SUPERVISOR DECLARATION

"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 (Design And Innovation)"

Signature : .....

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Date : 28 JUNE 2012

DESIGN AND FABRICATE AN ERGONOMICS COCKPIT FOR SINGLE SEATER FORMULA VARSITY ELECTRIC RACING CAR

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UNIVERSITI TEKNIKAL MALAYSIA MELAKA

JUNE 2012

DECLARATION

"I hereby declare that the work in this report is my own except for summaries and quotations which have been duly acknowledged."

Signature : .....

Author : JOEHAN ARIFF BIN ISMAIL

Date : 28 JUNE 2012

This thesis is dedicated to my father, En. Ismail Bin Hamzan who taught me that the best kind of knowledge to have is that which is learned for its own sake. It is also dedicated to my mother, Pn. Norlaila Binti Rosdin who taught me that even the largest task can be accomplished if it is done one step at a time.

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ABSTRAK

Diantara sukan bermotor yang semakin popular di peringkat institusi pengajian tinggi ialah Formula Varsiti anjuran Universiti Teknikal Malaysia Melaka (UTeM). Formula Varsiti UTeM diadakan dua tahun sekali. Objektif utama projek ini adalah untuk merekabentuk dan menghasilkan sebuah kokpit untuk kegunaan pemandu Formula Varsity yang akan datang. Kaedah yang digunakan untuk projek ini mengikut proses kejuruteraan rekabentuk dan perisian kejuruteraan. Hasil dari projek ini, sebuah kokpit pemandu akan dihasilkan. Di akhir projek ini, sebuah kokpit pemandu yang lebih baik dapat dihasilkan dan memuaskan hati pemandu yang akan menggunakannya pada siri perlumbaan Formula Varsity yang akan datang.

ABSTRACT

Among of motorsports events, the Formula Varsity organize by University Teknikal Malaysia Melaka (UTeM) is the most popular motorsports for higher education institutions. Formula Varsity was held once for two years. The main objective of this project is to design and develop a driver's cockpit for the upcoming Formula Varsity race. Methods used for this project in accordance with the engineering design process and engineering software. The result of this project, a driver cockpit will be developing. At the end of this project, a new better cockpit and can satisfy the driver when use it will be develop and will be used for the next series of Formula Varsity race.

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CHAPTER I

INTRODUCTION

1.1 INTRODUCTION

Cockpit is the important things in a race car. In the cockpit, there are located steering wheel, driver seat, throttle and brake pedal and gauges. It is like a control room to the car. The driver can know the car condition when driving. The gauge will let the driver know the car conditioning. It is important to design a cockpit that can comfort the driver. Improper design of the cockpit can make the driver difficult and feel uncomfortable. Also can affect the driver driving performance.

Comfort in the human-machine interface and the mental aspects of the product or service is a primary ergonomic design concern. Comfort is one of the greatest aspects of a design's effectiveness and is a primary ergonomics design concern. The utility of an item is the only true measure of the quality of its design. The job of any designer is to find innovative ways to increase the utility of a product. Physical comfort while using an item increases its utility. The mental aspect of comfort in the human-machine interface is found in feedback. The look, feel, use and durability of a product will make a mental determination about a product or service. Better ergonomics means better quality which means it will be more comfortable with the value of the item.

The safety of the design is a major aspect in the design, and should be considered through all stages. Due to limited budgets and time constraints the design

will need to be geared towards simplicity and strength but fulfill the ergonomics aspects. Figure 1.1 show the previous cockpit of the UTeM Formula Varsity car.

Figure 1.1 Previous Formula Varsity cockpit.

1.2 OBJECTIVE

For this project, it has three major objectives. The objectives are:

i. To design an ergonomics seat for single seater Formula Varsity electric racing car using CAD.
ii. To analyze the strength and comfortability of the ergonomics seat.
iii. To fabricate an ergonomic seat for single seater Formula Varsity electric racing car.

