DESIGN AND FABRICATE A WORKING ROTARY VANE COMPRESSOR SIMULATION RIG

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A report submitted in partial fulfilment of the requirements
for the award of the degree of
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I hereby declare that i have checked this project and in our opinion this project is satisfactory in terms of scope and quality for the award of the degree of Diploma of Mechanical Engineering

Signature:
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DEDICATION

First of all, I would like to show my expression of gratitude to Allah s.w.t whose guidance, help and grace was instrumental in making this humble work a reality. This dedication goes to my beloved parent, family and friend, without whom and his/her effort, my pursuit of higher education would not have been possible and I would not have had the chance to study for a mechanical course. Also to my supervisor, Muhamad Imran bin Mohmad Sairaji and mechanical staff, without whose wise suggestions helpful guidance and direct assistance, it could have neither got off the ground nor ever been complete. Thanks a lot to my friend in their support and advice towards this project.Thanks to all for your enduring patience and continuous encouragement.

ACKNOWLEDGEMENT

In the praise of Almighty Allah, the beneficent and Merciful-who showed the path of righteousness and blessed me to get the strength to embark upon this task of peeping into the realms of facts and events.This project was conducted under supervision of Muhamad Imran bin Mohmad Sairajiin University Malaysia Pahang (UMP) . I am very grateful to him for his patience and his constructive comment that enriched this research project. His time and efforts have been a great contribution during the preparation of this thesis that cannot be forgotten for ever.I would like to acknowledge with much appreciation the crucial role of the staff in Mechanical Laboratory, for their valuable comments, sharing their time and knowledge on this research project was carried out and giving a permission to use all the necessary tools in the laboratory.I also gratefully acknowledge the assistance of everybody who helped in the execution of this project in UMP. I also thank to all Mechanical students for their friendship and help when thinking through problem and for sharing their knowledge of experimental apparatus and computer systems. Finally, I would like to thanks to my family for their continuous support and confidence in my effort.

ABSTRACT

The idea to to design and fabricate a working rotary vane compressor simulation rig is come from supervisor that gives me this title and task for this project. To design and fabricated this rotary vane compressor simulation rig, 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 aturan simulasi putaran bilah pemampat ini datang daripada penyelia yang memberi saya tajuk dan tugasan untuk projek ini. Untuk merekabentuk dan pembinaan putaran bilah pemampat ini, ia hendaklah dibandingkan dengan produk lain yang mungkin berada dalam pasaran. Langkah pertama, dapatkan maklumat daripada internet, majalah, suratkhabar atau daripada sumber yang lain. Keseluruhan projek melibatkan pelbagai cara atau kaedah seperti mengumpulan 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 berupaya 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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CHAPTER 1

INTRODUCTION

1.1 Project Title

The title of this project is “Rotary vane compressor simulation rig”. Fabrication of the rotary vane compressor simulation rig is concern to strength, durability, and easy to understand .New concept require to improve durability and easy to understand.

1.2 Project Synopsis

Rotary vane compressor is one of the compressor type that commonly used for Proton’s car air conditioning system. This project is to fabricate a Rotary Vane Compressor housing using acrylic and the rig using flaxy glass. This will able viewer to see a working compressor and help them understand the basic principle of Wobble Plate Compressor.

1.3 Project Background

Rotary vane compressors are latest technology compressors, which incorporate simple, dependable and rotating slide vane technology to deliver sustained performance pressures or vacuums for off-loading liquids. A rotary vane compressor is fitted with an high performance inlet air filter to takes in atmospheric air and the compressed air is discharged at a higher pressure into the cargo tank.

Rotary vane compressors provide efficient and quiet delivery of oil-free gas or air. These compressors combine latest technology and advanced design to give maximum performance with minimum maintenance and effort.

The rotor, cylinder and side plates define sealing space at respective ends of which are provided suction bores and discharge bores.

1.4 Project Objective

Project objective divide by two .It is general objective and specific objective for the title of the project.

1.4.1 General Objective

Diploma final years project objective is to practice knowledge and skill of the student that have been gathered before in solving problem using academic research to born an engineer that have enough knowledge and skill. This project also important to train an increase the student capability to get know, research, data gathering, analysis making and 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 students that have capability to make good research report in thesis form or technical writing. This project also can produce an train student to capable of doing work with minimal supervisory and more independent in searching, detailing and expanding the experiences and knowledge. This project also important to generate and increase interest in research work field.

1.4.2 Specific Project Objective

The objectives for this project are:

1. To design and fabricate a working rotary vane compressor simulation rig.
2. To understand the basic principle rotary vane compressor.
3. Will able viewer to see a working compressor.

1.5 Problem Statement

Now day, people are facing problem while they need to know simulation rig about rotary vane compressor. Thus, with the design and fabricate a working rotary vane compressor simulation rig, I hope that it can contribute ideas how to solve this problem.

1.6 Project Scope

In order to finish this project require precise scope of work and proper plan need to be followed because this project must through various process before it would be produce. Beside that this project title is new idea which is come from instructor engineer in lab and as the knowledge isn't entirely covered in classes or lab. So it give us advantages to learn new process to produce this product and absolutely we could find lot of advantages neither we are realized or not. These are scope of work in this project.

These scopes help me to be focused and know about my job. The scopes are:

1. Literature review about rotary vane compressor
2. Design the housing of the rotary vane compressor use solid work& AutoCAD.
3. Fabricate the project using flaxy glass.
4. Test project and make report.

It is time where the soft skill e.g. punctuality, self discipline, time management and problem solving have been practiced because the project highly depend on the effectiveness of all the skill as much as the knowledge we have learnt.

1.7 Project Gantt chart

PROJECT ACTIVITIES		W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14
	Plan														
Attend briefing the final year project by lecturer															
	Actual														
	Plan														
Get title final year project from lecterur															
	Actual														
	Plan														
Do some planning, Gantt chart, Flow chart															
	Actual														
	Plan														
Literature review and gather imformation															
	Actual														
	Plan														
Dimension and sketchy															
	Actual														
	Plan														
Progress Presentation															
	Actual														
	Plan														
Fabricate the design that has been choose															
	Actual														
	Plan														
Continue with the fabrication															
	Actual														
	Plan														
Assembly															
	Actual														
	Plan														
Finalize the project															
	Actual														
	Plan														
Final report															
	Actual														
	Plan														
Final presentation															
	Actual														

Table 1.1: Project Gantt chart

This project will began with investigation and makes a research and literature review from internet. Reference books, supervisor and other relevant academic material that related to this project. To make this project more accurate and suitable, every week discuss with supervisor and continue detail research about rotary vane compressor. At the same time, some schedule management planning for this project is planned to make sure the project achieve its project and make sure all activity due to schedule.

After get all information from literature review. Make a sketching model. The sketching done using sketching at A4 size paper and convert to 3D drawing using solid work software. The design of the housing must be suitable with the objective.

The next task is preparation of progress presentation and report writing. Beside that, the student receives aids from the supervisor about the presentation. The preparation of the presentation requires comment and correction from the supervisor. This week also must be acquisition of the material for this project. The material must be suitable to get finished project very well.

For week 7, start fabricates the project. The fabrication was finish at week 12. After that, next come assembly, finalize, testing, or do some correction from the model. This fabrication was finished no sharp on time in week 13. Then, the product must be evaluation in testing the model. So this week is to test the product to know the functional of the product is successful or not. This week also to improve the product if has any mistake and deformity.

Lastly, the final report writing and prepare the presentation. This takes about one week to arrange and accomplish. A report is guided by UMP thesis format and also guidance from supervisor. Due to all problems that student facing, the management have agreed to extend the time to submit a report and presentation. All task scheduled is take around fourteen weeks to complete.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter is present about literature review of rotary vane compressor fabrication process such as Milling, Cutting, Grinding, drilling and other else. Before fabrication process, the material selection is crucial. The selection of joining process is also important to get a product with better strength and durability. Literature review about machine is also important. It is include guide to setup the machine, type of machine suitable for fabrication process and advantages using this machine.

2.2 Rotary vane compressors

Figure 2.1: Rotary vane compressors

Rotary vane compressors are latest technology compressors, which incorporate simple, dependable and rotating slide vane technology to deliver sustained performance pressures or vacuums for off-loading liquids. A rotary vane compressor is fitted with a

high performance inlet air filter to takes in atmospheric air and the compressed air is discharged at a higher pressure into the cargo tank.

Rotary vane compressors provide efficient and quiet delivery of oil-free gas or air. These compressors combine latest technology and advanced design to give maximum performance with minimum maintenance and effort. Rotary vane compressors have found to be ideal for handling a comprehensive range of industrial gases, which include - propane, butane, butadiene, propylene, vinyl chloride, and chemical intermediates.

2.2.1 Applications

An important application of rotary vane compressors is in the replacement for pumps in transport applications, which involve corrosives, containment concerns, high standards of purity, complete evacuation of residual product and high performance with corrosive and hard to handle fluids.

2.2.2 Features and Benefits.

Some of the important features and benefits of rotary vane compressors include –

- Suitable for pressure discharge of difficult fluids.
- Ideal for applications where purity and containment are of high concern.
- Based on a small-bore design, which reduces the blade tip speed for longer life.
- Designed with hard-coated cast iron housing that provides greater durability and corrosion resistance than aluminum.
- Fitted with an inlet air filter to provide clean air to protect the unit
- Designed with a highly efficient turbo cooling fan system, which protects the unit from overheating.
- Available in hydraulic drive versions.
- A perfect combination of pressure relief/check valve, which reduces plumbing requirements and allows remote mounting for ease of maintenance

2.2.3 Concept

To get a better understanding of how they function, consider the air tool, a device with comparable function. In an air tool, compressed air enters the smallest compartment of the vane-housing at shop pressure, usually at 90 PSI or higher.

In so doing, it drives the vane mechanism inside the tool in a rotary motion. The compressed air is 'trying' to get from an area of high pressure back to atmosphere, thus moving the vanes as it drives to the exhaust port of the tool.

