

DESIGN AND FABRICATE A SYSTEMATIC DISH RACK DRAINER

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Report submitted in partial fulfilment of the requirements  
for the award of Diploma in Mechanical Engineering

Faculty of Mechanical Engineering  
UNIVERSITI MALAYSIA PAHANG

NOVEMBER 2008

### **SUPERVISOR'S DECLARATION**

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

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Name of Supervisor : EN MOHD SAZALI B SALLEH

Position : VOCATIONAL TRAINING OFFICER

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### **STUDENT'S DECLARATION**

I hereby declare 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 diploma and not concurrently submitted for award of other diploma.

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## **ACKNOWLEDGEMENTS**

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## **ABSTRACT**

The idea to create and build a systematic dish rack drainer is come from supervisor that gives me this title and task for this project. To design and fabricated this cabinet, it must be compare with other product that maybe available in the market. First, get an idea from internet, magazine, newspaper or other from available data. Form there the information and idea to design and fabricated can be created.

Whole project involves various methods such as collecting data, concept design and fabrication process. The whole project involved various method and process that usually use in engineering such as concept design, analysis process and lastly fabrication process.

This final year project takes one semester to complete. This project is individual project and must be done within this semester. In this project, students must able apply all knowledge during their studies in this Diploma of Mechanical Engineering course. Overall from this project, time management and discipline is important to make sure this project goes smooth as plan and done at correct time.

## **ABSTRAK**

Idea untuk menghasilkan dan membina rak pinggan yang bersistematik ini datang daripada penyelia yang memberi saya tajuk dan tugas untuk projek ini. Untuk merekabentuk dan menghasilkan kabinet ini, ia hendaklah dibandingkan dengan produk lain yang mungkin berada dalam pasaran. Langkah pertama, dapatkan maklumat daripada internet, majalah, suratkhbar atau daripada sumber yang lain.

Keseluruhan projek melibatkan pelbagai cara atau kaedah seperti pengumpulan data, rekabentuk konsep dan proses membina. Kaedah yang selalu yang digunakan dalam kejuruteraan seperti proses analisis juga digunakan.

Projek akhir tahun ini mengambil satu semester untuk disiapkan. Projek ini adalah projek individu dan mesti disiapkan dalam semester ini. Didalam projek ini, pelajar mesti berusaha menggunakan segala pengetahuan yang mereka perolehi semasa pembelajaran mereka di dalam kursus Diploma Kejuruteraan Mekanikal ini. Secara keseluruhan daripada projek ini, pengurusan masa dan disiplin adalah penting dalam memastikan projek berjalan lancar dan siap tepat pada waktunya.

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# UNIVERSITI MALAYSIA PAHANG

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**SESI PENGAJIAN:** 2006/2009

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## **CHAPTER 1**

### **INTRODUCTION**

#### **1.1 Introduction**

The title of this project is “design and fabricate a systematic dish rack drainer”. Fabrication of this systematic dish rack drainer is concern to strength, systematic, and more function this project is design and fabricates a systematic dish rack drainer. The fabrication of this product is concern on stops the puddle problem. It will put an end to stains and unhealthy mildew build-up. Keeps rack dry and eliminates having to mop up after washing dishes. Also, acquire the skill and knowledge of solid work, Mechanical Design, punching, and basic machining.

#### **1.2 Objective**

Diploma final years project objective is to practice the knowledge and skill of the student that have been gathered in solving problem using academic research to born an engineer that have enough knowledge and skill. This project also important to train and increase the student capability to get know, research, data gathering, analysis making and then solve a problem by research or scientific research.

The project also will educate the student in communication like in presentation and educate them to define their research in presentation. The project also will generate student that have capability to make a good research report in thesis form or technical

writing. This project also can produce and train student to capable of doing work with minimal supervisory and more independent in searching, detailing and expanding and knowledge.

Nevertheless this project also important to generate and increase interest in research work field.

### **1.2.1 Specific Project Objective**

The objectives for this project are:

- i. To study the current design dish rack drainer
- ii. To design and fabricate a systematic dish rack drainer
- iii. To develop a dish rack drainer able to achieve the product on customer need.

### **1.3 Scope**

The project scope of this project:

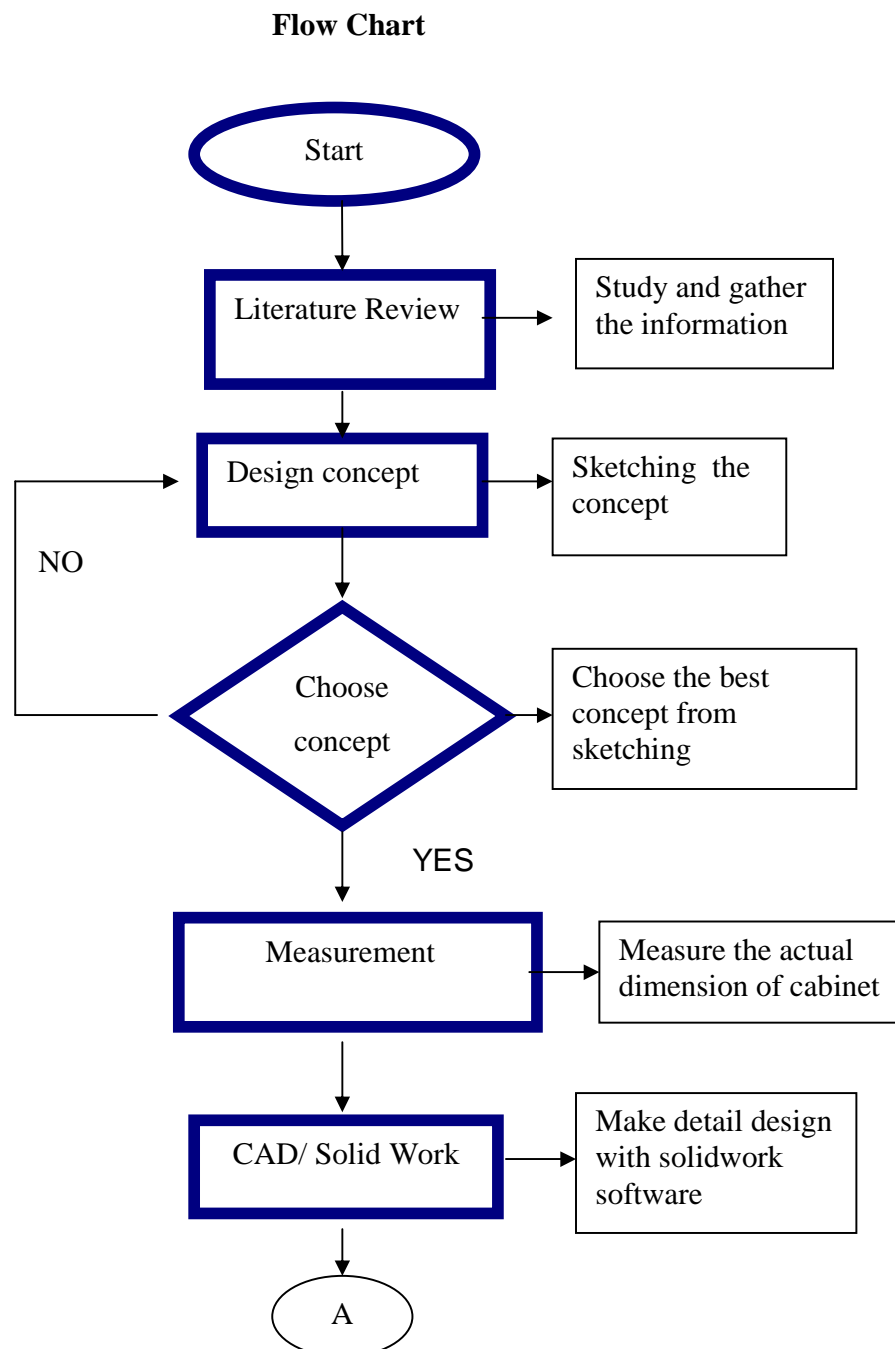
- i. To development of concept selection.
- ii. To determine about product specification.
- iii. Use solid work software to modeling systematic dish rack drainer.
- iv. To produce or develop using process such as bending and welding

