered during design processes. During high-speed maneuver, open-wheel race car has significant effect on aerodynamic behavior.

Lower value of drag force will increase the top speeds and increase the stability of the open-wheel race car. However, the drag force can be compensated by manipulating drag force into down force. As a result, it will push car downward and provide higher traction force on tire.

Traction force is defined as a force used to generate motion between a body and tangential surface. Traction force on tire is needed to deliver full power of engine to tire without any tire slip. As a result, it provides better tire grip and better acceleration. Traction force also needed to provide better traction during taking corner or overtaking maneuver during high speed. Appropriate traction force can provide better grip and stability during cornering; too much traction force can slow down the car, lack traction force can lead to spin tire during acceleration and under steer during cornering.

On open-wheel race car, aerodynamic factor can be highly influence by shape of side port and open cockpit shape. The occurrence is due to larger frontal area that generates drag force. Improper shape can cause the open-wheel race car to be unbalance due to turbulent flow. Air flow can be directed and shaped in order to have the best aerodynamic properties. It can be shaped by modifying the front spoiler, fuselage, and side port and rear spoiler shape. Down force can be obtained by manipulating drag force. The use of spoiler on front and rear race car body can change direction of air flowing through bodywork.

1.2 PROBLEM STATEMENT

FV Malaysia challenged the students to build a formula 1 style car. UTeM Racing Team has participated in FV Malaysia Race at Sepang International Circuit. Designing processes conducted by students in order to have the best design on aerodynamic factor. The computational Fluid Dynamics (CFD) has played important role to analyze bodywork recently. In order to get higher efficiency on aerodynamic factor, the drag force should be fully eliminated as it slows down the race car. The down force should be generated in order to maintain car on ground and has better traction control when taking corner.

1.3 OBJECTIVE

The objectives of this project are as follows:

1. To design the bodywork of FV race car by using CATIA
2. To Analysis aerodynamics properties of bodywork by using ANSYS

1.4 SCOPE OF PROJECT

The scopes of this project are:

1. To design model of bodywork using computer aided software
2. To analyze to several properties using ANSYS software:

   2.1 Coefficient of drag

   2.2 Coefficient of lift
3. Design modification to improve the area that has low aerodynamic properties.

1.5 GENERAL METHODOLOGY

The actions that need to be carried out to achieve the objectives in this project are listed below.

1. Design the Bodywork

   Journals, articles, or any materials regarding the project will be reviewed.

2. Computational Fluid Dynamics using ANSYS

   ANSYS tutorial conducted in order to expose initial stage for analysis.

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The methodology of this study is summarized in the flow chart as shown below. The research start with the literature review to gather as much as possible previous data and research that have been done. Since ANSYS software is not in compulsory subject, tutorial have been conducted in order to provide knowledge on how to use ANSYS software. Modeling a car using CATIA V5 software, during design stage generative surface design and part volume function has been used. The design consist several parts which is front spoiler, bodywork, and tire and rear spoiler. Model of the car will be transfer to ANSYS software, meshing is being included at different size in order to see difference. Boundary condition has been set up as realistic as possible with real world. Analysis has been conducted to retrieved coefficient of drag and lift for the car. By referring previous study, if the coefficient of drag and lift are not near to previous study, the design should have slight modification.

