POLITEKNIK
MALAYSIA
SEBERANG PERAI

SEMI AUTO KEROPOK LEKOR CUTTER MACHINE

MUHAMMAD FIRDAUS BIN ABD HALIM
MUHAMMAD HAFIZ BIN ABD RAHIM
JERIC NELSON JERSON
MIOR MUHAMMAD ALIF BIN AMRAN
SITI SYAHMAH BINTI MOHD NASIR
MOHAN KANNA A/L VEJAIAN

JABATAN KEJURUTERAAN MEKANIKAL
POLITEKNIK SEBERANG PERAI

SESI JUN 2017

DECLARATION FINAL REPORT SUBMISSION

DECLARATION FROM STUDENTS (GROUP LEADER)

PLEASES TICK (/)

[/]	We have made all the necessary amendments based on comments and suggestions given by the supervisor and panel.
[/]	Format for report writing is in accordance with the format guidelines.
[/]	We have the approval of the report from the supervisor.
[/]	This report is the property of Politeknik Seberang Perai.

Student Signature:  Date: 30.10.2017

Student's Name: MUHAMMAD FIRDAUS BIN ABD HALIM Matrix Number: 10DKM15F1096

CERTIFIED BY SUPERVISOR

Comments:

Signature of Supervisor: Date:

Office Cop:

STUDENTS CONFIRMATION

"We recognize this work is the work of our own
except each of which we have explained the source"

1. Signature : 
   Name : MUHAMMAD FIRDAUS BIN ABD HALIM
   Matrix number : 10DKM15F1096
   Date : 30.10.17

2. Signature : 
   Name : MUHAMMAD HAFIZ BIN ABD RAHIM
   Matrix number : 10DKM15F1132
   Date : 30.10.17

3. Signature : 
   Name : JERIC NELSON JERSON
   Matrix number : 10DKM15F1076
   Date : 30.10.17

4. Signature : 
   Name : MIOR MUHAMMAD ALIF BIN AMRAN
   Matrix number : 10DKM15F1092
   Date : 30.10.17

5. Signature : 
   Name : SITI SYAHMAH BINTI MOHD NASIR
   Matrix number : 10DKM15F1112
   Date : 30.10.17

6. Signature :

Name : MOHAN KANNA A/L VEJAIAN

Matrix number : 10DKM15F1124

Date : 30.10.17

PROJECT SUPERVISOR VERIFICATION

Project report entitled 'Keropok Lekor Slicer Machine' has been submitted, reviewed, and certified to meet the requirements and need of project that have been set for completion Diploma in Mechanical Engineering.

Checked by:

Supervisor Name : Encik Md Najip Bin Talibin

Signature of Supervisor : _____

Date :

Verified by:

Coordinator Name : En Lee Chee Me

Signature of Coordinator : _____

Date :

ACKNOWLEDGEMENT

By the Name of Allah, Most Gracious, Most Merciful

Primarily we would like to offer my gratitude to Allah that able to finish the report and our final project to meet the requirements provided for the award of Diploma in Mechanical Engineering.

We give our appreciation to Mr. Md Najip Bin Talibin, our final project's supervisor, who has helped our group for almost a year to produce the project and report. He also provided a lot of encouragement and advices that are useful to us and told us to never say no way as well as giving guidance to our group to succeed in our project.

Not forgetting both our parents and our families who have been passionate about our continued success and are struggling with the problems encountered throughout the process of producing this final semester project. Thank you to all lecturers in Seberang Perai Polytechnic who have been giving much guidance to us for the project, especially our Academic Advisor En Taufik bin A.Rahman.

Finally, we would like to express our appreciation to our fellow friends and the fellow people who were involved directly or indirectly in providing support and encouragement for this project. Lastly, we hope that the project that our group has produced may benefit the academic world and us in general.