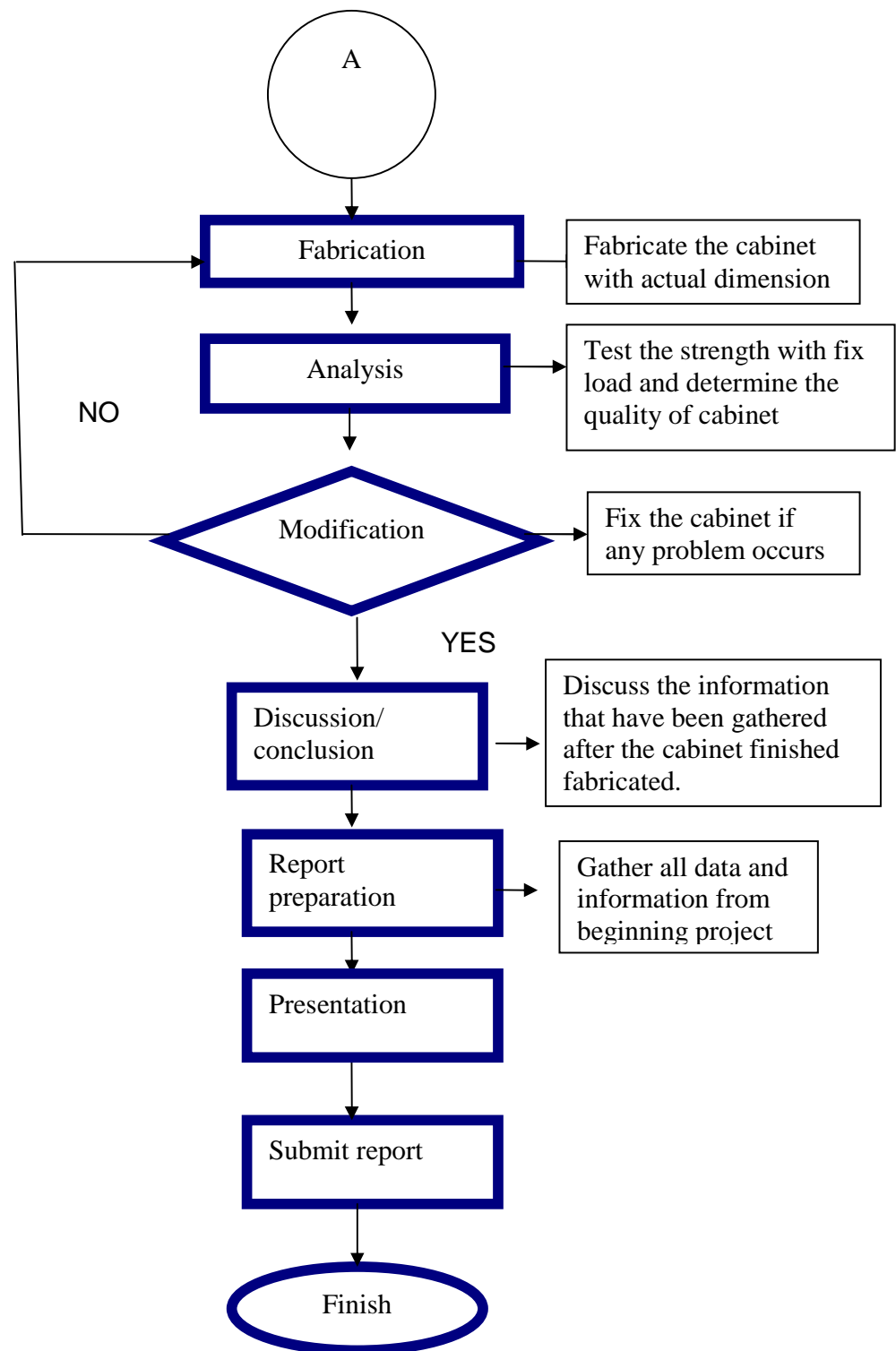




## 1.6 Flow Chart

In fabrication of systematic dish rack drainer, there is a planning of the overall progress to make sure the project can be finished on schedule.





**Figure 1.1:** Flow Chart

From the flow chart above, this project was start with literature review and research about the title. Then, study and make a lot of investigation about dish drainer. This includes a study about concept of dish drainer, process to fabricate, and material. These tasks have been done through study on the internet, books and others.

Then the information gathered and the project is continued with the design process. It is important to make a best design for the project. After several design sketched, the best concept have been chosen through it advantages. The selected design is then transferred to detail drawing by using Solid work software.

After all the engineering drawing finished, the drawing has been used as a reference for next process, which is fabrication process. The manufacturing processes include in this process are welding, cutting, drilling, bending and others. During the fabrication process, if any wrong occur the modification step will be take the action.

Analysis stage has been implemented after fabrication stage. The evaluation is by considering the strength, durability, safety and others.

Then after all processes that mentioned above are done, all materials for report writing are gathered. The report writing will be guided by the UMP final year report writing. Preparation for final presentation also being made by finished the slide show. The project ended after the presentation and submission of the report.

