



**NATIONAL TECHNICAL UNIVERSITY COLLEGE OF  
MALAYSIA**

## **Auto Retractable Roof**

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

**Mohd Salleh B Mat Yusop**

Faculty of Manufacturing Engineering  
December 2005


**KOLEJ UNIVERSITI TEKNIKAL KEBANGSAAN MALAYSIA**
**BORANG PENGESAHAN STATUS TESIS\***
**JUDUL: AUTO RETRACTABLE ROOF**
**SESI PENGAJIAN : 2005**
**Saya MOHD SALLEH BIN MAT YUSOP**

mengaku membenarkan tesis (PSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Kolej Universiti Teknikal Kebangsaan Malaysia (KUTKM) dengan syarat-syarat kegunaan seperti berikut:

1. Tesis adalah hak milik Kolej Universiti Teknikal Kebangsaan Malaysia.
2. Perpustakaan Kolej Universiti Teknikal Kebangsaan Malaysia dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. \*\*Sila tandakan (√)

 **SULIT**

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia yang termaktub di dalam AKTA RAHSIA RASMI 1972)

 **TERHAD**

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)

 **TIDAK TERHAD**

Disahkan oleh:

  
 \_\_\_\_\_  
 (TANDATANGAN PENULIS)

\_\_\_\_\_  
 (TANDATANGAN PENYELIA)

Alamat Tetap:

NO, 301, JALAN TIMUR,

FELDA TROLAK SELATAN,

35600 SUNGKAI, PERAK.

Cop Rasmi:

Tarikh: 5/DESEMBER/2005


Tarikh: \_\_\_\_\_

\* Tesis dimaksudkan sebagai tesis bagi Ijazah Doktor Falsafah dan Sarjana secara penyelidikan, atau disertasi bagi pengajian secara kerja kursus dan penyelidikan, atau Laporan Projek Sarjana Muda (PSM).

\*\* Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali sebab dan tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

## DECLARATION

I hereby, declare this thesis entitled “Auto Retractable Roof”  
is the results of my own research  
except as cited in the reference.

Signature :   
Author's Name : Mohd Salleh Bin Mat Yusop  
Date : 5 December 2005

## **APPROVAL**

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



.....  
Main supervisor

Faculty of Manufacturing Engineering

Zulkeflee b. Abdullah  
*Pensyarah*

Fakulti Kejuruteraan Pembuatan  
Kolej Universiti Teknikal Kebangsaan Malaysia  
Karung Berkunci 1200  
Ayer Keroh, 75450 Melaka.

## **ABSTRACT**

Auto retractable roof is a new accessory product that protect passenger or car user from the sunlight. Before beginning the design, the step of designing must be learning carefully. It is because there are a lot of steps to follow until the product can be produce. This is to give the comfortable to the consumer. To make this report and the prototype is successful, PDS and QFD concept are using. This concept is suitable for this project because this concept emphasize of the survey that performed bottom-up analysis from public requirement. This feedback gives all the data can make the design be more success and the design can be operate.

## ABSTRAK

"Auto retractable roof" ialah satu produk aksesori kenderaan yang terbaru yang mana fungsinya ialah melindungi pengguna kenderaan serta pemandu kenderaan dari terkena atau merasai kehangatan akibat pancaran cahaya matahari. Sebelum memulakan merekabentuk sesuatu, langkah mereka cipta mestilah difahami dengan jelas dan juga teratur. Ini adalah untuk memberi keselesaan kepada pengguna . Untuk menghasilkan projek dan juga prototaip yang baik, konsep PDS dan juga QFD digunakan. Ini adalah kerana ia amat sesuai disamping mementingkan keputusan pengguna yang telah mengisi boring kaji selidik dan ia dipanggil sebagai maklum balas dari pengguna. Dari maklum balas ini, segala data akan dikumpulkan dan dianalisis untuk menghasilkan reka bentuk yang baik serta kejayaan keatas kerja yang dijalankan. Untuk projek saya ini, saya akan mengikut segala langkah kerja yang telah ditetapkan sehinggalah prototaip dapat dihasilkan dan mematuhi segala laporan yang telah ditetapkan..