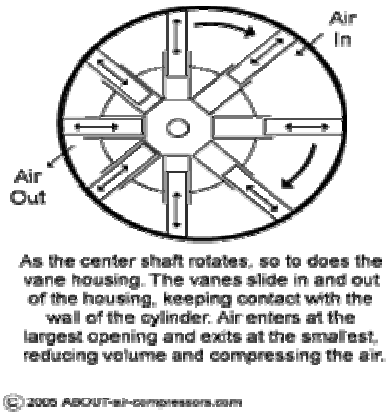


Figure 2.2: Concept of the rotary vane compressors

As the shaft in the vane-housing rotates, the vanes inserted into that housing slide in or out, depending on where they are in the cycle. Centrifugal force ensures that the vanes are always keeping contact with the inside of the outer cylinder, creating a seal. This forms air-tight compartments within the vane housing. Air flows from an area of high pressure to an area of low pressure, so the high pressure air in the small vane-compartment wants to get to the larger area vane, and ultimately, out. The shaft inside of the vane-housing extends through seals to the outside of the end of the tool, and is attached to tooling on the end. As a result, you get rotary motion of that tooling. The power that drives the air tool is compressed air.

The same principle works in the Rotary Vane Compressor, though, rather than compressed air being the power source to drive a shaft and do work, often it’s electricity, and the purpose is not to generate rotary motion of a shaft to drive a tool, but use the rotary motion of the vanes to compress air that you then can use to power a huge variety of compressed air-driven equipment. In-plant installations of Rotary Vane Compressors are most commonly driven by an electric motor.

Road site repair and building construction crews can use Rotary Vane Compressors too, these being powered by a gasoline, diesel or sometimes even a propane motor; this due to this industry's requirements for a portable compressor. The external power supply for the Rotary Vane Compressor drives a shaft inside the barrel of the compressor and at the centre of the vane-housing. This rotates the vane-housing.

The vanes, installed in the eccentrically located centre housing, are able to slide in and out and the vane's length depends on where they are in relation to the outer barrel. Centrifugal force presses the vanes against the inner-wall of the outer barrel. This seals each vane against the outer surface, creating relatively "air tight" compartments within. Where the volume between the vanes is largest, air enters the vane-housing through an inlet valve. As the center shaft continues to rotate, and since its off-center to the cylinder, the succeeding compartments are smaller and smaller as the vanes cannot extend as far, being closer to the outer wall. A higher volume of air compressed into a smaller volume – that’s an air compressor! When the vane-housing volume is the smallest, the air is as compressed as it can be in the cycle, and it’s released through another valve into a receiver or the shop air mains.

2.2.4 Advantages

1. Simple design and easy to install
2. Low to medium cost and low rotational speed
3. Very few moving parts

2.2.5 Disadvantages

1. Oil injected design have oil carry over
2. Single stage design have lower efficiency
3. Difficulty with high pressures (over 200 psi)

2.3 CNC Milling Machine

Figure 2.3: CNC milling machine

Computer numerical control (CNC) is a computer "controller" that reads G-code instructions and drives a machine tool, a powered mechanical device typically used to fabricate components by the selective removal of material. CNC does numerically

directed interpolation of a cutting tool in the work envelope of a machine. The operating parameters of the CNC can be altered via a software load program.

CNC was preceded by NC (Numerically Controlled) machines, which were hard wired and their operating parameters could not be changed. NC was developed in the late 1940s and early 1950s by John T. Parsons in collaboration with the MIT Servomechanisms Laboratory. The first CNC systems used NC style hardware, and the computer was used for the tool compensation calculations and sometimes for editing.

Punched tape continued to be used as a medium for transferring G-codes into the controller for many decades after 1950, until it was eventually superseded by RS232 cables, floppy disks, and now is commonly tied directly into plant networks. The files containing the G-codes to be interpreted by the controller are usually saved under the .NC extension. Most shops have their own saving format that matches their ISO certification requirements.

The introduction of CNC machines radically changed the manufacturing industry. Curves are as easy to cut as straight lines, complex 3-D structures are relatively easy to produce, and the number of machining steps that required human action have been dramatically reduced.

With the increased automation of manufacturing processes with CNC machining, considerable improvements in consistency and quality have been achieved with no strain on the operator. CNC automation reduced the frequency of errors and provided CNC operators with time to perform additional tasks. CNC automation also allows for more flexibility in the way parts are held in the manufacturing process and the time required to change the machine to produce different components.

2.4 Drilling Machine

Figure 2.4: Drill press

A drill press (also known as pedestal drill, pillar drill, or bench drill) is a fixed style of drill that may be mounted on a stand or bolted to the floor or workbench. A drill press consists of a base, column (or pillar), table, spindle (or quill), and drill head, usually driven by an induction motor. The head has a set of handles (usually 3) radiating from a central hub that, when turned, move the spindle and chuck vertically, parallel to the axis of the column. The table can be adjusted vertically and is generally moved by a rack and pinion; however, some older models rely on the operator to lift and reclamp the table in position. The table may also be offset from the spindle's axis and in some cases rotated to a position perpendicular to the column. The size of a drill press is typically measured in terms of swing. Swing is defined as twice the throat distance, which is the distance from the center of the spindle to the closest edge of the pillar. For example, a 16-inch (410 mm) drill press will have an 8-inch (200 mm) throat distance.

A drill press has a number of advantages over a hand-held drill:

- less effort is required to apply the drill to the work piece. The movement of the chuck and spindle is by a lever working on a rack and pinion, which gives the operator considerable mechanical advantage.
- the table allows a vise or clamp to position and lock the work in place making the operation much more secure.
- the angle of the spindle is fixed in relation to the table, allowing holes to be drilled accurately and repetitively.

Speed change is achieved by manually moving a belt across a stepped pulley arrangement. Some drill presses add a third stepped pulley to increase the speed range. Modern drill presses can, however, use a variable-speed motor in conjunction with the stepped-pulley system; a few older drill presses, on the other hand, have a sort of traction-based continuously variable transmission for wide ranges of chuck speeds instead, which can be changed while the machine is running.

Drill presses are often used for miscellaneous workshop tasks such as sanding, honing or polishing, by mounting sanding drums, honing wheels and various other rotating accessories in the chuck. This can be dangerous on many presses, where the chuck arbor is held in the spindle purely by the friction of a Morse taper instead of being held securely by a drawbar.

2.5 Horizontal Band Sawing Machine

Figure 2.5: Band saw machine

A band saw uses a blade consisting of a band of toothed metal, and may be powered by wind, water, steam, electrical motor or animal power. The band rides on two wheels rotating in the same plane. Band saws can be used for woodworking, metal working, or for cutting a variety of other materials, and are particularly useful for cutting irregular shapes. The radius of a curve that can be cut on a particular saw is determined by the width of the band and its lateral flexibility.

When cutting metals or timber, a constant flow of liquid over the blade facilitates cutting by lubricating to keep the blade cool as well as preventing encrustation or smearing on the blade, prolonging blade life and making for greater cutting accuracy. Brushes or brush wheels are sometimes used to remove chips and encrustation from the blade as it exits the material. Band saws are available in vertical and horizontal designs. These units range from manually operated machines to fully automatic machines. Band speeds range from 40 feet per minute to 5000 feet per minute.

Machine shop band saws may also be horizontal or vertical. Small band saws may employ a gravity-fed blade or the rate of descent may be controlled by a hydraulic cylinder bleeding through an adjustable valve. When the saw is set up for a cut, the operator raises the saw by hand and the material is clamped in place and the saw is turned on, the blade slowly descending into the material, cutting it as the band blade moves. When the cut is complete, a switch is tripped and the saw automatically turns off.

2.6 Laser cutting

Figure 2.6: Laser cutting machine

Laser cutting is a technology that uses a laser to cut materials, and is typically used for industrial manufacturing applications. Laser cutting works by directing the output of a high power laser, by computer, at the material to be cut. The material then either melts, burns, vaporizes away, or is blown away by a jet of gas, leaving an edge with a high quality surface finish. Industrial laser cutters are used to cut flat-sheet material as well as structural and piping materials.

CHAPTER 3

METHODOLOGY

3.1 Project Flow chart

For the diagram as shown below, the project starts with meeting with supervisor and discuss about this project. After that, the project undergoes with literature review and research about the title. These tasks have been done through research on the internet, books and other sources.

After gathering all the relevant information, the project undergoes review current design and takes dimension from beginning compressor. The project get trough to design process. In this step, from the knowledge gather from the review is used to make a sketch design. After several design sketched, design consideration have been made and one design have been chosen. The selected design sketched is then transfer to solid modeling and engineering drawing using solid work software. The material and the measurement needed are listed down.

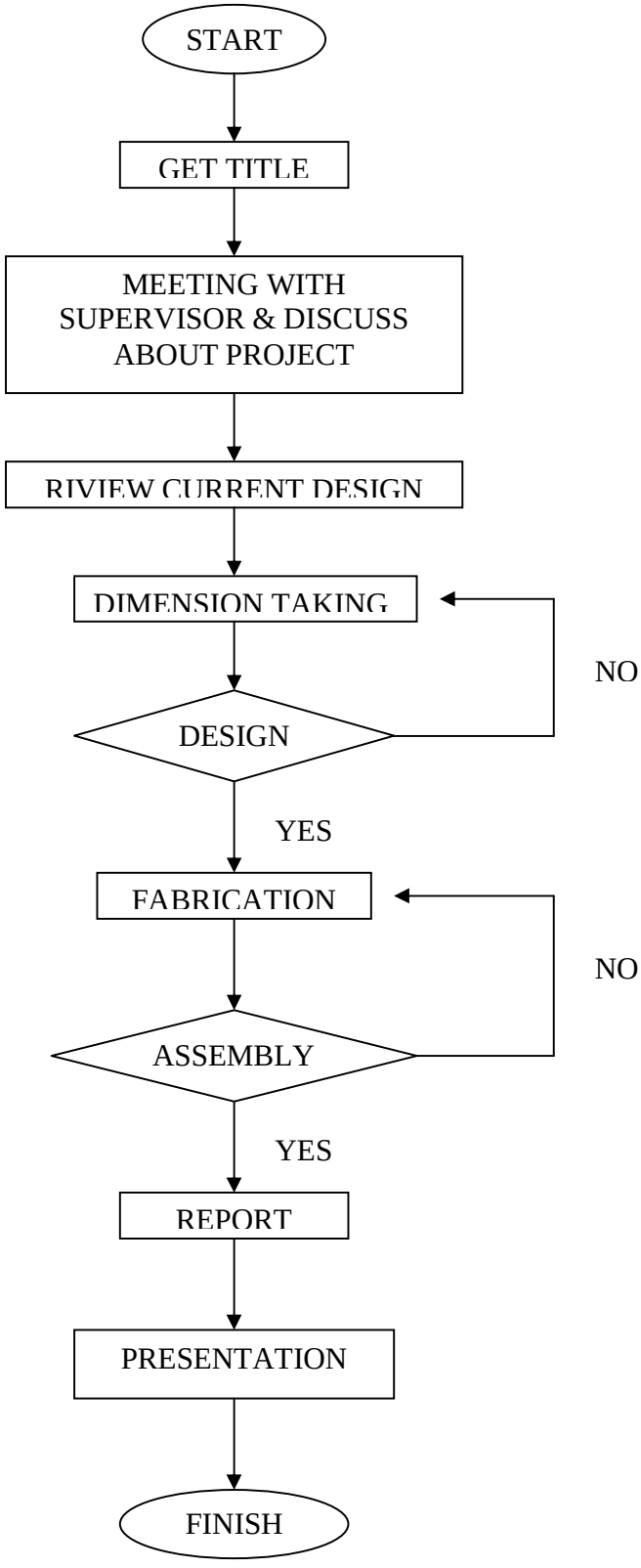
After material and measurement are list, include detail design and approved by supervisor, the drawing was used as a reference for the next process which is fabrication process. This process is consist fabricate the parts that have design before by following the dimension using various type of manufacturing process. The manufacturing process include in the process are drilling, finishing surface, milling, grinding and other. For through all this fabrication process, is used varied machine such as handsaw machine, milling machine, grinding machine, drilling machine.

