UNIVERSITI TEKNIKAL MALAYSIA MELAKA

AUTOMOTIVE AERODYNAMIC ENERGY HARVESTING FROM FRONT BUMPER

This report submitted in accordance with requirement of the Universiti Teknikal Malaysia Melaka (UTeM) for the Bachelor Degree of Mechanical Engineering Technology (Automotive Technology) with Honours

By

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APPROVAL

This report is submitted to the Faculty of Engineering Technology of UTeM as a partial fulfillment of the requirements for the degree of Bachelor Degree of Mechanical Engineering Technology (Automotive Technology) with Honours. The member of the supervisory is as follow:

………………………………

(Project Supervisor)

ABSTRAK

Pengguna mengambil berat tentang penggunaan bahan api dan teknologi hijau. Dalam industri automotif salah satu penyelesaian alternatif untuk mengurangkan penggunaan bahan api adalah dengan mengurangkan beban elektrik dari alternator.ia boleh direalisasikan dengan menuai tenaga daripada tenaga angin. Daya angin berkaitan dengan aliran udara di atas permukaan kenderaan. Oleh itu kajian mengenai aliran aerodinamik telah dilakukan. Kajian ini bermula dengan reka bentuk model Proton Perdana V6 menggunakan perisian CFD. Kemudian model lukisan akan mensimulasikan dalam perisian CFD untuk menentukan aliran angin pada bampar hadapan kenderaan ini. Selepas menamatkan simulasi keputusan yang diperoleh akan digunakan untuk menentukan kawasan untuk memasang turbin angin. Oleh itu ia mampu untuk memerangkap udara mengalir di sekitar bumper depan untuk menjadikan bilah menghasilkan tenaga. Apabila turbin telah dipasang kenderaan tersebut akan diuji untuk menentukan arus maksimum boleh diperoleh berdasarkan kelajuan yang berbeza

ABSTRACT

People are concerned about fuel consumption and green technology. In automotive industry, one of the alternative solution to improve fuel consumption is by minimizing the electrical load from the alternator. It can be realized by harvesting the energy from the wind force. The wind force is related to the air flow on the vehicle surface. Hence, a study on the aerodynamic drag has been performed. This research start with design the shape of Proton Perdana V6 model using CFD software. Then, the drawing model will be simulate in CFD software to determine the wind flow on the front bumper of this vehicle. After completing the simulation, the results obtained will be used to determine the area to install the wind turbine. Therefore it is able to trap the air flowing around the front bumper to turn the blades, thus it will gain the energy. When the turbine has been mounted, the vehicle will be tested to determine the maximum current can be generated based on different speed.

DEDICATION

To my parents, Abd Ghani Bin Yaacob, and Zaiton binti Abdullah who had gave me financial and moral support, and a greatest thank you to my siblings, my fellow friends, and my supervisor, Ir. Mohamad Hafiz Bin Harun , for supporting me.

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. All praises to the Almighty Allah, for giving me the strength, patience and guidance throughout the process of completing this investigation. I am grateful to have the morally and physically support from many people throughout completing this study. For this opportunity, I would love to thank whose are either directly or indirectly involved during the process of this research is conducted.

Most immediately, I would like to express my very special gratitude and appreciation to my supervisor, Mr Ir Mohamad Hafiz Bin Harun for his valuable suggestion, comments and advice in every stage of this project. All the discussion makes me understand every detailed in this aerodynamic from front bumper. My token of appreciation also goes to all the lecturers from Faculty of Technology Engineering especially from Automotive Department for being very nice and making this study easier to be completed.

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LIST OF ABBREVATIONS, SYMBOLS AND NOMENCLATURES

CFD	-	Computational Fluid Dynamic
KM / H	-	Kilometres / Hours
V	-	Voltages
VAWT	-	Vertical Wind Turbine
HAWT	-	Horizontal Wind Turbine
P a	-	Pascal
CATIA	-	Computational Aided Three Dimensional Interactive Application
VWT	-	Virtual Wind Tunnel
Mesh	-	Meshing
Nas	-	Nastran
Cd	-	Drag coefficient
Cl	-	Lift coefficient
Cc	-	Cross Coefficient
Cp	-	Pressure Coefficient

CHAPTER 1

INTRODUCTION

1.0 Background

Lately, main issues about oil prices cause customer demand for car manufacturers to produce vehicles that has high efficiency and low fuel consumption. High demand has forced the company to compete in the market to produce a beautiful car that can reduce wind resistance and fuel efficiency. it is very important for a manufacturer to produce of the best car in automotive field in order to fulfil customer requirement.

Design are being focus in a car manufacturing industry because the external surface of the car is very important in aerodynamics aspects of vehicles such as stability, comfort and fuel consumption at high speeds. Many previous studies have been made by using CFD techniques to detect wind resistance that touches the vehicle body. If a manufacturer make a research about the aerodynamic flow to the car, the wind that flow through the car can be converted into electrical power to support the alternator. so, it will be very helpful to reduce alternator load and at the same time, air pollution problems can also be solved. thus, if it can prevail, it will help to protect the environment.

1.1 Problem statement

From the observations that have been made, the vehicle alternator produce electric current and deliver it to the vehicle's battery. The main problem in the alternator on the vehicle is , when a vehicle used a lot electricity alternator load will increase and oil consumption also increased. Referring to the issue above, one of the turbine device will be review and will be install in the front of the car. The main purpose of installing the turbine is to generate current from wind energy when the car is driven and the current will be deliver to the alternator. Then, the usage this turbine will reduce alternator load and in the same time it will reduce fuel consumption.

1.2 Project Objective

i. To identify the position of maximum speed of wind on the front bumper.
ii. To allocate the proper position of wind turbine for energy harvesting.
iii. To harvest the maximum current generated by the wind turbine.

1.3 Scope of Project

This study will discuss about :

i. Potential of wind to generate electric current on a front bumper Proton Perdana v6.

ii. Utilization of CATIA software in designing vehicle.

iii. Use wind tunnel tests for simulation.

iv. Wind turbine will be install at the higher potential on the flow of the wind.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

Literature assessment is ready to recognize the principle of the research. The literature overview could be very important component to recognize first in any studies. Due to the fact we recognize the principle of the research, we will proceed it without difficulty. It's far may be clean to determine the way of the studies could be imposing and additionally the associated principle that has utilized in previous studies. The facts about the research can be located thru the journal, internet, thesis and reference books. On this studies case, all the records and theory that related to the road car aerodynamic. In this chapter will talk approximately preceding research, fundamental of car Aerodynamic , wind turbine , design blade , dynamo generator and computer fluid dynamic (CFD).

2.1 Design Software

Software design is the procedure procedure by which a specialist makes a detail of a product parameter. expected to perform objectives, utilizing an arrangement of primitive segment s and subject to limitations.

2.1.1 CATIA

At first named CATI (Conception Assistée Tridimensionnelle Interactive – French for Interactive Aided Three-dimensional Design), it was renamed CATIA in 1981 when Dassault made a backup to create and offer the product and marked a non-selective dispersion concurrence with IBM

Figure 2.1 : CATIA Sotfware icon

The catia V5 social plan change administration capacities utilize programmed redesigns, diminishing the effect of changes to the outline to assembling process. Through programmed overhaul in the building configuration stage, client don't need to restart the full plan prepare once more, permitting you to accomplish impressive investment funds in time and cash.

The biggest disadvantage is CATIA is way too expensive for small and medium design enterprises to purchase the licenses. Even if you purchase a license or two, you are limited in functionality because of what 'configuration' you purchased. Many useful functions of CATIA might not be available just because an inferior configuration was selected at the time of purchase. Adding up the functionalities will require to purchase more licenses: more money. Otherwise, CATIA experiences memory overflow problems and tends to crash, Orin Dassault's preferred terminology CATIA experiences a "premature exit".

2.2 Aerodynamic

Aerodynamic is a science that reviews the development of air and the way that question, for example, aeroplanes travel via air. The impact characteristics of a protest that influence how effortlessly it can travel through the air.(Khan and Umale, 2014)

2.2.1 Analysis Dynamic

Optimal design investigation is utilized as a part of the outline of auto to lessen drag coefficient. The examination has acquired the conduct of recently created turbulence models for complex geometry cases, an improved auto demonstrate, known as the Ahmed body, has been tried by Ahmed. The Ahmed body is comprised of a round front section, a moveable inclination plane put at back part of the body to concentrate the coefficient of drag and partition marvels at various edges, and a rectangular box, which associates the front part and the back inclination plane.(Khan and Umale, 2014)

As the wake detachment stream behind the Ahmed body is the principle supporter to the drag constrain, precise expectation of the partition procedure and the wake stream are the way to the fruitful displaying of this case. Numerous specialists (Sharma and Bansal, 2013) , (W. Meile, et al. (2011) have made utilization of CFD methods to perform numerical recreations identified with car. A few numerical reenactments were performed to examine the weight field, speed vector field, and streamlined compel expectation identified with a traveler auto.

The outside surface of the auto is crucial in optimal design parts of vehicles, for example, stable and fuel utilization on high speed. The totality load and change of the outer surfaces of the vehicle are the most crucial to enhance the optimal design qualities of the auto (S. Yongling et.al) , (A. I. Heave, 2012) These main characteristic are useful to enhance the cruising conditions, more noteworthy stable , and lower fuel utilization

2.2.2 Computational Fluid Dynamics (CFD)

Computational fluid Dynamic(CFD) is the utilization of connected science ,material science and computational programming to picture how a gas or liquid streams. Computational liquid elements has been around since the mid 20 the century and many individuals know about it as an apparatus for breaking down wind stream around vehicle and airplane. As the cooling framework of server rooms has expanded in many-sided quality, CFD has additionally turned into a helpful apparatus in the server farm for breaking down warm properties and demonstrating wind current

2.2.3 Altair Hyperwork

Figure 2.2 : Altair HyperWorks Software icon

Altair was built up in 1985. In 1990, HyperMesh was discharged. In 1994, Altair gets IndustryWeek's "Innovation of the Year" grant for OptiStruct.During the 2008 economy emergency, Altair began a program to offer free preparing on its item for unemployed people in Michigan. In September 2010, Altair acquired a 136,000-

square-foot (12,600 m2) Annex Facility in Troy, to at first house Altair's auxiliary ilumisys, Inc. Altair additionally procured SimLab in October 2011. 2011 started with another obtaining, ACUSIM Software, with their CFD Solver, AcuSolve. In September 2011, Altair ProductDesign uncovered BUSolution, a cross breed water powered bus.<http://en.m.wikipedia.org.html

2.2.4 Altair hyper work virtual wind tunnel.

Virtual Wind Tunnel HyperWorks is controlled by Altair's computational Fluid Dynamic solver, AcuSolve, a broadly useful, limited component based stream solver giving quick turnaround times, precision and strength . Architected for parallel execution on shared and conveyed memory PC frameworks, utilizing a half breed parallelization strategy, AcuSolve gives quick and productive transient and unfaltering state answers for unstructured matrices, and it is equipped for scaling over an extensive number of processing centers.

VWT accompanies a quick and productive unstructured volume mesher including limit layer era. Client characterized volume work refinement zones are utilized to make a privately refined volume work to catch essential stream marvels, e.g. the wake of a vehicle or a building. Parameters for limit layer lattice can be characterized all inclusive or on a section premise to have greatest control of the aggregate component tally and utilize refined layers just in districts where it is important. Volume coinciding for an outside car streamlined features investigation

The setup procedure is profoundly computerized, with a base number of parameters, and without trading off the arrangement quality. Extra controls over the different parameters are given in the client environment. The recreation can be effectively submitted to superior registering frameworks to facilitate memory and figure escalated undertakings, for example, volume lattice, comprehending and post-preparing.

2.3 Energy harvesting from flow induced vibration.

The turbine generator is the most develop technique for stream energy harvesting. Be that as it may, the proficiency of traditional turbines decreases with their sizes because of the expanded impact of grinding misfortunes in the direction and the lessened surface territory of the cutting edges. Besides, pivoting segments, for example, course experience the ill effects of weakness and wear, particularly when scaled down. These downsides of turbine generators urges development of another range in vitality collecting, i.e. vitality gathering from stream incited vibration. The stream here incorporates both fluid stream and wind current. (Tan, n.d. 2011)

2.4 Wind Turbine.

A wind turbine is a gadget that change Kinetic energy from the wind stream, likewise called twist vitality, into mechanical power, a procedure known as wind stream control. In the event that the physical vitality can be utilized to create power, the gadget might be known as a wind stream turbine or wind electric power plant

Wind turbine one of the best because it was no air emissions such as Sulfur Dioxide (SOB2B), Nitrous Oxide (NOx), or Mercury Emissions. Also don’t have Greenhouse Gas Emissions. Then it no need for fuel to, transport, or store for the source. It’s also don’t need any equipment like cooling water that we always use at fuel engine. After all there is no waste when used wind turbine.

2.4.1 Type of Wind Turbine

Wind turbines can be arranged into two general sorts, Horizontal and vertical as appeared in Figure 2.7. An even horizontal machine has its edges pivoting on a hub parallel to the ground. A vertical machine has its edges turning on a horizontal opposite to the ground. That sorts outlines for both and every sort has certain disadvantages and advantages .

