DESIGN AND DEVELOPMENT OF AUTOMATIC DRUM DEHEADER

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DESIGN AND DEVELOPMENT OF AUTOMATIC DRUM DEHEADER

AHMAD NAZARUDDIN BIN MAT ZIN

A report submitted in partial fulfilment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering
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NOVEMBER 2008

SUPERVISOR'S DECLARATION

We hereby declare that we have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

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STUDENT'S DECLARATION

I hereby declare that the work in this thesis is my own except for quotations and summaries which have been duly acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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Date: .....

To my beloved Father and Mother

Mat Zin Bin Haji Mahamood
Tina Suraini Bte Abdullah

and

Suraya Bte Shabingin

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All praises and thanks be to Allah S.W.T, who has guided us to this, never could we have found guidance, were it not that Allah had guided us!(Q7:43)

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ABSTRACT

Industrial drums are one of the types of packaging to protect goods for the consumers. When the drums already been use, the drum will become the hazardous waste for the environment. To prevent it happened, recycling play an important role for the Industrial drums. However, there is lacks of equipment and technology to reuse the old materials such as drums. This project presents a design of low cost an automatic drum deheader prototype by using less expensive materials. Designing and fabrication is the main process to develop this automatic drum deheader prototype. The end product from the research is the prototype of automatic drum deheader where the cutting method to cut the outside chimes is presented, so that the most metal drum covers can be removed without having to beat down the covers. This prototype had been developed for easily adjust the height and thickness of chime to accommodate with various drum and chime configurations. These prototypes also capable to complete one rotation around the drum in less than one minute like the other drum deheader available in market. The new design of automatic drum deheader prototype in this project basically is a simple design, lightweight and cheaper compare with others drum deheader. As a summary, the development of automatic drum deheader in this project is successfully done and research for the further improvement need to carry out to make this product more effective.

ABSTRAK

Industri tong drum adalah salah satu jenis kaedah pembungkusan untuk perlindungan terbaik kepada pengguna. Tong drum yang telah digunakan akan dibuang dan boleh menjadi sisa yang berbahaya kepada alam sekitar. Oleh yang demikian, kitar semula memainkan peranan penting kepada industri tong drum dalam mencegah masalah ini. Walaubagaimanapun, teknologi dan alat untuk mengitar semula bahan terbuang seperti tong drum masih kekurangan. Projek ini membentangkan rekaan alat pemotong tong drum automatik dimana kos penghasilannya adalah rendah dengan menggunakan bahan-bahan terpakai dan murah. Rekaan dan penghasilan merupakan proses utama dalam membangunkan prototaip alat pemotong tong drum automatik ini. Hasil daripada penyelidikan projek ini adalah sejenis prototaip alat pemotong tong drum automatik dimana kaedah pemotongan yang digunakan adalah memotong dari luar '*chime'* supaya penutup besi tong drum dapat digunakan semula tanpa perlu memukul penutup tersebut. Prototaip in dibangunkan bagi memudahkan ia dilaras mengikut ketinggian dan ketebalan '*chime'* untuk tong drum yang berbeza dan *'chime'* yang pelbagai rupa bentuk. Prototaip ini juga mampu melengkapkan satu pusingan tong drum kurang dalam satu minit seperti alat-alat pemotong tong drum lain yang terdapat di pasaran. Rekaan terbaru alat pemotong tong drum di dalam projek ini adalah ringkas, ringan dan murah berbanding alat pemotong tong drum lain. Kesimpulannya, pembangunan prototaip alat pemotong tong drum automatik ini telah berjaya dihasilkan dan penyelidikan berterusan di masa hadapan diperlukan untuk pembaikan supaya hasil produk ini lebih effektif.

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LIST OF SYMBOLS

n	Total number of link
j_p	Total number of primary joint
j_h	Total number of higher order joint
t	Time
V	Voltage
ω	Natural Frequency
ν	Velocity
r	Radius
rpm	Rotational speed

LIST OF ABBREVIATIONS

INCPEN	Industrial Council for Packaging and the Environment
OSHA	Occupational Safety and Health Administration
EPA	Environmental Protection Agency
DOT	Department of Transportation
Dc	Direct current
Ac	Alternating current
DOF	Degree of freedom

CHAPTER 1

INTRODUCTION

In this chapter introduction is made on some general information about the packaging Industry, the important of drum recycle, problem statement, research objectives and the scope of the project.

1.1 BACKGROUND

Nowadays, Industrial Packaging plays a valuable role in protecting goods. Packaging makes modern lifestyles possible. This industry continues to make packaging easier to use and more convenient for consumers, while providing better protection using less material and so generating less waste. As well as protecting and preserving goods, packaging carries vital information on ingredients, keeps hazardous products away from children, and ensures goods are safe. Companies that produce and use packaging make a positive contribution to society both directly and through membership of INCPEN (Industrial Council for Packaging and the Environment).

Recycling also play important role in Industrial Packaging to prevent the old materials from becoming hazardous waste. Recycling is the reprocessing materials of old materials into new products, with the aims of preventing waste of potentially useful materials, reducing the consumption of fresh raw materials and reducing energy usage. It also lowering greenhouse gas emissions compared to virgin products. Recycling also helps sustain the environment for the future generation. Everyone knows that reducing waste is good for the environment because it conserves natural resources. What many people do not know is that solid waste reduction and recycling also have an impact on global climate change.

Drums are the one of the types of packaging. By the way, empty drums in good condition can be re-used as collection containers for hazardous wastes, usually for the same type of product they originally contained. Damaged or excess metal drums can be washed and recycled as ferrous scrap metal. Basically they are many benefit in drum recycle which is saves the cost of purchasing new drums by reuse the drums. It also prevents drums from becoming hazardous waste. The other things are it reduces hazardous waste transportation and disposal costs. Recycling drums also generate income.

1.2 PROBLEM STATEMENTS

This project is extensively to define the solution in order to solve the problem listed below;

- There is lacks of equipment and technology to reuse the old materials for example steel drum. This is very important to prevent the old materials from becoming hazardous waste.
- Many types of drum deheader available in market basically cut the inside chimes. This will make the lid (drum cover) cannot be use anymore.
- The height and thickness of chimes is not standard in industry.
- The inside chime cut cannot protects the drum contents from contamination because metal drums have a removable bung or plug in a threaded opening through the drum cover. Contents in the drum can be poured from the threaded opening.

The new design of prototyping drum deheader will be develop based on the problems above for more productive and convenient to the user.

1.3 OBJECTIVES

Before begin this project, it is important to clearly state the purpose of this project. The objective to be achieved is;

- Develop a new design of low cost drum deheader prototype by using less expensive materials
- Design and prototyping more productive drum deheader which is suitable for industrial drum where it capable to adjust the height and thickness of chime and the method use to cut outside chime.
- Study and analyze the drum deheader prototype performances.

The objectives above clearly shown that the three important purpose why this project is being to do. To achieve these three objectives, more research and analysis must be done before develop a new prototype design.

1.4 SCOPES OF PROJECT

This research more focus on design and fabricate of new drum deheader prototype. The new design of prototype must be able to cut the outer rolled chime drum and the metal covers can be reused. Another important thing is the prototype is versatile and can be easily adjust to accommodate various drum and chime configurations.

CHAPTER 2

LITERATURE REVIEW

2.1 PACKAGING

Packaging can be defined as materials used for the containment, protection, handling, delivery, and presentation of goods. Packaging can be divided into three broad categories:

- **Primary** packaging is the wrapping or containers handled by the consumer.
- **Secondary** packaging is the term used to describe larger cases or boxes that are used to group quantities of primary packaged goods for distribution and for display in shops.
- **Transit** packaging refers to the wooden pallets, board and plastic wrapping and containers that are used to collate the groups into larger loads for transport, which facilitates loading and unloading of goods. [1]

The most common types of material used for packaging are paper, board, plastic, glass, steel and aluminum. These types of material are very important to the industrial drums.

2.2 INDUSTRIAL DRUMS

Industrial drums are large, industrial containers that serve as storage and shipping containers for a variety of hazardous and non-hazardous substances, including beverages, chemicals, petroleum and paint. Generally, these cylindrical industrial containers are used for the storage of liquids. Industrial storage drums are available in a variety of different materials, but the most common types are steel drums, plastic drums and fiber drums. These materials are particularly advantageous because they can be reconditioned for future use. The selection of a material depends upon the industrial application for which the drum will be used, as well as specific customer requirements. [2]

Steel drums are most often used for situations in which flammable chemicals and other hazardous substances need to be handled. Plastic drums are used to transport powders and many other substances that can be handled by steel industrial drums. Plastic drums are becoming increasingly standard because of their ability to be recycled for future use. Plastic drums also are preferable because they do not rust when they are exposed to the elements. Fiber drums are made from dense paper or fiber board. They are usually only used for a short time. Compared to other industrial drums, such as plastic drums and steel drums, fiber drums are more easily recycled. Fiber drums are commonly used in the food industry to transport large volumes of frozen or refrigerated goods such as ice cream and cheese. [2]

Industrial drum manufacturers make their products in a variety of sizes. The standard industry size is 55 gallons drums, but steel drum, plastic drum, fiber drum sizes can range from five gallons to 110 gallons drums. For larger volumes of substances, intermediate bulk containers are used. In addition to stock sizes, industrial drum manufacturers create custom sizes to fulfill specific customer requests. Special linings and surface coatings are available for both the interior and exterior of the steel drums, plastic drums, and fiber drums. For steel drums, the interior and exterior are often painted to prevent erosion and rust. Plastic drums may have a thin plastic film bonded to the interior to prevent leakage and ensure freshness of food products. The larger units require special handling and transportation

equipment, such as trolleys, hoists and belts to prevent them from tipping and spilling their content. [2]

Common industries in which steel drums, plastic drums, and fiber drums are found include the oil and gas, food and beverage processing, agricultural, automotive and pharmaceutical industries. Because many industries store and ship chemicals, pesticides and other hazardous materials, industrial drum manufacturers must adhere to the strict production and shipment standards of organizations like the Occupational Safety and Health Administration (OSHA), the Environmental Protection Agency (EPA) and the Department of Transportation (DOT). [2]

2.2.1 Types of Industrial drum

Basically, they are many types of industrial drums from various suppliers around the world as shown above:

- **55 gallon drums** are the standard-sized drums used for storage and shipping.
- **Agitator drums** are used for the mixing and combining of substances, such as paint and concrete. They have an opening in the cover for the entrance of the blades of an agitator, which mixes the substance, and are made most often with metal alloys, such as steel or aluminum.
- **Closed head drums**, also called "tight head drums," have a permanent lid with a small opening to allow for the pouring out of the material enclosed.
- **Fiber drums** are shipping and storage containers made of heavy paperboard materials.
- Open head drums often use removable heads, as opposed to closed head drums.
- **Plastic barrels** are used to transport and store liquids.
- **Plastic drums** are rust-proof alternatives to steel drums.
- **Reconditioned drums** are plastic or steel vessels that have been reconditioned to ensure optimum repeat use. Most often, the lid of the drum is what is replaced or reconditioned.

- **Salvage drums** are specifically designed for the safe and economic transport and storage of damaged drums. In the unusual event that a steel drum leaks, possibly due to extreme mechanical loading or impact, temporary solutions, such as salvage drums, may be required.
- **Seamless drums** have a smooth, creaseless interior that prevents the unintended trapping of the material being stored. Seamless drums are similar to process drums, which have a welded top curl to prevent entrapment, as well.
- **Steel Barrels** are closed-top drums used to ship and store liquids. [2]

Figure 2.1: Industrial Drums [3]

2.3 PACKAGING RECYCLING

Recycling is the reprocessing of old materials into new products, with the aims of preventing the waste of potentially useful materials, reducing the consumption of fresh raw materials and reducing energy usage, and thereby lowering greenhouse gas emissions compared to virgin production. Recycling is a key concept of modern waste management and is the third component of the "Reduce, Reuse, and Recycle" waste hierarchy. [4]

The increased use of packaging provides a physical barrier between a product and the external environment thereby ensuring hygienic conditions and reducing the risk of product wastage due to contamination. This is particularly important in the

case of food and beverage products. In the life cycle of food products, the highest energy input takes place during the production process. Appropriate packaging ensures that this energy is not wasted. Some packaging is also needed for safe and efficient transportation. Packaging is also used to provide customers with product information and usage instructions, some of which are required by law. [4]

Packaging has developed to a large extent in response to social and economic changes affecting consumers. Higher living standards in the western world have led to an increase in consumer goods and tastes for exotic foods, which cannot be grown locally and must be imported. A trend towards urbanization in the last century, which creates longer distances between food producers in rural areas and consumers in urban areas, has also led a greater demand for packaging. [4]

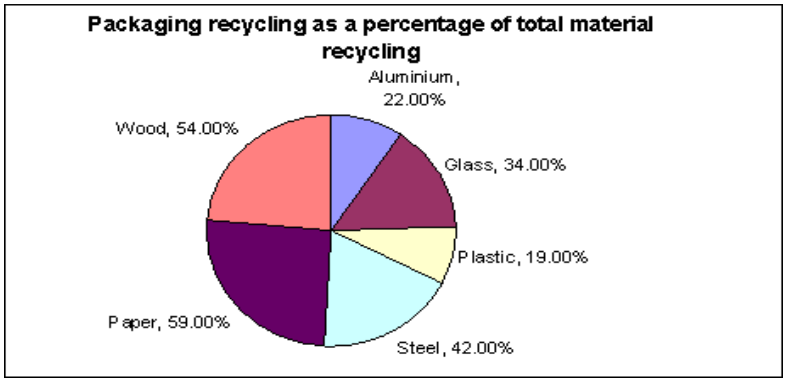


Figure 2.2: Packaging recycling as a percentage of total material recycling [4]

Generally, they are four steps in recycling packaging as shown above;

- **Reduce**: Many people are concerned about the amount of packaging products are sold in and try to avoid goods that they consider are 'over-packaged'. An example of over-packaging is the use of standardized boxes. This can lead to void space in the package, which is both a wasteful use of resources and misleading for consumers. In Korea, over-packaging is being prevented through legislative standards for certain types of packaging. For example, processed foods can have no more than 15% of the volume of the package taken by void space, and no more than two layers enclosing the product. Avoid buying small containers

where possible. An example might be to purchase one large bottle of drink instead of individual small bottles or cans.

