

DESIGN AND ANALYSIS OF THE SOLAR CAR BODY

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for the award of Diploma in Mechanical Engineering

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### **SUPERVISOR'S DECLARATION**

I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of Diploma in Mechanical Engineering.

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Date : 24 NOVEMBER 2010

## STUDENT'S DECLARATION

I hereby declare that the work in this report is my own except for quotations and summaries which have been duly acknowledged. The report has not been accepted for any degree and is not concurrently submitted for award of other degree.

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## **ABSTRACT**

This report shows the design and analysis of body parts for racing solar cars because this play an important role in the motor industry today and solar car also powered by sun energy (solar). This is obtained from solar panels on the surface of the vehicle. Photovoltaic (PV) cells convert the sun's energy directly into electric energy. This is project use the materials type as carbon fiber. Overall, this project involves many processes, starting from the design concept, in this project design is very long time and this part most important in solar car industry. Secondly start the analyzing the parts of the body because the body plays a role in absorbing solar energy as possible as well, the car body design aerodynamic.

## ABSTRAK

Laporan ini memaparkan reka bentuk dan menganalisis bahagian tubuh kereta solar untuk tujuan perlumbaan, kerana ini memainkan peranan penting dalam industri permotoran masa kini dan kereta solar juga dijana oleh tenaga matahari (solar). Tenaga solar ini diserap oleh panel suria pada permukaan kenderaan. Sel photovoltaic (PV) menukarkan tenaga solar menjadi tenaga elektrik. Projek ini menggunakan bahan jenis serat karbon. Secara keseluruhan, projek ini melibatkan banyak proses, mulai dari konsep mereka bentuk, masa untuk mereka bentuk projek adalah waktu yang sangat panjang dan ini bahagian paling penting dalam industri kereta suria. Yang kedua, memulakan menganalisis di bahagian tubuh, kerana bahagian tubuh memainkan peranan dalam menyerap tenaga suria sebanyak mungkin disamping, mereka bentuk tubuh kereta yang aerodynamik.

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 PROJECT SYNOPSIS**

The project contains of the designing and analysis of the solar car body for race. There have a many differences between this of the design body of solar car with current design in the world. This project is to develop and improving it performance as well so that there has no doubt about the design and concept. In this project, it needs lot of skills and information, research and also knowledge such as Computer Aided Design Software (Auto Cad), Solid works software and knowledge in automotive industries and solar industry.

This project must combine a technology typically used in the aerospace, bicycle, attentive energy, solar industries and automotive industries. So this design solar cars have been built for the purpose of solar car races only.

#### **1.2 PROJECT PROBLEM STATEMENT**

- i. Shaping the vehicle body to allow solar cells to receive more solar energy.
- ii. Maximum speed for solar car race.
- iii. Design the car body with the aerodynamic.

### **1.3 PROJECT OBJECTIVES**

#### 1.3.1 General objective

Diploma final year project objectives is to practices the knowledge and skill of the student that have been gathered before solving problem using academic research, to born an engineer that have enough knowledge and skill. This project also to complete the subject on this semester. The student also can be explore the advanced machine before involves in industries. The project otherwise will be produce and train student capable of doing word with minimal supervisor and moray independent in searching, detailing and expending the knowledge and experiences. The project also will generate student that have capability to make a good research report in thesis form technical writing.

#### 1.3.2 Specific project objective

The main objectives of this project is to design and analysis the solar car body for racing that light in weight and high durability using solid word, and other software.

### **1.4 PROJECT SCOPE**

- i. Maximum driver's weight up to 75kg.
- ii. The solar car have a three wheels only.
- iii. Design body solar car for racing only
- iv. Design of the body within 3.2m long, 1.2m wide and 0.8m high.

## 1.5 PROJECT PLANNING

This project is beginning with meet supervisor to collect information and otherwise search from via internet, books and survey at laboratory, this literature review must do for every week. The finding of information not will be stop on a week but continues along the way of this project because to get more information.