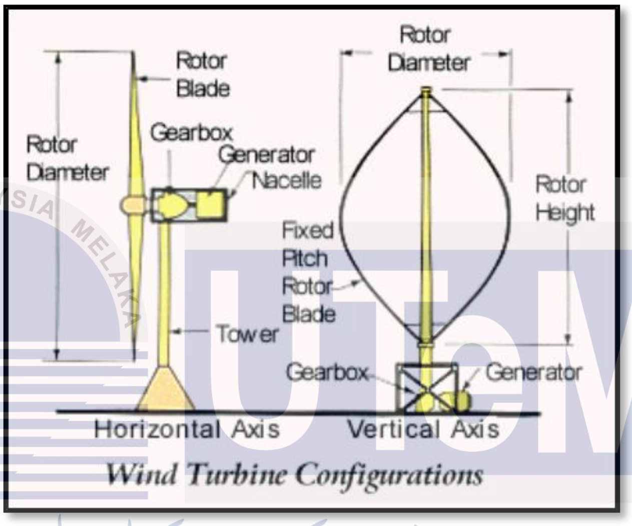

Figure 2.3 : Type of Wind Turbine

Horizontal wind machines are more normal since they utilize less material per unit of power created. Around 95 percent of all wind machines are even pivot. A run of the mill flat wind machine remains as tall as a 20-story assembling and has three sharp edges that traverse 200 feet over. The biggest twist machines on the planet have sharp edges longer than a football field. Wind machines stand tall and wide to catch more wind. Vertical-pivot wind machines make up only five percent of the wind machines utilized today

The run of the mill vertical wind machine stands 100 feet tall and 50 feet wide. Every wind machine has its points of interest and hindrances. Even hub machines require an approach to keep the rotor confronting the wind. This is finished with a tail on little machines. On extensive turbines, either the rotor is found downwind of the tower to act like a climate vane, or a drive engine is utilized. Vertical-hub machines can acknowledge twist from any course (children and vitality 2005).

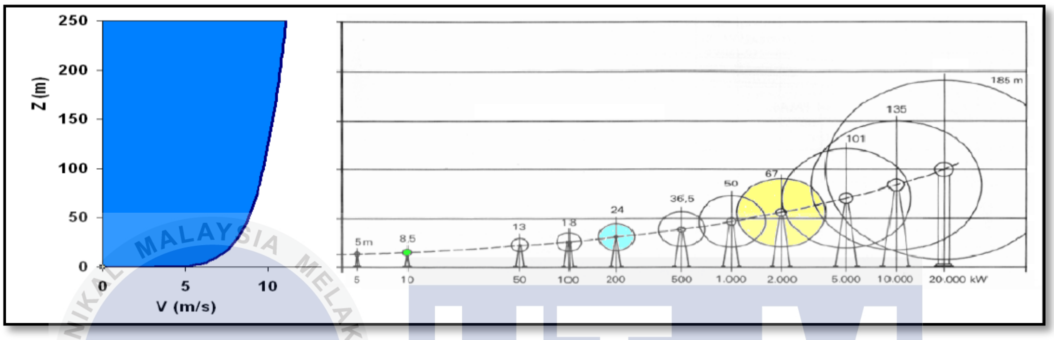

Figure 2.4: Typical vertical mean wind velocity distribution in the low atmospherical boundary layer, compared with the rotor size evolution

Based on the Figure 2.8 above, the power that a wind turbine can generate is dependent on the size of its rotor. From the graph, the author can conclude that, a larger turbine will generate or produce more power

2.4.2 Blade Profile

The span of an edge makes contrasts in their effectiveness. The bigger cutting edges deliver more dynamic vitality through one revolution of the sharp edges than the littler edges (Mayonge, A. W.) Smaller sharp edges just have a specific measure of surface territory on the substance of the cutting edges. The bigger edges have a more prominent surface zone, permitting them to work all the more proficiently (Crossley, P.J.S.a.R.J). For some situation, be that as it may, the littler length of the cutting edges, the better it will get twist at slower speeds (Layton, Julia). (Ronit K. Singh, M. Rafiuddin Ahmed)

2.4.3 Number of Blades

One of the significant issues for the little wind turbines is little torque that outcomes in trouble to begin turning in low wind speed, Manwell JF (2002). Wright AK, Wood DH. (2004). There are typically a few methods for taking care of this issue. The one received here was to utilize more sharp edges, as this could add more torque to begin the wind turbine. Despite the fact that they are harder to adjust and yaw, rotors with more cutting edges have solid curve at the finishes of the edges and henceforth gives a major beginning torque to begin. The attributes of having the capacity to begin turning at low wind speed is extremely attractive for little twist turbines, as they are well on the way to be introduced in developed regions, where moderate winds are predominant. Besides, there was a six-edge test wind turbine promptly accessible from a past review. Hence the new rotor had six sharp edges, an indistinguishable number from the one utilized as a part of a past review which was to first create and after that approve an efficient strategy in view of computational liquid elements (CFD) demonstrating . (Wang F)

One noteworthy significance in wind turbine configuration is its number of sharp edges. Number of cutting edge is incredibly impacting the level pivot wind turbines (HAWT). The most widely recognized number utilized are two and three sharp edges. Some HAWTs may have more than three edges, and regularly on the grounds that they utilizing for low speed wind turbines (Cao, Han) and the majority of the present business turbines utilized for power era have three cutting edges (Shammeri, T.A).It is realized that more sharp edges give a more noteworthy accessible surface zone for the twist to push, so it would create all the more turning force yet in a similar time a more prominent number of edges increment the weight to be turned by the turbine.

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Figure 2.5 : Small wind Turbine

This mean that the smaller number of rotor blades, the faster the wing turbine rotate to extract the maximum power from the wind (Carriveau, Rupp). As this study is to seek the performance of slotted and continuous types of wind turbine, thus this research will set the number of blade to three only.

This imply the littler number of rotor sharp edges, the speedier the wing turbine turn to separate the most extreme power from the wind (Carriveau, Rupp). As this review is to look for the execution of opened and ceaseless sorts of wind turbine, consequently this examination will set the quantity of edge to three as it were.

2.5 Fabrication process

Fabricate is the procedure used to produce steelwork segments that will, when gathered and joined, shape a total edge. The casing by and large uses promptly accessible standard areas that are obtained from the steelmaker or steel stockholder, together with so much things as defensive coatings and jolts from other pro providers.

2.6 Type Joining

Distinctive materials can be participated in a wide range of courses relying upon whether the joint should be lasting or semi-changeless. Perpetual: once this kind of joint has been developed, it can't be turned around without making harm the material/item. Semi-perpetual: this sort of joint is a technique for joining that is intended to be lasting; in any case, it can be dismantled without harmed the materials

2.6.1 Nuts, bolts and washers

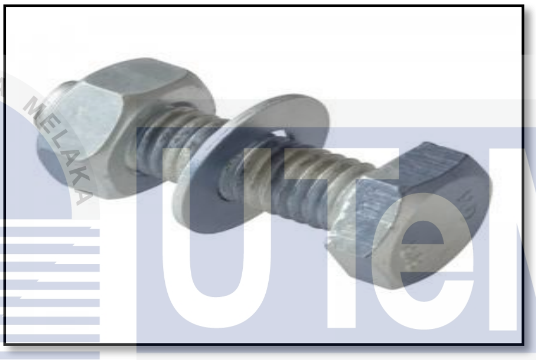

Figure 2.6 : Nuts , Bolts , and Washer

Stray pieces are utilized to hold at least two bits of materials together in a semi-lasting strategy for joining. Jolts have a tendency to be produced using high ductile steel and are strung (square and hexagonal strung) for all or part of the length of the pole. Nuts utilized with screws must have coordinating distance across and string structure. They come in various forms, from wing nuts (made for easy removal by hand) to hexagonal nuts and special locking nuts that resist coming loose Washers are utilized to secure the surface when nuts are fixed. They spread the heap connected to the surface and anticipate extricating that can be cause on by vibrations

2.6.2 Cutting Process

With regards to machining, a power cutter or cutter is any device that is utilized to expel material from the work piece by method for shear twisting. Cutting might be refined by single-point or multipoint instruments. Single-point instruments are utilized as a part of turning, forming, arranging and comparable operations, and expel material by method for one front line. Processing and boring apparatuses are regularly multipoint devices. Crushing devices are additionally multipoint

. Cutting instruments must be made of a material harder than the material which is to be cut, and the device must have the capacity to withstand the warmth created in the metal-cutting procedure. Likewise, the instrument must have a particular geometry, with freedom points composed so that the bleeding edge can contact the work piece without whatever remains of the apparatus delaying the work piece surface. The point of the cutting face is additionally critical, similar to the flute width, number of woodwinds or teeth, and edge measure. Keeping in mind the end goal to have a long working life, the greater part of the above must be streamlined, in addition to the rates and encourages at which the apparatus is run

2.6.2 Angle Grinder

An edge processor, otherwise called a side processor or plate processor, is a handheld power instrument utilized for cutting, crushing and cleaning. Edge processors can be controlled by an electric engine, petrol motor or packed air. The engine drives an adapted head at a right-edge on which is mounted a rough plate or a more slender cut-off circle, both of which can be supplanted when worn. Point processors normally have a movable monitor and a side-handle for two-gave operation. Certain point processors, contingent upon their speed range, can be utilized assanders, utilizing a sanding circle with a sponsorship cushion or plate. The sponsorship framework is ordinarily made of hard plastic, phenolic gum, or medium-hard elastic relying upon the measure of adaptability desired.

Figure 2.7: Angle Grinder

Point processors might be utilized for expelling overabundance material from a piece. There are a wide range of sorts of plates that are utilized for different materials and errands, for example, cut-off circles (precious stone cutting edge), grating pounding circles, crushing stones, sanding plates, wire brush haggles cushions. The edge processor has expansive heading to counter side powers produced amid cutting, not at all like a power bore, where the constrain is pivotal. Point processors are generally utilized as a part of metalworking and development, and also in crisis salvages. They are generally found in workshops, benefit carports and auto body repair shops

The grinding wheel is the business end of a grinder, much like the bit of a drill or the blade of a jigsaw. As the spinning wheel is pressed into a surface, it rapidly removes material to alter the look or feel of the surface. The higher the voltage of the motor, the faster the wheel spins. Likewise, the more pressure that is put onto the wheel as it presses into a surface, the more material it removes. Grinding wheels come in different sizes, depending on which size the grinder itself is compatible with. The most popular grinders are those that use 4.5-inch wheels.

There are several different types of wheels that can attach to a grinder. Each different wheel is designed to perform a specific type of work. This includes shaping, sanding, polishing, cutting, and much more. The materials a wheel is best suited to work with depends on the material that particular wheel is made from. However, there are some wheels that are considered general purpose, though they are still limited in what they can do.

2.6.3 Aviation Snips

Avionics cuts, otherwise called compound cuts, are perfect for cutting aluminum and sheet metal. Their handles are shading coded and it's not only for enrichment. Here's the way to pick the correct clips for the employment utilizing the right shading assignment.

Cutting curves in sheet metal is difficult. The material is awkward and unforgiving, as well as extremely sharp. There are three types of aviation snips that are designed to make three different cuts much easier.

Figure 2.8 : Aviation snips

Yellow handled snips are made to cut in a straight line. They can also cut wide curves and are ideal for flat pieces of metal. Green handled snips are designed to make straight and right (clockwise) cuts and are perfect for right handers cutting duct. Red handled snips cut best straight and to the left (counter-clockwise). You can use any of the snips in either hand but they will only perform well when cutting in the direction they were intended for.

Look for offset snips as they keep your hands up and away from the sharp metal and always wear leather gloves when handling and cutting metal and aluminium.

2.7 Maximum Current

(F. Wang) says that the maximum power of a wind turbine is tuned for a given wind speed by altering the rotational speed of the rotor. Figure 5 displays the maximum shaft power generated in the two wind tunnel test. The graph shows result for two models which is one with the scoop and another one is without scoop. The figure shows clearly that the higher wind speeds produce greater power for the both test and the use of the scoop improves power output. A close look shows that such improvement could be as good 50% increase in slow winds, from cut in speed up to about 10 ms^{-1} . In higher winds, such increases were lower at about 25%. This improvement at low speed could be very meaningful for micro wind turbine working in built-up areas, where winds are often low speeds.

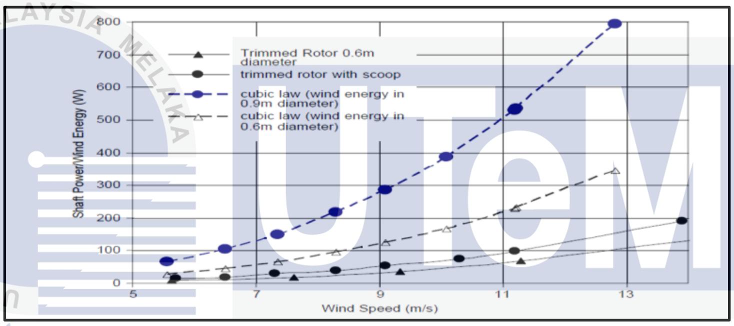

Figure 2.9: Results of the wind energy vs. wind speeds

2.8 Multimeter

Multimeter also known as a VOM (volt-ohm meter or volt-ohm-milliammeter), is an electronic measuring instrument that combines several measurement functions in one unit. A typical multimeter can measure voltage, current, and resistance. Analog multimeters use a micro ammeter with a moving pointer to display readings. Digital multimeters (DMM, DVOM) have a numeric display, and may also show a graphical bar representing the measured value. Digital multimeters are now far more common but analog multimeters are still preferable in some cases, for example when monitoring a rapidly varying value.

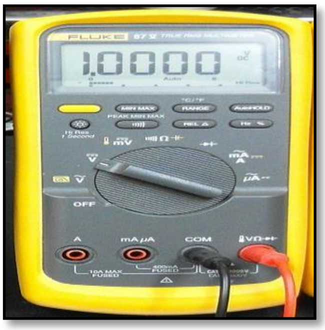

Figure 2.10 : Digital Multimemeter

Figure 2.10: Analog Multimeter

A multimeter can be a hand-held device useful for basic fault finding and field service work, or a bench instrument which can measure to a very high degree of accuracy. They can be used to troubleshoot electrical problems in a wide array of industrial and household devices such as electronic equipment, motor controls, domestic appliances, power supplies, and wiring systems.

