DESIGN A NON-ELECTRICAL TABLE FAN

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A report submitted
in fulfillment of the requirements for the degree of
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DECLARATION

I declare that this report entitled “Design A Non-Electrical Table Fan” is the result of my own work except as cited in the references

Signature :……

Name :……

Date :……

APPROVAL

I hereby declare that I have read this project and in my opinion this report is sufficient in terms of scope and quality for award of the degree of Bachelor of Mechanical Engineering

Signature :……

Supervisor's Name :……

Date :……

DEDICATION

To my beloved father, Mohamad Norani bin Mansor

and my mother, Normah binti Abu Bakar

ABSTRACT

The title of this project is to design a non-electrical table fan. Through this research, the electricity consumption can be reduced. Thus, this product will be user-friendly. Indirectly, this is because it can be carried anywhere without the use of energy source to turn on the fan. Through this design, the consumption of energy sources can be reduced as well as high levels of Carbon Dioxide can also be controlled. After that, this report explain in detail about literature review that was studied by researcher in previous years. Apart from that this report comment on methods used in designing non-electrical table fan. The software used to design the product is CATIA P3 V5R20. On the other hand, 'Finite Element Analysis' (FEA) are used to analyse the critical part so that safety factor can be identified. In this report, product simulation was done by using DMU Kinematics. The purpose of this simulation is to give an overview operation to users before buying. In the end of study, the manufacture of non-electrical table fan will be considered in future.

ABSTRAK

Tajuk projek ini adalah untuk mereka bentuk kipas meja bukan elektrik. Melalui penyelidikan ini, penggunaan elektrik boleh dikurangkan maka produk ini akan mesra pengguna. Secara tidak langsung, ini kerana ia dapat dipikul di mana saja tanpa penggunaan sumber tenaga memasang kipas. Melalui reka bentuk ini, penggunaan sumber-sumber tenaga boleh dikurangkan serta tahap Karbon Dioksida juga boleh dikawal. Selepas itu, laporan ini menerangkan tentang kajian ilmiah yang telah dikaji oleh pengkaji pada masa dahulu. Selain itu pula, di dalam laporan ini mengulas tentang kaedah-kaedah yang digunakan dalam mereka bentuk kipas meja bukan elektrik. Antaranya ialah dengan menggunakan CATIA P3 V5R20. Pada bahagian analisis pula, 'Finite Element Analysis' (FEA) digunakan pada bahagian kritikal untuk mengetahui faktor keselamatan telah dikenakan. Di dalam laporan ini, simulasi produk telah dilakukan dengan menggunakan 'DMU Kinematics'. Tujuan simulasi ini dijalankan agar dapat memberi gambaran kepada pengguna sebelum mereka membeli. Di akhir kajian ini, kipas meja bukan elektrik yang terbaik akan dipertimbangkan untuk dihasilkan pada masa akan datang.

ACKNOWLEDGEMENTS

Alhamdulillah, thanks to Allah S.W.T for giving me life and allowed me to complete this project on time. In this opportunity, I would like to express my deep gratitude to my parents that always pray for my smooth journey to be an engineer. A lot of thanks to my supervisor, Dr. Mohd Asri bin Yusuff for giving me space to grow intellectually. He continually and convincingly gives me the courage and supports beyond my imagination. He doesn't limit my creativity and asked me to be free with my decision making and work. I also want to express my deepest gratitude to the panels involve with my PSM project.

Last but not least, I would like to express my thanks to all of the my members that always motivate me for giving good cooperation in comment, opinion, and supports directly or indirectly to the very end.

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LIST OF ABBEREVATIONS

PSM	Projek Sarjana Muda
CAD	Computer Aided Design
CATIA V5R20	CATIA Version 5 Revision 20
DC	Direct Current
USB	Universal Serial Bus
EMF	Electromagnetic Flux
LSF	Low-Speed Flywheels
HSF	High-Speed Flywheel
micro-HSF	Micro-High-Speed Flywheel
RPM	Revolution Per Minute
FEA	Finite Element Analysis
2D	Two Dimension
3D	Three Dimension
BOM	Bill Of Material
DMU	Digital Mock-Ups
UTeM	Universiti Teknikal Malaysia Melaka
PDS	Product Design Specification

LIST OF SYMBOL

ω	Rotational speed of fan
g	The acceleration due to gravitional force
l	The length of the string
r	The radius at which string connect to the blade
θ	The angle of the string with the vertical

CHAPTER 1

INTRODUCTION

1.0 Introduction

The final year project as known as a Projek Sarjana Muda (PSM) is an individual project research related to mechanical engineering. The main purpose of this PSM is to apply the basic of science, mathematics and mechanical engineering. Additionally, this project provides exposure to product design and simulation to complement project objectives. This chapter explains the introduction of importance, objectives, scope, problem statement, and summary of project reports. All of these will be debated in the subtopic of this chapter.

The title of this project is to design a non-electrical table fan. Through this research, the electricity consumption can be reduced thus, this product will be user-friendly. Indirectly, this is because it can be carried anywhere without the use of energy source to turn on the fan. Through this design, the consumption of energy sources can be reduced as well as high levels of Carbon Dioxide can also be controlled.

1.1 Project History

Malaysia located near the equator line, being hot and humid throughout the year. So in this condition, people usually feel uncomfortable in a hot environment. Hence, the use of table fan is recommended to become one of the cooling agent product. This is because fan used to create a flow of the air. One of the advantages using this table fan is, it can be carried anywhere but has a limitation on the usage of electrical power. Therefore, the fan industry needs a positive transformation that can facilitate user to use table fan in various places. Thus, the existing electrical mechanism in table fan motor needs to be modified so that it no longer use electricity. The mechanism that can be replaced with another mechanical mechanism. However to design a new mechanism needs more research in

order to have a good result. So, the focus study in this project is to design a non-electrical table fan mechanism to replace the electric motor in a table fan.

1.2 Problem Statement

In a real world nowadays, most of the advanced technology industry requires a high electricity demand to run their production. It is good to produce goods, but the long-term impact of using high electricity can cause greenhouse effect leads to change of global climate. According to F. Anas Alam (2016), the haze that hit Malaysia in almost every year following El-Nino is the highlight of the global climate. Therefore in order to prevent this thing happen again, Malaysia is currently undertaking steps to reduce electrical energy consumption by replacing to renewable energy. The other way to use less energy is also by having a mechanical mechanism where it only has a mechanical part to move this product.

In addition, the problem of a traveler to use an electrical source during travel is limited. As Malaysia located near the equator line, being hot and humid throughout the year. The traveler who joint outdoor activities in Malaysia need to use portable table fan to comfort themselves. This is because portable table fan can be carried anywhere but there has limitation use on battery. The absence of electricity resource whenever going picnic or backpack in a long period becomes a problem to the users because of unable use table fan when sort of battery needed since it requires a power supply. Unfortunately, this table fan has a limitation on the usage of electrical power. This situation makes difficult to a user.

Therefore based on the problem above, one of the solutions had been made is to design a non-electrical table fan mechanism. This mechanism in table fan motor needs modified and replaced with other mechanical mechanisms so that it no longer use electricity.

1.3 Objectives

The objectives of this project are to:

1) Design a non-electrical table fan mechanism
2) Produce product design capable of penetrating the current market.

1.4 Scope

The priority of this project is the design of a mechanism of production that does not require the power source to move the desk fan blade. This product design and analysis uses Computer Aided Design (CAD) software, CATIA V5R20. However, this study does not cover angina from outside sources.

1) Collect to all information related to the table fan.
2) Design mechanism that allows the fan blade to move without using electrical energy.
3) Design and analyze mechanisms using Computer Aided Design (CAD) software and analytics software.
4) Simulation movement of table fan mechanism.

CHAPTER 2

LITERATURE REVIEW

2.0 Literature Review

Scientific research or better known as past studies is a study of some time ago. It is used as a guide and reference material for a new research. The information obtained is an increase in the research conducted. This scientific study can be found in journals, newspaper clippings, the internet, reference books and so on which are related to the research topic. The special reference material under this scientific study is acknowledged as its originality as it states the sources and evidence of the validity of the statements being discussed.

2.1 Establishment Of Table Fan

According to (Zein, 2015), there are two types of fans namely traditional fan and electric fan. The discovery of the fan has been identified for thousands of years and has been used by several countries in the world such as Egypt, Greece, Rome, and China. At that point, there have been various types and functions of the fan. About 4000 years ago, the first fan was found in Egypt's tomb of King Tutankhamen which was dug in 1922. This fan serves as a religious ritual so that a fan is a sacred thing. At that time, the fan was also a symbol of the power of the king. There are two fans found in the tomb of the king. One of the fans was a pair of gold-plated and made of ostrich feathers, while another fan was covered with ebony with gold and precious stones.

As stated by (Muhammad Nurdin, 2013), there is also a growing fan in Europe. In 1500 Italy was the first country to produce a fan. At that time, the fan was an exotic and very stylish trading commodity. The fan is also seen as a symbol of prosperity and one's social class. In the 16th century until the 18th century, the fan's development as a fashion

commodity was very popular. At the beginning of the 20th century, however, the fan function was riddled. At that time, the fan was no longer used as a fashion accessory but became an advertising tool. While in Spain, fans are a tool to cool air as the country has a hot climate. In 1882, the first electric fan was discovered by Suchuyler Wheeler. He introduced an electric fan with two blades without any protector and moved with electric motor power. After that, the fan technology was developed by Philip H. Diehl in 1887. Diehl introduced the ceiling fan and continued to expand its use. In 1904, he added split-ball joints to his electric fan. As time goes by, after three years later, this idea is the basis of mobile fan revenue. In 1902, Willis Carrier discovered air conditioning (AC).

At present, there are several types of fans, among them are air conditioning, air freshener, ventilation system, and dryer where each of its kind has a different function. Additionally, it can also be associated with a user's system

2.2 Type Of Table Fan

There are three commons type of table fan in current market which is electric table fan, USB table fan, and portable rechargeable battery fan. In the subtopic is explained in detailed about three of them.

2.2.1 Electric fan

According to M.W. & Rockwell, S. (2015), the electric fan is one of the most important electric inventions of all time. This electric table fan has blades similar to a water or steam turbine and also usually consist of a motor as shown in Figure 2.1. This motor drives a rotating shaft to make a blade rotate. It normally has a plug to connect to power supply.

Electric fans are comprised of a motor run by an electric current which is attached to fan blades via a shaft. The rotor shaft is run by the motor, and turns the fan blades at different speeds depending on the speed set for the motor (Calyton, V. (2013.).

Figure 2. 1: An old fan with a heavy larger motor M.W. & Rockwell, S. (2015)

Based on the article The Portable Appliance Expets, air and water, there are eleven types of electric fans such as table fans, pedestal fans, window fans, wall mount fans, floor fans, tower fans, ceiling fans, box fans, misting fan, industrial fans and blowers, decorative fans, and bathroom exhaust fans. By referring Table 2.1 below, each of this type fans style had own specification to make it special.

Table 2.1: Type of electric fans and it functions

Table Fans	Pedestal Fans
	
Table fan usually in a small and compact size to make the user can transport easily. This table fan are recommend for cooling personal spaces and can be placed on floors, desks, tables, or countertops.	This pedestal fans is adjustable height for convenient operation and also have oscillating heat for distributing air in left and right direction.
Window Fans	**Wall Mount Fans**
	
Window fans brings in fresh air and draws stale air out. This window mounting saves floor space and valuable table.	Wall mount fans creates a comfortable environment in areas with limited floor space. It also provides powerful air circulation. Usually setting in industrial such as warehouses, workshops, factories, garages and more.

Floor Fans

Usually for ventilation at foot level where it provide powerful airflow. An ideal for areas where mounting a fan on a wall or ceiling is not feasible. Good for cooling homes, warehouses and offices.

Tower Fans

A very thin and vertical design allows it to fit into small and compact spaces. Less likely to tip over than a top-heavy pedestal or stand fan. It is good for cooling homes and offices because it has no sound produce.

Ceiling Fans

Ceiling fans are located at ceiling where it comes with variety of styles. It also can slash heating costs when used in the winter and make rooms cooler by providing a circulatory breeze.

Box Fan

Extremely versatile because it can be placed on the floor or in an open window (similar to an AC). This box fans helps circulate indoor air and prevents it from getting stagnate. It suitable for most home cooling needs.

Misting Fans

Misting nozzles create a fine, cool mist which evaporates and creates a chilling breeze. Simple to assemble and incredibly energy efficient. This misting fans ideal for use in outdoor areas such as backyards, patios, and athletic fields.

Industrial Fans and Blowers

Usually constructed of durable metal or sheet and typically best suited for high-volume, and high static pressure applications. The purpose of this product is used for heat stratification, ventilation and preventing air stagnation.

Decorative Fans

This type of fan offer a refreshing change from traditional plastic electric fans. Cools off rooms in style and come in a variety of colors, designs, and styles.

Bathroom Exhaust Fans

Greatly reduces or eliminates problems created by excess moisture. The aims of this exhaust fans is to prevent pain from peeling, doors from warping, and accumulation of mold spores.

Source: The Portable Appliance Experts, https://www.air-n-water.com/electric-fan-guide.htm

2.2.2 Portable non-rechargeable battery fan

At indiamart.com, there has mini handy fan operates on 3AA size batteries or equal to 6v direct current (DC) adapter. It also comes with two-speed button and very effective in a no-electricity situation or while traveling or in outdoor activities like picnic or shopping. In addition, it provides perfumed air by putting perfume or air freshener.

Figure 2.2: Mini Handy Fan (Internet source: https://www.indiamart.com/nirmals-hitech-marketing/different-types-of-fan.html)

2.2.3 Portable rechargeable battery fan

Portable rechargeable battery fans are usually attached with lithium ion batteries. According to (Hobbs, B. 2016), rechargeable batteries power devices the same way that disposable batteries do by chemical reactions at the positive and negative electrode. The reaction allow positively charged ions to move from one electrode to the other inside the battery, and negative electrons to move through the wire in the circuit, producing a current. Contrary to rechargeable batteries, when the battery is charging into an external power source forces these chemical reactions to happen in reverse. The positive ions lithium in batteries recombines the battery is connected to a circuit.

Figure 2.3: Portable rechargeable fan (internet source: https://www.lelong.com.my/kx/rechargeable+fan.htm)

2.2.4 Office table solar-DC powered fan

As stated (Ismail, Ojolo, Orisaleye, & Olusegun, 2014), in order to minimum energy consumption, the fan was made not to oscillate but rather was made such that it could be manually tilted up and down to change its orientation. This aim is to create design ideas on the solar fan through product design specifications that would enhance better lifestyles and comfort of the user, designing a solar fan that meets safety requirements of the of the user in the environment. A table fan was necessitated by the need to ha a fan could be powered by a renewable energy source. In addition, a 12 DC batter was included just I case for back up use when there is no sunlight in the night.

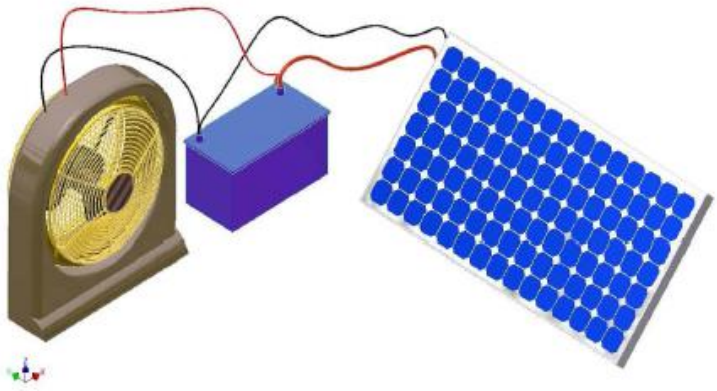


Figure 2.4: The table fan system setup (Ismail et al., 2014)

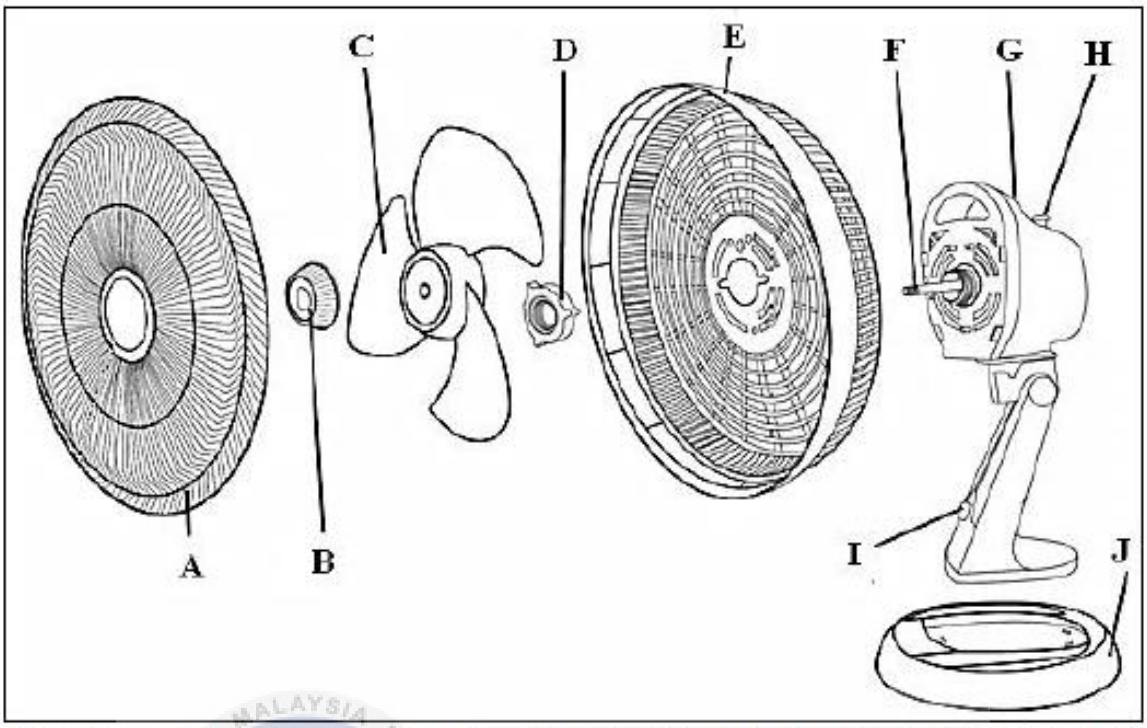
2.2.5 USB table fan

This USB table fan is compatible with all computers, laptops, power bank, portable chargers and other devices with USB output. This USB table fan usually comes with a small size where it can be easily to take, can be used anywhere. This USB table fan is quite strong wind with low power consumption.

Figure 2.5: USB table fan (internet source : http://www.lazada.com.my/lileng-6-inch-aluminium-mini-usb-table-fan-black-1081337.html)

2.3 Table Fan Components

In every product, there have several components to make the product function very well. So in order to build a non-electrical table fan, the researcher needs to know each of the component function in table fan. According to the (Sanghani, 2016), the basic element of the table fan include the stand, base, blade, motor, motor housing, gearbox, oscillator, shaft, and link. By referring Figure 6, the main parts of the table fan are stated.



A: Front Guard, B: Blade Cap, C: Fan Blade, D: Rear Guard Nut, E: Rear Guard, F: Motor Shaft, G: Motor Housing Assembly, H: Oscillation Knob, I: Speed Regulator, J: Base.

Figure 2.6: Assembly of table fan (Sanghani, 2016)

2.3.1 Stand and base

According to (Sanghani, 2016), the stand and base of table fan is important to reduce vibration and transmit all the loads to the floor. This is because when oscillating head fan is moved, the stand and base of table fan remain at one place without making any movement. The oscillating fan height can be adjusted in upward and downward of a rod within stand lock with a lever or knob at the bottom of the road.

2.3.2 Type of blade

The blades of table fan are designed to produce a cool air from the surrounding so that it can supply a proper and smooth air delivery. The aims of the blade is to take the air from back side and push it to the front side at a constant speed. Usually, the material of the blades are light and made up from plastic (Sanghani, 2016).

Generally, there are three type of table fans which is axial, radial and diagonal fan. Among three of them, axial fan is the most suitable for table fan. According to (EBMpapst,

2013), axial fan can provide a lots of wind with a less pressure needed. This is because rotating blades have a complex shape in order to achieve a good efficiency factor. In addition, the diameter of the blade (Figure 2.7) is profile alters by the curvature of the whole blade. The effect for this is the increasing circumferential velocity of the individual blade sections as the distance far away as increase the drive shaft.

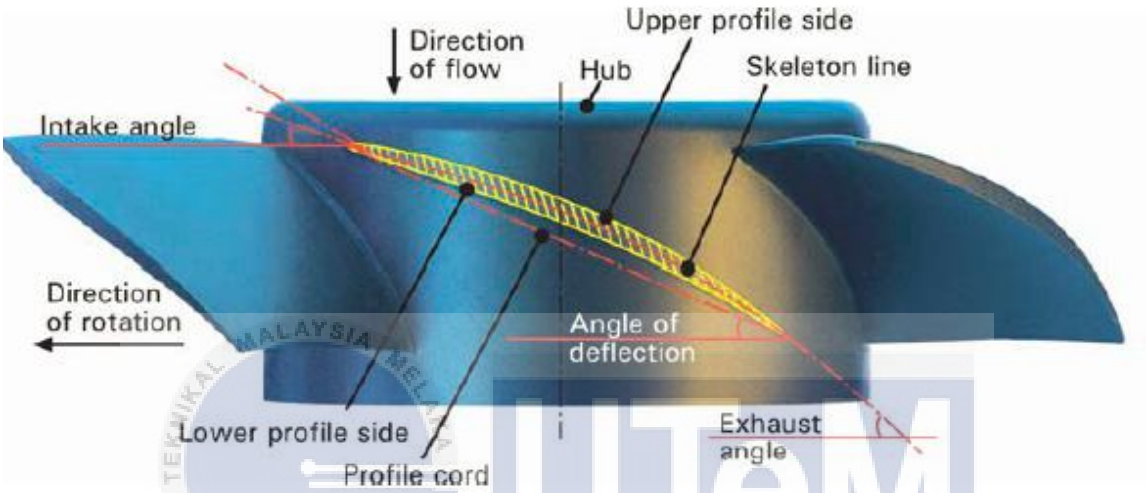


Figure 2.7: Sectional view of blade profile (EBMpapst, 2013)

The second type of blade is radial fans where it usually used for applications that require high pressure but at a limited flow rate. As stated in (EBMpapst, 2013), these radial fans provide higher potential kinetic energy of the air molecules creates a higher pressure. There are two different blower wheels which is blades are curved forward in the running direction and blower wheels where the blades curve backwards. The blades that are curved forward permit a more powerful direction of the air stream and achieve a higher energy conservation while blades that are curved backward are designed for buildup primarily static pressure within the blower wheel itself.

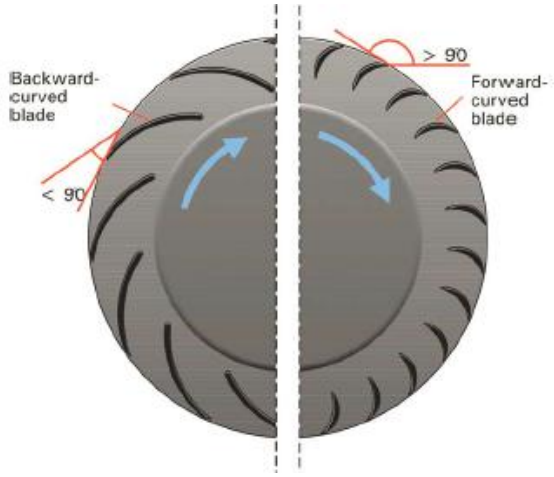


Figure 2.8: Radial fan blower wheel with forwards and backwards curved blades (EBMpapst, 2013).

The third type of blade is diagonal fan. This type of fan are for hybrid solution which occupies an intermediate position between axial fans and radial fans. An airflow is similar to axial fans whilst at the same time achieving a higher static pressure (EBMpapst, 2013).

2.3.3 Motor

Electronic motor is a driver to the table fan. It converts electrical energy into rotational mechanical energy. The rotor rotates inside the stator and had been separated by means of an air gap. In a motor, there are a rotor and stator, each consists of an electrical insulation, magnetic core, and windings necessary to establish a magnetic flux. In a process to generate the magnetic fields, the windings that carry an electric current is needed to district between two magnetic fields. At the end of motor shaft, one shaft having thread to connect with gear through the oscillating mechanism and blades (Sanghani, 2016).

As stated by (M.K.A. Ahamed khan1, S. Parasuraman2, Irraivan Elamvazuthi3, 2013) the table fan motor nowadays had a poor efficiency due to many losses such as type of material used for rotor and stator parts, the construction design and winding design. The authors stated that, single phase induction capacitor is used to start motor owing. The higher toque is required at the beginning of the blade movement. Hence, a capacitor is used to make the phase shift between running and starting winding.

2.3.4 Motor body

According to (Sanghani, 2016), motor body is a housing of electric motor and it is mounted on the stand of fan. The aim of this purpose is to protect the motor from dust, smoke and other impurities entering into motor. Furthermore, it is also reduce the losses of electromagnetic flux (EMF) and for the sake of human safety. This motor body covers motor, shaft of motor, oscillating mechanism and etc.

2.3.5 Guard

There are two guard in table fan which is front guard and back guard. These two guards are made out of wire mesh which the function are to covers and prevents the blades from any external objects coming. Other than that, it is also for safety purpose where it is to avoid injury to human hands touching the fan. Furthermore it is indirectly can be also as a guides for air flow in axial direction. The guards are locked together by using guard clips (Sanghani, 2016).

2.3.6 Bearing

As stated by (Sanghani, 2016), the use of this bearing is to convert rotary (mechanical) motion of shaft (inner end) into static or stationary (outer end) energy of guard.

2.3.7 Oscillating Knob

Oscillating knob is placed at the top of motor body where it is connected to fan head. The angle of oscillating fan can be adjusted by using oscillating knob when it is pushed, it connects to oscillating mechanism and vice versa. However, there is some limitation on the movement of oscillating mechanism. The movement angle of fan head only can be from side to side, which is the maximum angle 180° can be achieved. So in order to overcome this limitation, oscillating mechanism is modified to rotate table fan head 360° horizontally (Sanghani, 2016).

Figure 2.9: The modification mechanism at table fan (Sanghani, 2016)

2.3.8 Regulator

The purpose function is to regulate the speed of motor at the different levels. The regulator is directly connected with motor and control ON/OFF button of table fan (Sanghani, 2016).

2.4 Factor Of Fan Performance

Fan performance is importance to be considered as the effectiveness of a fan can fairly be evaluated in terms of how well it doing a job.

2.4.1 Airfoil fan blades

Airfoil impellers provide uniform, high volume airflow with low power consumption for optimum efficiency using the same aerodynamics that create flight. According to Bernoulli's Principle, the faster moving a across the top of the blade creates less pressure than the slower moving air on the bottom of the blade. This creates lift in an airplane wing and airflow in an impeller. In axial fans, the airfoil's twisted design ensures that the incident angle between the airflow and airfoil is constant along the blade loading for high efficiency and low noise fans.

2.4.2 Blade pitch

There are many type of blade in market likes flat blade, round blade, hanning blade, airfoil blade and etc. Each of the blade have a difference in angle of pitch as it will created external force from the outside. As described by (Gil. S, 2013), the blade pitch can be refer as an angle of the blades as it move through the air.

According to (Falahat, 2011) finding, the most optimum number of fan blades is four blades and the blade pitch range should be tilted between 45° to 55° from vertical for maximum airflow generation.. The advantage of the increasing of blade pitch would generate more airflow. Unfortunately, it indirectly increasing cost of having more powerful fan motor to move the blades.

As stated Afag and his associates in 2014, bending the blades upward between range 0° to 10° rake angle of a ceiling fans. In their study, they discovered that 6' rake angle generated the most airflow, with the additional benefit that does not required more powerful fan motor.

Next, some ceiling fans even have wiglets at the tip of the fan blades. The aims of these wiglets is to smoothen the flow of air around the blades by decreasing the air vortices at the blade tip which in turn reduces the overall drag and energy use.

2.4.3 Airflow profile

According to (Bassiouny, R. and Korah, N.S. 2011) studied the airflow pattern in a room due to a single rotating ceiling fan. The lowest airflow is located at the ceiling hub and at the fan blade tip. However, in between the fan center and fan blade tip, there have the highest airflow. From an observation, they plotted the graph of airflow velocity, m/s versus the distance from a center of blades, mm. The result shown that the airflow is generated by a ceiling fan, is increasing at a certain distance from the fan center to somewhere midway of the fan blade length before decline moving towards the fan blade tip. This graph pattern so-called humped airflow profile.

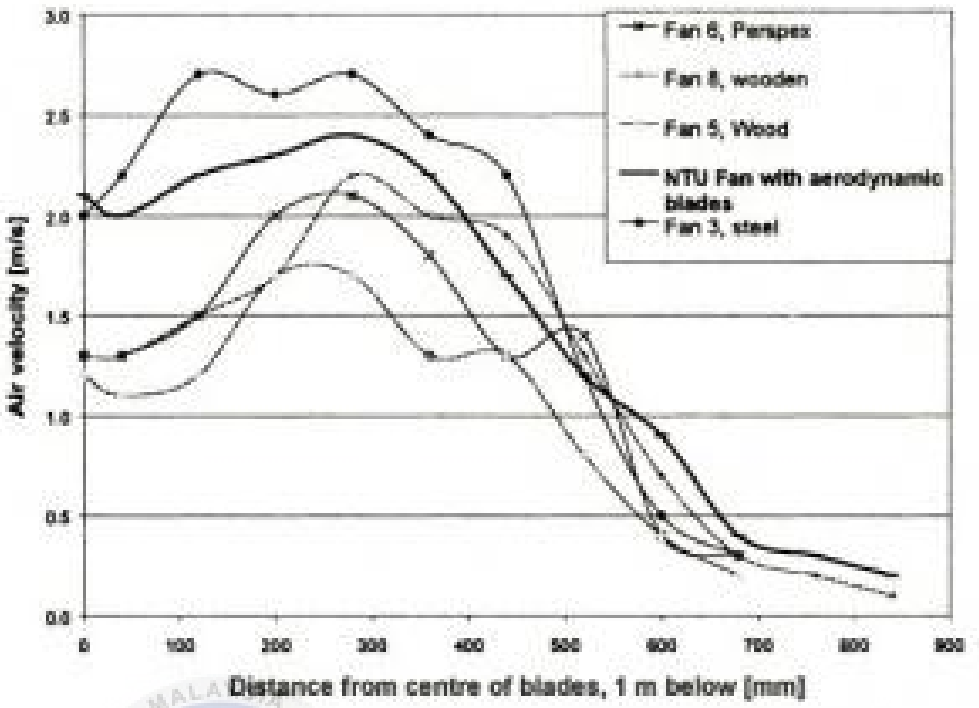


Figure 2.10: Airflow profile (Boong Sung, Christopher Teh.)