After fabrication process, comes assembly and testing process. The assembly and testing is to gathered information about design that has been fabricated. If there is something wrong occur such as not balance dimension so the process stop and go back to previous step. The project is expected to have an error that may cause the part to be fabricated again. This project is finished by doing some finishing process.

After all parts had been joined together, here comes the last phase of process that is data discussion. In data discussion the draft report and all the related articles are gathered and hard over to the supervisor for error checking. The finished product will be compare with the report to make sure that there is no mistake on both project and report.

After the product and report had been approve by the supervisor, the report is rearrange and print out to submit at supervisor, the project coordinator and faculty of mechanical engineering. In this stage, the final presentation was also being prepared and waited to be present.

FLOW CHART


START
GET TITLE
MEETING WITH SUPERVISOR & DISCUSS ABOUT PROJECT
RIVIEW CURRENT DESIGN
DIMENSION TAKING
DESIGN
NO
YES
FABRICATION
NO
ASSEMBLY
YES
REPORT
PRESENTATION
FINISH

3.2 Design

The design of the “Rotary vane compressor simulation rig” 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 aspect that must be considered in designing the “Rotary vane compressor simulation rig” are:

1. Ergonomic factors: Rotary vane compressor simulation rig must be user friendly as easy to bring anywhere.
2. Strength: It is second of important criteria in designing the rotary vane compressor simulation rig.
3. Material: Available of material is one of aspect that has been considered. The material available can be used depend on their purpose.
4. Cost: The cost of whole system must been not exceed from budget given and also reasonable.
5. Environment: The rotary vane compressor simulation rig is safe to be in all places.

3.3 Drawing

The drawings are dividing into two categories, which are:

1. Sketching: All the ideas for the rotary vane compressor simulation rig fabrication are sketched on the paper first to ensure that ideas selection can be made after the selected design choose.
2. Solid work Application: The design or concept sketched is chosen must transfer to solid modeling and drawing use solid work application.

3.4 Sketching and drawing selection

From the existing ideas, only three sketching that had been chosen to be considered as the final ideas, which are:

Concept A

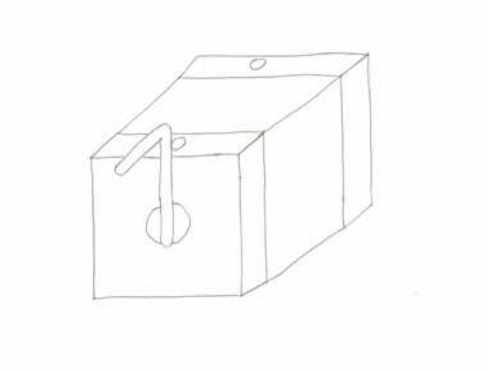


Figure 3.2: Concept A

This concept is the datum concept to generate other concept and make comparison with other concept. This concept just looks square. Pulley used to rotate the vane.

Concept B

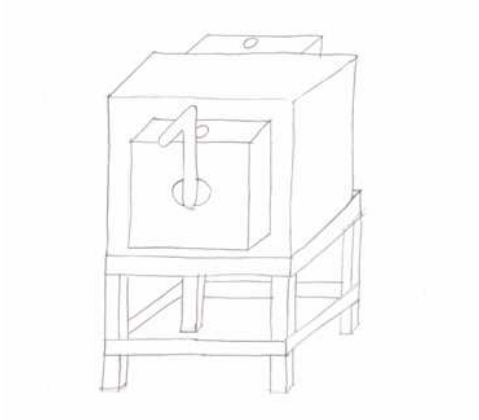


Figure 3.3: Concept B

This concept is generating from concept A. This concept nearly same like concept A, but concept B has base as support the housing. This support use hollow steel and welding process are using.

Concept C

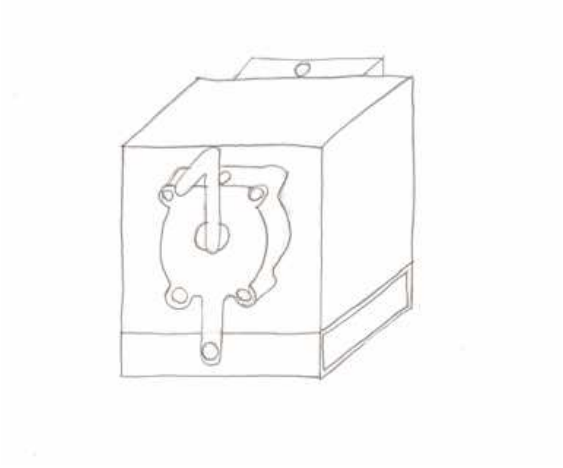


Figure 3.4: Concept C

This concept nearly same like concept A, but different for this concept than Concept A is it can carry anywhere. This concept also has support but the support just uses hollow steel. It can be light. It also uses bolt and nut. So, it's easy to install.

3.5 Concept generation and evaluation

Three concepts for the housing rotary vane compressor were developed. These are evaluated against the datum of the standard rotary vane compressor. A product in marketing is princess; this product will be making a datum. Two ways evaluated to get a new final design.

Table 3.1: Pugh concept

	Concept Variants			
Selection Criteria	Concept 1	Concept 2	Concept 3	Princess
Easy to handling	(-)	0	(+)	0
Easy to use	(+)	0	0	0
Easy to keep	(+)	(-)	0	0
Capability	(-)	0	(+)	0
Strength	0	(-)	(+)	0
Efficiency	(-)	0	(+)	0
Shapes	(+)	(-)	0	0
Weight	(+)	(-)	0	0
Power	(-)	(+)	0	0
Function	(-)	0	(+)	0
Pluses	4	1	5	
Sames	1	5	5	
Minuses	5	4	0	
Net	-1	-3	5	
Rank	2	3	1	
Continues	NO	NO	YES	

From the Pugh analysis, the advantages and disadvantages of the concept can be display.

Table 3.2: Matrix analysis

		concept 1	concept 2	concept 3	Final concept
1	Easy to handling	3	2	4	3
2	Easy to manufacturing	2	4	3	2
3	Easy to use	2	4	3	2
4	Easy to keep	4	2	2	1
5	Efficiency	2	3	5	3
7	Shape	2	4	3	2
8	Stability	2	3	4	3
9	Quantity of Material	2	3	4	3
10	Weight	2	2	3	3
11	Function	2	3	4	3
12	Strength	3	3	4	3
13	Capability	2	3	4	3
14	Power	2	4	5	3
15	Advantages	3	4	5	3
		33	44	* 53	

1	Very poor
2	Poor
3	Medium
4	Good
5	Very good

Follow from the Matrix analysis. Three designs will be make comparison. The very good concept will be give mark “5”. ,Good give mark “4” , Medium give mark “3” , Poor give mark “2”,and if the not enough criteria that concept will be given “1”.

3.6 Result

From two tables above, the advantages and disadvantages of the design can be outlined. Criteria or characteristic for the product to be fabricated are the important thing to be considered, before fabrication process. Fifteen criteria from Pugh concept and teen criteria from matrix analysis are been chosen to be considered. The important criteria are easy to handling, easy to use, easy to keep, capability, strength, efficiency, shapes, weight, power and function.

Based on the tables, study of concept selection shows that concept three scores the highest and positive signs. This concept get five pluses, five same, no minuses and the net is five, so this concept in first ranking.

3.7 Design with Solid Work

After a design has been selected, next step in designing process is dimensioning. The design is separated into part by part and the dimensioning process is firstly sketched on paper. The dimensioning is base relevant dimensions and also referring the existence rotary vane compressor so that the 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. Parts 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 the design.