## **1.7 Conclusion**

This chapter describe about the objective that have earning when start the final year project about systematic dish rack drainer until finish this project. Scope project also list in order that know what scope need to fabricate this product example development of concept selection. before make the product about systematic dish rack drainer problem statement about the current dish rack drainer must know to easy to create new design to settle the problem. Flow chart and Gantt chart must use for become this project finish on time

## **CHAPTER 2**

### **LITERATURE REVIEW**

#### **2.1 Introduction**

The title design and fabrication systematic dish rack drainer an amount of good understand on the knowledge of this science. Therefore executing a research is necessary to obtain all information available and related of this topic. The information or literature reviews obtained are essentially valuable assist in the construction and specification of this final year project. Research review about dish rack drainer is to gathered data to make systematic dish rack drainer.

## 2.2 Technical Review

### 2.2.1 Product 1



**Figure 2.1:** Product 1

### Product Description

If you have a small kitchen or a small sink a draining board Dish Doctor will come to the rescue!! It has an integral reservoir to collect the drips and means that it can be placed on work surfaces and in effect doubles draining board capacity! Just lift the tray out to empty the drips! Simple but special. Its spikes hold plates of all sizes firmly and 2 cutlery drainers make drying easier too. It is made from the same polypropylene as ordinary dish racks

#### Advantages:

- i. Modern design
- ii. Easy to put the dish

#### Disadvantages:

- i. Not have tray

### 2.2.2 Product 2



**Figure 2.2:** Product 2

#### **Product Description**

Excellent compact dish drainer, ideal for your washing up or equally handy for additional storage inside your cupboards or on worktops. Contra two sturdy wire mesh shelves ideal for plates and bowls, an extended hanging shelf for cups and wine glasses and a detachable cutlery holder with three separators.

#### **Advantages:**

- i. Have certain to place the dish

#### **Disadvantages:**

- i. Small design



### 2.2.3 Product 3



**Figure 2.3:** Product 3

#### **Product Description**

Made of chrome plated steel, this two-level rack gives you twice as much space as other dish drainers (drainage tray not included). Use this handsome space-saving tool to dry clean dishes after washing or for permanent storage if you are running low on cabinet space.

Includes an angled storage area on top that keeps plate, platters, and baking pans upright and vertical at one time as well as a second shelf on the bottom, for bowls, cups, glasses, and other items. It also comes with a white-painted cutlery caddy dish for eating and cooking utensils.

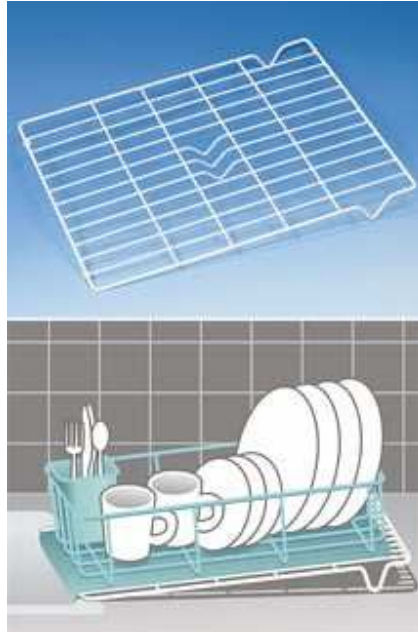
#### **Advantages**

- i. Dish fast to dry

#### **Disadvantages**

- i. Have puddle problem

#### 2.2.4 Product 4



**Figure 2.4:** Product 4

#### **Product Description**

Dish Rack Drainer stops the puddle problem! Tilted base holds dish rack and mat at an angle to drain excess water into sink. Puts an end to stains and unhealthy mildew build-up. Keeps counter dry and eliminates having to mop up after washing dishes. Rust-resistant, vinyl-coated steel

#### **Advantages**

- i. Systematic design

#### **Disadvantages**

- i. Must place at the sink

### **2.3 Design**

The Design of the systematic dish rack drainer must be compliance to several aspects. The design consideration must be done carefully so the design can be fabricated and the parts are all functioning. The aspects that must be considered in designing the systematic dish rack drainer are:

- i. Strength: Must have certain strength to ensure that it can load heavy dish items.
- ii. Ergonomics: dish rack must be user friendly as easy and convenience.
- iii. Cost: the cost of whole system must been not exceed from budget given and also reasonable
- iv. Environment: the systematic dish rack drainer is suitable to be use in all types home kitchen

### **2.4 Drawing**

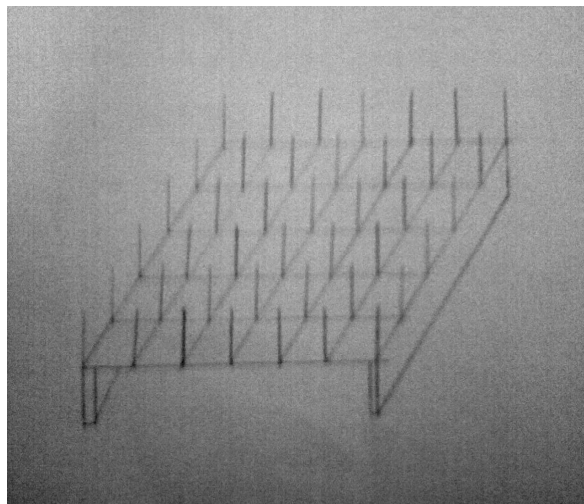
The drawing are dividing into 2 categories

- i. Sketching: all the ideas for systematic dish rack drainer are sketched on the paper first to ensure that ideas selection can be made after the selected design choose
- ii. Solid work: the design sketched transfer solid modeling and drawing using solid work

## 2.5 Sketched and Drawing Selection

From the concept selection, only 3 sketching that had been chosen to be considered as the final ideas.

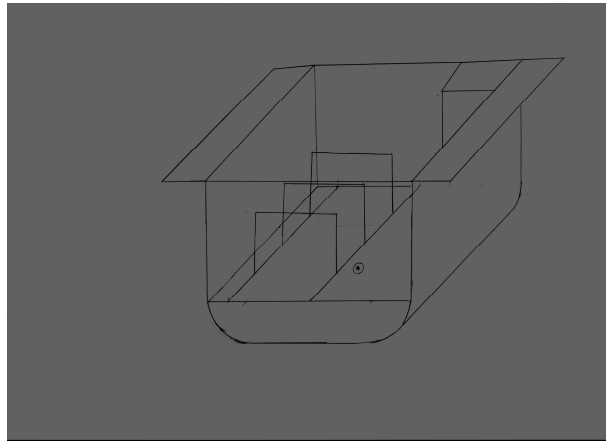
### 2.5.1 Concept 1



**Figure 2.5:** Concept 1

This concept is the datum concept to generate other concept. This concept is simple because can make any dish plate. Rod can plug and unplug follow suitable types of dish. Style to arrange the dish can be adjustable. To arrange the plate use angle 90° for easy dish to dry. Part of this concept use sheet metal steel and steel rod. This concept is not suitable for small dish plate.