2.4.4 Blade materials

According to (Schmidt and Patterson 2001), the early study comparison between the airflow generation and energy consumption of nine ceiling fans fitted with a metal, wood, and plastic fans blades. The highest amount of energy found at ceiling fans with wooden fan blades that generated the least airflow and does not produce any noise. However, when testing at metal blades, the ceiling fans generate the most airflow and produce the highest noise.

2.4.5 Factor of Safety

As stated in Creative Mechanisms website, to make a good design, an engineers must consider so many factors such as design for assembly, cost, logistics, manufacturability, reliability, and other qualities that require forethought and creativity. In addition, the most important qualities to be considered when creating parts or product is safety. This is because factor of safety usually refers to the actual load-bearing capacity of

a structure or component, and the required margin of safety for a structure or component according to code, law, or design requirements.

$$\text{Factor of Safety} = \frac{\text{Ultimate Stress}}{\text{Allawable Stress}} \tag{2.1}$$

2.4.6 Rotational Speed of the Fan

According to (Fibonatic. 2013), to determine the rotational speed of the fan by looking at the angle string is:

$$\omega = \sqrt{\frac{g \tan\theta}{r + l \sin\theta}} \tag{2.2}$$

Where θ = the angle of the string with the vertical, r = the radius at which the string connect to the blade, l = the length of the string, g = the acceleration due to gravity

2.5 Mechanical Mechanism

Mechanical mechanism is a kinematic chain arrangement which used to transmit motion, force or power. This mechanism is a part of machine usually the combination of mechanical part to produce a mechanism.

2.5.1 Flywheels

Flywheels are currently being developed for energy storage. As stated by (Wicki & Hansen, 2017), flywheels are based on a rotating mass that allowing short term storage of energy in kinetic form. So it is present an environmental friendly alternative change to electrochemical batteries. Therefore a flywheel can play an important role in sustainable energy transitions. There are three main types of flywheels such as low-speed, high-speed, and micro-high-speed flywheel as shown in Table 2.2.

Table 2.2: Typical characteristics of flywheels

Characteristics	**Low-speed flywheels (LSF)**	**High-speed flywheel (HSF)**	**Micro-high-speed flywheel (micro-HSF)**
Operating speed	<10,000 rpm	>10,000 rpm	>10,000 rpm
Rotor composition	Steel	Carbon fiber composite	Carbon fiber composite
Bearing type	Conventional	Low friction	Conventional
Typical specific energy	-5 Wh/kg	Up to 100 Wh/s	-10 Wh/kg
Typical weight	n/a (stationary equipment)	n/a (stationary equipment)	15-60 kg
Expected (full depth) discharge cycles	$10^5 - 10^7$	$10^5 - 10^7$	$10^5 - 10^7$
Expected lifetime	-20 years	-20 years	-20 years

Source: based on Bolund et al. (2007), Hadjipaschalis et al. (2009), Doucette and McCulloch (2011), Dhand and Pullen (2013), Akinyele and Rayudu (2014) and Mahlia et al. (2014).

Toy vehicles have been a frequency and popular toy for young children popular toy for young kids and frequently incorporate frictional and mechanical drive systems for moving the toy vehicle. In this toy vehicles is usually use an internal flywheel is connected by a gear train to the rear wheel assembly. The function of flywheels in this toy vehicles is to store kinetic energy for driving the toy vehicle. In the dimension of flywheel such as when mounted about a horizontal axis, the flywheel will directly contacted the support surface for translation driving moment (Bender, Glen, Buratto, & Evans, 1990).

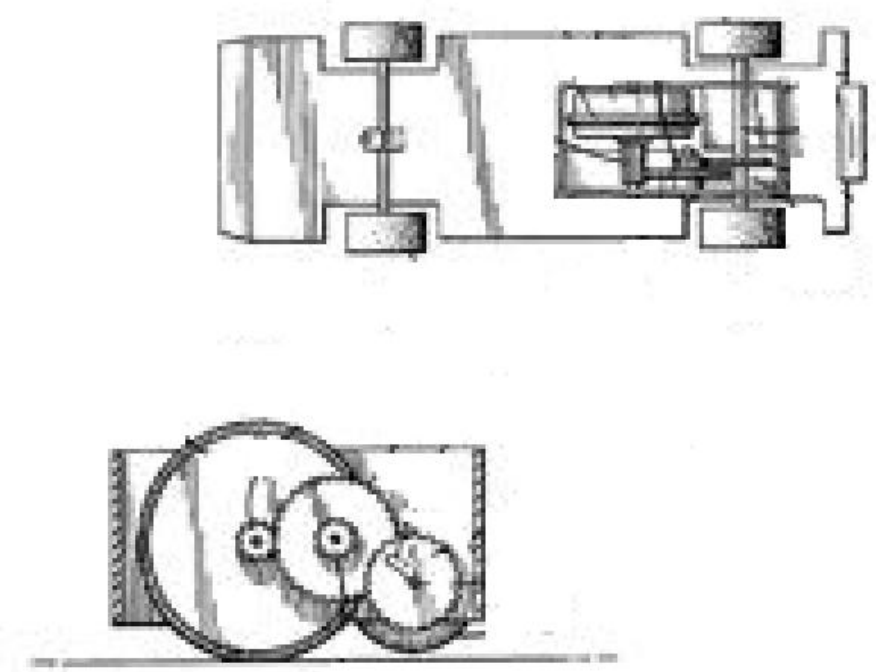


Figure 2.11: Top and side view of flywheel mechanism (Bender, Glen, Buratto, & Evans, 1990).

2.5.2 Music box ornament

The principle concept of a music box is an automatic musical instrument that produces sounds by the use of pins placed on a revolving cylinder or disk so as to plunk the tuned teeth of a steel comb. As claimed by (Spyrou & Town, 1996) the musical box ornament mechanism uses the reproducer of a wind-up music box and turn a rotary wheel with an eccentric rod, causing the eccentric rod of the reciprocate an ornament through a follower plate.

By referring Figure 2.12 below, the driven by the driving mechanism (clockwork) of the wind-up music box mechanism of a music box. The function of wind-up music box mechanism is a conventional device and supported base of the music box. When the reproducer is turned by the driving mechanism, the rotary is rotated to move the eccentric rod will, causing it to reciprocate the follower plate along the downward guide rod. When the follower plate is reciprocated, the tappet rod is carried to move the ornament up and down alternatively (Spyrou & Town, 1996).

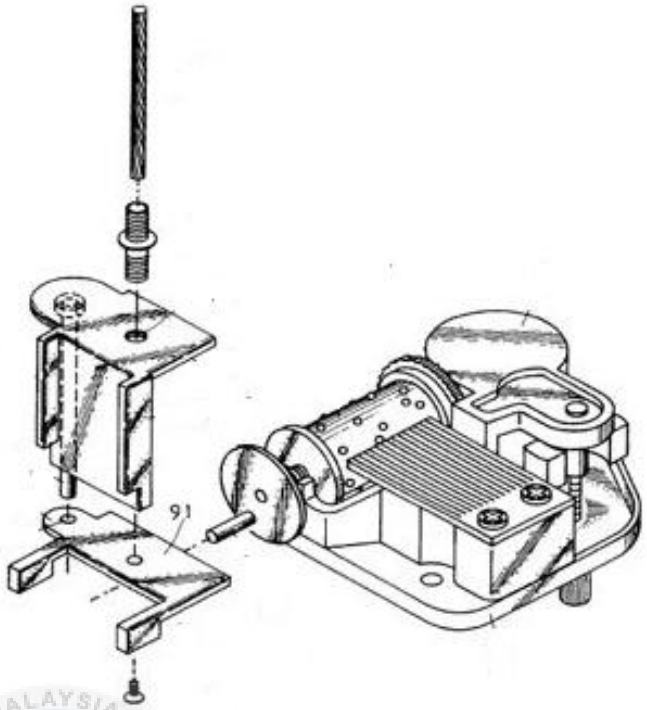


Figure 2.12: The exploded view of a transmission mechanism for music box ornament (Spyrou & Town, 1996).

(Chen, Ceccarelli, & Yan, 2018) mention that in a steel music comb and a cylinder with pins, there is a spring powered device that transmits its motion through a pair of gear. One gear attached to the spring barrel and the other connects with the cylinder. In addition, there is a speed governor connect to the spring barrel with several gear. This is only the device that can change the rotation speed of spring barrel. By changing the angle of pieces on the governor, the air resistance is fluctuated to modify the rotation speed of the governor. Hence, the release rate of spring power can be adjusted.

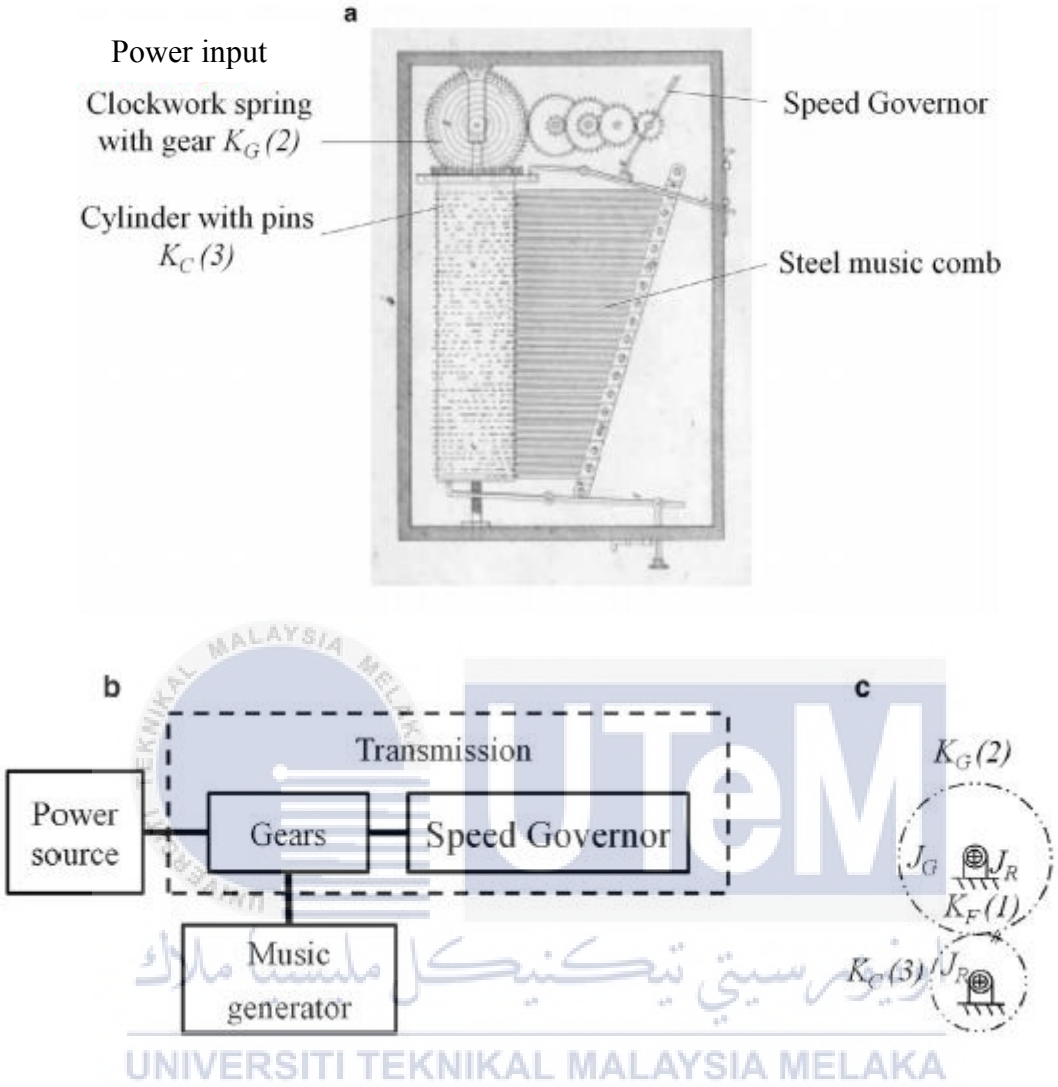


Figure 2.13: A music box recorded by Borgnis, a) drawing, b) structural block diagram, c) mechanism sketch (Chen, Ceccarelli, & Yan, 2018)

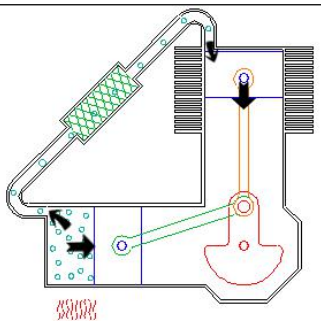
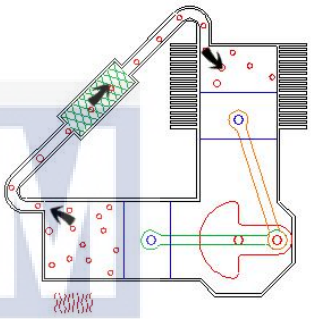
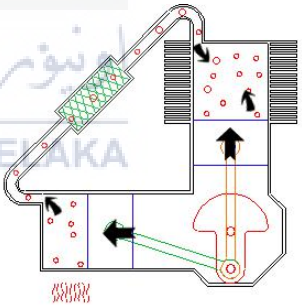
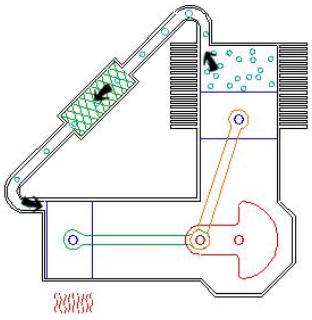
2.5.3 Stirling engine

The most common two design schemes are alpha and beta striling engine. As mention in (Hafez, Soliman, El-Metwally, & Ismail, 2016), the stirling engine are the devices work on heat cycle and use a compressible fluid likes air, helium, hydrogen or nitrogen.

Animated engine, two cylinder stirling engine. (2015) describe, the working principle of two-cylinder stirling engine as known as alpha stirling engine, one cylinder is kept in a hot condition while the other is kept cool. By reffering the illustrarion Figure

below, the lower left-cylinder is heated by burning fuel. The other cylinder is keep cool by air circulating through a heat sink. In this engine, there are four phases to complete the cycle which is explained in Table 2.3 below.

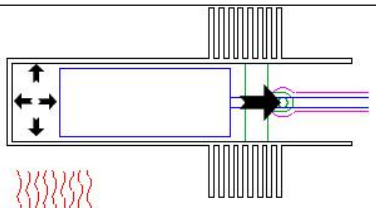
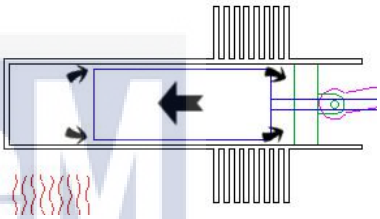
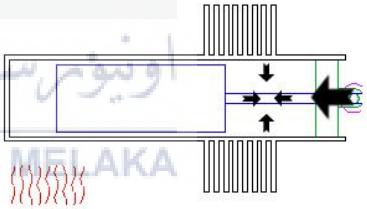
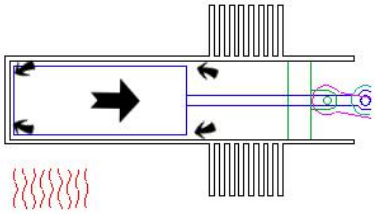
Table 2.3: The four phases of alpha string engine

Phases	Explanation	Diagram
Expansion	Most of the gas in the system has just been driven into the hot cylinder. The gas heats and expends driving both piston inward to the crankshaft.	
Transfer	The momentum of the flywheel carries the engine through the next 90°. This causes the most of the gas to be transferred over the cool cylinder.	
Contraction	Majority of the expended gas has shifted over to the cool cylinder. It cools and contracts which 'suck' both piston outward away from the crankshaft.	
Transfer	The momentum of the flywheel carries the engine through the next 90°. This causes most of the air to be transferred over the hot cylinder to complete the cycle.	

Source: Animated engine, two cylinder stirling engine. (2015)

As stated at animated engines, single cylinder stirling engine. (2015), beta stirling engine only have a single cylinder with a hot end and a cool end. The working gas is transferred from one end of the cylinder to the other by a device called a displacer. This beta stirling engine only requires slightly less heat and has the power piston and displacer within the same cylinder.

Table 2.4: Four phases of beta stirling engine

Phases	**Explanation**	**Diagram**
Expansion	Most of the gas in the system has just been driven to the hot end of the cylinder. The gas heats and expends, driving the piston outward.	
Transfer	The gas has expended. Most of the gas is still located in the hot end of the cylinder. The flywheel momentum carries the crankshaft the next quarter turn. The bulk of the gas is transferred around the displacer to the cool end of the cylinder.	
Contraction	The majority of the expended gas has shifted to the cool end. The gas cools and contract, drawing the piston inward.	
Transfer	The contracted gas is still located near the cool end of the cylinder. Flywheel momentum carries the crank another quarter turn, moving the displacer and transferring the bulk of the gas back to the hot end of the cylinder.	

Source: Animated engines, Single cylinder stirling engine. (2015)

2.5.4 Perpetual motion

Perpetual motion is defined as a set in function, continues to function perpetually without supplying any energy. According to The Indian Mathematician and Astronomer Bhaskaracharya (1114-1185), Figure 2.14 indicates, the machine rotates at full speed because as the mercury is at the one side of the wheel nearer the axis and farther from the the machine routes at full speed because the mercury is at the one side of the wheel nearer the axis and further from the other side.

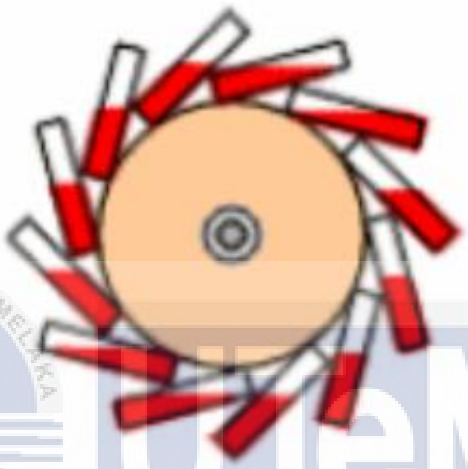


Figure 2.14: Bhaskaracharya's perpetual motion mechanism

Furthermore, a notebook of Villard de Honecourt was discovered that among of the several magnificent buildings and a series of machines there were a perpetual motion machine with masses (hammers), which change the center of mass during its rotation. Unfortunately, according to this notebook for sure the perpetual motion machine did not work because it is a version of Bhaskaracharya's concept.

Other than that, as mentioned by (D. Tsaousis, 2008), they build a perpetual motion machine based on the design of Arabian perpetual motion machine (Arabian Perpetuum Mobile), Figure 2.15 is a version of Bhaskaracharya's machine. The steam of Arabian Perpetuum Mobile which fold only towards the one direction were adapted on a disc made of bicycle chain, which were adapted on a disc made of Plexiglas. The noted have tied up nylon joints so that the chain can fold only towards one side as shown in Figure 2.16.

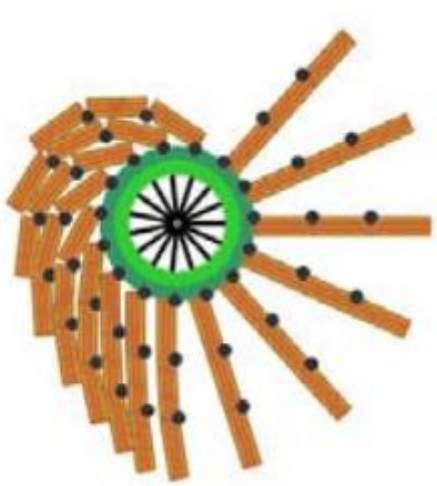


Figure 2.15: Arabian Perpetuum Mobile

Figure 2.16: Bicycle chain

In this design product, the magnetic and gravitional force is used. According to Hiscox, Gardmer Dexter (1822-1908) the illustration in Figure 2.17 below, at point B a strong magnet set in the open slot between the sides of the wheel A as shown in section C, an iron ball. The magnet is supposed to draw the ball to one side of the center, and the gravity given gives the ball the force to turn the wheel. This was patented in 1823.

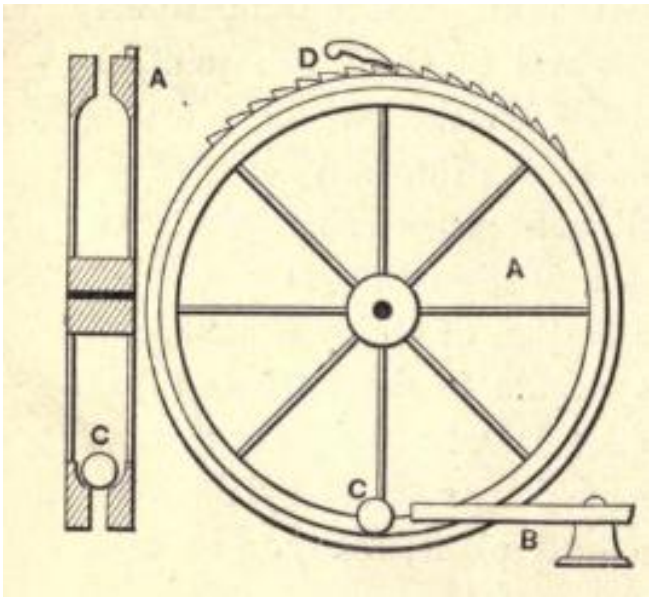


Figure 2.17: Perpetual wheel, Patented in 1923, Hiscox, Gardner Dexter (1822?-1908)

CHAPTER 3

METHODOLOGY

3.0 Methodology

This chapter explain in detailed the methodology used in designed and simulated a non-electrical table fan. The method should be fulfil according to the objectives. Generally, in this chapter will be go as stated at design process flowchart and Gantt chart. Other than that, there are many various ways can be used in order to complete this final project.

3.1 Design Process Flowchart

The design process is a guideline to a researcher for developing a product. In this research, the design process was visualized by using flow chart method to show the step need to accomplish this task. Figure 3.1 shows the flow of the designing and developing a product.

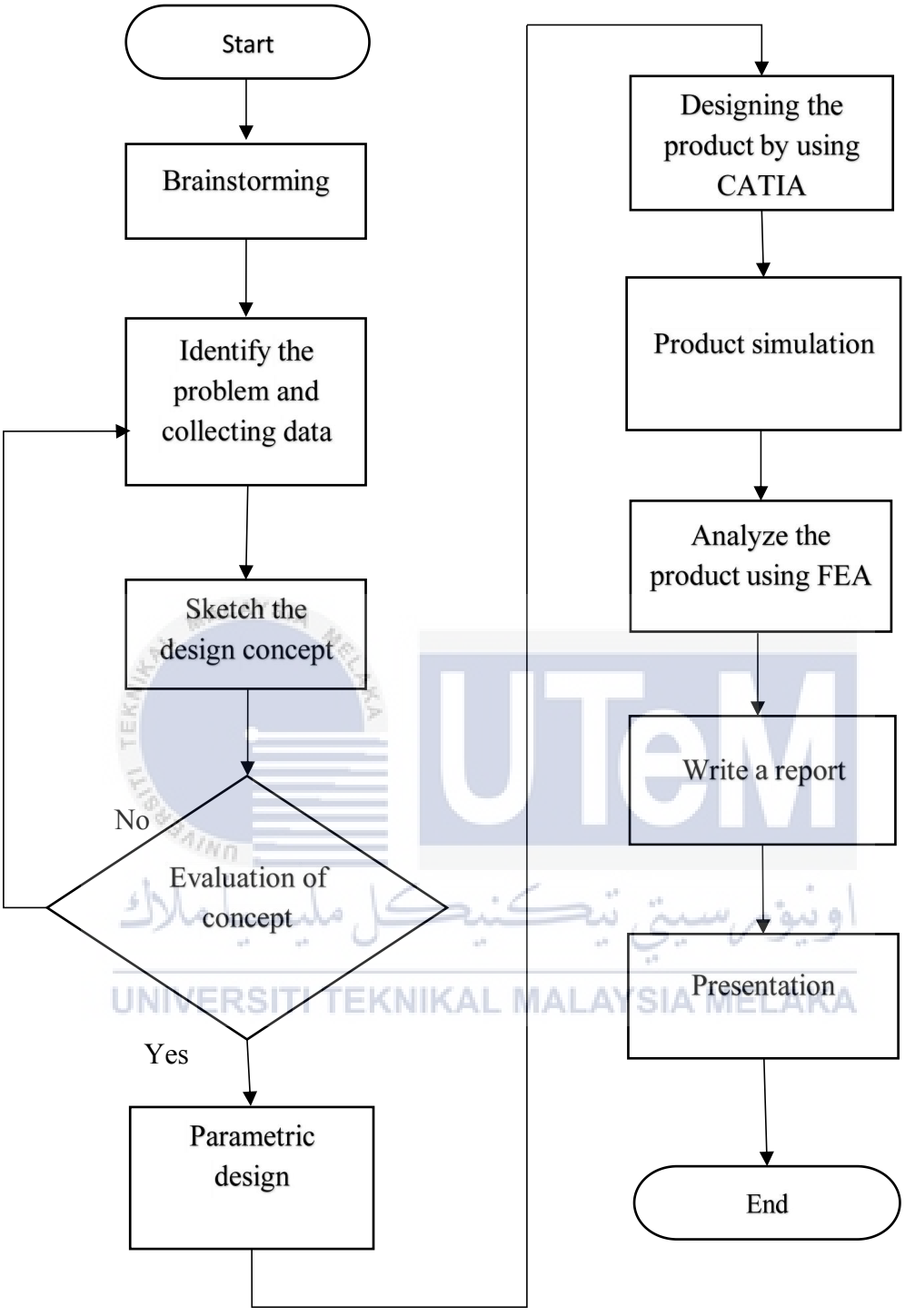


Figure 3.1: Flowchart of the general methodology

3.2 GANTT CHART

In project management of product design development, this Gantt chart was applied to make sure the tasks given should be complete in time. As shown in Table 3.1 below, this section presents a schedule for PSM 1 which occurred within week 1 to week 14.

Table 3.1: Schedule for completion of PSM I

No	Task	Weeks													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Project briefing						MIDSEM BREAK								
2	Searching and collecting data														
3	Preparation chapter 1: Introduction														
4	Preparation chapter 2: Literature review														
5	Submission progress report														
6	Sketch idea concepts														
7	Morphology chart														
8	Preparation chapter 3: Methodology														
9	Parametric design														
10	Submission of final report														
11	Presentation														

In this gantt chat indicates a schedule for PSM II. The time period of this project to be completed is 14 weeks. Table 3.2 refer the details of the schedule.

Table 3.2: Schedule for completion of PSM II

No	Task	Weeks													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Review PSM I														
2	Parametric design														
3	Design illustration														
4	Design configuration														
5	Design parameter														
6	Design using CATIA														
7	Design drafting														
8	Product simulation														
9	Analyze product using FEA														
10	Report PSM II														
11	Presentation														

MIDSEM BREAK

3.3 Data Collection

There are many ways to collect the idea and one of them is by observing, searching and collecting data. This method were used to analyze all the data related to this project. The sources of all the information must be valid to preserve its authenticity.

3.3.1 Observation

Most existing product problem nowadays perceives in real life. So, one of the methods to know a problem is by observation. Observation method is a research method that is used to identify problem consumer. Through observation, the researcher can saw the situation and consumer behavior towards a product that was identified. Researcher role was as observer towards behavioral changes, listen to, and saw subject's behavior whether from a long or short distance. Before making observations, a researcher had to make a good planning. Every observation must have a particular purpose, systematically performed, had to focus, and must be stated by neat and correct. The record made must be accurate, legal, and can be trusted.

3.3.2 Survey

To know the detail of the problem faces in society. The researcher needs to have a two ways communication among the communities. So in this project, the researcher makes a sociological investigation that use questionnaires to collect information about how people think and act. In this method gathers responses to question that are agree, neutral or disagree style. Other than that, it also includes an opinion about the problem and product design that suitable to the current market.

3.3.3 Internet

To understand the fundamental of the table fan was the purpose of this method. The basic knowledge of the table fan such as how the table fan work and type of the fan blade was search across the internet. The internet provides vast information regarding the basic concept of table fan. Particularly, Google search engine was used as primary resources to get vast information for the project.

3.3.4 Article

To obtain the information about the study on non-electrical table fan was the purpose of this method. The article helped the research study on the mechanism need to attach at the design. The factors that may relate to this mechanism were studied from the article.

3.3.5 Journal

To obtain the information about the study on table fan was the purpose of this method. Like the article, the journals serve the same purpose and same field of study. With the information got from the journals, the concept of the mechanism and standard size of the table fan design.

3.4 Morphological Chart

Morphological chart is one of the methods to generate ideas in an analytical and systematic manner. The main function of this product was taken as a starting point to make a good product. In this morphological chart had various sub ideas and it helps to evaluate the combination of an alternative design concept.

3.5 Design Concept

The design concept is the combined result of the sub-ideas in the morphological chart. This multi-function and design ideas are combined into products and eventually become the last project.

3.6 Concept Evaluation

There are so many way to evaluate design concept, among of them can be in a logic mind, additional information and opinion among the consumers. Other than that, the

designer can use pugh method, weight decision matrix, and house of quality. With all this methods can be utilized to make the best decision design concept.

3.7 Parametric Design

Each product already in the market has its own standard. It requires more detailed measurements and each mechanism will undergo process analysis to ensure each component is functioning properly. The analysis process was carried out in CATIA P3 V5R20 software. Among the analysis that can be done in this software was the type of Von Misses in Finite Element Analysis (FEA). From this analysis, torque results can be determined. As a result, the speed or revolution per minute of the blades of the fan blades can be identified.

3.8 Product Illustration

Product illustration is performed to show the condition of this non-electrical table fan product. It can be seen from various sides whether orthographic view, isometric view and etc. This product is designed by using CATIA P3 V5R20 software.

