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**DEVELOPMENT OF
THREE WHEEL CAR FOR DISABLE PERSON**

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Bachelor of Mechanical Engineering**

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ABSTRAK

Tesis ini membentangkan tentang rekabentuk dan juga pengubahsaiian untuk membangunkan kriteria kereta roda tiga untuk pesakit kurang upaya. Kereta roda tiga telah digunakan secara meluas pada masa kini, bukan sahaja untuk pesakit kurang upaya, malah digunakan juga oleh manusia biasa. Kriteria untuk pesakit kurang upaya ini ialah pesakit strok yang kurang upaya di bahagian kanan tangan dan kaki, berumur di antara 21 hingga 50 tahun, jantina lelaki ataupun perempuan, ketinggian di antara 120 ke 180 sentimeter di mana ketinggian tersebut adalah ketinggian purata bagi seluruh rakyat Malaysia, dan mereka terdiri daripada pesakit yang hampir 80% sembuh daripada penyakit strok tersebut. Satu sesi soal jawab telah dilakukan terhadap pesakit-pesakit strok untuk mereka memilih model kereta roda tiga yang bagaimana yang sesuai dan selesa bagi mereka. Mereka perlu menjawab soalan-soalan berkaitan dengan model kereta roda tiga dan ciri-ciri yang perlu ada pada kereta tersebut seperti jenis dan saiz pintu, jenis stereng, kedudukan tempat duduk kereta dan beberapa ciri lagi seperti yang kita boleh lihat dalam bahagian 4 tesis ini nanti. Jawapan-jawapan dari hasil soal jawab itu nanti akan dianalisis untuk memilih model dan ciri-ciri yang paling sesuai bagi pesakit kurang upaya. Rekabentuk kereta ini akan dilukis menggunakan perisian SolidWork di mana perisian ini merupakan perisian yang sesuai untuk melukis model kereta dalam tiga dimensi.

ABSTRAK

Tesis ini membentangkan tentang rekabentuk dan juga pengubahsaiian untuk membangunkan kriteria kereta roda tiga untuk pesakit kurang upaya. Kereta roda tiga telah digunakan secara meluas pada masa kini, bukan sahaja untuk pesakit kurang upaya, malah digunakan juga oleh manusia biasa. Kriteria untuk pesakit kurang upaya ini ialah pesakit strok yang kurang upaya di bahagian kanan tangan dan kaki, berumur di antara 21 hingga 50 tahun, jantina lelaki ataupun perempuan, ketinggian di antara 120 ke 180 sentimeter di mana ketinggian tersebut adalah ketinggian purata bagi seluruh rakyat Malaysia, dan mereka terdiri daripada pesakit yang hampir 80% sembuh daripada penyakit strok tersebut. Satu sesi soal jawab telah dilakukan terhadap pesakit-pesakit strok untuk mereka memilih model kereta roda tiga yang bagaimana yang sesuai dan selesa bagi mereka. Mereka perlu menjawab soalan-soalan berkaitan dengan model kereta roda tiga dan ciri-ciri yang perlu ada pada kereta tersebut seperti jenis dan saiz pintu, jenis stereng, kedudukan tempat duduk kereta dan beberapa ciri lagi seperti yang kita boleh lihat dalam bahagian 4 tesis ini nanti. Jawapan-jawapan dari hasil soal jawab itu nanti akan dianalisis untuk memilih model dan ciri-ciri yang paling sesuai bagi pesakit kurang upaya. Rekabentuk kereta ini akan dilukis menggunakan perisian SolidWork di mana perisian ini merupakan perisian yang sesuai untuk melukis model kereta dalam tiga dimensi.

