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CONCEPTUAL OF A SINGLE SEATER FORMULA RACING CAR

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This dissertation is presented in
Partial fulfilment of the requirements for the
Degree of Bachelor of Mechanical Engineering (Design & Innovation)

Faculty of Mechanical Engineering
Universiti Teknikal Malaysia Melaka

APRIL 2010

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"I declare this report is on my own work except for summary and quotes that I have mentioned its sources"

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To my beloved father, Idral bin Hassan
and my mother, Ramaili Bt Andema

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ACKNOWLEDGEMENTS

Alhamdulillah, thanks to Allah S.W.T for giving me life and allowed me to finish this project. Deep in my heart, I also thanked to my parents that always pray for my journey to be an engineer. A lot of thanks to my lecturers, Mr. Shafizal Bin Mat for supporting me to undergo this project and also providing his guidance, assistance and encouragement throughout the whole duration of the project.

Next, I would like to dedicate my thankful to my parents and to my siblings especially my brother Mohd Zaki Bin Idral for giving a full support morally and encourage me to face the problem with passion during the completion of my project.

Finally, thanks to my entire friend and any one those always motivate me for giving good cooperation in comment, opinion and supports directly or indirectly. Hopefully this dissertation will be useful as guidance for a student in future as their reference in further study.

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ABSTRACT

Formula Varsity is about formula racing car student organised by UTeM almost similar Formula-SAE competition. This competition delegate a valuable project where it combine academic work and learning with practical skill development engineering. In building a racing car, one of the main components should be taken into consideration is the structure (framework). Objective of this project is to produce design concept for UTeM Formula Varsity structure. Design criteria used in this building structure are predicated to FSAE rule 2009, ergonomics, and load analysis and safety factor. Software used in this project is CATIA V5R16 for 3D modeling and for structure analysis. There are 7 concepts that had been proposed in this project and the selection method used to find out the three best concepts to further into the next step which is detail design. The three best concept designs were selected based on the criteria that had been stated in Pugh Selection evaluation. Detail design will be preceded into the Finite Element Analysis to find out one of the design which is the best among three designs. A final design concept will be selected as the best design which following the SAE standards and regulations. After that, modification of a structure would be made to optimize the design (if necessary) to be more suitable and it will continue until the design achieve the target which is suitable and better to be used for next UTeM Formula Varsity.

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ABSTRAK

Formula Varsity adalah berkenaan kereta lumba formula pelajar yang dianjurkan oleh UTeM hampir menyerupai Formula-SAE. Pertandingan ini mewakilkan sebuah projek yang berharga di mana ia menggabungkan kerja akedemik dan pembelajaran dengan pembangunan kemahiran praktikal kejuruteraan. Dalam membangunkan sebuah kereta lumba, salah satu komponen utama yang perlu diambil kira ialah struktur (kerangka). Objektif projek ini ialah menghasilkan rekabentuk konsep bagi struktur Formula Varsity UTeM. Kriteria rekabentuk yang digunakan dalam membangunkan struktur ini adalah berdasarkan kepada peraturan FSAE 2009, ergonomik,analisis beban dan faktor keselamatan. Perisian yang digunakan dalam projek ini ialah CATIA V5 R16. Terdapat 7 jenis konsep yang telah dikemukakan dalam kajian ini dan kaedah pemilihan digunakan untuk menentukan tiga konsep terbaik yang akan diteruskan dengan rekebentuk terperinci. Tiga konsep tersebut dipilih berdasarkan kriteria yang telah ditentukan dalam penilaian kaedah “Pugh”. Rekebentuk terperinci akan diteruskan kepada penggunaan Analisis Unsur Terhingga untuk menentukan satu rekabentuk yang terbaik dikalangan tiga rekabentuk yang telah dilukis. Rekabentuk tersebut akan akan dipilih sebagai rekabentuk terbaik yang mana telah mematuhi paiwaian dan peraturan SAE. Selepas itu, pengubahsuaian terhadap struktur akan dilakukan (jika perlu) bagi mengoptimumkan rekabentuk menjadi lebih sesuai dan akan berterusan sehingga tujuan untuk mencari rekabentuk yang sesuai dan terbaik untuk digunakan pada UteM Formula Varsity seterusnya tercapai

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CHAPTER 1

INTRODUCTION

1.1 Project Introduction

Formula Varsity is a student competition that initiate by Universiti Teknikal Malaysia Melaka (UTeM), in which a small formula style race car are designed and built. However, the concept and regulation of this competition is almost similar with Formula Student Automotive Engineers (FSAE) competition. The basic of the competition is that a fictitious company has contracted a group of engineers to build a small formula car. The competition has rules limiting the race car engine to a maximum displacement of 610cc with a single inlet restrictor. Other rules require that the car must also satisfy safety requirements such as having a side impact protection, main hoop and front hoop. The vehicle should have very high performance in terms of acceleration, braking and handling and be sufficiently durable to successfully complete all the events described in the Formula SAE Rules and held at the Formula SAE competitions (Formula SAE Rules, 2009).