- **Reuse**: The most direct way to recover packaging is by reusing it in its original form. However the environmental impacts of washing and transportation have to be taken into consideration. Reusable packaging has to be sturdier to withstand cleaning processes, increased transportation and handling. This leads to increased material and energy use during its manufacture. Recycling activities also have an environmental impact, mainly in terms of energy consumption, because recyclables need to be transported, cleaned and reprocessed before they can be turned into new products. In some circumstances, it can therefore be less environmentally beneficial to recycle packaging, for example very small light-weight items such as cling-film. To identify packaging needs and optimize performance, a Life Cycle Analysis can be used to analyze the environmental impacts of each stage of a product's life cycle from raw material extraction to final disposal.

- **Recycle**: Many packaging materials can be collected for recycling. Examples include paper and glass and plastic bottles. It is best to purchase items for which you know that an infrastructure exists for recycling. Juice cartons have proved to be difficult to recycle although a plant now exists in Scotland for reprocessing this material.

- **Environmentally friendly packaging**: Many claims are made to promote a particular product. Where possible buy packaging that has been recycled - e.g. recycled cardboard boxes. Some packaging is promoted as being biodegradable. Although when composted this is a good way to lessen environmental impact, it is important that these materials do not end up being land filled as then the material cannot biodegrade and may in addition give off methane - a powerful greenhouse gas. [5]

2.3.1 Steel drum recycles

The cylindrical steel drum has been used for the carriage of liquids for the whole of the twentieth century.

Because it can be rolled, the cylindrical drum is the only form of large package than can be handled safely by one man without the need for mechanical handling equipment or prepared surfaces. It is largely for this reason that the steel drum remains the most popular form of shipping container in all corners of the world. [6]

Manufactured on high speed dedicated production lines, the steel drum can be produced cheaply in very large quantities to the very highest standards of quality and design. It is uniquely strong and is therefore regarded as the safest form of container for the most hazardous materials. [6]

Figure 2.3: Steel Drum [6]

The steel drum is the perfect example of a container which benefits from a higher effective and well-established infrastructure for reconditioning and recycling.

- **Reconditioning**

Unlike any other industrial packaging material, reconditioned steel drums have the advantage of meeting the same legal and safety requirements as new steel drums.

It has a significant re-use expectation and is serviced by a worldwide, dedicated reconditioning industry through licensed agents. Drum makers provide for the collection of used containers and the supply of reconditioned packaging, making multi-trip usage simple and cost-effective.

- **Recycling**

When steel drums have reached the end of their current life they can be easily recycled. Scrap drums are segregated and processed for return to processors where they are recycled to make new steel. This extensive infrastructure, combined with steel's magnetic properties, ensure a high quality of scrap, making steel drums the ideal choice for recycling. [7]

Figure 2.4: Hazardous waste of steel drum [7]

Many inventors around the world produce the product that can allow opening the steel drum. Some of them invent that machine is for opening the metal cover and capable to reuse the metal cover again. One type of that product available in market is drum deheader.

2.4 DRUM DEHEADER CONCEPT

There are many concept of drum deheader available in market. Their concept basically depends on the function of that drum for examples for food, industrial and etc.

Figure 2.5: Outside chime cut [8]

The figure above shown that the series cut on the outside of the rolled edge to minimizing the potential for contamination of the drum contents. Lid stay in place until lifted off and can be used as cover. This series is for use with food, pharmaceutical, or industrial drums where contamination risk must be minimized.

Figure 2.6: Inside chime cut [8]

For the inside chime cut, it cut inside of the rolled edge and leaving a strong chime for future reuse of the drum. This concept or series is for use in industrial drums and ideal for deheading drums that will be reused.

Figure 2.7: Outside shell cut [8]

The other concepts are cut on the outside of the drum shell and removing the entire drum top and bottom. This series basically for disposal or for use with drums that will be flattened, rebuilt, or scrapped. Speeds safe disposal and minimizes possibility of future drum use and ideal for clean-up projects and container management.[8]

2.5 TYPES OF DRUM DEHEADER

Basically there are three types of drum deheader available in market which is manual, automatic and compressed air. Manual deheaders are for deheading low to moderate volumes of industrial drums. This is the lowest cost alternatives to conventional manual deheaders. While for electric or automatic deheader is for deheading moderate to high volumes. This type is the lowest cost powered deheader on the market. The types of compressed air are the superior quality electric and pneumatics steel drum deheaders for deheading high volumes of food, pharmaceutical, or industrial drums. This is the most durable deheader on the market. [8]

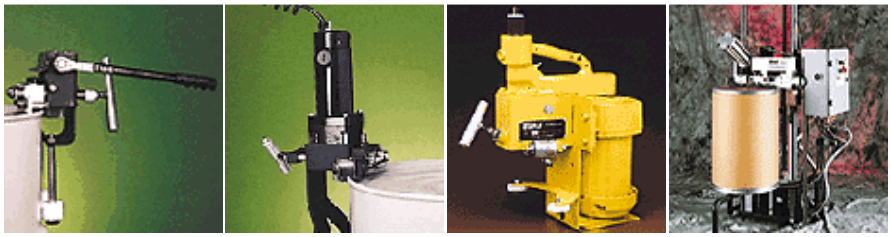


Figure 2.8: Drum deheader available in market [8]

2.5.1 Manual drum deheader

One known type of manually operable ***drum deheader*** includes a cutting blade attached to a slide plate slid ably mounted in a channel-like receiver which engages the annular chime of the drum. An elongated handle is pivotally mounted to the receiver and connected by a double hinged linkage for reciprocating the blade upwardly and downwardly to cut through the cover of the drum. A guide handle can

be attached to the slide plate so that it extends away from the drum. While this double hinged or pivoted design has been generally satisfactory, there is a need for an improved deheader which is more rigid and stable, and is more economical to manufacture. [9]

Figure 2.9: Manual Drum Deheader [8]

2.5.2 Automatic drum deheader

The other types of drum deheader is automatic drum deheader which is fiber drum deheader and metal drum deheader. The both types are using electric DC motor.

- **Portable Fiber drum deheader**

The invention is a portable fiber drum chime remover, and a method of using the chime remover to efficiently disassemble fiber drums. The portable fiber drum chime remover can be manufactured at much less cost than conventional dechiming machines, and is suitable for dechiming fiber drums on location. [10]

In one aspect, the invention is a portable fiber drum chime remover for disassembling a fiber drum. The preferred chime remover has a carrier with a generally vertical drive shaft bearing hole. A drive shaft is journeyed within the drive shaft bearing hole and a rotatable drive wheel is mounted to the drive shaft. The

drive wheel is disposed to engage an outer surface of the metal chime. The chime remover also has a front housing having a cutter shaft bearing hole. A rotatable cutting wheel, having a cutting head and a cutter shaft projecting perpendicularly from the cutting head, is mounted for rotation through the cutter shaft bearing hole in the front housing. [10]

In another embodiment, the cutting wheel stop limits the lowest position relative to the front housing that the cutting head can slide, but the cutting head would be free to slide upwards except for being guided by grooves or ribs associated with the fiber sidewall or chime. The preferred way of carrying out this embodiment is to have threads on the cutter shaft on the end of the cutter shaft opposite the cutting head, and slid ably mounting the cutter shaft in the front housing so that some of the threads are exposed above the front housing. A threaded shaft collar can then be screwed on to the exposed threads to limit the axial movement of the cutter shaft. [10]

Although the chime will normally be deformed by teeth in the drive wheel when the drive wheel and the cutting head are engaged to cut the fiber sidewall, it is preferred that the fiber drum chime remover include a restraint element or spacer to keep the cutting head from coming in direct contact with the drive wheel. This prevents the cutting head from becoming damaged prematurely. [10]

- **Portable Metal drum deheader**

Most metal drum openers use cutting heads with relatively large diameters. Small diameter cutting heads require more torque when kinks in the chime are encountered than large diameter cutting heads, and using a small diameter cutting head with conventional metal drum openers can therefore cause problems especially when kinks in the chime are encountered. Large diameter cutting heads can more easily work through kinks or bumps in the chime. [11]

Many industrial metal drums have a removable bung or plug in a threaded opening through the drum cover. Contents in the drum can be poured from the threaded opening. The bung often projects above the cover and is often located close

to the chime. A raised bung can interfere with the path of conventional large diameter cutting heads as the drum opener travels around the chime at the upper end of the drum. If a raised bung interferes with the cutting head, the bung needs to be removed or beaten flat with mallet. [11]

It is therefore also desirable to provide a portable metal drum opener that can use small diameter cutting heads and reduce inconvenience relating to interference caused by bungs in drum covers, and that can accommodate variations in chime geometry such as variations in chime height or chime kinks. [11]

An object of the invention is to provide a portable metal drum opener that is versatile and can easily adjust to accommodate various drum and chime configurations. Another object of the invention is to provide such a metal drum opener that allows the use of a cutting head with a relatively small diameter, thus eliminating the need to beat down or remove bungs in the cover of most drums. [11]

In one aspect the invention relates to a method for adjusting the chime cutting height on the inside surface of the chime and apparatus for carrying out the method. The method includes the steps of engaging a rotatable drive wheel against an outer surface of a chime and engaging a rotatable cutting head against the inner surface of an inside layer of the chime, driving the rotatable drive wheel to move the drive wheel and the cutting head in a cutting direction around the chime to cut the inside layer of the chime, tilting the cutting head downward in the cutting direction so that the cutting head will tend to move downward along the chime during cutting, and physically restraining the tilted cutting head from moving downward past a selected chime cutting height so that the cut along the inside layer of the chime is at the selected chime cutting height. [11]

In accordance with the invention, there are two preferred ways to power the metal drum opener. One preferred way is to use an electric direct current (DC) motor. A DC motor is preferred over an alternating current (AC) motor because DC motors can more easily accommodate kinks without stalling than AC motors. In order to eliminate or lessen transverse loads on an output shaft of the electric motor

and therefore enhance the durability of the electric motor, a transverse clearance is provided between the output shaft of the electric motor and the drive shaft. [11]

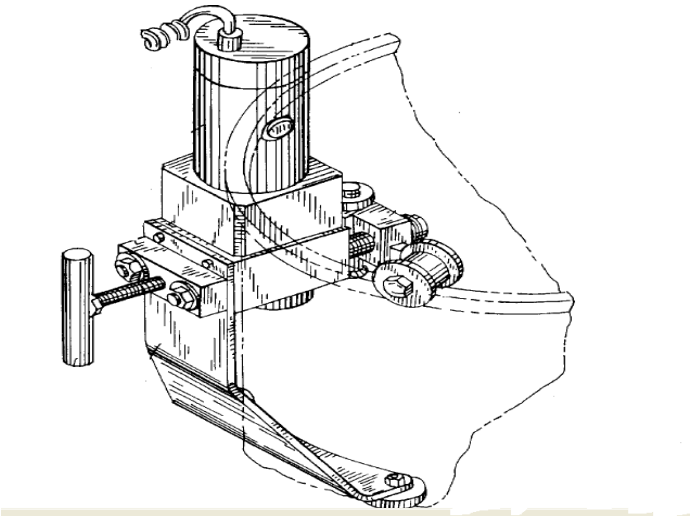


Figure 2.10**:** Automatic drum deheader drawing [11]

2.6 CONCLUSIONS

It is important to study and make an analysis from literature review to get the ideas, information, theory and conceptual design from the related areas and previous inventor. The conclusion is to gather the important information from this project before start to planning for the methodology in next chapter.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Methodology is defined as a particular procedure or set of procedures. For the methodology to make a new design of drum deheader, the information from literature reviews is important to make referring, guidelines and calculation to make dimension for designing this project. The information such as theories, concepts or ideas from the previous inventor of drum deheader is very important to make comparative study of different approaches and make an improvement. Defines the problem, data collecting, designing the project, list of material and calculation include for the methodology to carry out the new drum deheader.