3.8.1 Part Drawing

In this project design, a researcher had been choose table fan. The table fan was a product which made up by few components such as logo ring, screw, safe screw, safe nut, guard front, blade lock, blade, guard lock, guard back, oscillating rod, motor, hand, body, power cord, neck, timer, and switch. The detailed part drawing was performed for each component and presented in CAT file and 2D drafting. The CATIA P3 V5R20 software was used to perform part drawing.

3.8.2 Assembly Drawing

The table fan was assembled by using CATIA V5R20 software in 3D Assembly feature. All the part of table fan is assembled and presented in drafting. To perform the detailed assembly drawing, the feature of bill of material (BOM) and exploded view were applied in the drawing and all the parts were labeled with numbers.

3.8.3 Design simulation

Design simulation was used to have an overview of the real project. The goal of the simulation was to show the working mechanism in the project can be perform together with other component parts. This simulation also help in reducing the project cost. The simulation of table fan was developed by using Digital Mock-Ups (DMU) Kinematics Simulator in CATIA V5R20 which is it a combination of assembly part and motion.

CHAPTER 4

RESULT AND DISCUSSION

4.0 Result and Discussion

This chapter elaborates in details the finding on designing non-electrical table fan. Starting from the method to generate ideas. There are various methods that are applicable, such as through observation, conducting a survey, and surf the internet. All methods are known as data collection method. In addition, the use of House of Quality (HOQ) is important to known the consumer's needs. From the HOQ information, product specification has been listed. It is important to produce design concept which occupies all the requirements. One of the ways to generate ideas on sketching design product is by using a morphological chart where all the subs ideas will be consolidated and form concept design.

4.1 Data Collection

The results from data collection, observation methods, and surveys have been done. The following result and analysis had explained in detail in section 4.1.1, and 4.1.2,

4.1.1 Observation

From the observation, the researcher had been identified a problem faces by the user. The problem of a traveler to use an electrical source during travel is limited. As Malaysia located near the equator line, being hot and humid throughout the year. The traveler who joint outdoor activities in Malaysia need to use portable table fan to comfort themselves. This is because portable table fan can be carried anywhere but there has limitation use of battery. The absence of electricity resource whenever going picnic or backpack in a long period becomes a problem to the users because of unable use table fan when sort of battery

needed since it requires a power supply. Unfortunately, this table fan has a limitation on the usage of electrical power. This situation makes difficult for a user.

In another scope, the researcher had observed that the most traveler need to use a table fan during their travel time. This is because travel in a hot weather requires them to use a cooler. They usually carry a portable rechargeable table fan along them because it is easier to recharge it back. Unfortunately, along the time they find out the battery durability became short and weak as the performance of the table fan getting low from times to times. This problem may due to the overcharging battery while charge table fan. Furthermore, when the traveler travel for a long period, the power bank that they filled were getting low and low as they use it for recharge other devices likes mobile phone and camera as it is important to stay connected with people around and keep camera alive to capture every single moment they have along the journey. Hence, it is not enough to supply other things which like table fan.

Figure 4.1: People cooling down their body

4.1.2 Survey and analysis

Based on the observation, the researcher had created a form of a survey to know all the requirements and specification related to this non-electrical table fan. This survey form is to study the extent to which product requirements play an important role for consumers. It was very important to ensure that the non-electrical table fan meets the needs of the consumer. This form was also necessary to examine the extent to which the marketability of non-electrical table fan.

The survey form is answered by 20 respondents from Universiti Teknikal Malaysia Melaka (UTeM). This survey is divided into three section which is:

Section A – Demographic of respondents

Section B – Respondent for current requirement table fan

Section C – Respondent for future marketability of non-electrical table fan

4.1.2.1 Survey Data Collection

Section A, Demographic of respondent

Question 1: What is your gender?

This online survey form is published to answers by 20 students of UTeM. Based on the data collected, 65% of the total respondents consist of male respondent and the rest is female respondent as shown in Table 4.1.

Table 4.1: Analysis of question 1

Gender	No. of respondents	Percentage, %
Male	13	65%
Female	7	35%

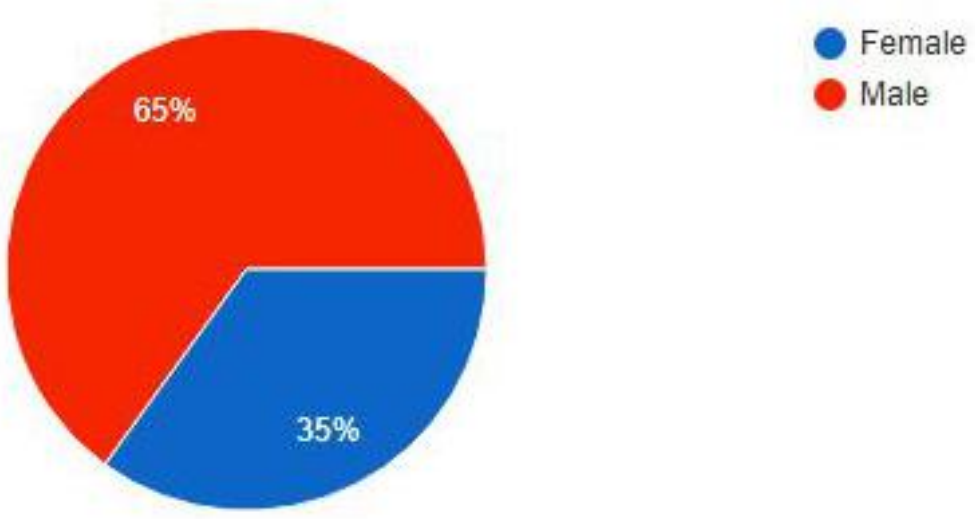


Figure 4.2: Percentage of question 1

Section B – Respondent for current requirement table fan

Question 2: How many times in a month do you travel in a long distance?

In this question generally asking about the frequency of respondents going to travel in a month. Based on Table 4.2 below, most of the respondents rarely travel in a long distance, because the table stated that 14 respondents had a less than three times in a month. On the contrary, only one respondent often travel within a month. Other than that, five respondents commonly travel at three up to five times in a month.

Table 4.2: Analysis of question 2

Frequency	**No. of respondent**	**Percentage, %**
Less than 3	14	65%
3 up to 5	5	30%
5 and above	1	5%

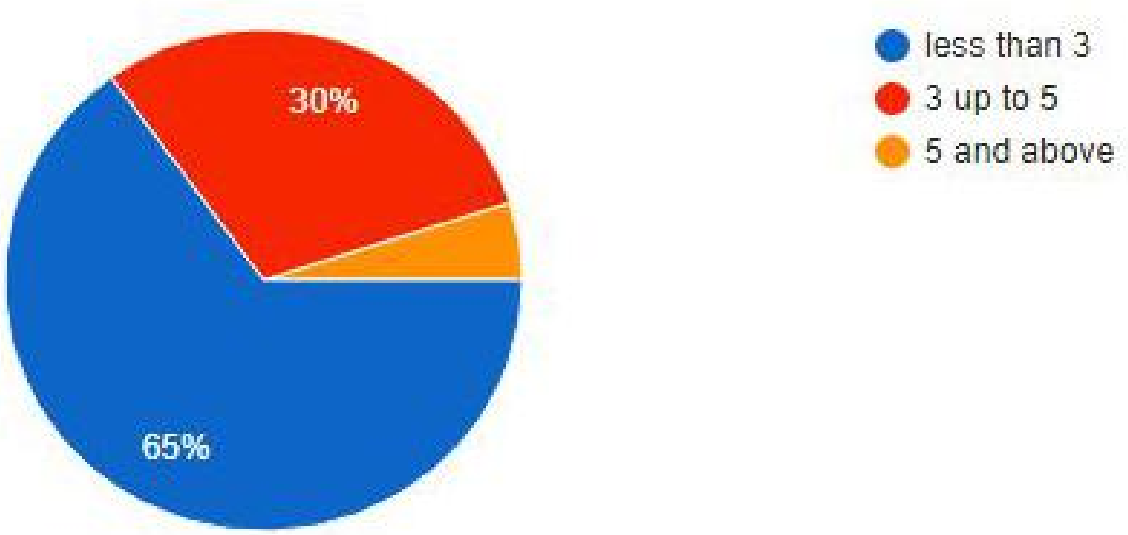


Figure 4.3: Percentage of question 2

Question 3: When are you doing some outdoor activities or going travel, do you need a fan to cool down your body?

Based on the result Table 4.3 below, 55% of the total respondents do needed a fan to cool down their body when doing outdoor activities such as sport or travel around the world. From the result, we also know the 45% of the respondent do not to use a fan to cool down their body.

Table 4.3: Analysis of question 3

Choice	No. of respondent	Percentage, %
Yes	12	55%
No	8	45%

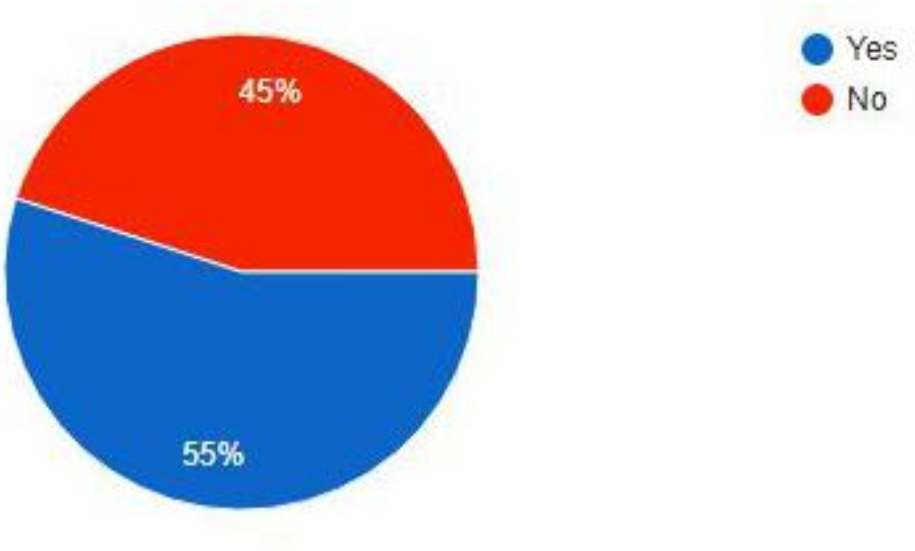


Figure 4.4: Percentage of question 3

Question 4: What type of fan you usually bring when you go outside?

There are four types of table fan in the current market, which is a portable fan with rechargeable battery, portable fan with non-rechargeable battery, traditional fan (hand fan) and electrical fan. So based on this pie chart Figure 4.5, portable fan with rechargeable battery and hand fan carries the same percentage which is 45% while a portable fan with non-rechargeable and electrical fan, each carries out 5% over all of the respondents.

Table 4.4: Analysis of question 4

Type of fan	No. of respondent	Percentages, %
Portable fan with rechargeable battery	9	45%
Portable fan with non-rechargeable battery	1	5%
Traditional fan (hand fan)	9	45%
Electrical fan	1	5%

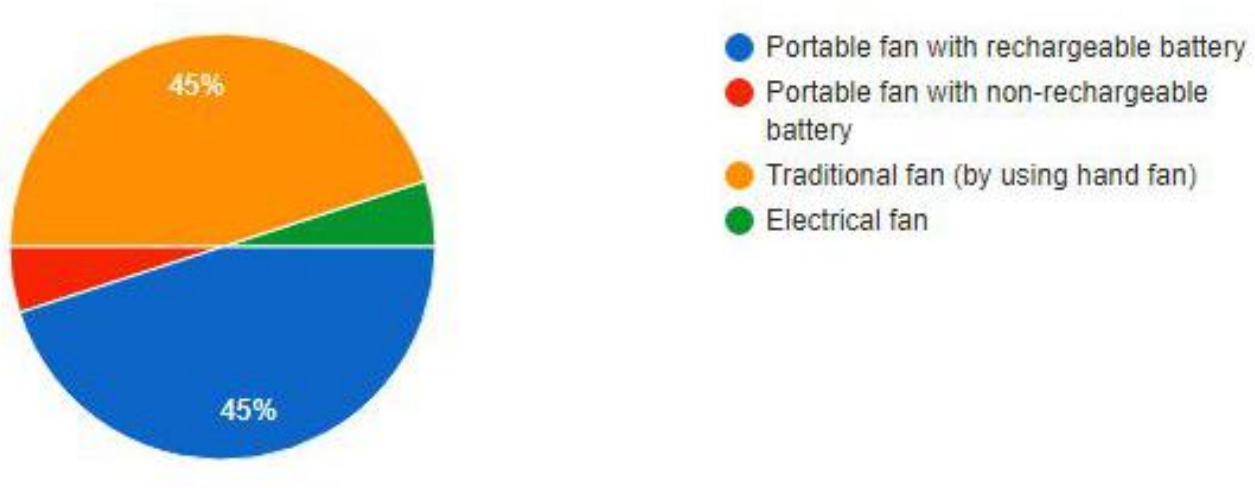


Figure 4.5: Percentage of question 4

Section C – Respondent for future marketability of non-electrical table fan

Question 5: Do you agree if we are planning to innovate an existing table fan in market?

The result in Table 4.5 obviously told that all the respondents agreed if a new invention created on the existing table fan in market.

Table 4.5: Analysis of question 5

Choice	No. of respondent	Percentage, %
Yes	20	100%
No	0	0%

Figure 4.6: Percentage of question 5

Question 6: Do you agree if we replaced electrical motor mechanism in table fan to mechanical mechanism (non-electrical table fan)?

Based on the percentage of the result Figure 4.7 stated, 80% of the total respondents agreed to replace electrical motor mechanism to mechanical mechanism. The rest of 20% respondents remain want to keep using electrical table fan.

Table 4.6: Analysis of question 6

Choice	No. of respondent	Percentage, %
Yes	16	80%
No	4	20%

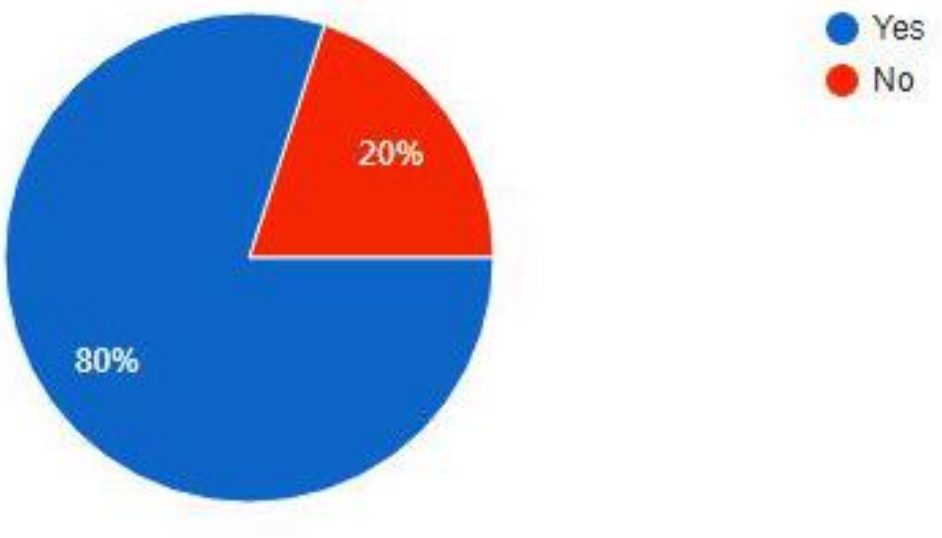


Figure 4.7: Percentage of question 6

Question 7: Why?

Based on the previous question, majority of the respondents agreed to replace the mechanism. The reason is they can save the use of electricity and the same times can reduce the cost of power consumption. Furthermore, the product be easier to bring anywhere since there is only mechanical part use to turn on the fan. In contrary, minority of the respondents said, they differ because it might give effect to the environment.

Table 4.7: Analysis of question 7

Choice	Explanation
Yes	1. It can save electrical consumption
	2. Save energy
	3. To save the energy
	4. Save energy, save BR1M
	5. Just wonder
	6. This is because using a fan that does not use electricity will save you money and it can be used for future
	7. Because it will help us to not use to much electric in our

	life
	8. It will make it easy to go everywhere
	9. Eco-friendly
	10. Reduce the power consumption and increase safety of the user
	11. Can produce more energy
	12. It more convenient to user
	13. Cut electrical cost
	14. So that it can perform better
	15. Easy
	16. More easier
No	1. I don't know
	2. It might give effect to the environment
	3. It might give effect to the environment
	4. Because it is easy to use

Question 8: Is the weight of non-electrical table fan importance to you?

Based on the data collected, Figure 4.8 explains that 60% of the total respondent care about the weight of table fan rather than 40% of the total respondent did not care about the weight.

Table 4.8: Analysis of question 8

Choice	No. of respondent	Percentage. %
Yes	12	60%
No	8	40%

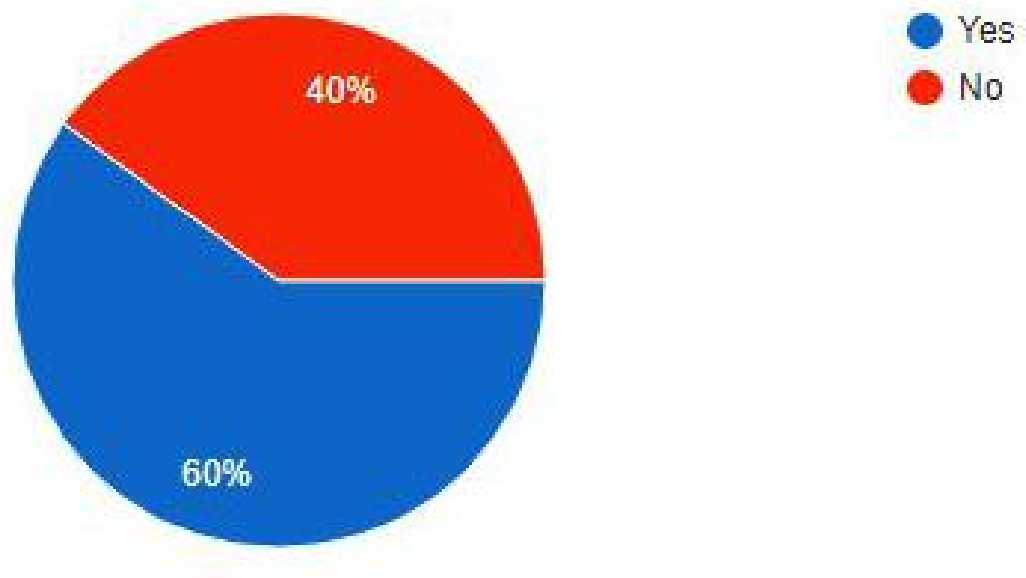


Figure 4.8: Percentage of question 8

Question 9: If yes why?

From the previous question, most of the respondents are considered about the weight of table fan. This is because it is easy to handle, carry and bring it anywhere but at the same time can also be easy to displace.

Table 4.9: Analysis of question 9

Choice	Explanation
Yes	1. Easy to carry
	2. Easy to carry
	3. Easy to displace
	4. Because it can be a portable fan and just put in handbag
	5. Easy to carry
	6. If it light, easy to handle
	7. So that it easy to bring when travel
	8. Easy to bring anywhere
	9. Easy to carry

Question 10: What size of non-electrical table fan you prefer to bring when you are going outside?

Question 10 is asking about the size of non-electrical table fan that respondent prefer to bring. Based on the percentage at Figure 4.8 below, 50% total of respondents choose a small size of fan, while 40% respondents choose a medium size. Only 10% respondents choose a large size of table fan.

Table 4.10: Analysis of question 10

Type of size	No. of respondent	Percentage, %
Small	10	50%
Medium	8	40%
Large	2	10%

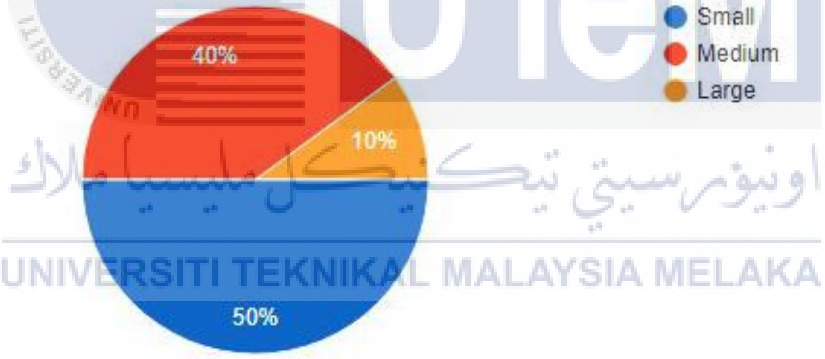


Figure 4.9: Percentage of question 10

Question 11: What are the main criteria being considered if we are planning to sale it to you?

Based on the percentage of this question, most of the respondents want all the performance, design, weight and costing of the product need to be considered. Other that than followed by 25% respondents who select only performance of product. 15% of total respondents said that costing of product is a main criteria to be chosen and 5% respondent considered others.

Table 4.11: Analysis question 11

Main criteria	No. of respondent	Percentages. %
Performance of product	5	25%
Design of product	0	0%
Weight of product	1	5%
Costing	3	15%
All above	10	50%
Others	1	5%

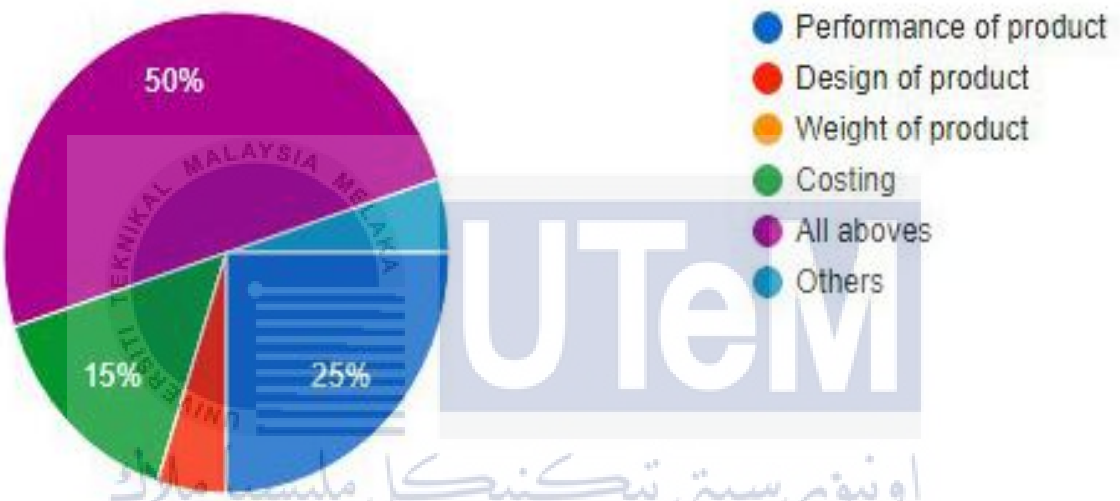


Figure 4.10: Percentage of question 11

Question 12: If you choose others, please state the reason.

Based on the previous question in question 11, only one respondent choose others as the main criteria. The respondent said that he choose a cheap and low-cost fan. So it's easy to manage and harmless.

Table 4.12: Analysis of question 12

Choice	Explanation
Others	I will choose a cheap, low-cost fan, so it's easy to manage and harmless

Question 13: Do you interested to buy this product if we sale it in market?

The last question is to know the marketability of upcoming planning product development. Based on this pie chart in Figure 4.11, all of the respondents definitely interested to buy this new product.

Table 4.13: Analysis of question 13

Choice	No. of respondent	Percentage, &
Yes	20	100%
No	0	0%

Figure 4.11: Analysis of question 13

4.1.2.2 Summary survey

This online survey form is published to answers by 20 students of UTeM. Based on the data collected, 65% of the total respondents consist of male respondents and the rest of 35% are a female respondent.

There are four types of table fan in the current market, which is a portable fan with rechargeable battery, portable fan with non-rechargeable battery, traditional fan (hand fan)

and electrical fan. Based on the survey results, most of the respondents were comfortable carried either portable fan with rechargeable battery or hand fan. Maybe because of the feature of the product that suits to their needs where they do not need to buy new batteries if the power of battery is out of services. Other than that, the weight of hand fan is very light, so it does not make difficulties to a user to bring it.

Hence from the statistics above, most of the respondents are comfort bring a light product rather than a heavy product. It stated in question 8 where the question is asking about the size of non-electrical table fan that respondents prefer to bring.

The majority answered when looking for a new innovated table fan; they possibly want a table fan which is, it does not need any electrical source as they can save it for other devices. It seems like people in travel does care a lot about the looks as long as it can fulfill the requirement that they needed such as cost, performance, weight, and design of product. Besides, the traveler needs to save a space for each thing that they bring. This is because they have a weight limitation on bringing the item around them.

Based on the survey, the marketability of the non-electrical table fan is encouraged as all the respondents are interested to buy it if the designer and manufacture are plans to create it.

4.2 House Of Quality

House of Quality (HOQ) is a diagram, used for defining the relationship between customer desires and the firm product capabilities. The "house of quality" is a basic design tool of the management approach known as quality function deployment (QFD). The HOQ of non-electric table fan was constructed based on the customer needed. Based on this HOQ, the important part in customer requirement has been recorded and listed for further analysis.

Legend	
9	Strong
3	Medium
1	Weak

Improvement direction		↑	↑	↓	↑	↑	Customer assesment of competing products		
Units		N/A	N/A	Kg	N/A	N/A			
Engineer characteristics / Customer characteristics	Importance weight factor	Marketability of product	Ease to manufacture	Weight of product	Stability	Material strength	Brandstar Portable Mini Lightweight Rechargeable Table Electric Fan - Pink	Kemanle Brand 16" 1500RPM Super Speed Rechargeable Table Fan (Green+White) Ka-2936	YI-5867FUT Solar Rechargeable LED light with mini fan
Costing	3	9	3	9		9	High	High	Low
Size of product	5	3	1		9	3	Medium	Large	Small
Easy to carry	4			9	3		Medium	Hard	Easy
Performance	5	9		3	9	9	Medium	Excellent	Good
Simplicity of design	1	1	9	3			Medium	Medium	Excellent
Aesthetics	2	3	3				Medium	Medium	Medium
Raw score		94	29	81	102	57			
Relative weight (%)		25.9	8.0	22.3	28.1	15.7			
Rank order		2	5	3	1	4			

Figure 4.12: House of quality

4.3 Product Design Specification (PDS)

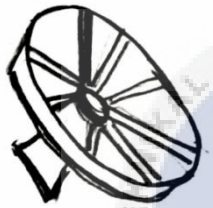
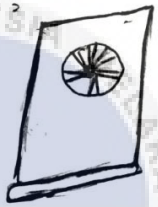
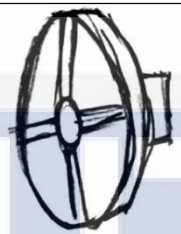
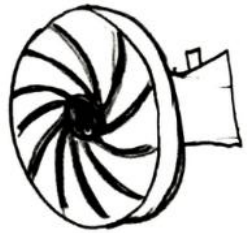
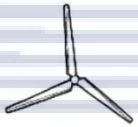
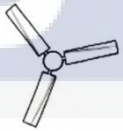
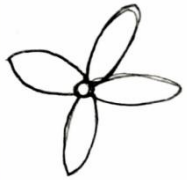
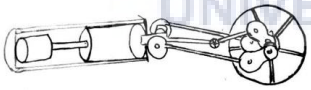
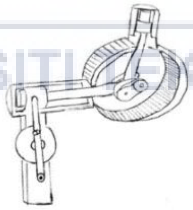
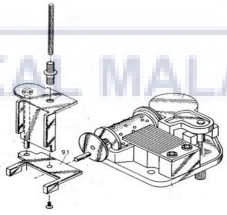
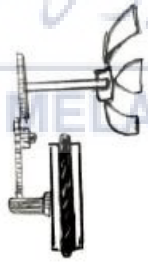
The PDS is the basic control and reference document for the design and manufacture of the product. Creating the PDS finalize the process of establishing the customer needs and wants, prioritizing them, and beginning to cast them into a technical framework so that design concepts can establish. Based on opinions and all the demand from customers, this products design specification was created. Hence, a non-electrical table fan solution or concept designs should be generated with reference to the PDS.

Table 4.14: List of Product Design Specification (PDS)

Performance	1. The product is design to overcome the difficulty of using table fan in outdoor activities. 2. The most important things for the product is adjustable at the head of fan, so that it can rotate freely. 3. The table fan is portable and must light in weight, to make sure users can bring it anywhere comfortably. 4. The best material has been added into the product to withstand the strength. 5. For the stability, the strong material has been selected in order to make a stable non electrical table fan.
Size	Dimension 14 x 10 x 4 cm
Weight	Around 300g
Material	Plastics (body part of table fan)
Target Production Cost	Around RM 15 to RM 20
Product Life Span	2 years (handle with care)
Customer	Focus on traveler
Environment	High efficiency and low loss. Energy saving and environmental protection
Ergonomics	The product is easy to handle and portable device. The product will reduces energy.
Appearance	Small and exquisite. The product are adjustable, portable and easy to be use. Ball fan. Wind strong and durable
Safety	The product are designed for safety operation

4.4 Mophological Chart

Morphological chart is one of the methods to generate ideas in an analytical and systematic manner. The main function of this product is taken as a starting point to make a good product. Table 4.15, shows all the main components in sketching with several alternative designs.

Design / Criteria	Option				
	1	**2**	**3**	**4**	**5**
Front and Rear Guard					
Blade					
Mechanical Mechanism					

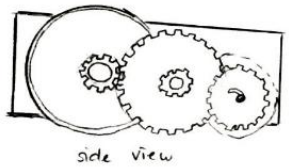
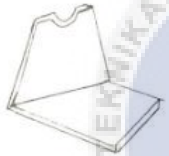
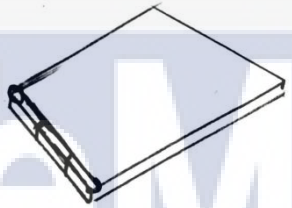
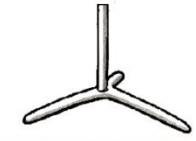
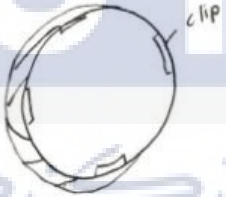
					
Base fan					
Connector					

Table 4.15: Morphological chart

4.5 Design Concept

In this subtopic, the concept design of non-electrical table fan is generated. From the morphological chart, it gives the wide range of alternative of design criteria. Then, the conceptual design of product will be designed base on this chart flow. There is no material choice in this chart because the material will be chosen after the stress analysis on critical point done.