The Gantt chart (time management) and flow chart (process management) will be developing on second week. This is done using Microsoft Excel using Gantt chart system.

The fourth week the Pugh analysis and matrix analysis will be developing. The function of this analysis is to get a final design, from three design any criteria will be research to get good concept. After get a final design solid word will be start.

Just final design will use this software for analysis. Each part will be developed and lastly the assembly part will be begun.

On weeks sixth and seventh the progress report will be start. Meeting with supervisor on weeks seventh and ninth gather date to complete progress report. That week the mid presentation also start.

The analysis of aerodynamic will be start after mid presentation. The process of analysis for the body and bottom of solar car start on week eleventh. At the same time the prepare for the final presentation. The planning process of analysis around week's twelfth until fourteenth.

After finish the process analysis, the final report will be start. To complete the report it will use format thesis 2010. The last presentation will be started on week fifteenth.

ACTIVITIES	WEEK													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Title Selections.	Red													
Proposal (background, objective, scope, problem statement)		Red	Red	Red										
			Blue	Blue	Blue									
sketch & design selection on project and then discuss with supervisor				Red	Red	Red								
				Blue	Blue	Blue	Blue							
Pre-presentation							Red							
								Blue						
Analysis and Discussion								Red	Red	Red				
									Blue	Blue	Blue	Blue		
Final report									Red	Red	Red	Red	Red	
										Blue	Blue	Blue	Blue	Blue
Final presentation														Red
														Blue

Table 1.1: Gantt Chart

## **CHAPTER 2**

### **LITERATURE VIEW**

#### **2.1 INTRODUCTION**

Body design is an important criterion for race car. Race car body is particularly important in aerodynamic because have a reduces drag and hence provides smooth air flow along the race car. Also, the body design is analogous as an upside down wing, providing negative lift or down force for stability. Besides that, car body encloses the driver and all important components so that to protect him against any projectiles created by the race car in front. Lastly, car body is a major contributor in a race car appearance. A race car with eye-catching body always is an attraction in racing competition.

## 2.2 BODY OF SOLAR CAR

### 2.2.1 Introduction

The Solar car have a smaller amount of energy available compared to conventional engine passenger vehicles. The power is needed to overcome the resistance to motion. These resistances generally caused by rolling resistance and air resistance (aerodynamics).

It can be represented in the form of an equation as:

$$R = k_r m g + k_a A V^2$$

Where,  $k_r$  = Co-efficient of rolling resistance

$m$  = Mass of vehicle

$g$  = Gravity constant

$k_a$  = Aerodynamic drag co-efficient

$A$  = Forward drag co-efficient

$V$  = Speed of vehicle

Hence, a well designed body or shell can reduce the air resistance on the car when it moves. Air resistance is referred to as aerodynamic drag. If a moving object is streamlined, the air will flow around it smoothly and cause less drag, therefore needed less energy to move the object. Beside that, one goal for the teams who design solar car is to achieve extremely low aerodynamic drag while still maintaining a suitable surface for the solar cells and adequate space for the driver and other component.

Some of Concept will be discussed is:

i. Aerodynamics

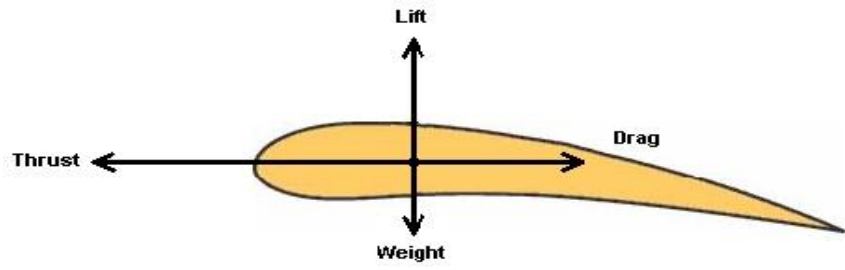


Figure 2.1: Forces on aerofoil shape

ii. Frontal Area

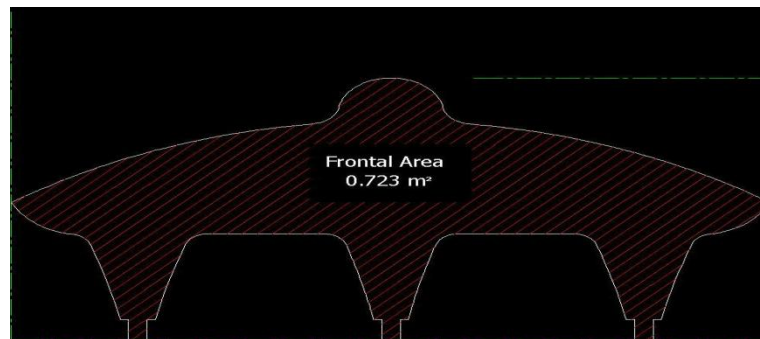


Figure 2.2: Frontal Area

iii. Shaping

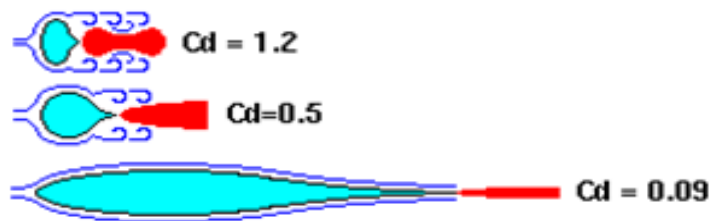


Figure 2.3: Affected of shape on  $C_d$

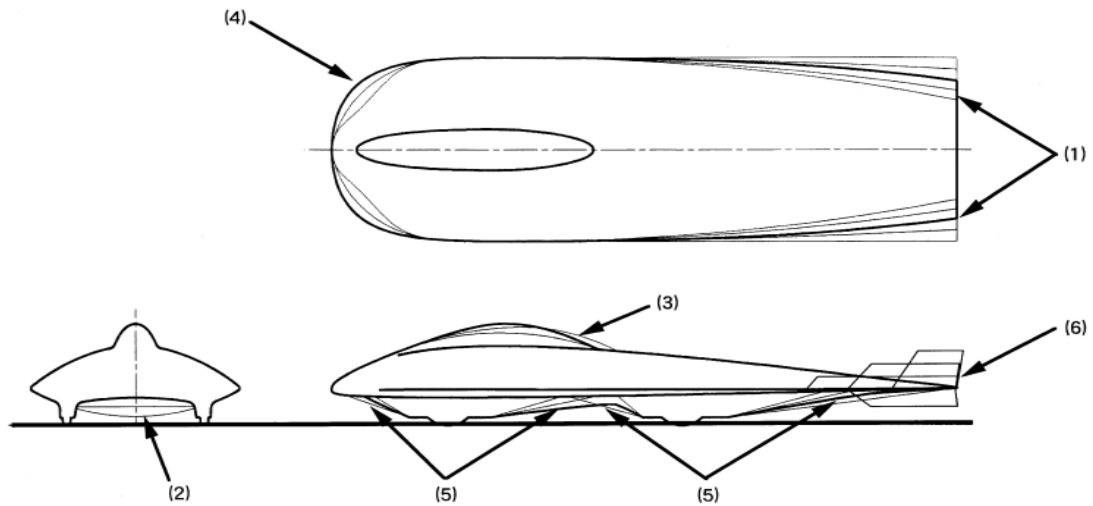


Figure 2.4: Model shape detail

### 2.2.2 Development of a solar car

The body of a solar car should be designed to optimize the balance of generating capacity of solar cells and aerodynamic performance in order to have the highest overall efficiency. Generating capacity will be increased by:

- a. Shaping the vehicle body to minimize drag force
- b. Increasing the area of solar cell installed on body
- c. Shaping the vehicle body to allow solar cells to receive more solar energy.