ABSTRACT

Keropok Lekor Cutter Machine aimed is focus on keropok lekor's entrepreneur to increase their production volume, create similar size of product and create hygiene process. This machine involved cutting and feeding mechanism. Firstly, *keropok lekor* dough that poured into the hopper will be purging by feeding mechanism using screw conveyer and the cutting blade will periodically rotate to implement cutting process. The length size of keropok lekor is based on speed of movement cutting blade and purging of keropok lekor dough. Based on our finding, this machine can run smoothly, however to increase the production rate, the power of motor should be increase from 1 horsepower to 1.5 horsepower, increase size of driven pulley and add another structure for receiving keropok lekor after cutting process. The suggestions and recommendation for improvement have been persuaded as a continuous improvement of the machine. Upon completion of the study, the entrepreneurs who seriously involved in the keropok lekor manufacturing industry can apply it.

ABSTRAK

Mesin Cutter Keropok Lekor bertujuan memberi tumpuan kepada usahawan keropok lekor untuk meningkatkan jumlah pengeluaran mereka, menghasilkan saiz produk yang sama dan mencipta proses kebersihan. Mesin ini melibatkan pemotongan dan mekanisme pemakanan. Pertama, adonan keropok lekor yang dituangkan ke dalam corong akan dibersihkan dengan mekanisme makan menggunakan alat penghantar skru dan pisau pemotong akan berputar secara berkala untuk melaksanakan proses pemotongan. Ukuran panjang keropok lekor didasarkan pada kecepatan gerak memotong pisau dan pembersihan adonan keropok lekor. Berdasarkan pada penemuan kami, mesin ini dapat berjalan dengan lancar, namun untuk meningkatkan laju produksi, kekuatan motor harus ditingkatkan dari 1 tenaga kuda menjadi 1,5 daya kuda, meningkatkan ukuran kren yang dipandu dan menambah struktur lain untuk menerima keropok lekor setelah proses pemotongan. Cadangan dan cadangan untuk penambahbaikan telah dipujuk sebagai peningkatan berterusan mesin. Setelah selesai kajian, usahawan yang serius terlibat dalam industri pembuatan keropok lekor boleh menerapkannya.

TABLE OF CONTENT

LIST OF TABLE

LIST OF FIGURE

CHAPTER 1

INTRODUCTION

1.1 Background project

Nowadays, Small and Medium-Sized Enterprise (SME) sector have been expanded widely and play an important role in generating Malaysian economy. SME products have been increased and become popular rather than well-known imported product. Previously, foods like nugget, burger, frankfurter, and fish ball are imported or very hard to find in the market but currently can be easily found. The development of SME has influenced many local foods such as keropok lekor, otak-otak, and many confectionary products to be commercialized. Therefore, SME entrepreneurs need a machine to increase their productivity in order to fulfill market requirement. Base on site visit, the keropok lekor process was also quite complicated and required a large number of workers to produce more output. This is because the process of making it takes a long time and requires a lot of workforce. It caused a long time to make the keropok lekor.

Figure 1.1: SME of keropok lekor at Kepala Batas

Figure 1.2: Interview session with the owner of the enterprise

1.1.1. Keropok Lekor

Keropok lekor is a famous snack food which is originated from East-Coast of Malaysia Peninsular. It is a specialty of Terengganu and now has been widely commercialized to entire country. Generally, keropok lekor can be categorized as a type of snack which is made of flavored with fish or shrimp. The mixture is being hand- rolled into a sausage form. Ingredients of the mixture are fish (mackerel), sago flour, salt, water, ice cubes, and pandan leaves.

There are two methods to eat keropok lekor which are eat freshly after it has been boiled or by deep frying it. Usually, the huge and long sausages are cut into smaller pieces and thrown into the pan to be deep-fried until they turn crispy gold. Another option to take keropok lekor is to just steam it. This gives it a fishier flavor but tastes as good as the crispy ones according to some people. A completely different kind of keropok lekor is keropok lekor pieces and it comes in different flavors: fish, squid, and prawn. Here, the keropok lekor is shaped into even bigger tubes and cut into thin slices to let it dry in the sun. Keropok lekor ready to be served with their chili sauce, or with own home-made chili sauce if one prefers or shrimp-based sauce is also common. The best way to eat the keropok lekor is by take it right after frying when it is still hot, crispy on the outside and tender at the inside.

Figure 1.3: Shows the one of example type of keropok lekor

There are many types of Keropok Lekor, which are Fried Keropok Lekor and Crisp Keropok Lekor. Fried Keropok Lekor is shaped into sausage size, tastes more chewer,

whereas Keropok Lekor pieces are shaped into slices, and has crispier texture. There is also a variant called Keropok lekor cheese" which is a mix of fish and selected cheese.