4.5.1 First Design Concept

Based on the Figure 4.13 below, the first design concept is the combination of front and rear guard, option 3. Meanwhile, mechanical mechanisms used in this design concept are like option 3. Base fan option 2 is as proprietary in this concept where it has the body support at the base fan. The blades that fit this concept are airfoil blade (option 4) and the majority of use of the appropriate connector is screws. The advantages of this design concept in terms of the use of the type of blade used. By using aerodynamic concepts, airfoil drivers provide uniform, high volume airflow with low energy consumption for optimum efficiency. Unfortunately, the lack of this concept design seems to be less stable because the user needs to hold at body fan.

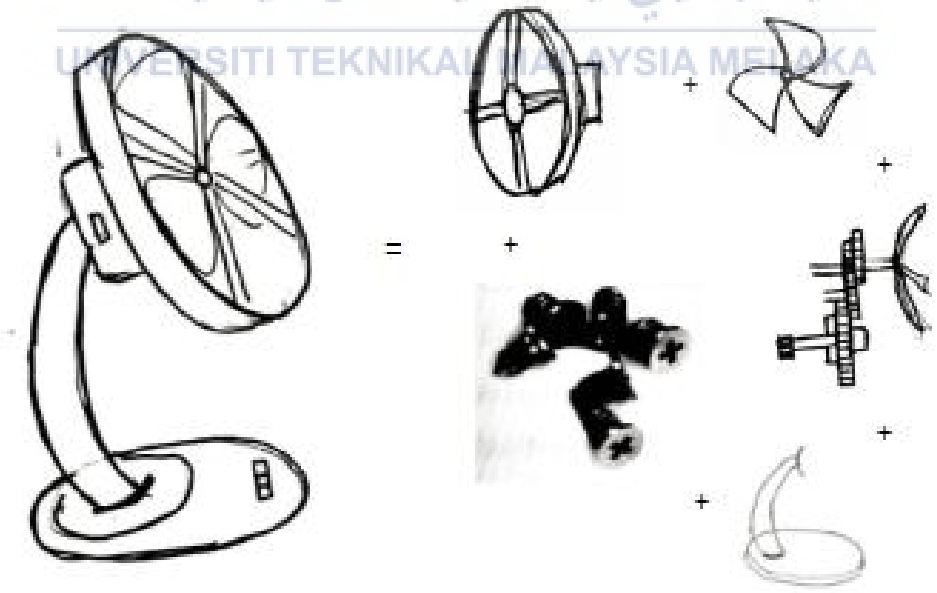


Figure 4.13: First design concept

4.5.2 Second Design concept

Benefit at this second concept is it can be fold and does not require more space. The use of bolt and nut are highly recommend in this design concept. For the type of blade, the usage of four blade comes with 6° blade pitch is applied in this design concept. The limitation of this design is there no front and rear guard which cover up the blades. . The choose of base fan as at option 5 is because it can easily grip by hand and the selected mechanical mechanism for this design concept as at option 2.

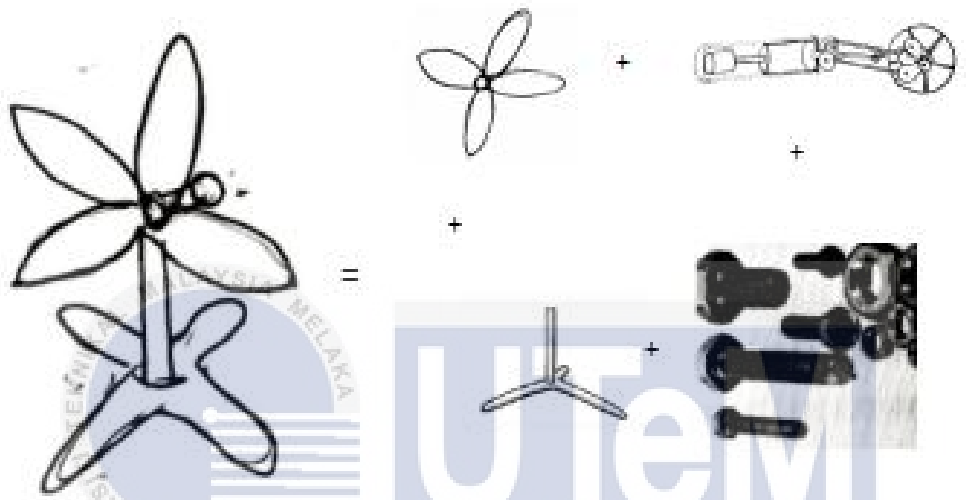


Figure 4.14: Second design concept

4.5.3 Third Design Concept

The third design concept is quiet unique because in the design concept use flywheel where it can store energy and realize it at the certain time travel. The third design concept is a combination of front and rear guard at option 4. Since hinge is a mechanical bearing that connects two solid object, it concept be applied to attach between base and guard. The advantage of using hinge is, the fan tilt can be function. The type of blades that fit this design is airfoil blade (option 4). The base fan suitable is at option 3 so that it can perfectly fit to the guards.

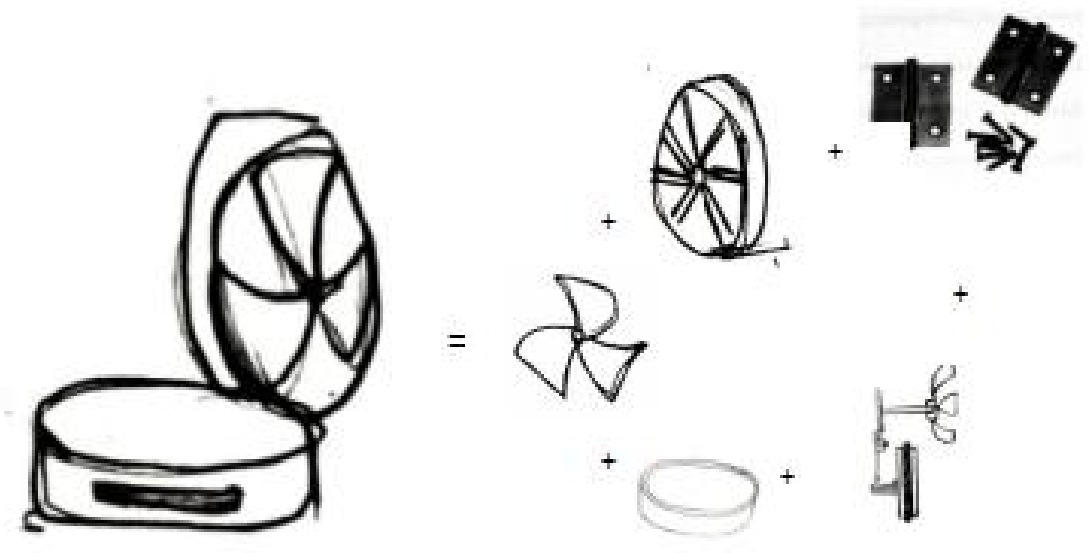


Figure 4.15: Third design concept

4.5.4 Fourth Design Concept

In creating the design for the fourth concept, focus on developing a low power consumption and reducing all the factor affecting an air resistance so that it can have a great performance. In this design concept, the front and rear guard use is option 1, where the pattern of the net can be seen in figure below. As the product is in a round shape, the mechanical mechanism suit to this design is at option 2. To make the mechanism not overwork, the angle of the blade must be at a small degree so the option 1 is selected. As all the component part in this design need to connected, the use of screws is the most suitable. Lastly, the choose of L shaped base fan is selected.

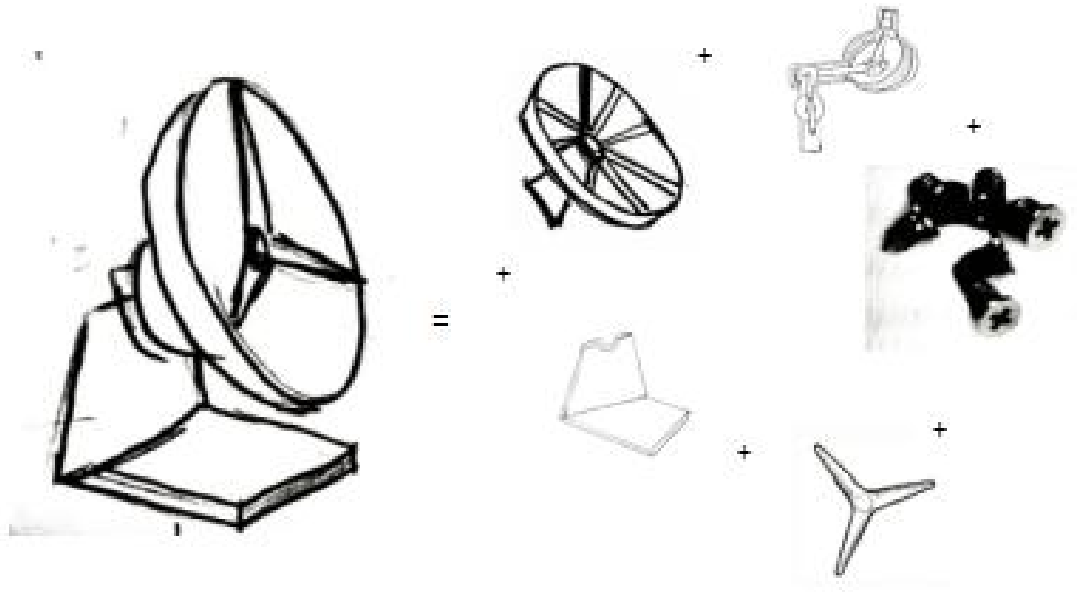


Figure 4.16: Fourth design concept

4.5.5 Fifth Design Concept

In designing the fifth concept, add more features into this product. The fifth concept made up from the fold of table fan. As shown in Figure 4.17 below, this concept design is a simple design but have more benefit rather than limitation itself. The shape of this design concept are rectangular where the guard can be bend at almost 270° and more. This is because, the use of hinge is begin helpful for the design product function very well. The suggested mechanical mechanism to make a blade move it by using magnetism and gravity perpetual motion, where use two magnets and a wheel to generate motion energy, so that the blade can be rotate in for a long time interval and to be more airflow, the use of optimum blade pitch is considered as an option 4.

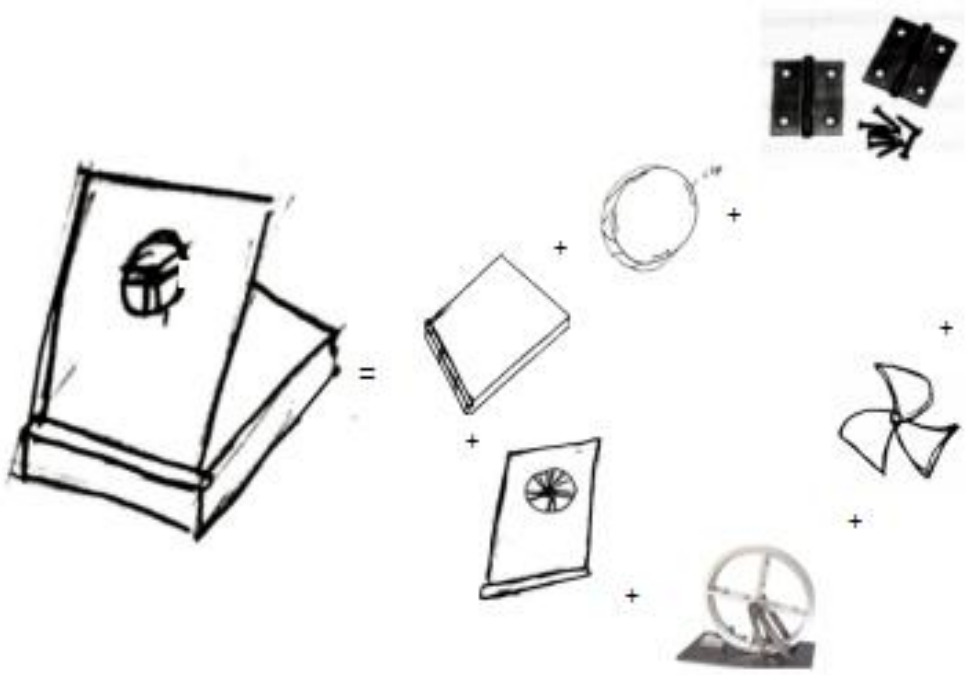


Figure 4.17: Fifth design concept

4.5.6 Sixth Design Concept

Design concept sixth is look alike fifth design concept above but there is some different in mechanism and features in this design concept. The unique of this design is it easily to detachable because the connector use is a clip connector. Most of this connector are applied at the electronic application such as hand phone. Other than that, the type of blade use in this design concept is an option 2. The type of mechanical use are perpetual motion machine with magnets.

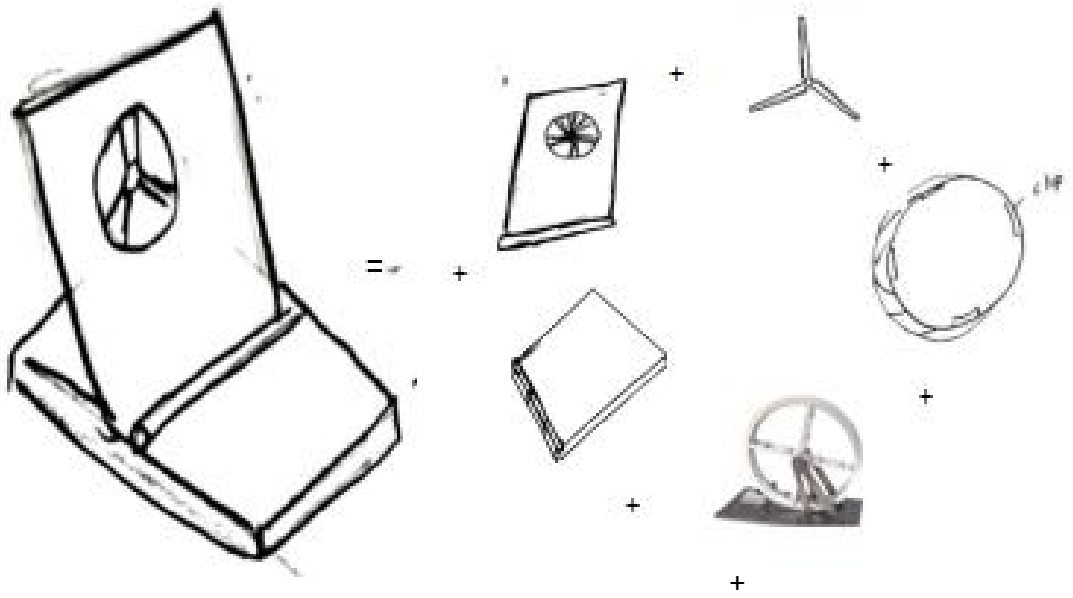


Figure 4.18: Sixth design concept

4.6 Pugh Method

Pugh method is used to help students in design decisions by establishing a procedure to choose the best design from the considered design. Based on the six design concept that stated above, this is the list of criteria compared.

Table 4.16: Pugh method

Criteria	Design Concept					
	1	**2**	**3**	**4**	**5**	**6**
Marketability of product	D A T U M	=	+	+	+	+
Ease of manufacture		+	+	_	+	+
Weight of product		+	_	_	+	_
Stability		+	+	+	+	+
Material strength		_	+	+	_	+
Portability		+	_	_	=	=
Life span		_	+	+	+	_
Safety		_	+	+	+	+
Cost of product		+	_	_	+	_
Efficiency of mechanism		_	+	+	+	=
Performance		=	+	+	+	+
Aesthetics		_	+	+	+	+
Simplicity of design		+	+	_	+	=
Total '+'		6	10	8	11	7
Total '-'		5	3	5	1	3
Total		1	7	3	10	4
Rank		6	2	4	1	3

4.7 Design Concept Selection

Based on the Pugh method result, the selected design concept had been made which is design concept number five. The fold table fan is better than the others because of its can be bend and save space. The fifth design concept is excellent in Pugh method which explains that the total numbers between plus and minus value added is the highest among other design concepts.

Figure 4.19: Selection of design concept

An additional mechanism is added in this design concept selection such as push button (Figure 4.20). The function of this push button is to push magnet near to the iron ball in the wheel. A strong magnet set in the close slot between sides of the wheel attracts an iron ball. The magnet is supposed to draw the ball to one side of the center to make the wheel permanently unbalanced. So in order to make a continuous motion, the gravity gives the force to the ball to turn the wheel.

Figure 4.20: Push button (groove profile)

Figure 4.21: Magnet and gravity perpetual motion

4.8 Product Illustration

As a result of the best design selection, this design is translated into CAD software to showcase this product more clearly. By referring Figure 4.22 and 4.23 there are some adjustment that need to fix in order to make all the component mechanisms can function together.

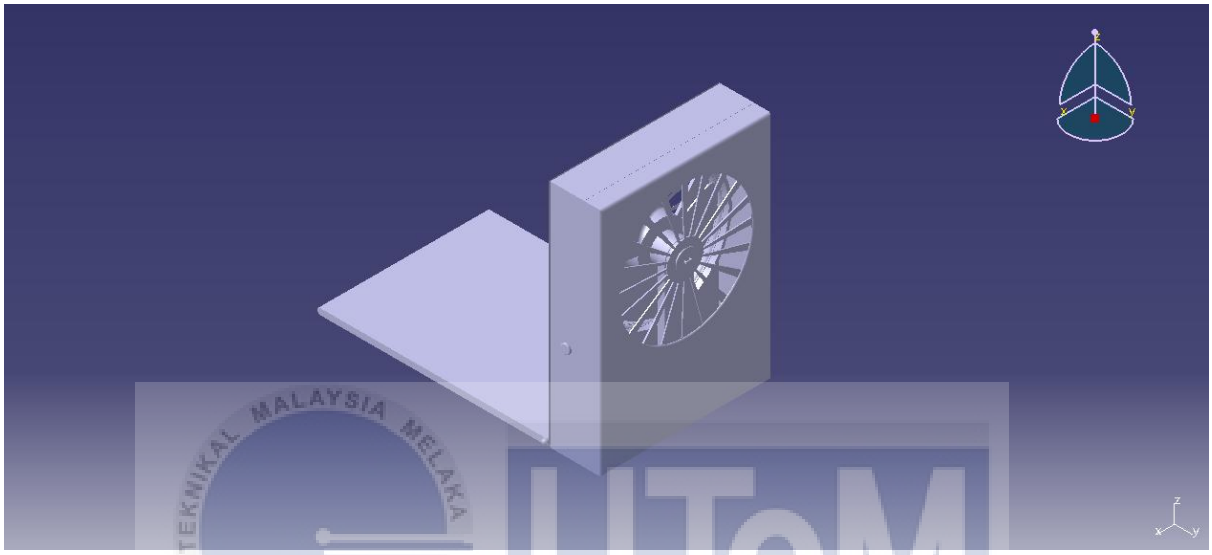


Figure 4.22: Product illustration by using CATIA V5R20 software

Figure 4.23: Orthographic view of the product by using CATIA V5R20

4.9 Complete Design

After all the part for each of the components had been designed, All the parts is combined by using assembly design in CATIA V5R20. A complete design with all the constraints and measurement need to be match each other in order to fix all the parts in one product. As shown in Figure 4.24, the full design of non-electrical table fan is generated.

An exploded view shows the components of an object slightly separated by distance, or suspended in surrounding space in the case of a three-dimensional exploded diagram. By referring Figure 4.26, below is the exploded view of non-electrical table fan.

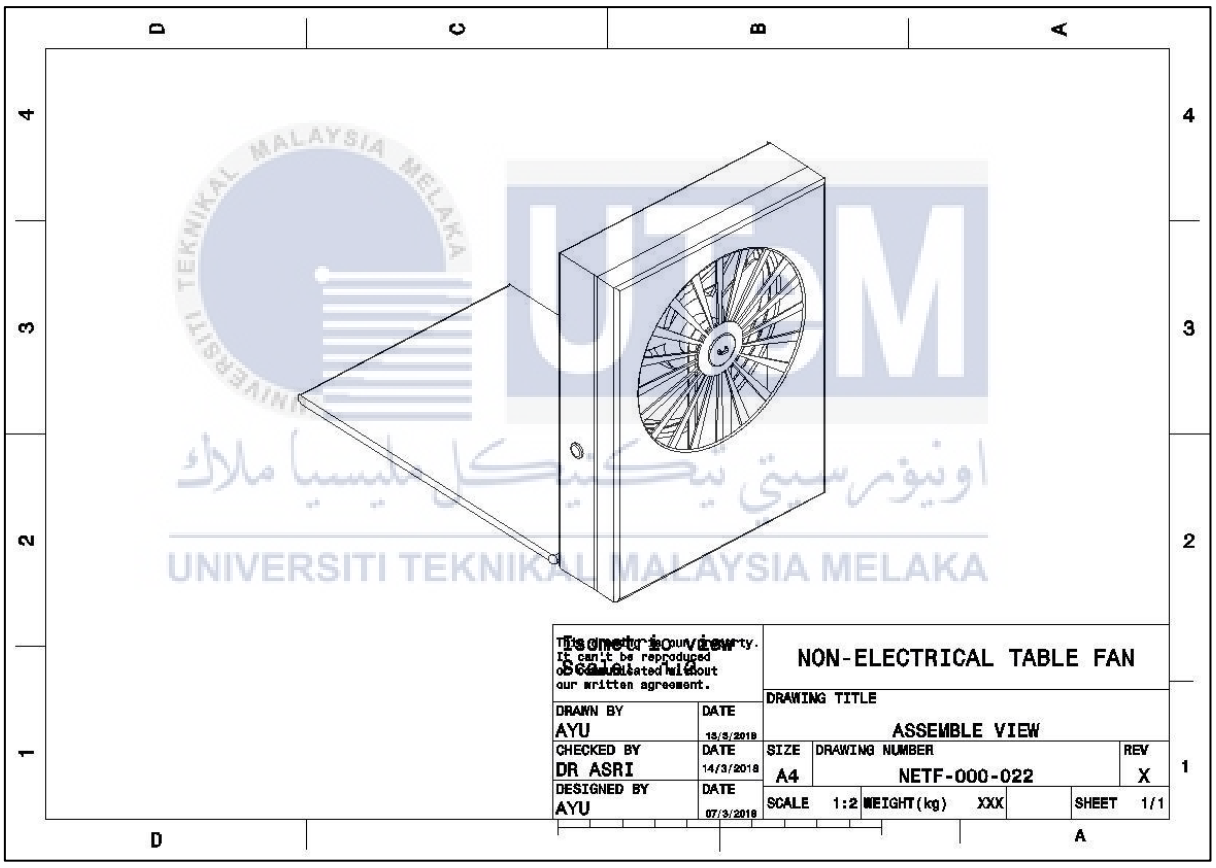


Figure 4.24: Assemble vie of Non-Electrical Table Fan

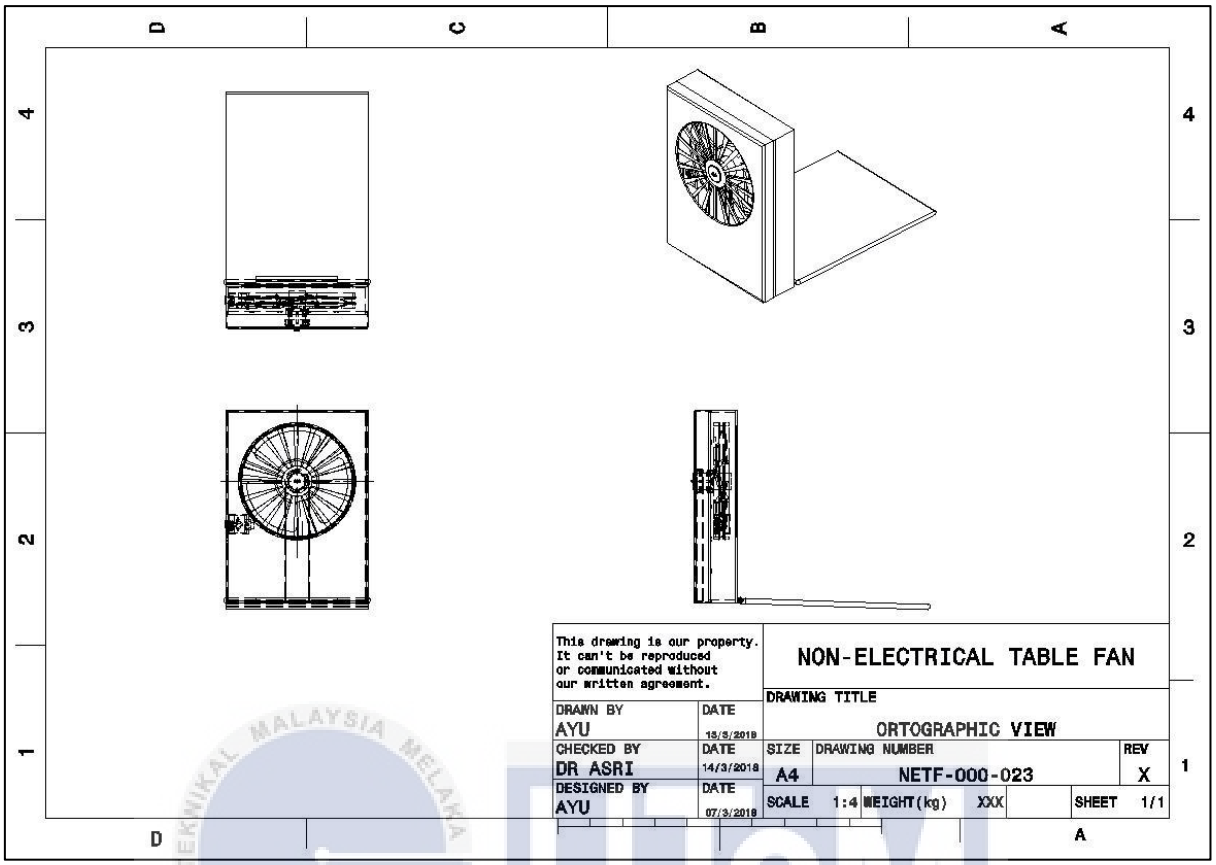
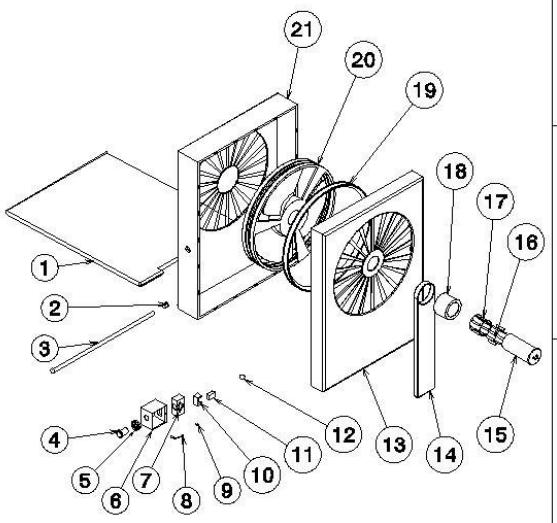


Figure 4.25: Orthographic view of Non-Electrical Table Fan

Bill of Material: Non-Electrical Table Fan

No.	Part Description	Part Number	Quantity
01.	Base Fan	NETF-000-001	1
02.	Button Bottom Shaft	NETF-000-002	1
03.	Bottom Shaft	NETF-000-003	1
04.	Button	NETF-000-004	1
05.	Spring	NETF-000-005	1
06.	Button Box	NETF-000-006	1
07.	Groove Box	NETF-000-007	1
08.	Shaft Mechanism	NETF-000-008	1
09.	Shaft Button	NETF-000-009	1
10.	Magnet Box	NETF-000-010	1
11.	Magnet	NETF-000-011	1
12.	Iron Ball	NETF-000-012	1
13.	Front Guard	NETF-000-013	1
14.	Bearing Holder	NETF-000-014	1
15.	Bearing Shaft	NETF-000-015	1
16.	Cylinder Bearing	NETF-000-016	8
17.	Inner Bearing	NETF-000-017	1
18.	Outer Bearing	NETF-000-018	1
19.	Cover Magnet	NETF-000-019	1
20.	Blade	NETF-000-020	1
21.	Back Guard	NETF-000-021	1



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NON-ELECTRICAL TABLE FAN

DRAWING TITLE: EXPLODED VIEW

DRAWN BY: AYU	DATE: 13/3/2018	SIZE: A4	DRAWING NUMBER: NETF-000-024		REV: X
CHECKED BY: DR ASRI	DATE: 14/3/2018				
DESIGNED BY: AYU	DATE: 07/6/2018	SCALE: 1:4	WEIGHT(kg): XXX		SHEET: 1/1

Figure 4.26 : Exploded view of Non-Electrical Table Fan

4.10 Materials Selection

Selection of materials are important to prevent any failure that can cause injury. Therefore, after process designing take place is identify the materials to be used. Each component have a different material to sit different working conditions and speeds.

Table 4.17: Materials selection for design product

No.	Components	Parts	Materials
01.	Framing body	Front guard	Acrylonitrile Styrene Acrylate (ASA) Blend
		Back guard	Acrylonitrile Styrene Acrylate (ASA) Blend
		Base fan	Acrylonitrile Styrene Acrylate (ASA) Blend
		Bottom shaft	Acrylonitrile Styrene Acrylate (ASA) Blend
		Button bottom shaft	Acrylonitrile Styrene Acrylate (ASA) Blend
02.	Fan blade	Blade	Acrylonitrile Styrene (AS) Plastic
		Cover magnet	Acrylonitrile Styrene Acrylate (ASA) Blend
		Iron ball	Iron
03.	Blade shaft	Bearing holder	Acrylonitrile Styrene Acrylate (ASA) Blend
		Bearing shaft	Acrylonitrile Styrene Acrylate (ASA) Blend
		Inner bearing HK1616	Hardened Carbon Steel Alloy
		Outer bearing HK1616	Hardened Carbon Steel Alloy
		Cylinder bearing (Roller)	Chrome Steel
04.	Push button mechanism	Button box	Acrylonitrile Styrene Acrylate (ASA) Blend
		Groove box	Acrylonitrile Styrene Acrylate (ASA) Blend
		Magnet box	Acrylonitrile Styrene Acrylate (ASA) Blend
		Magnet	Magnet
		Spring	Chrome Silicon
		Shaft mechanism	Acrylonitrile Styrene Acrylate (ASA) Blend
		Shaft button	Acrylonitrile Styrene Acrylate (ASA) Blend
		Button	Acrylonitrile Styrene Acrylate (ASA) Blend

4.10.1 Plastics

Material make this capital structure must from hard things because it will support other components. Apart from that, the material should light so that easy to be carried anywhere. Therefore, material proposed is plastic. Here are the characteristics of plastic:

1) Easy to work and shape.
2) Have a low production cost
3) Possess low density.
4) Tend to be waterproof.
5) Good electrical insulation
6) Acceptable acoustic insulation.
7) Good thermal insulation, but most can not withstand very high temperatures.
8) Resistant to corrosion and chemical factors

In this project, there are two type of plastics that suitable for manufacturing a non-electrical table fan which are Acrylonitrile Styrene Acrylate (ASA) Blend and Acrylonitrile Styrene (AS) Plastic. The details about these two material was discussed in this sub-topic below.