From the study of literature review, the design and development of new automatic drum deheader in this project is based on the Portable Metal Drum Deheader. This design will be choose because it capable to remove the drum cover made from metal or steel. However, the concept use is cut the inside chime and cannot protects the content in drum from contamination. To prevent this happen, the new concept of drum deheader in this project is be able to cut the outside chime.

3.2 METHODOLOGY OF FLOW CHART

To achieve the objective of the project, a methodology flow chart purposely uses to give the guidelines and directions to make this project work out successfully. The important part is designing the project because to make this project successfully,

the good design must find out to achieve the objective for the new design of drum deheader. **Figure 3.1** show the flow chart of the overall process;

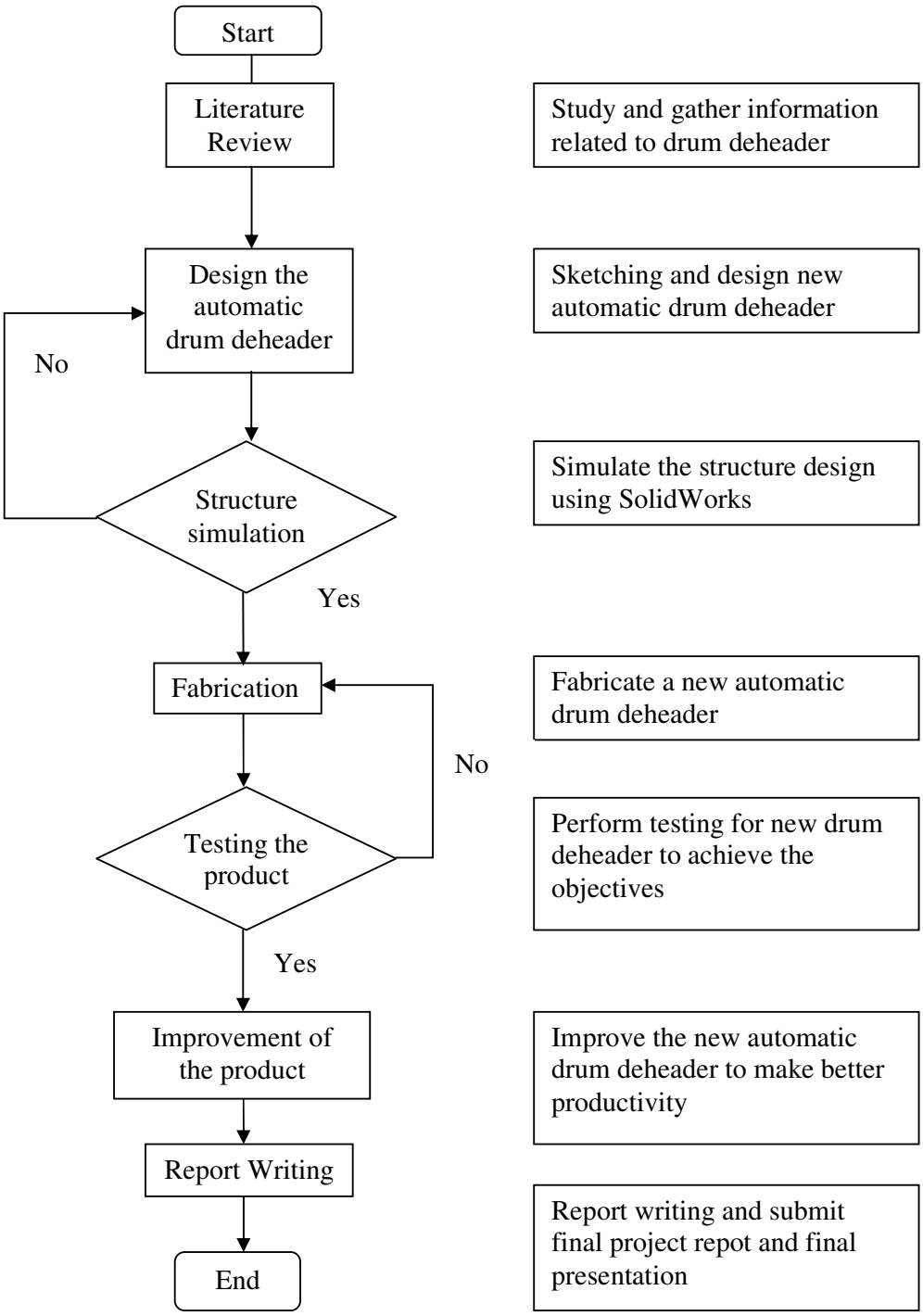


Figure 3.1: Flow chart for the overall process

3.3 DATA COLLECTING

Data collecting is important because the project design must know the diameter and range of height the chimes of drum. However, chime configuration and particularly the height of chimes are not standard in industry. There are two types of drum chime;

I. Flat chime

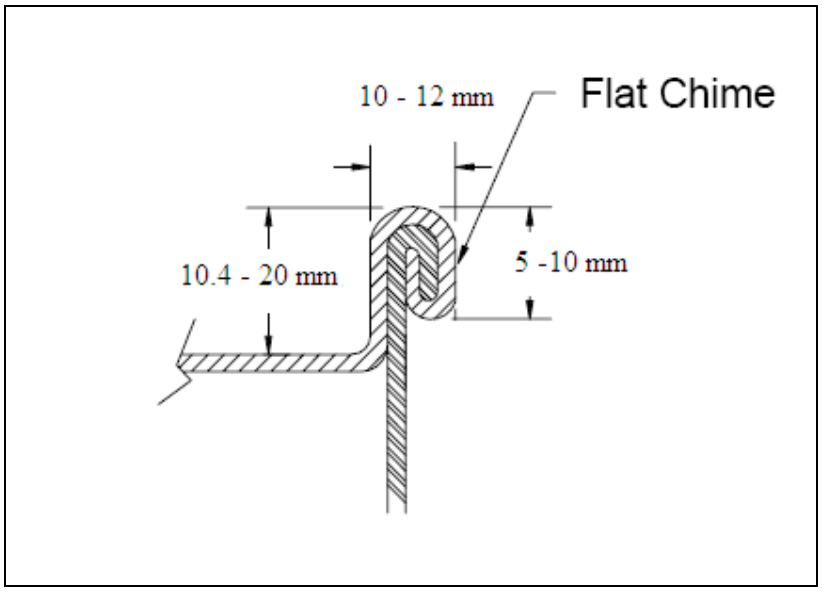


Figure 3.2 : Flat chime

II. Rounded Chime

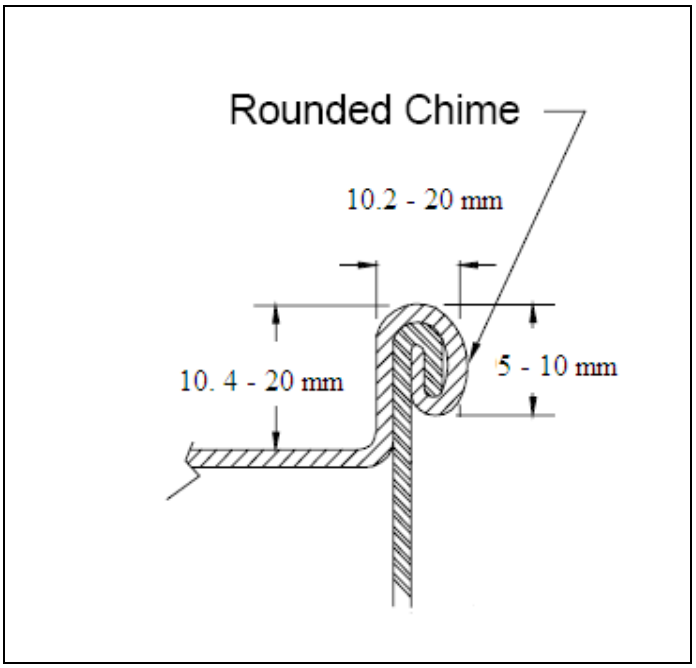


Figure 3.3: Rounded Chime

Figure 3.2 and 3.3 show the types and dimension of chimes. However, the dimensions show only the range because chime configuration and particularly height is not standard in industry. Vernier Caliper is use to measure the dimension of chimes as shown on figure 3.4.

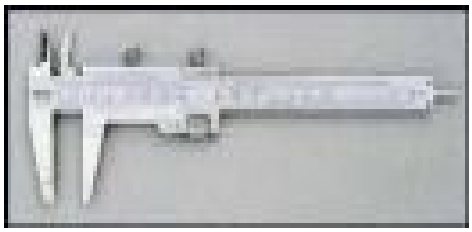


Figure 3.4: Vernier Caliper

3.4 CONCEPTUAL DESIGN

The concept of new drum deheader in this project is to make easier for the user in order to remove the metal drum cover and the metal cover can be reused. Large industrial drums normally include a cover that is secured to the edge of cylindrical wall of the drum by rolled chime. At the location of use, the cover normally removed by power operated drum opener. In one type of drum opener a drive wheel is engaged with the upper edge of the chime, while a cutter wheel is located directly opposite the drive wheel and is engaged with the lower edge of the chime. Operation of the drive wheel will cause the opener to travel around the upper end of the drum and the cutter will cut the outside chime to release the cover.

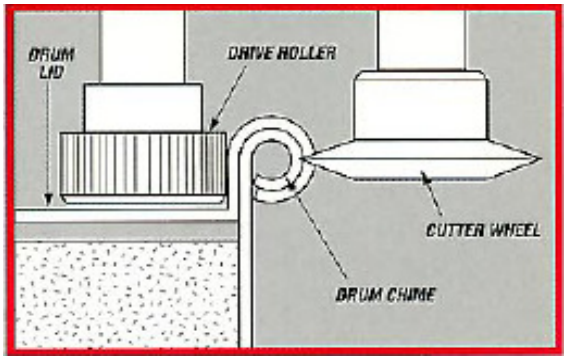


Figure 3.5: Cutting Operation

The most important thing of consideration when make a new design of drum deheader is their design and arrangement of the inner system. So, the system must include the requirement in drum deheader system available in the market to give more efficient to the user. The material when fabricate the drum deheader is also must be inexpensive material to make more suitable for all community usage in the world especially in Malaysia.

In accordance with this invention, there are two preferred ways to power the metal drum opener. One preferred way is to use an electric direct current (DC) motor. A DC motor is preferred over an alternating current (AC) motor because DC motors can more easily accommodate kinks without stalling than AC motors. In

order to eliminate or lessen transverse loads on an output shaft of the electric motor and therefore enhance the durability of the electric motor, a transverse clearance is provided between the output shaft of the electric motor and the drive shaft.

The drum deheader available in the market is very expensive. So, to overcome this problem, the drum deheader gratify to all faction people in Malaysia. The objective is to develop inexpensive drum deheader without neglecting their quality. The drum deheader must give more convenience to the user.

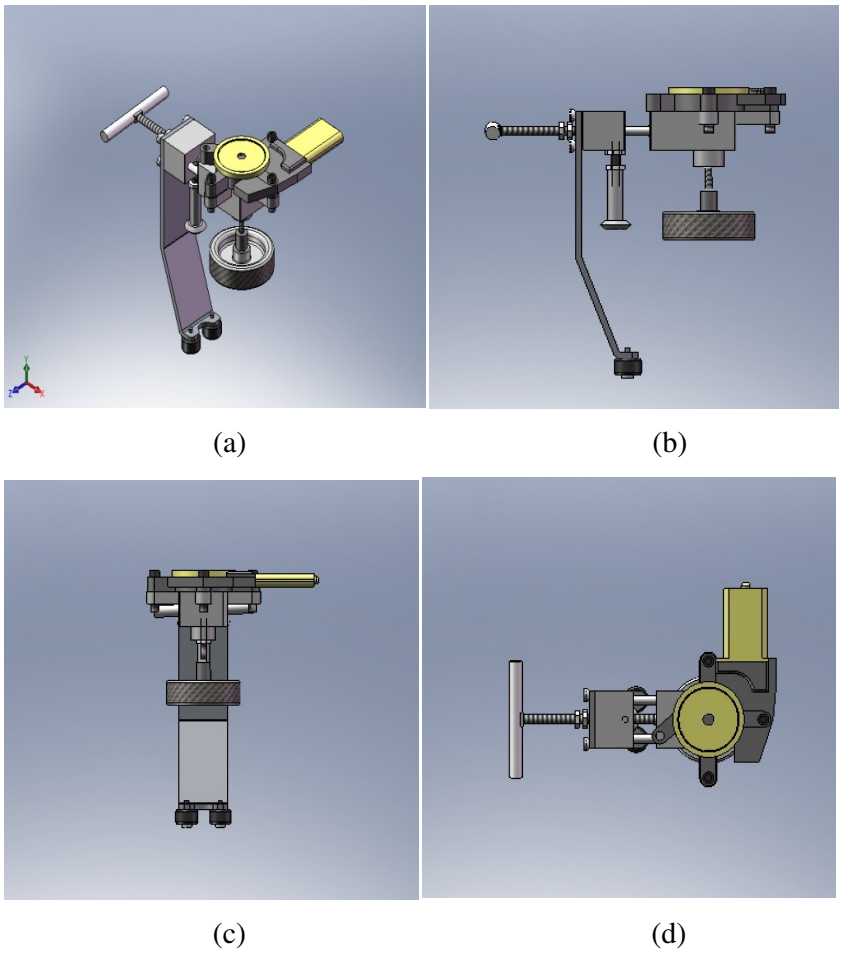


Figure 3.6: Completed design using SolidWorks 2007. (a) Isometric. (b) Front view (c) Right view. (d) Top view

3.5 LIST OF MATERIAL

To finish this project, some parts are buying from the market because it is cheaper and easy to get. That materials buy from the market is tire of trolley and bearing as shown in Table 3.1.

