DESIGN AND FABRICATE AN AUTOMATIC FISH FEEDER

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BORANG PENGESAHAN STATUS TESIS ◆

JUDUL: **DESIGN AND FABRICATE AN AUTOMATIC FISH FEEDER**

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DESIGN AND FABRICATE AN AUTOMATIC FISH FEEDER

CHAN SEE LING

A report submitted in partial fulfillment of the requirements

for the award of the degree of

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Faculty of Mechanical Engineering

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NOVEMBER 2009

SUPERVISOR’S DECLARATION

I hereby declare that I have checked this project report and in my opinion this project is satisfactory in terms of scope and quality for the award of the degree of Diploma in Mechanical Engineering.

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Date: 20 NOVEMBER 2009

STUDENT'S DECLARATION

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

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DEDICATION

To my beloved parents, Mr. Chan Yoke Leong and Mdm. Lee Fong Yin , other siblings, family and friends, without whom and his/her lifetime efforts, in encouraging and supporting my pursuit of higher education in mechanical engineering.

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ABSTRACT

The objectives of this thesis are to design and fabricate a low cost and longer life span automatic fish feeder. This automatic fish feeder is designed to dispense food into the aquarium at a particular time each day. In this project, concepts are generated through the research on the existing patents to improve its limitations. Water power is used as the main mechanism to design this fish feeder. To accomplish the factors of lost cost and longer life span, water wheel is used to transmit the input power from water. In this concept, a water wheel connected with the food container by a shaft. The water from aquarium filter is drip into a rotatable water container with a constant rate. A valve is used to control the flow of water that drip into the rotatable water container. The container empties the water by drop on the water wheel when it is pivoted by the weight of the water. The water wheel is rotating once the water flow through it. A rotational movement of water wheel cause the food container rotates and dispenses the food from a small hole.

ABSTRAK

Objektif tesis ini adalah untuk merekabentuk satu pengumpan ikan automatik yang dapat mengurangkan kos penggunaan dan digunakan dalam jangka masa yang lama. Pengumpan ikan automatik ini direka untuk membahagikan makanan ke dalam akuarium pada waktu tertentu setiap hari. Dalam projek ini, konsep-konsep yang dihasilkan adalah melalui kajian tentang konsep yang telah ada untuk memperbaiki kelemahan produk tersebut. Tenaga air digunakan sebagai mekanisme utama untuk mereka pengumpan ikan ini. Untuk mengurangkan kos penggunaan dan memanjangkan jangka hayat produk, roda air digunakan untuk menghantar kuasa input dari air. Dalam konsep ini, roda air disambungkan dengan bekas makanan oleh aci. Air yang ditapis akan menitis ke dalam bekas air yang fleksibel secara konsisten. Injap digunakan untuk mengawal aliran air yang dititis ke dalam bekas air tersebut. Air dalam bekas air tersebut akan dialirkan pada roda air apabila berat air dalam bekas tersebut mencapai tahap tertentu. Maka, roda tersebut akan berputar apabila air mengalir melaluinya. Putaran roda menyebabkan bekas makanan berputar dan makanan dijatuhkan dari satu lubang kecil.

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LIST OF SYMBOLS

a	Acceleration = $9.81 m s^{-2}$
A	Area
d	Distance
ρ	Density
Q	Flow rate
F	Force
g	Gravity = $9.81 m s^{-2}$
h	Height
J	Polar moment of inertia
$\dot{m}$	Mass flow rate
M_o	Moment of the force
n	Number of trials
X	Number of successes in n trials

p	Numerical probability of success
q	Numerical probability of failure
Π	Pi = 3.142
P	Pressure
P(X)	Probability
r	Radius
c	Radius of shaft
τ	Shear stress
σ	Stress
t	Time
T	Torque
V	Volume

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter explained about the background of the project, problem statement, project objectives and project scopes. Beside that, this chapter also consists of report arrangement.

1.2 BACKGROUND OF THE PROJECT

An automatic fish feeder is a solid investment for any aquarium. It is an electrical or electronic gadget that is designed to dispense the accurate amount of food into the aquarium at a particular time each day. Some fish feeders can be set to feed the fish more than once a day. Automatic fish feeders are either run on electricity through a power cord or battery operated. The advantage of electrical power feeders is there is no worry about the battery dying while battery operated feeders is without worry of electric shock or power outages. Fish feeders are usually clamped to the wall of the tank just over the water. They consist of a hopper which is loaded with a variety of dry food, a timer which rotates the hopper at regular intervals, or a method of setting the interval between feeding and the amount of food dispensed. This allows the fish to be fed on a regular basis without overfeeding. The mounting technique will vary depending on which model of fish feeder you purchase. Some have mounting brackets that will hook onto the edge of the aquarium while others have suction cups the will attach to the inner walls of the aquarium.

1.3 PROBLEM STATEMENT

Aquarist of the home based aquarium leads a busy life especially those who are away on vacation. They are often difficult to maintain a regular feeding schedule. However, the fish require regular care in order to remain healthy. If fish are not constantly fed small amounts at regular intervals, there can be significant loss of fish due to starvation. But, too much food in the water can easily clog up important filters, and cause you to have to spend more time cleaning your aquarium tank. Thus, they are recruiting a reliable helper to ensure that the fish are properly fed.

There are many different designs and brands on automatic fish feeders on the market, but some limitations on the existing fish feeders need to be improved. Though some feeders are designed specifically to keep food dry, many designs allow moisture to seep into the food hopper. This can cause clumping, and can result the failure of the mechanism. Feeding fry has been difficult. Pendulum and vibratory feeders are not very suitable, due to small particle size of fry feeds. Alternatively, clockwork feeders offer an apparent solution. However, in the presence of humidity, the feed sticks to the large surface area of the belt, and fungus grows. Consequently, a lot of labor is required to keep it running. In addition, the clockwork mechanism has to be wound up daily. Therefore, some improvement or new invention is developing to solve these problems.

1.4 OBJECTIVES

The objectives of this project are included:

i. To design an automatic fish feeder.

ii. To fabricate a low cost automatic fish feeder.

iii. To fabricate a longer life span automatic fish feeder.

1.5 SCOPES

This project development is limited within the following scopes:

i. **A**nalysis the efficiency of the mechanism used on the automatic fish feeder.

ii. Fabricated the automatic fish feeder by using industrial machine and engineering tool which are drilling machine, vertical bend saw, protractor and vernier caliper respectively.

iii. Designed the automatic fish feeder by using engineering software which is Solidworks.

iv. Focus on habits of tropical fish.

1.6 PROJECT ORGANIZATION

Chapter 1 is the introduction of this project. Basically, it discuss about the project background, problem statement, the objectives and scopes.

Chapter 2 is a literature study on automatic fish feeder used to acquire better understanding of each special component. Beside that, it consists with the study of existing product and US patents. Design of the studies is listed for future use in this project.

Chapter 3 is the methodology chapter where the objective of the project is determined. The require concept design is chosen based on objective. Each criteria of concept design is defined by the literature study. The require materials and component are determine based on the chosen concept. Meanwhile, the dimension of component is defined by using measurement instrument for determining the dimension for fabricated part to allow component to assemble together. Fabrication of the feeder is using industrial engines.

Chapter 4 is a chapter of result and discussion on this feeder. This new concept is use to analysis the efficiency of food dispenses. Beside that, the result of testing is used to develop a suitable dimension of the fish feeder. In this chapter, the problem encountered is discussed. The solution manual to use the feeder is developed via the trial run on the feeder.

Chapter 5 is the conclusion and recommendation chapter of this project. This new concept and design of automatic fish feeder is built based on the limitations of the existing products. In this chapter, it included the conclusion of this project and the improvement can be doing for the future invention.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter is provided detail description of literature review done regarding the project title of design and fabrication for automatic fish feeder. The literature review started with the types of mechanism for the conceptualization use. The types of mechanism consists water power, clock system and timer. Each component required on each mechanisms is provided to understanding the characteristics for develop a new design of automatic fish feeder. Beside that, it is explain the characteristic of chosen materials and habits of fish. Furthermore, the study of patents on automatic fish feeder is acquired to define the advantages and disadvantages.

2.2 TYPES OF MECHANISM

2.2.1 Water Power

The nature of water energy is related to kinetic and gravitational potential energy. All around the planet Earth, water is on the move. Water flows downhill under the force of gravity in rivers and creeks. The amount of available energy in moving water is depends on its flow or fall.

Many centuries ago, farmers take advantage of the currents in rivers and streams for a variety of agricultural purposes, including pumping water for irrigation and grinding grain. Water energy is generated in the form of water clocks and waterwheel. To start the mill, the miller opened a gate to allow water flow over the top of the wheel. Normally, the wheel's diameter is 10 to 16 feet. One type was called the overshot wheel. Water ran down a slanted wooden chute that ended at the top of the wheel. Then the water spilled into paddles which attached to the wheel. Power generate when the water's weight and impact forced the wheel to turn. The water wheel is connected to a massive millstone or metal saw blade via a system of gears. Water for the wheel usually came from a small dam and reservoir, called the millpond. The energy extract from moving fluids when the speed of water which passes through water wheel slowing down. Figure 2.1 show a water wheel is connected to a system of gear to transmit water power.

Figure 2.1: A water wheel is connected to a system of gear

Source: Alice Longstaff Gallery Collection

2.2.2 Water Clock

The water clock does not affected by sunlight, so it could be used to track time on cloudy days or throughout the night. Water clock was like pots made of stones, with long slanting sides that allowed water to drip down at a constant rate through a small hole in the bottom. Other versions were bowl or cylindrical shaped containers designed to slowly fill with water coming in at a constant rate. The inside surface is marked on with twelve separate columns with consistently spaced to measure the passage of hours as the water level reach them. Some of the water clocks were different. They measured time depends on the amount of water. The wheel turned and indicated the hour of a day as the water level changed. A water clock that depends completely the flow of water has limited accuracy because the rate of flow of water is difficult to accurately control. With no hard to dispose of batteries and no electricity use, water clocks are eco-friendly time machines.

A Greek physicist and inventor, Ctesibius of Alexandria improved the ancient Egyptian clepsydra. The water is dripping into a container raised a float that carried a pointer to mark the hours. Beside that, a rack that turned a tooth wheel is attached to the float. Meanwhile, there have been water clocks that used a siphon to automatically recycle it. Figure 2.2 and 2.3 show two types of water clock.

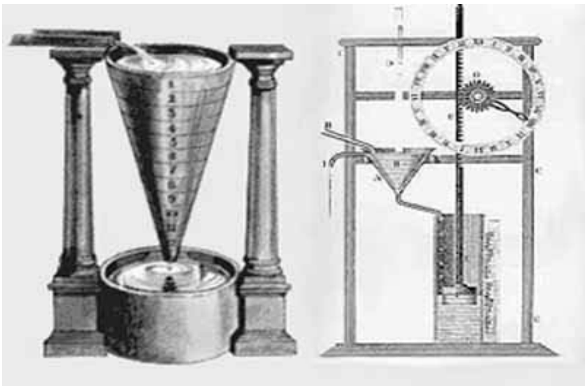


Figure 2.2: Greek water clock

Source: GreenJoyment.com

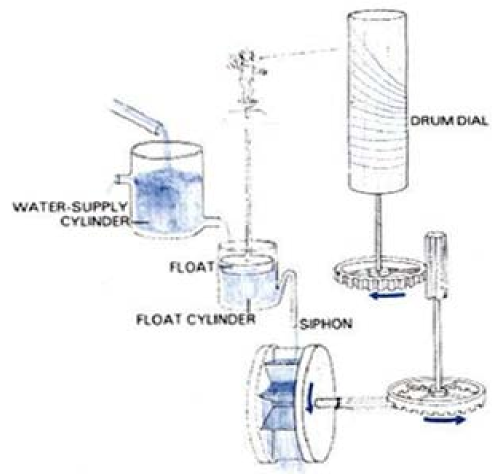


Figure 2.3: An illustration of clepsydra or water clock

Source: ThinkQuest Team (1999)

2.3 WATER WHEEL

A water wheel is produce by a large wooden wheel with blades or paddles that turn on an axle. The purpose of water wheel is slows down the speed of moving water and transmits the energy released from the water to turn a shaft which can be hooked to machinery such as a saw for cutting timbers into boards. Gears, pulley and belts are used in transmission of energy. There have many shapes, sizes and forms of water wheel.

Generally, they can be classified into three main types such as undershot, breastshot and overshot. In undershot water wheel, it had flat blades that allow the water flows along the base of the wheel, retaining the same level all the same time. The flow of the water against the flat blades at the base of the wheel made the wheel turn. In breastshot water wheel, the water flows into the bucket at about the middle of the wheel. In overshot water wheel, it had bowls shaped blades that can catch up the water that is flows to the wheel through a channel or trough. Therefore, the water enters the buckets at the top on the down-running side. However, some water wheel had a penstock that could be moved back and forth. In one position it would allow the water flow under the wheel and at other times it could be set up to flow over the top of the wheel. Figure 2.4, 2.5 and 2.6 show three types of water wheel.

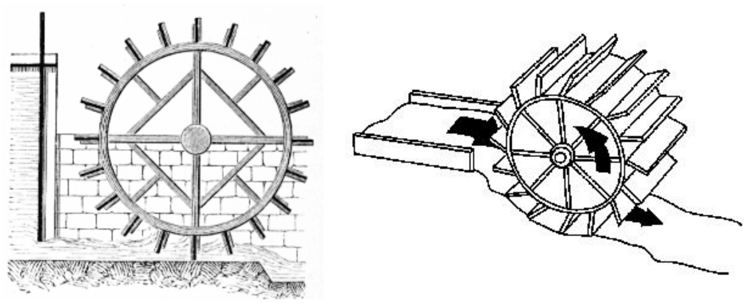


Figure 2.4: Undershot water wheel

Source: hp-gramatke.net & cnx.org

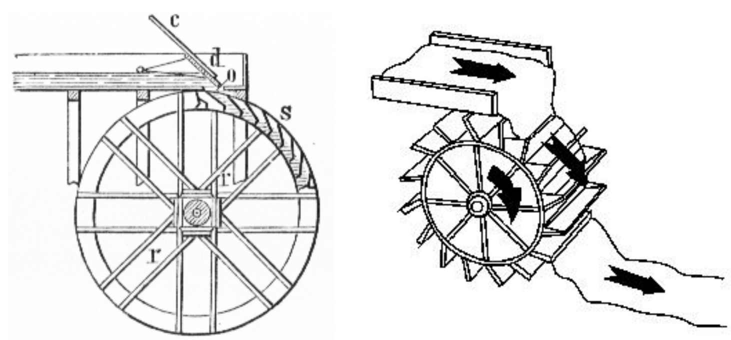


Figure 2.5: Overshot water wheel

Source: hp-gramatke.net & cnx.org

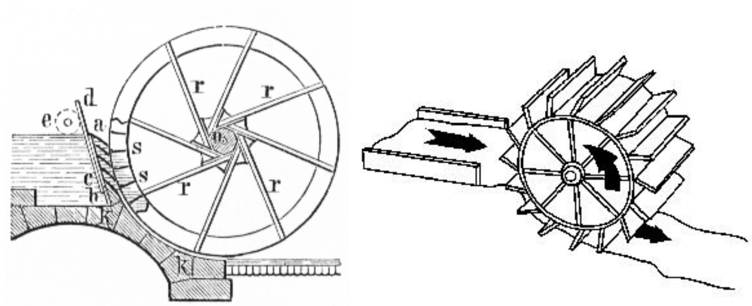


Figure 2.6: Breastshot water wheel

Source: hp-gramatke.net & cnx.org

In these three types of water wheel, overshot wheels is performed efficiently than undershot and breastshot. This is because the wheel is driven by the weight of water and the pressure or force of water directed into the buckets by the pentrough. The speed of the wheel is defined by the amount of the water flowing through the wheel. To spin the water wheel, one side of the water wheel should hold some water and become heavy. This is because more water makes more weight and more torque or rotational force on the wheel. A penstock is located in the pentrough to manipulate the flows. The flow of water increased when the penstock raise higher. Pulleys and gears are used to increase the rotational speed which is number of turns per minute.