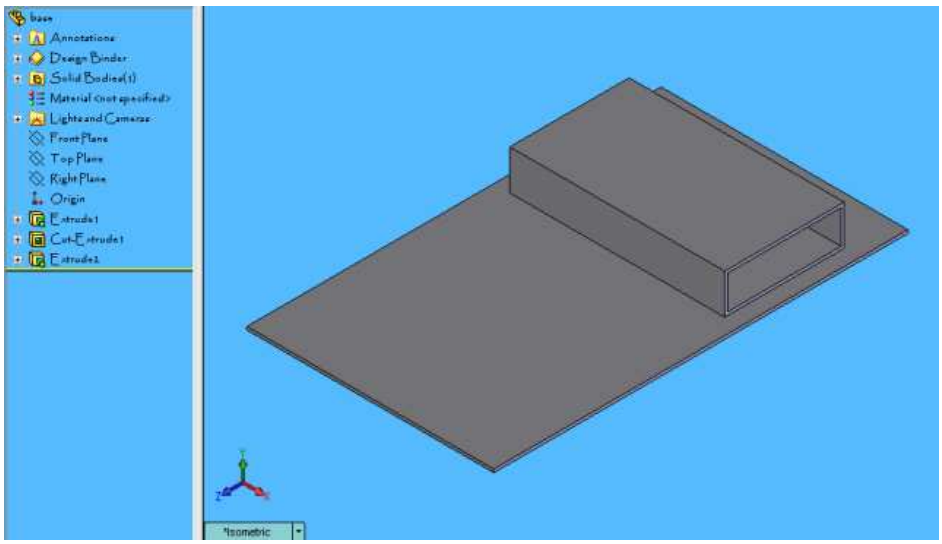


Figure 3.5: Base

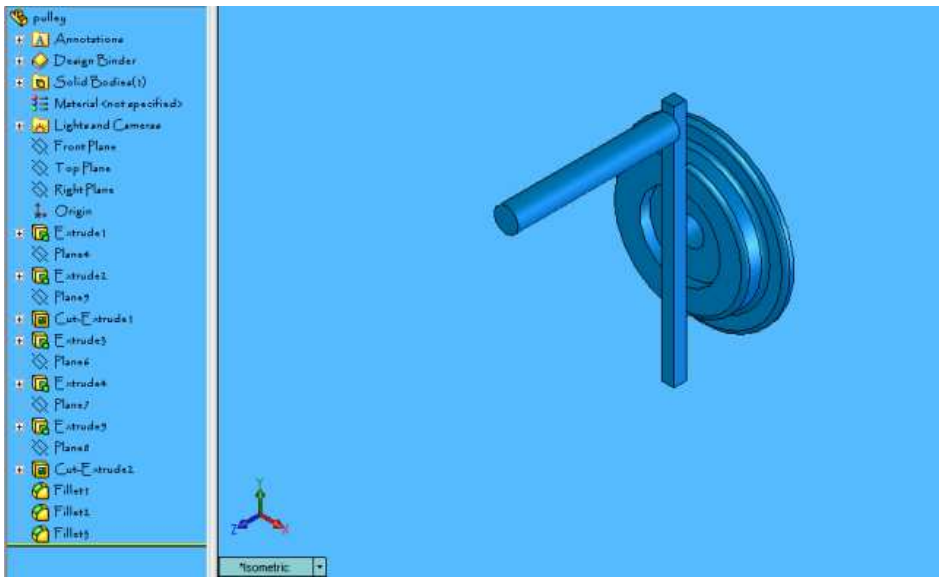


Figure 3.6: Pulley

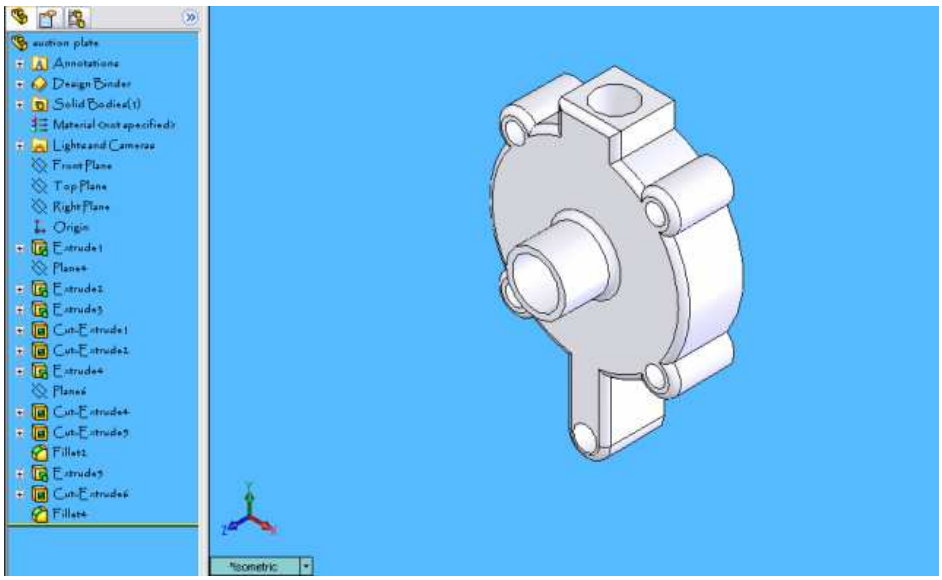


Figure 3.7: Suction plate

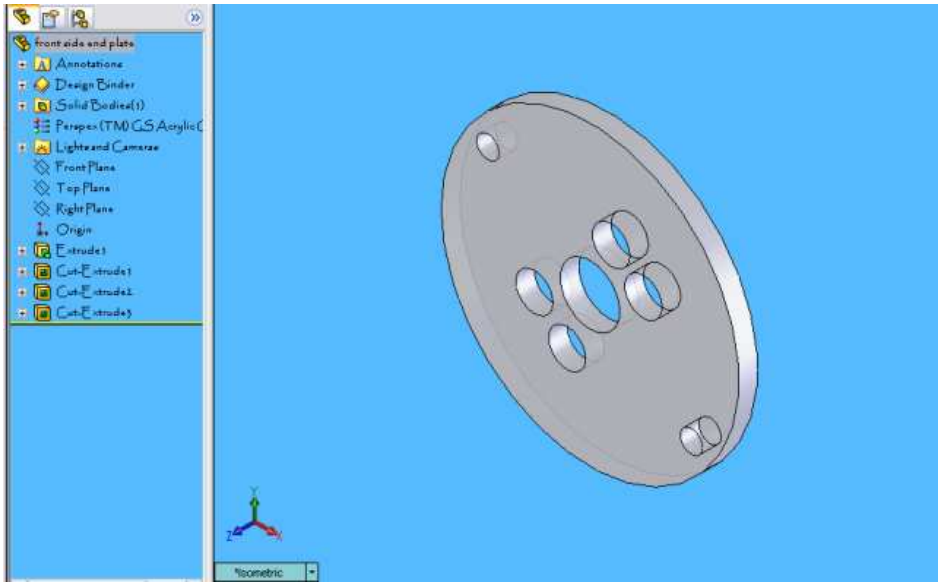


Figure 3.8: Front side end plate

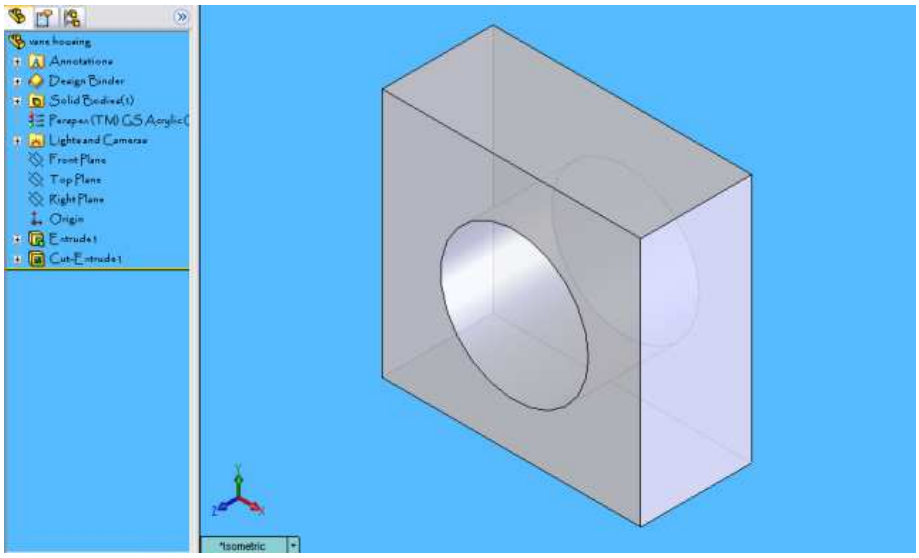


Figure 3.9: Vane housing

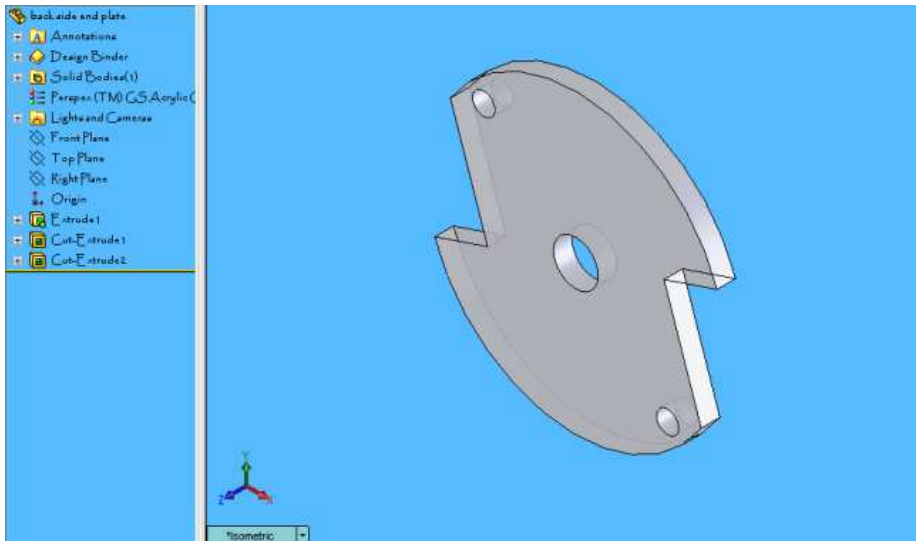


Figure 3.10: Back side end plate

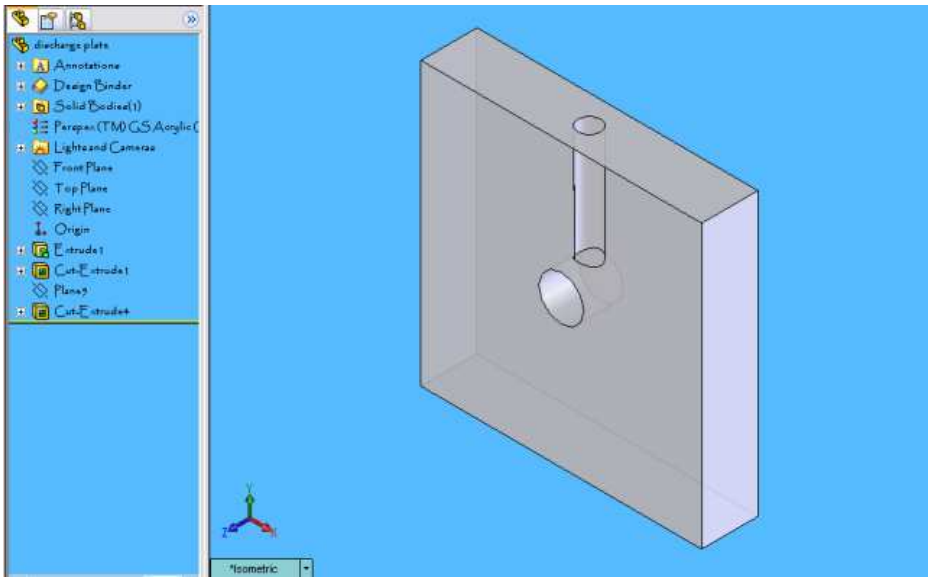


Figure 3.11: Discharge plate

3.7.1 Design specification

Based on the drawing and sketching selection, after generated and evaluated the best concept selection. A final concept has been produce that can be fabricated. Below is the detail product design specification of the final design.