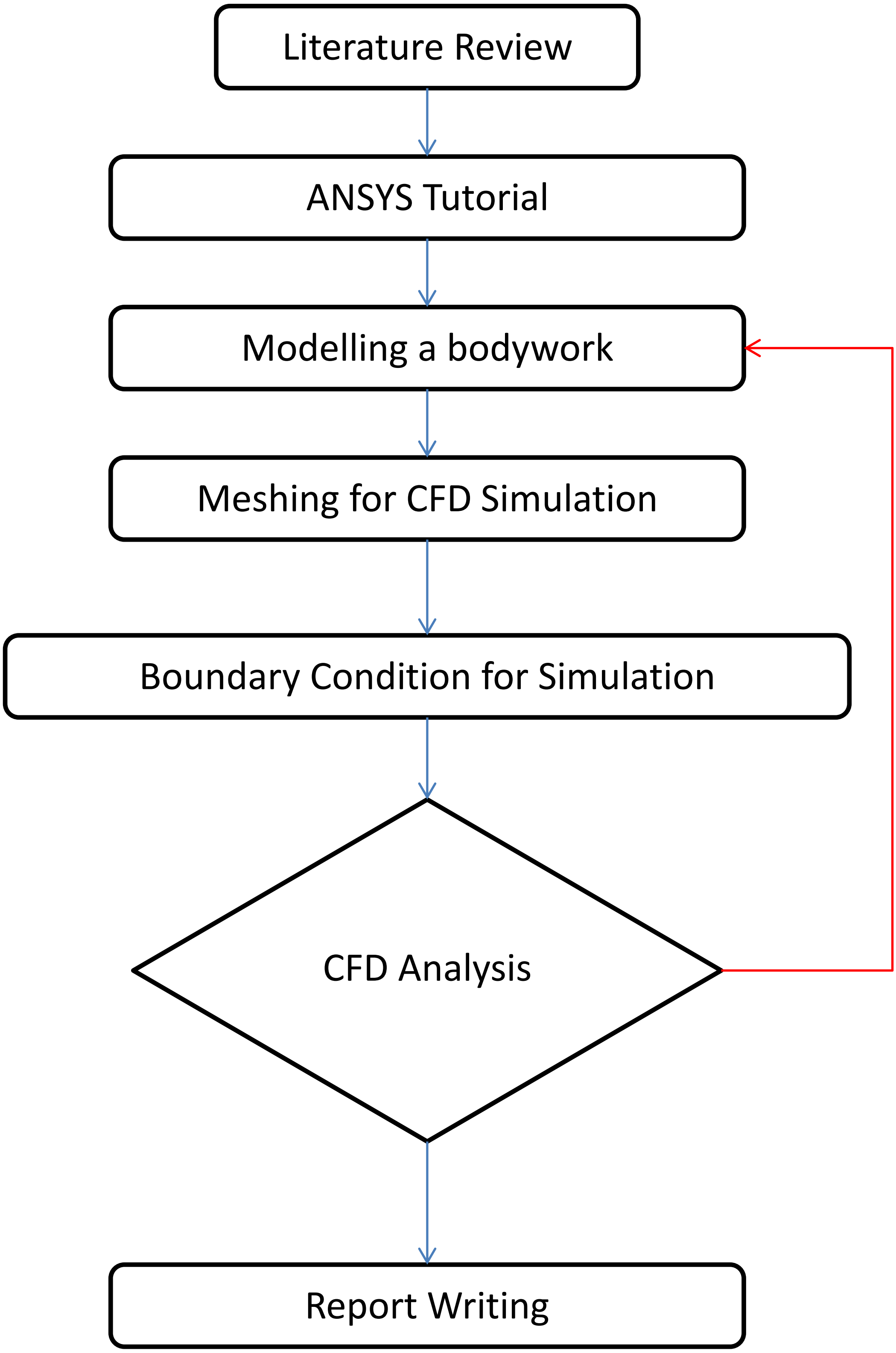

Figure 1.1: Flow chart of the methodology

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Aerodynamics has high influence in designing an open wheel race car. Road load has higher contribution in aerodynamic effect. By reducing the road load or improving the flow passed on vehicle body can give enormous advantages. In addition, drag force, lift force and down force are few road load factors that will affect the aerodynamic properties on open wheel race car. As a matter of fact, good aerodynamics properties can reduce the fuel consumption during driving, improve handling when taking high speed cornering and increase handling stability during high speed maneuver. However, early car model was designed without considering the aerodynamic factors. Early designs were based on horse carriage until such time as modern world being considered aerodynamic factor when designing a car. As an example, early model was designed to look like a carriage with bulk and square shape. For an example Henry Ford's car T-1 that has square shape. Retrieved from http://classiccarpicturesalmanac.com/archives/cars/1914-ford-model-t-touring-wide-track.html

Figure 2.1: T-1 Model on early Henry Ford's design

2.2 PREVIOUS STUDY

Multiples studies Koike et al. (2004) have been conducted regarding open wheel race car aerodynamic. Installation of vortex generator on rear side of sedan car controls the separation of airflow and increases the aerodynamics performances. In their research, applying vortex generator on Mitsubishi Lancer Evolution car reduced the drag coefficient and lift coefficient by 0.006.

