“Saya akui bahawa saya telah membaca karya ini dan pada pandangan saya karya ini adalah memadai dari segi skop dan kualiti untuk tujuan penganugerahan Ijazah Sarjana Muda Kejuruteraan Mekanikal (Rekabentuk & Inovasi)”

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DESIGN THREE DIMENSIONALLY ADUSTABLE HEAD REST (TDAHR) FOR CAR SEATS.

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"Saya akui laporan ini adalah hasil kerja saya sendiri kecuali ringkasan dan petikan yang tiap-tiap satunya saya jelaskan sumbernya"

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ABSTRACT

The purpose of this study is to investigate and design the new Head Rest. The parameters measured from the test head rest are strength, tensile and safety. The purpose of this study is also to design three dimensionally adjustable head rest (TDAHR). In an automobile, the headrest is a device attached to the top of the seat behind the occupant's head. Headrests are featured mainly for comfort as well as safety, as they can break the backlash movement of the occupant's head during a collision; thus preventing potentially fatal neck injury. Headrests became a common safety feature in most automobiles during the 1970s. Today, most headrests are cushioned for comfort, height adjustable and most commonly finished in the same material as the rest of the seat.

Correct vertical adjustment of head rests reduces the risk of soft tissue neck and back injury during a rear-end crash. Whiplash or soft-tissue injuries, defined as a sprain of the neck or back, account for approximately 70% of all injuries reported annually. ICBC surveys show that about 60% of vehicles on the road have improperly adjusted head rests. The current headrest is design to protect the head and neck injury. However this device should be innovating to make the consumer fell more comfortable will drive and needs more ergonomic. The current headrest just can adjustable upward and downward only. Some easy automate mechanism should be implemented to improve the current product. As summary, I will produce the new three dimensionally adjustable head rest (TDAHR) for car seats that will help the consumer and improve the existing product.

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LIST OF ABREVIATIONS

TDAHR	:	Three Dimensionally Adjustable Head Rest
CAD	:	Computer Aided Design
CAM	:	Computer Aided Manufacturing
CT	:	Computed Tomography
FDM	:	Fused Deposition Modeling
FEM	:	Finite Element Analysis
FMVSS	:	Federal Motor Vehicle Safety Standard
IGES	:	Initial Graphics Exchange Specification
GVWR	:	Gross Vehicle Weight Rating
GSA	:	General Services Administration
UVA	:	University of Virginia
NHTSA	:	National Highway Traffic Safety Administration
MCW	:	Medical College of Wisconsin
RID	:	Rear Impact Dummy
IIHS	:	Insurance Institute for Highway Safety
LAN	:	Local Area Network
LOM	:	Laminated Object Manufacturing
PC	:	Programmable Computer
3D	:	Three-Dimensional
3DP	:	Three Dimensional Printing

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CHAPTER 1

INTRODUCTION

In an automobile, the headrest is a device attached to the top of the seat behind the occupant's head. Headrests are featured mainly for comfort as well as safety, as they can break the backlash movement of the occupant's head during a collision; thus preventing potentially fatal neck injury. Headrests became a common safety feature in most automobiles during the 1970s. Today, most headrests are cushioned for comfort, height adjustable and most commonly finished in the same material as the rest of the seat.

Figure 1.0 The headrest in automobile

Correct vertical adjustment of head rests reduces the risk of soft tissue neck and back injury during a rear-end crash. Whiplash or soft-tissue injuries, defined as a sprain of the neck or back, account for approximately 70% of all injuries reported annually. ICBC surveys show that about 60% of vehicles on the road have improperly adjusted head rests. The current headrest is design to protect the head and neck injury. However this device should be innovating to make the consumer fell more comfortable will drive and needs more ergonomic. The current headrest just can adjustable upward and downward only. Some easy automate mechanism should be implemented to improve the current product.

As summary, I will produce the new three dimensionally adjustable head rest (TDAHR) for car seats that will help the consumer and improve the existing product.