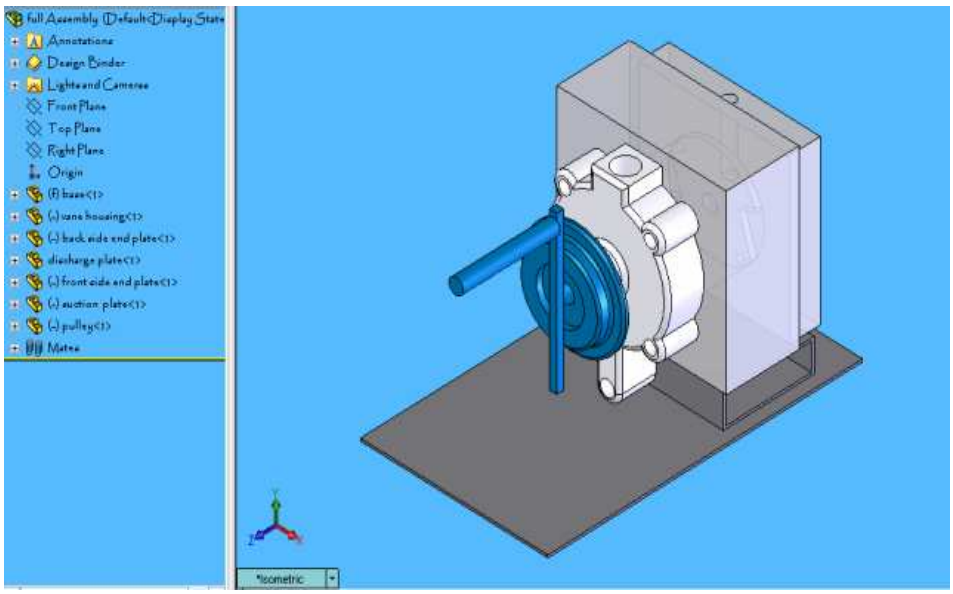


Figure 3.12: Full Assembly

3.8 Material

All part of the body use Perspex material and the base component use rectangular hollow steel. Pulley made from steel material. This is a type of the material will be use in this project.

3.9 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 a product, like cutting, milling, drilling, painting, tapping, welding 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 way include part by part fabrication until assembly to others component.

3.9.1 Process involve

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

i. Getting material

Figure below introduces the material have in UMP mechanical laboratory. These racks have more type of steel rectangular hollow steel, prospect and etc.

Figure 3.13: Get material

ii. Measuring and marking

After get the material, the next step is measurement and making material like figure below. The equipment used in this in this process is measuring tape and marker pen. The scale is from solid work software and this scale is the true.

Figure 3.14: Measuring and marking

iii. Cutting material

Figure introduces the process cutting the material using floor cutter disc after measurement and making process.

Figure 3.15: Cutting use floor cutter disc

Figure introduces the process cutting the material using bend saw machine.

Figure 3.16: Cutting use band saw machine

Figure introduces the process cutting using laser cutting machine for cutting front side and back side end plate.

Figure 3.17: Use laser cutting machine

iv. Joining process

Figure below introduce about joining method using MIG welding .This process is used to joining the chassis part. The reason why using this type of welding because the sheet metal that used only have small thickness and it more proper if using MIG welding than Arc welding as well.

Figure 3.18: Welding

v. Drilling process

This figure introduce about drilling process to make the hole for nut and bolt process. The tool of drill must be applicable with the size of nut.

Figure 3.19: Drilling

vi. Grinding process

After cutting and welding process the chip from work piece must remove using hand grinding. Figure below show to remove chip after process cutting and remove bead after welding process on the work piece and get smooth surface before joining and after joining process. This step must take to protect from dangerous because the chip is very sharp.

Figure 3.20: Use hand grinding

vii. Milling process

Figure below introduce about mulling process to make hole for support the vane of compressor. . It using CNC Milling machine where basic form is that of a rotating cutter which rotates about the spindle axis (similar to a drill).

We have to draw a design using Master Cam software and then would be transfer into CNC program before machine center at CNC Milling machine read it. After that the machine would run and operate automatically until the desire shape done.

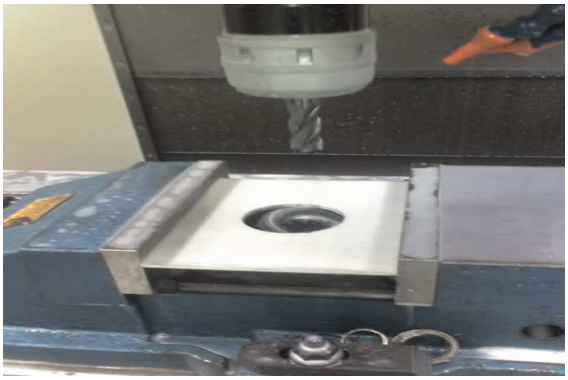


Figure 3.21: Use CNC machine

viii. Finishing process (painting)

The purpose of painting is to make the product be more interesting.

Figure 3.22: Sprayed the product

3.9.2 Process procedure

Step 1: Measuring the material into the require dimension based on design specification. Rectangular hollow steel was the first material that measure. Second, the Perspex. All the measuring and marking process is done by using steel ruler. Measuring tape, and steel marker.

Step2: Cut the material into desire length based on measuring and marking process by using floor cutter disc for hollow steel and small steel. Before proceeding with this process, safety measurement had been carried out by wearing personal protection equipment (PPE) such as goggle, glove and ear plug. These safety measurements are so important in order to prevent the projectile spatter from the process.

Step 3: All material that had been cut is grinded to give smooth surface on the edge to make sure that joining process can be done precisely. Then all material was arranged into joining position. The joining carried out by using MIG (metal inert gas).

Step 4: Using CNC milling machine, make hollow and take the help from instructor.
Then, make the hollow and drill the suction component using conventional milling machine. Drawing must be converting in Master Cam installer.

Step 5: Cutting the Perspex using cutting machine to make the front side end plate and back side end plate because the laser cutting just can cut Perspex that have thin size only.

Step 6: Several parts and location were drilled at hollow steel and Perspex. The drilling process is to make holes for bolts for joining the rotary vane compressor simulation rig. Use press drill during the process.

Step 7: After all component had been finish. Process grinding will be do because want to make a smooth surface. Then, assemble all part bye following drawing had been done. Then, rotary vane compressor simulation rig can be sprayed as finishing product.

3.10 Summary

This chapter has been discussed generally about project methodology, how to manage flow work and process involve. Throughout this project have learned how to design start with sketching, design concept, concept selection and drawing until fabricate and assemble structure with step by step .This project can be developed the skill to manage the machine such as milling machine, drill, hand grinding, cutter and welding

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter will discuss about the project. It includes the completed fabrication, types of defects, product specification and cause of problem of the project. The analysis also was helped to give improvement of the table. It also will show the product defected and how to troubleshoot the defect. At the same time, this analysis also to compare between of the product specification was target and product specification when completed fabricate.

4.2 Result

After finish fabrication process, all information about this product is collected and gathered. It is important to classify the product before it can use. The complete fabrication multi-purpose table like below.

Figure 4.1: Isometric view

Figure 4.2: Front view

Figure 4.3: Rear view

Figure 4.4: Side view (right)

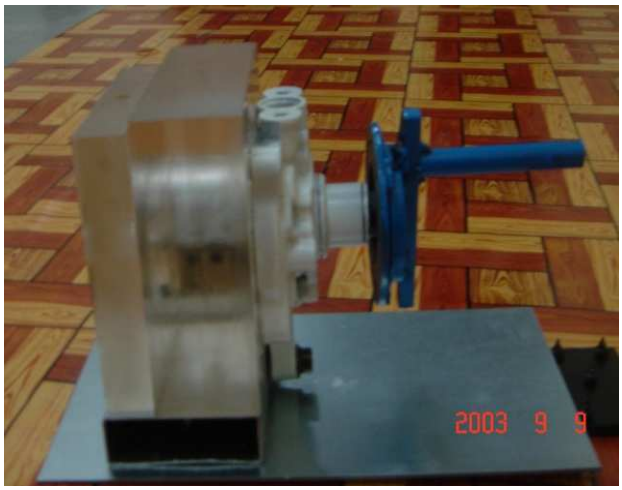


Figure 4.5: Side view (left)

4.2.1 Product Specification

This is another example of analysis process. The product is classify to several category such as weight, colour, wide, height and other else. The product specification is like below.

Table 4.1: Table of product specification

Category	Result
Weight	4 kg
Colour	Blue, white, silver, grey
Wide and long	155mm x 260mm
Height	160mm
Maximum force can be load	70N

4.3 Discussion

Discussion is diving by two parts. Firstly is discussion about type of defect on the final product .Second, is about the problem in progress start with literature review until fabricate and finish this product.

4.3.1 Types of Defect

After finish fabrication process, many types of defects are exist. It happens from fabrication process and the weakness using several machine and tool. At the same time, this event can give someone more experience and knowledge. Type of defects is like below.

Bead

Figure 4.6 is an example for a defect in chassis. The bead is not trim from welding process. The voltage when welding process is not suitable for this material. Insufficient experience to handle this machine also cause of the defected.

Figure 4.6: Bead at the pulley

Not parallel at product dimension

Figure 4.7 is an example for a defect happen cause by less skill when process fabricate this rotary vane compressors.