The keropok lekor process takes a while because the dough needs to be kneaded into a dough. Then the dough should be threaded before long cut into small pieces. The cuffing process needs to be done carefully to ensure the dough has the same size.

1.1.2. Cutting System

Cutting is the separation of a physical object, or a portion of a physical object, into two portions or more, through the application of directed force. An implement commonly used for cutting is the knife or scissor for lightweight material, while axe is used for heavyweight task. Nevertheless, any sufficiently sharp object is capable of cutting if it has a hardness sufficiently larger than the object being cut, and if it is applied with sufficient force. Cutting also describes the action of a saw which removes material in the process of cutting. In the scope of this study, cutting mechanism is the way how to separate keropok lekor to the small pieces.

Theoretically, cutting process is a combination of compressive and shearing phenomenon. It will only occur when the total stress generated by the cutting implement exceeds the ultimate strength of the material of the object being cut. The simplest applicable equation is stress = force/area. In the cutting process, the forces will act on a body; there is an accompanying change in shape or size of the body (keropok lekor). Here, can be assumed that the stress generated by a cutting implement is directly proportional to the force which it is applied, and inversely proportional to the area of contact. Hence, the less force is needed when cutting small area, higher force is needed when cutting higher surface area.

1.2 Problem Statement

Keropok lekor, a popular fish based snack, is usually molded from kneaded fish meat and dough. Usually keropok lekor prepared using traditional methods with some mechanical

equipment such as horizontal mixer and horizontal mince to knead the fish meat. Meanwhile degutting and deboning of the fresh fish is done manually. The job to roll the kneaded fish meat and boil is also done manually. More, keropok lekor itself should be cut into smaller size before being fry and this job also done manually because no proper machine has been created. The high requirements of keropok lekor in the market urge entrepreneurs to increase their production but they are facing a lot of problem to fulfill market requirement.

The entrepreneurs faced a problem to increase production volume because a lot of process in producing keropok lekor has been done manually. In manual cutting and current practice, mass production for keropok lekor is not suitable. Material characteristics of keropok lekor which is well-known as sticky, glutinous, and gummy have influenced to the time taken to cut the keropok lekor itself. If the entrepreneurs want to increase their production, major of the process should be done in automated way. Besides, the use of automated equipment compensates for the labor cost disadvantage relative to competitors. More, automations can decrease production cycle times, and increases product quality and consistency. This statement was firmly proved that if the keropok lekor entrepreneurs want to increase their product volume.

Nowadays, invention of machine that would cut keropok lekor to small pieces or specific size still not widely discovered in Malaysia. Thus, the invention of keropok lekor cutter machine should be done to help the keropok lekor entrepreneurs to automate cutting process.

1.3 Objective of the project

The aims of this project are to produce Keropok lekor slicer machine that capable to embark on the following objectives:

a) Increase volume of product in certain time.
b) Increase level of hygiene production process.
c) Produce the same diameter and length of keropok lekor.

1.4 Scope of study

In order to meet the objectives listed, the scopes of this project have been defined. There are:

a) Fully automation keropok lekor cutting process.

b) Small Medium Entreprise level.

c) Maximum weight is 5 kg dough of keropok lekor in hopper during process.

d) Maximum power is 1 horsepower due to cost consumption.

e) Maximum diameter of keropok lekor is 24 mm.

1.5 Definition of Term

Terms that can describe our project more details in this study are:

a) Keropok Lekor

Keropok lekor is a traditional Malay fish cracker snack originated from the of Terengganu, Malaysia. It is also called fish sausage, fish stick, or fish fritters. It is made from fish and sago flour and seasoned with salt and sugar. It is slightly grayfish in colour and tastes fishy. The origin of the word "Lekor"is said to be derived from Terengganu Malay which means "roll". It comes in three main forms: lekor (which is long and chewy), losong (steamed) and keeping (which is thin and crispy).

b) Small Medium Enterprise (SME)