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LIST OF SYMBOLS

B	Hip-Point to Accelerator Heel Point
A	X-distance from Hip Point to Ball of Foot Point
x	Reference line
Θ	Pedal plane angle

LIST OF ABBREVIATIONS

2F1R	2 front 1 rear
1F2R	1 front 2 rear
F3	Formula 3
TriRod	Three-wheeled straddle-mount motorcycles with two wheels in front and one in the back
kph	Kilometres per hour
mph	Miles per hour
MPV	Multi-purpose vehicle
2D	Two dimensional

CHAPTER 1

INTRODUCTION

1.1 PROJECT BACKGROUND

Nowadays, the statistic of people get stroke per year increase rapidly. Stroke killed 143,579 people in 2005. It's the third largest cause of death, ranking behind "diseases of the heart" and all forms of cancer in the world. Usually stroke will cause death and also permanent disability. For people who got stroke, they have problem to move. Usually they use wheelchair to move but for the long distance journey they face the problem to drive a car in handling, parking and also not enjoy the journey. They need someone to drive them every day. So, for this problem I design and develop a Three Wheel Car which is user friendly for person who got stroke.

A three-wheel car is, by design, basically a triangle shape. Depending on where the passengers sit, the location of the engine, and the placement of other critical mechanical components, this means the car either has two wheels up front and one in the rear or two wheels in the rear and one up front. The engine can drive the single rear wheel or the two rear wheels, and the steering can be done either way as well.

Having one wheel up front and two in the back is known as the delta configuration. Karl Benz's creation followed this setup, as did the Reliant Robin. The original three-wheeled Mazda automobile, the Mazda-Go, was configured this way to allow for a pickup truck bed in the back. The benefit to the delta setup is its inherent low cost. Most cars set up this way have the engine driving the rear wheels and leave steering to the front one. It's relatively easy to build a steering setup with only one wheel.

The second type of three-wheeler setup is called the tadpole or reverse trike. The opposite of the delta, this formation has two wheels up front and one in the back. This setup is the basis for the speedy Campagna Motors T-Rex, as well as the exciting Volkswagen GX-3 concept vehicle. Tadpole designs are much more stable than the delta setup because the back wheel drives the vehicle while the two wheels up front are responsible for steering. There's also an aerodynamic benefit, since the vehicle is shaped almost like a teardrop. This allows air to flow easily over the vehicle's bodywork.

For my invention I prefer the delta type. I choose this type of three wheel car not because of its stability but more to handling. For delta shape the handling wheel is only one thus improve the handling. To improve the stability three wheelers are designed as tilting three wheelers so that they lean while cornering like a motorcyclist would do. The tilt may be controlled manually or by computer. Electric three-wheelers often lower the center of gravity by placing the heavy battery pack at the base of the vehicle. This type of three wheel car is more fun driving and also can be consider as stroke user friendly.

1.2 PROBLEM STATEMENT

- i. The disable person still wants to live their life as normal person. Go to work as always and also do the job by their own.
- ii. Disable person (Hemiplegic/Hemiparetic Patients) faces problems in driving car in term of handling because of limited abilities.
- iii. The three wheel motorcycle is not safe enough for the disable person.

1.3 OBJECTIVE OF THE PROJECT

- i. Design and develop a three wheel car that user friendly to Hemiplegic/Hemiparetic patients.
- ii. Analyze the mechanism design.
- iii. Come out with a general blueprint and specifications of three wheel car.

1.4 PROJECT SCOPE

This project is focusing on development of a three wheel car that user friendly to stroke patient and it consists of studying and designing a three wheel car. This focus area is done based on the following aspect:

- i. Design a three wheel car for disable driver that 80% recover from the stroke.
- ii. Study the concept of three wheel car. The advantages and disadvantages.
- iii. Design a three wheel car considering the comfortability, ergonomic and also friendly user to disable person.
- iv. Produce a guidance of designing three wheel cars with general specificatio

CHAPTER 2

LITERATURE REVIEW

2.1 THREE WHEEL CAR HISTORY

Three-wheeled cars have been around for a very long time, even pre-dating the Patent Motor Wagen design. For instance, in the 15th century Leonardo da Vinci created sketches of a primitive, three-wheeled car that was propelled using a wind-up mechanism similar to a clock. And French engineer Nicolas Cugnot created a large, tractor-like vehicle in 1769 that used a three-wheel design and was powered by a steam engine.