2.4 FISH

2.4.1 Fish Habits

Providing fish with a varied diet is always recommended to ensure the fish obtain all necessary nutrients. Different species of tropical fish required different types of food. A good quality of pellet or flake food is a good base for many tropical fish species in order to obtain well balanced diet. Universal fish foods that claim to be suitable for all types of aquarium fish is therefore always a middle rood that will keep most species alive, but seldom allow them to thrive. As the fish grow older, the aquarist should change the diet of their fish. They have their own significant requirements between fry, immature fish, breeding adults and old specimen. The younger fish need to be feed more frequently than the older ones.

Overfeeding always encountered among the aquarist. Aquarist should not feed their fish more food than they will consume within 3-5 minutes. Over food leave in the aquarium can pollute the water and begin to decompose. Beside that, obesity can be results if the fish is over eating. A fish that over eating will produce more waste products and these waste products can also pollute the water. Study on fish habits and recognize the characteristics between the different species help a lot when feed fish. The culture conditions, type of food and the individual fish can affect the amount of fish that need to be feed.

2.4.2 Types of Tropical Fish

In this world, there are hundreds of types of freshwater aquarium fish. Therefore, the conceptualization of automatic fish feeder is design based on common tropical fish such as gold fish and guppy.

Gold fish can be classified into many types such as common goldfish, black moor, ranchu, fantail, shubunkin, ryukin such as celestial. However, all the species of gold fish have the similar characteristics. Its will tolerate changes in water temperature easily as long as it is not in the extreme. They are not picky and selective with the provided food. Its will easily accept fish food flakes, pellets, cucumbers, peas and live foods. Beside that, they will discharge a lot of waste and fouls the water easily. Thus, more time is needed to feed gold fish and maintain the quality of water. Figure 2.7 shows three types of tropical fish.

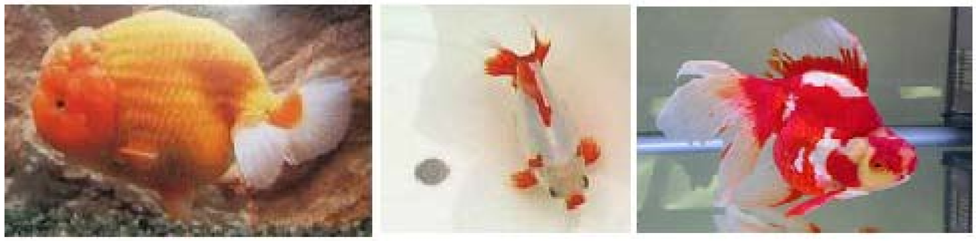


Figure 2.7: Ranchu, Common gold fish and Ryukin

Source: All about Aquarium Fish (2007)

Similarly, guppy will tolerate different range of aquariums temperatures and not sensitive to changes in water quality. Beside that, it is not picky in food which can be pellet, flake or live food. Generally, all the tropical fish have same characteristic in habits.

2.4.3 Types of Fish Food

There are many kinds of fish food which can be classified as live foods, frozen foods, pellet, flake food, worms and freeze dried food. But there are some considerations in this design of automatic fish feeder where it only can feed dry food such as flake and pellet food.

Flake and pellet food are inexpensive, well balanced and easy to use. Thus, it is most widely used food for all types of aquarium fish. There are available in many forms including specially formulated mixtures for certain conditions and fish. Flakes only can be fed in small amount with one to four times a day. But do not feed more flake food, than your fish can eat in less than 3 minutes. However, nutrient in flake foods will lose very fast, so it’s best to only buy when the aquarist can use within one month. Pellet foods might be more suitable for larger fish due to the size. Mostly, fish are able to take in the food they need within 5-10 minutes of their feed. After the first 10 minutes of feeding, the food left in the aquarium is not needed by the fish, and will collect in the aquarium as waste. Usually fish is fed twice a day with a small amount of foods. However, newly hatched fry and young fish not fully grown, require more frequent feedings of special foods designed for fry. Generally, young fish need 4 times of feeding interval per day. Figure 2.8 show common flake and pellet food.

Figure 2.8: Flake and pellet food

Source: howstuffworks.com

2.5 CHARACTERISTICS OF PLASTIC

Plastic are polymers of high molecular weight. Typically, it may contain other substances to improve performance and reduce cost. Plasticity of manufacture allows them to be manufacture into different shapes such as bottle, sheet, tubes and much more. Plastic can be classified into two types which are thermosets and thermoplastics. Thermosets, such as polyester do not melt or soften in any applied heat power. Thermoplastics, such as polystyrene and polyethylene will melt and soften when enough heat is applied.

Plastic are used in expanding range of products because of the plastic characteristics, such as ease of manufacture, relatively low cost, imperviousness to water and versatility. Thus, many types of plastic have been developed and modify for many uses. There are some types of plastics which is consider in this project such as polystyrene and PVC and polyethylene.

Polystyrene is a brittle, rigid, inexpensive plastic that used to produce plastic model kits. Meanwhile, PVC, polyvinyl chloride is strong, stiff, weather and heat resistant. PVC is used to produce gutters, house siding, plumbing and other electronic gears.

Polyethylene develops gradually into two forms which are low density polyethylene and high density polyethylene. This type of plastic is cheap, durable, chemically resistant and flexible. High density polyethylene is used to produce containers, automotive fitting and plumbing, while low density polyethylene is used to produce packaging materials and film. The Table 2.1 below shows the tensile strength of plastics.

Table 2.1: Tensile strength of the plastics

Polymer type	**Ultimate tensile strength (MPa)**
Polyamide-Imide	110
Polycarbonate	70
Polyethylene, HDPE	15
Polyethylene Terephthalate (PET)	55
Polyimide	85
Polypropylene	40
Polystyrene	40

Source: Matweb (1996)

2.6 PATENT

2.6.1 US Patent 4429660

A fish feeder assembly having at least one water receiving container eccentrically mounted on a rotatable shaft for oscillating the shaft as the container is sequentially filled with water and emptied when the contained and shaft are pivoted by the weight of the water. The assembly includes a frame having an interior portion defining a longitudinal opening, a feed bin having at its lower portion a passageway communicating with the longitudinal opening for passage of fish feed, a metering rotor securely affixed to the shaft and essentially filling a transverse sectional area of the passageway for rotation whereupon metered portions of fish feed are dispensed from the hopper through the longitudinal opening in the frame. A wing structure has a bushing for receiving the shaft in fixed relation thereto and for mounting said at least one water container, the wing structure including a stop pin disposed in general parallel relation to the axis of the shaft and cooperating with an adjustment stop for limiting actuate movement of the shaft and consequently control the amount of fish food metered by the rotor. The metering rotor may have a set of grooves for metering different amounts of fish feed for a given actuate displacement.

2.6.2 US Patent 4628864

A fish feeder which is utilizes water to fill a water container to induce a rotational movement in a rotatable arm. A predetermined rotation of the water container causes the water container to dump its contents and cause a rotation of the rotatable arm in an opposite direction. Abrupt halting of the rotational movement of the rotatable arm induces a vibration movement to cause fish feed to be dispensed from a feed pan. The amount of fish feed dispensed for a wide range of grain sizes is provided in the present invention in addition to a precise control of the frequency at which food can be dispensed.

2.7 CONCLUSION

The US Patent is used as reference of the concept generation. The study on the specified mechanism shows that water power is power save, longer life span and low cost. The concepts of fish feeder will be carried out in following chapter.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter provides detailed explanation on the methodology of carrying out this project from beginning to the end. A detail related literature review was done and important information were acquired and explained in previous chapter. Therefore, in this chapter, rough idea of required mechanisms and components are listed, measurements of each component are also determined accordingly. Sketches of conceptualization on fish feeder are done and only one of the concepts which fulfill target objectives is selected. Beside that, process of choosing materials and determination of machine for fabrication are also consists in this chapter. Lastly, this chapter is consists of the procedure of fabrication and assembly of fish feeder.

3.2 PROJECT FLOW

Figure 3.1 shows the process flow of design and fabricate an automatic fish feeder. The development process consists of 14 phases.

a) Phase 1 - Determination of objective & scope
b) Phase 2 - Documentation on Literature review
c) Phase 3 - Determine required mechanism
d) Phase 4 - Verify required components
e) Phase 5 - Conceptualization
f) Phase 6 - Selection of concept
g) Phase 8 - Selection of materials
h) Phase 9 - Verification of equipment used
i) Phase 10 - Fabrication and assembly
j) Phase 11 - Analysis on the product
k) Phase 12 - Result and Discussion
l) Phase 13 - Conclusion
m) Phase 14 - Documentation

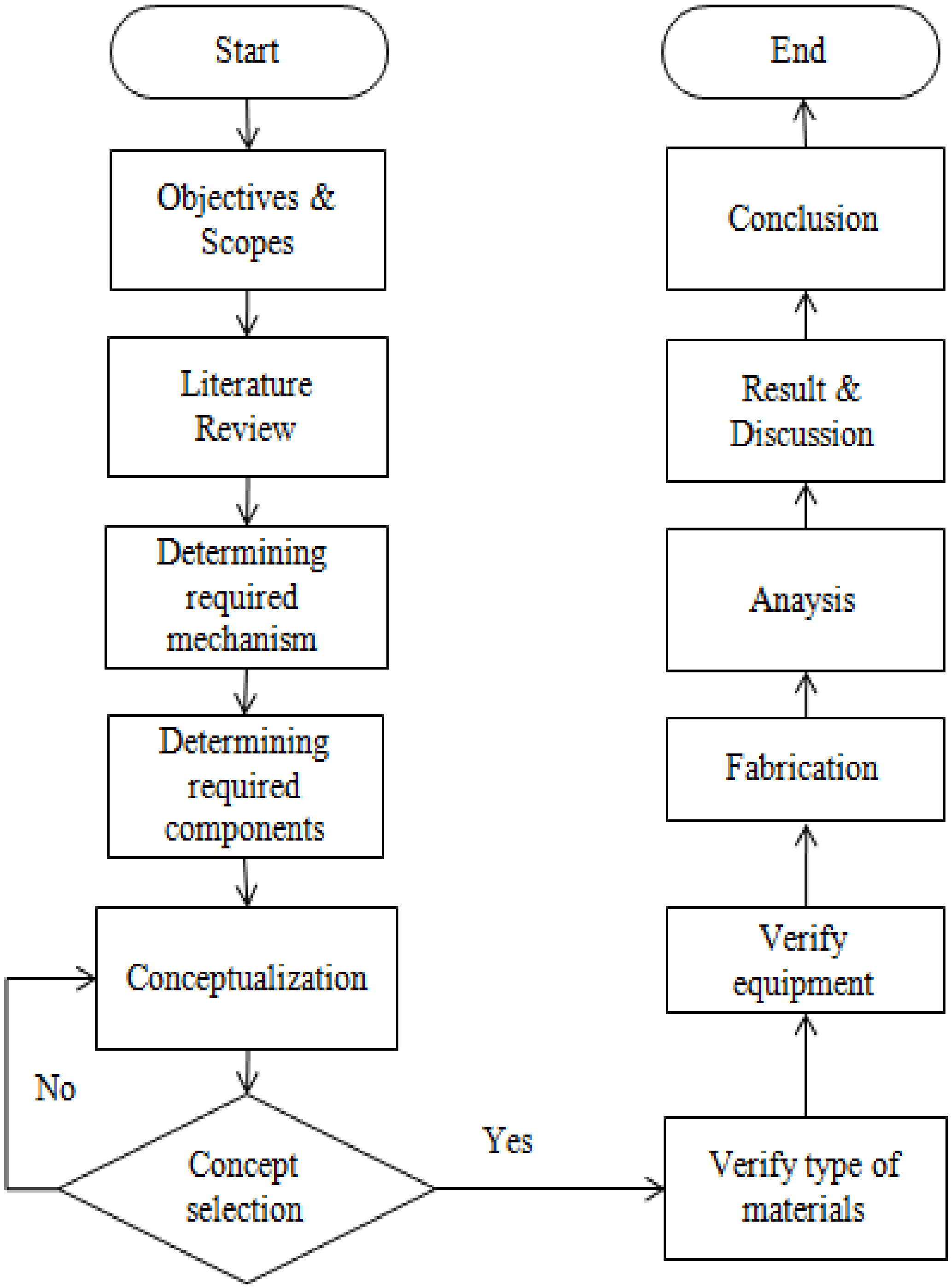


Figure 3.1: Flow chart of project

At the first phase of project, title of project is decided regarding discussion and consultation with project supervisor. Then, objectives and scopes of project are determined. After the determination of objectives and scopes, the project is further with searching information on literature review to strengthen the project objectives.

After searching information on literature review, documentation on chapter two is started. The literature review is used to define the rough idea of this new design of automatic fish feeder. After the rough idea has been determined, required components and mechanism are use in conceptualization. Dimension for each of the required components have to be determined for sketching.

After the conceptualization, the final concept is selected based on the objectives and comparisons among each of the concepts. Then, material of the concepts is verified and selected. After material have been chosen, tools and machines are determined to fabricate the automatic fish feeder.

After the fabrication and assembly on the product, the fish feeder is used to testing and analysis. The analysis is document in result and discussion. Finally, this project is finished with conclusion and recommendation.