1.3 PROBLEM STATEMENT

Due to the racing condition, it is important for driver to feel comfort during the race. An improper design of the seat can affect the driver condition like back pain, muscle stress and strain and bad psychology. As a result, it also will contribute lack of performance of the driver during the race. The most important factors need to

be considered are the seat design and angle of the driver seat, the position of the steering wheel and the driver bottom part position / leg. Therefore, the performance of the driver will improve while racing.

Known as, comfortability and strength of the seat is the main point that affects the driver performance. So, the main purpose of this project is to design and develop a seat that can support the back of the driver also the tight to make the driver feel comfort during race. The fully support seat will hold the driver especially when taking a corner.

This project carried out all of the necessary background research required to sustain an accurate database of design criteria. Design criteria then allowed the design process and methodology to be derived and to allow for smooth construction of an efficient and effective seat. Once construction of the seat was completed, analyses were conducted to investigate the effects of working loads on the seat.

1.4 SCOPE

There are several scopes for this project. The scopes for this project are:

i. To produce detail and 3D design of the seat using CATIA.
ii. Study the requirements of the ergonomics seat for single seater FV electric racing car
iii. Study and find the best design reliable for the driver of the electric car.
iv. Study the suitable material used in fabricating an ergonomics seat.
v. To fabricate the chassis using suitable manufacturing process.

CHAPTER II

LITERATURE REVIEW

2.1 INTRODUCTION

The Formula Varsity is a student competition in Malaysia. The competition such as like Formula SAE give impression for engineering student to gain experience in the design, manufacture and test of the vehicle. The concept of this event also came from SAE competition held in United Kingdom, America and Canada. The objectives of such event are to expose student to practical work, to give students to apply theories into practical and to develop new talent of students in automotive industry.

As we know, seat is the chair that used in automobile. Seat should have lumbar and thigh support. Lumbar is the region of the spine between the diaphragm and the pelvis. It supports the most weight and it is the most flexible in human body. A new definition of comfort related to the seated position is proposed and the erect trunk position is demonstrated as an indispensable requirement for comfort. After more than a century since the automobile's first appearance, its seats are still being designed to the same fundamental ergonomic principles and even though they are equipped with sophisticated mechanism and endowed with the most refined padding and coverings, the seats still are defective from a comfort point of view. The material also will affect the characteristic and comfortablility of the set. Due to the Formula Varsity rules, any kind of materials considered exotic such as carbon fiber, are strictly prohibited from the car design including seat.

2.2 COMPETITION RULES

Adhering to the rules that govern the chassis for the competition is a pivotal part of the research. If one small sub-section rule is not followed by the chassis, it will disqualify the whole car from the competition.

Within the competition rules that are solely for the chassis, when attempting to insure all the rules are met, it is easy to miss small details when the rules are set out in this form. So, to simplify this process a summary of the rules was created and broken down into all individual areas of the chassis layout. These areas were, Main Hoop, Front Hoop, Bulkhead, Main Hoop Bracing, Front Hoop Bracing, Bulkhead Support, Other Bracing and Side Impact Members. The design of the seat will determine the seating position of the driver it will affect the height of the roll cage and indirectly, will affect the chassis design.