1.1 Problem statement

The major problem being determined to make sure the design is useful, ergonomic and safety.The problem of this designing this (TDAHR) is about the mechanism that to be used to make sure this project has delivered its objective. The mechanism that been used in current product is actually to make the headrest move upward and downward only. This causes the driver fill not comfortable, the drive have their way to fill comfortable will driving such the headrest can adjustable like the way they want. Here still have a problem from the existing product, the problem is:

- It just can move upward and downward.
- Design of the headrest is limited such a movement, shape and fabric.
- The cost to make the headrest more durability, comfortable and adjustable is to expensive cause many mechanisms have to apply on it, so the cheep cars will not have it.
- No ergonomic cause from the studied the important part to make the driver fill comfortable is rest at the neck not 100 % at the head.
- No safety cause the existing product 100 % focus on safety of head but not focus safety will driving, when the drive not fill comfortable will driving their will face with more risk.

1.2 Objective

On this design it have an objective to make sure it achieve its goal in order from solving some major problem in a real life situation. Some objective that being list below are:

a) To solve the mechanism that will produce the three dimensionally adjustable head rest (TDAHR).To make the headrest can move like shows in Figure 1.1.

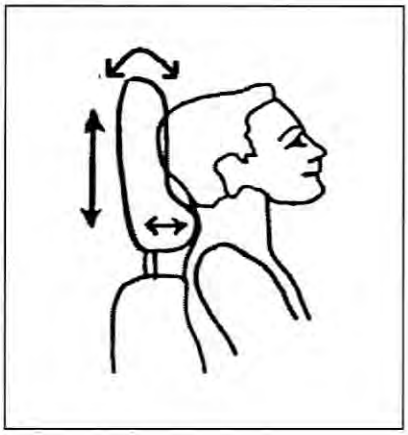

Figure 1.1 The way of adjustable will made

b) To create and design a new concept of headrest device include the value of safety and ergonomic.

c) Applied the process of understanding especially on mechanisms design of the headrest device.

1.3 Scope of Project

This project is target to be updating the current product. The (TDAHR) is produce to make the new headrest with three dimensionally adjustable help the consumer fill comfortable and more safety. This project is basically is to design and fabricate new device that upgrade the current product. All the studies been made are in the range off those scope.

1.4 Thesis Outline

This part will summarize all the chapters contain in this first draft.

Chapter 1:
This chapter contains the introduction, problem statement, objective, and scope of project. It summarizes the basic information about the project which will be performed and the objective of this project.

Chapter 2:
This chapter concludes all the research that has been done to provide ideas and specification as a guideline to produce the design.

Chapter 3:
This chapter summarizes the flow processes that have been planned for this project.

CHAPTER 2

LITERATURE STUDY

In this chapter, some researchers have been performed to obtain some information which might able to help to perform the final project and design the concept. Moreover, all this information gain shall guide me throughout this project and make me know the client or customer needs and solve their problems. In this part, contain all the information that has been gathered from the research that has been performing before. Since January 1, 1969, passenger cars have been required by Federal Motor Vehicle Safety Standard (FMVSS) No. 202 to provide head restraints that meet specified requirements for each designated front-outboard seating position. On September 1, 1991, FMVSS No. 202 requirements were extended to trucks (LTs), multipurpose passenger vehicles (MPVs), and buses with a gross vehicle weight rating (GVWR) of 10,000 pounds or less. The standard requires that either-of-two-conditions-be-met:

1.) During a forward acceleration of at least 8g on the seat supporting structure, the rearward angular displacement of the head reference line shall be limited to 45 from the torso reference-line;-or
2.) The head restraint must measure at least 27.5 inches above the seating reference point, with the head restraint in its fully extended position. The width of the head restraint, at a point 2.5 inches from the top of the head restraint or at 25 inches above the seating reference point, must not be less than 10 inches for use with bench seats and 6.75 inches for use with individual seats. The head restraint must withstand an increasing rearward load until there is a failure of the seat or seat

back, or until a load of 200 pounds is applied. When the load reaches 120 pounds, the portion of the head form in contact with the restraint must not exceed a rearward displacement.

Three types of head restraints have been utilized to meet the requirements of FMVSS No. 202:

a) Integral head restraints -- This system consists of a seat back high enough to meet the 27.5 inch height requirement. There is a variety of integral head restraint designs (Figure 2.0).