## **DEDICATION**

*For My family:*

*Mr. Mat Yusop Bin Rais,*

*Mrs. Isyah Binti Abdul Kahar*

*Mr. Zulkiflee Bin Mat Yusop,*

*Mrs. Azizah Binti Mat Yusop and Family,*

*Mrs. Siti Hajar Binti Mat Yusop and Family,*

*Ms. Sarina Binti Mat Yusop,*

*Ms. Nurul Naim Binti Mat Yusop.*

*Ms. Siti Zaharah.*

## ACKNOWLEDGEMENTS

To complete my Final Project II many of people around me give their assist. First, I would like to express my thanks thought to En. Zulkeflee B. Abdullah as my project supervisor who always gives of advice and thought me how to make this report success willing completely. En Zulkeflee always gives ideas, support, information valuable guidance.

This acknowledges goes to my best of my friends who give their cooperation. I would like thank whose produce directly or indirectly supported me. My special thanks goes to:-

1. Ahmad Syahrul Adli
2. Zulkifli Abdul Majid
3. Jaafar Sidek
4. Amirol Nozam
5. Helmy Rizal
6. Mohd Amir Syarifuddin
7. Muazam Shah
8. Mohd Shariman

Lastly, I would like dedicate to thanks to my family member in Sungkai, Perak because they gave me supported for my study and my project from beginning until finish.

Thank You.....



# TABLE OF CONTENTS

Declaration	i
Approval	ii
Abstract	iii & iv
Dedication	v
Acknowledgements	vi
Table of Contents	vii - x
List of Figures	xi
List of Tables	xii
List of Graph	ix
List of Abbreviations, Symbols, Specialized Nomenclature	x
<b>1. INTRODUCTION</b>	<b>1</b>
1.1 Background	1
1.2 Objective	2
1.3 Scope of the project	2
1.4 Summary	2
<b>2.LITERATURES REVIEW</b>	<b>3</b>
2.1 Temperature and heat	4
2.2 Motor	5
2.2.1 DC Brushless motor	5
2.2.2 DC Brushed motors	5
2.2.3 AC Synchronous motor	5
2.2.4 AC induction motors	6
2.3 Selection for motor	6
2.4. Choosing material.	7
2.4.1 Material 1	7
2.4.2 Material 2.	8
2.4.3 Material 3	8
2.4.4 Material 4	9

2.4.5 Material 5	10
2.4.6 Selecting the polyethylene fabric	10
2.5 Literature review of product design specification (PDS).	11
2.6 Literature review of quality functional deployment (QFD)	11
2.6.1 The QFD process	12
2.7 Summary	14
<b>3.0 METHODOLOGY</b>	<b>15</b>
3.0 Introduction	15
3.1 Product design specification (PDS)	15
3.2 Auto retractable roof for vehicle concept map	15
3.3 Construction of the concept map	16
3.3.1 Product title	19
3.3.2 Mission statement	19
3.3.3 Customer needs	19
3.3.4 New or special features	19
3.3.5 Competition	19
3.3.6 Intended market	19
3.3.7 Price	19
3.3.8 Functional performance	19
3.3.9 Service environment	20
3.3.10 Human factors	20
3.3.11 Performance	20
3.3.12 Material.	20
3.3.13 Assembly	20
3.3.14 Size	20
3.3.15 Weight	20
3.3.16 Design planning.	21
3.3.17 Design process	21
3.4 Quality functional deployment (QFD)	21
3.4.1 Overview of quality function deployment	22
3.5 Step 1. Customer requirement/ user need / benefit section	24
3.5.1 Planning matrix	25

3.5.2. Importance rating	26
3.5.3 Technical requirements	29
3.5.4 Interrelationship	29
3.5.5 Final step: determine co-relationship (Roof Top)	30
3.5.6 The House of quality	31
3.6 Summary	33
<b>4.0 PROJECT CASE STUDY/ANALYSIS</b>	<b>34</b>
4.1.0 Basic concept	34
4.1.1 Conceptual design idea 1.	34
4.1.2 Conceptual design idea 2	35
4.1.3 Conceptual design idea 3	36
4.1.4 Conceptual design idea 4	37
4.1.5 Final concept	38
4.2.0 Expanding idea and concept	38
4.2.1 Design selection criteria	39
4.3.0 Final design	40
4.3.1 Description of Auto Retractable of Auto Retractable Roof for vehicle	41
4.3.2 Auto Retractable Roof Advantages.	41
4.3.3 The Auto Retractable Roof Disadvantages.	42
4.4 Result from QFD method.	43
4.4.1 Location of the project.	43
4.4.2 Results from the survey	43
4.4.3 Feedback responses from the car user.	44
4.4.4 Respondent background.	44
4.4.5 Analysis graph using Excel	47
4.5 Result from the QFD capture.	59
4.6 Results for technical requirement after finish using the QFD software.	60
4.7 Summary	61