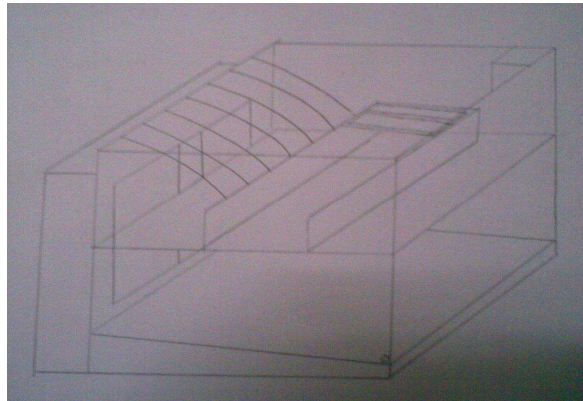
### 2.5.2 Concept 2



**Figure 2.6:** Concept 2

This concept is place on the sink. Have the section to place dish, glass, spoon and fork. Dimension of this concept design follow the area of the sink. Drain plug place at the bottom to flow water at sink. This concept use stainless steel sheet metal and hollow stainless steel. These concepts only suitable for home have two sink.

### 2.5.3 Concept 3



**Figure 2.7:** Concept 3

This concept is generated from concept 1 and 2. this concept has a section to place any types of dish and use angle 90°. It has 3 major parts and then assemble into 1 main part. These concepts have a systematic flow system. Use drain board and hose to flow water. Fan also use in order that dish fast to dry.

## 2.6 Metric Chart and Evaluation

Concepts for systematic dish rack drainer were developed. These are evaluated against the datum of the dish rack drainer

**Table 2.1:** Metric Chart

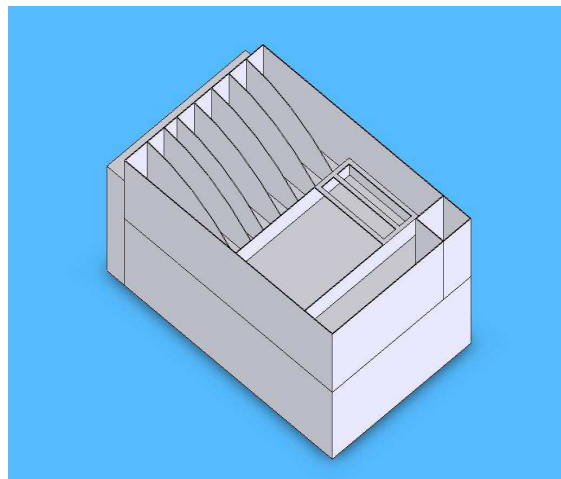
criteria	design 1	design 2	design 3	best design
simple design	*****	****	***	1,2
have section	**	***	*****	3
flow system	*	****	*****	2,3
portable	****	****	****	1,3
not have puddle problem	*	***	*****	3
dish fast to dry	***	***	*****	3
have drain board	*	****	*****	2,3
<p><b>Notes:</b></p> <p>* = very bad</p> <p>** =bad</p> <p>*** = medium</p> <p>**** =good</p> <p>***** = very good</p>				

From the metric chart table, the advantages and disadvantages of design can be outline. Criteria or characteristic for the product to be fabricated are the important thing to be consider before fabrication process.6 criteria are been chosen to be considered. According the table, study of concept selection show that concept 3 has many same with need criteria.

## **2.7 Solid work Design Drawing**

After a design has been selected, the next step in designing process is dimensioning. The design is separated into part by part and dimensioning process is firstly sketched on paper. The dimension base on relevant dimensions and also referring the existence dish rack drainer so that design is fit into other part

After dimensioning, the drawing of the design is drawn using solid work application, at this stage solid modeling method is used. Part by part solid modeling create according to the dimension done before, after all part create, the 3D model is assemble with each other base on design



**Figure 2.8:** Solid work Design



## **2.8 Conclusion**

According to literature study can see many products at the market. After the analysis of the advantages and disadvantages made, some criteria about systematic dish rack drainer necessary to create the concept. 3 concept design for systematic dish rack drainer were developed. After developed the concept design metric chart and evolution done, the best concept can be choose. Then, Solid work design did to create 3D concept and fabricate the product.

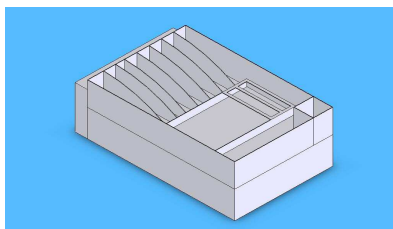
## **CHAPTER 3**

### **METHODOLOGY**

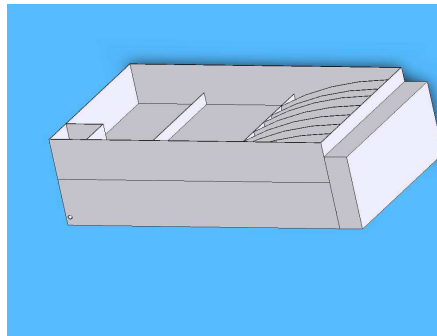
#### **3.1 Introductions**

After designing phase, comes fabrication process. These processes is about using the material Selection and make the product base on the design and by followed the design dimension. Many methods can be used to fabricate a product, like welding, fastening, cutting, drilling and many more method. Fabrication process is difference from manufacturing process in term of production quantity. Fabrication process is a process to make only one product rather then manufacturing process that focus to large scale production. Fabrication process was used at the whole system production. This was include part by part fabrication until assembly to others component.