3.3 CONCEPTUALIZATION

3.3.1 Determining Required Mechanism

According to the objective tree of this project, the mechanism used has to be easy to use where less maintenance and easy to install. Meanwhile, this new design of fish feeder should save cost in usage, manufacturing and materials. The usage cost can be defined as the cost to spend during this product is using by aquarist where included power supply cost and maintenance cost. Other than usage cost, manufacturing cost is included machining, fabrication and joining. While, the material cost is consider in the characteristics of materials. Beside that, this fish feeder has to be longer life span. Thus, the energy source to operate the feeder and the material to fabricate it has to be considered.

Thus, from the study of literature review, combination of water power and mechanism of water clock are the most suitable mechanisms to operate this fish feeder. Water power required water wheel to run with. Water power is renewable source where does not pollute the aquarium. Compare with other mechanism, water power is easy to install, use and maintenance. Most importantly, it is low cost and no worry on power outage because water recycled automatically. Beside that, the fabrication cost is less expensive. And, it has longer life span than other mechanism. The Figure 3.2 and Table 3.1 show the objective tree and comparison in types of mechanism.

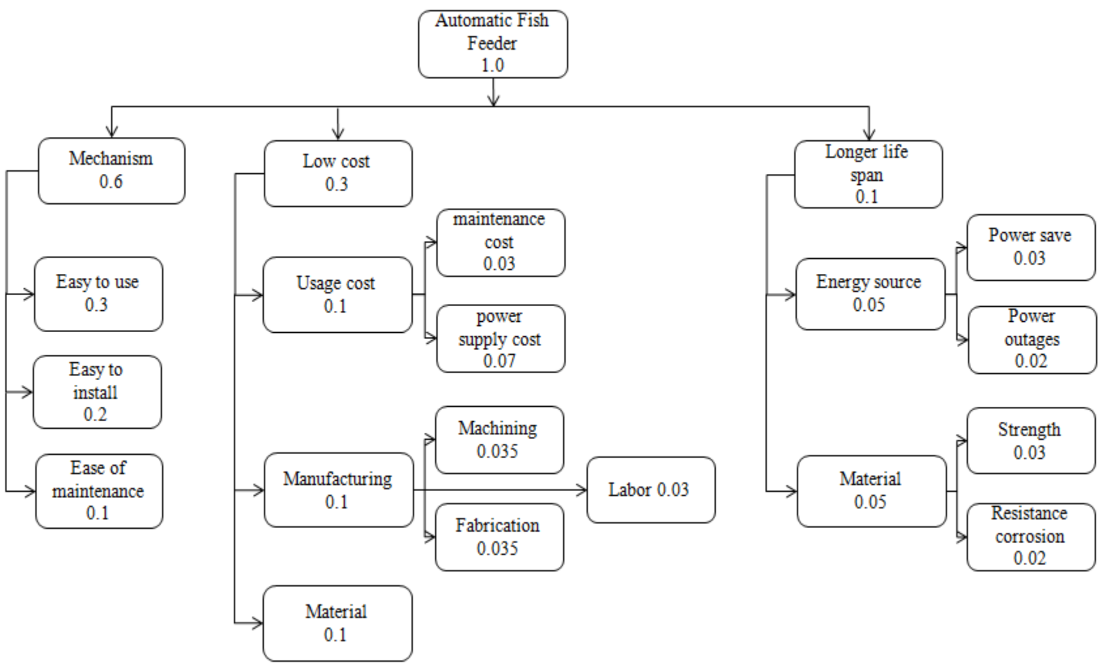


Figure 3.2: Objective tree

Table 3.1: Comparison in types of mechanism

Characteristics	Score	Water power & water clock	Timer	Pendulum clock
Ease of maintenance	0.1	0.08	0.03	0.06
Ease of install	0.2	0.14	0.16	0.12
Ease of use	0.3	0.25	0.2	0.15
Power supply cost	0.07	0.06	0.04	0.05
Maintenance cost	0.03	0.02	0	0.01
Machining cost	0.035	0.03	0.02	0.03
Labor cost	0.03	0.015	0.015	0.01
Fabrication cost	0.035	0.025	0.02	0.015
Material	0.1	0.07	0.08	0.07
Power save	0.03	0.025	0.01	0.025
Power outage	0.02	0.02	0.01	0.02
Strength	0.03	0.02	0.015	0.015
Resistance corrosion	0.02	0.018	0.018	0.018
Total score	**1**	**0.773**	**0.618**	**0.593**

3.3.2 Determining Required Components

The required components for combination mechanism of water power and water clock are included water wheel, water container, shafts, gears and food container. Table 3.2 shows the features of required components that are used to design the fish feeder.

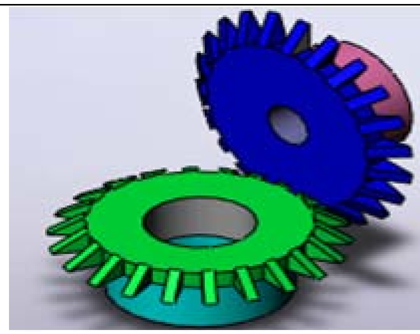
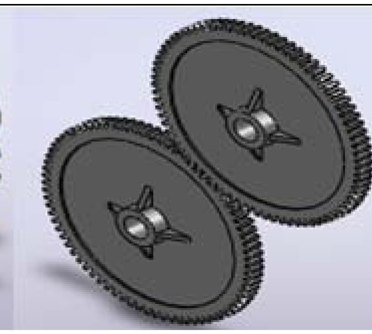
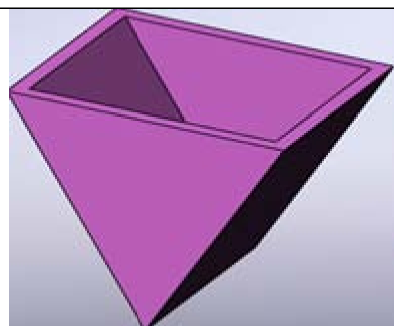
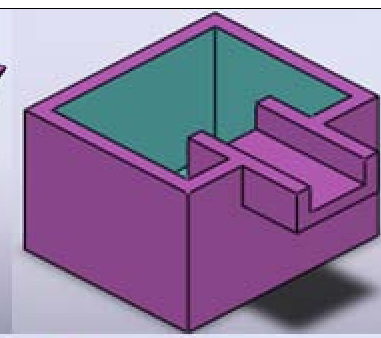
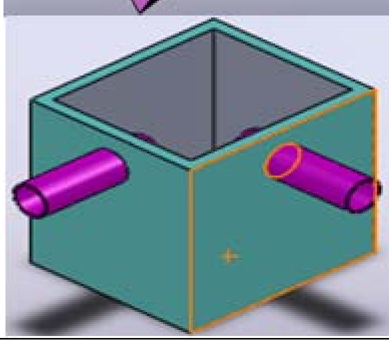
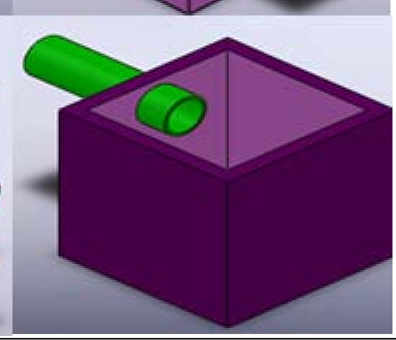
Table 3.2: The features of required components

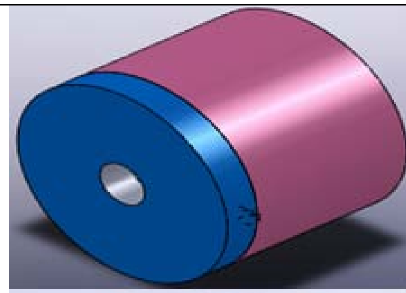
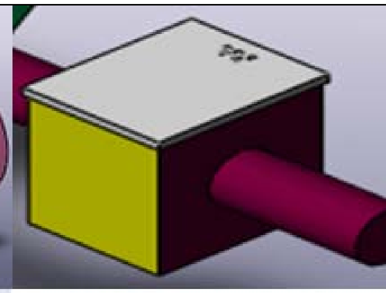
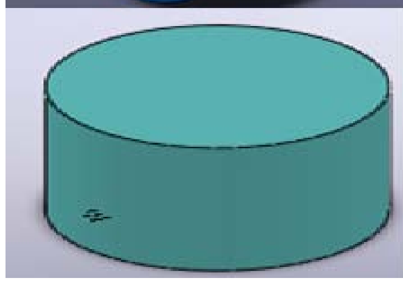
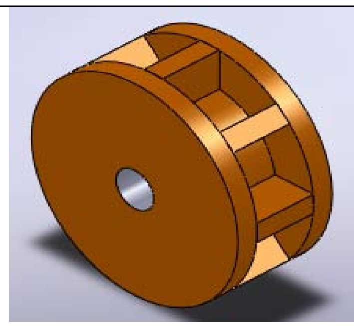
Components	Features
Water wheel	To slow down the water flow and rotate the shaft
Water container	To let the water flow from filter and fall through the water wheel
Shafts	To connect the water wheel and food container
Food container	To store the fish food
Gears	To transmit the food container

3.3.3 Concept Generation

Table 3.3 shows the different design of components. These components are used to generate new concepts of automatic fish feeder. The components included gears, water containers, food container and water wheel.

Table 3.3: Components of automatic fish feeder for concept generation

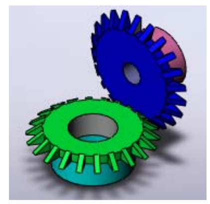
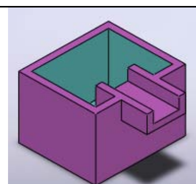
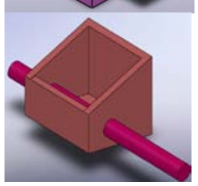
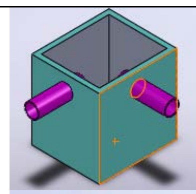
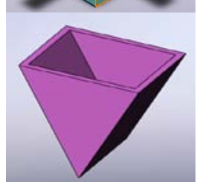
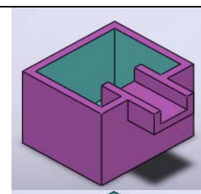
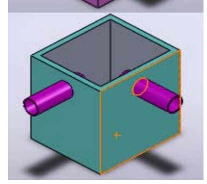
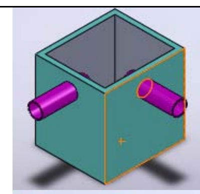
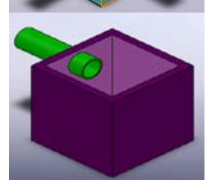
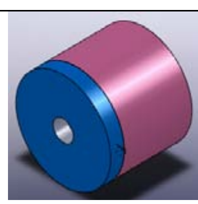
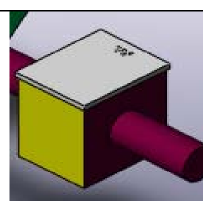
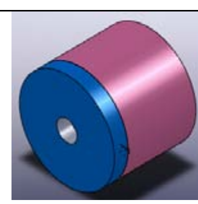
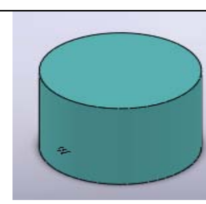
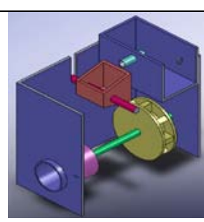
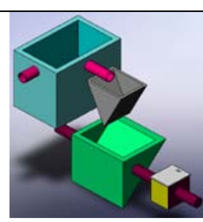
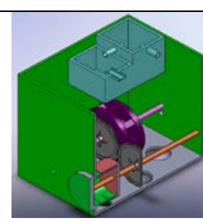
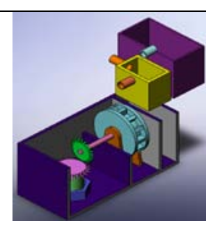
Gear	 
Water container	   

Food container	  
Water wheel	

3.3.4 Concept Combination

Table 3.4 shows the concept combination of each component to develop new designs of fish feeder. There is consists of detail descriptions for these concepts.

Table 3.4: Concept combination of automatic fish feeders

	Concept A	**Concept B**	**Concept C**	**Concept D**
Gears	Not available	Not available	Spur gears 	Bevel gears 
Water container	 	 	 	 
Food container				
Drawing				

3.3.4.1 Concept A

Refer to Appendix B2, water wheel is used to slow down the speed of water and rotate the shaft. The shaft is connected between the food container and water wheel. The food container has a specific diameter holes and cover by a fix plane. When the food container is rotate and reaches the hole on the fix plane, the fish food is dispensing into aquarium. The water used is recycling automatically by the filter.

3.3.4.2 Concept B

Refer to Appendix B8, this concept is used water power to operate the fish feeder. There are a cylinder food container and water container in this feature. The food container has a specific diameter of holes and close by a cover. The water container is connecter with a food container by shaft. The water from the filter drips down at a constant rate through a hole into water container. When the water container reaches a particular weight, the water container is rotating the food container to dispense food into aquarium. Meanwhile the water is fall into the aquarium.

3.3.4.3 Concept C

Refer to Appendix B9, water wheel is used to slow down the speed of water and rotate the shaft. The shaft is connected between the spur gears and water wheel. The gear connected with food container which has a specific diameter holes and cover by a fix plane. When the food container is rotate and reaches the hole on the fix plane, the fish food is dispensing into aquarium. The water used is recycling automatically by the filter.

3.3.4.4 Concept D

Refer to Appendix B10, water wheel is used to slow down the speed of water and rotate the shaft. The shaft is connected between the bevel gears and water wheel.

The gear connected with food container which has a specific diameter holes and cover by a fix plane. When the food container is rotate and reaches the hole on the fix plane, the fish food is dispensing into aquarium. The water used is recycling automatically by the filter.

3.4 CONCEPT SELECTION

After concept generation and combination, all the concepts are comparing between each others to select the final concept. Table 3.5 shows the concept scoring for the generated concepts. Finally, concept A is selected as the design of this project (Appendix B1-B7).