As the world moved into the 20th century, three-wheelers gained in popularity as low-cost, lightweight vehicles -- that is, until about the late 1920s, when cars generally started going more along the four-wheel track.

But after World War II, things changed once again. In war-torn countries like England, France, Germany and Japan, gasoline and mechanical supplies were scarce, but people still needed a way to get around. In many cases they couldn't afford full-sized, four-wheel cars or those cars simply weren't available and a motorcycle was far too small to meet their needs.

In postwar England, Bond Cars Ltd. found success in making small, three-wheel cars powered by single-cylinder motorcycle engines. These small cars proved popular among motorcyclists looking to protect themselves from the elements, and as an added benefit, the car didn't require an automobile driver's license. In addition, their ability to achieve more than 100 miles per gallon (42.5 kilometers per liter) was extremely

helpful at a time when fuel was expensive and supplies were scarce. Bond Cars continued to make three-wheelers well into the 1970s.

BMW began selling a three-wheel version of the colorful, egg-shaped Isetta micro car during the 1950s. Again, the three-wheel variant of this car was extremely popular in Great Britain, because they could be driven there with a motorcycle license. In Japan, car companies like Daihatsu made three-wheelers that became popular as taxis, light trucks and other utility vehicles. Again, many were small and powered by inexpensive motorcycle engines. England's Reliant Robin, a fiberglass micro car, was made off-and-on for more than 30 years, and arguably remains one of the most iconic three-wheelers of all time.

But where do three-wheel cars fit in today? While it's true that there are far less of them around now than in the 1950s and '60s, modern examples include the electric CityEl, the performance-minded Can-Am Spyder and numerous exotic concept cars from companies like Volkswagen and Peugeot.

2.2 TYPES OF THREE WHEEL CAR

The basic shape of a three wheel car is a triangle shape. The characteristics of a car, which is having two wheels up front and one in the rear (2F1R) or two wheels in the rear and one up front (1F2R), both are depending on the sitting position of the passengers, the engine's location, and also the placement of other critical mechanical components. The engine can either drive the single rear wheel or the two rear wheel. Same goes to the steering also, which can be done on either way as well.

2.2.1 Delta Configuration

Delta configuration is known as a type that have one wheel up front and two in the rear (1F2R) as shown in Figure 2.1. Karl Benz's creation followed this setup, as did the Reliant Robin. The original three-wheeled Mazda automobile, the Mazda-Go, was configured this way to allow for a pickup truck bed in the back (George, 2009). The advantages of this configuration are its inherent low cost, relatively easy, tends to be an attractive shape, aerodynamically clean and also inexpensive to build a steering setup with only one wheel.

Besides that, it is naturally wide across the occupant's shoulders where extra room is needed and narrower near the occupant's feet where less width is required (George, 2009; Riley, 2003). Most of the three wheel cars are being setup with this shape, by having the engine driving the rear wheels and leave steering to the front one. This configuration will produce a high resistance to rollover but at the same time, it will create a rear-heavy vehicle that leads to oversteer (Riley, 2003; Julien, 2008). Oversteer can be reduced by placing larger, wider tires at the rear and by appropriate suspension design.



Figure 2.1: Delta configuration

Source: www.thekneeslider.com

2.2.2 Tadpole Configuration

Tadpole also known as reverse strike is the other design of a three wheel car as shown in Figure 2.2. The configurations of this type are opposite to the delta, which are having two wheels up front and one in the rear. Campagna Motors T-Rex and Volkswagen GX-3, both are using this concept as the basic setup (George, 2009). This design is said to be much more stable compared to delta design because the back wheel is supposed to drive the vehicle while as for the two wheels at the front, they are responsible for steering.