2.9 Dynamo generator concepts.

Dynamo and generators change over mechanical pivot into electric power. Dynamo is a gadget that makes coordinate current power control utilizing electromagnetism.it is otherwise called a generator, however the term generator typically alludes to a " alternator' which makes rotating current power. other than that the term of generator is utilized to depict an alternator which makes air conditioning power utilizing electromagnetism .

CHAPTER 3
METHODOLOGY

3.0 Introduction

This chapter is a review of the method and the appropriate design used for this study. The detail of the flow will be explain in this chapter.

3.1 Flow Chart

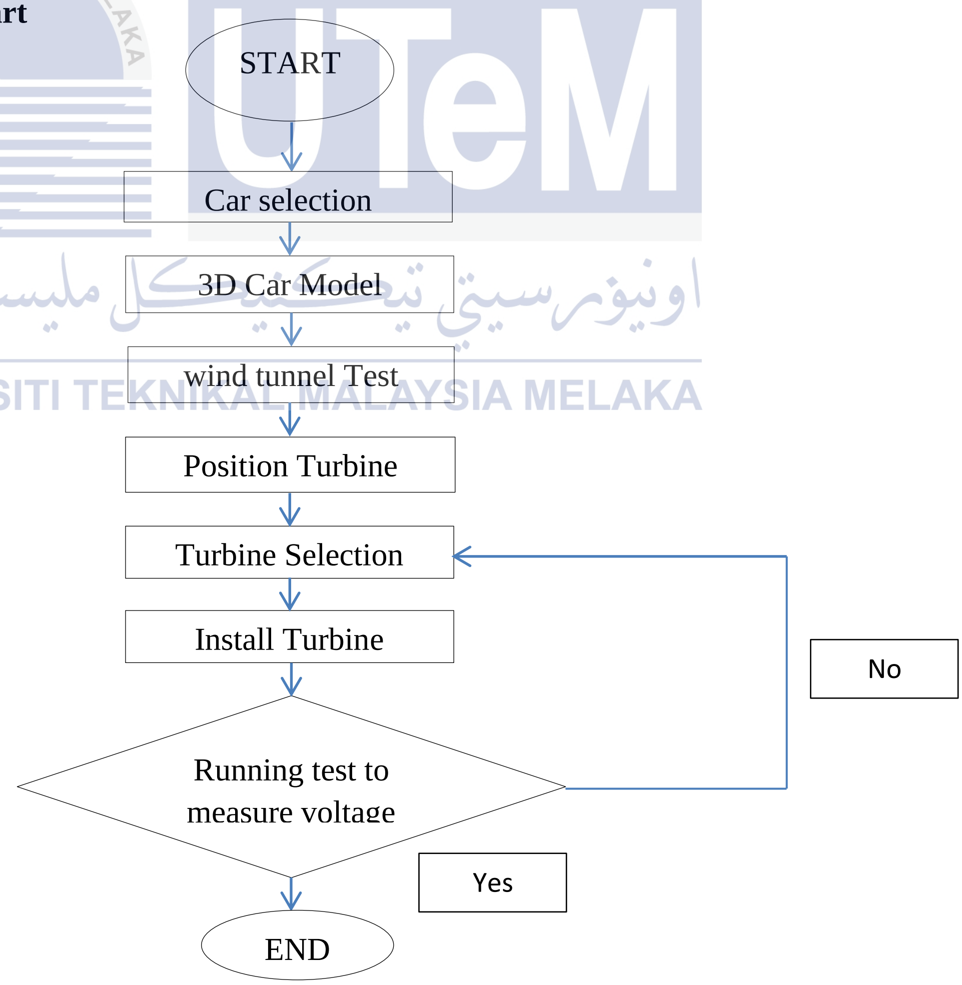

Figure 3.1 : Flow Chart

As start , objectives of this research and the scope this project is for study an aerodynamic performance on a vehicle and to produce the idea wind turbine system installation for energy harvesting. CFD software were used in this method to analysis process. Otherwise to complete this process it will used other software to design simulation process. The result from the simulation will discuss.

3.2 Car selection

Firstly of the process is the selection type of vehicle. after previous research about the type of vehicle ,the sedan car has been selected in this project and Proton perdana model had been choose for this project.

3.3 Position turbine

The other case is to explain the objective where the author wants to study the flow of wind on a body of vehicle. To achieve this, a models were created and the wind turbine is placed on the front bumper. If a result not satisfied a modification should be made to the concept design and a process start again. Hence previous review was proven that there is no significant change in the value if the wind turbine is install on the front bumper, the author wants to investigate to review the aerodynamic potential of the car with a wind turbine.

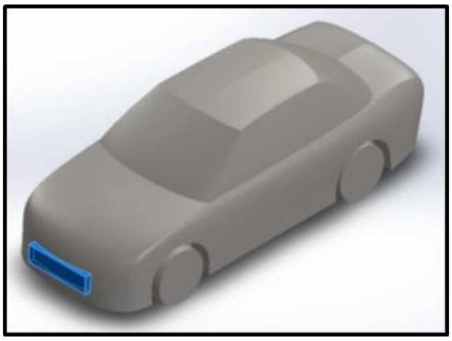

Figure 3.2 : model with wind turbine on front bumper.

3.4 Development of 3D Model

The method in this study is to design a vehicle Proton Perdana V6 for running the simulation. Catia VR521 program was used to complete this process. In this case, to accomplished an objective of the study where the author want to identify the position of maximum speed of wind on the front bumper of vehicle in the same time to identify a maximum current generated by the wind turbine

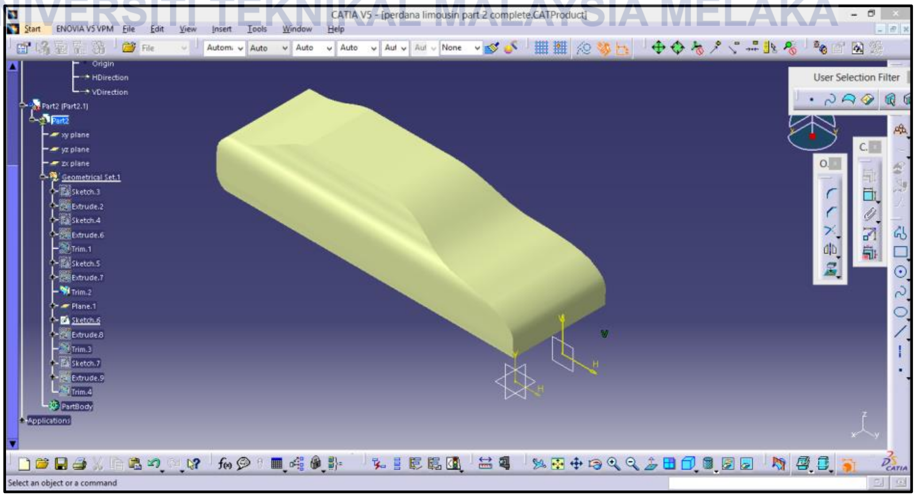

Figure 3.3 : Complete design model of car using CATIA software

These 3D models will simulated using CFD software (virtual wind tunnel) to identify the maximum current generated by the wind turbine Simulation will running in a different value of velocity used is 80 km/h , 100 km/h, 120km/h.

3.4.1 Process to develop 3D model of Proton perdana

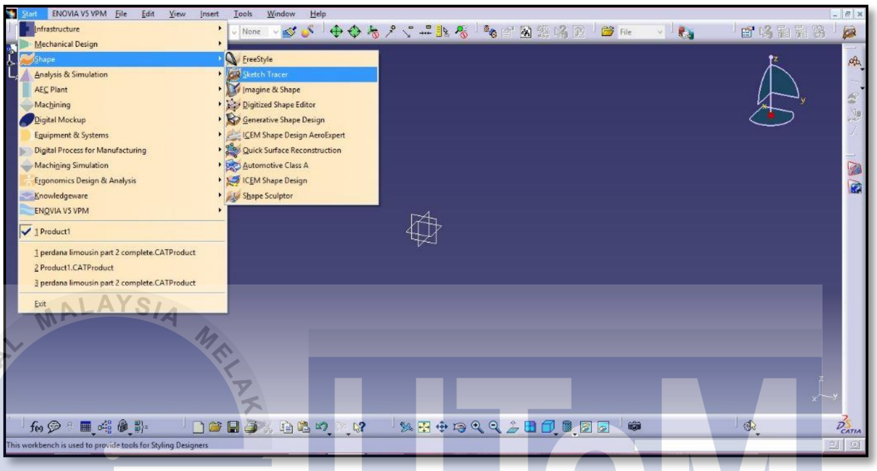

Figure 3.4 : Open software CATIA

Step 1 :

i. First step to development of model car.

ii. Click start , shape , and Sketch Tracer.

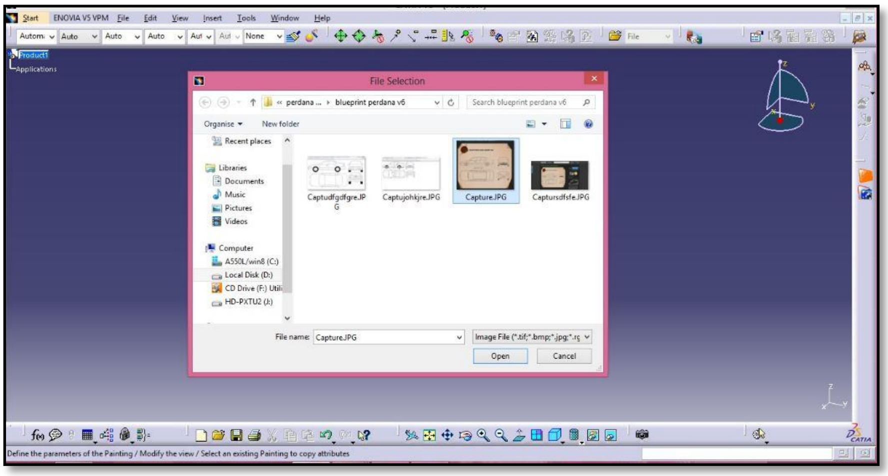

Figure 3.5 : Insert Blueprint of Vehicle**.**

Step 2 :

i. On the right tools bar click orange button colour (create an immersive sketch) , select file blueprint , open.

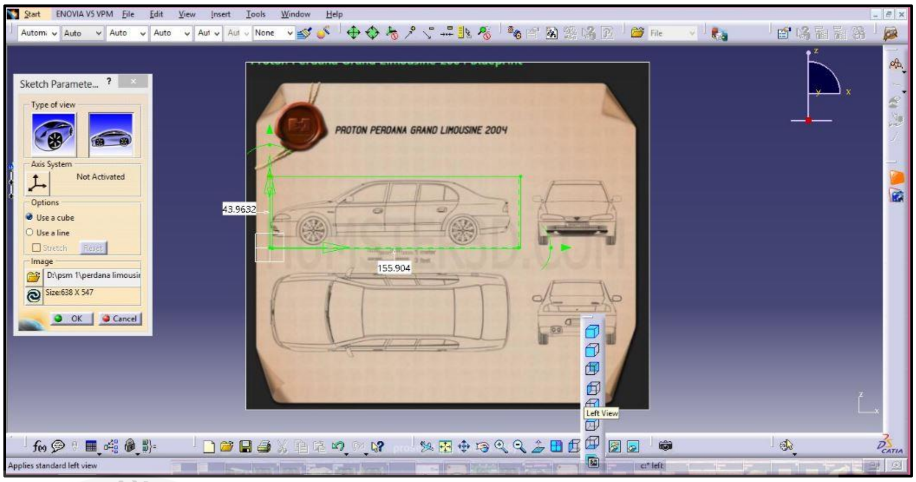

Figure 3.6 : Crop image

Step 3 :

i. On the bottom toolbar click icon left view.

ii. Crop the image into desirable size.

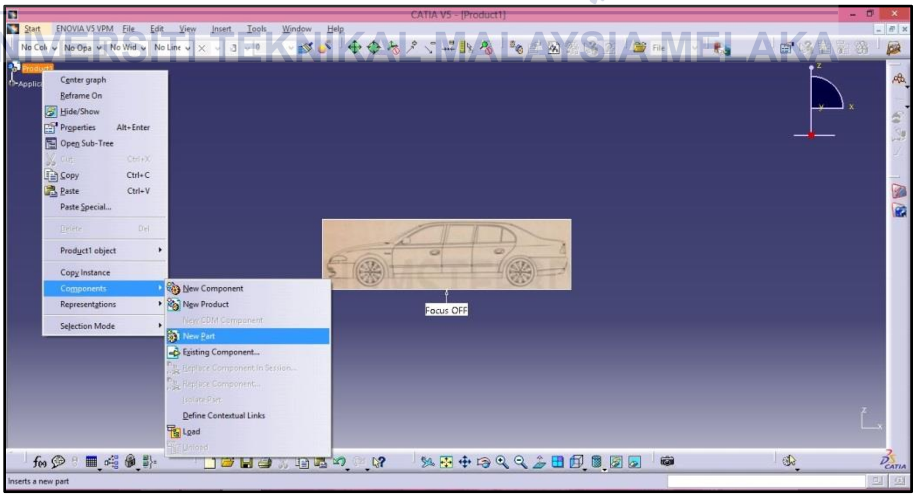

Figure 3.7 : Insert new part.