Table 3.5: Concept scoring of the designs

Characteristics	Score	Concept A	Concept B	Concept C	Concept D
Ease of maintenance	0.1	0.08	0.07	0.06	0.05
Ease of install	0.2	0.15	0.16	0.1	0.09
Ease of use	0.3	0.25	0.2	0.2	0.18
Power supply cost	0.07	0.06	0.06	0.06	0.06
Maintenance cost	0.03	0.02	0.02	0.01	0.01
Machining cost	0.035	0.025	0.02	0.015	0.015
Labor cost	0.03	0.02	0.02	0.015	0.015
Fabrication cost	0.035	0.03	0.03	0.02	0.02
Material	0.1	0.08	0.09	0.06	0.05
Power save	0.03	0.03	0.03	0.03	0.03
Power outage	0.02	0.02	0.02	0.02	0.02
Strength	0.03	0.03	0.01	0.02	0.015
Resistance corrosion	0.02	0.02	0.02	0.02	0.02
Total score	**1**	**0.815**	**0.75**	**0.63**	**0.575**

3.5 PRODUCT DESIGN SPECIFICATION

3.5.1 Product Title

Automatic fish feeder

3.5.2 Purpose of the Product

This product is developing to provide the most convenience automatic fish feeder and easier user daily life. Beside that, it is a development of new concept of the automatic fish feeder to decrease usage cost.

3.5.3 New or Special Features

This fish feeder is operated by water power so it can be power save and easy to install and use. The material used is lightweight and corrosion resistance. So it can be easy to install at aquarium and does not react with fish food and affected by the condition. Beside that, the design of this feature is less of maintenance so it is save usage cost.

3.5.4 Competition

Will compete against with standard automatic fish feeder

3.5.5 Intended Market

Sell to aquarium shops.

3.5.6 Need for Product

The existing product in the market is operate electrically and difficult to install. This new product is to provide a low cost and longer life span automatic fish feeder.

3.5.7 Relationship to Existing Products Line

This is a concept that improve the existing product by modify the limitations.

3.5.8 Price

A unit of automatic fish feeder is selling at RM 52.00. The manufacturing cost should less than RM 50(Refer to Table 4.7).

3.5.9 Functional Performance

This automatic fish feeder can be installed easily, easy to maintenance, easy to clean, refilled and easy to store in aquarium. Beside that, the dimension of the fish feeder is suitable for every aquarium and can be fed more than twice per day within a month.

3.5.10 Physical Requirement

Weight does not exceed 2kg.
Length does not exceed 300mm
Width does not exceed 200mm
Height does not exceed 250mm
Capability to take on load should not exceed 100kg

3.5.11 Service Environment

This automatic fish feeder can be use in any condition and everywhere.

3.5.12 Life Cycle Issues

The material used to manufacture this product is plastic. Plastic is hard and corrosion resistance so it does not react with water.

3.5.13 Human Factors

There are no sharp edges at every corner of the feeder so does not hurt or cause injuries on fish or aquarists.

3.6 BILL OF MATERIAL

The Table 3.6 shows the bill of materials for the fabrication of automatic fish feeder.

Table 3.6: Bill of material

No	Materials	Dimension	Quantity
1	Plastic sheet	260 x 220	2
2	Plastic sheet	220 x 160	2
3	Plastic sheet	80 x 80	2
4	Plastic sheet	160 x 80	3
5	Plastic sheet	70 x 80	2
6	Plastic sheet	90 x 70	1
7	Plastic tube	Ø12	2
8	Valve	Ø5	1
9	Water wheel	Ø110	1

3.7 FABRICATION

i. Prepared all the required materials and equipment such as plastic sheets, tubes, silicone sealant, rulers, scriber and hand saw as shown in the Figure 3.3, 3.4 and 3.5.

Figure 3.3: Silicone sealant, plastic tubes and plastic sheet

Figure 3.4: Ruler and 90-degree ruler

Figure 3.5: Scriber and hand saw

ii. Mark the dimensions on the plastic sheet by using measure tools such as ruler, scriber and 90-degree ruler as shown in Figure 3.6.

Figure 3.6: Marking dimension with scriber

iii. After all the marking process cut the plastic sheet into small pieces with a hand saw and vertical bend saw as shown in Figure 3.7 and 3.8.

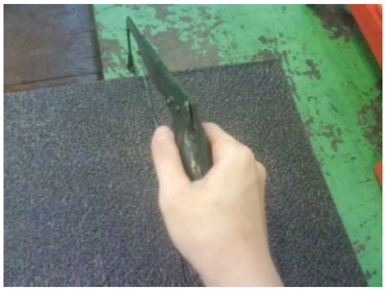


Figure 3.7: Sawing the plastic sheet with hand saw

Figure 3.8: Sawing the plastic sheet with vertical band saw

iv. Then, the fabrication is furthered with drilling process at all the holes as shown in the drawing (Appendix B1).

3.8 ASSEMBLY PROCESS

After all the process of sawing and drilling, the plastic sheets are assembling by using the silicone sealant as shown in the Figure 3.9 to produce a final product (Figure 3.10). Referring to the exploded drawing (Appendix B3), assemble the upper water container and rotatable water container. Then, assembly process is furthered with assemble of the water wheel and food container. The water wheel is joining to the shaft by silicone sealant. An external food container is connected at the end of the shaft. After the upper water container is assembled, it is joining with the external container of fish feeder by using silicone sealant. Then, water wheel with food container is assembling into external container. Lastly, connected the rotatable water container with a shaft and assemble at the external container.

Figure 3.9: Assemble the plastic sheet by using silicone sealant

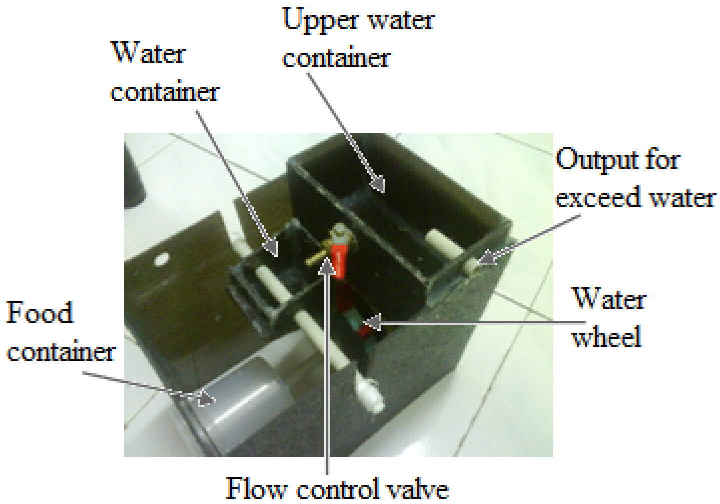


Figure 3.10: Final product

3.9 CONCLUSION

In this chapter, it can be conclude that the design and fabrication of the concept is accomplished according to the objective stated. A new concept had developed to produce an automatic fish feeder through concept generation, combination and selection. This project is further with analysis and testing to figure out the efficiency of this feeder.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

This chapter consists of the improvements and result for this project. The first part of this chapter consists of the solution manual to operate this feeder which is developed from the trial run on the product. Secondly, the performance of fish feeder is discussed by analysis the stress, torque and moment of the force. Through testing on the product, the probability of efficiency is calculated to determine the limitations of the product. Furthermore, improvement on the limitations is carried out to develop an efficient product. Lastly, this chapter is discussing the problem encountered and the solution for problem encountered.

4.2 SOLUTION MANUAL

The solution manual below shows the instruction to use the fish feeder. Figure 4.1 shows the parts of automatic fish feeder.

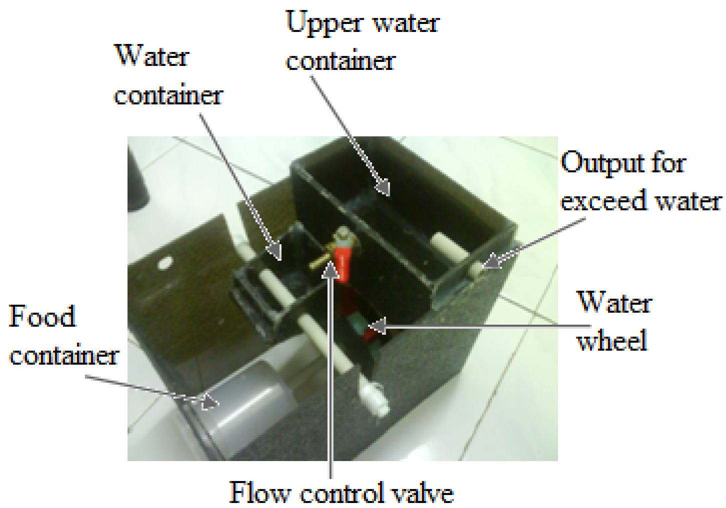


Figure 4.1: Parts of fish feeder

i. Fill the fish food in food container.
ii. Put the water filter pipe in the upper water container.
iii. Then turn on the valve with the minimum range.
iv. The water from upper water container drips down in the rotatable water container at a constant rate.
v. The container is emptied when the water in the container is flow out.
vi. Then, the water drop is rotating the water wheel.
vii. The water wheel is connected with food container by a shaft; the food container is rotate to dispense food when the water wheel is rotate.

4.3 ANALYSIS OF FISH FEEDER

4.3.1 Moment of the Force

4.3.1.1 Water Container

This fish feeder is operated based on the weight of water. Thus the moment of the force of water container is defined by using the following formula:

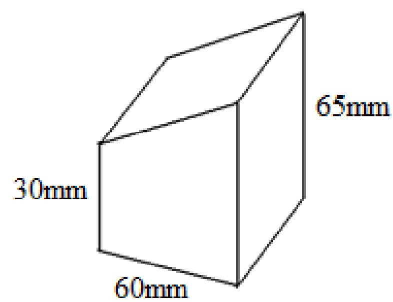


Figure 4.2: Dimension of water container

Refer to the Figure 4.2 and 4.3, assume that the force applied on the shaft of water container is equals to volume of water container.

Volume of the water container, $V = \frac{1}{2}(a+b) \times h$ (4.1)

$$= \frac{1}{2} \times (15mm + 32.5mm) \times 60mm \times 2$$

$$= 2850mm^3$$

$$= 0.00285m^3$$

The mass of the water in water container, $m = \rho V$ (4.2)

$= 1000kg/m^3 \times 0.00285m^3$

$= 2.85\ kg$

Force of the water container, $F = ma$ (4.3)

$= 2.85kg \times 9.81ms^{-2}$

$= 27.96N$

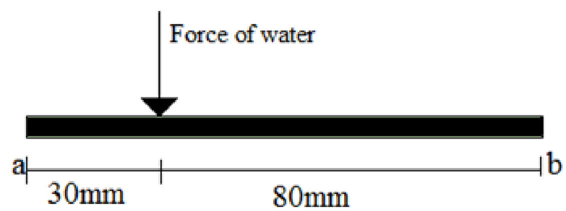


Figure 4.3: Free body diagram of water container with shaft

Momentum of the force, $M_a = Fd$ (4.4)

$= 27.96N \times 0.03m$

$= 0.8388Nm$

Momentum of the force, $M_b = Fd$ (4.5)

$= 27.96N \times 0.08m$

$= 2.2368Nm$

Magnitude of M_o is measures the tendency of the force to cause rotation of the shaft about an axis along M_o. The momentums of forces for the shaft of water container are 0.8388Nm and 2.2368Nm.

4.3.1.2 Water Wheel and Food Container

Refer to the Figure 4.4, assume the mass of water wheel and food container are equal to the volume of the water wheel and food container respectively. Beside that, density of water is used to calculate the equation. Thus, the momentum of the force between food container and water wheel is defined by following formula:

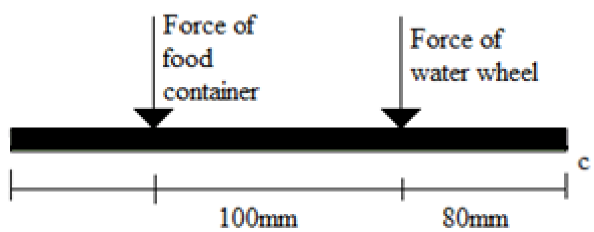


Figure 4.4: Free Body diagram of water wheel with food container

Volume of water wheel $= \frac{1}{3}\ \pi r^2 h$ (4.6)

$$= \frac{1}{3}\pi \times (0.065m)^2 \times 0.03m$$

$$= 1.33\ x\ 10^{-4} m^3$$

The mass of the water wheel, $m = \rho V$ (4.7)

$$= 1000kg/m^3 \times 1.33 \times 10^{-4}m^3$$

$$= 0.1327\ kg$$

Force of the water wheel, $F = ma$ (4.8)

$$= 0.1327kg \times 9.81ms^{-2}$$

$$= 1.3023N$$

Volume of the food container = $\frac{1}{3}\ \pi r^2 h$ (4.9)

$$= \frac{1}{3}\pi \times (0.035m)^2 \times 0.065m$$

$$= 8.34\ x\ 10^{-5}m^3$$

The mass of the food container, $m = \rho V$ (4.10)

$$= 1000kg/m^3 \times 8.34 \times 10^{-5}m^3$$

$$= 0.0834\ kg$$

Force of the food container, $F = ma$ (4.11)

$$= 0.0834kg \times 9.81ms^{-2}$$

$$= 0.8181N$$

Momentum of the force, $M_c \quad = \; Fd$ (4.12)

$= 1.3023N \times 0.18m + 0.818N \times 0.08m$

$= 0.2344Nm + 0.06544Nm$

$= 0.29984\ Nm$

Meanwhile, the momentum of force for the shaft of water wheel with food container is 0.29984Nm. This magnitude shows that force of 0.8181N and 1.3023N are apply on the shaft when the water wheel and food container is rotating.

4.3.2 Stress Analysis

The stress analysis is calculated with the following equation to avoid the exceed load or weight of water to apply in the container and the water wheel.

Stress, $\sigma \; = \; F/\,A$ (4.13)

4.3.2.1 Water Container

Refer to the Figure 4.5, the water container is storing water before it drop on the water wheel. Thus, the pressure that applied on the container is calculated to determine the stress that water container can be applied on container.

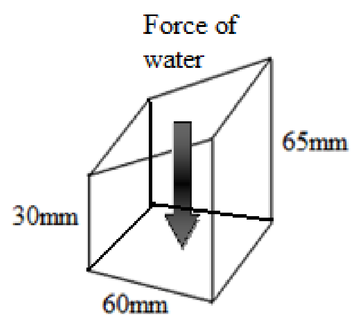


Figure 4.5: Diagram of applied force on water container

Pressure that applied on the container, $P_w = \rho g h$ (4.14)

$$= 1000kg/m^3 \times 9.81ms^{-2} \times 0.065m$$

$$= 637.65Pa$$

Stress on the water container, σ = Pressure that applied on the container

$$= 637.65Pa$$

The calculation shows the applied pressure and stress on a water container is 637.5Pa.

4.3.2.2 Water Wheel

Refer to the Figure 4.6, assume that the height is equal to the height of water drop on the bucket of water wheel.

