



**NATIONAL TECHNICAL UNIVERSITY COLLEGE OF  
MALAYSIA**

**Design and Analysis Multi Purpose Vehicle  
(MPV) Chassis**

Thesis submitted in accordance with the requirements of the  
National Technical University College of Malaysia for the Degree of  
Bachelor of Engineering (Honours) Manufacturing (Process)

By

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Faculty of Manufacturing Engineering

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## KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA

### BORANG PENGESAHAN STATUS TESIS\*

JUDUL: DESIGN AND ANALYSIS MULTI PURPOSE VEHICLE (MPV) CHASSIS

SESI PENGAJIAN : 2/2005-2006

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## APPROVAL

This thesis submitted to the senate of KUTKM and has been accepted as fulfillment of the requirement for the Degree of Bachelor of Manufacturing Engineering (Honours) (Manufacturing Process). The members of the supervisory committee are as follows:



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## **ABSTRACT**

Recent, the foundation for the application of computers in the product development process is the development of models of products using computer-aided design (CAD). Throughout the life cycle of engineering products, computers have a prominent, often central role. In the process of product design and manufacture, this role is becoming increasingly important as competitive pressures call for improvement in product performance and quality, and for reductions in development time-scales. Computers assist design engineers to improve the productivity with which they carry out their work. Through simulation and analysis they allow the performance of a product to be evaluated before prototype is made.

This project is used to develop a research with a title 'Design and Analysis Multi Purpose Vehicle (MPV) Chassis' by concerning with the fundamentals of modeling process by which designs are defined using computers, and with exploration of applications of CAD. CAD is use to produce a detail drawing, simulation and conduct some analysis to the design. The chassis is designed to be able to contain the various components of an MPV. It is also designed to hold the driver, and hence the safety of the chassis has to be a major aspect of the chassis design.

The research of this study involved the application of reverse engineering in producing an MPV chassis. The main focus of this study is the methodology and the application of reverse engineering in a real situation of product development. The process will follow normal reverse engineering and design steps and procedure and also will look on ways to produce a new product by taking an existing part as a reference. In this study, the main property to be identified is a design process on how to design an MPV chassis.

## ABSTRAK

Pada masa kini, penggunaan komputer telah diaplikasikan di dalam proses pembangunan produk baru dengan menggunakan perisian rekabentuk. Komputer memainkan peranan yang amat penting di dalam kitar hayat kejuruteraan sesuatu produk. Di dalam proses merekabentuk dan pembuatan sesuatu produk, peranan komputer menjadi bertambah penting kerana dapat meningkatkan prestasi dan kualiti produk dan dapat menjimatkan masa pembangunan produk. Komputer telah mambantu para jurutera rekabentuk untuk meningkatkan produktiviti dimana komputer telah memudahkan kerja mereka. Melalui proses simulasi serta analisis, seorang jurutera dapat menyelesaikan masalah bagi sesuatu produk yang baru sebelum prototaip dibina.

Projek ini dijalankan bertujuan untuk membangunkan kajian yang bertajuk ‘Merekabentuk dan Menganalisis Casis Kenderaan Pelbagai Guna (MPV)’ dengan kesemua proses merekabentuk model dilakukan melalui penggunaan komputer serta aplikasi perisian rekabentuk produk dan perisian kejuruteraan produk. Perisian rekabentuk digunakan untuk menghasilkan lukisan kejuruteraan, melakukan simulasi serta analisis untuk rekabentuk yang telah dihasilkan. Casis direkabentuk untuk berfungsi sepenuhnya dimana dapat menyokong pelbagai komponen kenderaan pelbagai guna (MPV). Casis juga direkabentuk untuk membawa pemandu serta penumpang dan soal keselamatan adalah perkara yang amat dititikberatkan di dalam rekabentuk casis.

Kajian ini juga melibatkan aplikasi ‘*reverse engineering*’ di dalam proses pembangunan produk. Fokus utama di dalam projek ini ialah kaedah perlaksanaan dan aplikasi ‘*reverse engineering*’ di dalam situasi sebenar pembagunan produk. Proses perlaksanaan akan mengikuti langkah ‘*reverse engineering*’ serta prosedur rekabentuk dengan mengambil contoh produk di pasaran sebagai rujukan. Perkara utama didalam projek ini adalah untuk mengenalpasti proses merekabentuk casis untuk kenderaan pelbagai guna (MPV).