This competition started at United States in year 1981. Then, in 1998, two cars each from the US and UK competed in a demonstration in UK, held at the MIRA Proving Ground. The initiative was considered to be very worthwhile in providing students with excellent learning opportunities and practical skills. The Institution of

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Mechanical Engineers (IMechE) agreed to be to manage the European venture in a partnership with SAE to make this competition succeed (Robinson B., 2004).

Formula SAE promotes careers and excellence in engineering as it encompasses all aspects of the automotive industry including research, design, manufacturing, testing, developing, marketing, management and finances. This project is rarely opportunity among the engineering student. Formula SAE takes students out of the classroom and allows them to apply textbook theories to real work experiences. It also realized the student about the work field live and to train them dare to face it after finish the study.

In 2004, Formula SAE has attracted entries from 66 different universities, from 19 different countries, from the UK, mainland Europe and from North America, Asia and Australia. For the universities, Formula SAE represents a valuable project that blends academic work and learning with the development of practical engineering skills. They are increasingly using it to attract school leavers to their degree programmers, and to forge closer links with industries. So, hopefully this project can be an initial step for UTeM to develop a Formula SAE car that can represent the UTeM as a World Class University (WCU) to the outside world.

1.2 Project Objective

The objectives of this project are to design and perform the structural analysis of single seater formula racing car for Formula Varsity UTeM car that satisfies the design criterions.

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1.3 Project Scopes

The scopes of this project are:

- Literature review on the design and structural analysis and ergonomic analysis of a single seater formula racing car.
- Conceptual design of single seater formula racing car
- Selection of the concept design
- Detail design using CATIA V5 R16 software.
- Structural analysis analysis using CATIA V5 R16 containing the total weight, acceleration, braking, cornering and torsional stiffness.
- Final design and justification.

1.4 Problem Statement

Formula Student Automotive Engineers is the platform for all engineering student especially design and automotive to show off their skill and knowledge in engineering. The concept behind Formula SAE is that a fictional manufacturing company has contracted a design team to develop a small Formula-style race car. The prototype race car is to be evaluated for its potential as a production item. Each student team designs, builds and tests a prototype based on a series of rules whose purpose is both to ensure onsite event operations and promote clever problem solving. By doing many testing and improvement to achieve the best design which is suitable for during race days.

The main problem which is occurring during conducting this project is the rules and regulation that should be followed for each team involvement. This rules and regulation formatted always change every year to ensure each team has to follow up the design into their racing car. The testing in calculation or software solving is the best ways to define the design to become more functional without disobeyed the FSAE rules.

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Designing and analysis the concept of the structure of Formula Racing Car is the main purpose of this project. The result of this project should be better than the existing design which is UTeM Formula Varsity Racing Car. The current design did not include the side impact protection that will be mentioned in the next chapter. The capacity of the engine used in FSAE should consider the 610cc as main requirement. However, in UTeM design just for 110cc capacity of engine. The design of formula racing car always expand to optimize and improvement to become the best of design. This situation will never end because the high profile event for example Formula 1 Grand Prix team always try to develop their design to find out the greatest car to compete among other competitor team.

1.5 Methodology View

In the initial steps, all the recommendation to design the structure will be studied such as the FSAE 2009 Rules, components to put inside the structure and the condition of the driver. After that, material for the structure will be selected according to the material's trait. Then, it will come out with lots of conceptual designs according to the best structure and FSAE regulation. After that, the best three will be selected and continue to the next step of detail designs which will be drawn in CATIA V5 R16 for 3D modeling. These detail designs will be analyzed using CATIA Analysis & Simulation *(Generative Structural Analysis)* to find out the best result in structural analysis among of those three designs that had been analyzed. Based on the result and the complexity for each designs, one of the designs will be selected to become the best design. Finally, it will be optimized and improved instead of the design structure and the comparison with continuously to be improving until it reaches the best design and satisfy the UTeM racing car development.