<b>5.0 TECHNICAL DRAWING</b>	62
5.1 Layout drawing.	63
5.1.1 Detail drawing.	64
5.1.2 Orthographic view.	65
5.1.3. Isometric view	66
5.1.4 Summary	66
<b>6.0 QFD CAPTURE SOFTWARE</b>	67
6.1.0 QFD software	68
6.1.1 The second step	69
6.1.2 The third step.	70
6.1.3 The fourth step	71
6.1.4 The final step.	72
6.1.5 The final result from this software.	73
6.1.6 Summary	73
<b>7.0 DISCUSSION</b>	74
<b>8.0 CONSLUSION</b>	75
<b>9.0 RECOMMENDATION</b>	76
<b>10. REFERENCE</b>	77
<b>APPENDICES</b>	
<b>A Technical Drawing</b>	
<b>B QFD capture software</b>	
<b>C Electronic Circuit.</b>	

## LIST OF FIGURES

2.1	The material analysis selection Multibond fabric	7
2.2	The material analysis selection (Technalon II Fabric)	8
2.3	The material analysis selection (Noah Fabric)	9
2.4	The four phases of QFD.	12
2.5	The important element in the HOQ	13
3.0	The Ladder concept Map for this project	17
3.1.	The house of quality.	23
3.2	QFD and software development life cycle	31
3.3	House Of Quality.	31
4.1	The conceptual design number 1	35
4.2	The conceptual design number 2	36
4.3	The conceptual design idea 3	37
4.4	The conceptual design number 4	38
4.5	The gender results	47
4.6	Results for the ages of the car user	48
4.7	The status of the user result	49
4.8	The status car results	50
4.9	The comfortable car user results	51
4.10	The Easy to handle results	50
4.11	The light condition results	52
4.12	The Easy transfer results	53
4.13	The firm results	54
4.14	The heating resistant results.	55
4.15	The graph for the price	56
4.16	The result from QFD capture software.	59

5.0	The 2D drawing	60
5.0	Detail drawing.	60
5.3	Orthographic View	61
5.4	Isometric view	62
6.1	The basic step which must be filling with the criteria.	65
6.2	The second step for the technical requirement.	66
6.3	The third step.	67
6.4	The requirement for the What's and WHY's list.	68
6.5	The shown the value has bee input in the column and value rating will be calculated to get the best results for the product which the requirement takes from the VOC.	69
6.6	The final results for the QFD Analysis using the QFD Capture software.	70

## **LIST OF TABLES**

3.0	The summary on important rating form respondent.	27
3.1	VOC requirement	28
4.0	Auto Retractable Roof idea.	39
4.1	The evaluation chart for the 7 comparable concepts.	40
4.2	Summary of respondent (car user in 100 respondents)	44
4.3	Summary of response from customer survey for Auto Retractable Roof.	45
4.4	Summary of Responses importance from the car user.	46
4.5	Priority Technical Requirement of Auto Retractable Roof	60

# **LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE**

DC	-	Direct current
PDS	-	Product Design Specification
QFD	-	Quality Functional Deployment
HOQ	-	House of Quality.
VOC	-	Voice of Customer



# CHAPTER 1

## INTRODUCTION

### 1.1 Background

The purpose of this project is to develop and design the component of Auto Retractable Roof. Therefore, the approach of the design that features here could be use or implement for a car especially. Auto Retractable Roof is the alternative can be used to cover the car from the sunshine effect. This application can be used as a new alternative for car covers when we park our cars under sunshine. The retractable is used to save the body of the car from corrosion and at the same time save the passenger from the heat after park under sunshine with high temperature that is about  $36.5^{\circ}\text{C}$ . Further, this product uses the motor to generate the roof before were engine car switch off. Then, the power is used to move the motor. Finally, the motor is used to generate the mechanical system of the retractable roof with the material from the cover of the car between the roof and the mirror.

Auto Retractable Roof is the new idea for the accessory of vehicle that combined from battery and the retractable sunshade to produce power. This is more suitable for a long period when park under the sunshine, which compare to other car cover in market nowadays. It also can be used for hanging around or fun purposes using the remained car cover at the roof. The standard cars cover categories:

Class A: Full- Fully covers a car.