4.10.1.1Acrylonitrile Styrene Acrylate (ASA) Blend

Most of the parts in this product are made of Acrylonitrile Styrene Acrylate (ASA) Blend. This is because ASA Blend provide high temperature stability, good impact strength and also at cold temperature combined with very good UV-Stability and surface properties. Table 4.18 below shown the specification properties of ASA Blend.

Table 4.18 : Density, tensile strength and modulus of elasticity of ASA Blend

Density	1200 kg/m^3
Tensile strength	35MPa
Modulus of elasticity	2.5GPa

4.10.1.2Acrylonitrile Styrene (AS) Plastic

Acrylonitrile Styrene (AS) is a group of co-polymers that have the transparency of polystyrene, but with improved resistance to solvents and stress cracking. This material is selected based on the characteristics of plastic which is, it can withstand both thermal and electrical insulator. This types of plastics are usually are considered for all the electrical appliances, cords, outlets and wiring that are made or covered with plastics. Hence, this AS Plastic was choosen.

Table 4.19: Density, tensile strength and modulus of elasticity of AS Plastic

Density	1060 kg/m^3
Tensile strength	72MPa
Modulus of elasticity	3.6GPa

4.10.2 Magnet

Magnet is a material that produces a magnetic field. The magnetic filed can not be seen in a rough eyes, it invisible but is responsible for the most notable property of a magnet. A force that push on other ferromagnetic materials such as iron and attract or repels other magnets. A strong magnet set in the open slot between sides of the wheel attract an iron ball.

4.10.3 Iron

One of the characteristics of iron ball is to attract magnet so that it can make the wheel blade move.

4.10.4 Hardened Carbon Steel Alloy

Steel material is used at drawn cup bearing component. This is because the material must made of a material that has high hardness, resistant to rolling fatigue, wear resistance and has good dimensional stability. In addition, for the bearing cage material must have the strength to withstand rotational vibrations and shock loads. These materials must also have a low friction coefficient and be light weight.

4.10.5 Chrome Silicon

The material group of this chrome silicon is from alloy steel wire. The material is choose because it can stand high stress and be able to handle shock or impact loading occurs.

Table 4.19: Technical specification of Chrome Silicon

Young's Modulus,E (MPa)	207 000
Modulus of Rigidity, G (MPa)	79 300
Conductivity, % IACS	5
Density, g/cm^3	7.860
Maximum temperature, ℃	245

4.11 Product Structure

The manufacture of this structural product is intended to describe each sub component of this non-electrical table fan. This product contains five main components such as the framing fan body, bottom shaft, fan blade, blade shaft and needle roller bearing.

4.11.1 Framing Fan Body

This framing fan body consists of back guard, front guard and base. This guard is needed to protect the humans when the blade is rotating. As shown in Figure 4.27 below, the exploded view of framing fan body component. The bottom shaft is used to make a link between back guard and base fan. This component is act like a hinge that make the framing fan body able to move in a various angle degree.

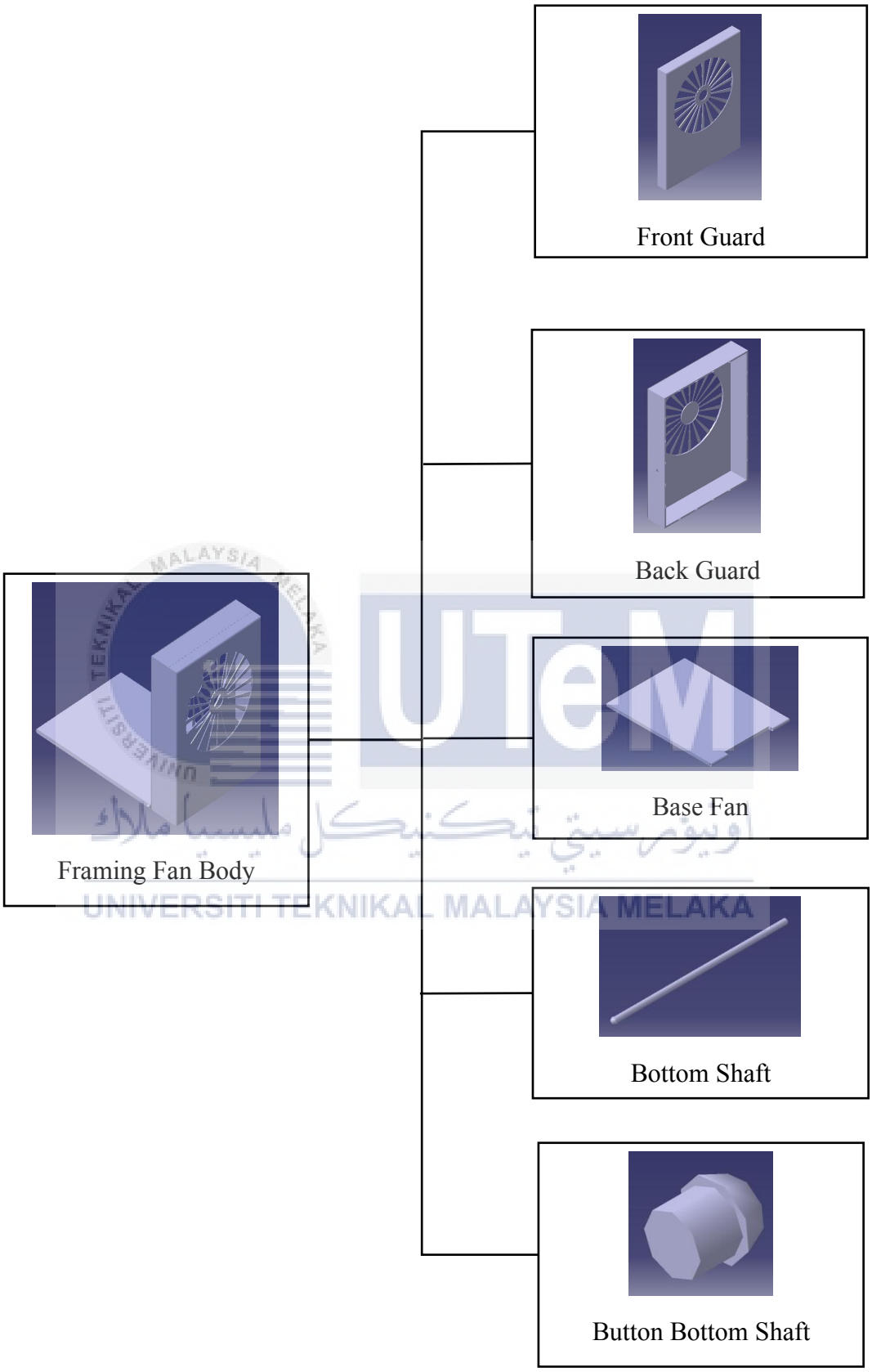

Figure 4.27: Framing fan body structure

4.11.2 Fan Blade

Fan blade is designed to create air flow so that the air will blow directly to people.

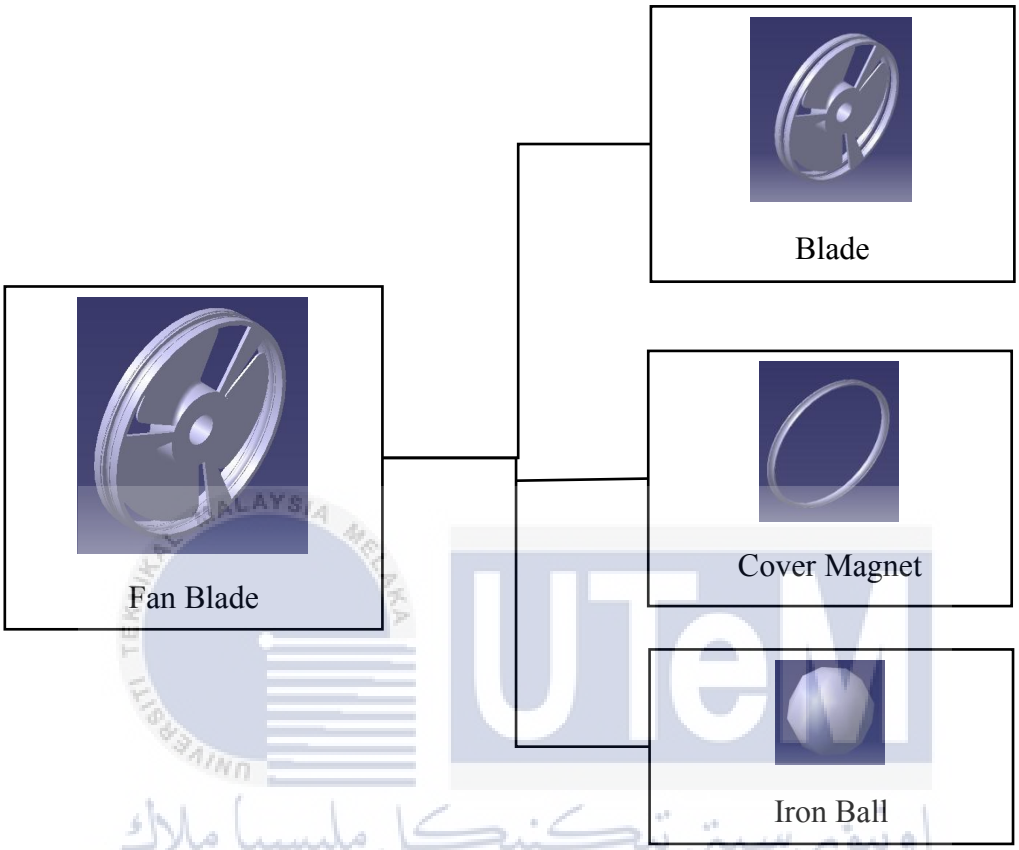

Figure 4.28: Fan blade structure

4.11.3 Blade Shaft

Blade shaft is designed to make the users able to rotate the blade manually for the first time period. This because the iron ball need to attach with the magnet in order to make a blade in perpetual motion. In addition, the use of needle roller bearing is to reduce stress impact while the user rotate it manually. They also had their own size standard where it had a very specific measurement. If there is some modification related to dimension, then modifications will be made but still use the same material to maintain the strength of the product.

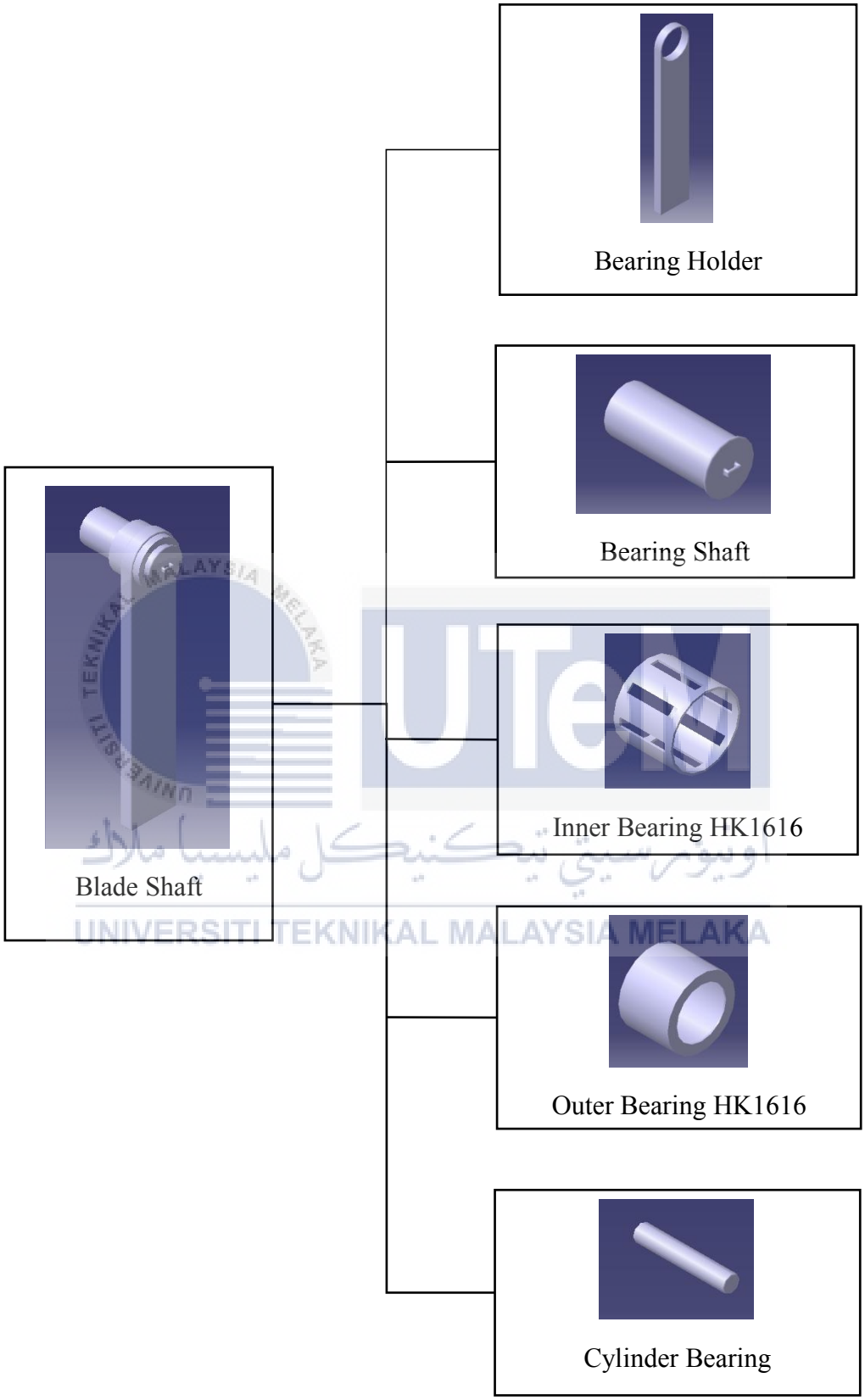

Figure 4.29: Blade shaft structure

4.11.4 Push Button Mechanism

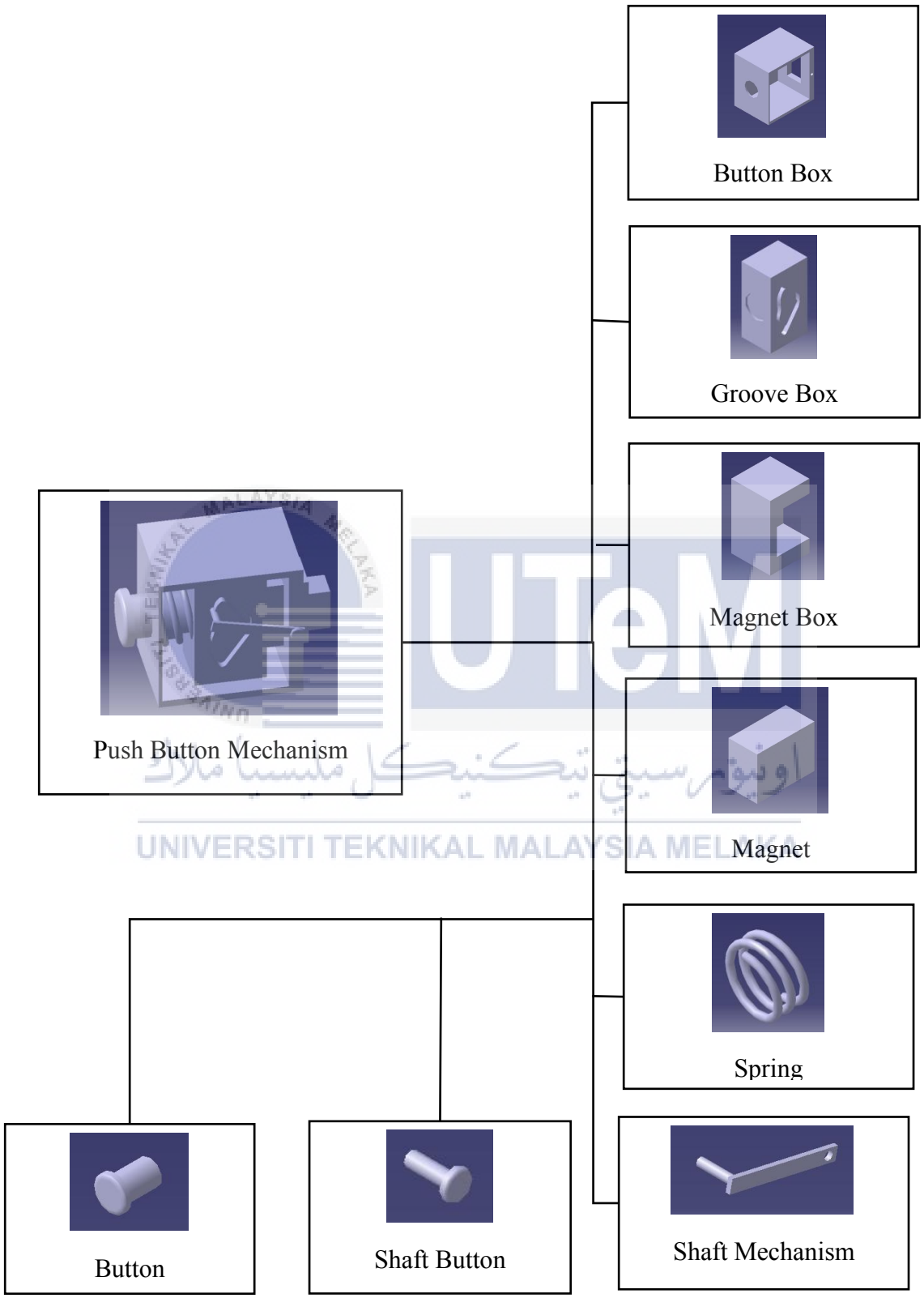

Figure 4.30: Push button mechanism structure

4.12 Product Analysis

This analysis are depends on the data from results. Before fabricate a product, a few experiment needs to be done to ensure the product able be functional. There are a few methods that can be used, among them is by simulating and analysis. This experiment made using software. This way even more frugal because does not produce cost and does not require particular space, merely using a computer only. For the project, experiment carried out is Finite Elements Analysis (FEA) from CATIA V20 software and a few calculation. In this Finite Element Analysis (FEA) can be divided into three parts namely Von Mises Stress, Translational Displacement and Deformation.

4.12.1 Spring

The use of this spring is to push magnet toward iron ball. Based on the Figure 4.31 shown, results analysis carried out on component spring. The material used is Chrome Silicon (ASTM A 401) with 1620-2069 MPa yield stress value. Maximum value of Von Mises Stress is $7.69x10^8$ MPa and to Translational Displacement is 5.4 mm. The aim of this analysis is to know how many impact amount that can be imposed on this spring.

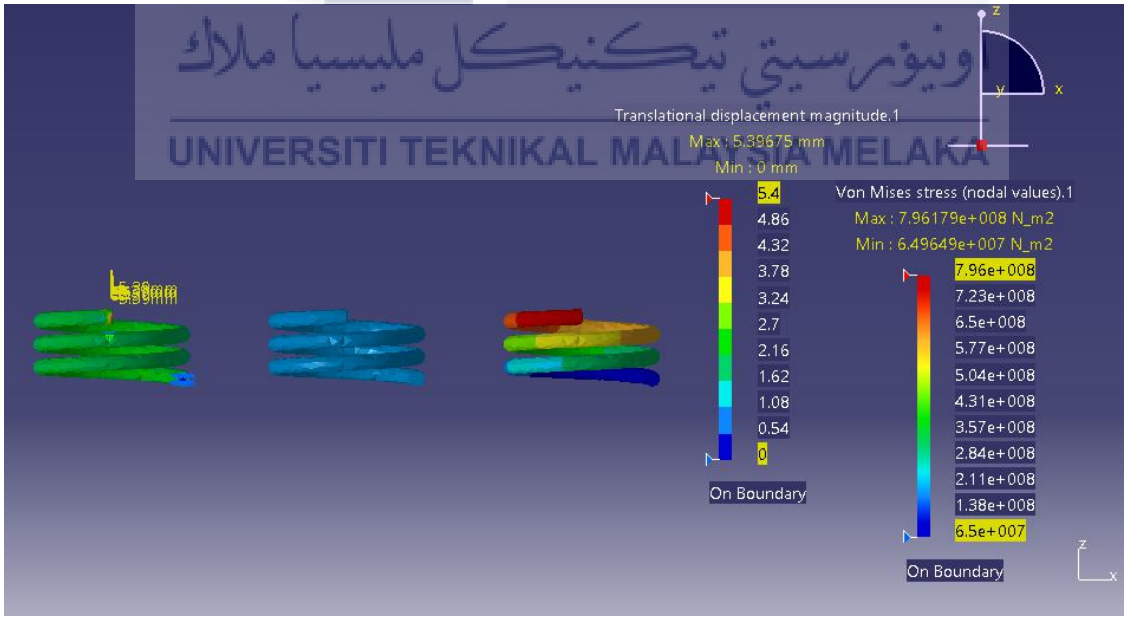

Figure 4.31: Spring result analysis from left side: Von Mises Stress, Deformation and Translational Displacement.

Hence to make sure that this design withstand the design load, the maximum value of Von Mises Stress in design product should less than the yield point value of Chrome Silicon (ASTM A 401) material. Thus, only a fraction of the ultimate load capacity of spring is used when the allowable load is applied. The remaining portion of the load-carrying capacity of the member is kept in reserve to assure its safe performance. So the factor of safety Eq. (2.1) is

$$\text{Factor of Safety} = \frac{\text{Ultimate Stress}}{\text{Allawable Stress}}$$

$$F.S = \frac{2069x10^{6}\,Pa}{7.96x10^{8}\,Pa}$$

$$F.S = 3$$

4.12.2 Bearing Shaft

Bearing shaft is located between front guard and back guard. The main function of bearing shaft is to rotate blade fan manually so that ball iron able bring closer near to magnet plate. Manually this revolution only at beginning before the blade can turn continuously due to magnetic and gravitional force that applied in the iron ball. In between, the bearing shaft hold the blade and roller needle bearing HK 1616 but with support by bearing holder (Figure 4.29).

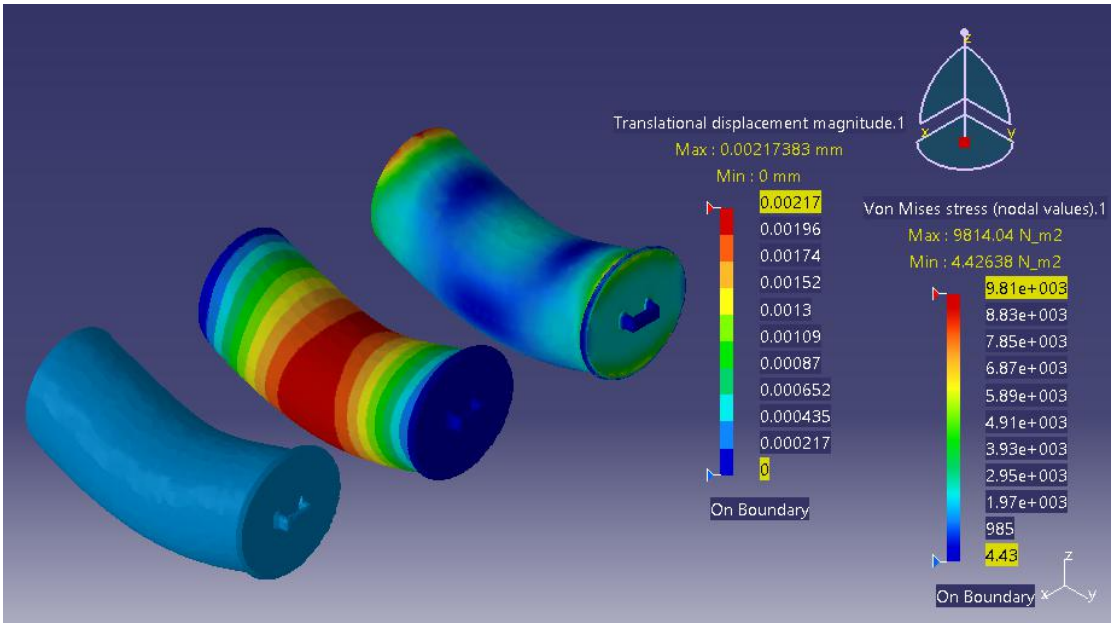

Figure 4.32: Bearing shaft result analysis, from left side: Deformation, Translational Displacement and Von Mises Stress.

The material used in this bearing shaft is Acrylonitrile Styrene Acrylate (ASA) Blend with a load capacity from blade, bearing holder and bearing load are 0.37N, 0.19N, and 0.14N respectively act along the shaft. The material properties of ASA Blend is in Table 4.18. The yield stress value of Acrylonitrile Styrene Acrylate (ASA) Blend is 35MPa. By referring Figure 4.32, the Von Mises Stress analysis shown that the maximum value act at the center of the shaft is $9.81x10^{3}$ MPa, meanwhile the highest Translational Displacement is about $2.2x10^{-3}$ mm downward.

4.12.3 Base Fan

The base fan is designed to give degree of freedom at front and back guard so that it allow the user feel the air flow in an ideal direction toward their body. Based on the Figure 4.33 shown, results analysis carried out on base fan part. The material used is ABS Plastic with 40 MPa yield stress value. Maximum value of Von Mises Stress is $8.28x10^{3}$ MPa and to Displacement Translational is $1.11x10^{-5}$ mm downward.

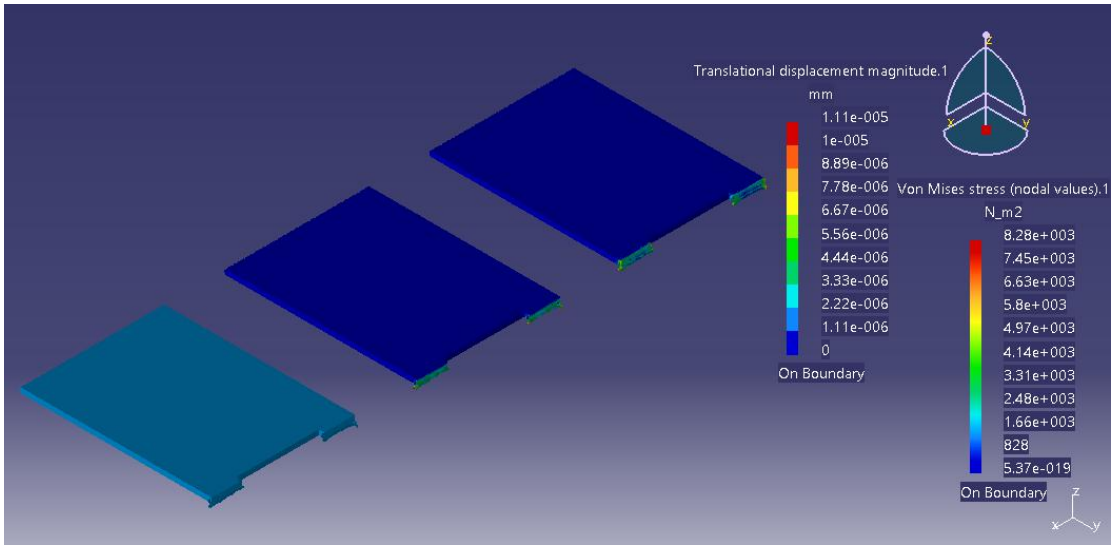

Figure 4.33: Base fan result analysis, from left side: Deformation, Translational Displacement and Von Mises Stress

4.12.4 Bearing

This bearing HK1616 is used to reduce friction between moving parts such as nearing shaft and blade. This bearing provide for free linear movement of the moving part or for free rotation around a fixed axis. Hence, Table 4.20 shown the specification of bearing HK1616:

Table 4.20: Specifications of bearing HK1616

Bearing type	Cage retained roller, two seals	
Outer diameter	22	mm
Width	16	mm
Dynamic load rating	7.6	N
Static load rating	9.7	N
Maximum speed	11	rpm
Shaft	16	mm
Weight	14	g

4.12.5 Blade

The main part in this design is to make sure that the non-electrical table fan can be function nicely. Hence, the characteristics of the blade need to be in exact value, so that, we know weather this blade can be run properly or not. Figure 4.34 below shown the details of the blade part.