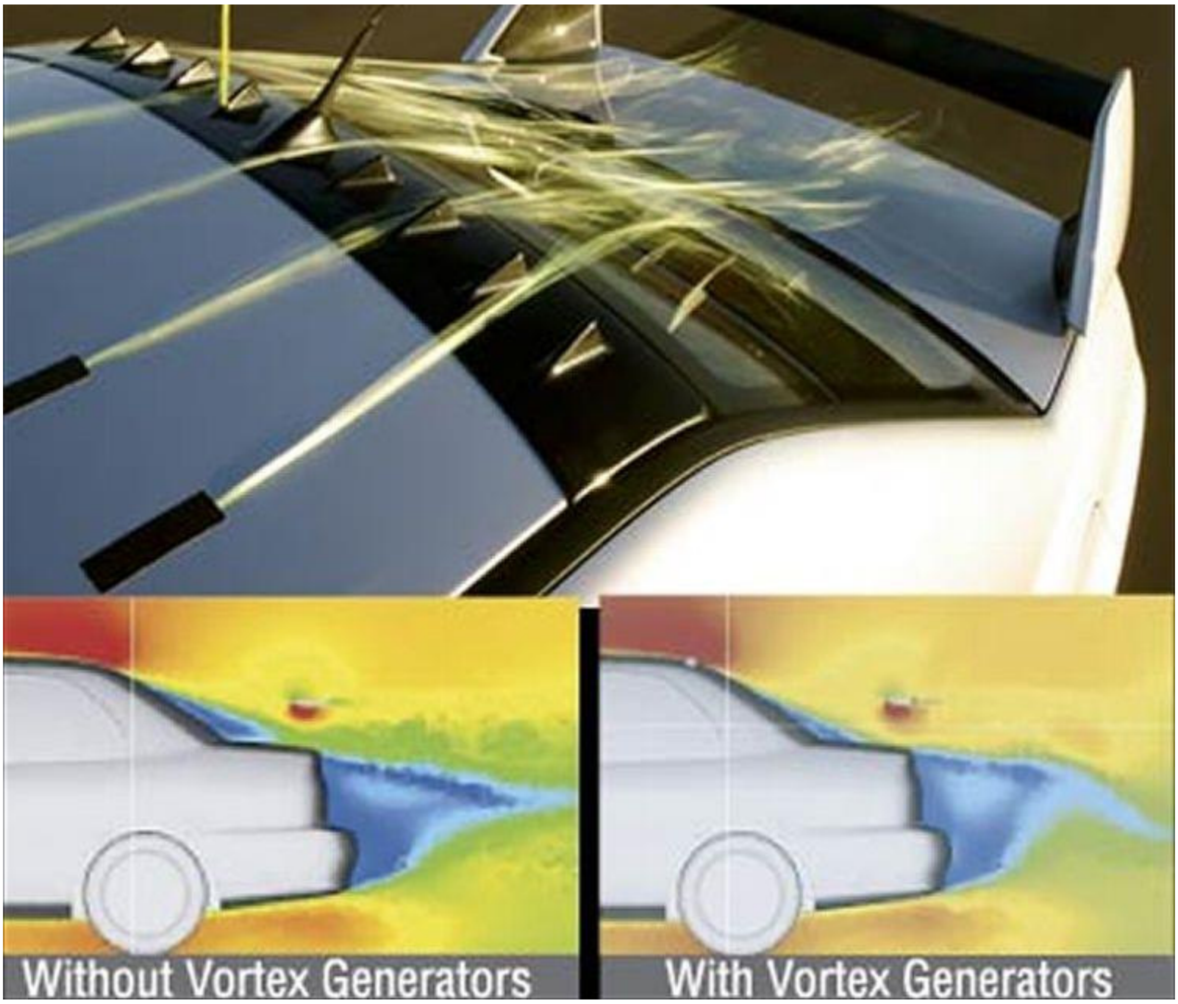

Figure 2.2: Velocity vectors around separation point

There are several factors that contribute to effect of vortex generator, stream wise vortices are formed whenever air going through the vortex generator. To add to it, lower layer of boundary layer formed and will cause change the flow separation point to be downstream. From this characteristic, we can safely assume pressure at entire rear surface will increase thus will reduce the drag force.

The studies identify how aerodynamic influence the performance of the open wheel race car. However, very few studies Edvaldo and Gabriel (2015) have been conducted on influence of elements inside the wheelhouse on the vehicle aerodynamic. On their research, to analyze the aerodynamics load on inside the wheelhouse can be possible by using a mathematical model. On a contrary, flow behavior inside the wheelhouse can be too complex and have too much recirculation regions. In their research, they agree that analysis on box on wheels, wheel tire set are not suitable for aerodynamic performance research. However, Aerodynamic performance can be analyzed whenever the vehicle travel at low speed.

Krishna and Jayachandra (2012) in their research on conceptual design of wind friction reduction attachments to the rear portion of car for better fuel economy at high speeds, has suggested implementation of collapsible wind friction reduction attachment at the rear of the vehicle. By providing the wind friction reduction attachments to the rear portion of car bluff body, the wind friction drags coefficient can be reduced from around 0.4 to around 0.2

Drag force can also be significantly reduced by designing front wing for open wheel race car. It has been proved. (Price, 2011)