Figure 4.7: Product not parallel

4.3.2 Problem in Progress

Many problems occur in progress to design and fabrication of this table such as gather raw data and literature review, design and fabrication. The problem in progress just like below

i. Literature Review

The problem during literature review is mainly about the difficulty to know about the title such scope, concept and how to fabricate it into reality. Raw material also the problem encountered during this step because the raw material at UMP mechanical lab not available for the first design the project .The whole design was change to suitable with material available at UMP mechanical lab and the problem like limited resources to get the relevant and suitable materials such as books and internet connection problem.

ii. Design Problem

The problem also occurs at this step. The problem came during decision making to design that suitable with available machine in UMP mechanical lab .During this period many concept design have been find out when to choose one design that have all criteria needed by specification is can proceed and running machine. After a design is selected, another problem encountered is detail dimensioning; the dimension should suitable with scope of the project and after consider all part and material use the dimensional was suitable with project scope.

iii. Fabrication Problem

Problem during this stage is very critical that make the actual progress not follow project planning schedule. First, the problem is to find material that suitable for the title of the project .The suggestion material to produce rig was finish. After consider all problems about material available design for the project was change follow material available.

The problem also come during fabrication process, mainly is hard to fabricate the material with the design was change in order to be easy in machining process such as about used CNC milling machine.

4.4 Analysis and Testing

After finish fabrication process, the product has been analyzed and testing. At this stage, it will discuss and describe about the function and strength that rotary vane compressor. The analysis and testing result is like below.

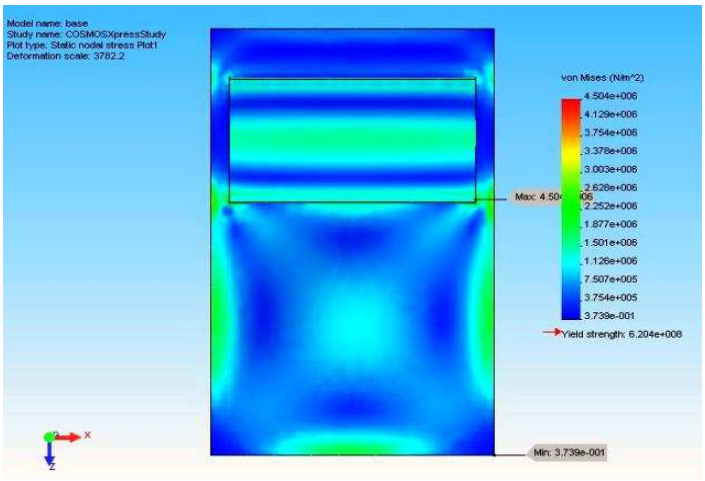
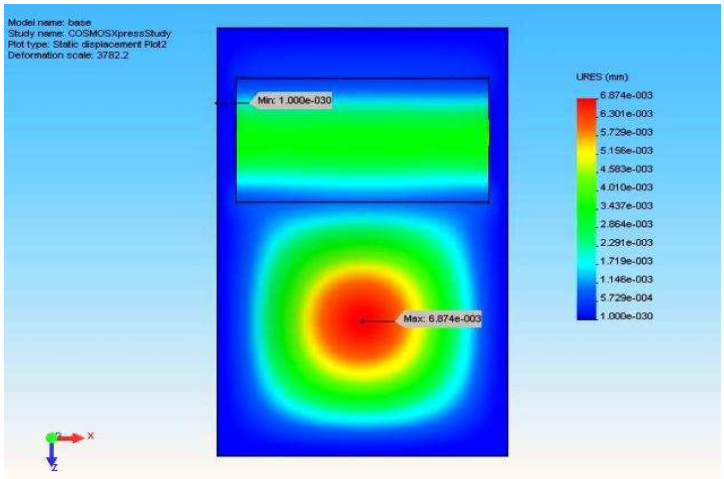


Figure 4.8: Static nodal stress



CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Introduction

For the final chapter it represent 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 had been done. These project problems also make the student to think more creative to solve the problem. This chapter will also discuss about the conclusion of the project, concluding all the process involved. Beside, this chapter also contains recommendation about the project. So for this recommendation it can make improvement about the project for future work.

5.2 Conclusion

The conclusion, the project to fabricate the rotary vane compressor simulation rig was achieves the objective successfully. This project was done around fourteen week included the report, almost all the step such as literature review, design, fabrication process. To complete this project was follow with the planning and Gantt chart.

5.3 Recommendation

Several recommendations to express for my self and the faculty for the future final year project are:

a) Add more type of material in UMP mechanical laboratory
b) Process to order material must be faster because process to fabricate will be take more time to finish.
c) To fabricate the rig, must know how to use CNC milling. So student must be learning to make the code for running this machine.

REFFERENCES

1. Henry,D (1950), *The Industrial Designer and The Businessan*, Havard Business Review, University of H avard

2. Ulrich T. and. Eppinger Steven D, *Product Design and Developmen*t, Newcastle, United Kingdom

3. Kapakjian S, Schmid S.R and Musa. H (2000). Mamufacturing Engineering and Technology. USA: McGraw-Hill.

APPENDIX A

Solid Work drawing 3D

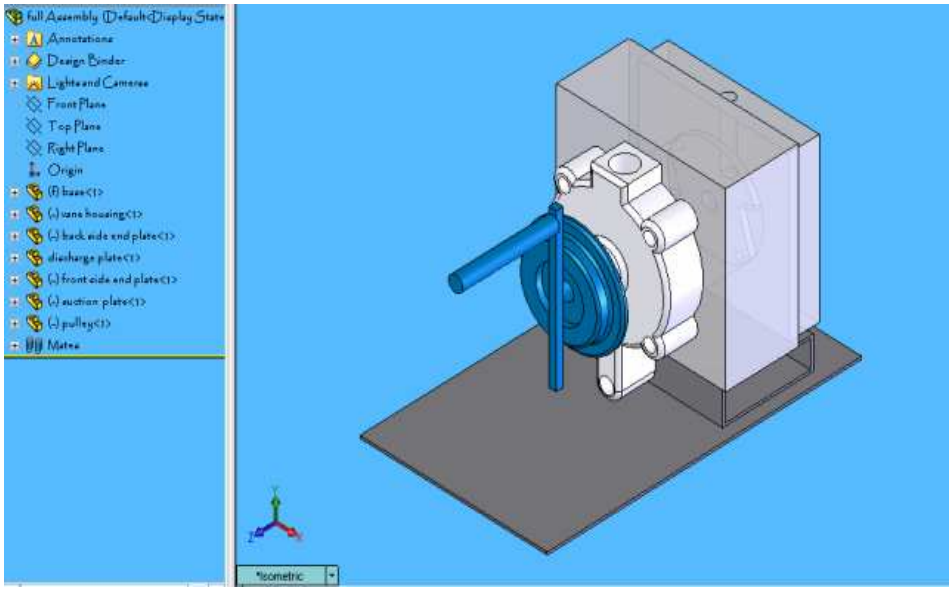
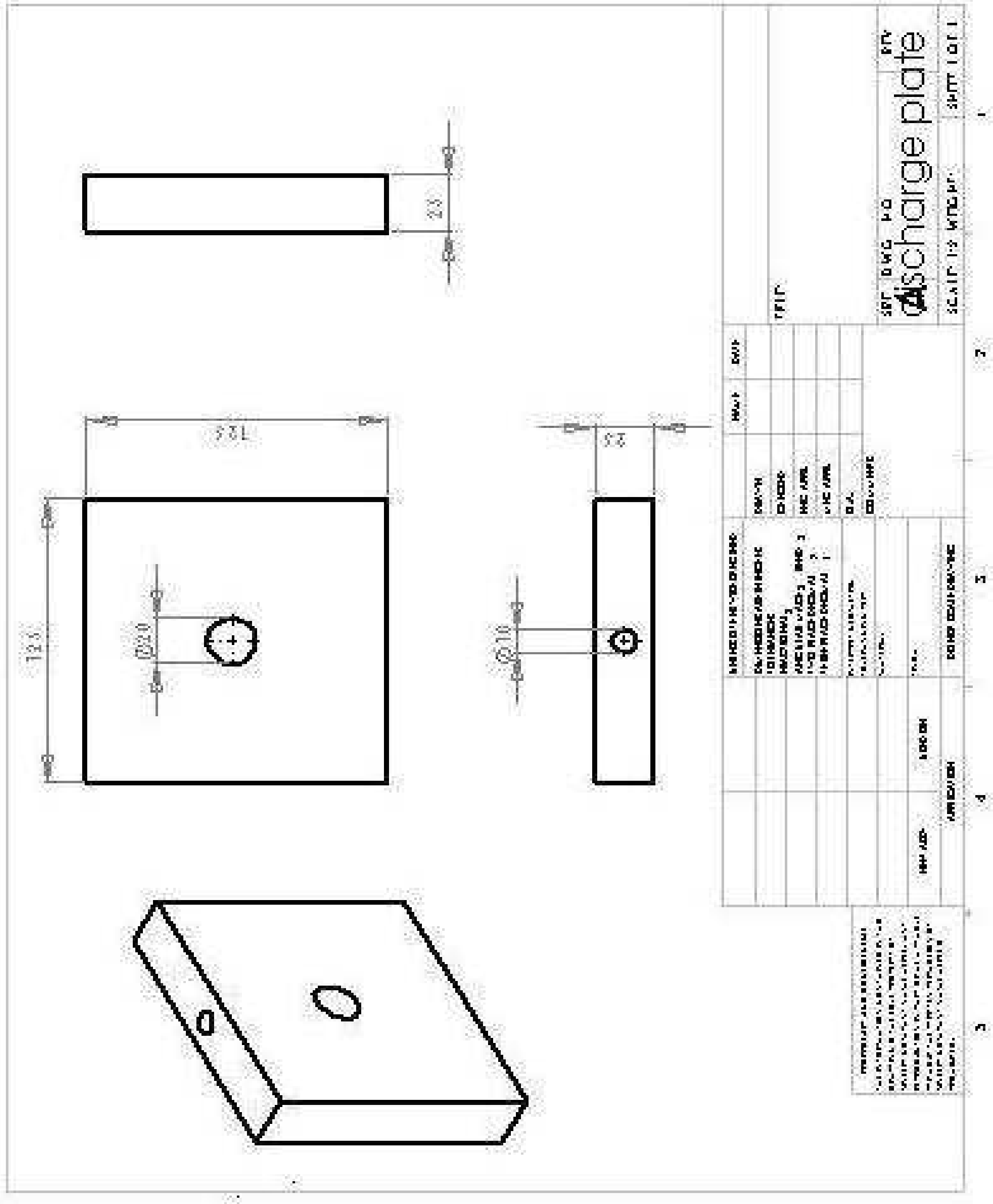
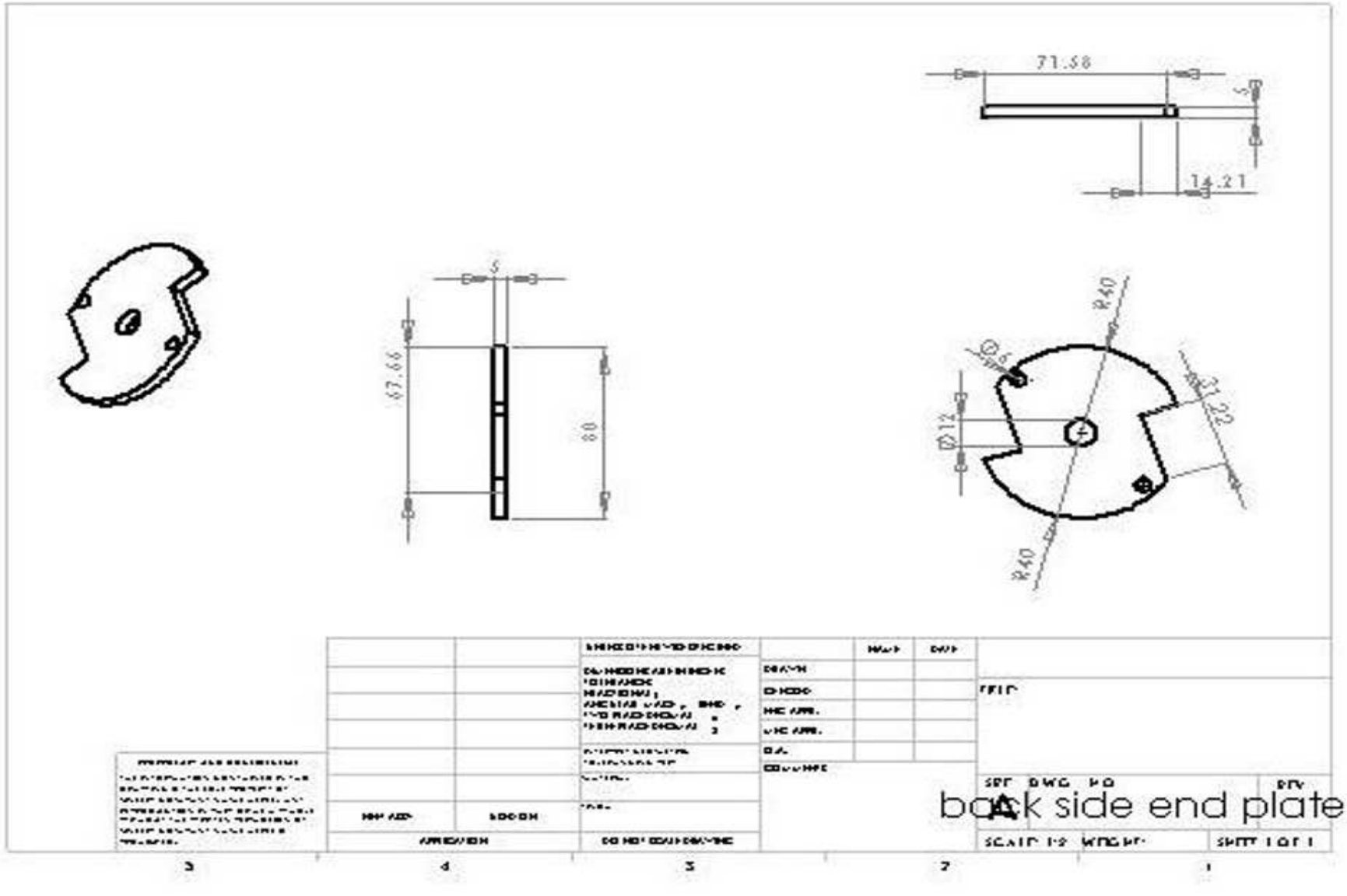