Step 4 :

i. After crop image, click at product , component and click new part

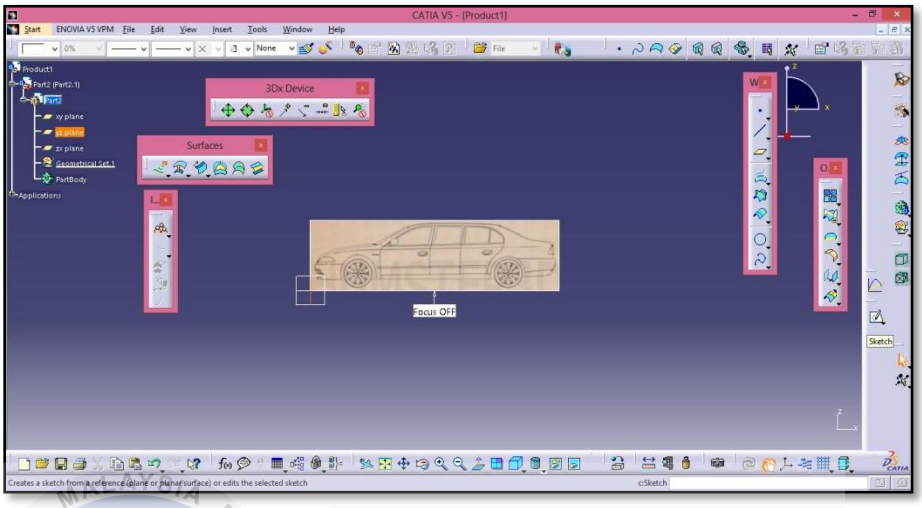

Figure 3.8 : Click plain to sketch.

Step 5 :

i. choose plane .

ii. click sketch.

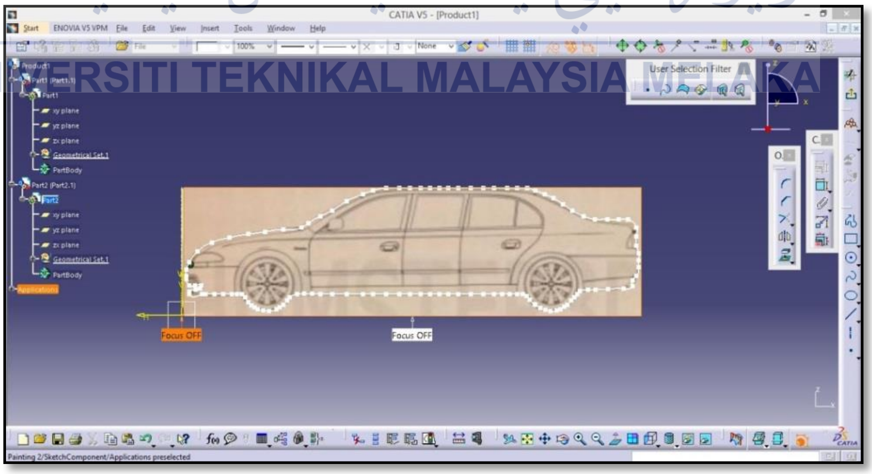

Figure 3.9 : Draw a line.

Step 6 :

i. On the right tool bar find a spline and click spline icon .

ii. Draw point of spline based on figure above.

iii. after finish create point , click exit work bench on the top right tool bar.

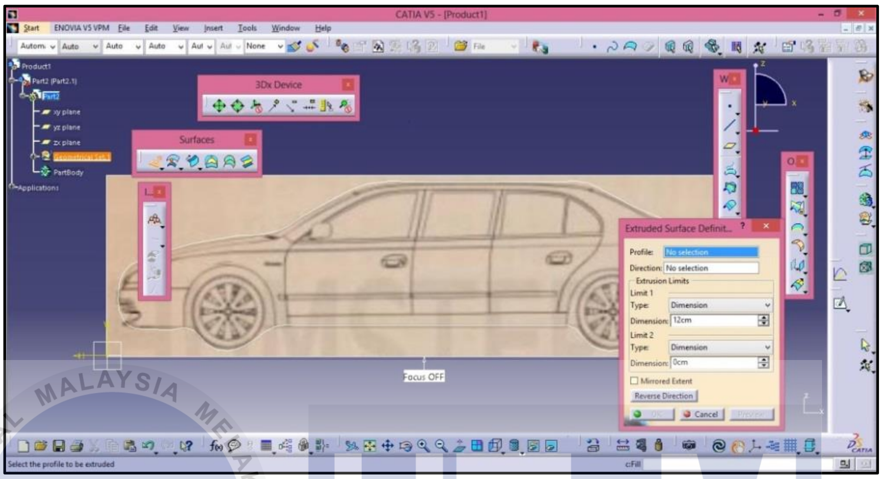

Figure 3.10 : Extrude

Step 7 :

i. click tool bar surface and click extrude.

ii. Insert dimension to extrude.

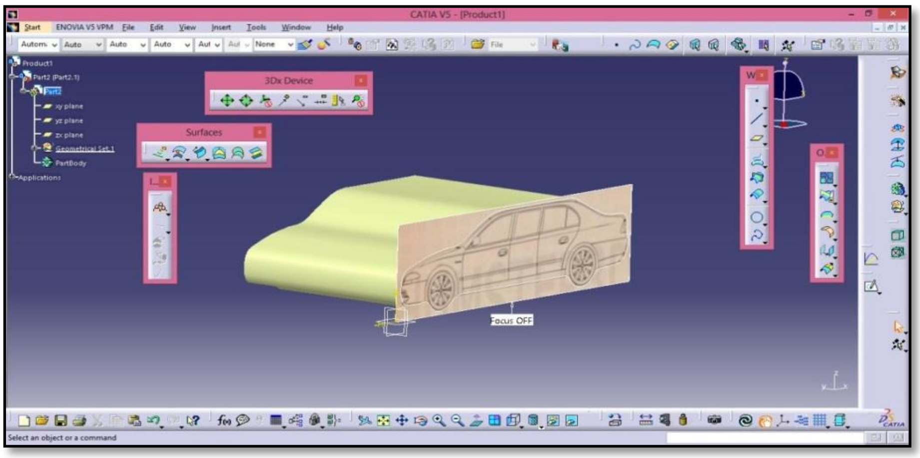

Figure 3.11 : model has been extruded

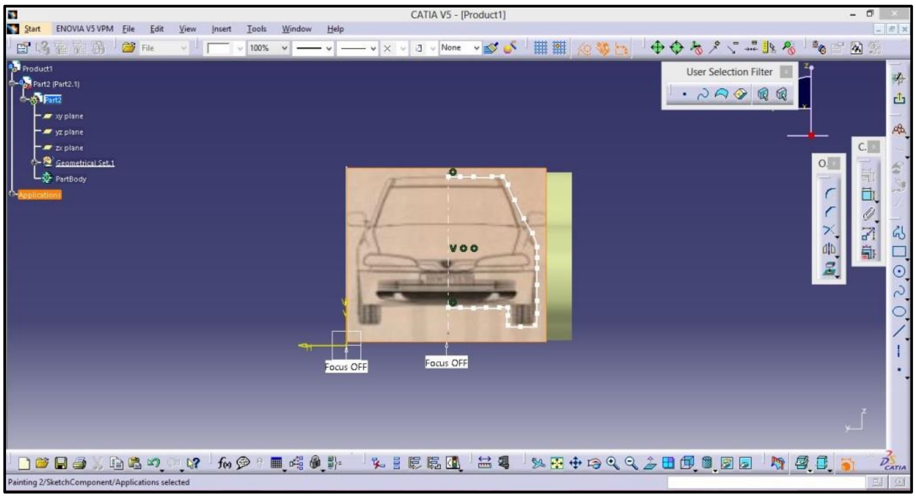

Figure 3.12 : Repeat step from step 1 until step 6.

Step 8 :

i. Draw a construction line at the center

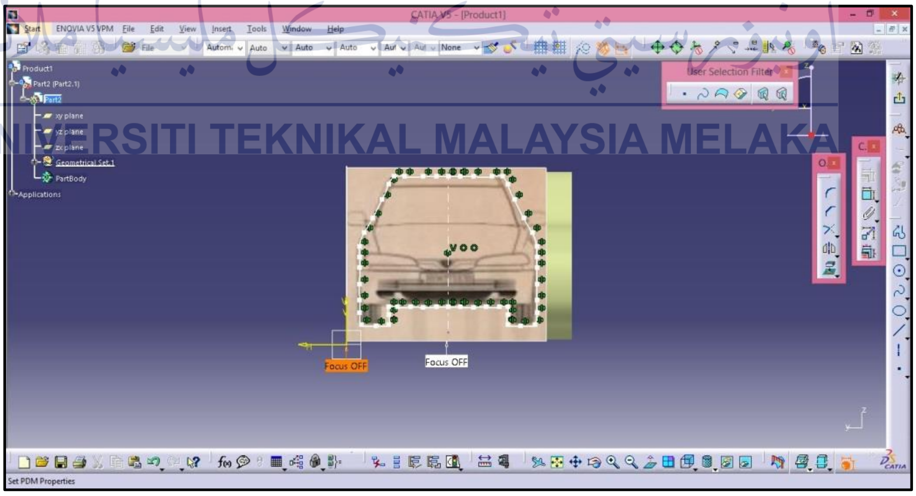

Figure 3.13 : Mirror line on construction line

Step 9 :

i. Click icon mirror

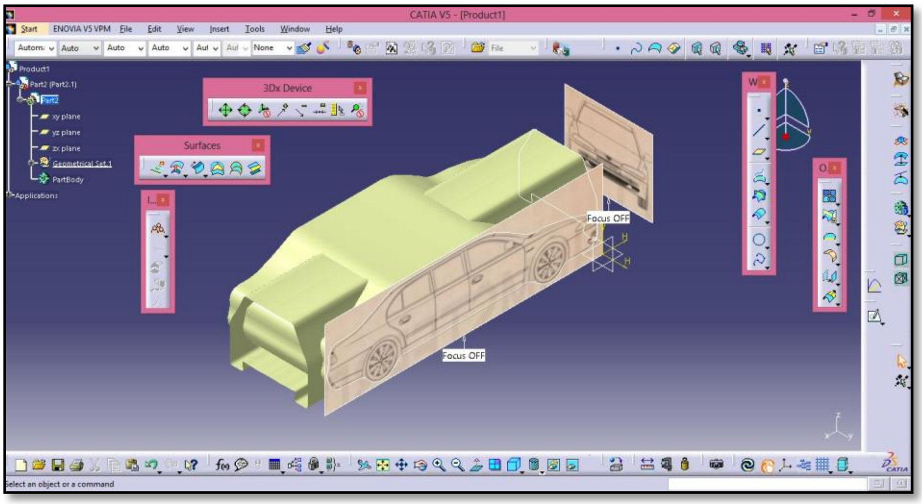

Figure 3.14 : The model after being completely extruded without trimming.

Step 10:

i. repeat step 6 to step 7.

ii. make sure the extruded model has no hole to ease the trimming process

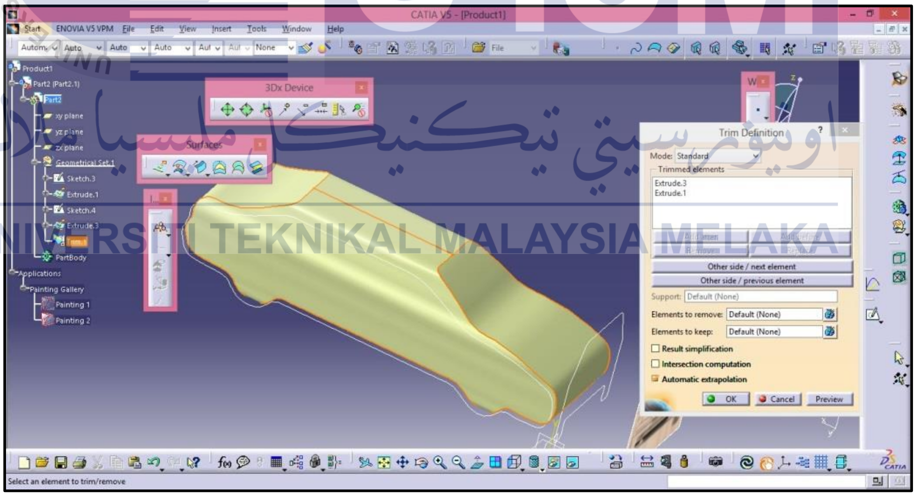

Figure 3.15 : Trimming Process.

Step 11 :

i. On the right tool bar , click trim

ii. Click on the surface want to trim.

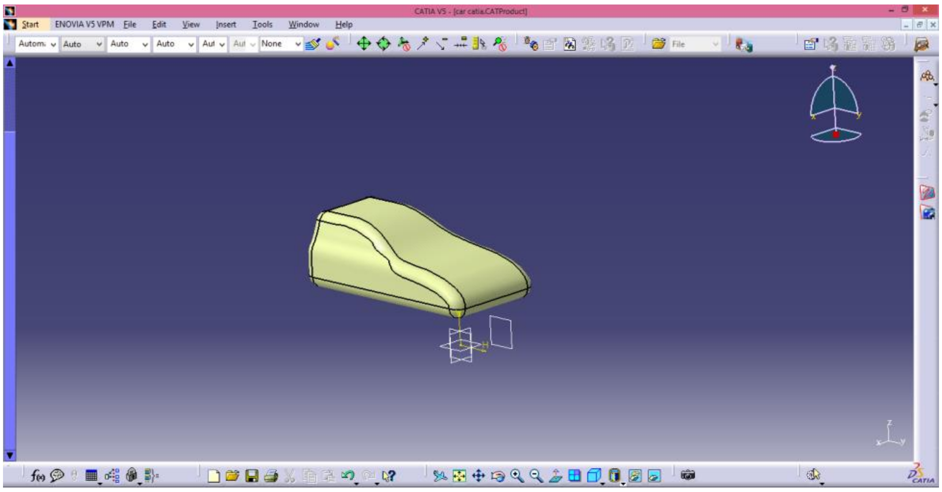

Figure 3.16 : Ready to study analysis process.