Basically this product uses in the local market and also don't use the motor to generate the cover. This is the basic of the car cover, and use the High Performance fabric.

## **1.2 Objective**

- i. Come out for new accessories of a car.
- ii. Design a new concept of auto retractable roof of vehicles.
- iii. Use design methodology
- iv. Doing QFD to get input from possible user and obtain the info about what they want so we can design and fabricate accordingly.

## **1.3 Scope of the project**

- i. Study the capabilities of the existing product,
- ii. Literature survey,
- iii. Proposed a futuristic or a new design of Auto Retractable Roof.

## **1.4 Summary**

From the introduction the conclusion are the Auto Retractable Roof is the news accessories for vehicle that can used by the car user to protect them from heat in the car while they park their car under the sunshine. For this project, it will be used the Product Design Specification (PDS) and Quality Functional Deployment (QFD) to get the design and the results. In this semester, the main of objective is to develop the product by used QFD which to refined the design while used the PDS. At the last, these projects try to achieve the objective for this semester.

## CHAPTER II

### LITERATURE REVIEW FOR AUTO RETRACTABLE ROOF.

This chapter includes all the information about the Auto Retractable Roof. Automobiles, like the earth's atmosphere, are subject to the so-called "greenhouse effect." When short-wave heat radiation from the sun travels through the glass windows and hits material inside the car, the interior heats up, and the heat is trapped inside.

Cars also get hot because the sun heats up the roof of the vehicle and the heat conducts inward. The thickness of the insulation in the roof and walls of most cars and trucks is a fraction of what is used in the attics of most buildings.

The results of these two effects are that the temperature of the interior of automobiles that parked in bright sun in hot climates can rise to more than  $\pm 36.5^\circ$ . After existing this condition for a while, not only the air in the car very hot, but all of the material in the interior of the car (dashboard, seats, arm rests, etc.) are as well - even to a depth of several inches are also heated. When a driver enters the car, it can takes 10-20 minutes for even the best automobile air conditioners to cools the space around the driver to a comfortable temperature. If there are several passengers and the air conditioner vents are directed at all of them, the cool-down time can take at 30-40 minutes.

Several devices have been developed to reduce the heat build-up in cars. Some of these are listed as follows:

- **Tinted glass.** This helps reduce the green house effect somewhat, but does nothing to reduce the inward conduction of heat from the roof.
- **Windshield reflectors.** These are positioned inside the windshield to reflect the short-wave heat radiation back out through the windshield. The sun

continues to enter through the other windows and, these reflectors do nothing to stop the heat conducting through the roof.

- **Increased insulation.** The auto retractable roof will protect car user from the heat and Ultra Violet.
- **Traditional automobile covers.** These are effective to the extent that they stop the short-wave heat radiation, but they are trouble to put on and take off a car and are rarely used.

## 2.1 Temperature and Heat

An object temperature is a measurement that describes the level of motion and vibration in the atoms and molecules of which it is composed (that is, the internal energy of the atoms and molecules). The higher the temperature of the object, the more vigorously its atoms and molecules move around and bounce off each other and the more disorderly is their motion. This means that heat flowing into an object increases the internal energy and disorder in that object, while heat flowing out of it decreases its internal energy and disorder. For example, the water molecules in a snowflake are arranged in an orderly pattern. If you hold a snowflake in your hand, it will melt and become a drop of water. While it melts, the orderly pattern of the snowflake is changed into the more disorderly form of liquid water. . In general, heat passes from one substance or object to another by:

### i. Conduction

- Heat moves through material without any of the material moving.
- E.g., the tip of a metal pitchfork placed in a fire:

Vibration of atoms is transmitted from the tip throughout the pitchfork, but none of the atoms move from the tip to other parts of the pitchfork.

### ii. Convection

- Heated material moves and carries heat with it.
- E.g., heating water in a pot on a stove: hot liquid from the bottom of the pot rises up, while cold water sinks down to be heated.

### iii. Radiation

- Heat is transmitted via electromagnetic radiation, either through a medium (such as air) or without need for material (e.g., through space).
- E.g., infrared rays, ultra violet.

## 2.2 Motor

There are four types of motor that always been used to move the roof, there are *DC Brushless Motors*, *DC Brushed Motors*, *AC synchronous Motors*, and *AC Asynchronous Motors* or *AC Induction Motors*.