## **DEDICATION**

*To my beloved father, mother and family.*

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## List of Abbreviations, Symbols, Specializes Nomenclature

MPV	-	Multi Purpose Vehicle
CAD	-	Computer Aided Design
CADD	-	Computer Aided Design and Drafting
CAM	-	Computer Aided Manufacturing
CAE	-	Computer Aided Engineering
FEA	-	Finite Elements Analysis
N/A	-	Not Available
OSHA	-	Occupational Safety and Health Administration
HSS	-	High Strength Steel
QFD	-	Quality Function Deployment
PSM I	-	Projek Sarjana Muda 1
PSM II	-	Projek Sarjana Muda 2
PDS	-	Product Design Specification
N	-	Unit for Newton
N/m <sup>2</sup>	-	Newton per meter squire
N/mm <sup>2</sup>	-	Newton per milimeter squire
MPa	-	Mega Pascal
GPa	-	Giga Pascal

# CHAPTER 1

## PROJECT INTRODUCTION

### 1.1 Introduction

The multi purpose vehicle (MPV) is a passenger carrying vehicle that allows for the load- and passenger-carrying capabilities of a station wagon with a vaguely one box design like a van but with a difference being that the engine is in front of the axle where else with most vans, the engine is on top of the axle. Drivers and passenger of MPVs sit much higher than their fellow road-users, allowing a greater field of vision of their surroundings. There is also a greater feeling of security from the acres of metal, it's easy to feel more cosseted and secure on the road.

In recent years, the increasing popularity of multi purpose vehicle (MPV) in Malaysia is not surprising. Based on personal observation, it's evident that many car importers and distributors in Malaysia have at least one MPV in their stables.

The Malaysian automotive maker's must take part in a competition of delivering best MPVs for the growing market in not only in Malaysia but international. Almost all automotive maker's from Malaysia are still depending on technology and design from overseas. This will result to their price not competitive. So they need to design a localized part to cut the production cost.

The chassis is the one of the MPV part that Malaysia auto maker still depending on the design from overseas.

## **1.2 Problem statement**

The process to develop and design a chassis is not a simple process but very complex. That is why Malaysia auto maker take an easy way to produce their complete vehicle by using a design from oversea but at the same time they need to pay more as a royalty. The process in designing a chassis is very complex because the chassis is a main part of the vehicle and there is a need to consider the manufacturing process. The facilities that they have must support process to manufacture the chassis like the processes machinery, and experience workers. They must consider about economies scale which designed parts are capable of being used in multiple products, aim to standardize as much as possible and use a simple, low cost operation.

Application of DFX methodologies and reverse engineering will solve some of design issues at earlier stage of design process. DFX often referred to “design for X”, where X is some attribute such as manufacturing, assembly, reliability or affordability.

## **1.3 Objectives of the project**

The main objective of this project is to design the best chassis for MPV. To choose a best design, a variety of model chassis design will be develop in term of finding the best chassis appropriate for an MPV. As an example, integrated CAD/CAM/CAE software like CATIA V5 (produced by Dessault System) will help to reduce time of design and modifying the model and ease in analysing the model by applying the variable loads at any point of modelled. Then, last but not least the new model of chassis will be developed. Analysis should be based on actual conditions and testing of the vehicle.

## **1.4 Scope of the project**

The scope of the project is divided into 3 categories. They are:

- To produce detail drawings and simulations.
- To conduct Finite Element Analysis
- To produce Product Data Specification and Product Manufacturing Instruction

Focus is given on understanding what the client and users want and need from the design and later translated the client and user needs and their desires into terminology that help to find ways to realize those needs. Finally, to find a method to measure how well it is met.

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

##### **2.1.1 Multi Purpose Vehicle (MPV)**

**MPV** is short for Multi Purpose Vehicle. The term is becoming more popular in Asia and Malaysia; minivan is the nearest equivalent. An MPV is a passenger carrying vehicle based on a car platform, and is generally a one box design - neither a distinct bonnet nor boot but rather a maximized interior space. MPVs generally have a flat floor and removable seats except for the front row, and give great flexibility of seating arrangements and cargo capacity. The Renault Espace, launched in 1984 was the first MPV.

The North American concept of a "minivan" is very similar, except that the minivan classification implies a certain vehicle size while in Europe, MPVs vary in size quite a bit. Some MPVs are produced on quite small car chassis while others definitely fit within the minivan class; (Dictionary.LaborLawTalk.com, 2005)

### 2.1.2 Chassis

**Chassis** in this topic mean the rectangular, usually steel frame, supported on springs and attached to the axles, that holds the body and motor of an automotive vehicle.

**Basic (Stripped) Chassis** – an incomplete vehicle, without occupant compartment, that requires the addition of an occupant compartment and cargo-carrying, work performing, or load-bearing components to perform its intended function.

(Ford Motor Company).

**Chassis Cab** – an incomplete vehicle, with completed occupant compartment, that requires only the addition of cargo-carrying, work performing, or load-bearing components to perform its intended functions.