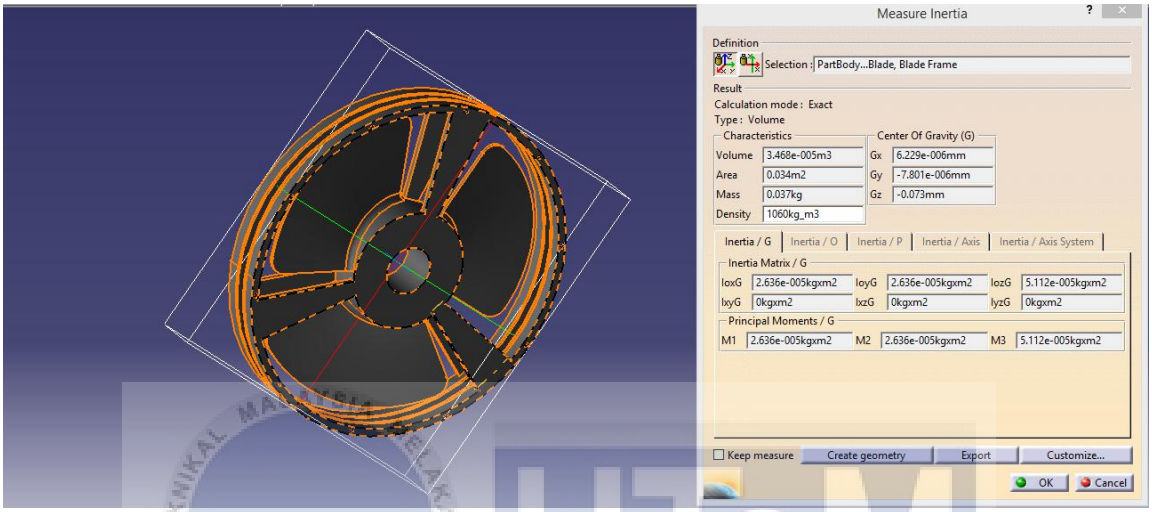

Figure 4.34: The volume, area, mass, density and moment of inertia of the blade fan

It is importance to know what is the speed of the blade can work properly to produce an air to the customers. Hence, by using the Eq. (2.2) of rotational speed of blade to calculate speed

$$\omega = \sqrt{\frac{g \tan\theta}{r + l\sin\theta}}$$

$$= \sqrt{\frac{9.81\tan(45)}{0.07 + 0.03\sin(45)}}$$

$$= 12.90 rad/s$$

Converting rad/s to RPM

$$12.90\frac{\text{rad}}{\text{sec}} = 12.90\frac{\text{rad}}{\text{sec}} \text{x} \frac{1\text{rev}}{2\pi\text{rad}} \text{x} \frac{60\text{sec}}{1\text{min}}$$

$$= 123.19\frac{\text{rev}}{\text{min}}$$

$$= 123.19\text{RPM}$$

4.13 Product Simulation

As a result of the best design selection, this design is translated into CAD software to showcase this product more clearly.

4.13.1 Final Design

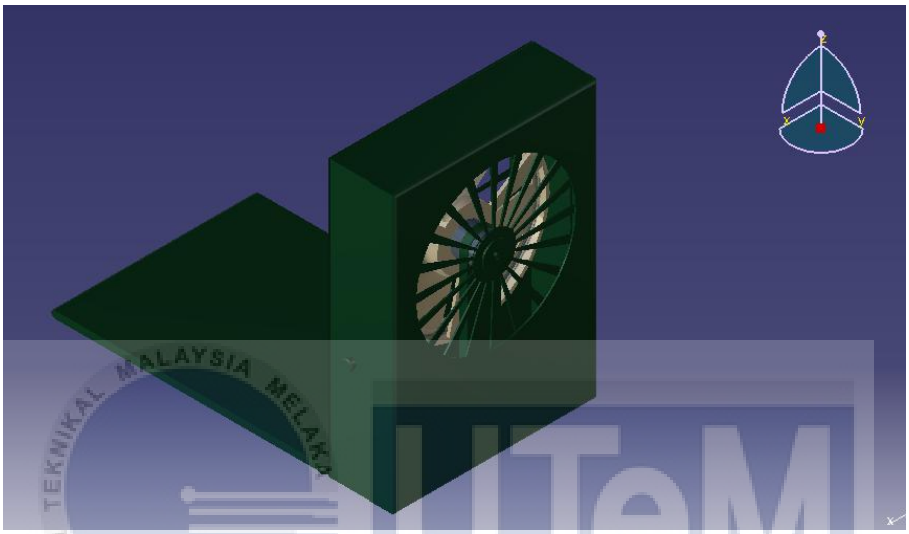

Figure 3.45: The final product

Product simulation was done by using DMU Kinematics. The simulation result had been attached in CD.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.0 Conclusion And Recommendation

This chapter contains a brief summary of the entire work, including methods, results conclusion ad recommendations arising from this project.

5.1 Conclusion

In conclusion, main object namely to design a non-electrical table fan and product design capable of penetrating the current market was achieved. There were many processes involved. The first stage was sketch some ideas of produces conceptual design. A total of six projects design can produce and sketch by using hand. After that the product was choose based on Pugh Method. The best design concept that had been selected was proceed to achieve the objective of PSM. Survey method is used to collect the data to identify product specification and product marketability to be sold. It is very important to ensure that the product meets the needs of the consumer.

This project had been covered in all processes. The studies are more focusing on the product illustration for the selected design concept in order to show the specific design of non-electrical table fan product by using CATIA P3 V5R20 software. After that, design simulation is used to have an overview of the actual project. The goal of the simulation was to show the working mechanism in the project can be perform together with other component parts. The simulation of table fan was developed by using Digital Mock-Ups (DMU) Kinematics Simulator in CATIA V5R20 which is it a combination of assembly part and motion. Lastly, the analysis process is carried out in CATIA P3 V5R20 software. Among the analysis that can be done in this software was the type of Von Misses Stress, Deformation, and Translational Displacement in Finite Element Analysis (FEA). From an analysis, safety factor will be achieved.

5.1 Recommendation

It is recommended that the design of non-electrical table fan must be included in this study to get the better results on the mechanism system. This is because, when designing the mechanism for the first time, it is almost impossible to predict all the possible design criteria required to create perfect design. As this was the first product of non-electrical table fan by using perpetual motion, there is no guarantee to the system can be function properly as expected but a conservative approach was taken to prevent failure.

For the improvement in future, this product can be upgraded by manufacturing a mechanisms that can make the blade of speed move faster. Apart from that, this product can also been increased his function by adding another system which could generate and store electricity from the speed that blade had generated. This will make the non-electrical table fan as 2 in 1 product.

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APPENDICES

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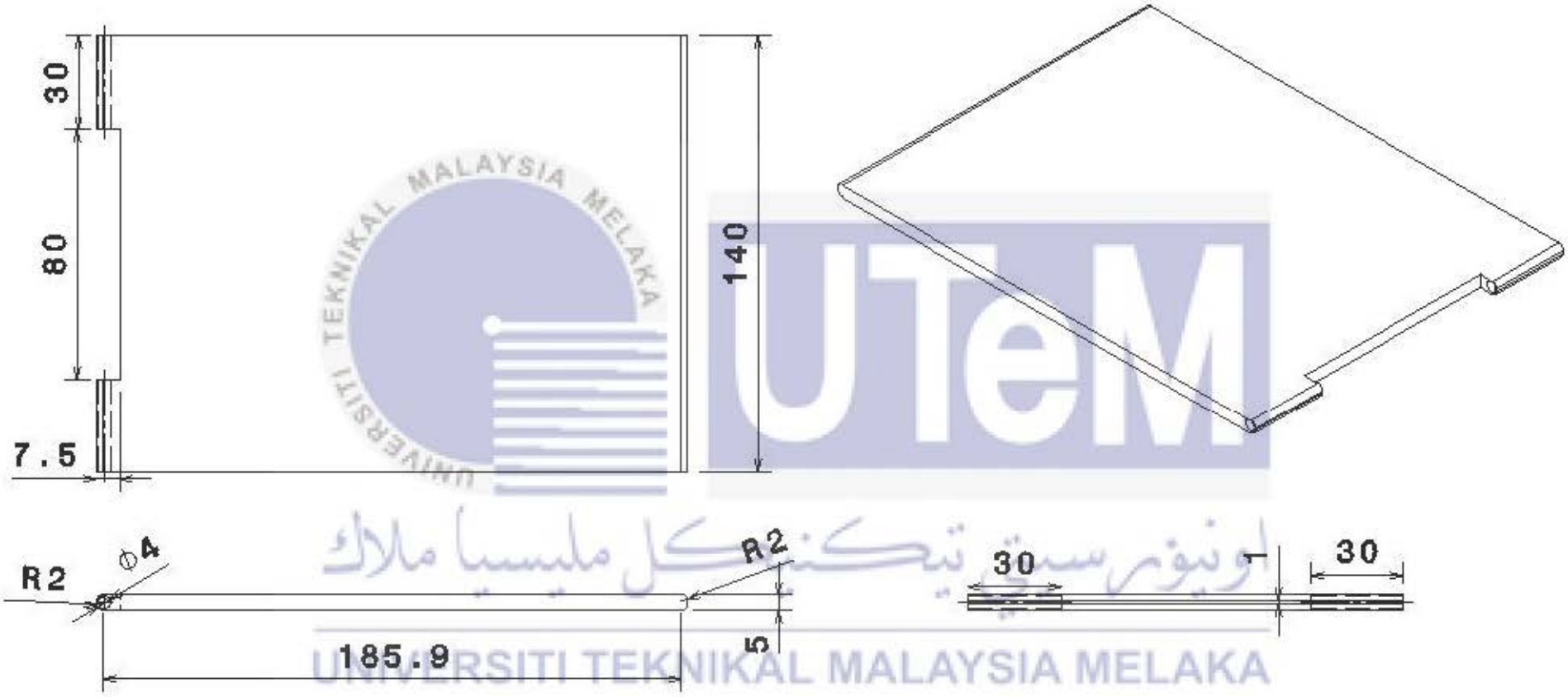

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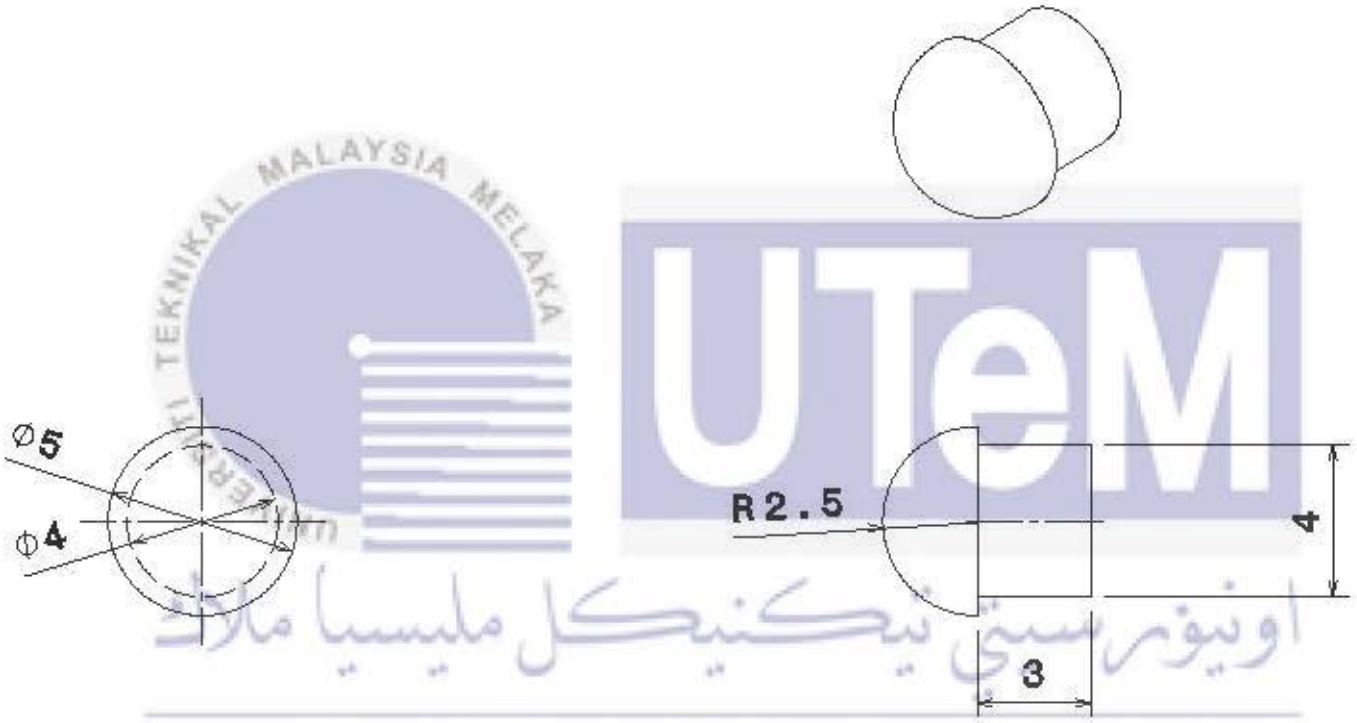
DESIGNED BY: AYU	DATE: 07/3/2018	SCALE: 1:2	WEIGHT(kg): XXX		SHEET: 1/1	



NON-ELECTRICAL TABLE FAN

DRAWN BY: AYU	DATE: 13/3/2018
CHECKED BY: DR ASRI	DATE: 14/3/2018
DESIGNED BY: AYU	DATE: 07/3/2018

DRAWING TITLE: BUTTON BOTTOM SHAFT

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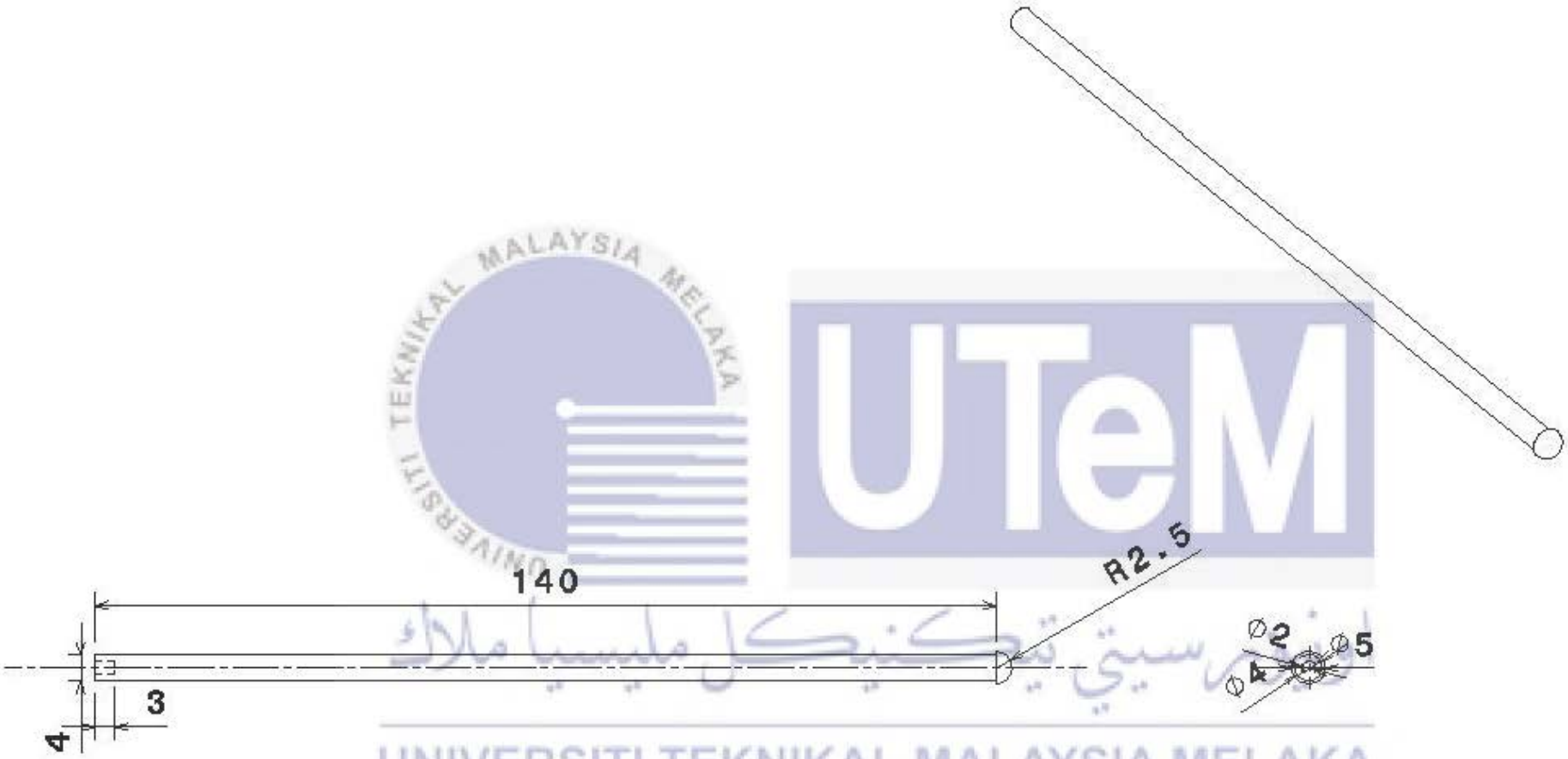
SCALE	WEIGHT(kg)		SHEET
6:1	XXX		1/1



NON-ELECTRICAL TABLE FAN

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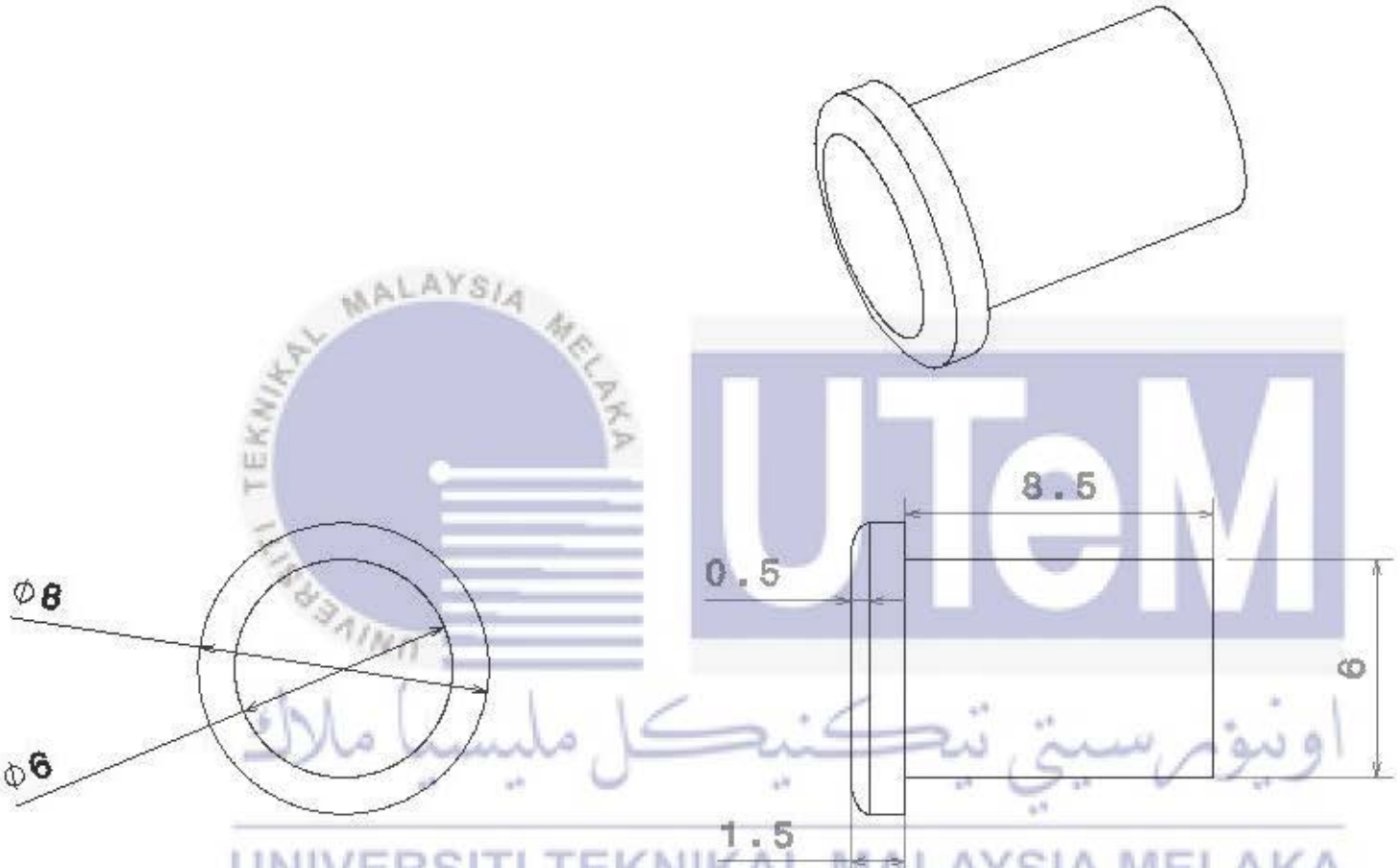

NON-ELECTRICAL TABLE FAN

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CHECKED BY: DR ASRI	DATE: 14/3/2018
DESIGNED BY: AYU	DATE: 07/3/2018

DRAWING TITLE: BUTTON

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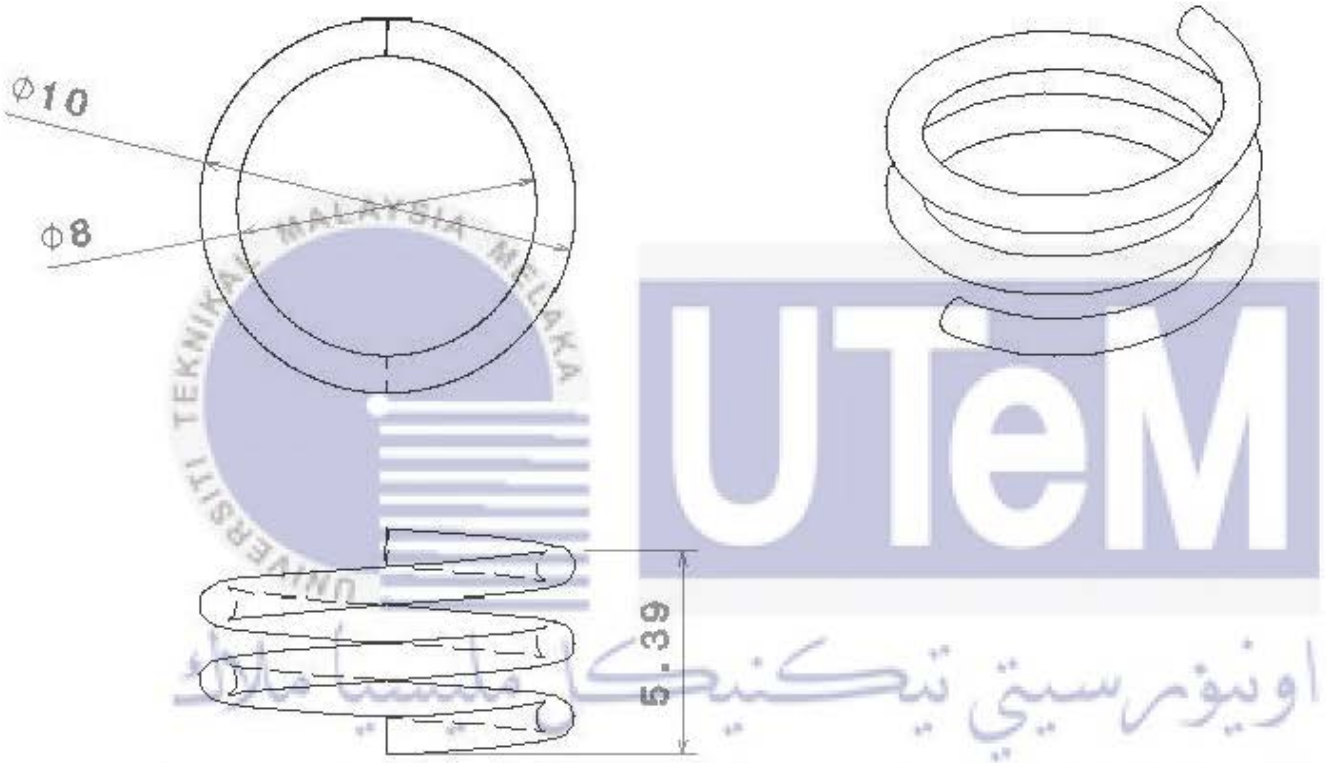

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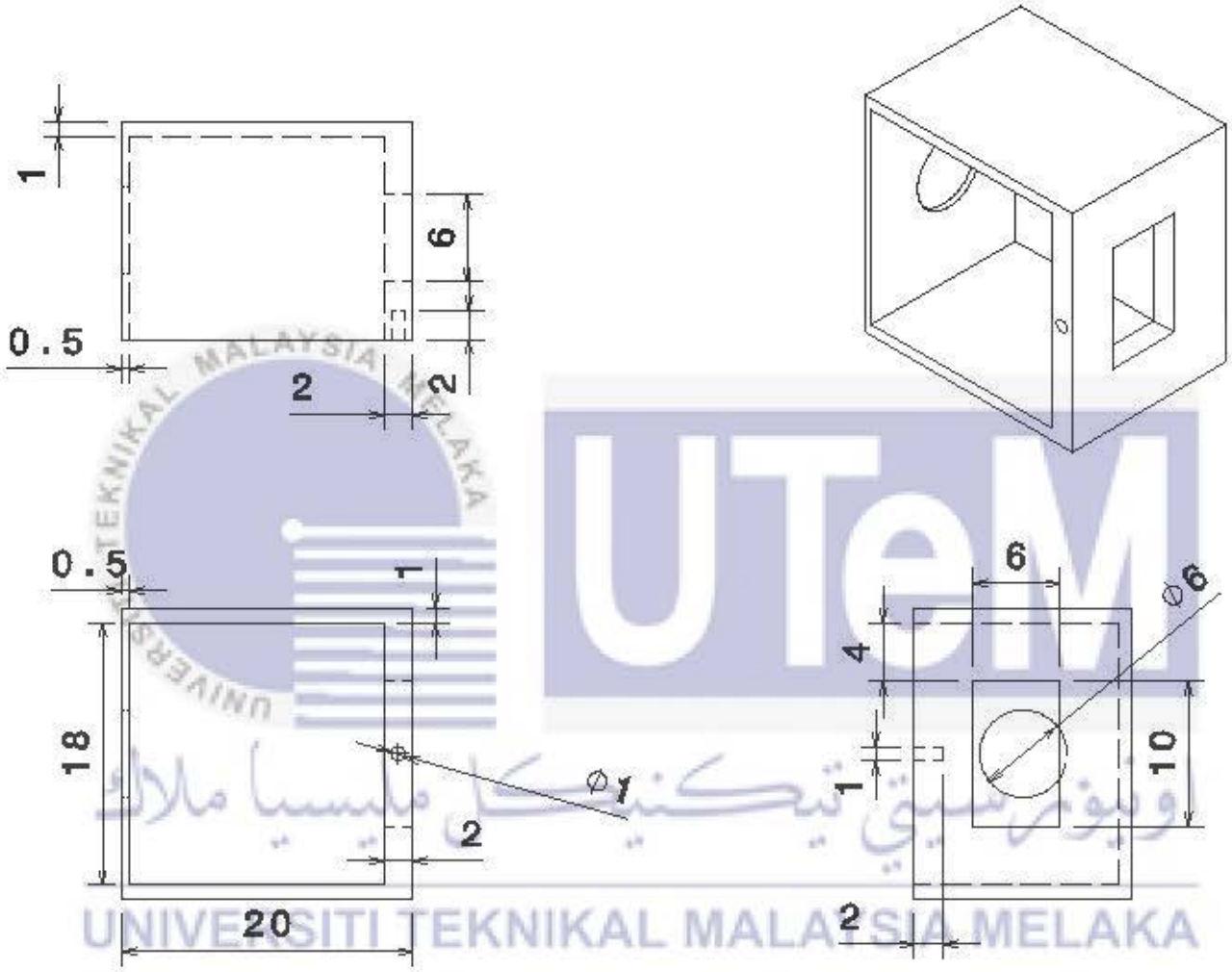

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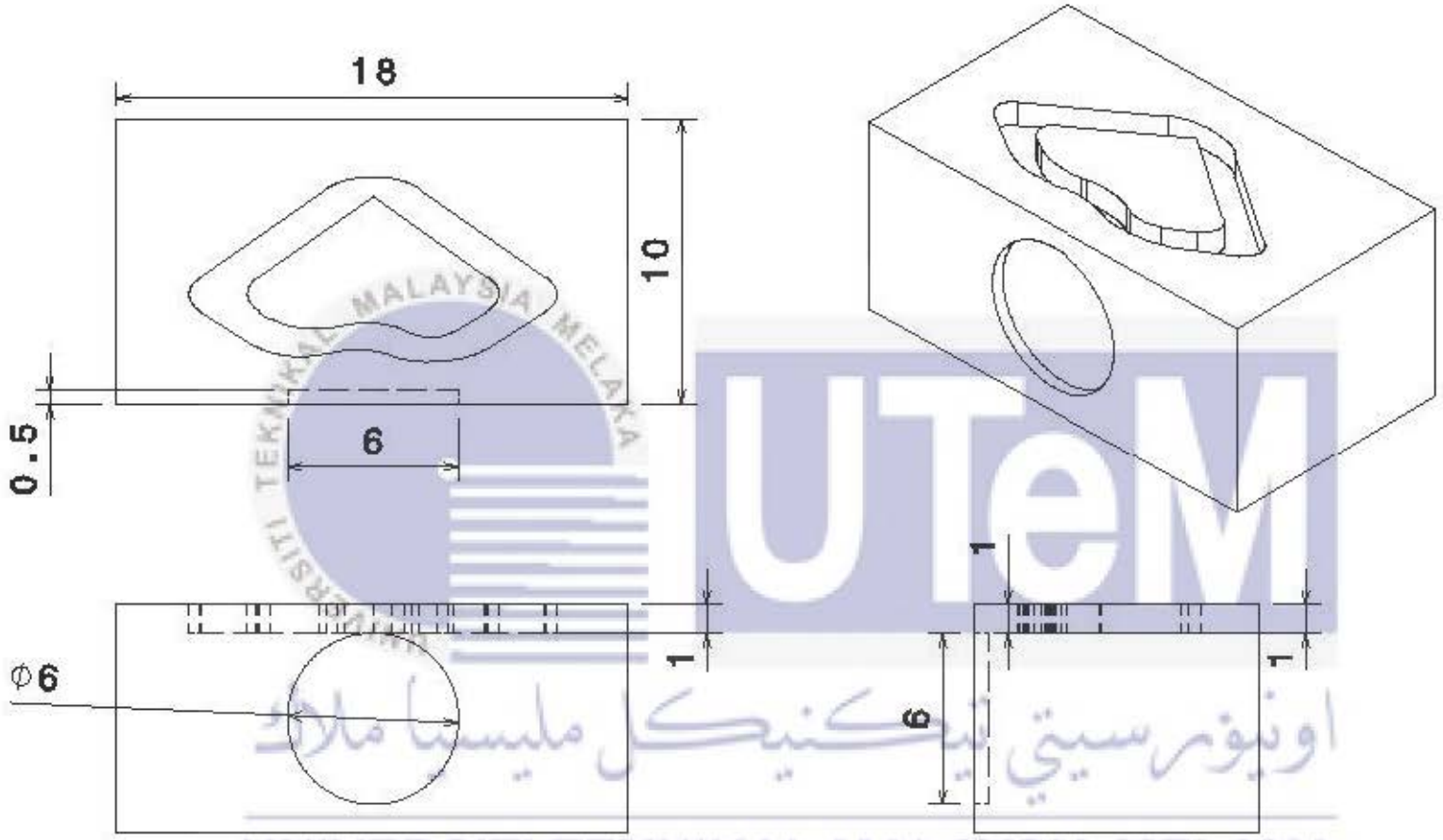