Table 3.1: List of Material

Quantity	Particulars	Rate	Amount
1		RM 5.00	RM 5.00
2		RM 2.50	RM 5.00
1		RM 10.00	RM 10.00
	Total		RM 20.00

3.5.1 Raw Material

Raw material that use for this project to make a carrier and front housing is mild steels. It is being choosing because this material has relatively low tensile strength and hardness. It is also cheap and malleable. Mild steels also are suitable for machining. Table 3.7 shown the size and quantity use Mild steels.

Table 3.2: Size and quantity use Mild Steels

Quantity	Particulars	Size (mm)
1	Carrier	60 x 60 x 60
1	Front Housing	45 x 45 x 45

3.5.2 Sheet Metal for Guide Roller Bracket

Aluminum is the sheet metal use for this project to make guide roller bracket. It is being choosing because this material is soft, durable, lightweight, malleable metal with appearance ranging from silvery to dull gray, depending on the surface roughness. Table 3.3 shown the size and quantity use Aluminum.

Table 3.3: Size and quantity use Aluminum

Quantity	Particulars	Size (mm)
1	Guide Roller Bracket	215 x 50 x 3

3.6 FABRICATION PROCESS

Fabrication is used as an industrial term, applies to the building of machines, structures, or process equipment for the chemical or fertilizer sector, by cutting, shaping and assembling components made from raw materials. In this project, fabrication process is the important part to make the project was successfully done. Various processes like machining, bending, drilling and etc is useful to build new design drum deheader prototype based on engineering drawing.

3.6.1 Design of drum deheader

The main components for fabrication in this project are carrier, front housing, guide roller bracket, coupling and cutter wheel. To make this parts, various processes are needed which is machining, bending, facing and drilling. This process need to operate the machine such as Conventional Lathe machine, Bend saw, Bending machine and another machine. Learning and training process must spent more time to make trainer can apply, use and operate itself. The learning process include learn how to setup the operation with the command necessary to operation and learn how to setting work piece and machine.

The first step of process is cutting raw material using bend saw machine to made work piece in size needed based on detail drawing. The next process is to fabricate the component of drum deheader using various processes in manufacturing

3.6.2 Facing process

The raw materials are already cutting go to the next process at milling machine for carrier and front housing. For the shaft, lathe Machine is use for this process. The raw materials need to facing because to make the surface more smooth and flat. This process also make easy to manufacturing.

Figure 3.7: Milling machine

Figure 3.8: Lathe machine (ERL-1330)

3.6.3 Drilling process

The next process is drilling process. This process using a drill bit in a drill to produce cylindrical hole for thread in raw materials. The parts in this process are front housing and carrier.

Figure 3.9: Drilling machine

3.6.4 Punching process

Punching process is needed to make a guide roller bracket. This process is use to punch to make hole and shape needed. The sheet metal is setting for clamping and then the command drawing (.Lst) loaded in turret punch machine. After setting machine and command drawing, machining process is already running.

Figure 3.10: Punching machine

3.6.5 Bending process

For the next process of guide roller bracket is need to bend at bending machine. This machine did not use drawing command file but the process just setup machine and sheet metal include length want to bend, type of sheet metal and also the degree want to bend. For this process use 200 degrees to bend.

Figure 3.11: Bending machine (TrumaBend V85 S)

3.7 COUPLING FABRICATION

Another part in fabrication process is to design and fabricate the coupling for power window motor. This is important to joint the power window motor with the drive roller as a rotatable wheel. The process needed to make this part is using lathe and drilling machine. The material used is mild steel.

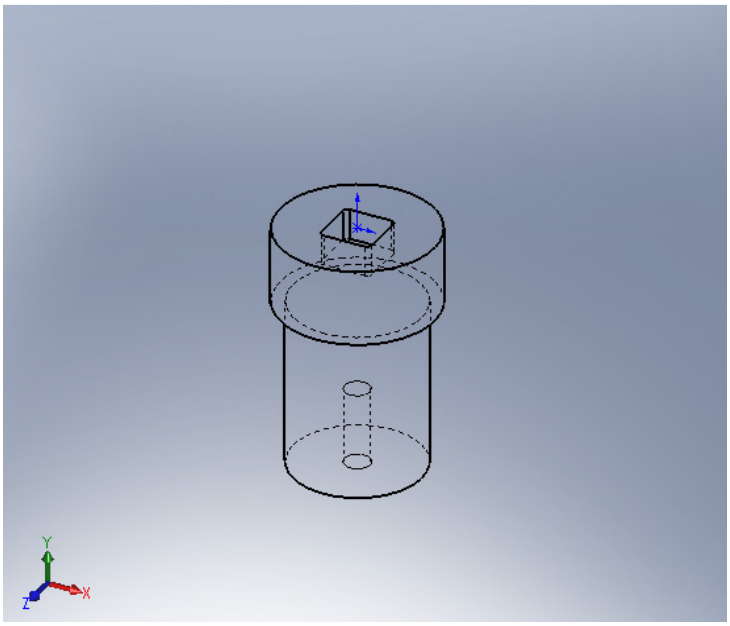


Figure 3.12: Coupling design using SolidWorks

3.8 CUTTER WHEEL FABRICATION

The last part in fabrication process is to make a cutter wheel using CNC Turning. The material use for cutter wheel is Titanium-6AL-4V. The most important thing in order to design this part is to know the angle and coordinate of that part as shown above.

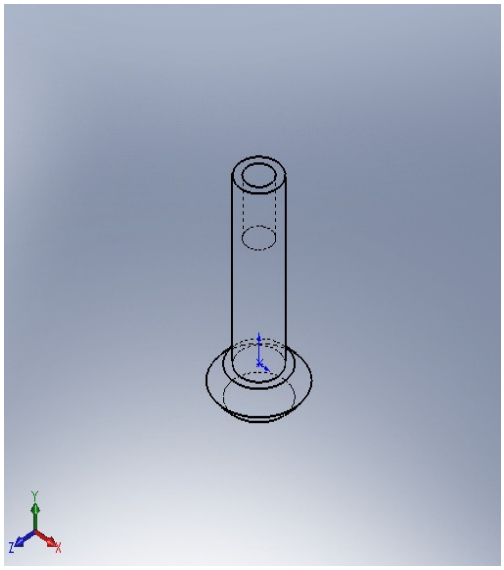


Figure 3.13: Cutter wheel design using SolidWorks

3.9 CONCLUSION

Method of design and developed the automatic drum deheader in this project is clearly shown in this chapter. This is very important to make sure that the invention is successfully done. For the next chapter, the results obtain from the development of automatic drum deheader in this chapter is analized.

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 INTRODUCTION

The most important issues that will be discussed in this chapter are the problem and consideration while doing fabrication process and the final result of the automatic drum deheader. To make the process is fully automatic the device must be control using power window. The complete fabrication of automatic drum deheader then will be tested to analyze their performances.

4.2 FABRICATION RESULT

It is very important to analyze the mechanical part from the fabrication process that already been done. When all the parts already been fabricated, the next step is to assemble all the parts for complete automatic drum deheader. Table 4.1 shows the parts from the fabrication result.

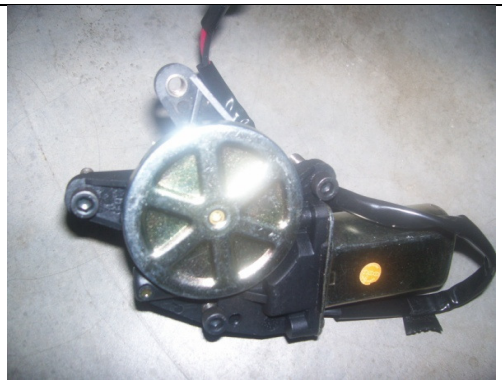
Table 4.1: Parts in Automatic drum deheader

Picture	Name of part
	Front Housing
	Carrier
	Coupling

	Guide Roller Bracket
	Handle Bar
	Cutter Wheel

The others mechanical part and device that been used for this Automatic drum deheader prototype is supplied by the shop as shown in Table 4.2:

Table 4.2: Mechanical component and device

Picture	Part/Device
	Bolt, nut, screw and stud
	Drive roller
	Power window (12V)
	Bearing

4.3 ASSEMBLY SYSTEMS

The individual parts and components produced by various manufacturing processes are assembled into finished products by various methods. The method use in this project basically manual assembly that is relatively simple tools and generally is economical for small lots. Because of the dexterity of the human hand and fingers and their capability for feedback through various senses, workers can manually assemble even complex part without much difficulty and the human is capable of doing this simple operation with relative ease.

Figure 4.1: Before assemble all the part

Figure 4.1 shows all the parts in Automatic drum deheader are putting together before it assemble as a prototype. Mechanical components also including on that figure like a bolt, nut, screw, bearing and stud. This mechanical component is important to support the joints between links.

4.3.1 Detail description

Exploded view from the SolidWork design will come out to easier for the user to understand how the system is assembling as shown above.

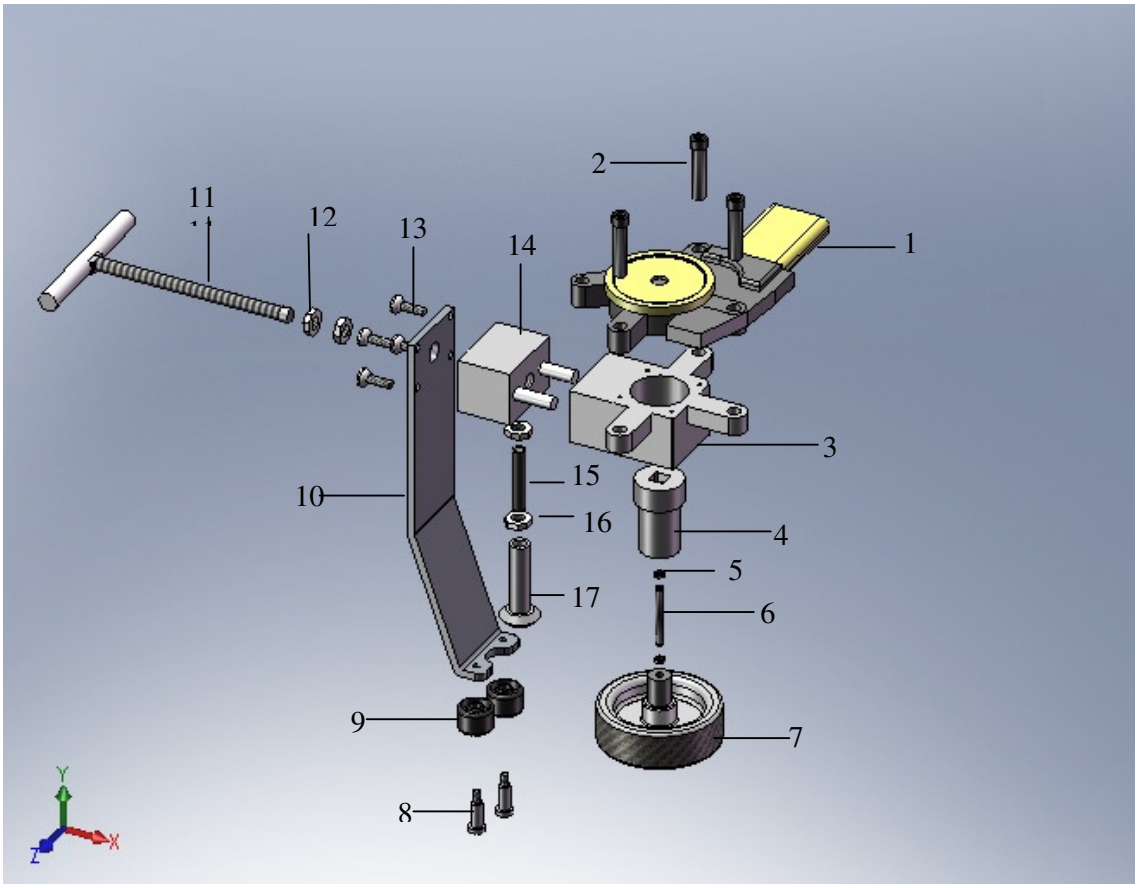


Figure 4.2: Assembling view from SolidWork

Figure 4.2 illustrates a new design and development of automatic drum deheader prototype that is used to remove a metal cover from a large metal drum. This prototype has a carrier **3** to which other components of the opener are mounted. The carrier generally has a coupling **4** hole which is mounted with the power window **1** as an electric powered drum opener. The power window **1** with power source 12V will attached at the upper of carrier **3** with three screws **2.** The drive roller **7** are mounted with the coupling **4** using a stud **6** with 6 mm diameter and two bolts **5** is use to lock between the coupling **4** and drive roller **7**.