### 2.2.3 Aerodynamic development

One goal for the teams who design solar cars, is to achieve extremely low aerodynamic drag while still maintaining a suitable surface for the solar cells and adequate space for the driver and the other components. Once a design is proposed, the shape should be tested to obtain figures for drag.

Testing proposed aerodynamic shapes is generally done in one of two ways. The first is to build scale models that are tested in a wind tunnel to simulate air flow across the car. The second is to use a powerful computer program that does the same kind of air flow simulation using a computer-generated model of the car.

One objective of aerodynamic studies is the design of shapes that offer the least resistance to the flow of air. Air offers a resistance to any object moving through it. Air resistance is influenced by the shape of an object. Aerodynamics engineers study the way in which air flows around objects, but it is still somewhat a black art.

Air resistance is referred to as aerodynamic drag. If a moving object is streamlined, the air will flow around it smoothly and cause less drag, therefore needing less energy to move the object. Such a design is considered to be aerodynamically efficient. When an object produces poor airflow, more energy is required to push it forward.

Aerodynamics also is the way air moves around things, under aerodynamic development have a two sections of the end, is;

a) Drag coefficient ( $C_d$ )

The drag coefficient ( $C_d$ ) is a number that describes a characteristic amount of aerodynamic drag caused by fluid flow, used in the drag equation. Coefficients for rough unstreamlined objects can be 1 or more, for smooth object much less.

Generally  $C_d$  values come from test of shapes with known cross sectional area. These experiments will be done by use wind tunnels. The arrow in front of the shape gives the direction of the air blowing over the shape.

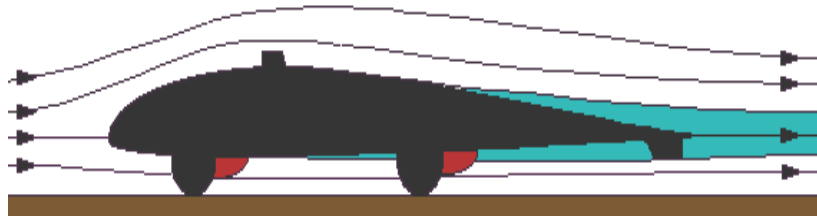


Figure 2.5: Slipstream Aerodynamic

Shape	Drag Coefficient
Sphere → ○	0.47
Half-sphere → ◐	0.42
Cone → ▲	0.50
Cube → □	1.05
Angled Cube → ◇	0.80
Long Cylinder → ▭	0.82
Short Cylinder → ◻	1.15
Streamlined Body → ◡	0.04
Streamlined Half-body → ◡	0.09

**Measured Drag Coefficients**

Figure 2.6: Drag coefficients for some basic shapes

### b) Drag equation

The drag equation gives the drag force by an object moving through a fluid. This equation related to  $C_d$ , the drag coefficient;  $A$ , frontal area and the speed of air past it. This equation shows an important point – aerodynamics forces are proportional to the square of the speed. That means

$$D = \frac{1}{2} \rho v^2 A C_d$$

- $D$  is the force of drag,
- $\rho$  is the density of the fluid,
- $v$  is the velocity of the object relative to the fluid,
- $A$  is the reference area, and
- $C_d$  is the drag coefficient

### 2.2.4 The Solar Car Array

The solar array is the vehicle's only source of power during the cross-country Rayce. The array is made up of many (often several hundred) photovoltaic solar cells that convert the sun's energy into electricity. Teams use a variety of solar cell technologies to build their arrays. The cell types and dimensions of the array are restricted by the Regulations, depending on the vehicle size and class.

The cells are wired together to form strings. Several strings are often wired together to form a section or panel that has a voltage close to the nominal battery voltage. There are several methods used to string the cells together, but the primary goal is to get as many solar cells possible in the space available. The solar cells are very fragile and can be damaged easily. Teams protect the cells from both the weather and breakage by