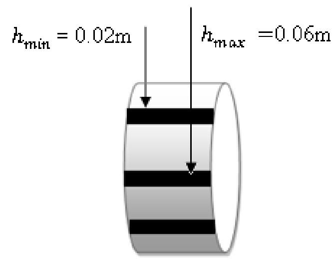


Figure 4.6: Diagram of water wheel

Pressure that applied on the waterwheel, $P_w \;=\; \rho g h$ (4.15)

Pressure of minimum height P_{min} $=1000 kg/m^3 \;\times\; 9.81 ms^{-2} \;\times\; 0.02m$

$= 196.2Pa$

Pressure of minimum height P_{max} $=1000 kg/m^3 \;\times\; 9.81 ms^{-2} \;\times\; 0.06m$

$= 588.6Pa$

Stress on the water wheel, σ_{min} = Pressure of minimum height P_{min}

$= 196.2Pa$

Stress on the water wheel, σ_{max} = Pressure of minimum height P_{max}

$= 588.6Pa$

The stress analysis shows that the stress of the water drop applied on the water container and water wheel. The calculated magnitude of stress is based on the volume of the water into the rotatable water container. Thus, different volume of the water container has different magnitude of stress. The minimum and maximum stress that applied on the water wheel is 196.2Pa and 588.6Pa respectively.

4.3.3 Torque Analysis

The torque analysis of the rotating shaft is calculated with the following equation to avoid the exceed load or weight of water to apply on the shaft to prevent bending. Torque can be calculated by the following equation:

$$\text{Torque, } T = \frac{J\tau}{c} \quad (4.16)$$

$$\text{Polar moment of inertia, } J = \frac{1}{2}\pi({c_2}^4 - {c_1}^4) \quad (4.17)$$

4.3.3.1 Water Container

Refer to the Figure 4.7, assume the shear stress on the shaft of the water container equals to the stress of the water container (Equation 4.14).

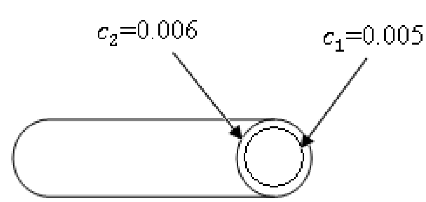


Figure 4.7: Dimension of shaft

Shear stress on the shaft of the water container, $\tau = 637.65Pa$

Polar moment of inertia, $J = \frac{1}{2}\pi(0.006^4 - 0.005^4)$

$$= 0.5 \times \pi\,(1.296 \times 10^{-9} - 6.25 \times 10^{-10})$$

$$= 1.054 \times 10^{-9}\,m^4$$

Torque of the shaft = $(1.054 \times 10^{-9} m^4 \times 637.65Pa) \div 0.006$

$$= 1.120 \times 10^{-4}\,Nm$$

Regarding to the calculation, shear stress of 637.65Pa is produce torque of $1.120 \times 10^{-4}\,Nm$ on the shaft.

4.3.3.2 Water Wheel and Food Container

Assume the shear stress on the shaft of the water wheel and food container is equal to the stress of the water wheel (Equation 4.15).

Polar moment of inertia, J = Polar moment of inertia for water container (Equation 4.18)

$$=1.054 \times 10^{-9}\,m^4$$

Shear stress on the shaft of the water wheel, $\tau_{min} = 196.2Pa$

Minimum torque of the shaft = $(1.054 \times 10^{-9} m^4 \times 196.2Pa) \div 0.006$

$$= 3.45 \times 10^{-5}\,Nm$$

Shear stress on the shaft of the water wheel, $\tau_{max} = 588.6Pa$

Maximum torque of the shaft = $(1.054 \times 10^{-9}m^4 \times 588.6Pa) \div 0.006$

$= 1.033 \times 10^{-4}\ Nm$

The minimum and maximum of torques at shaft of water wheel are $3.45 \times 10^{-5}\ Nm$ and $1.033 \times 10^{-4}\ Nm$ respectively.

4.3.4 Performance and Efficiency Test

There is a testing of the performance and efficiency on the product after the fabrication. The position of water flow is control by a valve. In this experiment, this feeder is undergoing testing in three positions. The tables show the result of the experiments.

4.3.4.1 Position 1

Table 4.1 shows the result of experiment in first position. The first position of valve is in the range of 30° as shown in Figure 4.8. The result shows that the first position of valve to drop the water does not rotate the water wheel and dispenses the fish food.

Figure 4.8: First position of valve in testing

Table 4.1: Result of experiment in first position

Measurement	Volume, m^3	Time of water drop, s	Flow rate, m^3/s	Rotating water wheel
1	0.00285	120	2.375×10^{-5}	No
2	0.00285	106	2.689×10^{-5}	No
3	0.00285	102	2.794×10^{-5}	No
4	0.00285	137	2.08×10^{-5}	No

4.3.4.2 Position 2

Table 4.2 shows the result of experiment in second position. The second position of valve is in the range of 60° as shown in Figure 4.9. The result shows that the second position of valve to drop the water does not rotate the water wheel and dispenses the fish food sequentially.

Figure 4.9: Second position of valve in testing

Table 4.2: Result of experiment in second position

Measurement	Volume, m^3	Time of water drop, s	Flow rate, m^3/s	Rotating water wheel
1	0.00285	28.8	9.9×10^{-5}	No
2	0.00285	24.1	1.18×10^{-4}	No
3	0.00285	26.9	1.059×10^{-4}	No
4	0.00285	27.2	1.05×10^{-4}	No

4.3.4.3 Position 3

Table 4.3 shows the result of experiment in third position. The third position of valve is in the range of 90° as shown in Figure 4.10.The result shows that the third position of valve to drop the water does not rotate the water wheel and dispenses the fish food sequentially.

Figure 4.10: Third position of valve in testing

Table 4.3: Result of experiment in third position

Measurement	Volume, m^3	Time of water drop, s	Flow rate, m^3/s	Rotating water wheel
1	0.00285	12.2	2.336×10^{-4}	No
2	0.00285	12	2.375×10^{-4}	No
3	0.00285	10.5	2.714×10^{-4}	No
4	0.00285	9.1	3.132×10^{-4}	Yes, but in short distance

4.3.5 Performance of Fish Feeder

4.3.5.1 Probability

The performance of the fish feeder is defined through the experiments done on the feeder. Thus, the result of the experiment is used to calculate the probability of success on the new design of feeder. Table 4.4 shows the probability on performance of the fish feeder.

$$\text{Probability, } P(X) = \frac{n!}{(n-X)!X!} \; p^X q^{n-X} \tag{4.18}$$

The probability of the first position, $P(X) = \frac{4!}{(4-0)!0!} \; \frac{1}{2}^0 \times \frac{1}{2}^{4-0}$

$$= \frac{1}{16}$$

The probability of the second position, $P(X) = \frac{4!}{(4-0)!0!} \; \frac{1}{2}^0 \times \frac{1}{2}^{4-0}$

$$= \frac{1}{16}$$

The probability of the third position, $P(X) = \frac{4!}{(4-1)!1!} \; \frac{1}{2}^1 \times \frac{1}{2}^{4-1}$

$$= \frac{1}{4}$$

Table 4.4: Probability on performance of the fish feeder

Position	Probability, P(X)
1	0.0625
2	0.0625
3	0.25

From Table 4.4, the calculated probability, P(X) is less than 0.5. Thus, it can be conclude that the performance of the fish feeder is not efficient. And, this product needs to be improved and modified to produce a success product.

4.3.5.2 Mass Flow Rate

The mass flow rate affects the efficiency of water wheel. The average mass flow rate for each position is calculated by following equation. Table 4.5 shows the calculation of mss flow rate.

$$\dot{m} = \rho Q \tag{4.19}$$

Table 4.5: Mass flow rate for average of flow rate at each position

Position	Average flow rate	Average time of water drop, s	Mass Flow rate, m^3/s
1	2.4845×10^{-5}	116.25	0.024845
2	1.07×10^{-4}	26.75	0.107
3	2.639×10^{-4}	10.95	0.2639

4.3.6 Cost Analysis

The manufacturing, labor, material and assembly cost is calculated to analysis the cost of fish feeder. Table 4.6 shows material cost needed. Table 4.7 shows the required cost to manufacture this automatic fish feeder.

Table 4.6: Cost for materials

Materials	Unit	Cost	Total cost, RM
Plastic	253500	6.11×10^{-5}per mm	15.50
Plastic tube	2	0.20	0.40
Valve	1	9.90	9.90
Water wheel	1	4.50	4.50
Container	2	0.50	1.00

Cost of plastic sheet, $360000mm^2 = RM22.00$

Cost of plastic sheet required, $253500mm^2 = RM22 \div 360000 \times 253500$

$$= RM15.50$$

Total cost of material = RM31.30

Assume labor cost is equals to RM1.00 per hour. A worker is needed to finish this product in 10 hours. While the manufacturing and assembly cost are equals to RM0.30 and RM0.40 per hour respectively.

Labor cost = $10\ hours \times RM1.00 = RM10.00$

Manufacturing cost = $10\ hours \times RM0.30 = RM\ 3.00$

Assembly cost = $RM0.40 \times 10 = RM4.00$

Table 4.7: Required cost of manufacturing

Description	Cost, RM
Material	32.90
Manufacturing	3.00
Labor	10.00
Assembly	4.00
Total cost	49.90

4.4 DISCUSSION ON THE FEEDER

According to the analysis on the fish feeder, it can be conclude that the efficiency of the fish feeder to dispense food is less efficient. The limitations of the fish feeder are defined through the result of analysis. The limitations consist of the efficiency of rotation of water wheel, the pressure of water drop to rotate the feeder and the volume and size of water container. Moreover, the weight of water wheel is not suitable for this design due to the friction force on water wheel. Thus, the water in the container is not enough to rotate the water wheel.

From the analysis, the opposing gravity forces and loss of water due to the centrifugal forces make the water wheel does not produce efficient output to rotate the food container. To avoid these loses, more water is necessary and the flow of water should be increases. The calculation below shows the assumption of mass flow rate and weight of water that required rotating the wheel.

From the Table 4.5, the mass flow rate that can rotate the water wheel in a small distance at the third position is equals to 0.2639kg/s. Assume that the mass flow rate to rotate the water wheel and dispense food is 0.7917kg/s.

Mass flow rate, $\dot{m} = 0.7917kg/s$

Flow rate, $Q = 0.7917kg/s \div 1000kg/m^3$

$= 7.917 \times 10^{-4}m^3/s$

The calculated flow rate from assumption is greater than the flow rate at third position (Table 4.5). Thus, assume the water wheel is rotating the food container and dispense food.

$$\text{Flow rate, } Q = V/t \tag{4.20}$$

Assume volume of water drop = $10.0 \times 10^{-3}m^3$

Time taken of water drop, $t = V/Q$ (4.21)

$= 10.0 \times 10^{-3}m^3 \div 7.917 \times 10^{-4}m^3/s$

$= 12.63s$

According to the assumption, mass flow rate, 0.7917kg/s is generate flow rate of $7.917 \times 10^{-4}m^3/s$. Assume the volume of water to accomplish this flow rate in order to rotate the water wheel is $10.0 \times 10^{-3}m^3$, the time take of water drop is 12.63s. Therefore, the water container should have a volume of $10.0 \times 10^{-3}m^3$.

4.5 CONCLUSION

In this chapter, it can be conclude that water power can be used to operate the fish feeder. However, the fabricated product is failure to run in properly movement due to some limitations that have been discussed in this chapter. At the last part of this chapter, it consists of the assumption flow of water, volume of water drop and time of water drop that required rotating the water wheel in order to dispense food.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

This chapter consists of the summary of overall process and analysis of this project. Beside that, this chapter also included the recommendations for further invention in automatic fish feeder.

5.2 CONCLUSION

This invention has been achieved the objective which is to design and fabricate a low cost and longer life span automatic fish feeder. However, this feeder is not operating as in the design concept. The water flow from the water container is related to the rotation of water wheel in order to dispense food from food container.

According to the testing on the feeder, the result state that the feeder is failure in operation due to the weight of the water and flow of water does not rotate the water wheel sequentially. Therefore, in the chapter of result and discussion, there is some assumption of calculation to improve and modified the limitations of the fish feeder.

From the studies, it explains that water wheel can be operating for a longer life time. The water flow into the water container is the output water from the aquarium filter. Therefore, it can be conclude that concept of water wheel is accomplished the objectives where is longer life span and low cost.

5.3 RECOMMENDATIONS FOR FUTHER INVENTION

Due to the failure of operation in the fish feeder, a few improvements can be done for the further invention for this design. Due to the time constraint, this invention cannot be done along with this project. The recommendations below are stated to improve a few limitations, which are:

i. Improvement on the angle of buckets on the water wheel. The different angle of buckets is one of the factors that affect the water flow and the weight of water that required rotating it.

ii. Improvement on the shape and size of water container. The size and shape of water container determine the weight of water flow and the period of water drop onto water wheel.

iii. Improvement on the weight of water wheel. The largest weight of water wheel required highest weight of water to rotate it.

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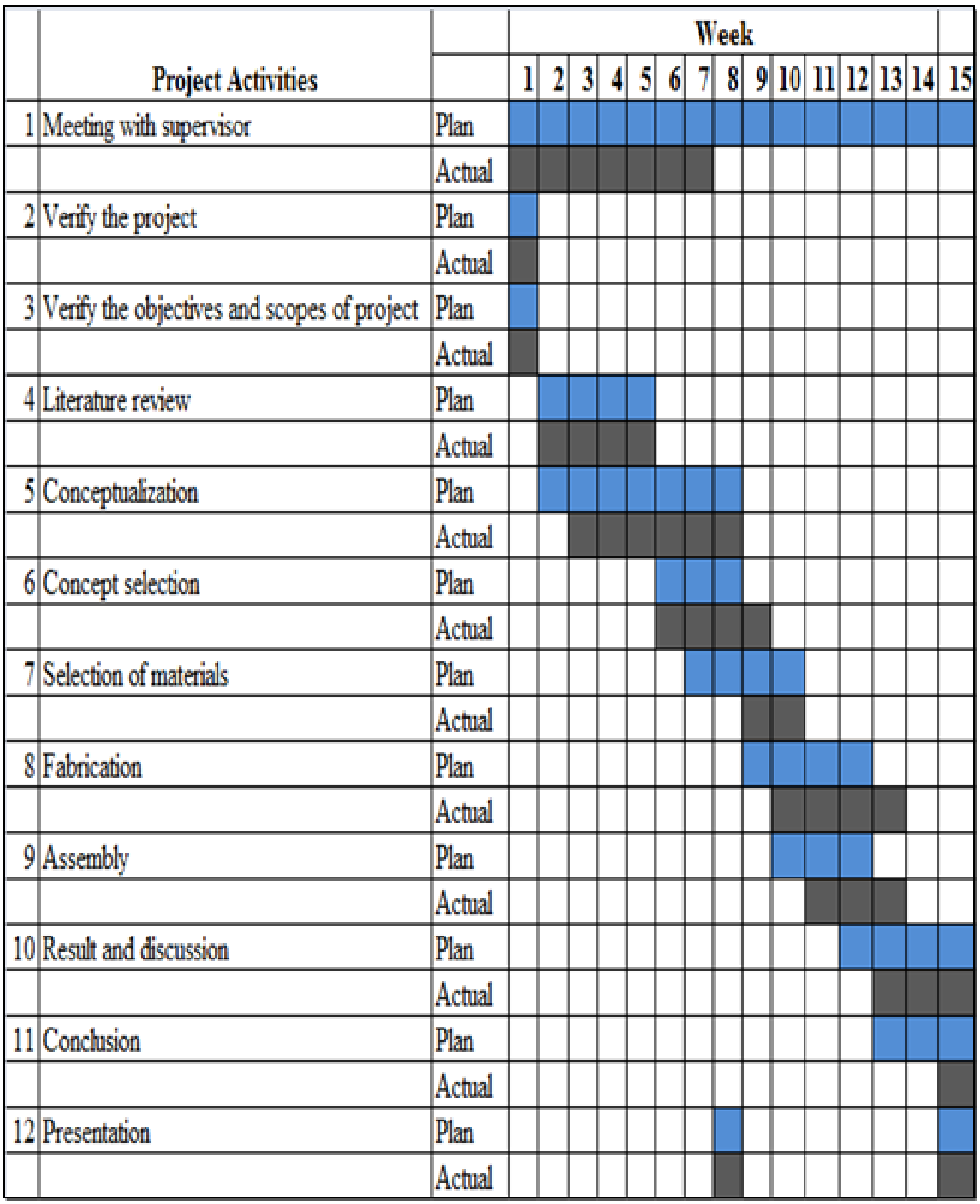
APPENDIX A

GANTT CHART

Appendix A consists of the Gantt chart for this project.