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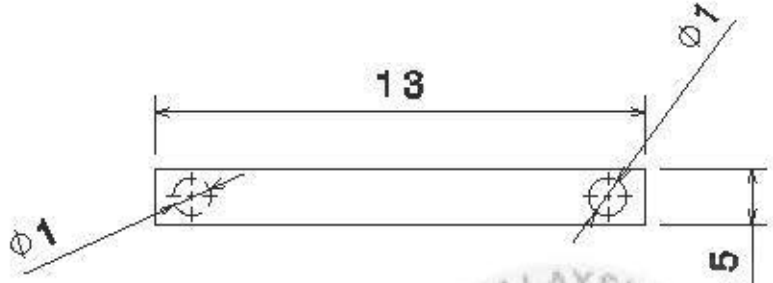
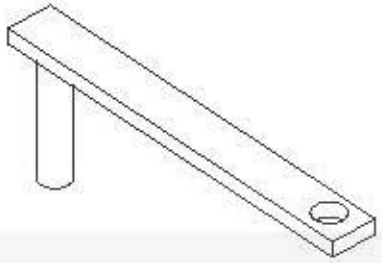
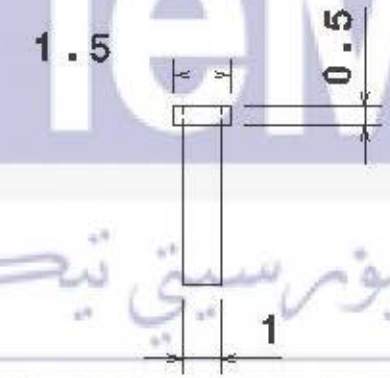
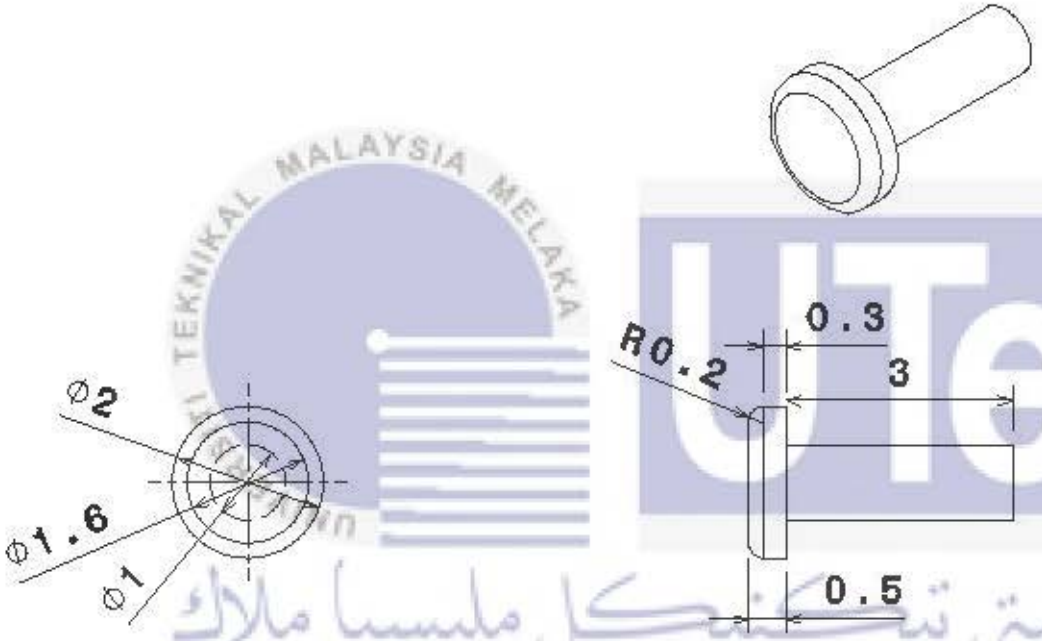
DRAWN BY AYU	DATE 13/3/2018	DRAWING TITLE GROOVE BOX				
CHECKED BY DR ASRI	DATE 14/3/2018	SIZE A4	DRAWING NUMBER NETF-000-007			REV X
DESIGNED BY AYU	DATE 07/3/2018	SCALE 4:1	WEIGHT(kg) XXX		SHEET 1/1	



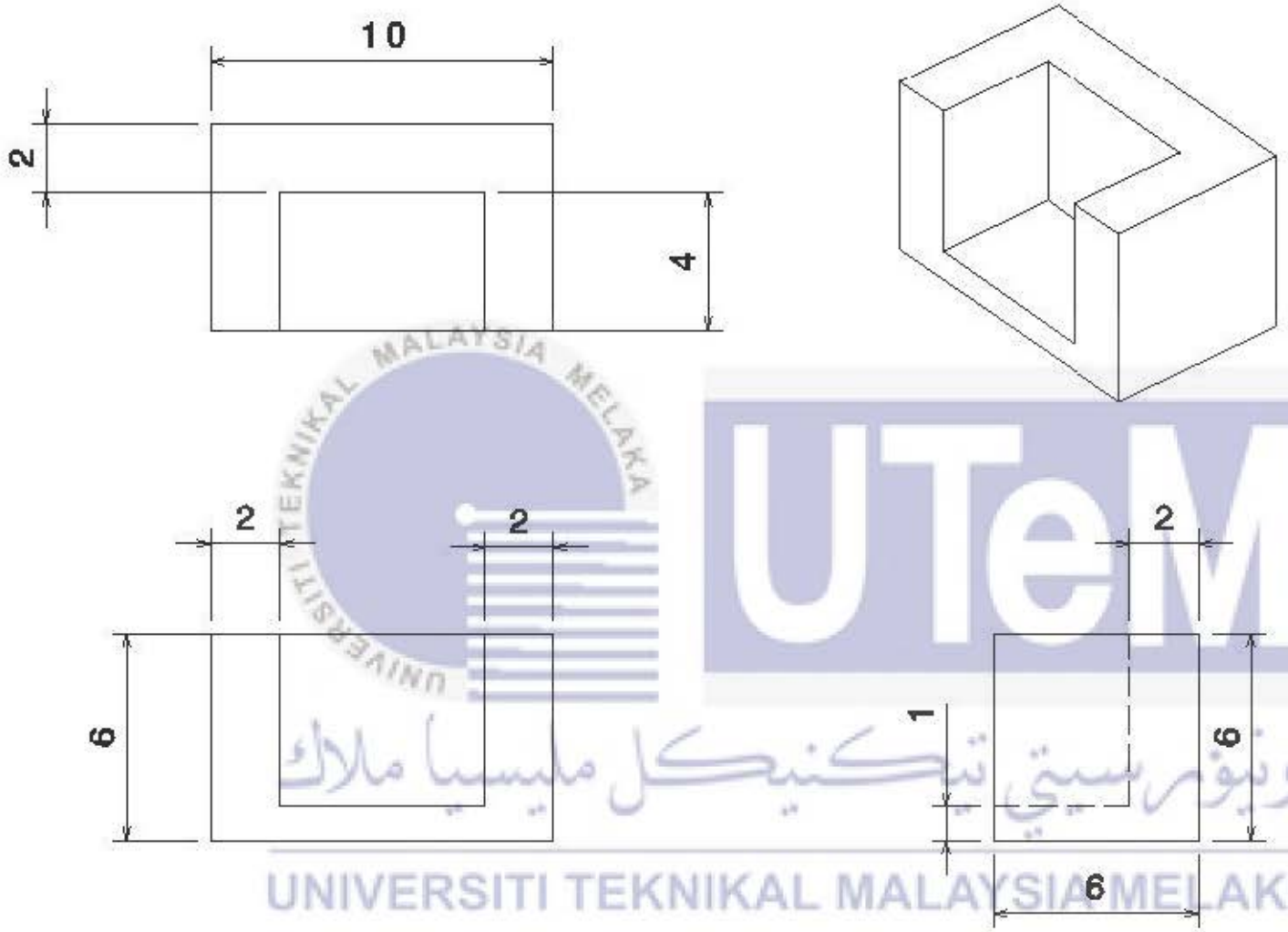




This drawing is our property. It can't be reproduced or communicated without our written agreement.		NON-ELECTRICAL TABLE FAN				
DRAWN BY AYU	DATE 13/3/2018	DRAWING TITLE SHAFT MECHANISM				
CHECKED BY DR ASRI	DATE 14/3/2018	SIZE A4	DRAWING NUMBER NETF-000-008			REV X
DESIGNED BY AYU	DATE 07/3/2018	SCALE 5:1	WEIGHT(kg) XXX		SHEET 1/1	

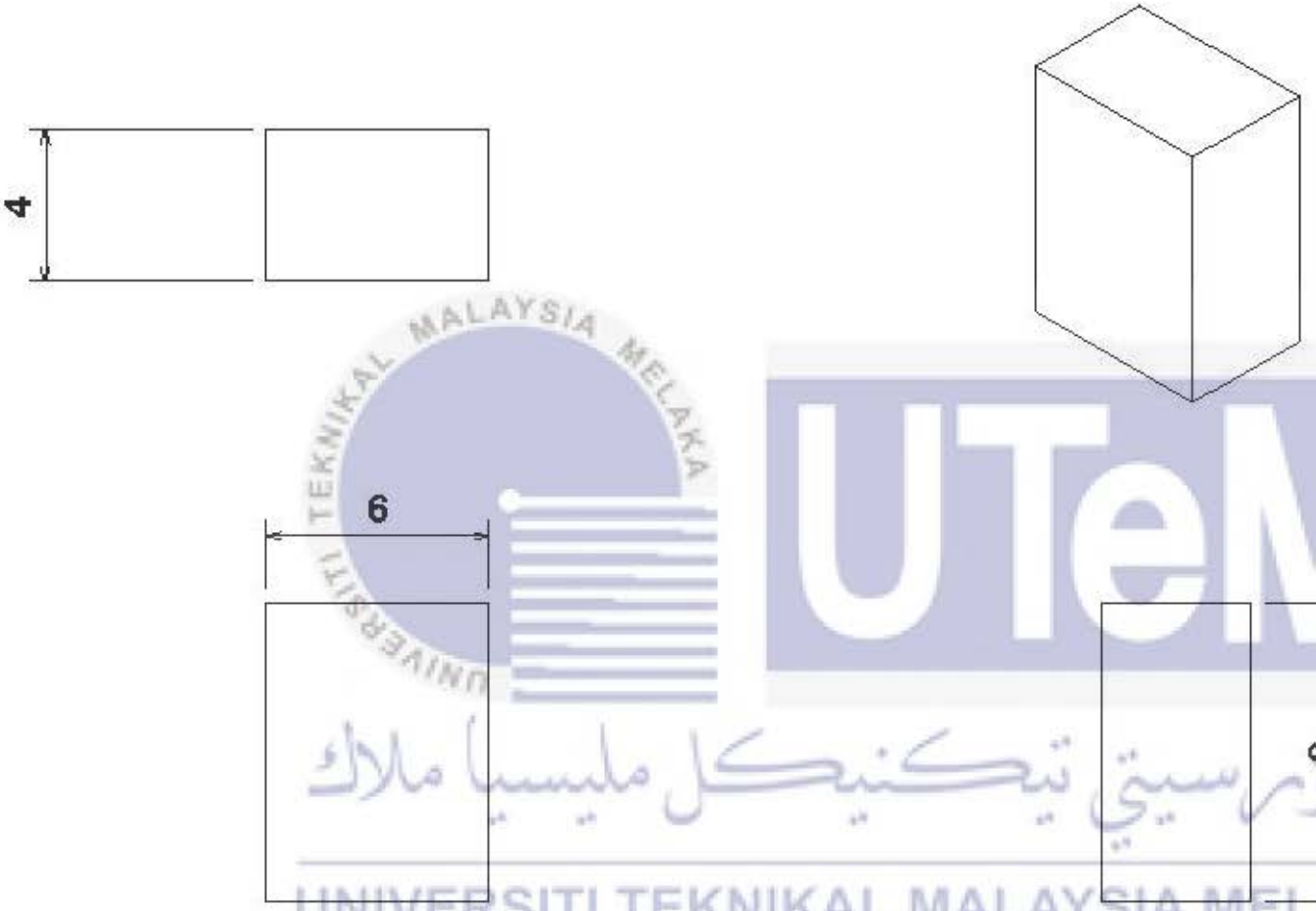


This drawing is our property. It can't be reproduced or communicated without our written agreement.		NON-ELECTRICAL TABLE FAN			
DRAWN BY AYU	DATE 13/3/2018	DRAWING TITLE SHAFT BUTTON			
CHECKED BY DR ASRI	DATE 14/3/2018	SIZE A4	DRAWING NUMBER NETF-000-009		REV X
DESIGNED BY AYU	DATE 07/3/2018	SCALE 10:1	WEIGHT(kg) XXX		SHEET 1/1



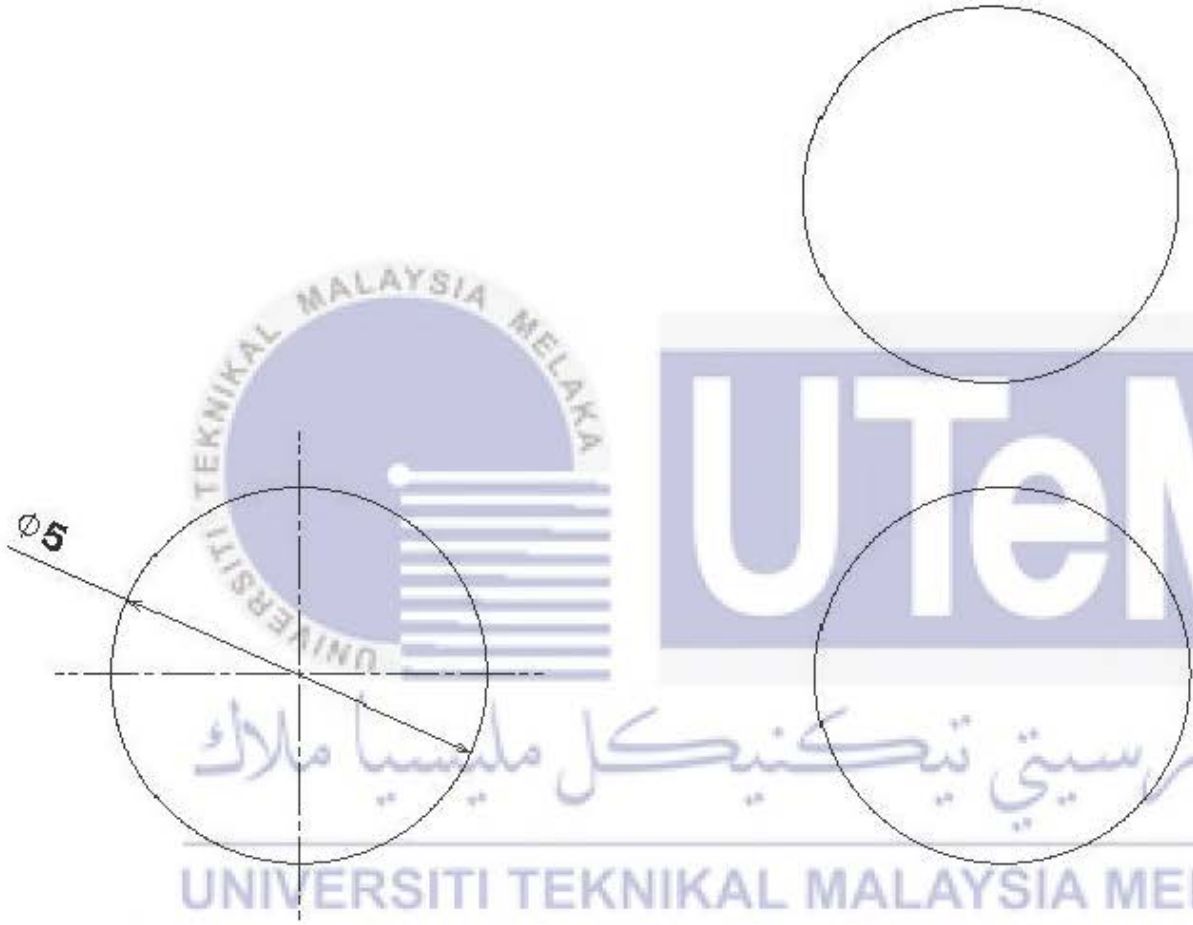
NON-ELECTRICAL TABLE FAN

DRAWN BY: AYU	DATE: 13/3/2018	DRAWING TITLE: MAGNET BOX			
CHECKED BY: DR ASRI	DATE: 14/3/2018	SIZE: A4	DRAWING NUMBER: NETF-000-010		REV: X
DESIGNED BY: AYU	DATE: 07/3/2018	SCALE: 5:1	WEIGHT(kg): XXX		SHEET: 1/1



DRAWN BY AYU	DATE 13/3/2018	NON-ELECTRICAL TABLE FAN			
CHECKED BY DR ASRI	DATE 14/3/2018	DRAWING TITLE MAGNET			
DESIGNED BY AYU	DATE 07/3/2018	SIZE A4	DRAWING NUMBER NETF-000-011		REV X
		SCALE 6:1	WEIGHT(kg) XXX		SHEET 1/1

ci



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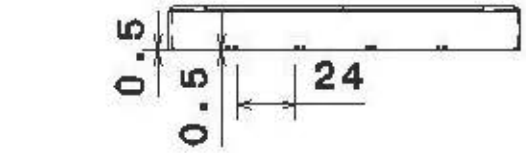
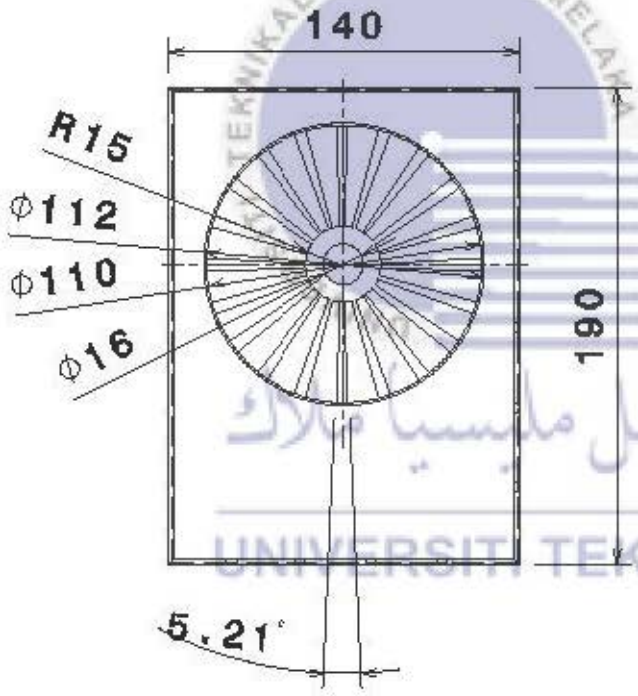
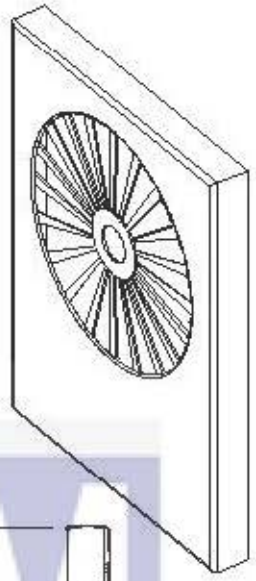
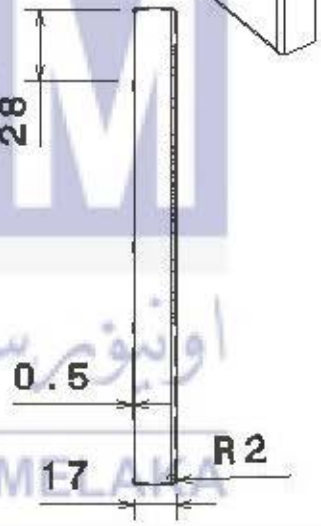
DRAWN BY AYU	DATE 13/3/2018	DRAWING TITLE IRON BALL			
CHECKED BY DR ASRI	DATE 14/3/2018	SIZE A4	DRAWING NUMBER NETF-000-012		REV X
DESIGNED BY AYU	DATE 07/3/2018	SCALE 10:1	WEIGHT(kg) XXX		SHEET 1/1









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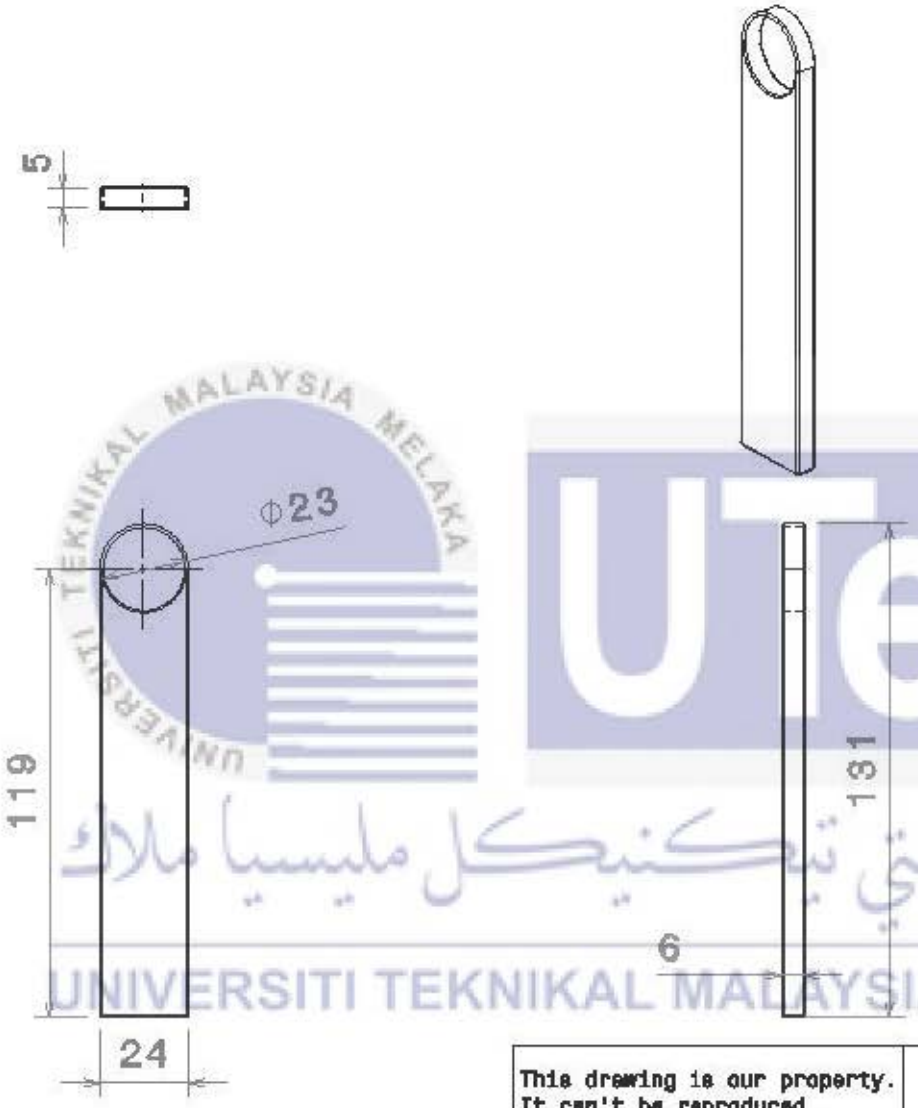
DRAWN BY AYU	DATE 13/3/2018	DRAWING TITLE FRONT GUARD				
CHECKED BY DR ASRI	DATE 14/3/2018	SIZE A4	DRAWING NUMBER NETF-000-013			REV X
DESIGNED BY AYU	DATE 07/3/2018	SCALE 1:3	WEIGHT(kg) XXX		SHEET 1/1	



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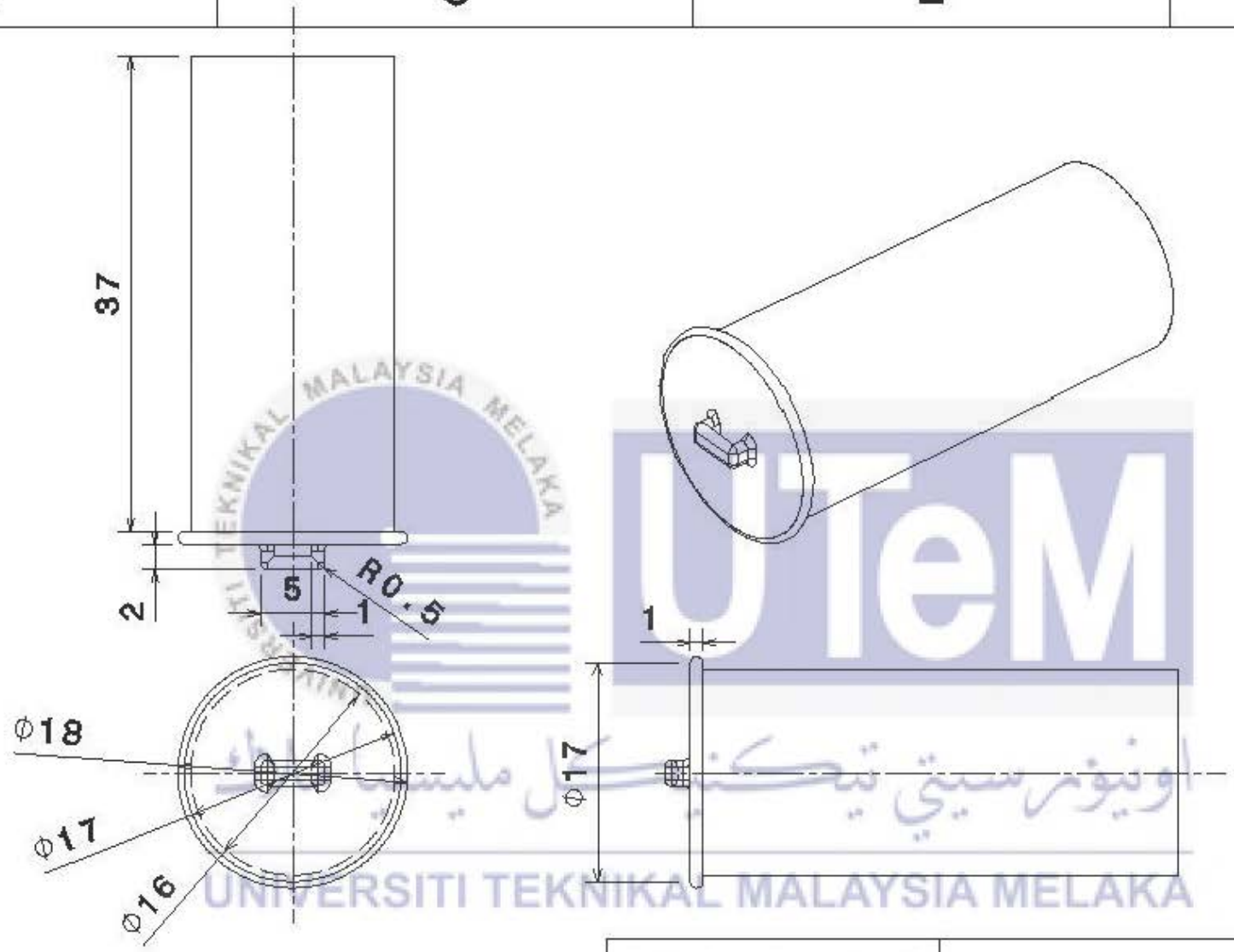
DRAWN BY AYU	DATE 13/3/2018	DRAWING TITLE BEARING HOLDER			
CHECKED BY DR ASRI	DATE 14/3/2018	SIZE A4	DRAWING NUMBER NETF-000-014		REV X
DESIGNED BY AYU	DATE 07/3/2018	SCALE 1:2	WEIGHT(kg) XXX		SHEET 1/1