A cutter wheel **17** assembly is slidably mounted to the carrier **3**. It has a front housing **14** with a generally vertical hole at the lower part. The cutter wheel **17** is attached with the stud **15** with 8 mm diameter and two bolts **16.**

A guide roller bracket **10** is attached to the front housing **14** by screws **13**. The guide rollers **9** are attached to the bottom of the bracket with two custom screws **8**. The guide rollers **9** are disposed to engage the metal drum side wall and stabilize the opener as it travels around the drum.

Handle bar **11** with shaft threaded can be turned to push the front housing **14** against the carrier **3** to engage the cutting wheel **17** to cut the outside layer of the chime. Two nuts **12** is use to tighten the handle bar **11** tight enough so that the cutter wheel cuts the outside chime in one revolution around the drum.

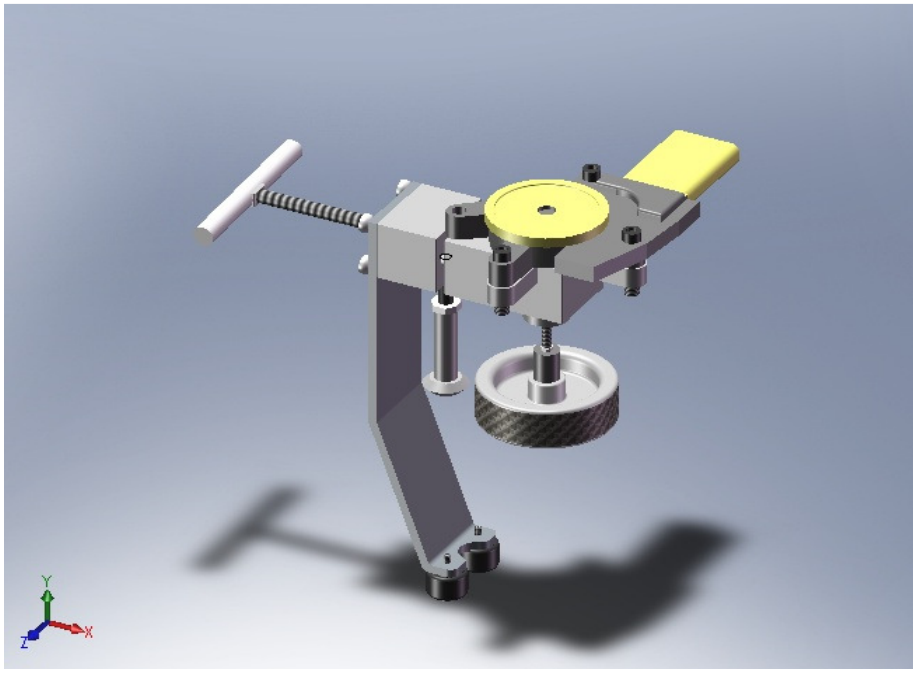


Figure 4.3: Finished products using SolidWorks

The system assembly is already been completed and the new invention of automatic drum deheader prototype is being shown in Figure below;

Figure 4.4: Actual prototype of Automatic drum deheader

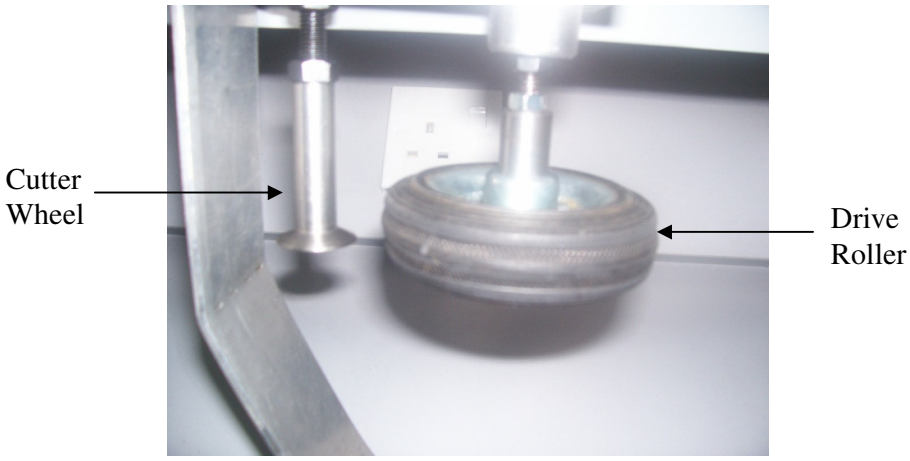


Figure 4.5: Position of cutter wheel and drive roller

4.3.2 Bearing Application

The bearing application is to permit constrained relative motion between two parts, typically rotation movement in this application. This concept operation is to accommodate with various drum chime configurations so that the user can easily adjust the distance between cutter wheels and drive roller. The application on this prototype is shown in Figure 4.5.

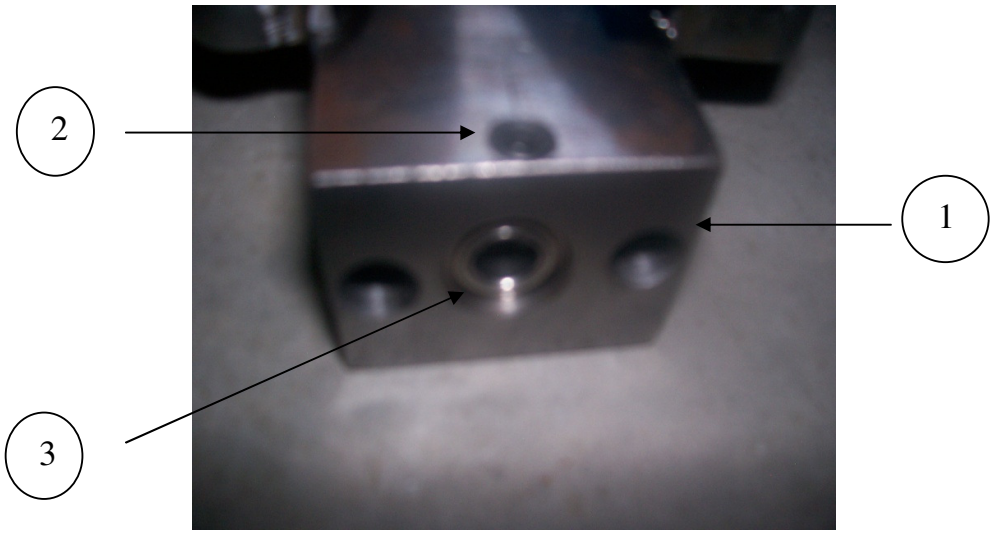


Figure 4.6: Bearing position

Point 1 is the carrier which is has a small hole on the right side view of carrier to locate a bearing in point 3 with 9 mm inner and 17 mm outer diameter. To make sure the bearing is not skidding on its position, a small hole on the upper side of carrier is locate with screw as shown in point 2 to lock the bearing to its position. Then the bearing will attached with the handle bar as shown in Figure 4.5.

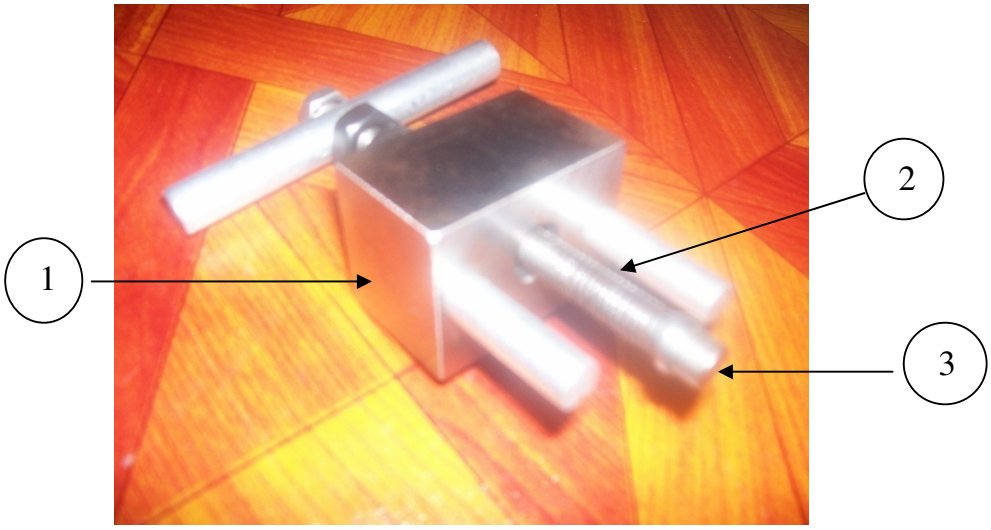


Figure 4.7: Front housing with handle bar

Point 1 is the front housing that is assembles with the handle bar on point 2. The bearing will attach to the end point of handle bar at point 3. Point 3 basically already being fabricated using turning and welding process to appropriately tight with the inner diameter of bearing. The complete of bearing application on this device is shown below.

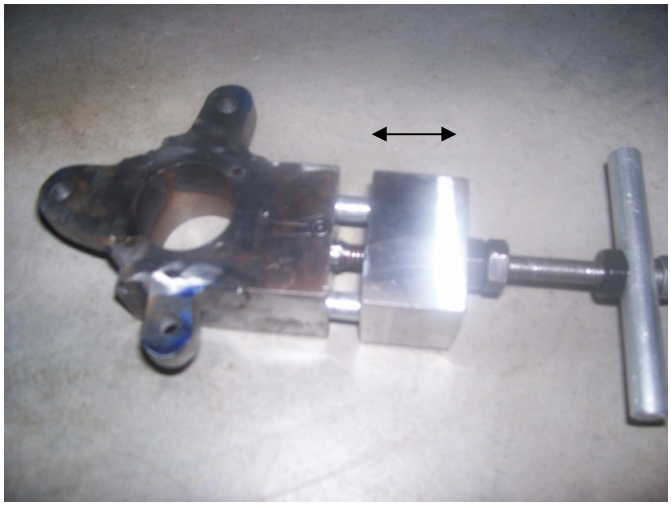


Figure 4.8: Complete bearing application

4.3.3 Mechanism design Analysis

There are many types of mechanism design in mechanical engineering application especially in fabricating product. In this project, the combination of all device and assembly of the main body of automatic drum deheader is very important to make a good arrangement and suitable for the user. In this project, the main body of automatic drum deheader is very important for kinematics analysis which is it can be used to find the possible range of motion for a given mechanism. Kinematics is the study of motion of bodies or objects and systems, while ignoring the forces that cause the motion.

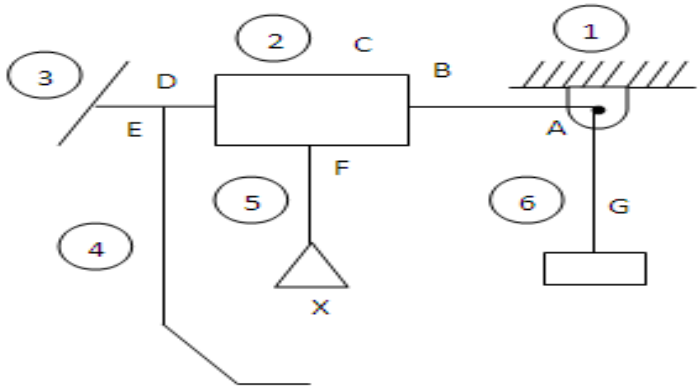


Figure 4.9: Kinematic Diagram of automatic drum deheader

Frame or Link 1: Carrier

Link 2: Front Housing

Link 3: Handle Bar

Link 4: Guide Roller Bracket

Link 5: Cutter Wheel

Link 6: Drive Roller

From the kinematic diagram in Figure 4.8, the mobility or degree of freedom (DOF) can be calculated in order to know whether the mechanism of automatic drum deheader is constrained or un-constrained mechanism by using Gruebler's equations:

$$F = 3(n-1) - 2j_p - 2j_h$$

n = total number of links
$2j_p$ = total number of primary joints
$2j_h$ = total number of higher order joints

n = 6, j_p = 6 pins + 1 slider, j_h = 0

Thus,

F = 3(6-1) – 2(7) – 2(0)
= 1 (constrained)

With one degree of freedom, the mechanism of automatic drum deheader is constrained. It moves only one link which is the front housing when the handle bar is rotated.