#### **3.2 Research Design**



**Figure3.1:** Research Design



**Figure3.2:** Research Design

### 3.3 Design Specification

Based on the drawing and sketching dimension, after generate and evaluated the best concept selection refer to metric chart. The concept 3 is the best design that can be fabricated. This is detail product specification of concept 3

**Table 3.1:** Design Specification

No	Parts	Description /Type of materials	Dimension (cm)	Quantity
1	Drain board	Sheet metal (zinc) 1.5mm Aluminum 1mm	45 x 20 30 x 4	1
2	Below Chassis	Hollow bar (iron)	300 x 1.5	1
3	Cover below chassis	Sheet metal (aluminum) 0.3mm	200 x 200	1
4	Fan cover	Acrylic 5mm	21 x 40	1
5	Tray chassis a	Acrylic 5mm	40 x 10	2
6	Tray chassis b	Acrylic 5mm	60 x 10	2
7	Divider dish	Acrylic 5mm	25 x 10	9
8	Spoon chassis	Acrylic 5mm	8 x 8	2
9	Saucer chassis	Acrylic 5mm	20 x 10	1
10	Divider section	Acrylic 5mm	40 x 3	3
11	Net	Plastic	60 x 40	1
12	Hose	Plastic	50	1

### **3.4 Fabrication Process**

After designing phase, fabrication processes take place. These processes are about using material selection and make the product base on the design and by followed the design dimension. Many methods can be used to fabricate the a product, like shearing,drilling,punching and many more methods. Fabrication process is a process to make only one product rather then manufacturing process was used at the whole system production. This ways include part by part fabrication until assembly to other component

### **3.5 Process Involve**

In order to make the design come to reality, fabrication process needs to be done first. The fabrication process starts from dimensioning the raw material until it is finish as a desired product. The processes that involved are:

- i. Measuring: Materials are measured to desired dimensions or location.
- ii. Marking: All measured materials need to be marked to give precise dimension.
- iii. Shearing: Marked materials are then cut into pieces.
- iv. Bending: sheet metal undergoes process bending to get true shape for the project
- v. Joining: Materials joined by the method of MIG welding and rivet.
- vi. Drilling: Marked holes are then drilled to make holes for rivet.
- vii. Laser cutting :cut the prospect
- viii. Assembly: assemble part to another part

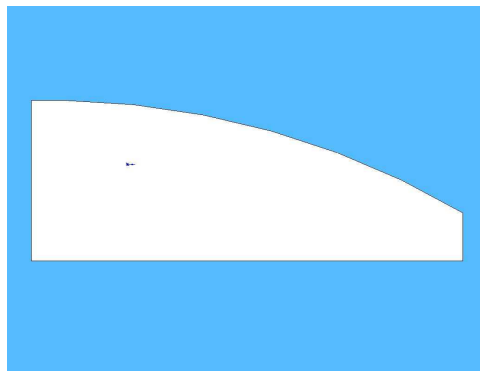
### 3.6 Part by Part Fabricate

#### 3.6.1 Tray Chassis



**Figure 3.3:** Tray Chassis

- i. Design part by part with solid work design



**Figure 3.4:** Example Design Part by Solid work

- ii. Convert design to art cam software
- iii. Use program pcnc.h to convert G code to machine

- iv. Set the delay 2800
- v. Move machine use program jogging edit
- vi. Cut the acrylic use laser cutting machine



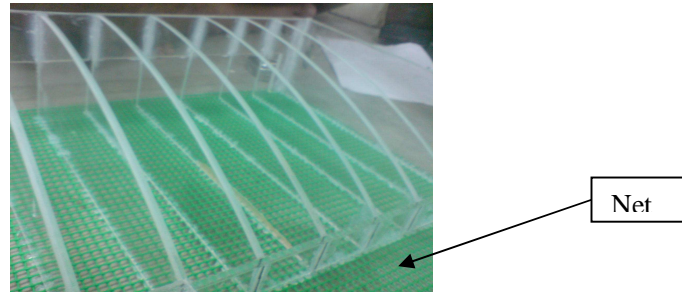
**Figure 3.5:** laser Cutting Machine

- vii. Overall Time take to cut the acrylic is 15 minutes
- viii. Use silicon gum to joint part by part



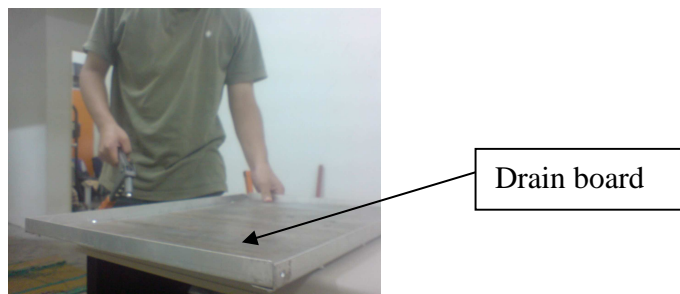
**Figure 3.6:** Joint Process use Silicon Gum

- ix. Put plastic net to support



**Figure 3.7:** Net

### 3.6.2 Drain Board



**Figure 3.8:** Drain Board

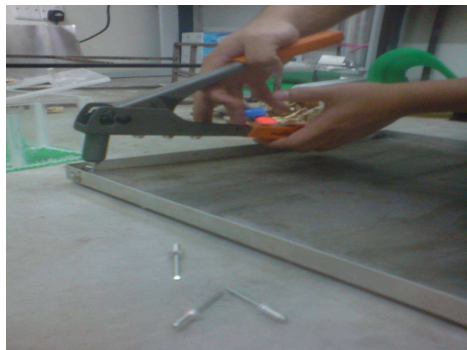
- i. Material use is sheet metal aluminum and zinc
- ii. Measuring the material to required dimension
- iii. Cut the material using shearing machine
- iv. Use bending machine to make L shape 90°

- v. Drill to make holes



**Figure 3.9:** Drill Process

- vi. Rivet to joint



**Figure 3.10:** Rivet

- vii. Put the hose at drain board



### 3.6.2 Below Chassis



**Figure 3.11:** Below Chassis

- i. Material use is hollow bar iron 1.5mm x 1.5mm
- ii. Measuring material to required dimension
- iii. Use disc cutter to cut the material



**Figure 3.12:** Disc Cutter

- iv. Joining process is using MIG (metal inert gas) welding.