civ



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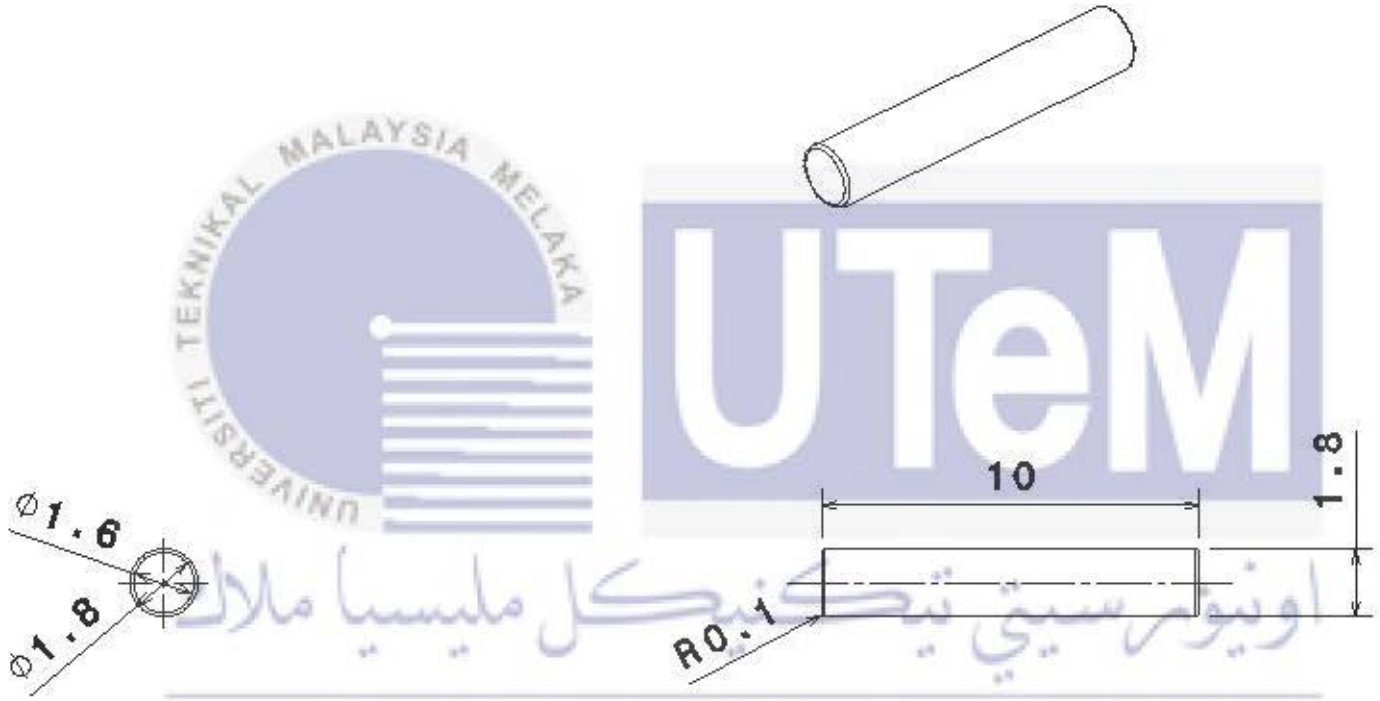
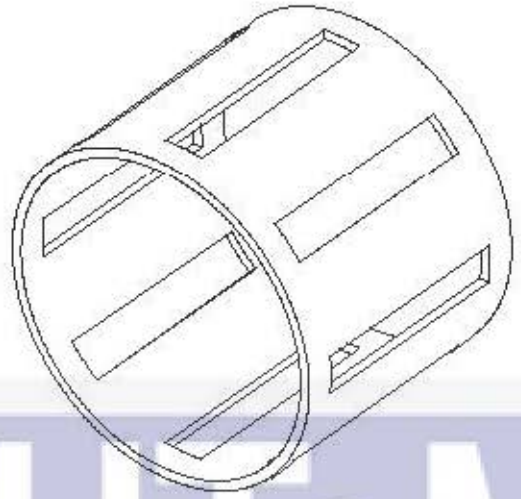
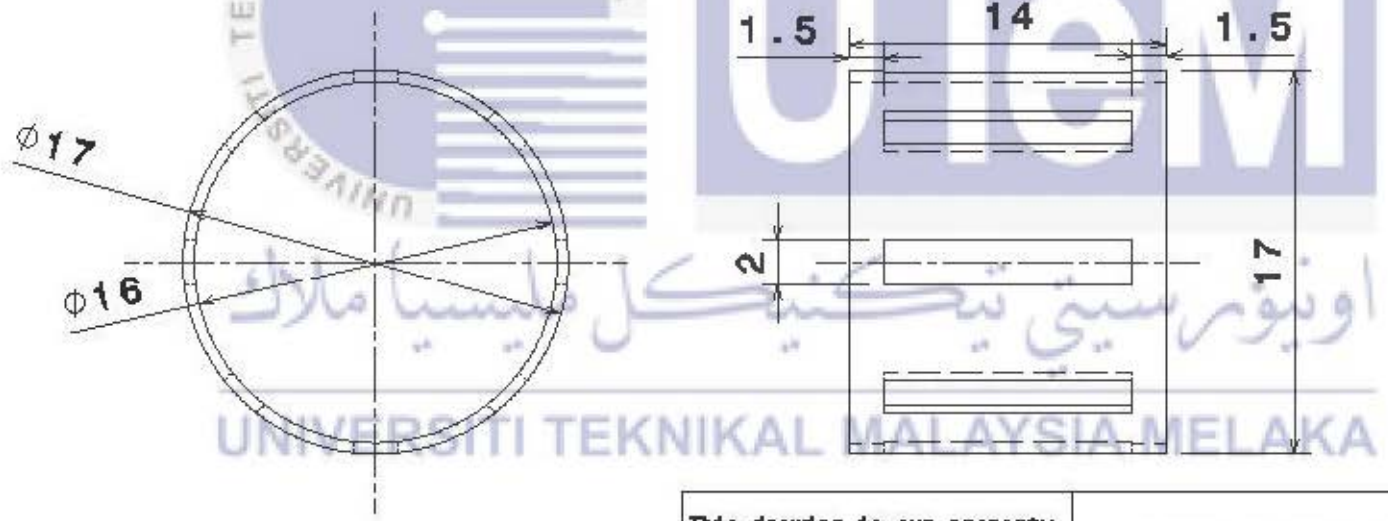
DRAWN BY AYU	DATE 15/3/2018	DRAWING TITLE BEARING SHAFT			
CHECKED BY DR ASRI	DATE 14/3/2018	SIZE A4	DRAWING NUMBER NETF-000-015		REV X
DESIGNED BY AYU	DATE 07/3/2018	SCALE 2:1	WEIGHT(kg) XXX		SHEET 1/1

cv

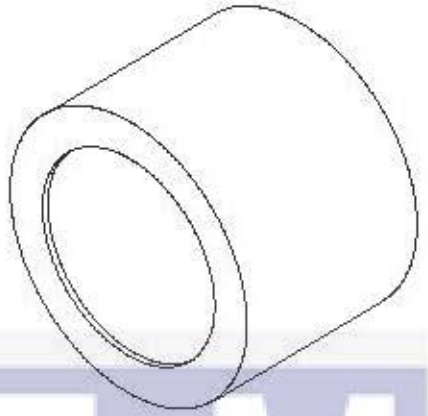


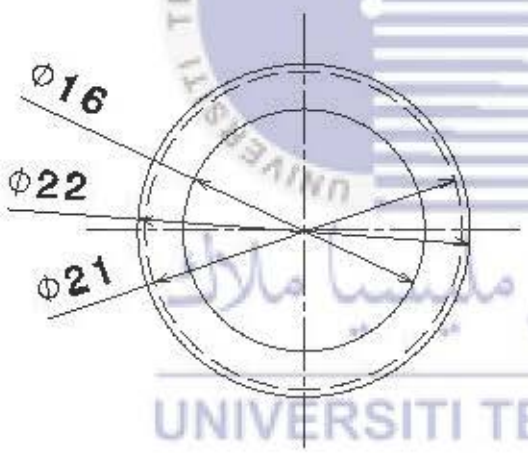
This drawing is our property. It can't be reproduced or communicated without our written agreement.		NON-ELECTRICAL TABLE FAN				
DRAWN BY AYU	DATE 13/3/2018	DRAWING TITLE CYLINDER BEARING				
CHECKED BY DR ASRI	DATE 14/3/2018	SIZE A4	DRAWING NUMBER NETF-000-016			REV X
DESIGNED BY AYU	DATE 07/3/2018	SCALE 5:1	WEIGHT(kg) XXX		SHEET 1/1	

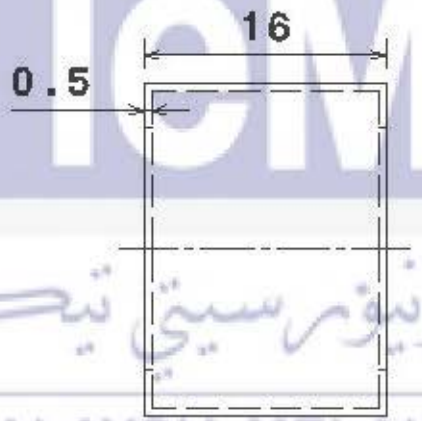




This drawing is our property. It can't be reproduced or communicated without our written agreement.		NON-ELECTRICAL TABLE FAN			
DRAWN BY AYU	DATE 13/3/2018	DRAWING TITLE INNER BEARING			
CHECKED BY DR ASRI	DATE 14/3/2018	SIZE A4	DRAWING NUMBER NETF-000-017		REV X
DESIGNED BY AYU	DATE 07/3/2018	SCALE 3:1	WEIGHT(kg) XXX		SHEET 1/1







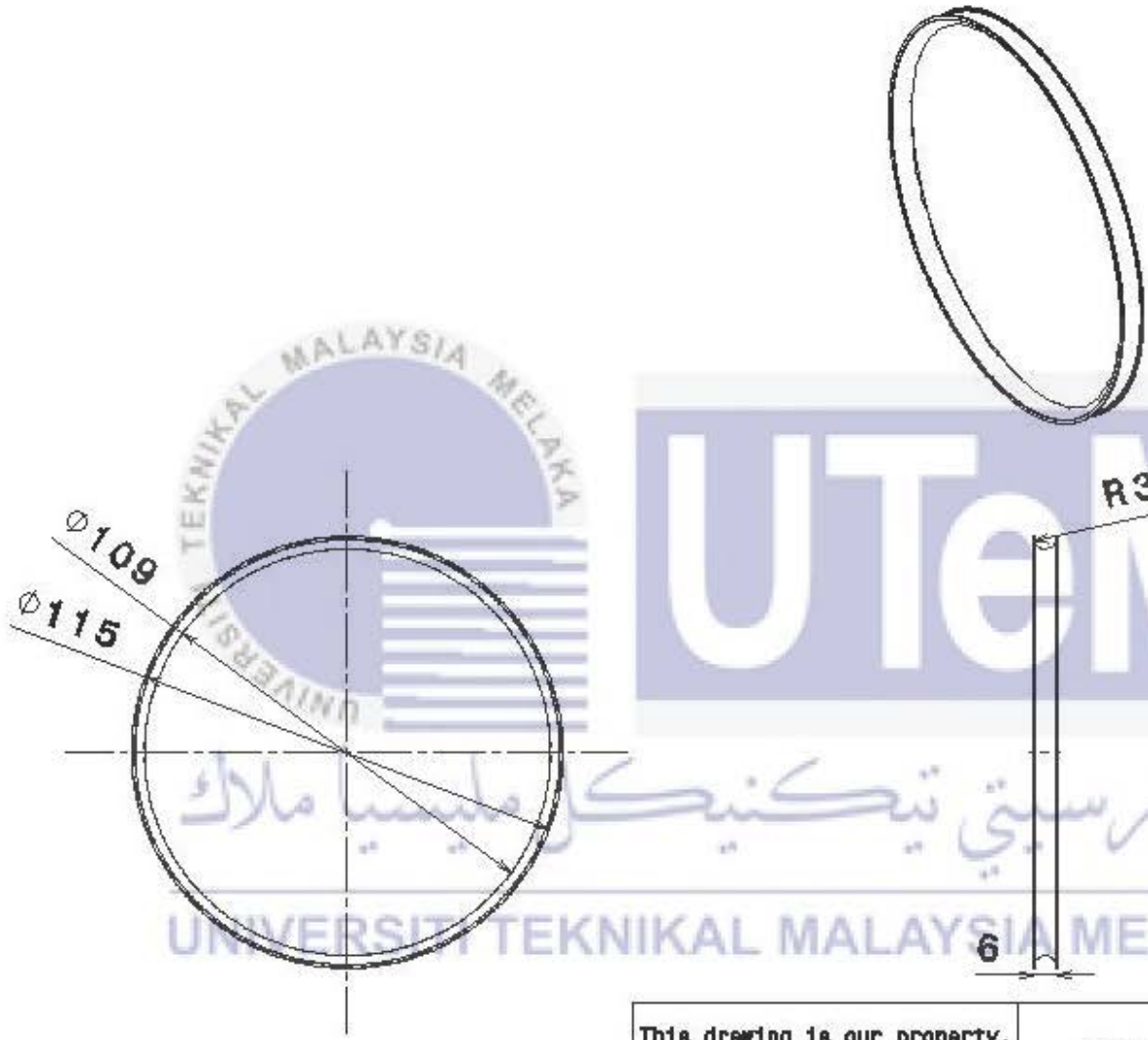
NON-ELECTRICAL TABLE FAN

DRAWN BY: AYU	DATE: 13/3/2018
CHECKED BY: DR ASRI	DATE: 14/3/2018
DESIGNED BY: AYU	DATE: 07/3/2018

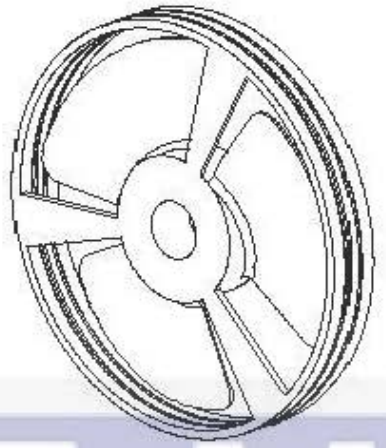
DRAWING TITLE: OUTER BEARING

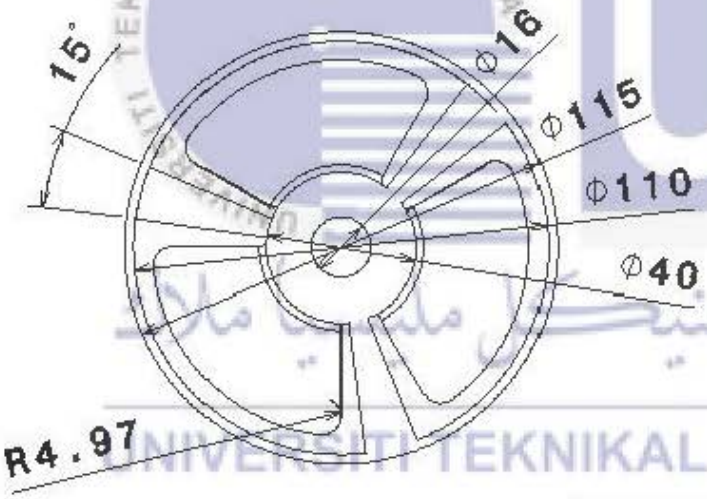
SIZE	DRAWING NUMBER	REV
A4	NETF-000-018	X

SCALE	WEIGHT(kg)		SHEET
2:1	XXX		1/1



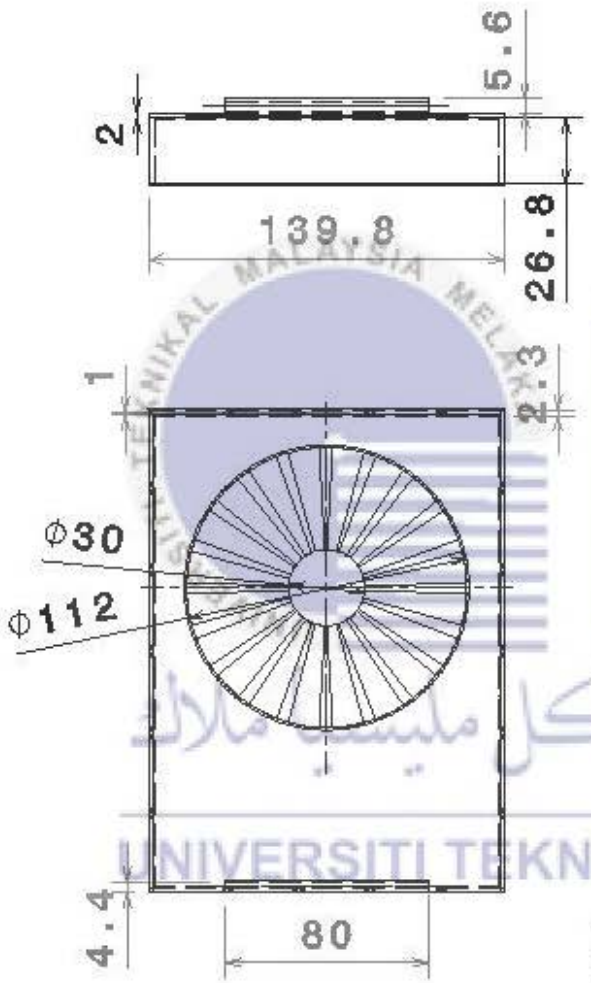
This drawing is our property. It can't be reproduced or communicated without our written agreement.		NON-ELECTRICAL TABLE FAN			
DRAWN BY: AYU	DATE: 13/3/2018	DRAWING TITLE: COVER MAGNET			
CHECKED BY: DR ASRI	DATE: 14/3/2018	SIZE: A4	DRAWING NUMBER: NETF-000-019		REV: X
DESIGNED BY: AYU	DATE: 07/3/2018	SCALE: 1:2	WEIGHT(kg): XXX		SHEET: 1/1

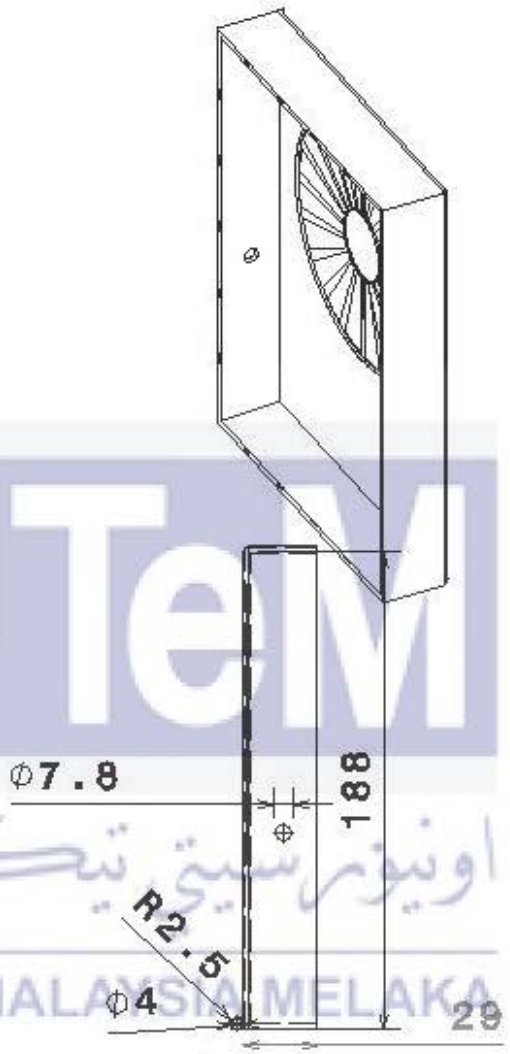




NON-ELECTRICAL TABLE FAN

DRAWN BY: AYU	DATE: 13/3/2018	DRAWING TITLE: BLADE			
CHECKED BY: DR ASRI	DATE: 14/3/2018	SIZE: A4	DRAWING NUMBER: NETF-000-020		REV: X
DESIGNED BY: AYU	DATE: 07/3/2018	SCALE: 1:2	WEIGHT(kg): XXX		SHEET: 1/1





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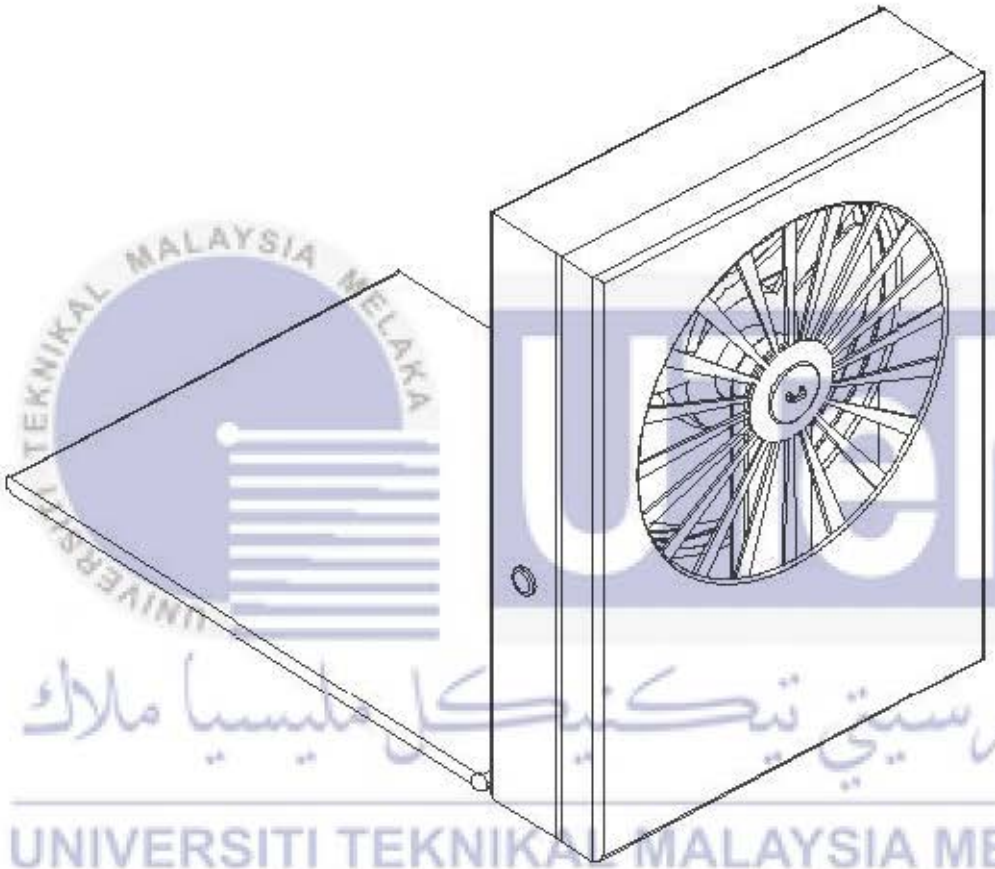
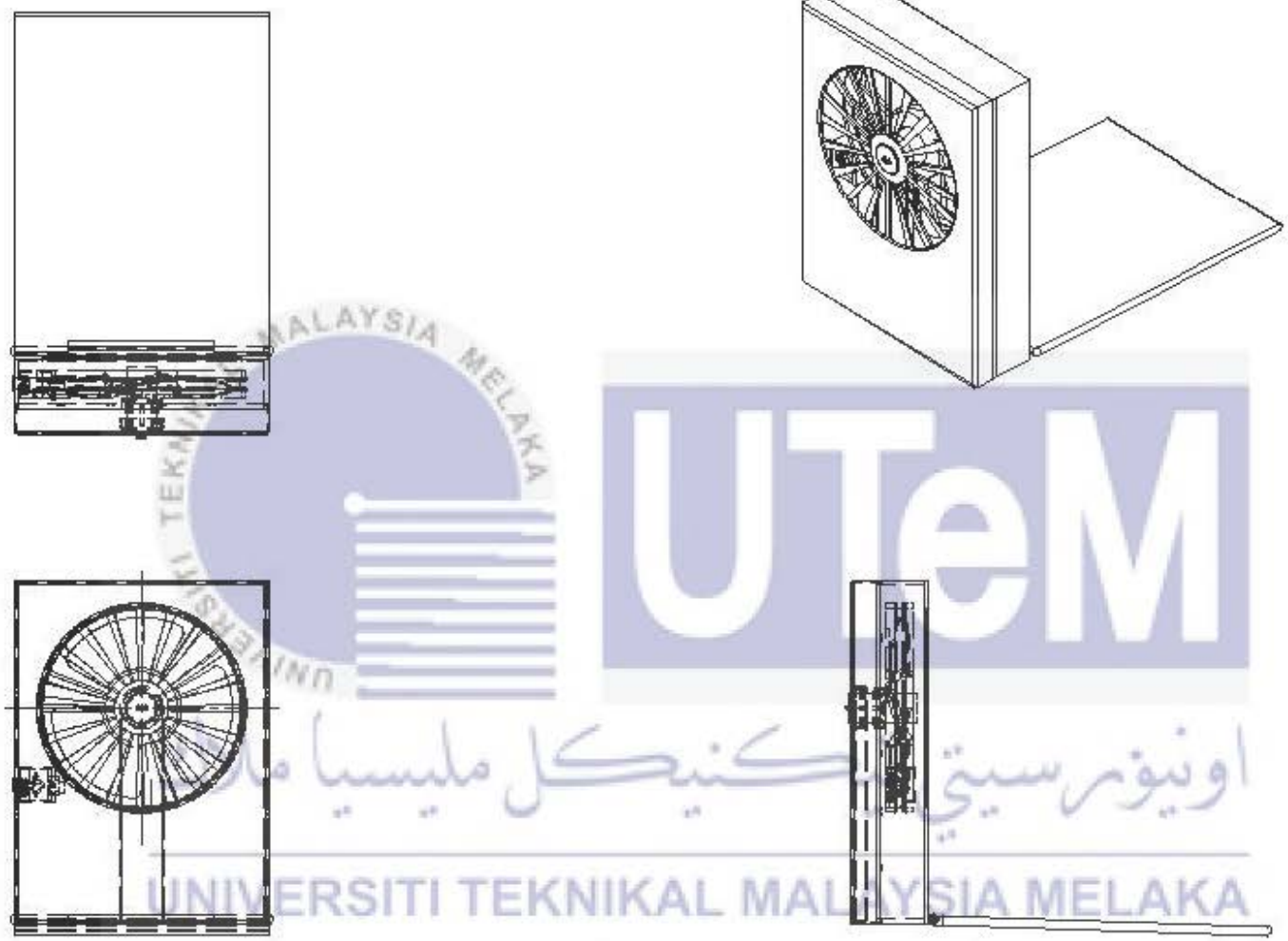
DRAWN BY: AYU	DATE: 13/3/2018	DRAWING TITLE: BACK GUARD			
CHECKED BY: DR ASRI	DATE: 14/3/2018	SIZE: A4	DRAWING NUMBER: NETF-000-021		REV: X
DESIGNED BY: AYU	DATE: 07/3/2018	SCALE: 1:3	WEIGHT(kg): XXX		SHEET: 1/1



NON-ELECTRICAL TABLE FAN

DRAWING TITLE: ASSEMBLE VIEW

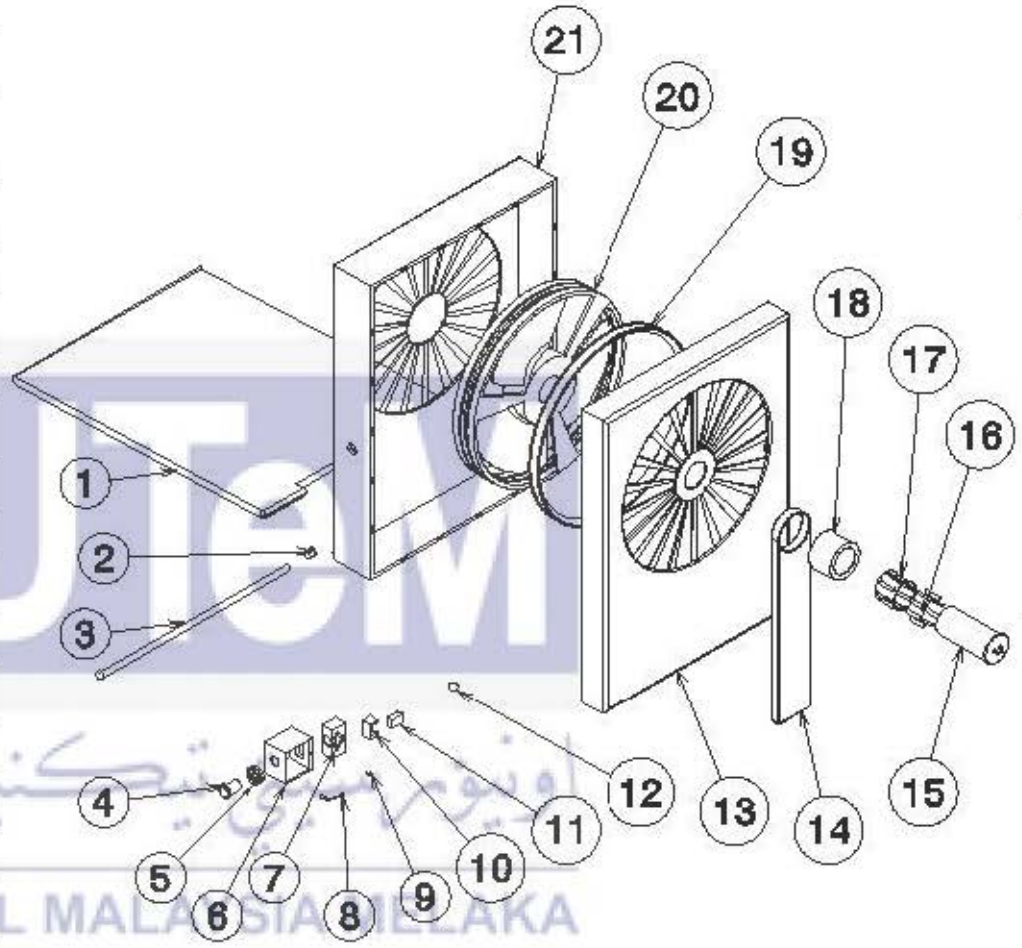
DRAWN BY: AYU	DATE: 13/3/2018			
CHECKED BY: DR ASRI	DATE: 14/3/2018	SIZE: A4	DRAWING NUMBER: NETF-000-022	REV: X
DESIGNED BY: AYU	DATE: 07/3/2018	SCALE: 1:2	WEIGHT(kg): XXX	SHEET: 1/1



This drawing is our property. It can't be reproduced or communicated without our written agreement.		NON-ELECTRICAL TABLE FAN			
DRAWN BY: AYU	DATE: 13/3/2018	DRAWING TITLE: ORTOGRAPHIC VIEW			
CHECKED BY: DR ASRI	DATE: 14/3/2018	SIZE: A4	DRAWING NUMBER: NETF-000-023		REV: X
DESIGNED BY: AYU	DATE: 07/3/2018	SCALE: 1:4	WEIGHT(kg): XXX		SHEET: 1/1

Bill of Material: Non-Electrical Table Fan

No.	Part Description	Part Number	Quantity
01.	Base Fan	NETF-000-001	1
02.	Button Bottom Shaft	NETF-000-002	1
03.	Bottom Shaft	NETF-000-003	1
04.	Button	NETF-000-004	1
05.	Spring	NETF-000-005	1
06.	Button Box	NETF-000-006	1
07.	Groove Box	NETF-000-007	1
08.	Shaft Mechanism	NETF-000-008	1
09.	Shaft Button	NETF-000-009	1
10.	Magnet Box	NETF-000-010	1
11.	Magnet	NETF-000-011	1
12.	Iron Ball	NETF-000-012	1
13.	Front Guard	NETF-000-013	1
14.	Bearing Holder	NETF-000-014	1
15.	Bearing Shaft	NETF-000-015	1
16.	Cylinder Bearing	NETF-000-016	8
17.	Inner Bearing	NETF-000-017	1
18.	Outer Bearing	NETF-000-018	1
19.	Cover Magnet	NETF-000-019	1
20.	Blade	NETF-000-020	1
21.	Back Guard	NETF-000-021	1



NON-ELECTRICAL TABLE FAN

DRAWN BY: AYU	DATE: 13/3/2018	DRAWING TITLE: EXPLODED VIEW			
CHECKED BY: DR ASRI	DATE: 14/3/2018	SIZE: A4	DRAWING NUMBER: NETF-000-024		REV: X
DESIGNED BY: AYU	DATE: 07/6/2018	SCALE: 1:4	WEIGHT(kg): XXX		SHEET: 1/1