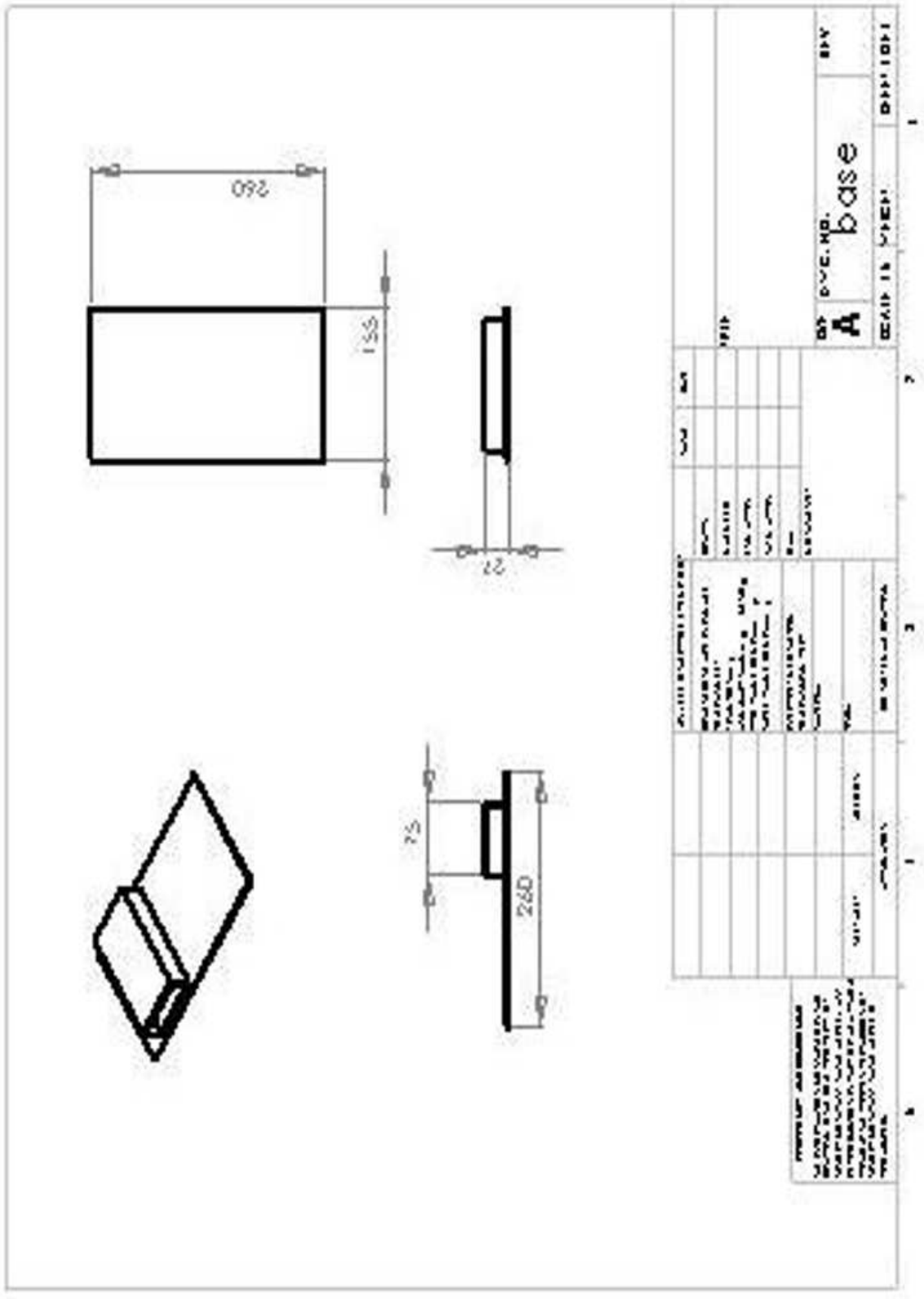
Figure A1: Isometric view

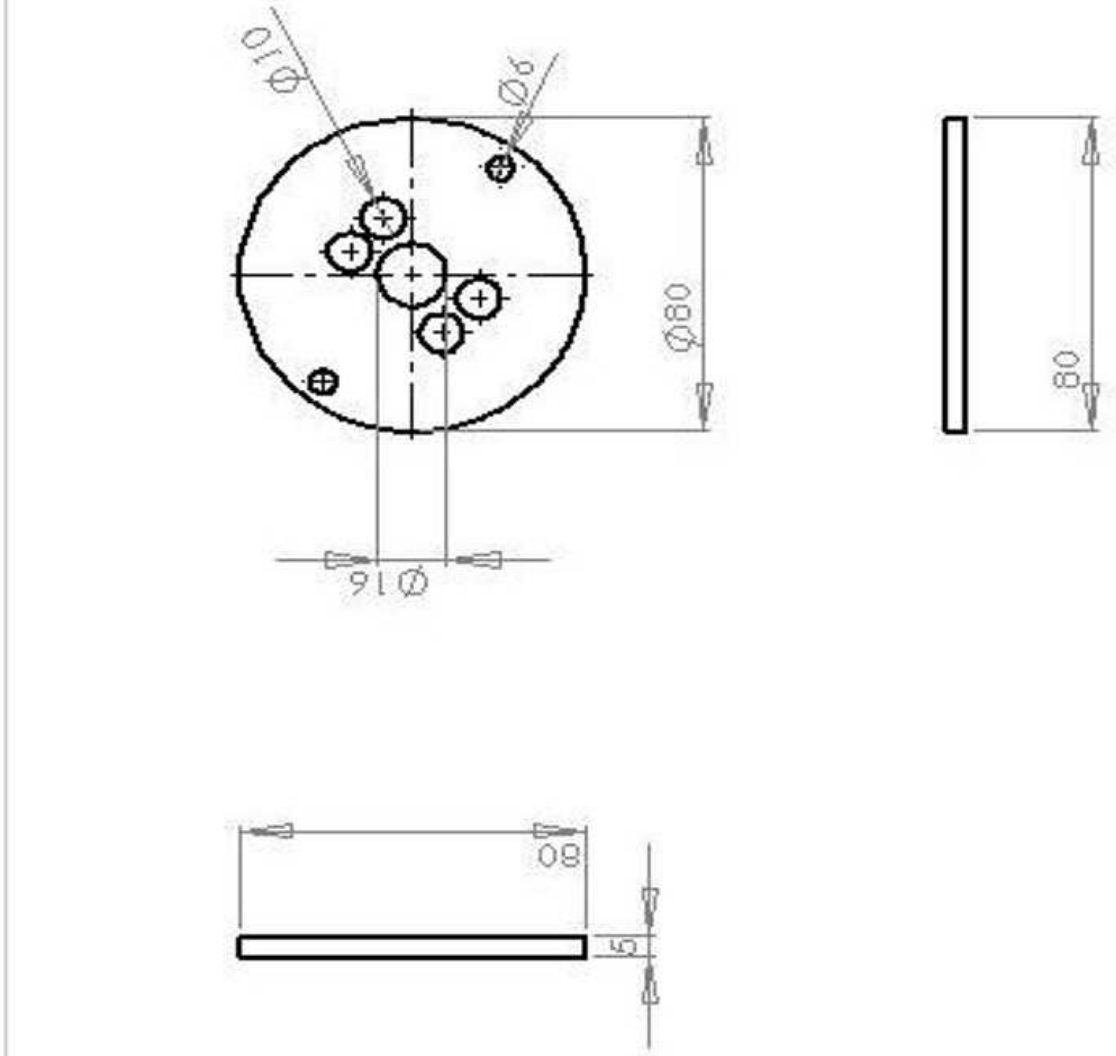
APPENDIX B

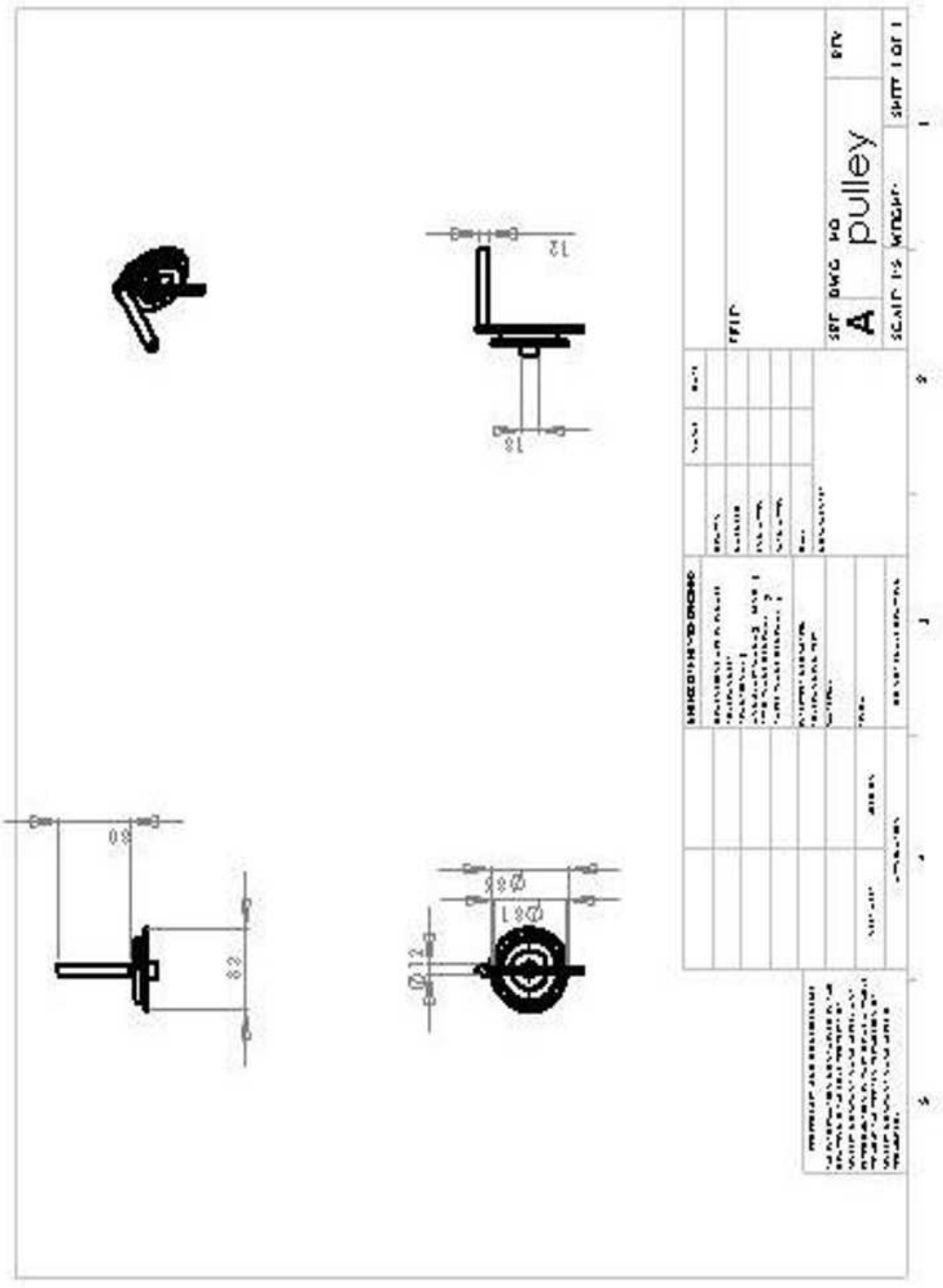
Auto graphic Drawing

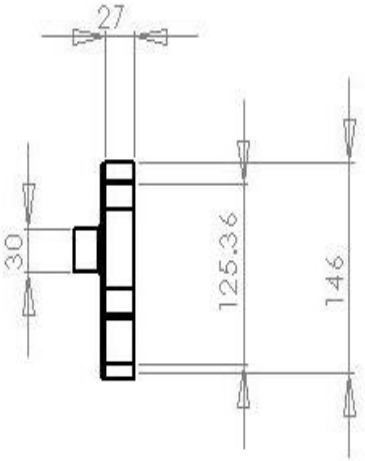

discharge plate

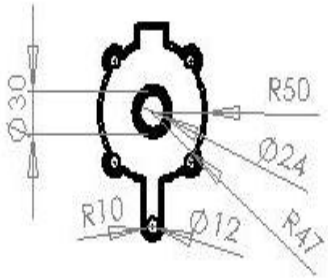

71.58
5
14.21
5
67.66
60
R40
Ø6
Ø12
31.22
R40
back side end plate


260
155
22
75
260
base


Ø10
Ø6
Ø80
Ø16
80
80
5


pulley
A
SIZE DWG NO
SCALE 1:1 WEIGHT