4.4 PERFORMANCE ANALYSIS

It is important to test run the system to analyze their performance and define the problems occur during the test run experiment. In order to test the system, some device needed to setup before the experimental test can be running.

4.4.1 Power window Application

The motor used to run the drum deheader prototype is automotive power window motor. This application is to rotate the drive roller around the inner of drum chime. A key specification of this Automotive Power Window motor is;

- Working voltage: 12V
- No-load current: less than 5A
- No-load speed: 80 to 95rpm
- Current (3Nm): less than 8.2
- Speed (3Nm): greater than 50rpm
- Maximum torque: greater than 11Nm
- Block current: less than 30A

Figure 4.10: Power supply

Figure above shown the power supply is the important device to run the power window motor. This device is capable to control the speed of power window motor by control the voltage as a variable. The maximum voltage of power window motor is 12 V which is the highest speed and the minimum voltage is 7 V. From this device it capable to read the minimum amps needed to run the power window motor which is 0.9 A.

Figure 4.11: Power window motor testing

The results from the experimental to power window motor show that the drive roller is capable to rotate with different speed by changes the voltage from the power supply.

4.4.2 Test run prototype

The next step is to test run the automatic drum deheader prototype on the drum. This is because to observe whether the drive roller is capable or not to rotate around the inner chime and also to cut the outer drum chime.

Figure 4.12: Setting up before test run

The results observe from the experimental test shown that the prototype is only capable to travels about quarter of the drum circle. After quarter rotation of the drum circle, the cutter wheel is tendency to slip from its position and make it the rotation is not smooth and unbalance condition. There are several possibilities this causes will happened as shown below.

- There is no cutting direction on the drum chime when it travels around the drum.
- The diameter of cutter wheel is too small and tendency to slip.
- The drive roller material is not suitable to travel around the drum because it does not have knurled edge which is preferably drive roller in order to prevent from slipping.

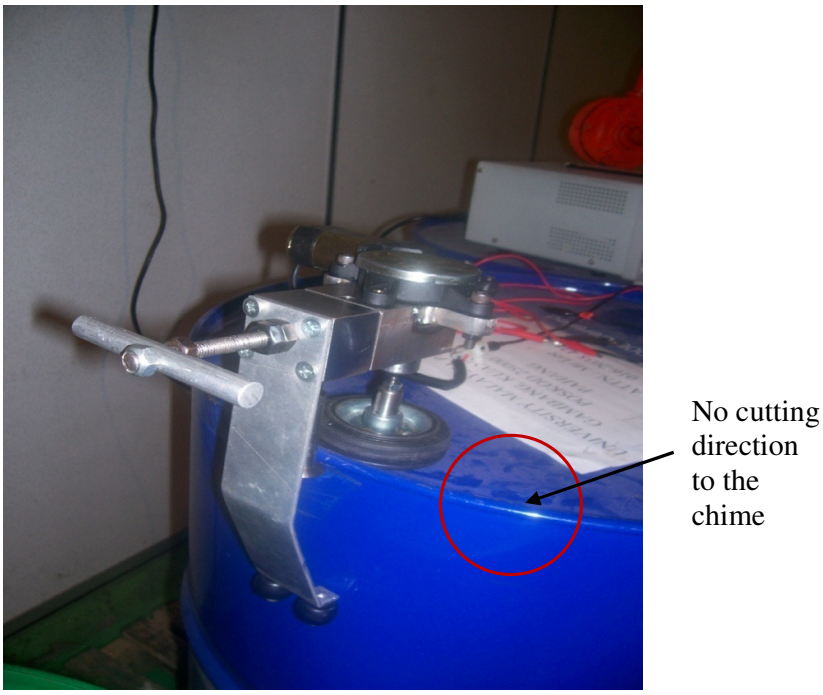


Figure 4.13: Cutting direction position

Another observation from the experimental test is the cutter wheel also unable to cut the outer chime when it travels about quarter of the drum circle. However, the possibility to cut the outer chime is possible because it leave a cutting mark to the chime but it required more than 10 times repeated from experimental test to show the cutting mark at the chime.

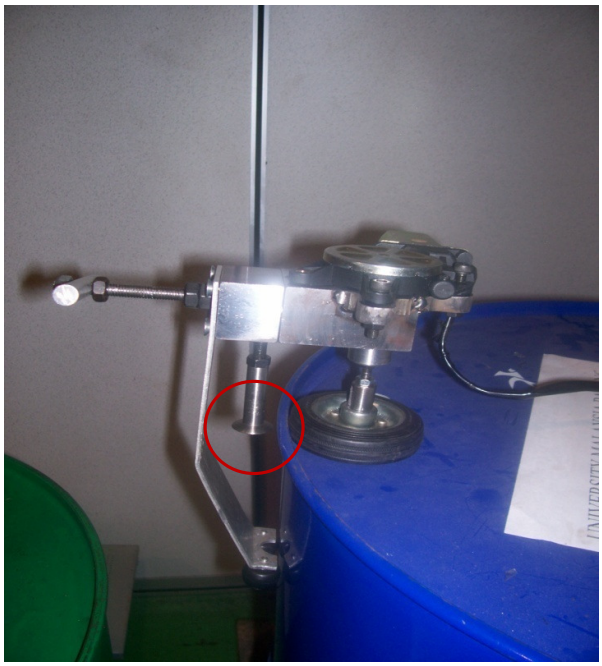


Figure 4.14: Position of cutter wheel to cut the outside chime

4.4.3 Data Analysis

From the experimental test, the prototype is only capable to travel around the quarter of drum circle. To measure the time taken of prototype to complete one rotation it travel along the drum circle, the time it travel for quarter of the drum is being taken as a data. From the data being taken, the time of prototype to complete one rotation travel along the drum is being able to estimate by multiply it to 4 as a complete rotation. The data and calculation to estimate the time taken it travel along the drum is being shown below.

Time for complete one rotation:

$t_{complete} = 4 \times t_{quarter}$

Table 4.3: Time taken to complete one rotation around the drum

Voltage (V)	Time taken for quarter of rotation drum, t (s)	Time taken for complete one rotation around the drum, t(s)
12.0	13	52
11.5	15	60
11.0	16	64
10.5	19	76
10.0	21	84
9.5	24	96
9.0	26	104

From the data above, the rotational speed and velocity of the prototype when it travel along the drum is been calculated. The sample calculation for 12 V power window motor is been shown below.

$$\omega = \frac{\Delta\theta}{\Delta t} = \frac{360^{\circ}}{52s} = 6.923 \text{ deg/s} \left[\frac{1rev}{360deg}\right]\left[\frac{60s}{1min}\right]$$

$= 1.154$ rpm $= 0.1208$ rad/s

Figure 4.15: Diameter of drum used

Thus, the velocity is

$$V = r\omega = \left(\frac{0.580m}{2}\right)(0.1028rad/s) = 0.03 \text{ m/s}$$

The overall result for the velocity and rotational speed of the prototype when it travels along the drum circle is being shown in Table 4.4.

Table 4.4: Velocity and rotational speed of the prototype to travel along the drum

Voltage (V)	Time taken for complete one rotation around the drum, t(s)	Rotational speed (rpm)	Velocity (m/s)
12.0	52	1.154	0.0350
11.5	60	1	0.0304
11.0	64	0.9375	0.0285
10.5	76	0.7895	0.0240
10.0	84	0.7143	0.0217
9.5	96	0.625	0.0190
9.0	104	0.5769	0.0175

Based on the results above, the graph of rotational speed and velocity versus time had been developed. It shows that the velocity and rotational speed of the prototype when it travels along the drum circle will decrease when the time needed to complete one rotation on the drum is increased. The conclusions is the maximum voltage of power window motor which is 12V is the best performance in order to complete one rotation in less than one minute. Compare to the product available in market, the new prototype of automatic drum deheader is capable to give healthy competition to the other product in market. However, there is still some improvement for further research to compete in market area. The graph is shown in Figure 4.15 and 4.16 below.

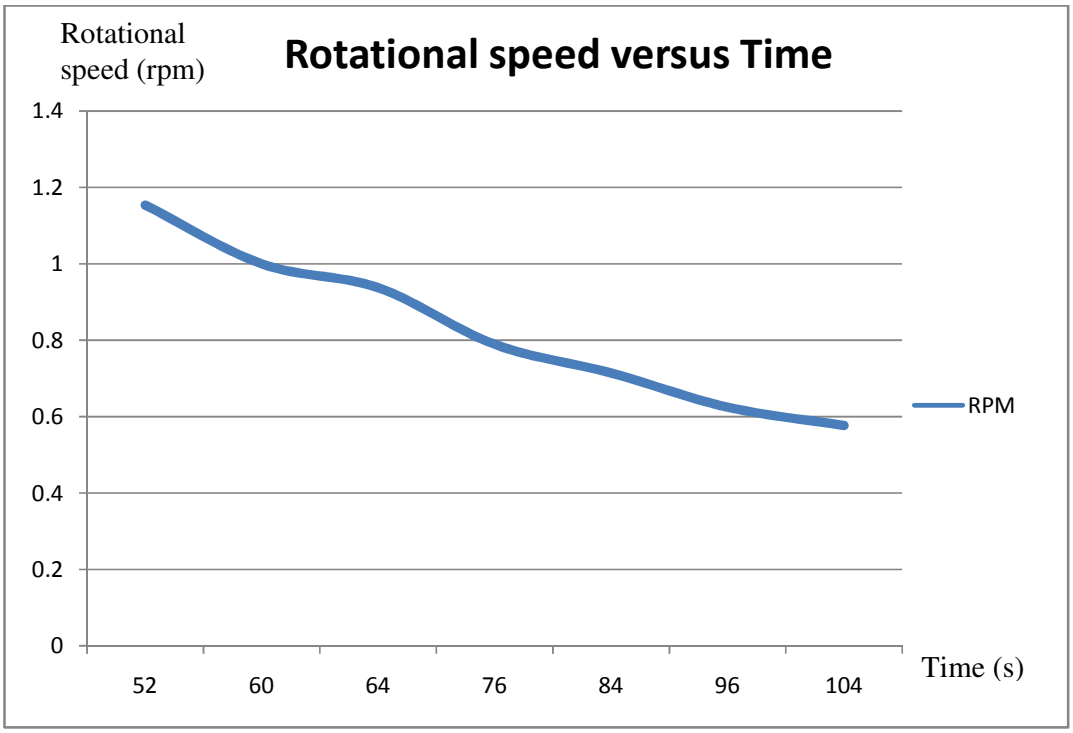


Figure 4.16: Graph of rotational speed versus time

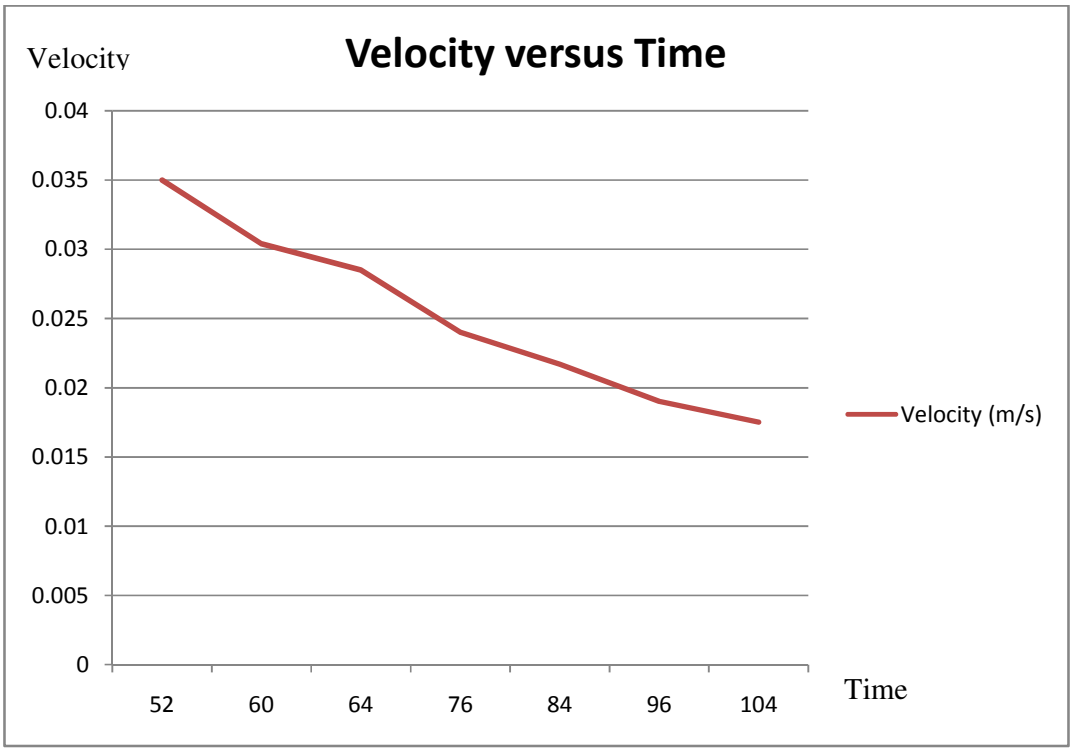


Figure 4.17: Graph of velocity versus time

4.5 COST ANALYSIS

The overall cost for this project is Ringgit Malaysia 750 as shown in Table 4.4. This new design of automatic drum deheader is cheaper than the automatic drum deheader in market area. This is because the new design of automatic drum deheader is simple and the system is not complicated than the other design in market. The power window is an electric motor used in this project also cheaper and east to get.