There's also an aerodynamic benefit, since the vehicle is shaped almost like a teardrop which is wide and round up front and tapering off in the rear. This allows air to flow easily over the vehicle's bodywork (George, 2009; Riley, 2003). For the tadpole configuration, braking turns no longer present a problem because the consumers are familiar with it. By having side-by-side front wheels, the vehicles tend to understeer. For a three wheeled vehicle having two wheels at the front, only the front two wheels will experience lateral weight transfer and so only the total front stiffness value would decrease due to load sensitivity (Starr, 2006). The disadvantages of this configuration are resulting in entering or leaving the vehicle over or behind the outboard wheels, reduced interior space resulting from the steering angle of the front wheels, and also the limited ability to transfer power through a single powered rear wheel. The tadpole design is becoming more and more favored among auto designers for its stability, aerodynamics and ability to house a fuel-efficient engine.

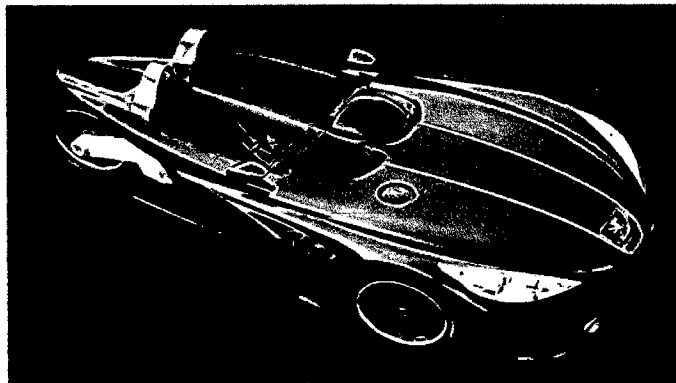


Figure 2.2: Tadpole configuration

Source: www.rsportscars.com/peugeot/2005

2.3 ADVANTAGES AND DISADVANTAGES OF THREE WHEEL CAR

2.3.1 Advantages

Many of the early three-wheeled vehicles ran on motorcycle engines and they were great at sipping fuel, while also providing the storage space, seating and protection from the elements you can only get from a car. In addition to hosting smaller engines, the triangular shape is more aerodynamic than a boxy car, meaning it can achieve better fuel economy simply from its body design alone.

They also offer far more safety than motorcycles. While smaller than cars, many of them have enclosed bodies with seatbelts and windshields, keeping the driver and passengers protected from outside impacts. A three-wheeled car's small size, plus the inclusion of a powerful engine, can mean exciting performance as well. The F3 Adrenaline, a three-wheel vehicle from TriRod, is made of carbon fiber and boasts a powerful V-Twin engine. Because it has three wheels, it's built much lower to the ground than a typical motorcycle and that lower center of gravity gives it incredible handling characteristics (George, 2009).

Keep in mind that three-wheelers are also much more stable than their two-wheeled cousins. You don't have to worry about learning to balance a three-wheeler or putting your foot down to keep it upright when the vehicle stops. The vehicle's triangular base means it can support itself, and they also don't have the uncomfortable seating that characterizes motorcycles. Moreover, tilting three wheel cars, vehicles that lean into turns like motorcycles, point the way toward a new category of products of unparalleled performance and cornering power, and nearly infinite design possibilities (Riley, 2003).

Three wheel cars are more sensitive to center of gravity displacement, both longitudinally and vertically, compared to the four wheel cars. As we look into the mechanical parts of the three wheel car, it gives an advantage which result primarily from the elimination of one wheel. By eliminating redundant fourth wheel, the chassis

become inherently less costly to manufacture. It is also inherently lighter, and in many cases may be comparatively stronger (Riley, 2003).

2.3.2 Disadvantages

While a three-wheel car often combines the advantages of a car and a motorcycle, they also carry the weaknesses of both. First, let's look at the small size. There have been very few large three-wheelers throughout automotive history and most of them end up being subcompacts or motorcycle-sized vehicles.

That means you won't see too many three-wheelers with large engines, and despite the high-performance of some models, most of them haven't set the world ablaze with their speed. For example, the Reliant Robin could only muster 0 to 60 mph (0 to 96.6 kph) in about 16 seconds. Another point to remember is they aren't quite as agile as motorcycles can be.