SHEET 1 OF 1





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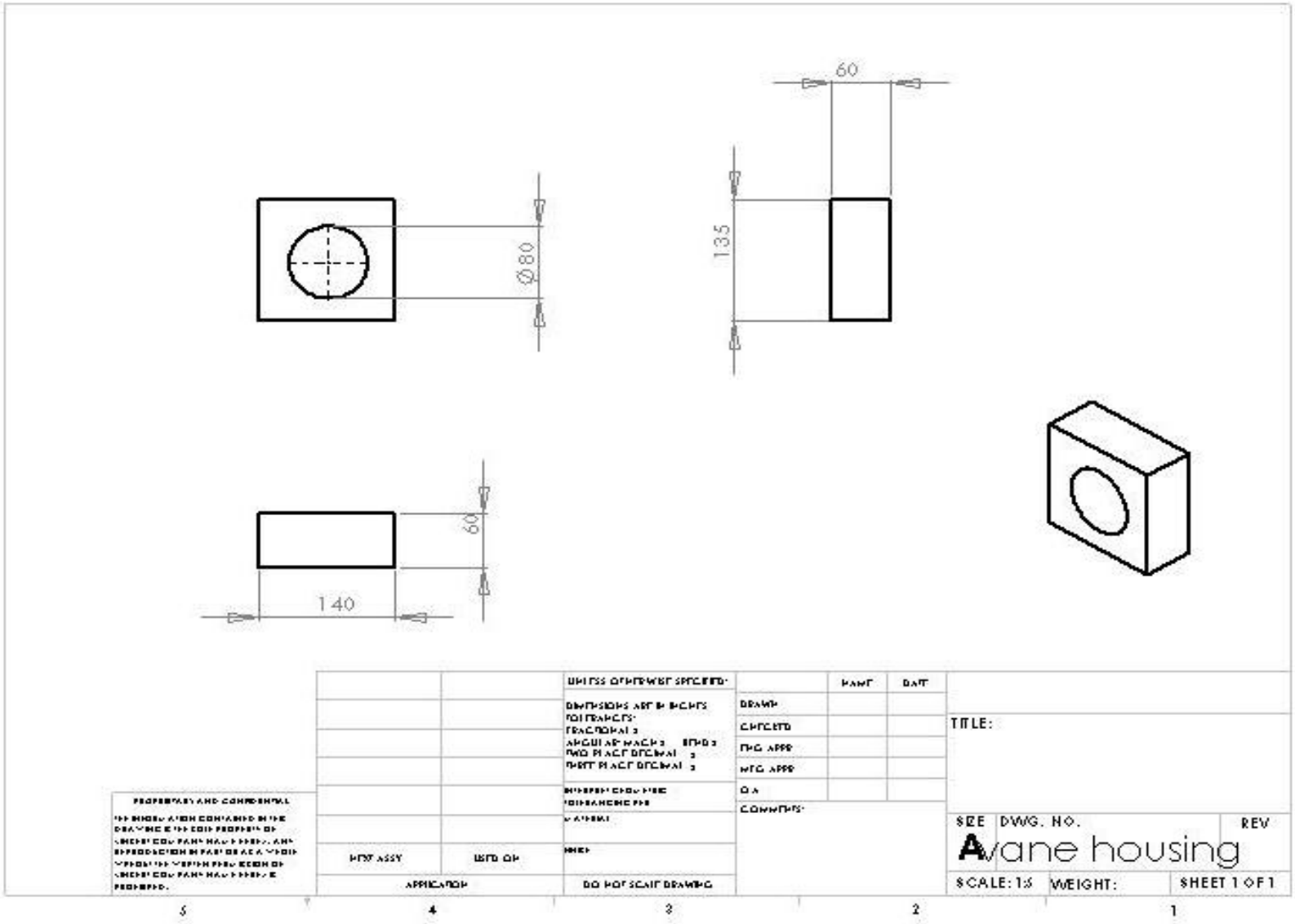
			ENG APPR.		
			MFG APPR.		
			Q.A.		
		INTERPRET GEOMETRIC TOLERANCING PER:	COMMENTS:		
		MATERIAL			
		FINISH			

TITLE:

SIZE | DWG. NO. | REV

Suction plate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TITLE:
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REV
Avane housing
SCALE: 1:5
WEIGHT:
SHEET 1 OF 1