APPENDIX A1

Gantt chart

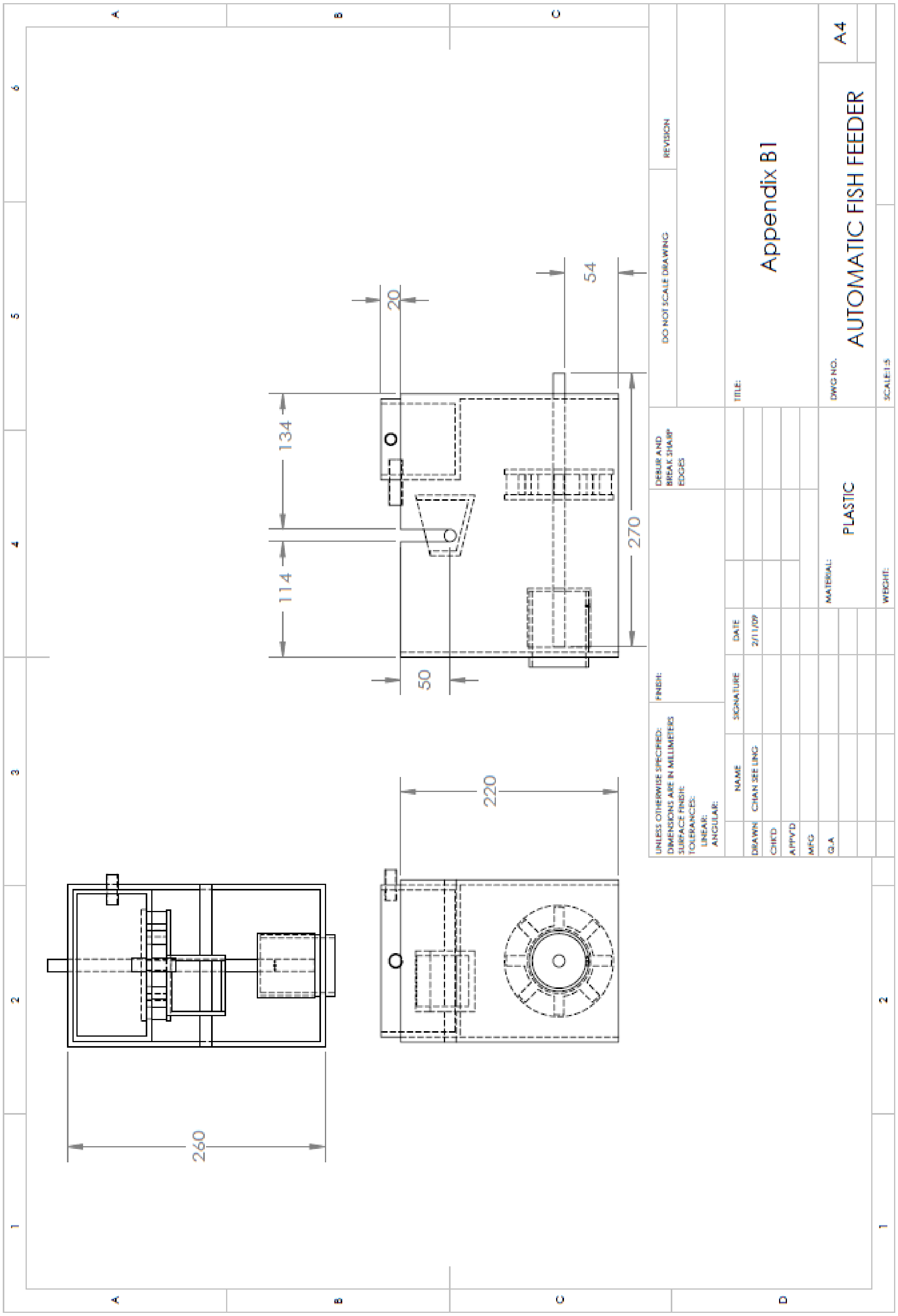


APPENDIX B

DRAWING

Appendix B consists of the all the drawings for this project by using Solidworks software, which are:

- 2D drawing of automatic fish feeder
- 3D drawing of automatic fish feeder
- Exploded drawing
- External container
- Water wheel
- Rotatable water container
- External food container
- Concept B
- Concept C
- Concept D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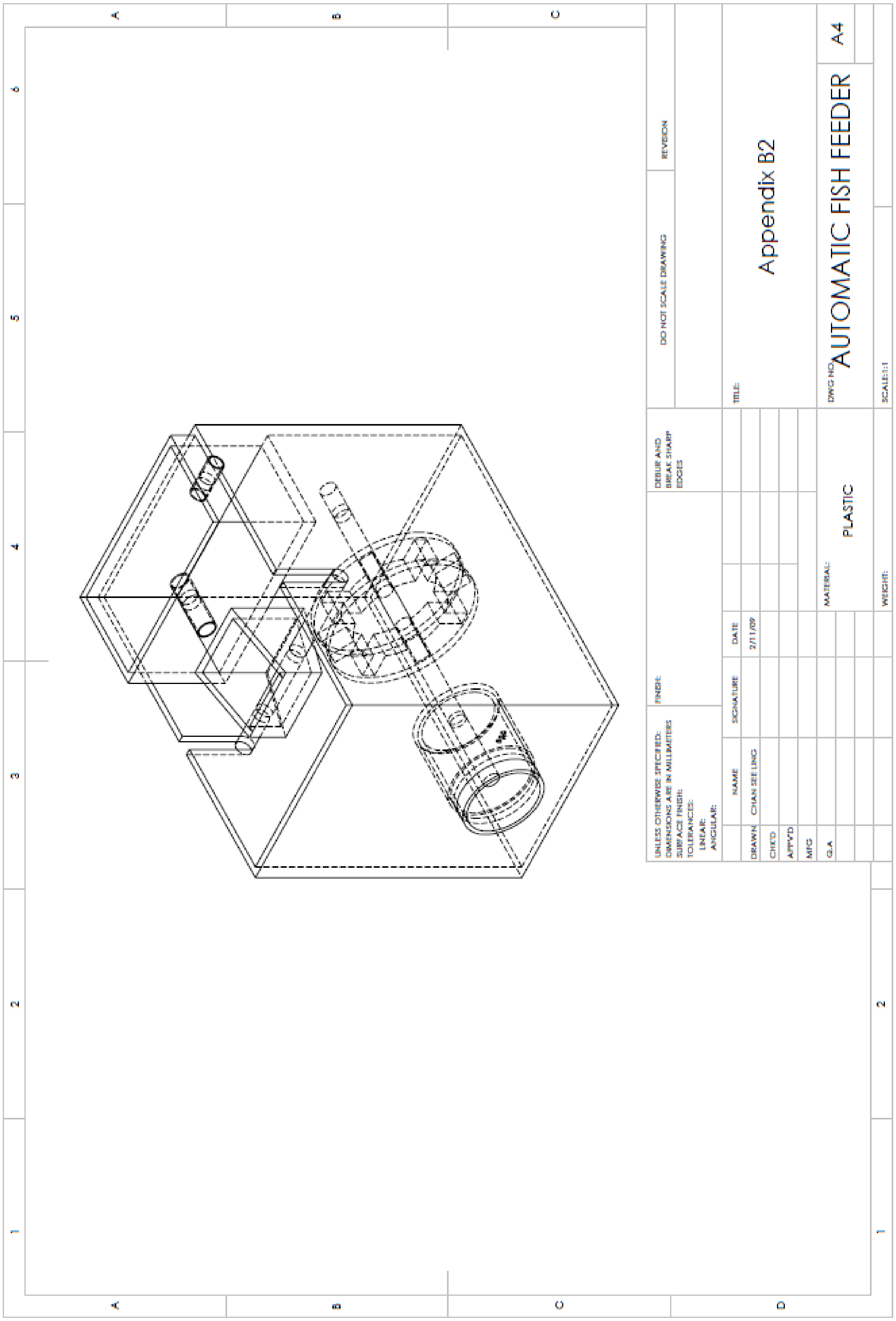

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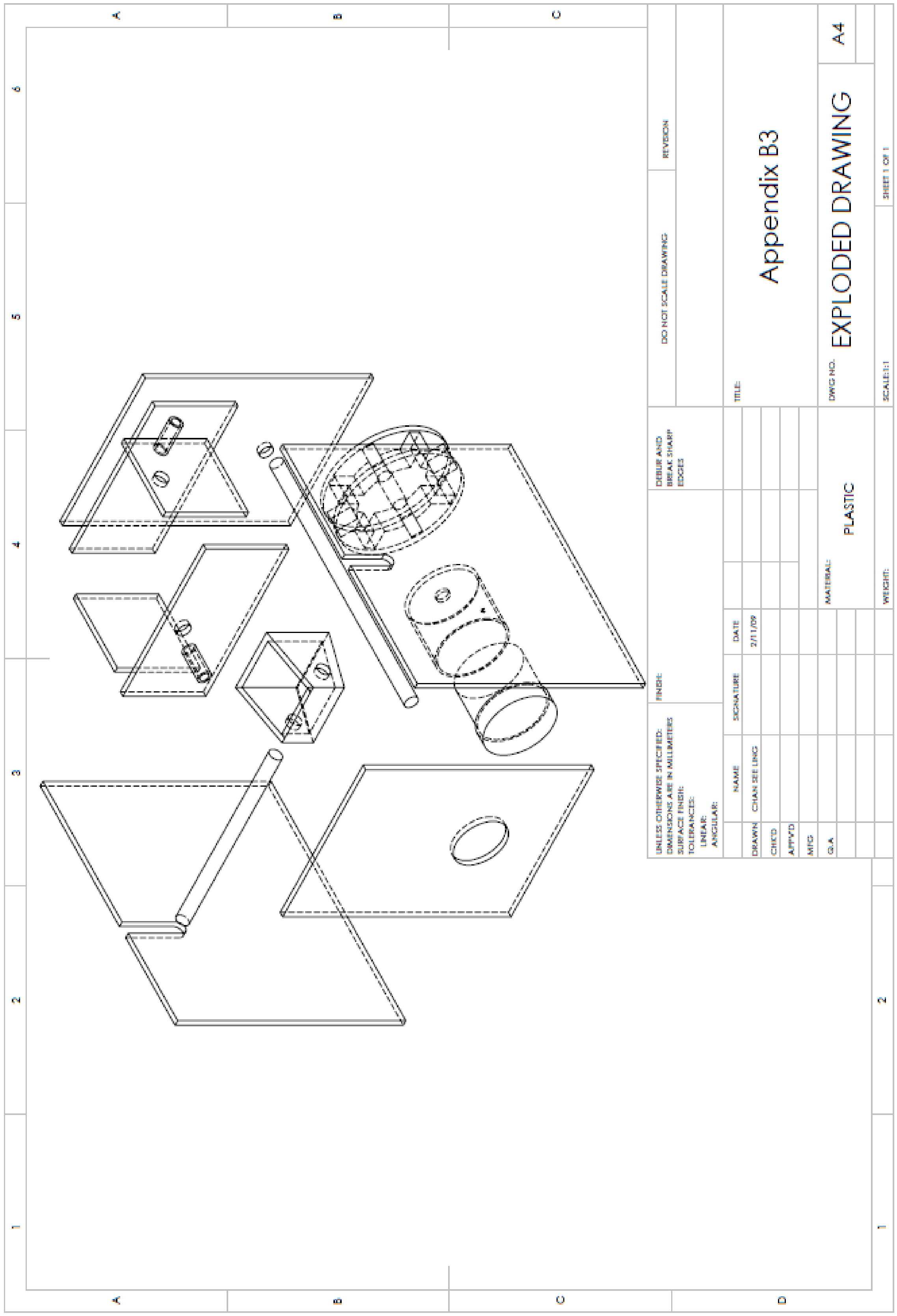
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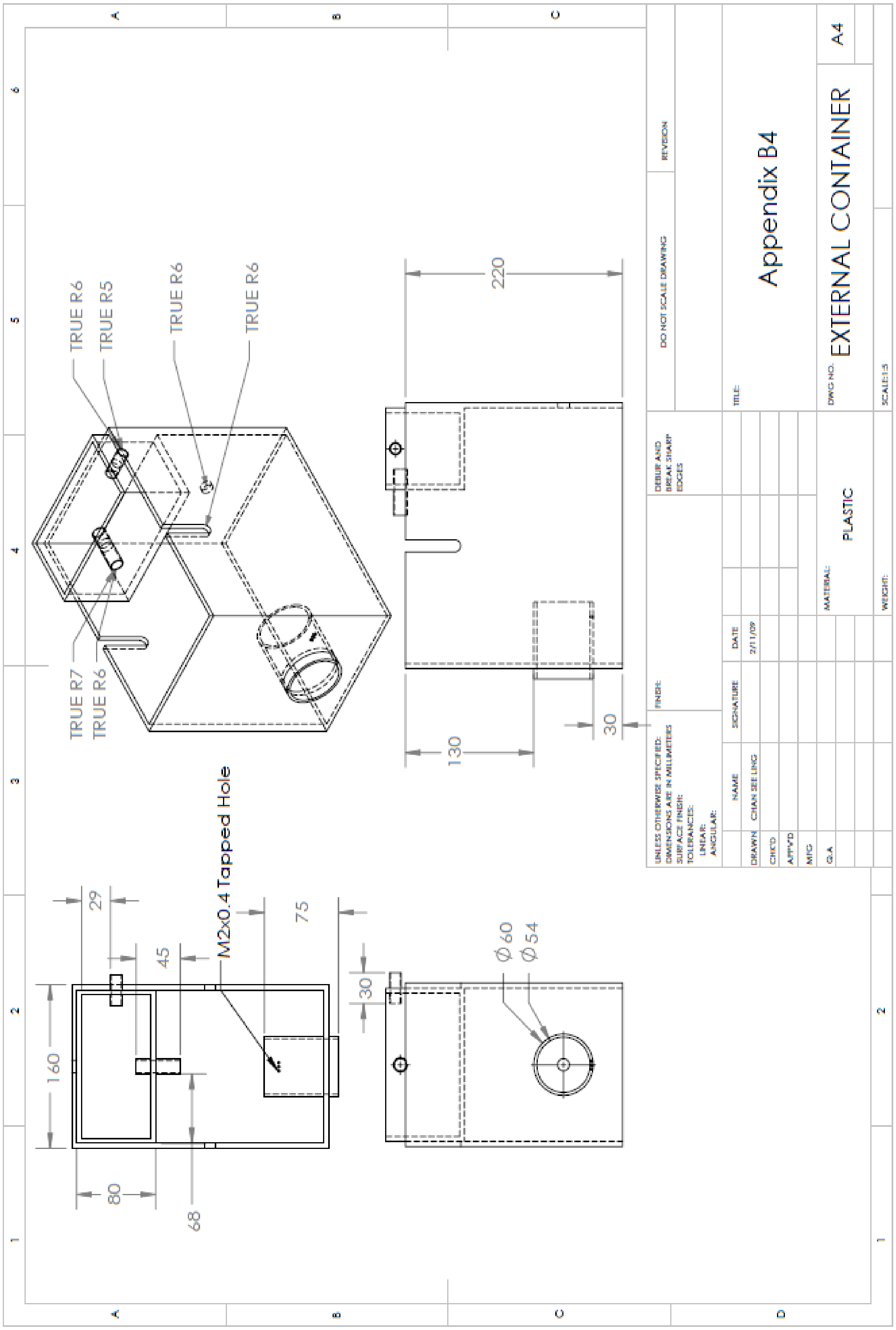