**Figure 3.13:** MIG Welding

- v. Then grinded to make sure that the entire joint surface was smooth from any spatters or sharp edge



**Figure3.14:** Grinded

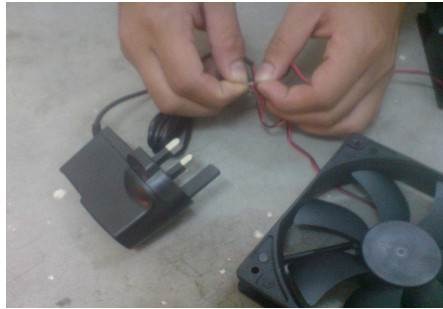
- vi. Cover below chassis with sheet metal aluminum. Joining method use rivet

### 3.6.4 Fan Chassis



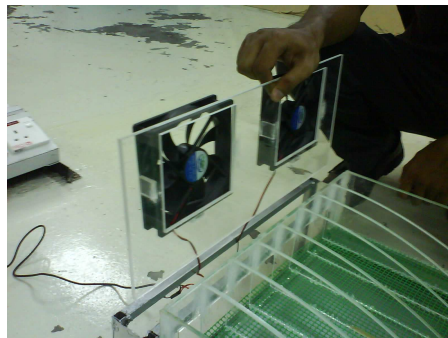
**Figure 3.15:** Fan Chassis

- i. Material use is acrylic
- ii. Design with solid work design
- iii. Convert design to art cam software
- iv. Use program pcnc.h to convert G code to machine
- v. Set the delay 2800
- vi. Move machine use program jogging edit
- vii. Cut the acrylic use laser cutting machine
- viii. Time take to cut the prospect is 20 minutes
- ix. Make the wire ring between fan and adapter



**Figure 3.16:** Wire ring

- x. Test fan
- xi. Put the fan at the chassis



**Figure 3.17:** Put Fan at Chassis

## **CHAPTER 4**

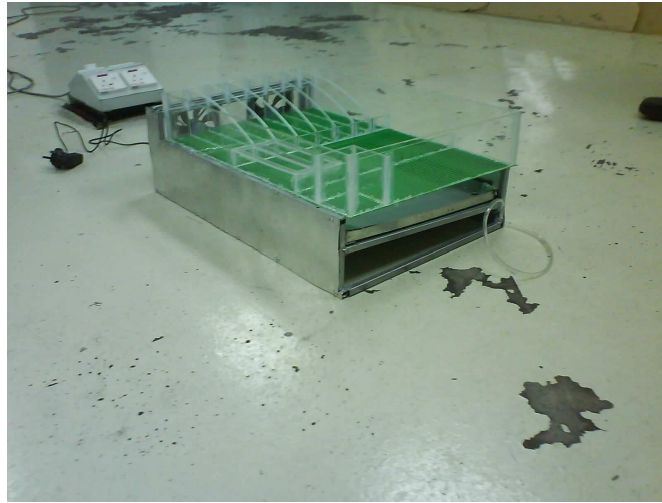
### **RESULT AND DISCUSSION**

#### **4.1 Introduction**

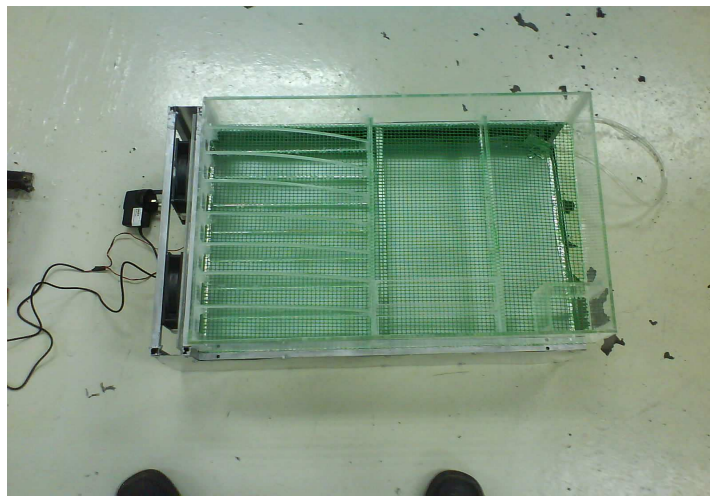
After done fabrication process the design would through testing process where the data would be taken and then analysis process by using Solidwork+Cosmos software where could determine the strength and ductility of product when it perform. In this process too we could notice the design functionality when the data from testing process in demonstration are gained and being tabled then. After done with it the discussion would took place which is come out from the result in testing process and all matter about the design such as it specification including it weight and dimension.

#### **4.2 Final Product**

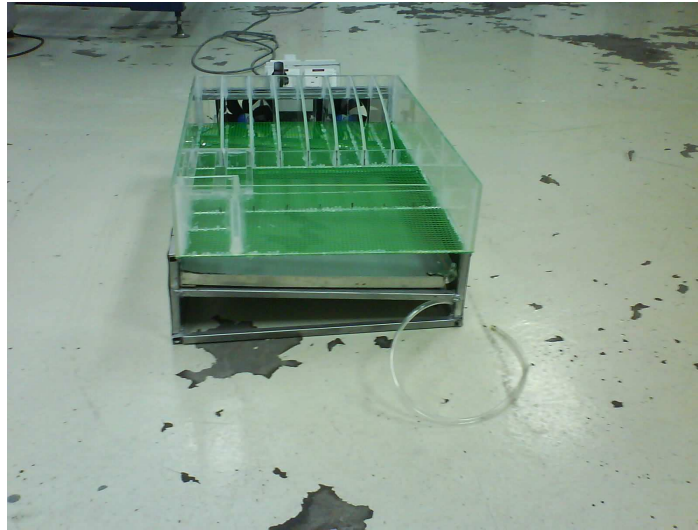
The systematic dish rack drainer was finish and get result after undergoes step by step start with literature review, design and sketching ,technical drawing and solid modeling using solid work application, fabrication process with cutting, drilling, joining and assembly At this stage, all information about this product is collected and gathered. It is important to classify the product before it can use. The complete fabrication of the product is like below



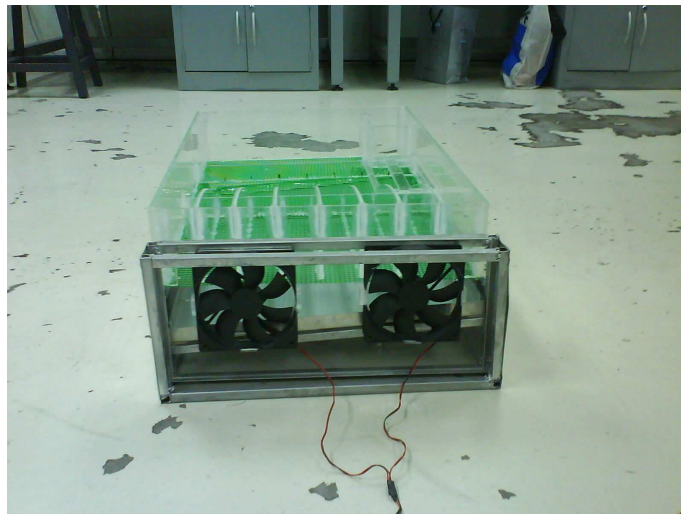
**Figure 4.1:** Systematic Dish Rack Drainer Isometric View