SME definition was endorsed at the 14th NSDC Meeting in July 2013. The definition covers all sectors, namely services, manufacturing, agriculture, construction and mining & quarrying. Sales turnover and number of full-time employees are the two criteria used in determining the definition with the "OR" basis as follows: For the manufacturing sector, SMEs are defined as firms with sales turnover not exceeding RM50 million OR number of full-time employees not exceeding 200. For the services and other sectors, SMEs are defined as firms with sales turnover not exceeding RM20 million OR number of full-time employees not exceeding 75.

c) Periodic

Occurring or recurring at regular intervals. It is repeatedly from time to time. Besides that, it is consisting of or containing a series of repeated stages, processes, or digits.

d) Machine

A machine uses power to apply forces and control movement to perform an intended action. Machines can be driven by animals and people, by natural forces such as wind and water, and by chemical, thermal, or electrical power, and include a system of mechanisms that shape the actuator input to achieve a specific application of output forces and movement.

CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This chapter briefly explains about the definition and information of design, automated, cutting mechanism, motor, 'keropok lekor' characteristics, pneumatic system and software; their scope, features, and relationship among them in implementation of this project. Besides, that, a few techniques, which are related with the invention, will be explained at this chapter. Generally, this chapter focused on a single question that tries to identify, appraise, select and synthesize all higher quality research evidence relevant to this project. Before starting this project, researchers have made observations and studies on all aspects that need to be made on each machine to be created. There are various aspects that need to be addressed so that the machine produced can improve the quality and facilitate the manufacture of 'keropok lekor'.

Based on the search engine quality is a machine that is kept in terms of safety factor as it concerns employee safety (OSHA) and also wants to reduce the risk of frequent injuries from time to time as a result of machine-less security in terms of security. Additionally, it requires more careful research and research to complete a machine that is safe to use.

Among the things emphasized to produce a quality machine is in terms of the appropriate shape selection, selection of components and materials, and their respective advantages and disadvantages. Below is a brief review of the machine that the inventor follows from the results of the research and research that the researcher has conducted.

2.1 Design and analyze

Numerous definitions have been proposed for the word design. According to the Norton (1999), the word design is derived from Latin word „designare", which means "to designate, or mark out". Meanwhile, Madara & Kremer (2004) proposed that design can be identified in artistic or technical category. Artistic design is based on the personal expression which includes painting, sculptures, and landscapes. Meanwhile, technical design focused on the development of a product or process. Generally, design can be divided into conceptual design and detail design. Both are categorized as an engineering design.

In this chapter's researcher it explains the study of the literature and the research that has been done for this project. This study has been conducted on several types of machines previously built. In addition, there is a study of the components used in the project. By studying the previous machine, there are differences in each project that has been made. The first difference is how its work and the procedures used to speed up the machines and materials used. Although there is a difference in the way of improving the function, most of which have the same uses.

2.1.1 Prior Arts

Engineering design is the systematic, intelligent generation and evaluation of specifications for artifacts whose form and function achieve stated objectives and satisfy specified constraints (Dym and Lewit, 1991). Besides, engineering design has been defined as the process of applying the various techniques and scientific principles for the purpose of defining a device, a process or a system in sufficient detail to permit realization (Norton, 1999). He also stated that design may be simple or enormously complex, easy or difficult, mathematical or nonmathematical which may involve a trivial problem or one of the great important.

Then, design concepts listed in third stage. Stage four is synthesis while fifth is analyzable model. Analysis, experiment, and optimization located at stage six, while presentation listed at the last stage. The seven stage of engineering design produced by Erdman and his colleagues is such in Figure 2.1.

Figure 2.1: Slicers of keropok lekor (Edrman 2001)

"Keropok lekor" are indeed the favorite Malaysian snacks. Keropok lekor is a traditional food of the east coast of Peninsular Malaysia, especially in Terengganu. Food is made from sea fish, sago mixture and a little salt. High fish content makes lobster crackers as high protein foods rich in natural iodine.

Fish crackers can be eaten fresh as soon as they are picked up and roasted with spicy chili sauce. At present, the manufacture of "keropok lekor" has already spread to several other states. Crackers are usually non-durable. However, if stored for longer durability, the plastic crackers should be wrapped with plastic and placed in the rocks to prevent the smell of other food contaminants.