3.5 Simulation Process

After the model of the design process is complete, the next step is the simulation process. Author will use simulation software to run simulation Altair hyperwork. This simulation is to identify the ability of the turbine to convert wind energy.

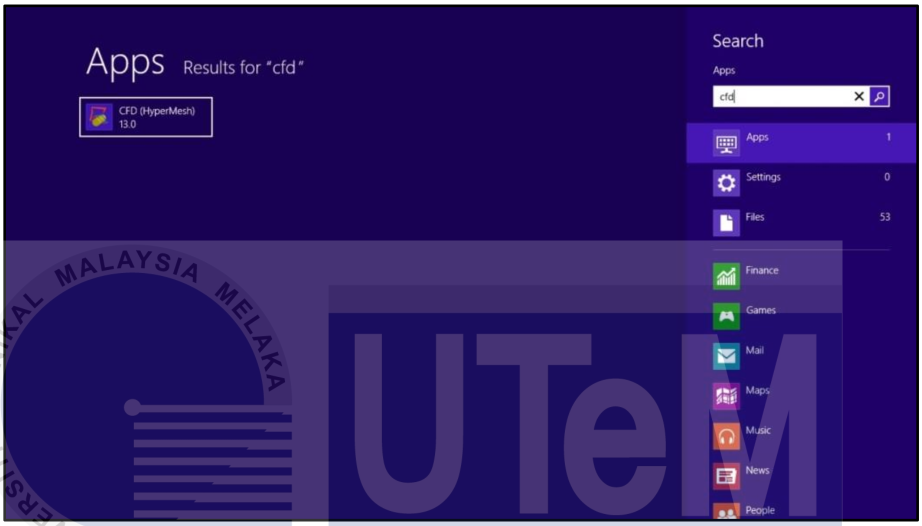

Figure 3.17 : CFD (Hypermesh) software 13.0

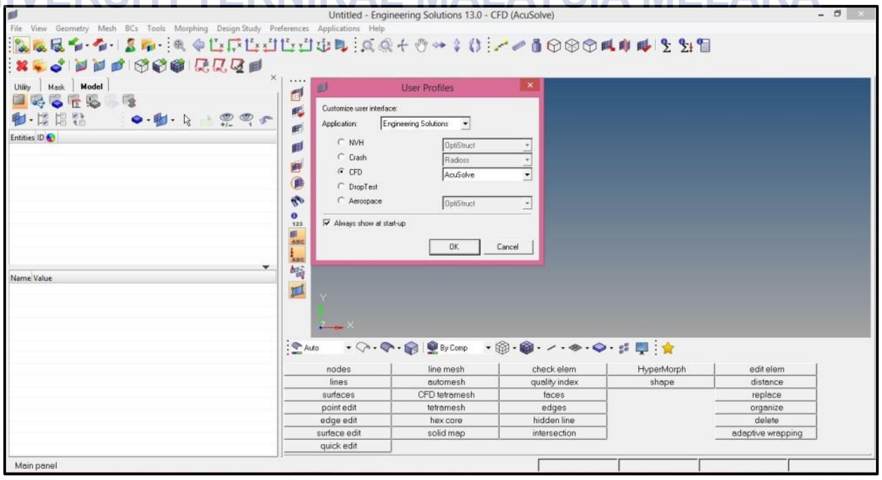

Figure 3.18 : Selected user profiles (CFD)

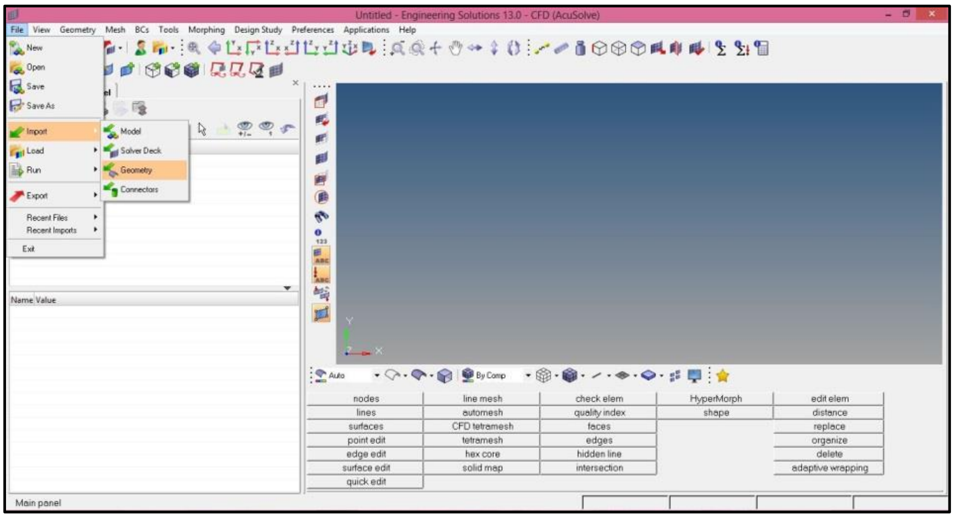

Figure 3.19 : Selected file and Import geometry

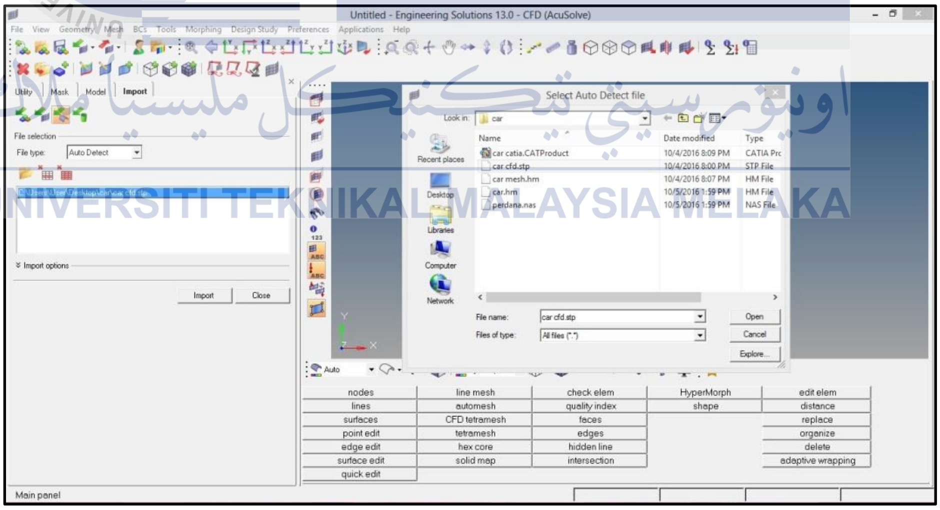

Figure 3.20 : choose file to open

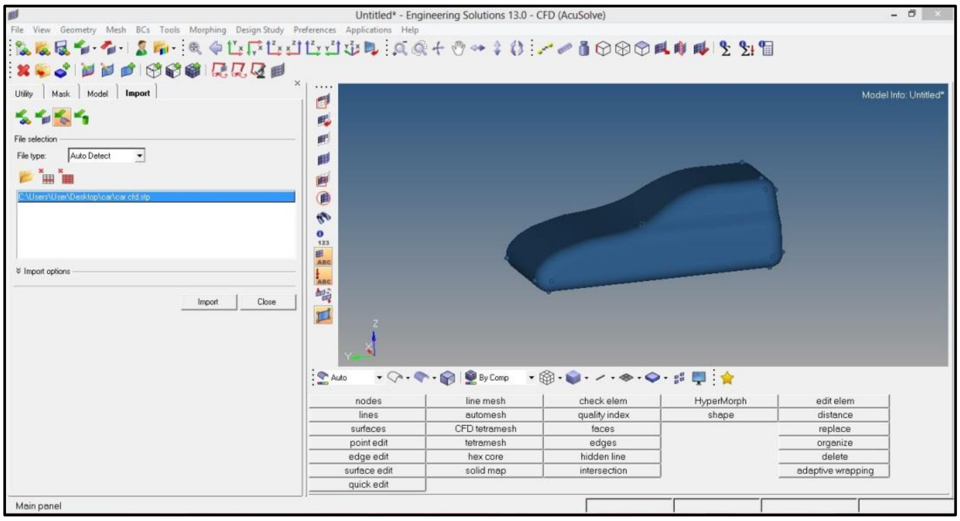

Figure 3.21 : File has been import

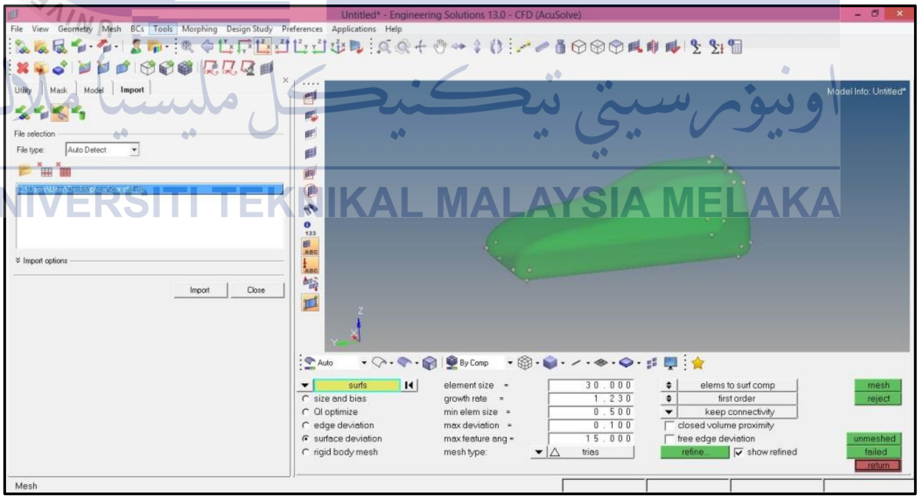

Figure 3.22: Click tab “Surfs” to selected element

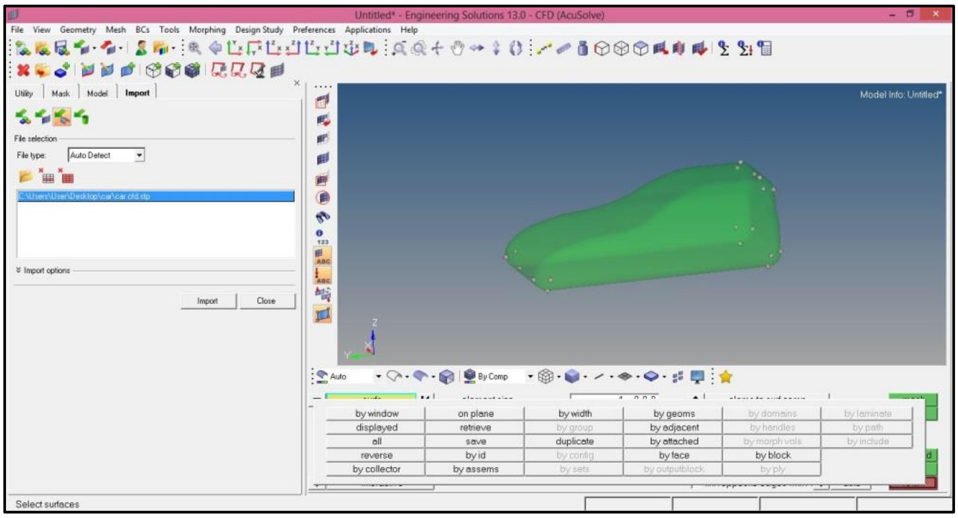

Figure 3.23 : Choose surface “all”

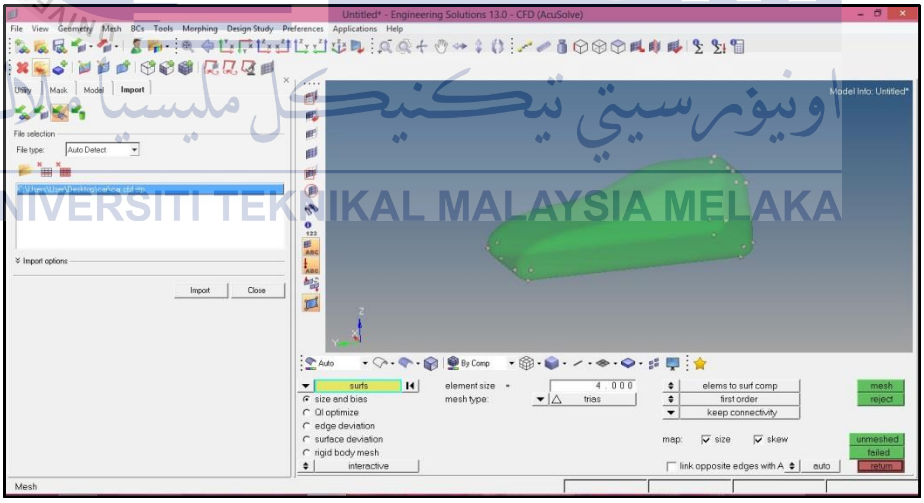

Figure 3.24 : Click “size and bias” after that adjust size of element to “ 4.000” and choose trias and click button mesh.