Because of their smaller size, three-wheelers don't offer the seating and storage option you see in most four-wheel cars. They may be large enough for some people to use to get around town, but a small three-wheeler won't meet the needs of a large family with a lot of people or cargo to haul.

One of the main problems with three-wheel cars is instability. Anyone who's ever ridden a tricycle knows how easily they can tip over. That's because many three-wheel designs, in the delta configuration, are simply more prone to tipping over than four-wheel cars are. Three-wheeled cars, with one less wheel to provide support, carry an increased possibility of roll over in a corner. However, this instability can be reduced by choosing a three-wheeler with a tadpole setup which as mention earlier, has two wheels up front. Cars that follow this pattern have proven to have greater cornering ability than the delta setup, which is why nearly all new three-wheel designs have gone this route.

2.4 AUTOMOTIVE PACKAGING

Automotive packaging requires the designer or engineer to obtain an overall understanding and know-how knowledge of vehicle requirements for comfort, safety, legal and assembly. The skill level is expected to the extent that the designer can create new design or modified design which will conform to competitive packaging in terms of vehicle type, function and cost. It is often desirable for the package to meet logical solution that is able to be manufactured with the acceptable cost and method. Exciting concept design usually perceived as high in quality coupled with the comfort and safety features as well as affordability.

As shown in Figure 2.3, Honda designers have implemented near flat rear floor for their recent car models. This greatly increased space for rear passenger leg room and made the car feel more spacious. Usually flat floor can only be designed for multipurpose vehicle or van and pickup trucks. The original design of tunnel floor was to accommodate for exhaust pipe space and drive shaft if the car is rear driven. This example shows how the innovative aspect that took place even though the conventional way of designing floor is always with high tunnel.

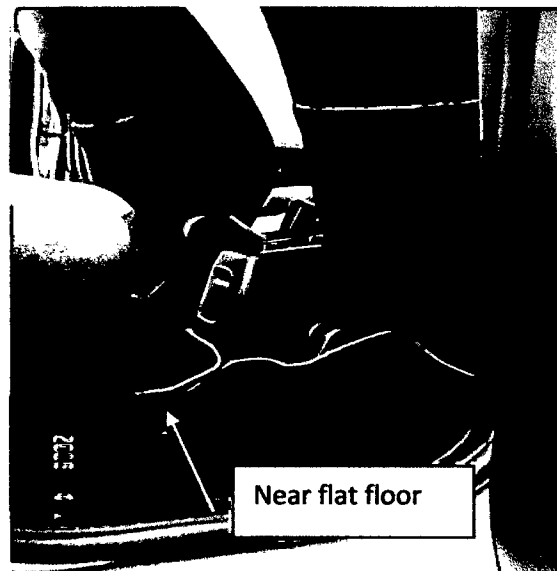


Figure 2.3: Honda City rear interior

Source: Automotive Design & Styling Lecture Notes

To enable reader to easily identify some features that are the result of good packaging practice, Figure 2.4 are shown with some of the important attractive features.