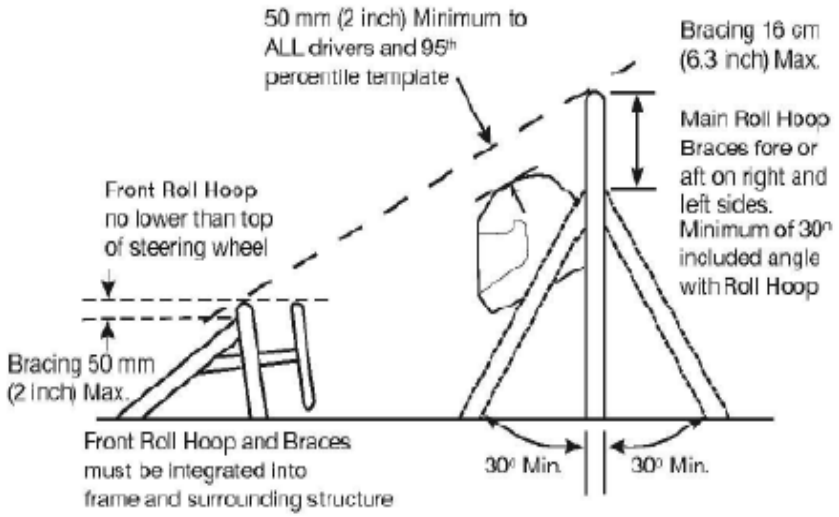
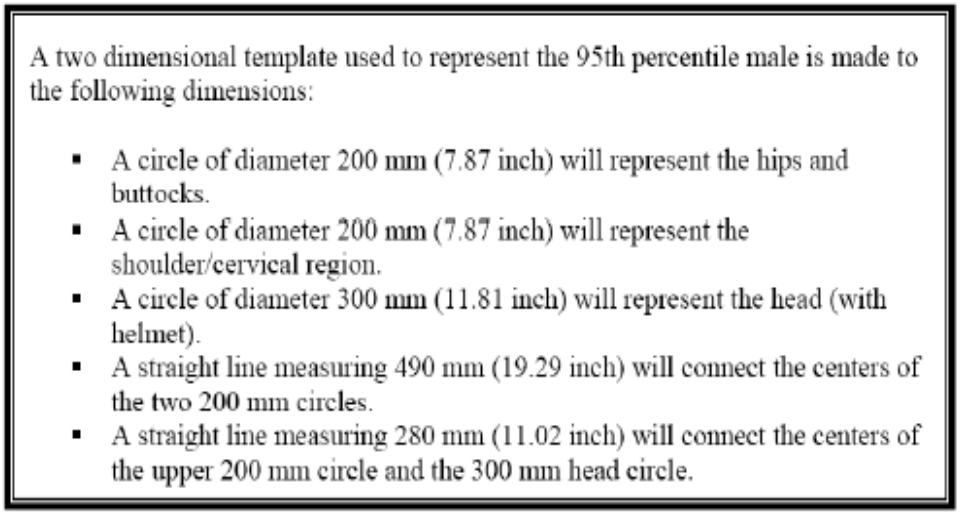


Figure 2.1 Illustration of the clearance required above the drivers head. (http://formulavarsity.utem.edu.my, 2010)


A two dimensional template used to represent the 95th percentile male is made to the following dimensions:

- A circle of diameter 200 mm (7.87 inch) will represent the hips and buttocks.
- A circle of diameter 200 mm (7.87 inch) will represent the shoulder/cervical region.
- A circle of diameter 300 mm (11.81 inch) will represent the head (with helmet).
- A straight line measuring 490 mm (19.29 inch) will connect the centers of the two 200 mm circles.
- A straight line measuring 280 mm (11.02 inch) will connect the centers of the upper 200 mm circle and the 300 mm head circle.

Figure 2.2 95th % percentile male dimensions as depicted in the 2010 rules. (http://formulavarsity.utem.edu.my, 2010)

2.3 DRIVER SEATING POSITION

The driver seating position in Formula One car is ultimate fit. A seat is manufactured by sitting the driver in full suit, in a bag full of seating foam positioned inside the car. The driver will choose either want an arched back or straight back. Once the seat is manufactured, it is perfectly fit to the contours of the driver's body. In Formula One seat, there is no cushioning for comfort, in fact there is no room for movement once the seatbelts are done up tightly. Driver also can choose either want laid back sitting position or sit more upright position. The design of the chassis will allow the choice to be made. In laying back position, more strength required turning the wheel but it is aerodynamically efficient and the center of gravity will be lower. The line of sight of the driver also will effect due to the driver sitting position. With different driving position, different driver's head will be at different heights. The reach of the driver is critical, and the steering wheel is positioned to be held with arms slightly stretched, but bought close to the body. Having fully outstretched arms can consider as a bad driving position, as the driver must support the arms full weight which, when totaled up, is 5.1% of the overall body weight (http://www.atlasf1.com/2000/nov29/gray.html). In open-wheel car, the body is very shallow in height and the cockpit very narrow. The driver's legs are relatively straight out with a slight bend in the knee and the feet just barely below the hips. The