Table 4.5: Total cost for development of Automatic drum deheader

No	Part	Price (RM)
01	Mild Steel (150 x 80 x 50 mm)	150
02	Aluminum Sheet metal (150 x 50 x 3 mm)	200
03	Titanium-6AL-4V (50 x 25 mm)	300
04	Mechanical Component (Bolt, nut, screw and etc)	20
05	Power Window (dc motor)	50
06	Bearing	20
07	Roller	10
	TOTAL	750

4.6 CONCLUSIONS

Overall in this chapter discuss the results and the problem of the new design of automatic drum deheader for industrial application. From the design using SolidWorks and the development to the actual product did not give same results. This is because of the error when the fabrication process to develop the product. The performance results also give possibility to compete with other product in market. Thus, the results and problem discuss in this chapter is very important for the future research to make an improvement.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSIONS

As the conclusions from this project, a new idea of design and development of automatic drum deheader is very important for the industrial application. The contribution of new development of automatic drum deheader is to make easier for the user to open the cover of drum. The most important thing is the method use in this development is to cut the outside chime where the drum cover can be reused and prevent the drum content from contamination. It also gives the opportunity to recycle in human life and also to prevent the old materials such as drum from becoming hazardous waste. Everyone knows that reducing waste is good for the environment because it conserves natural resources.

For this project, the main part to design and fabricate the prototype of automatic drum deheader is well achieved. The new prototype design of automatic drum deheader is capable to adjust the height and thickness of chime because the chime is not standard in industry. The cutting method in this prototype is to cut the outside chimes and the drive roller is on the inside chime to drive the prototype travel along the drum circle. The drive roller on that prototype is driven by the power window motor that is capable to travel along the drum less than in one minute by using 12 V.

However there are still some problems cannot be avoided from this project. The cutter wheel use in this project is use to cut the outside chime is not function properly when the prototype is being testing on the drum. The prototype design also

tendency to slip from the drum and the rotation when it travel along the drum also not smooth.

Finally, the prototype of new automatic drum deheader is fabricated successfully for the user to remove the metal cover of drums. However, there is still some improvement in order to make the system is capable to cut the outside chime. The idea and concept are well achieved but the most important thing is to make this first invention of new automatic drum deheader as important references for the future improvements.

5.2 RECOMMENDATIONS

Recommendations are needed to make an improvement and more effective for further research in this project. The recommendations are as stated below:-

1. For further fabrication process in this project, the dimensions use for carrier and front housing must be suitable with the diameter of cutter wheel and drive roller. It is because to prevent contact between the links after it assemble.
2. Chime roller to be added in the fabrication process. The use of chime roller is to guide the direction of chime when it travels along the drum so that they will travel smoothly without having tendency to slip.
3. The diameter of cutter wheel and drive roller must be same or not much gap. This is because to prevent the cutter wheel from slip on the drum.
4. For further invention, the drive roller is preferred to be fabricating to design the knurled edge in order to prevent slipping.
5. The machining of cutter wheels must be setting correctly and need some research about the best penetration angle for cutting tools.
6. Create and design shape of product to make this equipment more interesting and can be commercialized.

The recommendation for this project is proposed to make the automatic drum deheader is more successful and productive.

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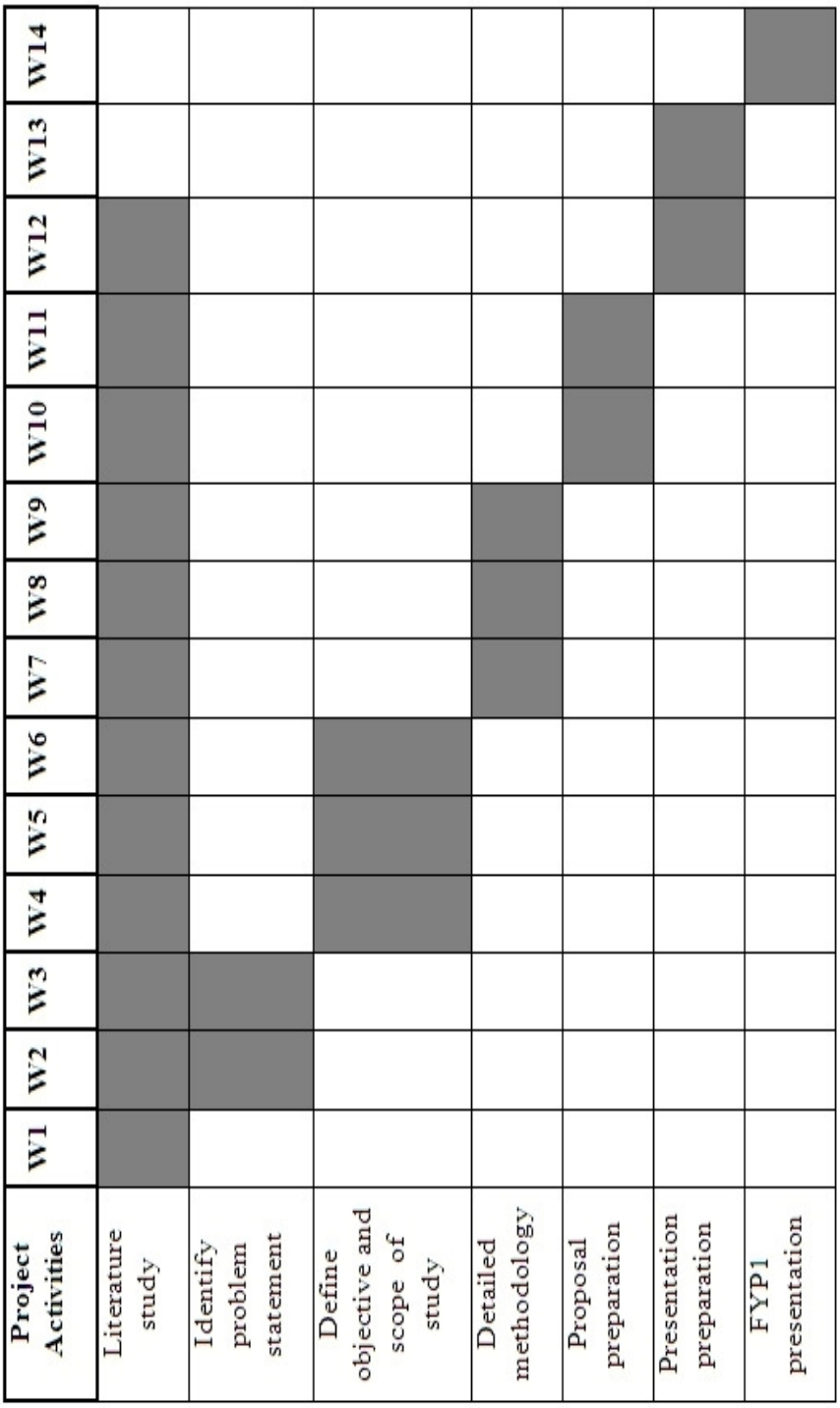
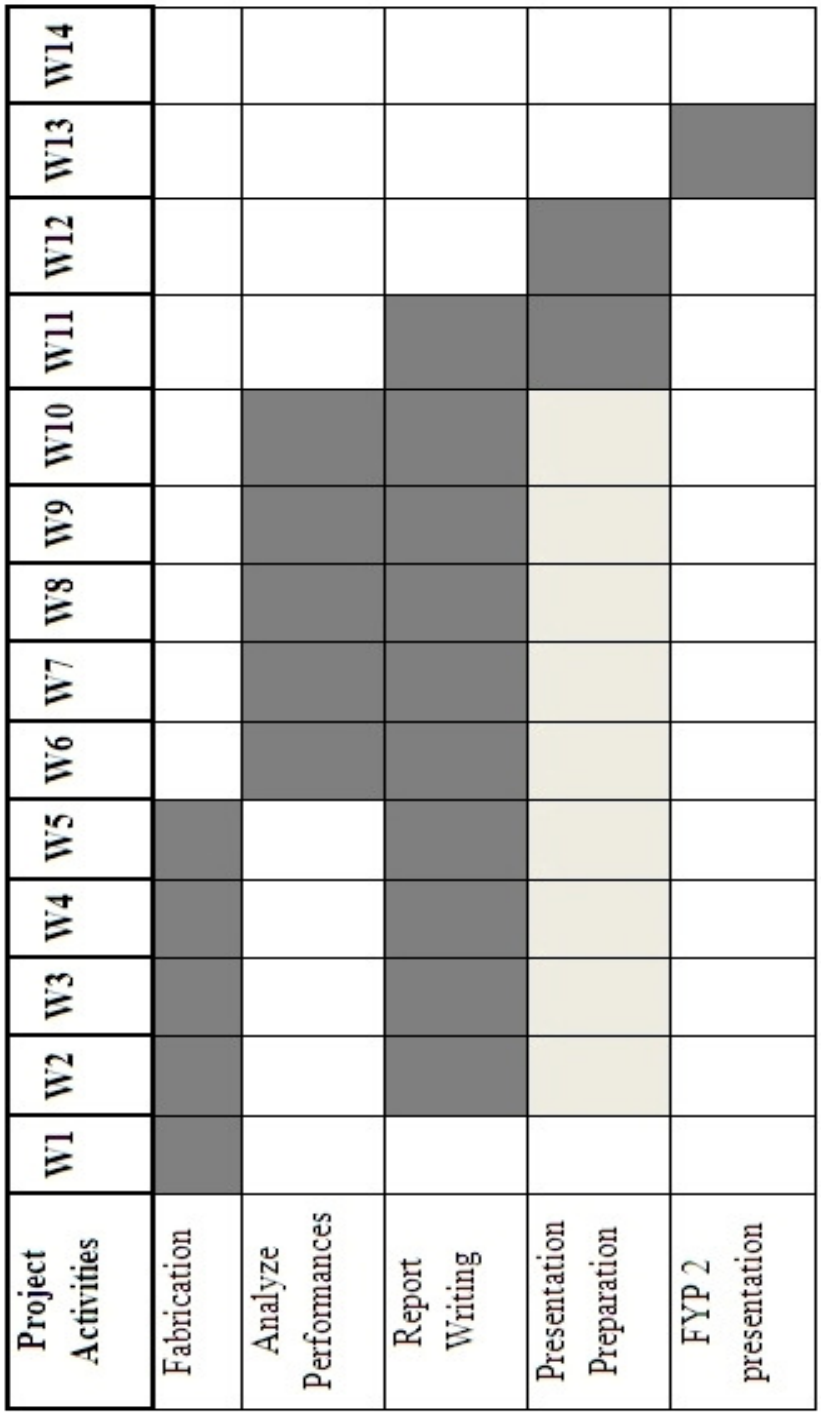
APPENDIX A

(Gantt chart Final Year Project 1)



(Gantt chart Final Year Project 2)