**Cutaway Chassis** – an incomplete vehicle that has the back of the cab cut out for the intended installation of a structure that permits access from the driver's area to the back of the completed vehicle; (Dictionary.LaborLawTalk.com, 2005)

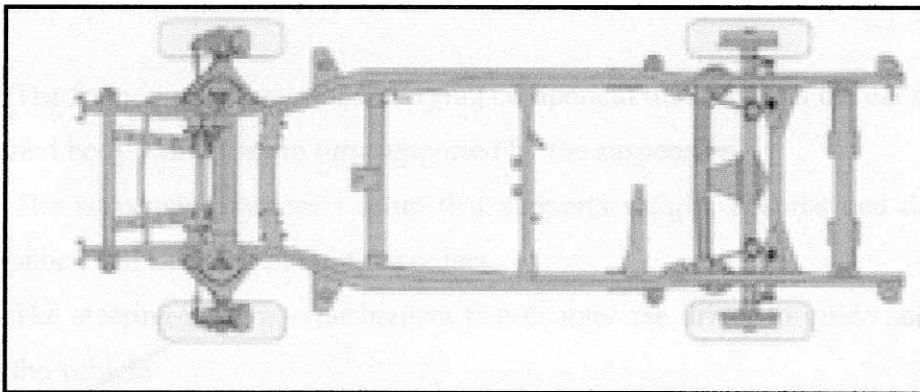


Fig. 2.1.2.1: Example: Chassis for Toyota Innova MPV; (UMW Toyota, 2005)

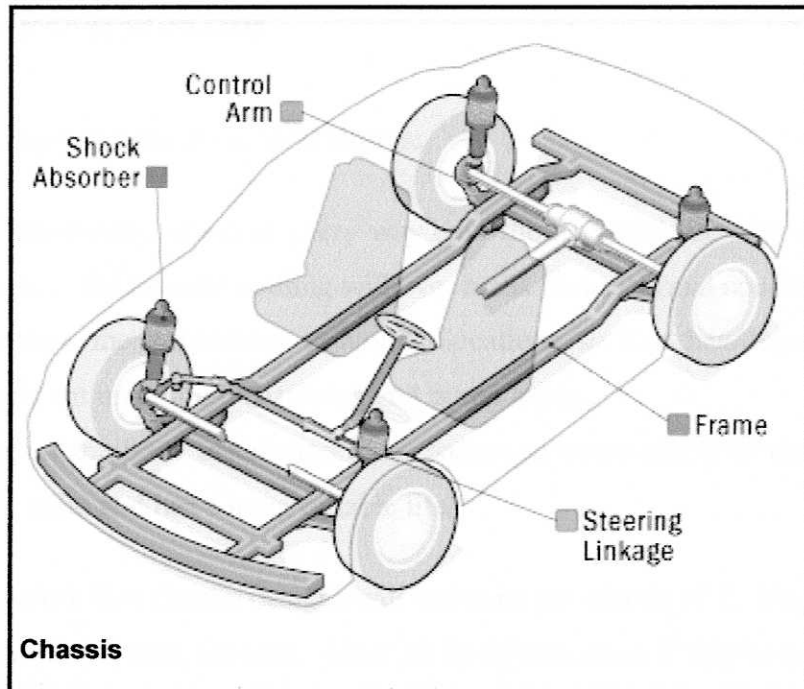


Fig. 2.1.2.2: Example of chassis (HowStuffWork.com, 2004)

The chassis systems include; (HowStuffWork.com, 2004)

- The frame - structural, load-carrying component that supports the car's engine and body, which are in turn supported by the suspension
- The suspension system - setup that supports weight, absorbs and dampens shock and helps maintain tire contact
- The steering system - mechanism that enables the driver to guide and direct the vehicle
- The tires and wheels - components that make vehicle motion possible by way of grip and/or friction with the road .

## 2.2 Criteria of good chassis

### **Any good chassis must do several things:**

1. Be structurally sound in every way over the expected life of the vehicle and beyond. This means nothing will ever break under normal conditions.
2. Maintain the suspension mounting locations so that handling is safe and consistent under high cornering and bump loads.
3. Support the body panels and other passenger components so that everything feels solid and has a long, reliable life.

In the real world, few chassis designs will not meet the criteria of 1. Major structural failures, even in kit cars, are rare. Most kit designers, even if they're not engineers, will overbuild naturally. The penalties for being wrong here are too great. The trouble is, some think that having a "strong" (no structural failures) chassis is enough.

Structural stiffness is the basis of what we feel at the seat of our pants. It defines how a car handles, body integrity, and the overall feel of the car. Chassis stiffness separates a great car to drive from what is merely good; (ERA Chassis, 2000)

Different basic chassis designs each have their own strengths and weaknesses. Every chassis is a compromise between weight, component size, vehicle intent, and ultimate cost. And even within a basic design method, strength and stiffness can vary significantly, depending on the details. There is no such thing as the ultimate method of construction for every car, because each car presents a different set of problems; (ERA Chassis, 2000)