**Figure 4.4:** Systematic Dish Rack Drainer Top View



**Figure 4.3:** Systematic Dish Rack Drainer Front View



**Figure 4.2:** Systematic Dish Rack Drainer Back View

### **4.3 Product Specification**

This specification actually was change a little bit from initial plan because after through some processes such as fabrication process and material preparation process the result shown improper result. After done with it the final specification could be finalized as shown below;

#### **4.3.1 Material**

- i. Aluminum
- ii. Acrylic
- iii. Zink
- iv. Hollow bar iron

#### **4.3.2 Dimension**

65cm x 40cm x 21cm

#### **4.3.3 Fabrication Method**

- i. Rivet, fastening process and glue to join part by part
- ii. Shearing machine to cut off Aluminum and zinc plate
- iii. Laser cutting pc\_nc
- iv. Welding (MIG) to joint part

#### **4.3.4 Overall Weight**

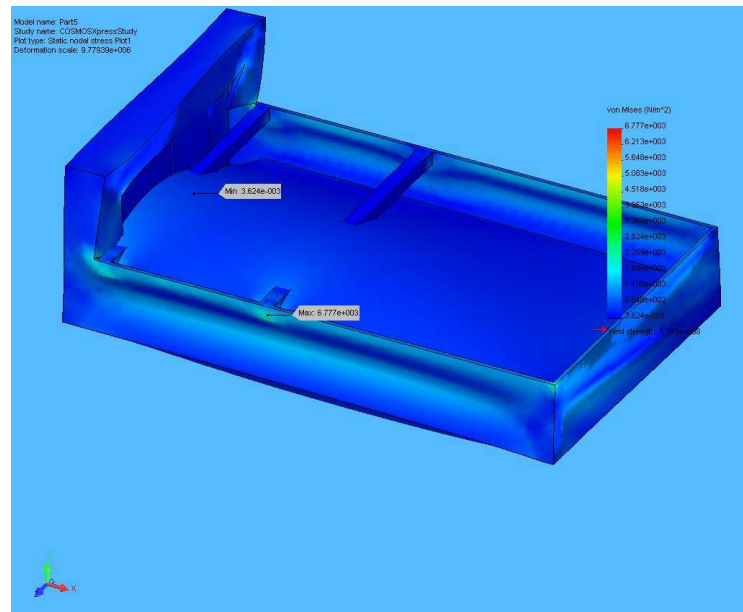
It was estimate 5kg



#### 4.4 Product Analysis

If the dish put at the rack, there have forces that acted on the net at the rack. We need to determine and study the effect on that which is bringing up by dish. To study the effect whether design would failure to perform well or it would damage when demonstration is held. By using Solid work + Cosmos analysis software it would help us to study the stresses that acted on design and determine the condition of design such as crack and bending at design. Basically this process is very important because for engineer or designer who intend to fabricate and designing new product the analysis should be held because it directly help us a lot of benefit such as got reduce cost and know the design capable off.

#### 4.5 Cosmos Analysis



**FIGURE 4.5:** Cosmos analysis

#### 4.5.1 Introduction

Summarize the FEM analysis on below chassis

#### 4.5.2 File Information

##### Model name:

Below chassis

##### Study name:

COSMOSXpressStudy

#### 4.5.3 Material

**Table 4.1:** Material

No.	Part Name	Material	Mass	Volume
1	Below chassis	[SW]Ductile Iron	42.8558 kg	0.00542478 m <sup>3</sup>

#### 4.5.4 Load and Restraint Information

##### Restraint

Restraint1 below chassis

On 1 Face(s) immovable (no translation).

##### Load

Load below chassis

On 3 Face(s) apply normal force 10 N using uniform distribution

#### 4.5.5 Study Properties

**Table 4.2:** Study Properties

Mesh Information	
Mesh Type:	Solid mesh
Meshed Used:	Standard
Automatic Transition:	Off
Smooth Surface:	On
Jacobian Check:	4 Points
Element Size:	17.574 mm
Tolerance:	0.8787 mm
Quality:	High
Number of elements:	16073
Number of nodes:	32504

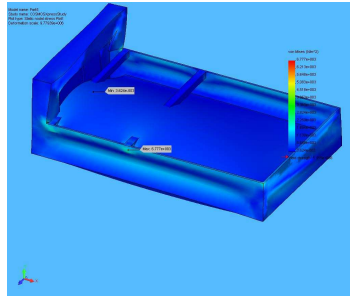
Solver Information	
Quality:	High
Solver Type:	FFE

#### 4.5.6 Stress Results

**Table 4.3:** Stress Results

Name	Type	Min	Location	Max	Location
Plot1	VON: von Mises stress	0.00362399 N/m <sup>2</sup>	(0 mm, 93.5241 mm, 159.532 mm)	6777.3 N/m <sup>2</sup>	(202.101 mm, 92.6583 mm, 363.01 mm)

### Below chassis –COSMOSXpressStudy-Stress-Plot1



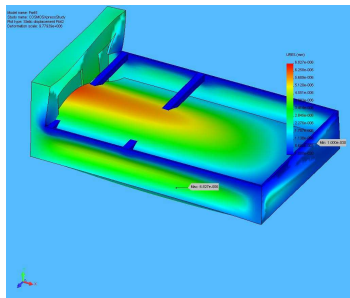
**Figure 4.6:** Stress Result

#### 4.5.7 Displacement Results

**Table 4.4:** Displacement Result

Name	Type	Min	Location	Max	Location
Plot2	URES: Resultant displacement	0 mm	(0 mm, 110 mm, 363.01 mm)	6.82724e-006 mm	(263.875 mm, 0 mm, 228.88 mm)

**Below chassis -COSMOSXpressStudy-Displacement-Plot2**



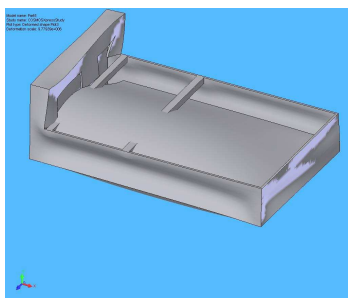
**Figure 4.7:** Displacement Result

#### 4.5.8 Deformation Results

**Table 4.5:** Deformation Result

Plot No.	Scale Factor
1	9.7794e+006

**Below chasis-COSMOSXpressStudy-Deformation-Plot3**



**Figure 4.8:** Deformation Result

#### 4.6 Actual Analysis and Data Result

After fabricate the dish rack drainer actual analysis must do. The objective make the actual analysis is to know how many loads can hold. The analysis make at the tray chassis because it important part. Tray chassis use to hold the load. That place is place to put dish, glass and etc. This process was conducted by using the design to place dish follow the heavy and the result from testing process is shown below.