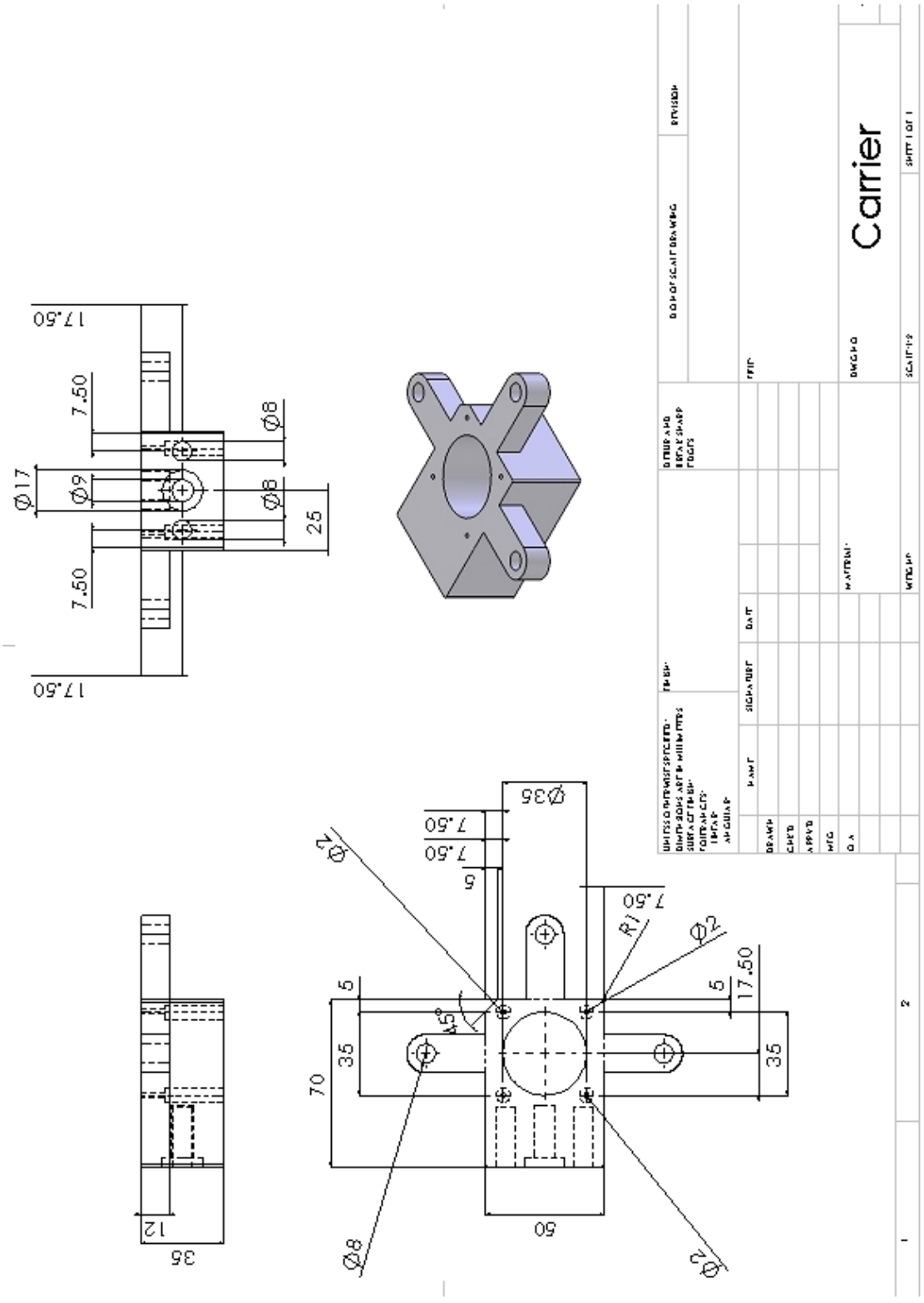


APPENDIX B

(Actual Product)

APPENDIX C

(SolidWorks drawing)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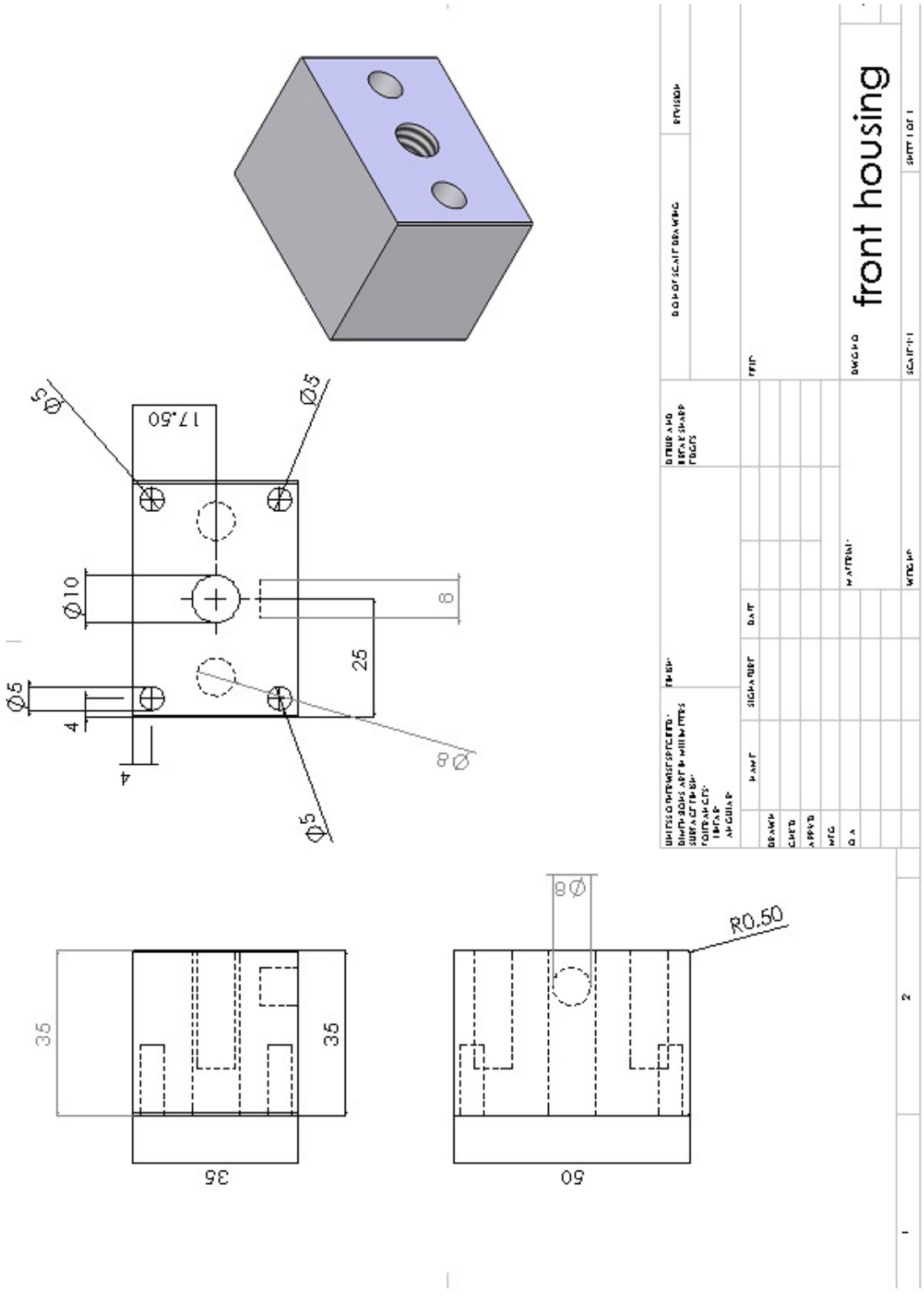
7.50
Ø8
Ø17
Ø9
25
Ø35
7.50
5
R17.50
Ø2
45°
70
35
17.50
50
Ø8
12
35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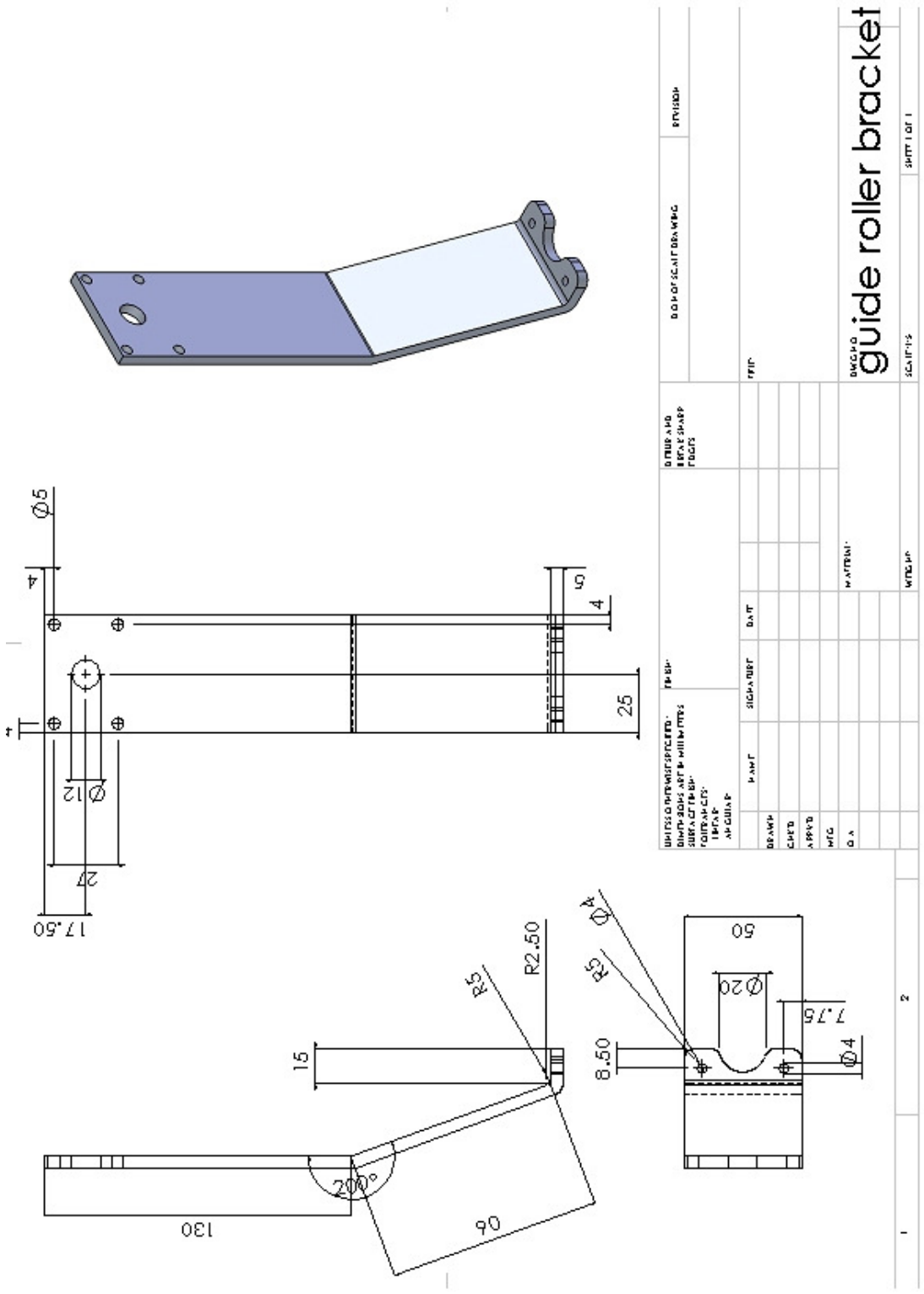
Ø10
Ø5
25
8
4
35
50
R0.50


guide roller bracket
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WEIGHT
SHEET 1 OF 1
MATERIAL
DRAWN
CHECKED
APPROVED
MFG
Q.A
DO NOT SCALE DRAWING
REVISION
UNLESS OTHERWISE SPECIFIED:
DIMENSIONS ARE IN MILLIMETRES
SURFACE FINISH:
TOLERANCES:
LINEAR
ANGULAR
FINISH
DEBURR AND BREAK SHARP EDGES
NEXT ASSY
USED ON
APPLICATION
SIGNATURE
DATE
130
90
200°
15
R5
R2.50
Ø4
R2
8.50
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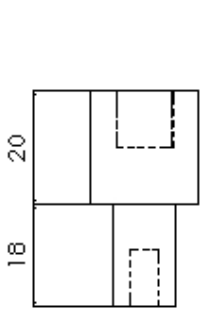
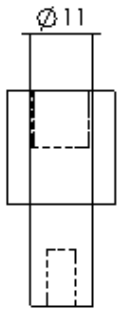
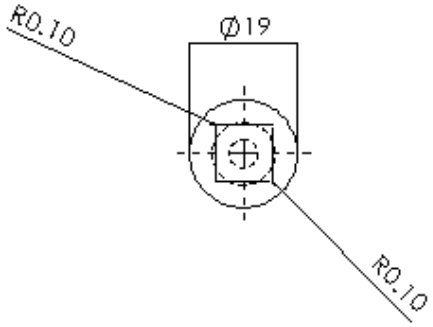
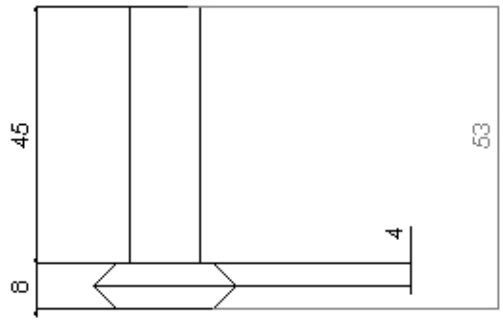
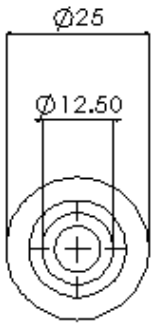






UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:				FINISH:			DEBURR AND BREAK SHARP EDGES	DO NOT SCALE DRAWING	REVISION
	NAME	SIGNATURE	DATE						
DRAWN								DWG NO.	
CHKD								coupling	
APPVD									
MFG									
Q.A				MATERIAL:					
				WEIGHT:				SCALE: 1:1	SHEET 1 OF 1





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	NAME	SIGNATURE	DATE				TITLE:	
DRAWN								
CHK'D								
APPV'D								
MFG								
Q.A				MATERIAL:			DWG NO. Cutter Wheel	
				WEIGHT:			SCALE: 1:1	SHEET 1 OF 1