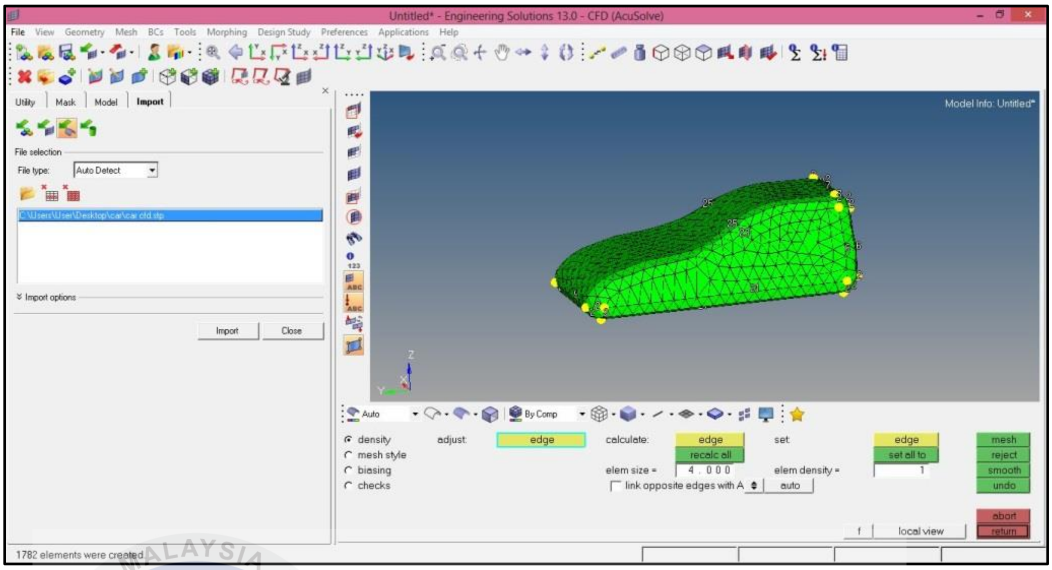

Figure 3.25 : Model after mesh and click button return

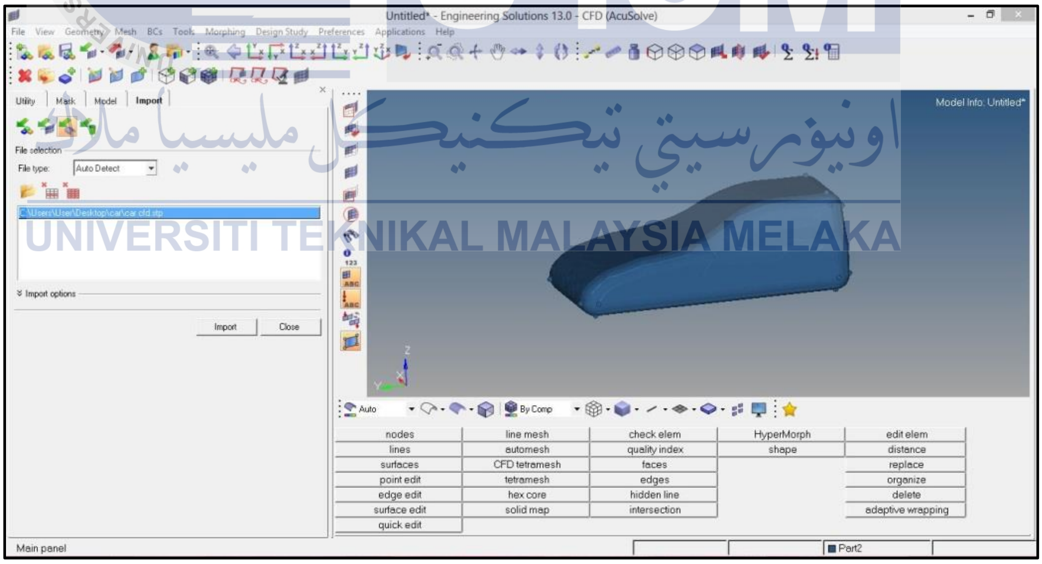

Figure 3.26 : Click quality index to check failure of mesh

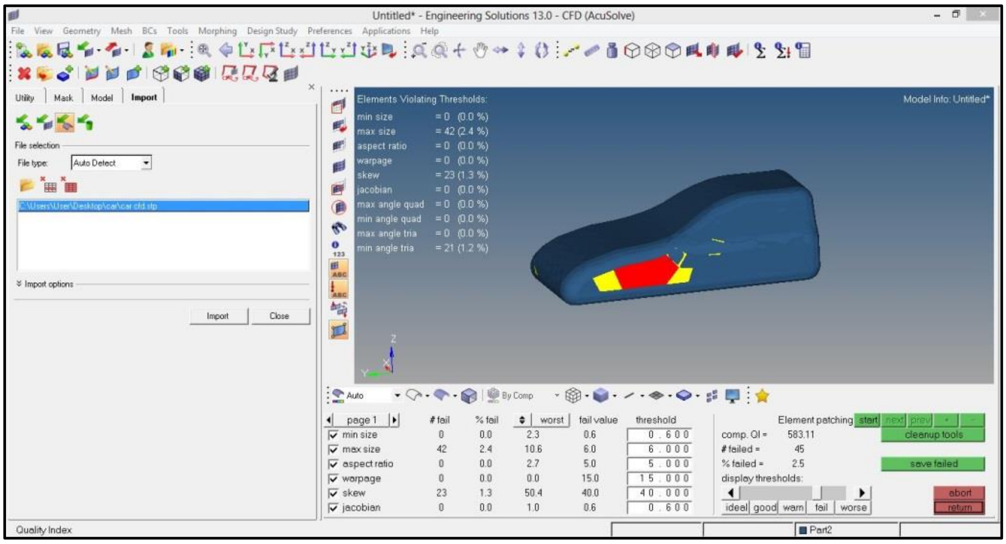

Figure 3.27 : "#failed" has 45 element can't mesh. Click return back to mesh again

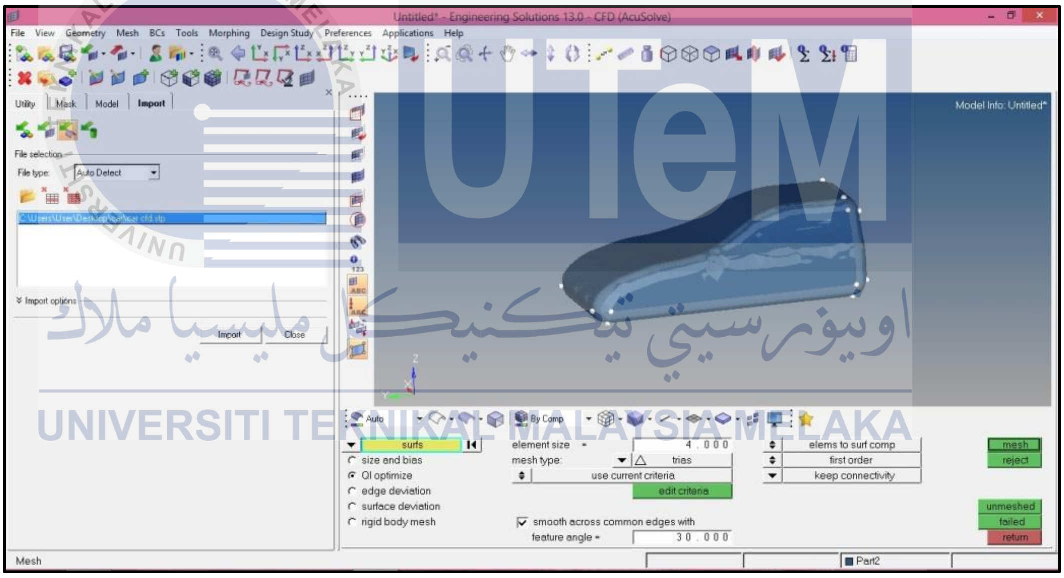

Figure 3.28 : Repeat step from Figure 3.21 to figure 3.24 .Click " QI Optimize" and mesh again. make sure quality index is 0

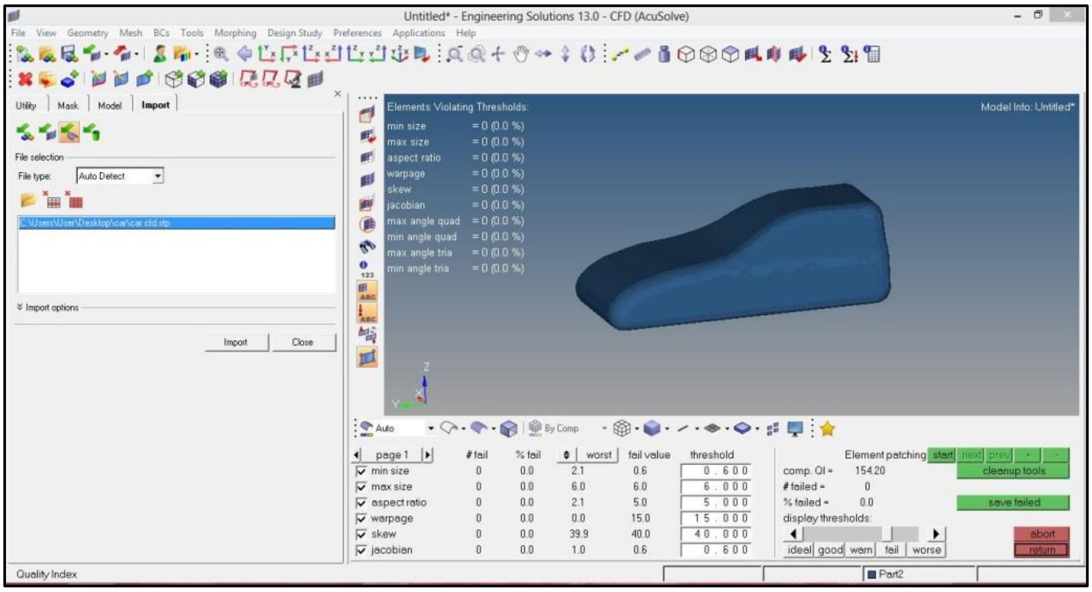

Figure 3.29: Check quality index is 0

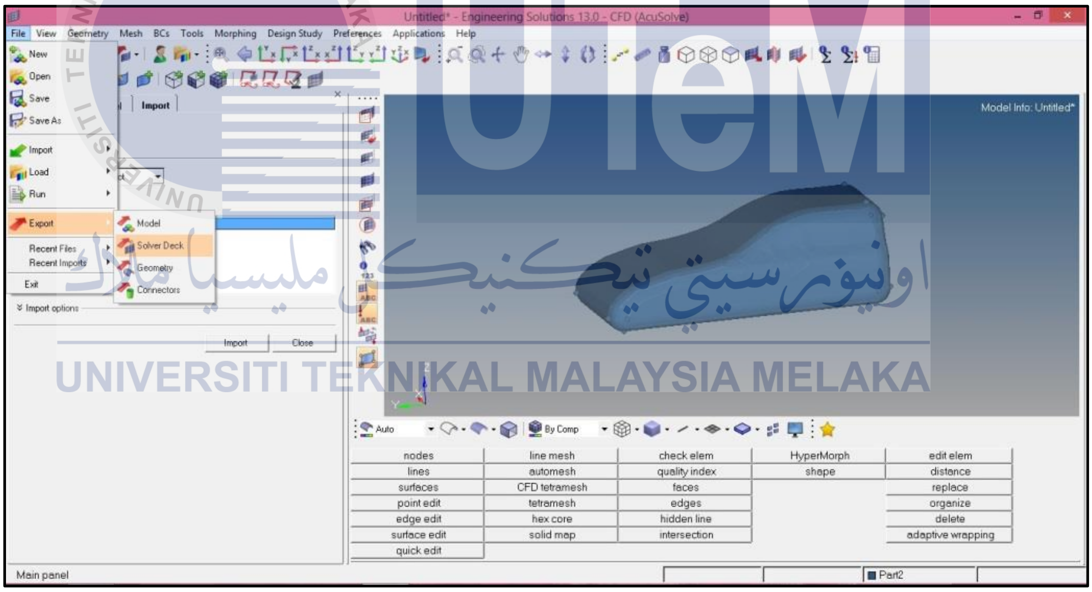

Figure 3.30: Save file " Export to solver deck"

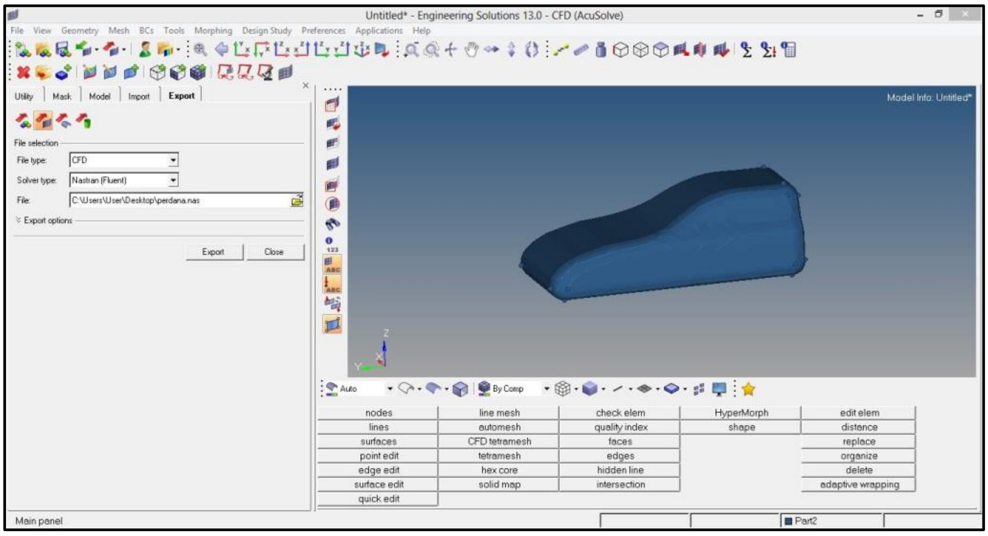

Figure 3.31: save file in “NAS” type.