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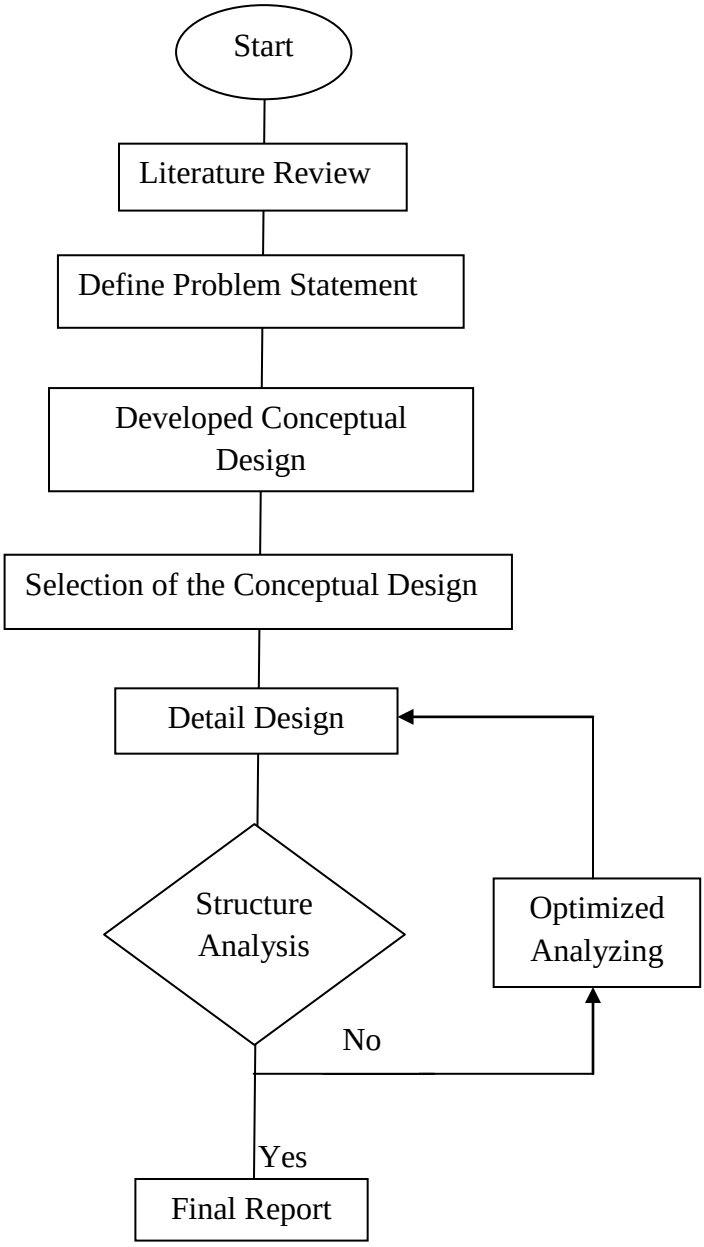

Figure 1.1 Methodology Chart

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CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This section explains some of the literature reviews about the race cars and structural analysis. It includes race car the chassis, structural design and analysis in Finite Element Analysis (FEA). This chapter consist based on the research and statement from the previous and it will be the guideline for this dissertation to continuous the finding of the result in designing and analysis the Structure of Single Seated Formula Racing Car.

The Formula SAE Series competitions challenge teams of university undergraduate and graduate students to conceive, design, fabricate and compete with small, formula style, autocross racing cars. To give teams the maximum design flexibility and the freedom to express their creativity and imaginations there are very few restrictions on the overall vehicle design. Teams typically spend a few period times to designing, building, testing and preparing their vehicles before a competition. The competitions themselves give teams the chance to demonstrate and prove both their creativity and their engineering skills in comparison to teams from other universities around the world.

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2.2 Chassis

The purpose of the auto chassis is to link up the suspension mounting points, final drive, steering, engine / gearbox, fuel cell and occupants. The auto chassis requires rigidity for precise handling, light weight to minimize both construction and running costs and inertia, and toughness to survive the quite severe fatigue loads imposed by the driver, road surface and power plant from statement of Fenton, 1980. This is the purpose required when the chassis design criteria that need to be considered before the design and analysis begin.

According to Owen & Bowen (1967), the original and oldest form of chassis used for thousands of years even before the invention of the wheel (a sled has a chassis). This is a clay model (probably a toy) from the Harappa Civilization (Indus Valley) from 4000 years ago.

Figure 2.1 Clay Model - 2000 BC
(Source: Owen & Bowen, 1967)

The platform chassis did not change much over the following 3800 years below is the Cugnot Steam Tractor, which was used for hauling heavy artillery during one of those indeterminable European wars that seem to have started when the Romans left and have continued until this day. However, this was also the beginning of the Industrial Revolution.

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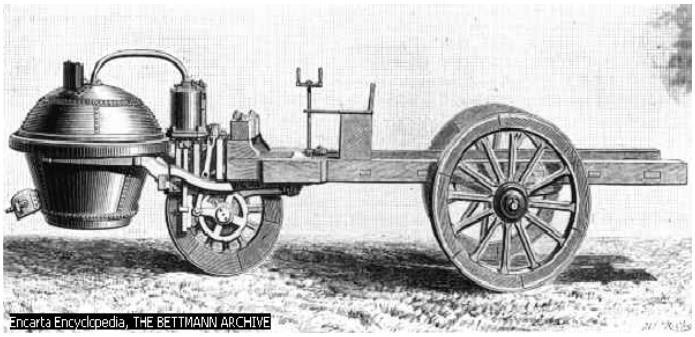

Figure 2.2 Cugnot Steam Tractor 1770 AD

(Source: Owen & Bowen, 1967)

This was a turning point in chassis design it was the first known selfpropelled road vehicle. The dynamics of this new development led to new and better things like the horseless carriage just over 100 years later said Anthony M O'Neill (2005).

Figure 2.3 The Horseless Carriage 1890 AD

(Source: Owen & Bowen, 1967)

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