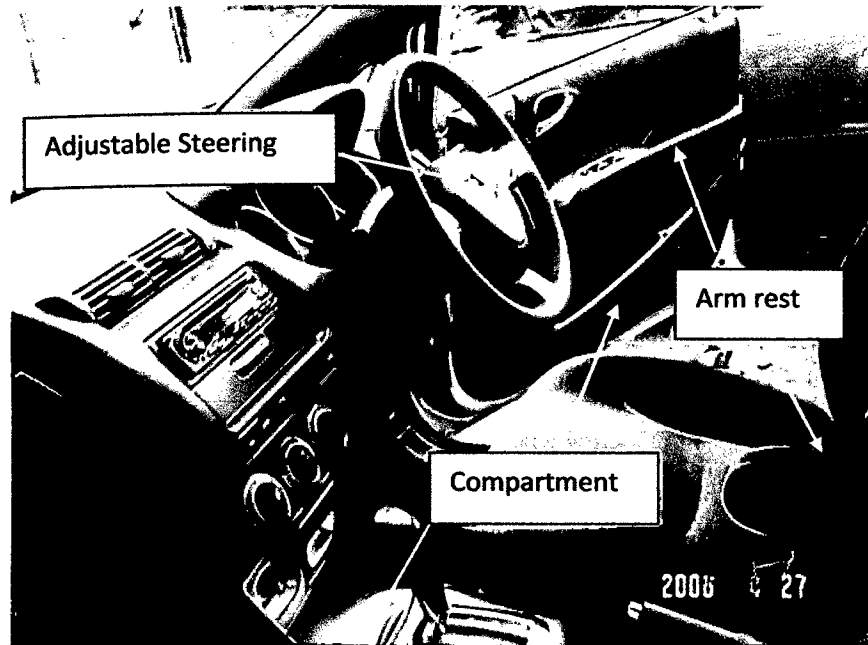


Figure 2.4: Front interior

Source: Automotive Design & Styling Lecture Notes

The detail such as the size of pull handle pocket at door is also important so that all sizes of people can reach and grip it comfortably. Example of an acceptable size of the pocket handle is shown in Figure 2.5.

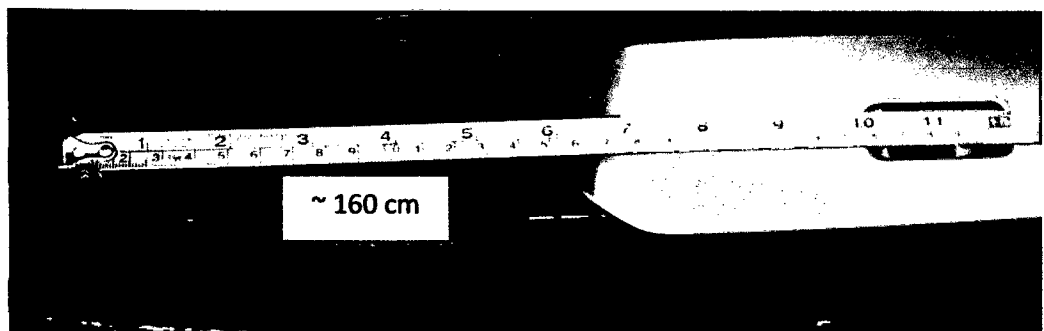


Figure 2.5: Pull handle

Source: Automotive Design & Styling Lecture Notes

While Figure 2.6 illustrate the dash design for MPV which includes steering mounted gear shift and center-positioned meter display.