3.6 Simulation Virtual wind Tunnel.

After the meshing process is complete, the next step is the running simulation on Virtual wind tunnel.

Figure 3.32: Open software Virtual Wind Tunnel

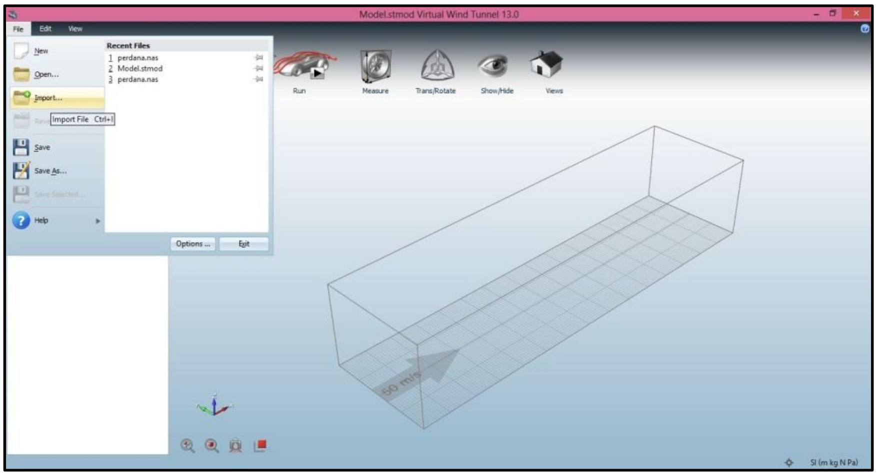

Figure 3.33: Import file that save in “Nas” type.

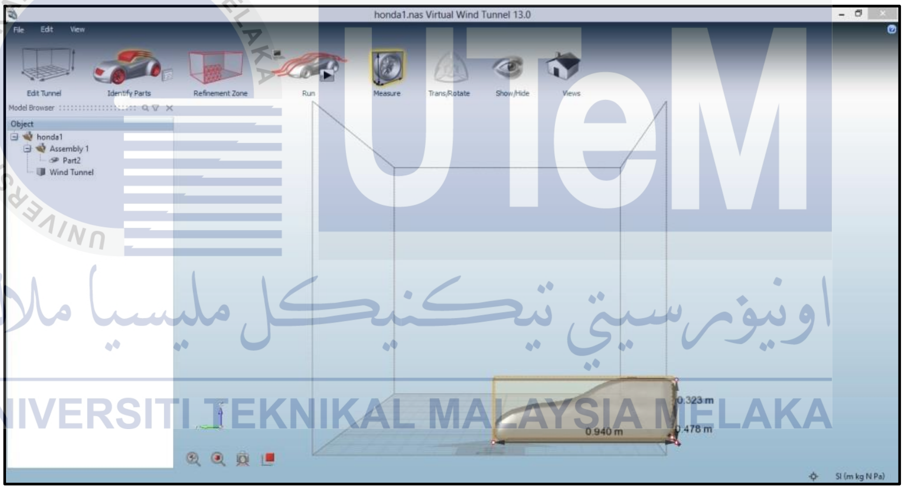

Figure 3.33: Model has been import. Click on model and click on the tab Measure to show dimension of model. Measurement of model will show like in figure 3.32

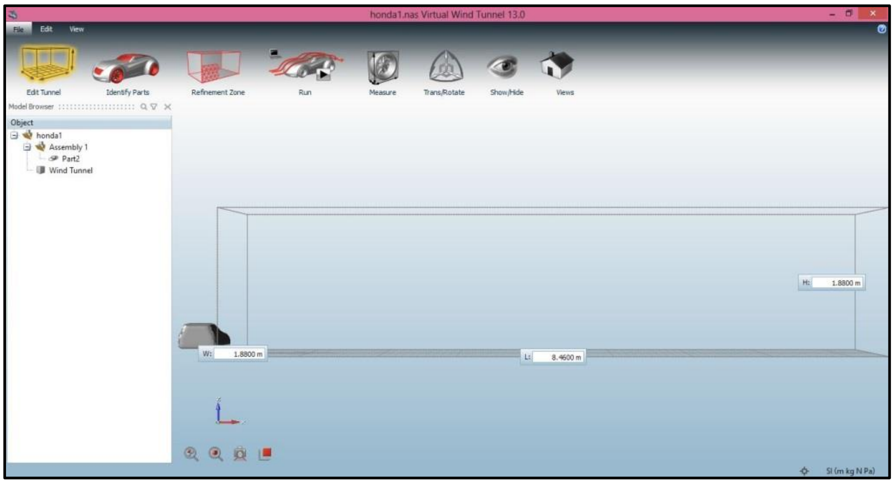

Figure 3.34 : Click tab edit tunnel, and key in value of dimension model. Length of model must be multiple 9 and value height must multiple 2.

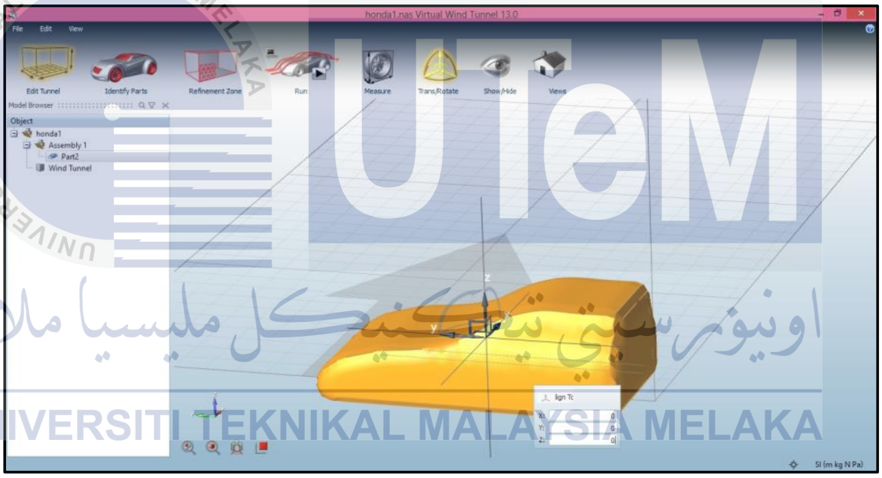

Figure 3.35: Click on model and click tab "Trans/Rotate" and click on centre of axis x, y, z and set to 0.

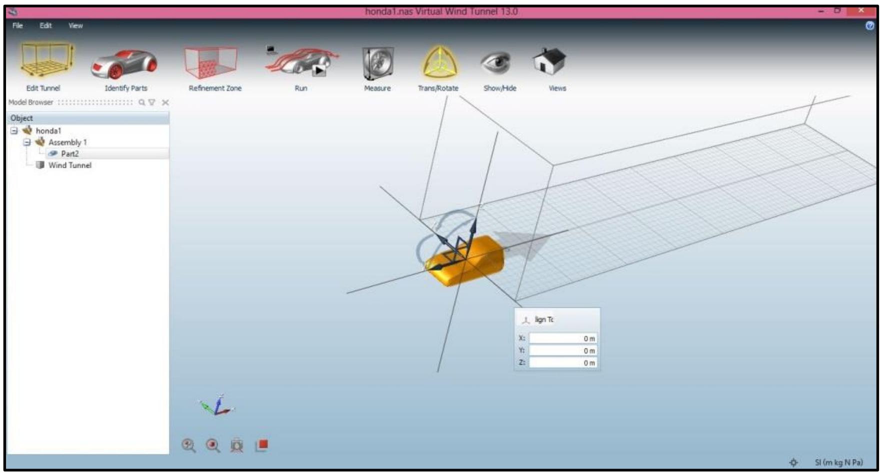

Figure 3.36: Model has been set to 0 axis. click on tab “edit tunnel” and click tab” Trans/rotate” to adjust a tunnel

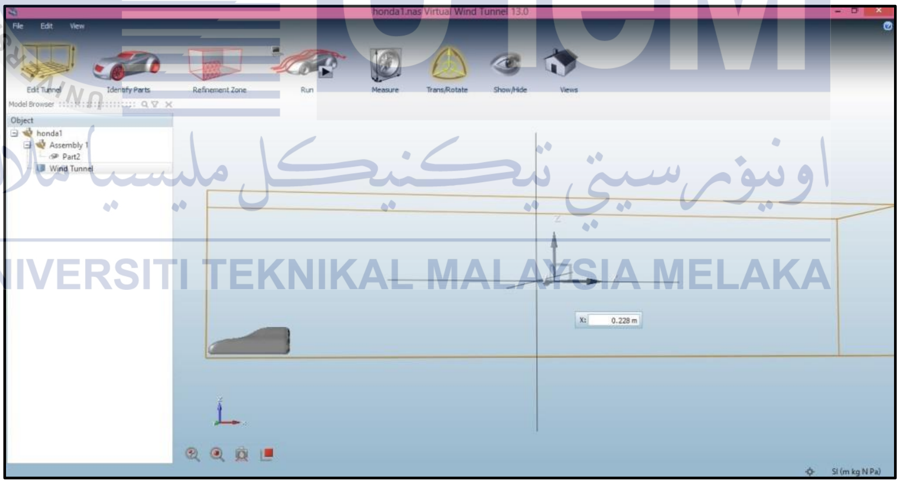

Figure 3.37 : Adjust tunnel to model in tunnel

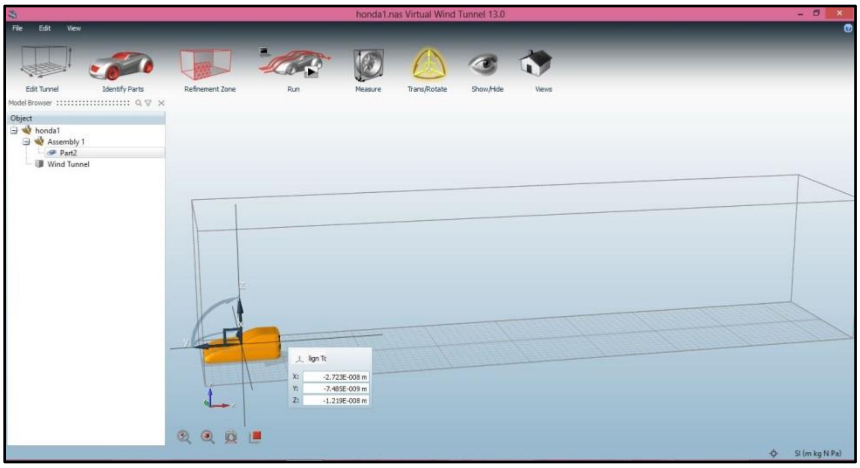

Figure 3.38: Click on model and click Trans/rotate and set to x axis. value of length model must multiple 3.