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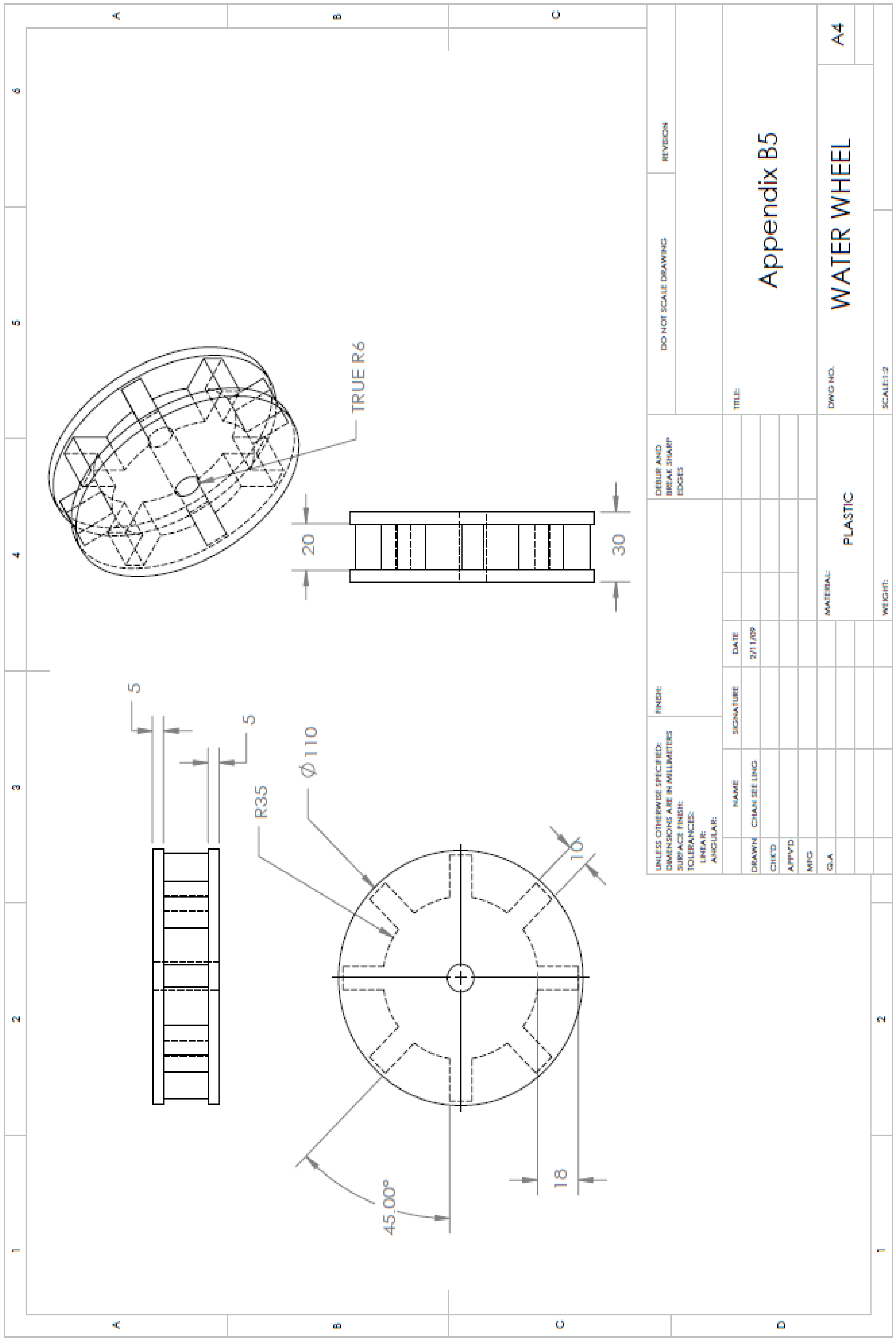
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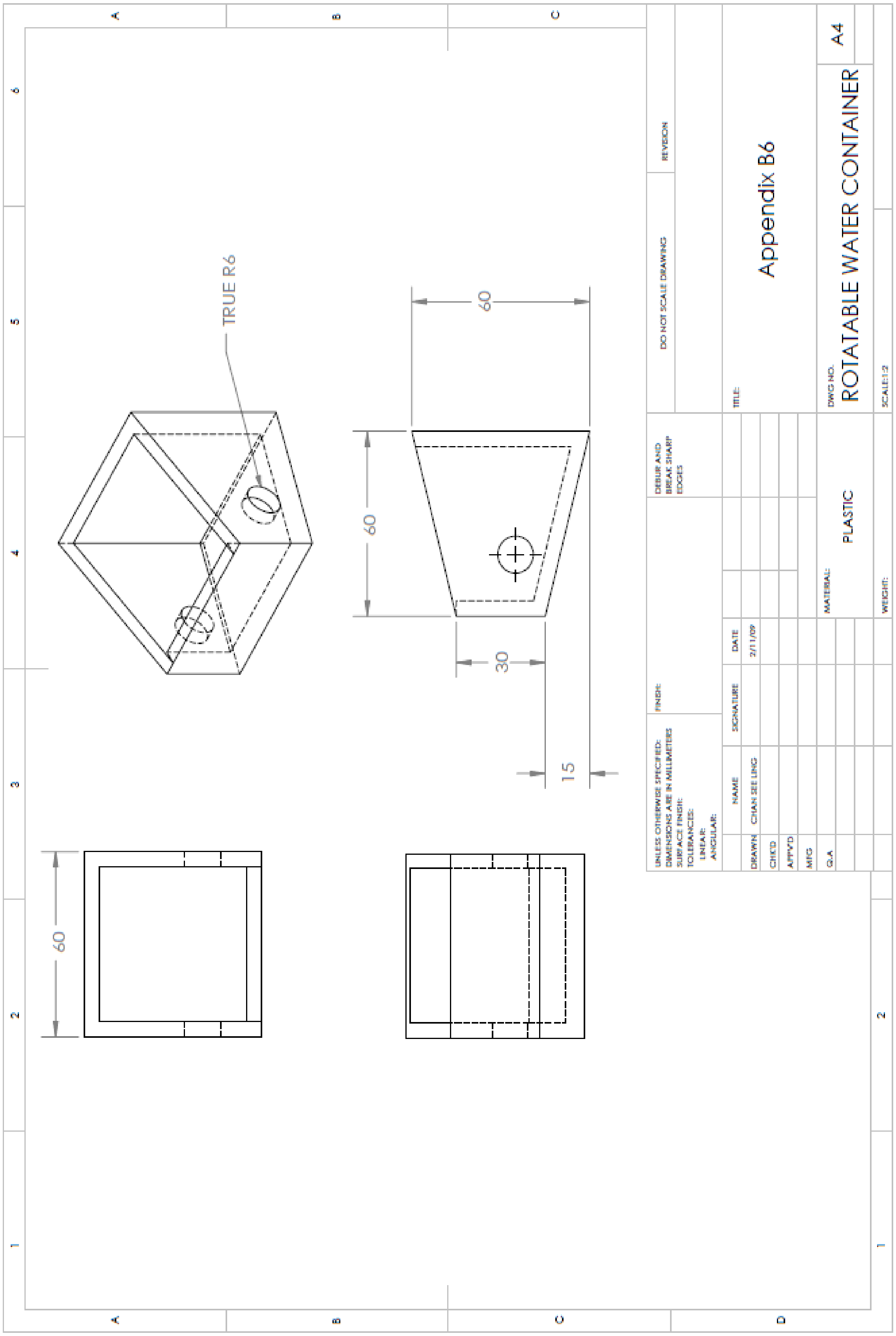