pedals also require little more than a flexing of the ankle to go from 0-100% depression. The driver also has to make sure that his butt sits all the way to the back of the seat where exactly the base and back of the seat are joined. A more upright stance can be enjoyed by the driver and the natural curvature of the spine would be maintained and this would actually reduce the stress on the ligaments of the spine. A slouched position result in restricted head rotational movements and this can actually reduce the line of vision for the driver. Moreover, backward bending of the head becomes almost impossible when one is slouched forward and such a posture can even result in a whiplash injury from a slight rear end impact.

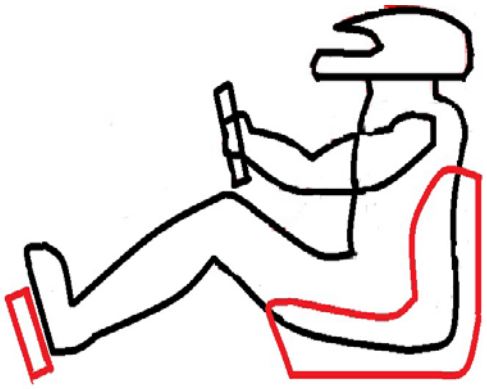


Figure 2.3 Previous driver sitting position on UTeM Formula Varsity car.

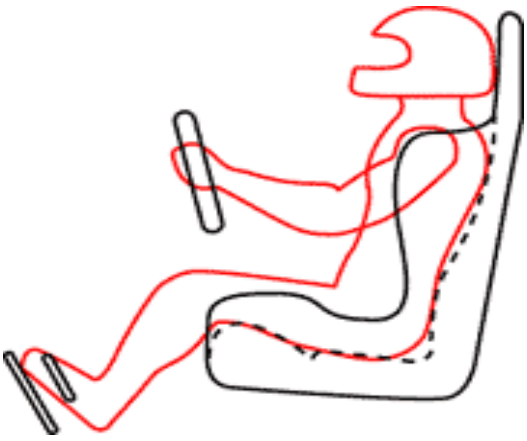


Figure 2.4 Sitting position on street car.
(http://www.turnfast.com/tech_driving/driving_seating)

Figure 2.5 Laying back sitting position
(http://www.atlasf1.com/2000/nov29/gray.html)

2.3.1 Arm Positioning

The arm position while driving is important to prevent muscle stress at the shoulder. The arms should be relaxed as possible and elbow should bent 20 to 30 degree of angle. Most of cars have an adjustable steering wheel, so, adjust it in the mid to lower position. The steering wheel shouldn't obstruct the view of the instrument panel like speedometer and fuel gauge. When the driver is tightly strapped into to the seat, the arms when fully extended should allow the wrist to rest at the top of the steering wheel. This will allows the arms to be slightly bent at the elbow when fully extended during turns and it is an ideal condition to drive without stretching one's arms. The shoulder should not need to lift from the seat back even in full arm crossover condition. The effects of overextending the arms are the driver to lose sensitivity to the vibration at the steering wheel and will cause them to tire quickly. This action also can reduce to a great extent of stress on the shoulder. Hands should be positioned at the 10 and 2 o'clock. This position is the traditional favorite because, in theory, a higher grip allows a driver to keep the car running smoothly without needing to jerk the wheel suddenly if cut off or there is hazard in the road. Most racing car including Formula Varsity car steering wheel only can turn about 80 to 90 degree of angle to the right side and same maximum angle to the other side. So