When to eat, it needs to be washed and boiled again with water mixed with salt. Otherwise, crackers will feel bland. Additionally, lobsters can also be further processed into crackers. The boiled "keropok lekor" will be thinned and dried to make dried crackers called shellfish crackers. The crackers of this piece will grow when fried in hot oil and it is very delicious when eaten with chili sauce.

Product Code	Power Supply	Descriptions	Dimensions (L x W x H)
MK03	1HP x 4P Motor	3" S/Steel Roller (3')	1200 x 610 x 925 mm
MKA03	1HP x 4P Motor	Semi Auto Conveyer Type	1360 x 648 x 460 mm

Figure 2.2: Fish Dough Roller Automatic

The Figure 2.2 show one of the dough roller automatic machine. This machine is easier to use because they just put the dough into the slot. Then the fish dough will come out However, their production will not produce a fixed length. This machine only focusing on the diameter or size of the 'keropok lekor'.

Besides that, Figure 2.3 shows a fish dough roller. This help the worker to roll the dough. It doesn't give the a fixed sized of length, size and diameter. This machine contains a lot of disadvantages. Furthermore, this machine only has two roller and it mean the machine can only roll one dough in one time.

Model	: SW - FDR 72	
Usage	: To form fish dough (keropok lekor) by rolling fish dough on 2 rollers.	
Capacity	: 100 kilograms per hour (approx.)	
Dough Size	: 72" x 1.5" (L x D)	
Energy	: a) Requirement	: A.C Motor, 230V, 50HZ,
	b) Power	: 2 HP, c/w Starter
Material	: Body & Frame	: Stainless Steel, AISI 304
	Rollers	: Stainless Steel, AISI 304
Weight	: 100 kilograms (approx.)	
Dimension	: 213cm x 106cm x 92cm	(L x W x H)
	84" x 42" x 36"	(L x W x H)
Castors	: 4 x 4" Wheels	
Origin	: Malaysia	

Figure 2.3: Fish Dough Roller

2.1.2 Theoritical

Erogonomic

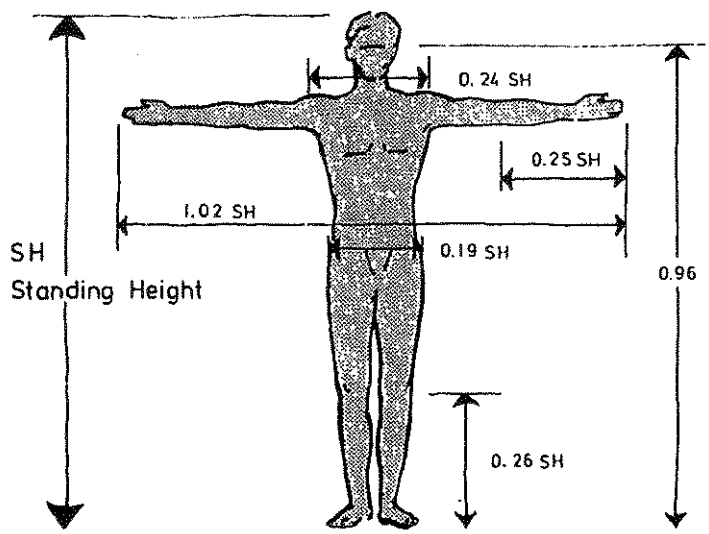

Figure 2.4: Human Body

Ergonomics is the process of designing or arranging workplaces, products and systems so that they fit the people who use them. Most people have heard of ergonomics and think it is something to do with seating or with the design of car controls and instruments and it is... but it is so much more. Ergonomics applies to the design of anything that involves people work spaces, sports and leisure, health and safety. Ergonomics (or 'human factors' as it is referred to in North America) is a branch of science that aims to learn about human abilities and limitations, and then apply this learning to improve people's interaction with products, systems and environments. Ergonomics aims to improve work spaces and environments to minimize risk of injury or harm. So as technologies change, so too does the need to ensure that the tools we access for work, rest and play are designed for our body's requirements.