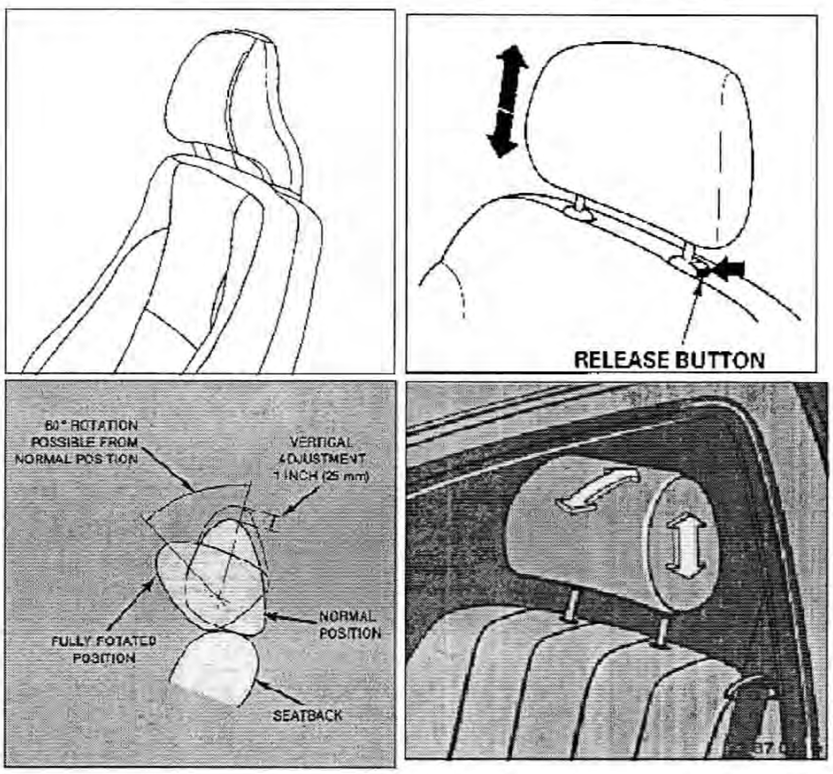

Figure 2.0 Adjustable Head Rest

b) Adjustable head restraints -- This system consists of a separate head restraint pad that is attached to the seat back by sliding metal shaft(s). The occupant may adjust the restraint to the top, bottom, or intermediate positions. Some restraints allow angular rotation (Figure 2.0). The angular adjustment feature allows the occupant to adjust the restraint closer to the rearmost portion of the head.

c) Fixed or "built-in" head restraints

A "built-in" head restraint is actually the upper part of the vehicle seat back and is not adjustable. If the seat back is at least level with the top of the ears, or higher, the back of your head and neck will be supported in case your vehicle is rear-ended.

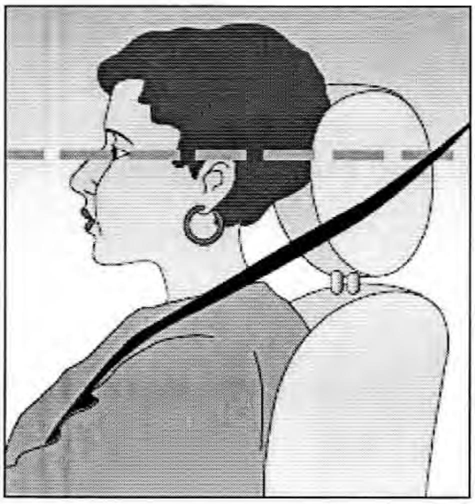

Figure 2.1 Head position at Head Rest

2.2 Adjusting your head restraint

- Raise the head rest so the top is at least level with the top of the ears, higher is even better.
- Your head rest should be less than 10cm from the back of your head. Closer head restraints can be twice as effective in preventing injuries as those which are set too far back.
- Make the adjustment every time you ride in a vehicle that is equipped with adjustable head rest.
- In addition to sufficient head restraint height, the best protection is provided when the distance between the back of the head and the restraint is as small as possible. Consider this additional safety feature when purchasing your next vehicle.