Figure 3.39: Value of x axis when multiple 3

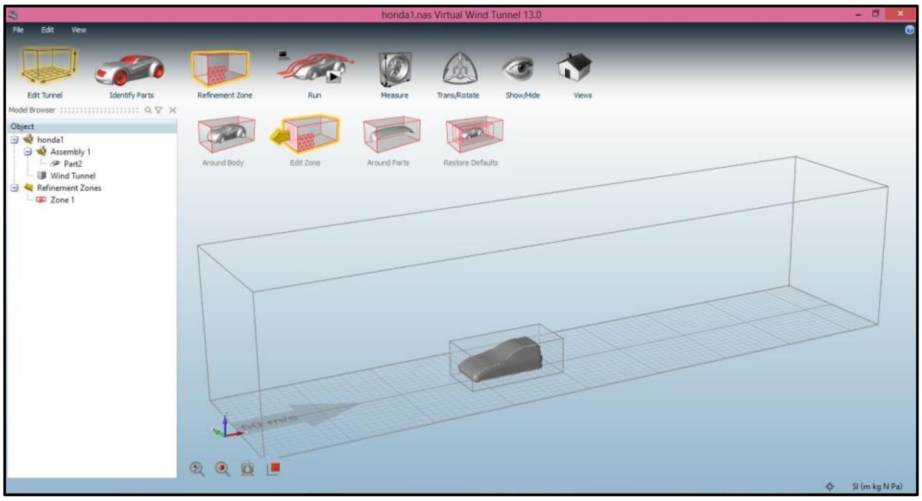

Figure 3.40: Click tab “ refirement zone

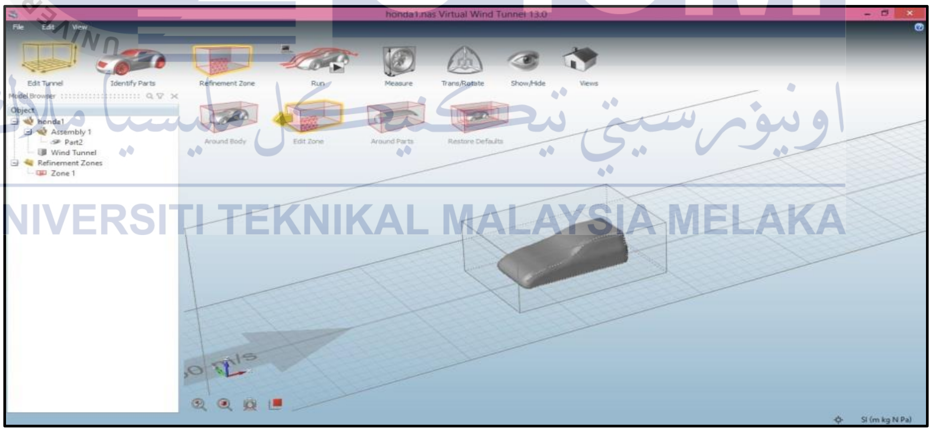

Figure 3.41: Edit zone make it close with body model

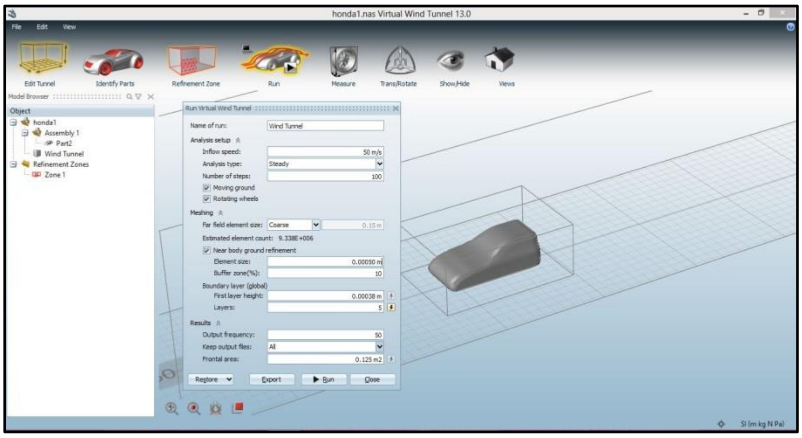

Figure 3.42: Click run. and adjust the data based on requirement

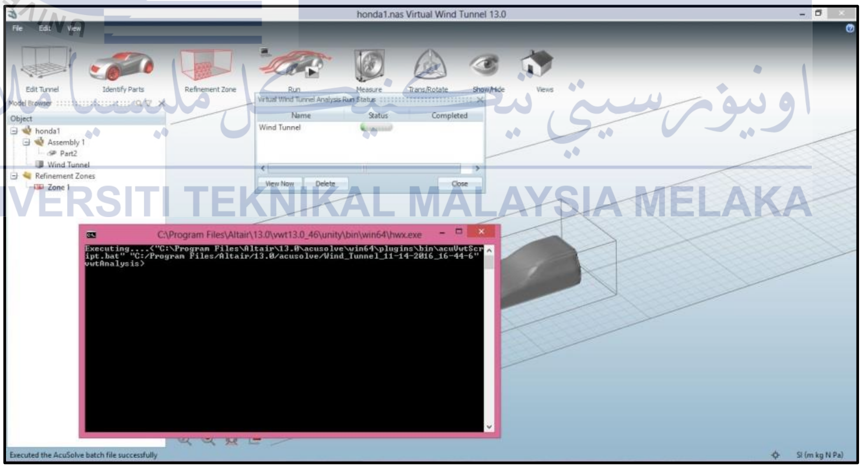

Figure3.43: Analysis is running.

3.6 Turbine Selection.

In this review, the vertical turbine model will be chosen. (VAWT) will be used for turbine blade positioned vertically in a very convenient place on the front bumpers. This is because what the authors understand the wind coming from the front in a horizontal state with a uniform velocity of the blade will rotate more efficiently

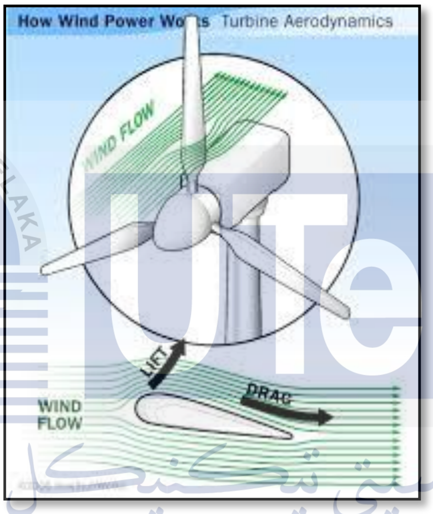

Figure 3.44 : Flow of air around a wind turbine blade cross section

3.7 Fabrication process

After define the best turbine to be used, the fabrication process can be start. First process to begin is the cutting process. The frame wind turbine will be placed on the front bumper to draw a line of outer it’s outer shape. Then, the angle grinding machine will be used to cut the area that have been labelled and then the frame wind turbine will be joint to the front bumper by using bolt and nuts. Next, The turbine will be attach to the scoop in horizontal position.

3.8 Measure Maximum Current

For measuring a current, a digital multimetre have been choose because a digital multimetre is more accurate and precise when reading a current compare to the analog multimetre

CHAPTER 4

Result & Discussion

4.0 Introduction

This chapter focusing on a result and discussion of an Acusolve's CFD technology and manual running testing . The detail of the result will be explain in this chapter.

4.1 Determining Location of Pressure

Figure 4.3 and Figure 4.4 shows the CFD simulation Acusolve. The figure shows the color of the surface pressure on each car body. Based on the scale of the pressure diagram below, the dark blue color that is the minimum pressure and red color that is the maximum pressure. Minimum pressure indicates a value of Gambar rajah 4.3 dan gambar rajah 4.4 show the process simulation Acusolve CFD. The minimum pressure point is -66.078 (Pa) where the surface it is dark blue color .While the red color indicates the maximum pressure value of 1069.117 (Pa).

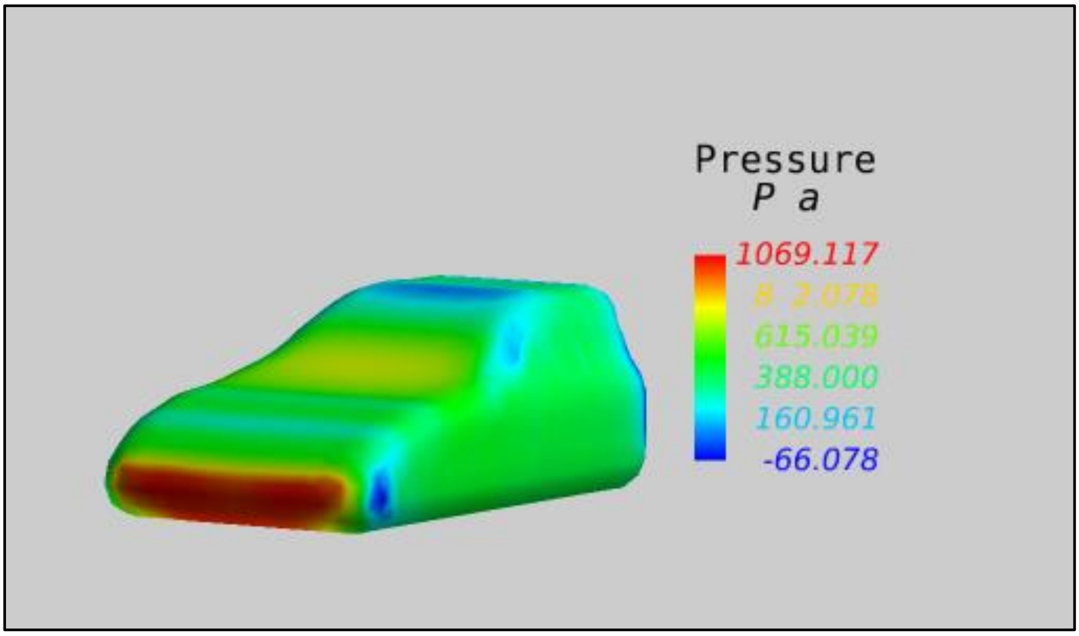

Figure 4.1 : Body Surface Pressure Contours

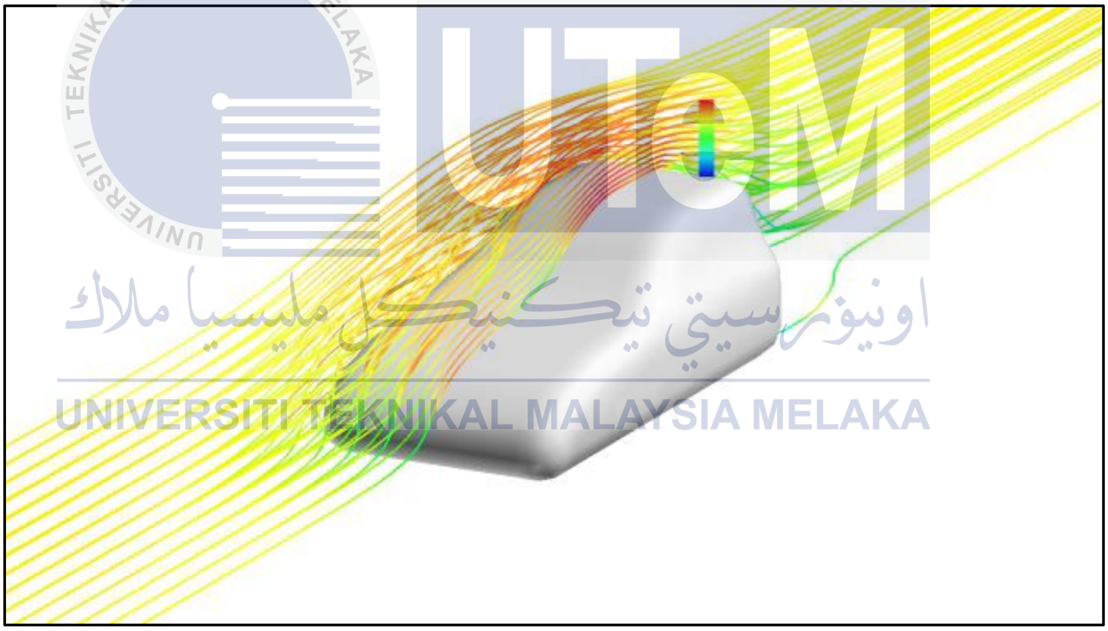

Figure 4.2 : Streamline

4.2 Current Generation

Before the experiment was conducted , there are two options to put the turbine vertically or horizontally. But from the results of the study , with the position of the front bumper in order to produce a better voltage is positioned in a vertical turbine. But there should be little magnet turbine to produce flux. Use a lot less disruptive magnetic turbine movement. Table 4.8 shows the data of experiment conducted for a voltage that can be generate by the turbine. This experiment in the test from a velocity of 10 km/h to 140 km/h. At a speed of 10 km/h to 30 km/h , there is no output voltage resulting. However at a speed of 40 km/h ,output voltage has changed to 0.1 v. This experiment continues with speeds reaching 140 km/h. When speed of 140 km/h output voltage were recorded is 9.2 V.

Table 4.1 : Velocity Vs Voltage

Velocity (km/h)	Voltage (v)
10	0
20	0
30	0
40	0.1
50	0.2
60	0.8
70	2.6
80	4.1
90	4.8
100	5.9
110	6.2
120	7.5
130	8.2
140	9.2

Figure 4.8 shows a graph of voltage Vs Velocity . The resulting graph is a plot of the data are ongoing experiment. From velocity 0 km/h to 140 km/h the resulting graph is like figure 4.8. From the graph show an increase of voltage evenly. Because the magnets in the turbine, current starts to generate at a speed of 40 km/h.

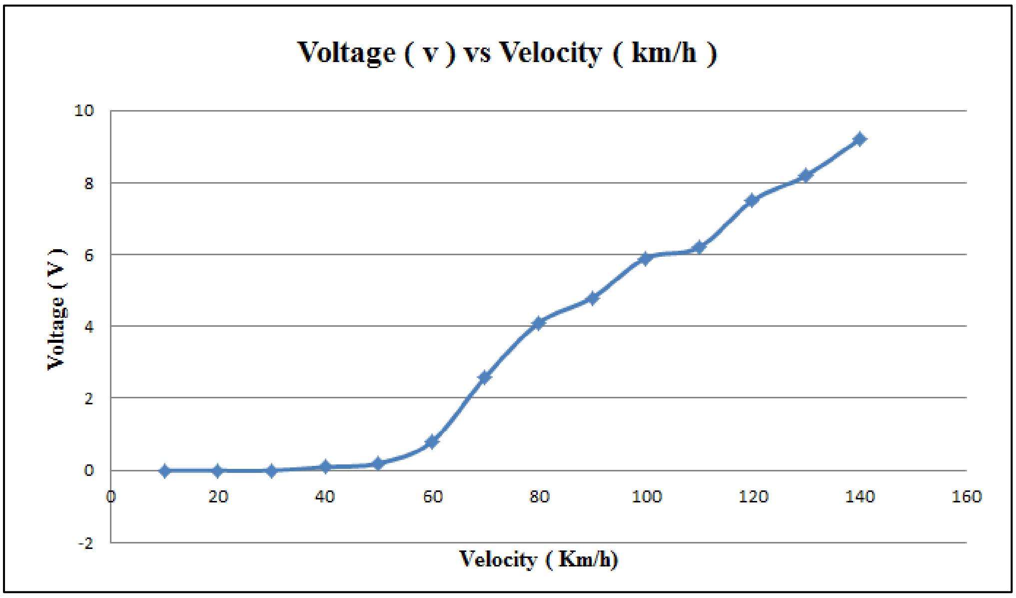

Figure 4.3 : Graph Voltage (v) Vs Velocity (Km/h).

CHAPTER 5

CONCLUSION

5.0 Introduction

This chapter focusing on conclusion and improvement for future work of this final year project. The detail of the conclusion will be discussed in this chapter.

5.1 Summary Of Research

As the conclusion after completing aerodynamic simulation process, the process to identify the position of wind on the front bumper for energy harvesting is achieved. On the other hand, the position of turbine can be determined appropriately for energy harvesting .The objective of this project to harvest the maximum current generated by the wind turbine has been performed.

5.2 Recommendation Future Work

For recommendation improvement for this project is to identify the appropriate turbine that can generate higher voltage Conclusively, this research can be enhanced by adding the voltage storage management system. This voltage storage system are able to supply the current to the electronic devices continuously .

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APPENDICE