In the workplace: According to Safe Work Australia, the total economic cost of work-related injuries and illnesses is estimated to be $60 billion dollars. Recent research has shown that lower back pain is the world's most common work-related disability – affecting employees from offices, building sites and in the highest risk category, agriculture. Ergonomics aims to create safe, comfortable and productive workspaces by bringing human abilities and limitations into the design of a workspace, including the individual's body size, strength, skill, speed, sensory abilities (vision, hearing), and even attitudes. In the greater

population: The number of people in Australia aged 75 and over is forecast to double over the next 50 years. With this, equipment, services and systems will need to be designed to accommodate the increasing needs of the ageing population, applying to public transport, building facilities, and living spaces.

Ergonomics is a relatively new branch of science which celebrates its 50th anniversary in 1999, but relies on research carried out in many other older, established scientific areas, such as engineering, physiology and psychology.

To achieve best practice design, Ergonomists use the data and techniques of several disciplines:

- anthropometry: body sizes, shapes; populations and variations
- biomechanics: muscles, levers, forces, strength
- environmental physics: noise, light, heat, cold, radiation, vibration body systems: hearing, vision, sensations
- applied psychology: skill, learning, errors, differences
- social psychology: groups, communication, learning, behaviours.

Structural analysis

Structural analysis is a comprehensive assessment to ensure that the deformations in a structure will be adequately lower than the permissible limits, and failure of structural will not occur. The aim of structural analysis is to design a structure that has the proper strength, rigidity, and safety. Deformations in a structure can be either elastic that is totally recoverable, or inelastic that is permanent. Structural analysis assists in the design of structures that meet their functional requirements, are economical and attractive. Structural analysis integrates the disciplines of mechanics, dynamics, and failure theories to compute the internal forces and stresses on the structures to be designed.

Structural analysis is carried out by an examination of the real structure, on a model of the structure created on some scale, and by the utilization of mathematical models. Tests are conducted on the real structure when production is required of similar structures in large quantities, like frames of a particular car, or when the test expenses are acceptable due to the significance of the task. When elements of the main structures are to be examined, then models are used for the estimation of the different loads to be endured. Most structural

analyses are conducted on the mathematical models, in which the model could be elastic or inelastic, forces may be static or dynamic, and the model of the structure might be two dimensional or three dimensional.

Calculation of gear ratio and speed

In order to calculate gear ratio and speed, it is important to understand what a gear is. A gear is a toothed wheel that works together with another toothed wheel to alter the speed or direction of a driving mechanism (such as a motor). Gears normally act in pairs; the driving gear and driven gear. The driving gear is the gear that is rotated by the prime mover, and the driven gear is the gear that is pushed (or driven) into rotation by the driving gear. A gear ratio is the relationship between the speed of the driving and driven gear in a gear set.

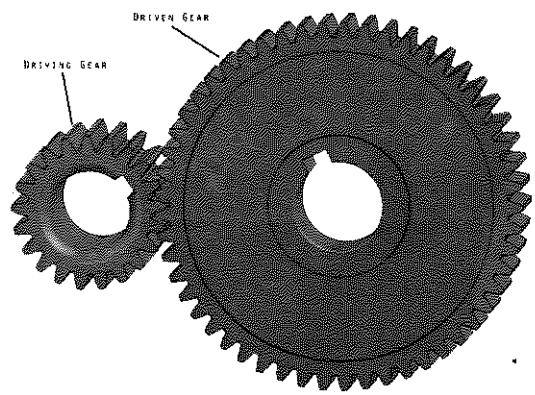

Figure 2.5: Spur Gear

When two meshed gears have a different number of teeth, a reduction in speed is produced. The gear ratio and speed for a gear set can be calculated by knowing the number of teeth on each gear and by knowing the speed in revolutions per minute (rpm) of each gear in the stage.

When you know the number of gear teeth:

$$rpm_{driven} = rpm_{driving} \times \frac{Teeth_{driving}}{Teeth_{driven}}$$

When you know the gear set speed:

$$gear\ ratio = \frac{rpm_{input\ (driving)}}{rpm_{output\ (driven)}}$$

It is most common that the input speed (rpm) and gear ratio are known, and the above equation is solved for the output speed (rpm). Gear ratio is typically written using the normal notation for ratio. This format conveys that the input gear rotates a certain number of times for every one time the output gear makes a full rotation. Gear ratios also change the torque from the input to the output. Torque is a twisting or turning force. If the speed is reduced by the ratio, the torque is increased by the same ratio. The torque will also be affected by the system's efficiency, but we will ignore that for this exercise.