### 2.2.1 DC Brushless Motor

Dc Brushless Motor is the most popular among the other motor where it use a power or energy from *rare-earth permanent magnets* such as *samarium cobalt* or *neodymium-iron-boron*, which placed inside the rotor. The wire-circle in the stator is to produce torque to the motor. Then the power will rotate the motor. This motor is compact, non-heavy, and gives the high efficiency around 92% to 96 %. Because of the wire-circle in the stator, the cooling process is more efficient and ratio power per weight is high. This type also has high peak torque value while the wire-circle can control the current without occur superheated. (Raman, S., 2000)

### 2.2.2 DC Brushed Motors

This motor is also popular instead of *DC Brushless* type. The mechanism system of this motor is same to the DC Brushless motor except the wire-circle has been placed in the rotor and the magnet placed in the stator. The disadvantage of this motor is instead of non-compact, is heavy and produced low efficiency than *DC Brushless* motor. The efficiency is less than 90 %. This motor required high maintenance compared than *DC Brushless* type. But then, the cost of this motor is low. (Raman, S, .2000)

### 2.2.3 AC Synchronous Motors

This motor is same with *DC Brushless* type. The magnet and the wire-circle are in the same location with *DC Brushless* motor. But, this motor needs a converter to change

direct current (DC) to (A.U). The motor has the same character to DC Brushless motor; it also compact, light and can produce high peak torque value. The efficiency of this motor is about 97%-98 % (Raman, S., 2000).

#### **2.2.4 AC Induction Motors**

Also known as *Squirrel cage* motor using simple rotor with iron core. The rotation (usually 3 phase) could produce electric current in the core and formed magnetic field inside the rotor. To increase the efficiency, the rotor has been divided into several segments. AC Induction motor is one of the simplest motor, low-priced, and also don't suitable for this prototype because a car use the DC motor.

#### **2.3 Selection for Motor.**

In this project, I will choose the DC motor to generate my retractable roof. It is because this motor is connected to the battery from the car and there is in Direct Current. So, for this project, I will use this motor. DC Brushless motor is the most popular among the other motor where it use a power or energy from *rare-earth permanent magnets* such as *samarium cobalt* or *neodymium-iron-boron*, which placed inside the rotor. The wire-circle in the stator is to produce torque to the motor. Then the power will rotate the motor. This motor is compact, non-heavy, and gives the high efficiency around 92% to 96 %. Because of the wire-circle in the stator, the cooling process is more efficient and ratio power per weight is high. This type also has high peak torque value while the wire-circle can control the current without occur superheated. (Raman, S., 2000)

This motor are same use at the sunshade in the car (Proton Wira) and this motor are not to be heavy, light and the same time less use the cooling system after we implement this prototype. The characteristic for this motor:-

- i. 12Volt
- ii. 4Watt
- iii. Low torque
- iv. Cheap

## 2.4. Choosing Material.

Auto retractable roof are design to make your save from the sunshine and to protect the paint of our car. Beside this, we can see many people just using the manual sunshade to put at the window. In case, the sunshine is designed to compliment at top of car.

### 2.4.1 Material 1.



Figure 2.1: The material analysis selection Multibond fabric

#### **MULTIBOND:**

1. Multibond is a light-duty version most popular fabric Evolution (Technalon) to cover a car.
2. It is similar in structure to Evolution, but is three layers of bonded polypropylene rather than four.
3. Deterioration from ultraviolet (UV) exposure.

#### **Good:**

1. It rolls up much more tightly than Evolution, although not as tightly as Ultralon.
2. It's moderately water resistant and it is the least expensive of all the car cover fabrics.
3. Cheap.

#### **Bad:**

1. It is difficult to handle in a breeze.

## 2.4.2 Material 2.

### EVOLUTION IV (TECHNALON II)



Figure 2.2: The material analysis selection (Technalon II Fabric)

Same material as Multibond which is a four-layer bonded polypropylene fabric

#### **Good:**

1. Water-resistant.
2. Due to its thickness, it offers some resistance to parking lot dings.
3. Mid-priced
4. Evolution is available in three colors (tan, blue, and grey) in custom patterns.

#### **Bad:**

1. It folds up extremely large.
2. Compressibility is miserable with a new one for only the cost of shipping.

## 2.4.3 Material 3. NOAH:



Figure 2.3: The material analysis selection (Noah Fabric)

- NOAH is the newest bonded polypropylene fabric.