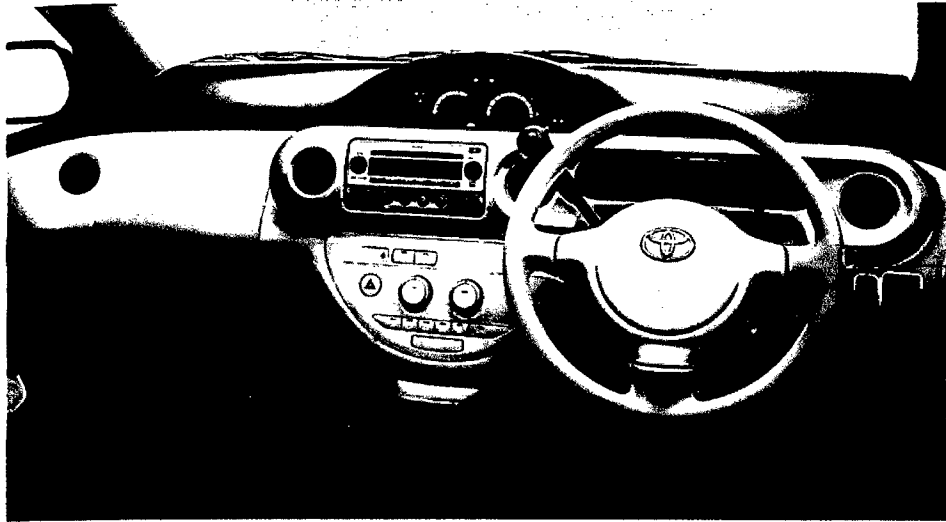


Figure 2.6: Dash

Source: Automotive Design & Styling Lecture Notes

2.4.1 Vehicle Packaging

The process of Vehicle Packaging started with the major dimension of the car. Once the car segment has been proposed, package designer would get the rough idea about the car size. This car size will be not very much different from the same car segment in the market. Otherwise, the car will not be in the right segment and will be deviated from the potential customers. After dimensioning study and comparison, package designer will come up with the proposal dimension after considering the carry over parts versus new parts. Figure 2.7 shows the major dimension of a passenger car.

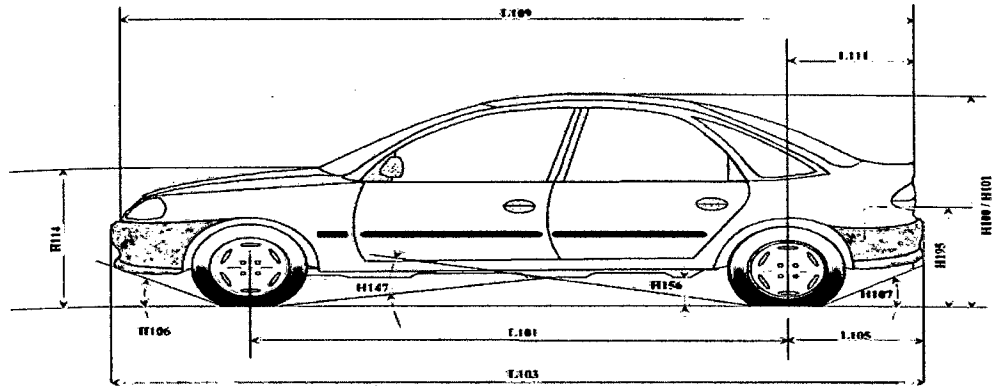


Figure 2.7: Major dimension of passenger car

Source: Automotive Design & Styling Lecture Notes

At the same time, designer will also study the space inside the car. The positioning of the driver and the passenger will be studied and the reasoning will be given according to internal criteria such as spaciousness, reach ability and vision. The interaction of driver and passenger with components inside the car will be very much dependent on the internal dimensions of the car. Figure 2.8 shows the internal dimension of a passenger car according to package designer criteria.

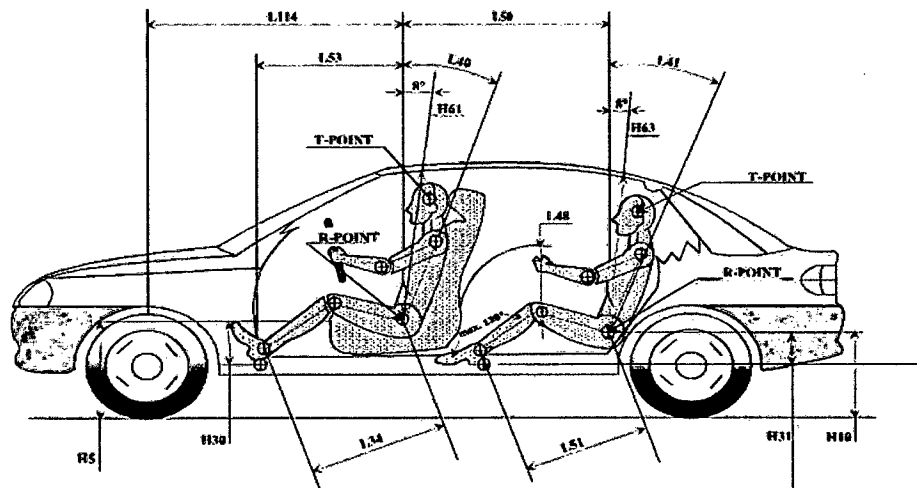


Figure 2.8: Internal dimension of a passenger car

Source: Automotive Design & Styling Lecture Notes