In order to calculate torque, you must know the force and radius. Force is a push or pull and is often measured in pounds. Radius is the distance from the center of a circle/sphere to its perimeter. The radius of a gear is defined by the pitch circle. The pitch circle is the circle that can be drawn around each gear in a gear set that allows the two gears to roll. Torque is the product of force multiplied by radius. Therefore, if either the force or radius is changed, the torque will change.

Torque = Force x Radius

T = F x R

2.2 Materials and components

2.2.1 Electric motor AC & DC

An electric motor is an electrical machine that converts electrical energy into mechanical energy. An electric motor is an electrical machine that converts electrical energy into mechanical energy. The reverse of this is the conversion of mechanical energy into electrical energy and is done by an electric generator, and generators and motors have much in common. Most electric motors operate through the interaction between an electric motor's magnetic field and winding currents to generate force. In certain applications, such as in regenerative braking with traction motors in the transportation industry, electric motors can also be used in reverse as generators to convert mechanical energy into electric power.

Figure 2.6: Electric motor (AC)

Figure 2.7: Electric motor (DC)

Found in applications as diverse as industrial fans, blowers and pumps, machine tools, household appliances, power tools, and disk drives, electric motors can be powered by direct current (DC) sources, such as from batteries, motor vehicles or rectifiers, or by alternating current (AC) sources, such as from the power grid, inverters or generators. Small motors may be found in electric watches. General-purpose motors with highly standardized dimensions and characteristics provide convenient mechanical power for industrial use. The largest of electric motors are used for ship propulsion, pipeline compression and pumped-storage applications with ratings reaching 100 megawatts. Electric motors may be classified by electric power source type, internal construction, application, type of motion output, and so on.

Electric motors are used to produce linear or rotary force (torque), and should be distinguished from devices such as magnetic solenoids and loudspeakers that convert electricity into motion but do not generate usable mechanical powers, which are respectively referred to as actuator.

2.2.2 Pulley and Belt

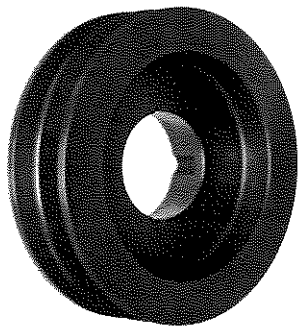

Figure 2.8: Pulley

Figure 2.9: Belt

A pulley is a wheel on an axle or shaft that is designed to support movement and change of direction of a taut cable. The supporting shells are called blocks. A pulley may also be called a sheave or drum and may have a groove or grooves between two flanges around its circumference. The drive element of a pulley system can be a rope, cable, belt, or chain that runs over the pulley inside the groove or grooves.

Hero of Alexandria identified the pulley as one of six simple machines used to lift weights. Pulleys are assembled to form a block and tackle in order to provide mechanical advantage to apply large forces. Pulleys are also assembled as part of belt and chain drives in order to transmit power from one rotating shaft to another.

A belt is a loop of flexible material used to link two or more rotating shafts mechanically, most often parallel. Belts may be used as a source of motion, to transmit power efficiently, or to track relative movement. Belts are looped over pulleys and may have a twist between the pulleys, and the shafts need not be parallel.

In a double pulley system, the belt can either drive the pulleys normally in one direction (the same if on parallel shafts), or the belt may be crossed, so that the direction of the driven shaft is reversed (the opposite direction to the driver if on parallel shafts). As a source of motion, a conveyor belt is one application where the belt is adapted to carry a load continuously between two points.

2.2.3 Power supply

Figure 2.10: Power supply (12V)

A power supply is an electronic device that supplies electric energy to an electrical load. The primary function of a power supply is to convert one form of electrical energy to another. As a result, power supplies are sometimes referred to as electric power converters. Some power supplies are discrete, stand-alone devices, whereas others are built into larger devices along with their loads. Examples of the latter include power supplies found in desktop computers and consumer electronics devices.

Every power supply must obtain the energy it supplies to its load, as well as any energy it consumes while performing that task, from an energy source. Depending on its design, a power supply may obtain energy from various types of energy sources, including electrical energy transmission systems, energy storage devices such as a batteries and fuel cells, electromechanical systems such as generators and alternators, solar power converters, or another power supply.