**Figure 4.9:** Test Product

**Table 4.6:** Actual Analysis Result

Load (g)	Result
50	ok
100	ok
150	ok
250	Ok
300	Ok
400	No (net start to crack)

From the table actual analysis, the tray chassis can hold the maximum load is 30kg. according the result when apply load 35 kg the net start to crack. It shown the load did loose the elastic region and become plastic region.

#### **4.7 Conclusion**

After gained all the data the conclusion about design whether it performing well or otherwise could be notice and then the improving work being implemented in order to overcome the failure in previous. In this chapter it used two methods to analyze the design which is one is testing manually and the other one by using software. These two processes are depending on each other because the failure only could be determine by using these two methods.

## **CHAPTER 5**

### **CONCLUSION AND RECOMMENDATION**

#### **5.1 Introduction**

For the final chapter it present about conclusion and recommendation for the project. The important things for this chapter are about the problems encountered during the whole project carried out. The problem are included the process planning that have been done. These project problems also make the student to think more creative to solve the problem. This chapter also discuss about the conclusion of the project that is concluding all the process involved. Beside that, this chapter also contains recommendation about project. This is very important to make some improvement about the project for future work.

#### **5.2 Conclusion**

As the conclusion, the objective of the project was achieved. The dish rack drainer has better space for better arrangement of dish. This because the dimension of the rack is 650 x 400 x 210 mm. So it has very suitable space to storage the dish. Besides that this dish rack that has been designed to systematic. So the Systematic Dish Rack Drainer stops the puddle problem. It will put an end to stains and unhealthy mildew build-up. Keeps rack dry when storage the dish. This rack also provide better ergonomic factor for the comfortable situation when using it. It also was introduced new concept of the rack that suitable with costumer specification.



## 5.2 Recommendation

After finish the project, the rack look very systematic and interesting. But several recommendations to improvement for me and faculty for future final year project are still need.

- i. change material drain board

The material that be used for drain board need to change from sheet metal zinc to sheet metal aluminum. This can avoid the rust of the project and then drain board become light.

- ii. Use acrylic

Use acrylic to all part of the dish rack to appear more ecstastic.

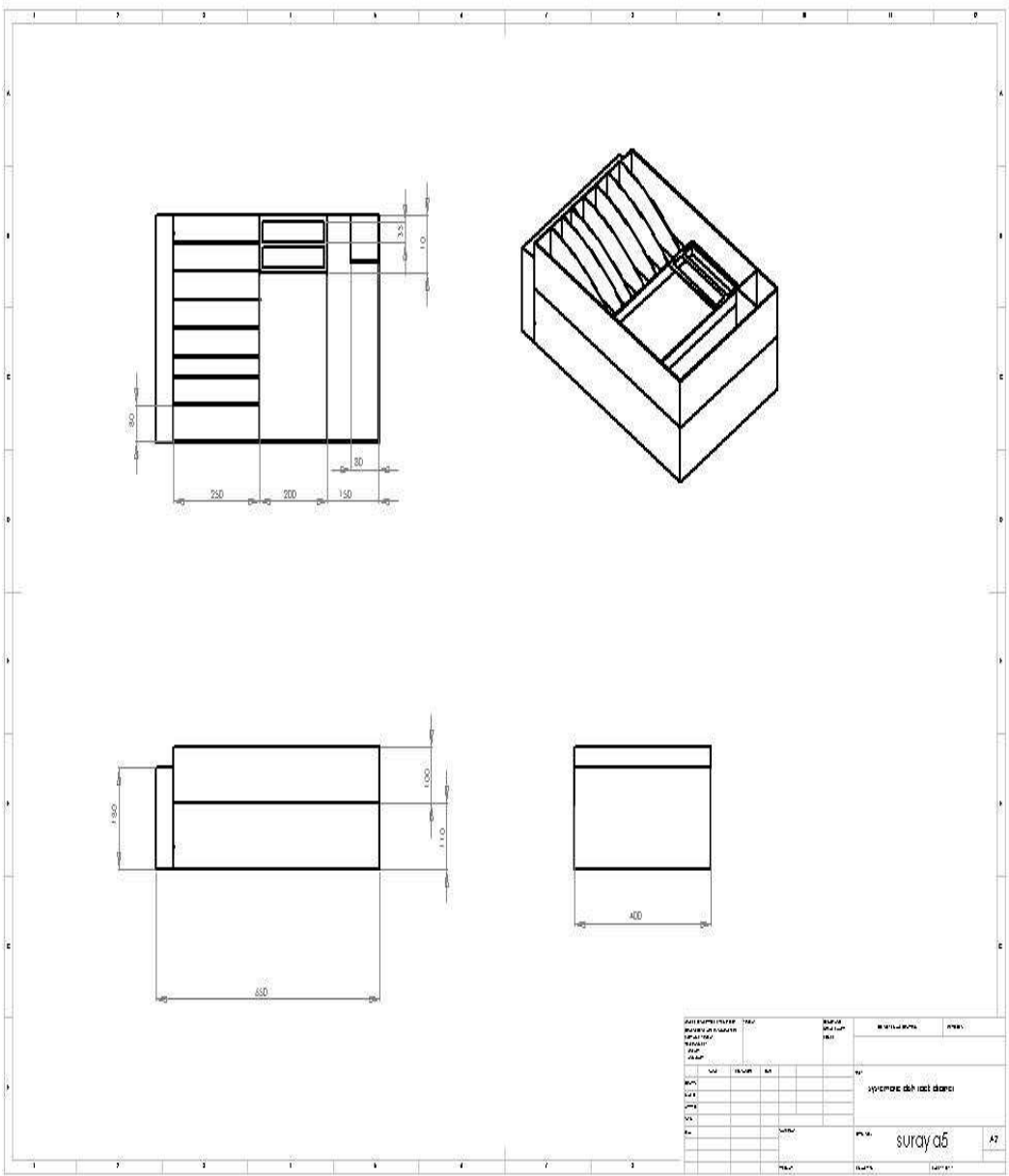
- iii. Use battery for fan

Easy to place the dish rack at any place. If use the plug the dish rack drainer must at place have plug. This cause trouble to consumer dish rack drainer.

## REFERENCES

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APPENDIX A



## **APPENDIX B**

### **MACHINE TOOL AND EQUIPMENT**



**MIG Welding Machine**



**Abrasive Cutter**



**Measuring Tape**



**Hand Grinding**



**Personal Protection Equipment (PPE): Visor, Goggle, Glove & Apron**



**Hand Drill**



**Rivet Pop**