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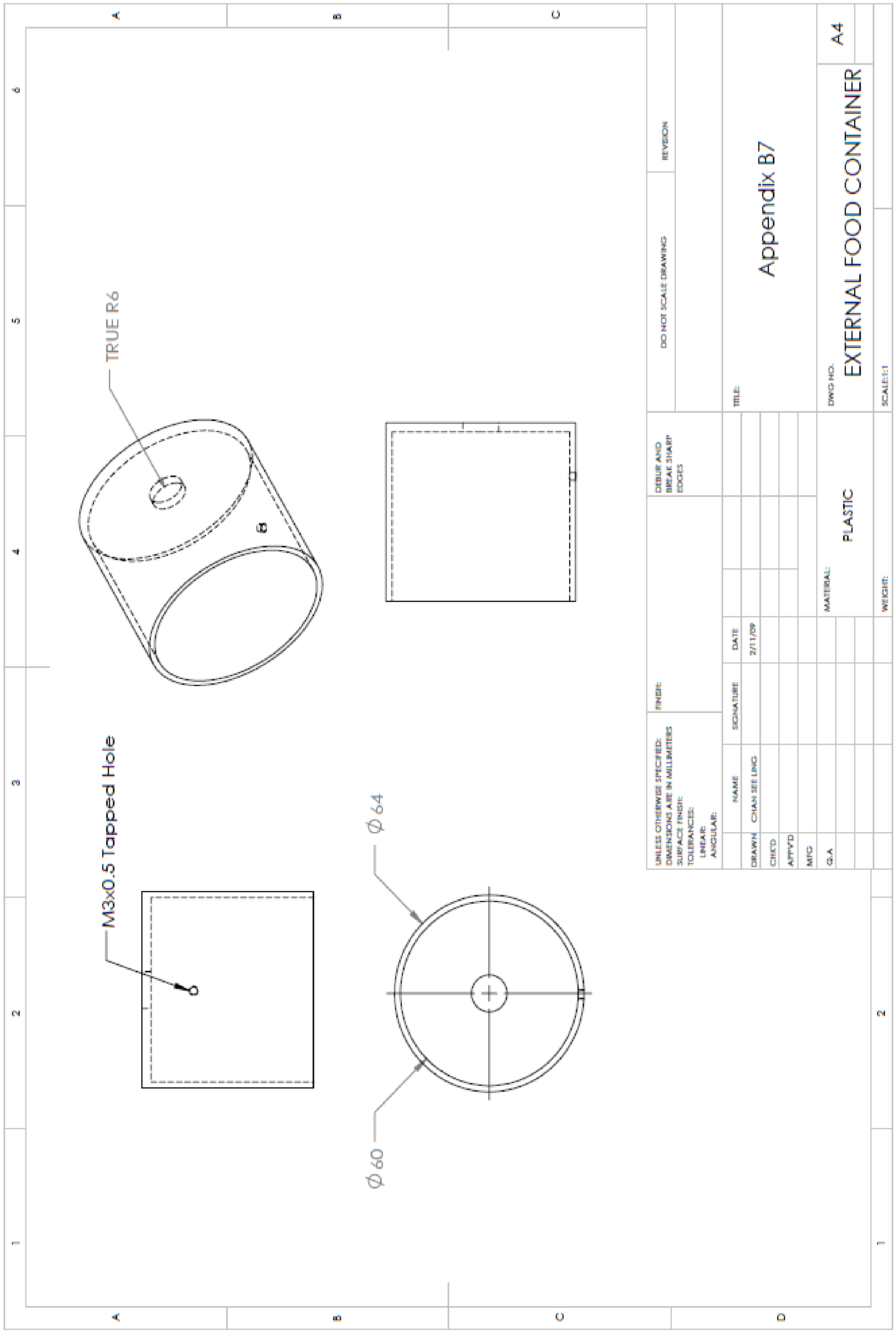
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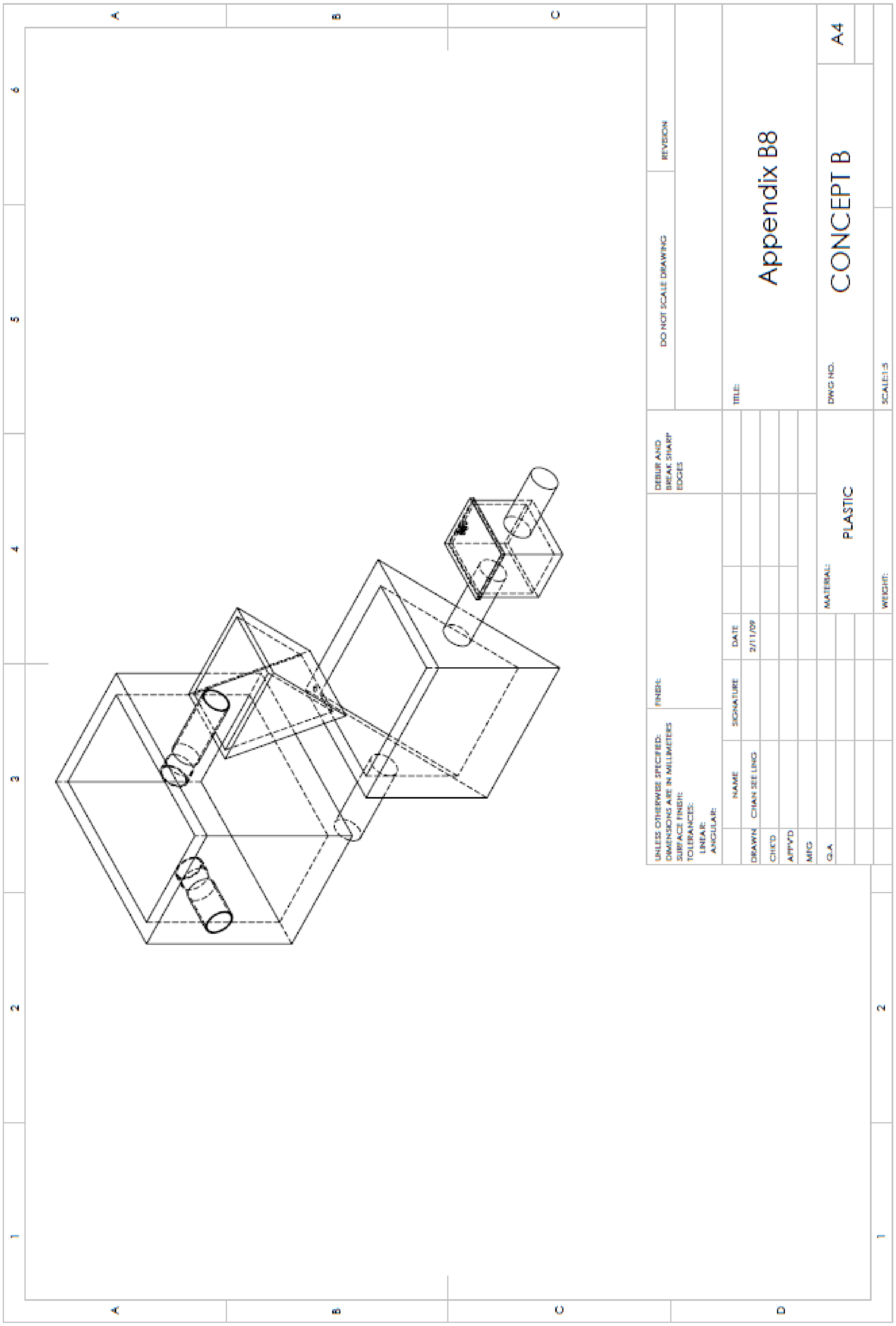
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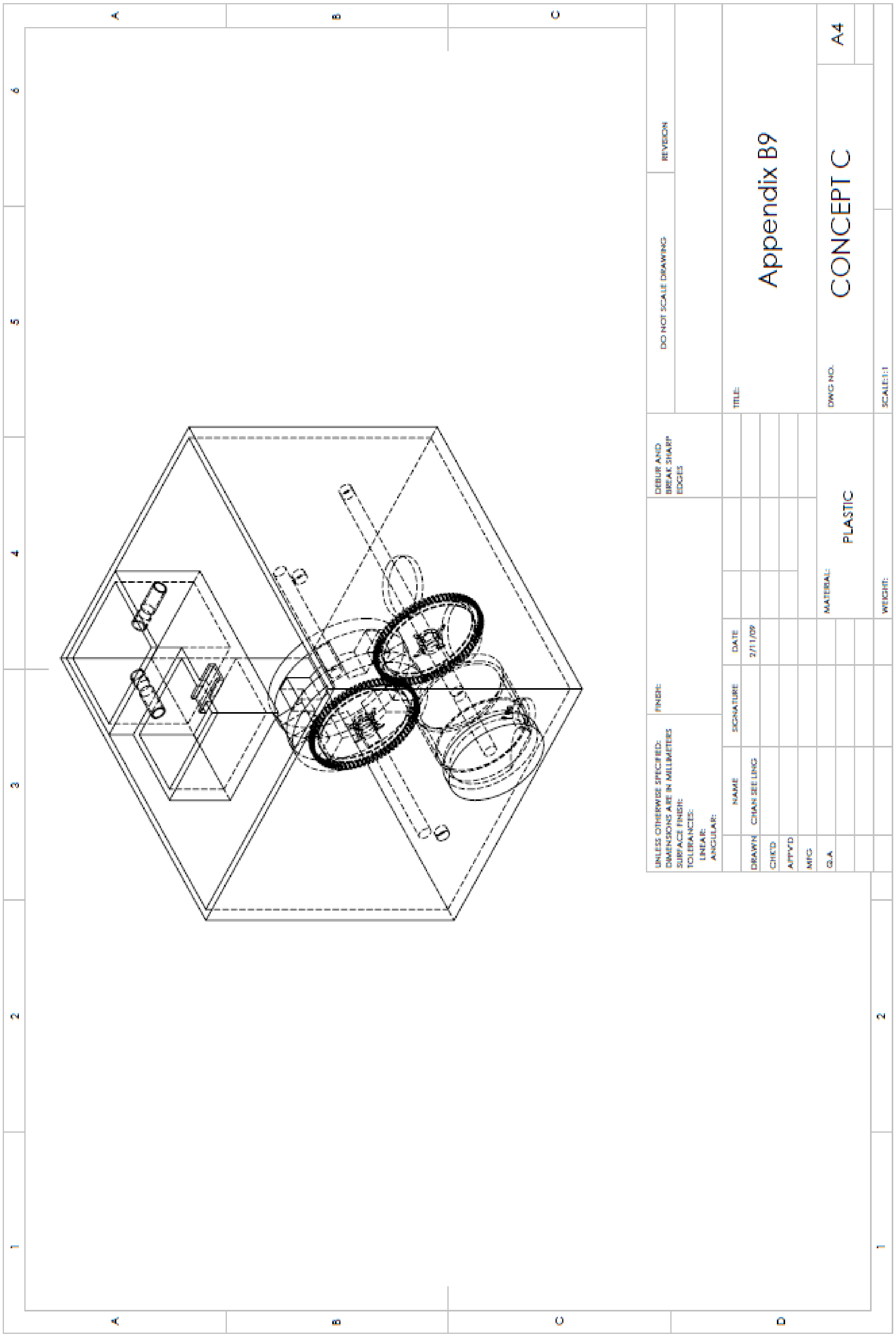
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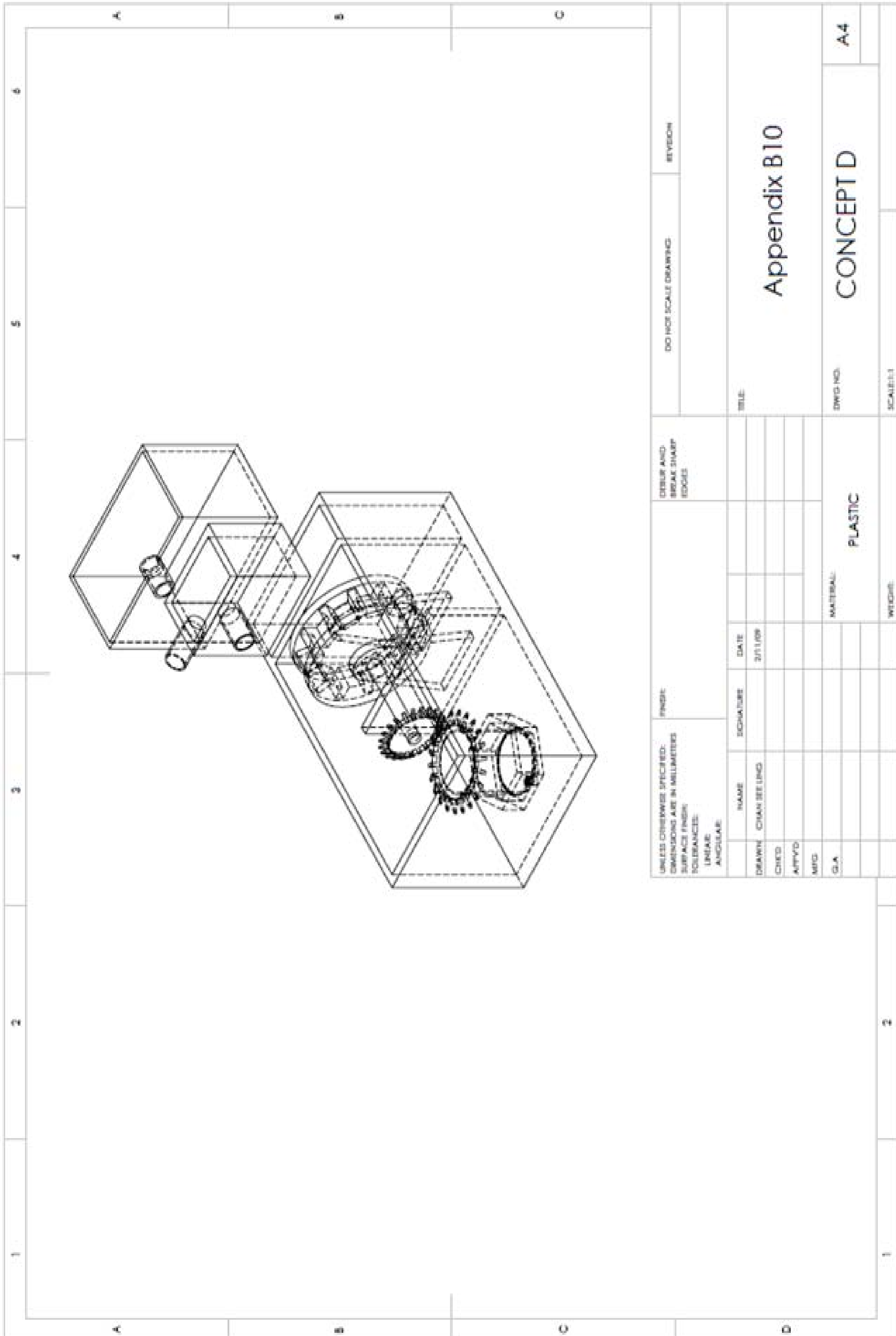

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APPENDIX C

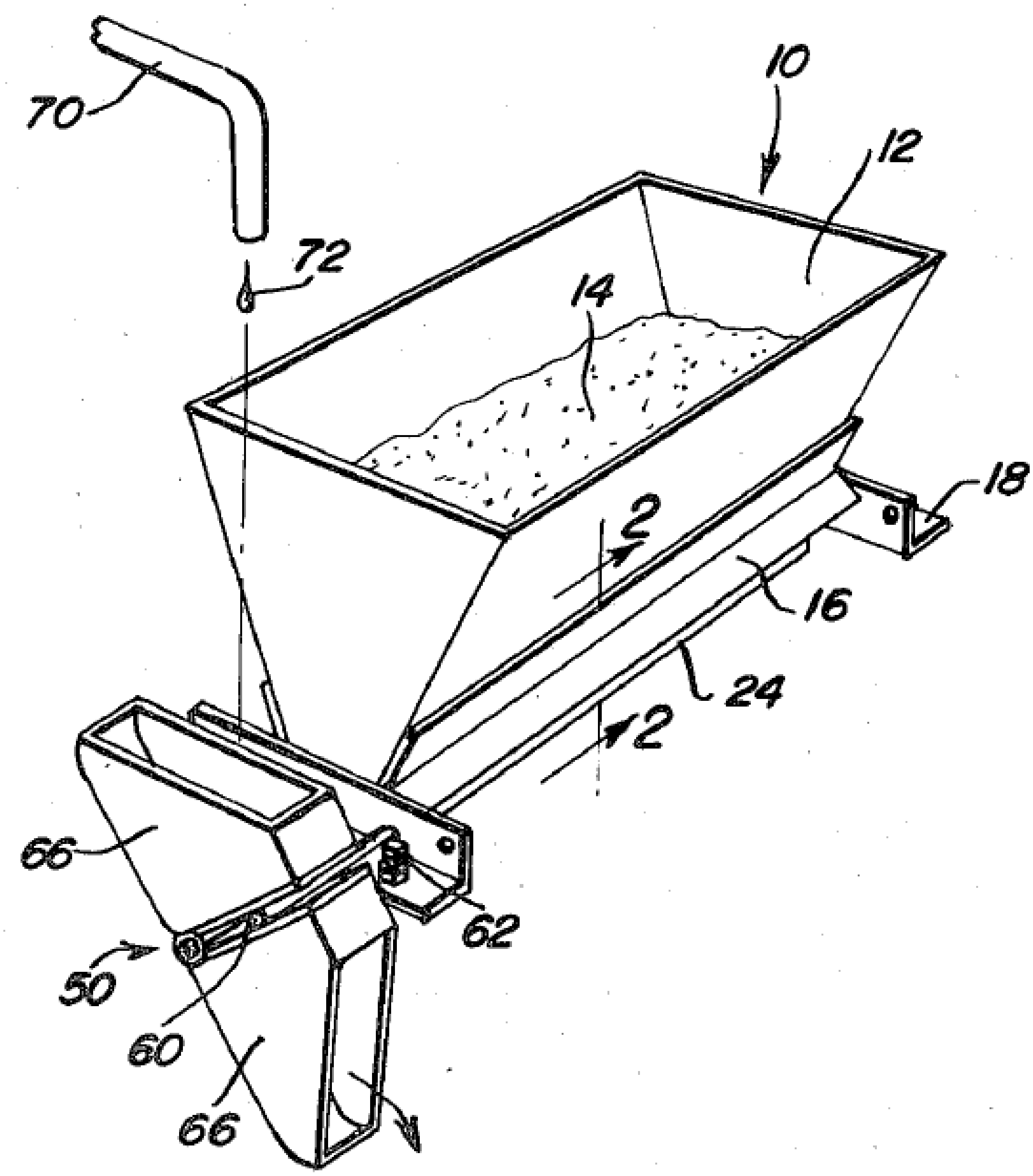
PATENT

Appendix C consists of the US Patent that used as references to generate concepts, which are:

- US Patent 4429660
- US Patent 4628864

Appendix C1

US Patent 4429660



Appendix C2

US Patent 4628864