All power supplies have a power input, which receives energy from the energy source, and a power output that delivers energy to the load. In most power supplies the power input and output consist of electrical connectors or hardwired circuit connections, though some power supplies employ wireless energy transfer in lieu of galvanic connections for the power input or output. Some power supplies have other types of inputs and outputs as well, for functions such as external monitoring and control.

2.2.4 Bearing

Figure 2.11: Bearing

A bearing is a machine element that constrains relative motion to only the desired motion, and reduces friction between moving parts. The design of the bearing may, for example, provide for free linear movement of the moving part or for free rotation around a fixed axis; or, it may prevent a motion by controlling the vectors of normal forces that bear on the moving parts. Most bearings facilitate the desired motion by minimizing friction. Bearings are classified broadly according to the type of operation, the motions allowed, or to the directions of the loads (forces) applied to the parts.

Rotary bearings hold rotating components such as shafts or axles within mechanical systems, and transfer axial and radial loads from the source of the load to the structure supporting it. The simplest form of bearing, the plain bearing, consists of a shaft rotating in a hole. Lubrication is often used to reduce friction. In the ball bearing and roller bearing, to prevent sliding friction, rolling elements such as rollers or balls with a circular cross-section are located between the races or journals of the bearing assembly. A wide variety of bearing

designs exists to allow the demands of the application to be correctly met for maximum efficiency, reliability, durability and performance.

The term "bearing" is derived from the verb "to bear"; a bearing being a machine element that allows one part to bear (i.e., to support) another. The simplest bearings are bearing surfaces, cut or formed into a part, with varying degrees of control over the form, size, roughness and location of the surface. Other bearings are separate devices installed into a machine or machine part. The most sophisticated bearings for the most demanding applications are very precise devices; their manufacture requires some of the highest standards of current technology.

Table 2.1: Types and Sizes of the bearing

unite NO.	d	a	e	i	g	l	s	z	t	B	n	Bolt Size	Bearing No.	Housing No.	Weight(kg)
UCF201	12	86	64	15	12	25.5	12	33.3	37.5	31	12.7	M10	UC201	F204	0.6
UCF202	15	86	64	15	12	25.5	12	33.3	37.5	31	12.7	M10	UC202	F204	0.59
UCF203	17	86	64	15	12	25.5	12	33.3	37.5	31	12.7	M10	UC203	F204	0.58
UCF204	20	86	64	15	12	25.5	12	33.3	37.5	34.1	14.3	M10	UC204	F204	0.56
UCF205	25	95	70	16	14	27	12	35.8	40	34.1	14.3	M10	UC205	F205	0.8
UCF206	30	108	83	18	14	31	12	40.2	44.5	38.1	15.9	M10	UC206	F206	1.12
UCF207	35	117	92	19	16	34	14	44.4	48.5	42.9	17.5	M12	UC207	F207	1.46
UCF208	40	130	102	21	16	36	16	51.2	55.5	49.2	19	M14	UC208	F208	1.84
UCF209	45	137	105	22	18	38	16	52.2	56.5	49.2	19	M14	UC209	F209	2.15
UCF210	50	143	111	22	18	40	16	54.6	59.5	51.6	19	M16	UC210	F210	2.42
UCF211	55	162	130	25	20	43	19	58.4	63	55.6	22.2	M16	UC211	F211	3.31
UCF212	60	175	143	29	20	48	19	68.7	73.5	65.1	25.4	M16	UC212	F212	4.28
UCF213	65	187	149	30	22	50	19	69.7	74.5	65.1	25.4	M16	UC213	F213	4.99
UCF214	70	193	152	31	22	54	19	75.4	81.5	74.6	30.2	M16	UC214	F214	5.85
UCF215	75	200	159	34	22	56	19	78.5	83.5	77.8	33.3	M16	UC215	F215	6.91
UCF216	80	208	165	34	22	58	23	83.3	88.5	82.6	33.3	M20	UC216	F216	7.5
UCF217	85	220	175	36	24	63	23	87.6	92.6	85.7	34.1	M20	UC217	F217	9.66
UCF218	90	235	187	40	24	68	23	96.3	101.5	96	39.7	M20	UC218	F218	12.06