2.3 Biomechanical Aspects of Neck Injuries and Head Restraint Design

2.3.1 Neck Anatomy and Range of Motion

When a vehicle is struck from behind, the vehicle is accelerated forward and the raised head restraint stops the head and neck from extending backwards on impact, reducing the risk of soft tissue injury. The skeletal structure of the neck is comprised of seven cervical vertebrae defining the top of the spine between the thorax and skull. The vertebrae are numbered from C1 to C7 as they descend the neck. The C1 vertebra is named the atlas and provides the bearing surface upon which the skull rests. The superior surface of the atlas and the occipital condoyle of the skull form a synovial joint. This joint allows up/down movement of the head which is exemplified by the 'yes' gesture. Another synovial joint is formed by the atlas and the axis (C2 vertebra). This allows rotation of the head from left to right about the axis of the neck exemplified by the "no" gesture. The remainders of the vertebrae are separated by fibro cartilaginous discs. The vertebrae are tied together by many anterior (front) and posterior (rear) ligaments which run the length of the spinal column. The skull, torso and vertebrae are connected by multiple muscles which are symmetric about the midsagittal plane. Movement of the head with respect to the torso is provided by these muscles.

The following terms are used to describe neck kinematics. The term flexion refers to the combined translation and rotation of the head/neck complex forward and down in the midsagittal plane. Extension is the movement rearward and down in the same plane. Lateral flexion is the translation and rotation of the head/neck complex in the medial lateral or transverse plane. Rotation is as described above. If the prefix "hyper" is used with these terms it means motion beyond the normal or voluntary range.

2.3.2 Head Restraint and Seat Design as Related to Neck Injury Mechanisms

In a 1957 study, a head restraint design was proposed to minimize neck injury. The study proposed that a padded 6-inch fixed head restraint be attached to the top of automobile seat backs for neck protection . The General Services Administration (GSA) Standard 515/22 Head Restraints for Automotive Vehicles , went into effect in October of 1967 for vehicles purchased by the federal government . It required that the head restraint be adjustable to 27.5 inches above the H-point and be between 1 and 4 inches behind the torso line. The preamble of the final rule contains no details as to the selection of this parameter, but states that this standard, along with the other GSA automotive standards were "developed through consultation with Government agencies, the medical profession, trade associations, technical societies, and the automotive industry".

In 1967 Severy et al., performed 12 full scale dynamic rear impact crash tests using pairs of identical Ford sedans at impact speeds of 10, 20, 30, 40 and 55 mph. Seat back heights of 22 and 25 inches were used along with seat backs and seat back/head restraint combinations of 28 inches. Seat heights were measured from the undeformed seat surface along the seat back. This was believed to be equivalent to measuring from the H-point. In part, the research was aimed at determining the "lowest seatback consistent with effective protection from whiplash". It was concluded that a 28 inch seat back provided "adequate protection against the injury producing forces of most rear-end collisions", even for 95th percentile males. Results showed that in a 30 mph impact, with a 28 inch seat and the test dummy positioned with a 3 and 6 inch backset, the test dummy's rearward head rotation was 16 and 24 degrees, respectively. Kahane presented anthropometric information to support the idea that a 27.5 inch head restraint provides adequate support for the head and neck of a 50th percentile male (70 inch tall) . Adequacy of height was measured against the restraint's presumed ability to reduce whiplash caused by neck hyperextension. Kahane made the following assumptions. *"A head restraint or seat back should come close to achieving its full benefit if it is high enough to reach beyond the top of the occupants neck - i.e., up to the skull. Additional seatback height would provide little additional restraint. The seatback would provide little or no protection if it fails to reach even the bottom of the occupant's neck. If the seat back reaches somewhere between the top and bottom of the neck, it would presumably give an intermediate amount of protection".*

a) Kahane theorized through a statistical model for a 70 inch occupant; the erect seating
b) height to the base of the skull of a 50th percentile male is about 27.5 inches above the chair base; b) people slouch between 0 and 2.5 inches; and c) the length of the neck is about 4 inches, head restraint with heights below 22 inches have almost no benefit and above 27.5 inches have almost full benefit.