# DESIGN AND FABRICATE ADJUSTABLE LAB CHAIR WITHBCK REST

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# DIPLOMA OF MECHANICAL ENGINEERING UNIVERSITI MALAYSIA PAHANG

## **UNIVERSITI MALAYSIA PAHANG**

JUDUL: <u>DESIGN AND</u>	JUDUL: <u>DESIGN AND FABRICATE ADJUSTABLE LAB CHAIR WITH</u> <u>BACK_REST</u>		
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## DESIGN AND FABRICATE ADJUSTABLE LAB CHAIR WITH BACK REST

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

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NOVEMBER 2010

## SUPERVISOR'S DECLARATION

I hereby declare that I had read this thesis and in my opinion this thesis is sufficient in terms of scope and quality for the purpose of the granting of Bachelor of Mechanical Engineering.

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## **AUTHOR'S DECLARATION**

I declare that this thesis entitled "*Design and Fabricate Adjustable Lab Chair with Back Rest*" is the result of my own research except as cited in references. The thesis has not been accepted for any diploma and is not concurrently submitted in candidature of any other diploma.

Signature:Name of candidate: MUHAMMAD ZULFADHLI BIN ROSLANEDate:

This book is dedicated to my mom and dad.

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#### ABSTRACT

Durable, functional and adaptable seating is essential for specialized workplaces. Muscle and spine disorders are two of the top ranking causes of inability to work. The long-term duration of these complaints means they cause about one third of all lost working days. A problem often caused by incorrect or neglected seating. Industrial and lab workplaces have different seating requirements to the office: moisture, chemicals, static, different table heights, different shifts, multiple users. Fitting the chair to the task, and the materials to the environment, creates the most productive and healthy solution. Industrial and lab seating typically needs to be adjustable for a wide range of body types, to take into account workers over multiple shifts who might share the same chair: a contrast to the office environment, where workers usually don't need to share task seating. Thus the ergonomic requirement for industrial seating is quite important.

#### ABSTRAK

Tahan lama, berfungsi dengan baik dan mudah untuk digunakan adalah ciri-ciri penting yang patut terdapat dalam sesebuah kerusi makmal. Sakit otot dan tulang belakang adalah dua punca utama ketidakmampuan untuk bekerja dengan produktif. Masalah ini berpunca dari posisi badan yang tidak betul ketika duduk ataupun masalah dari kerusi makmal itu sendiri. Industri dan tempat kerja makmal mempunyai keperluan tempat duduk yang berbeza berbanding dengan pejabat. Kelembapan, bahan kimia, statik, ketinggian meja yang berbeza, pergeseran yang berbeza dan berbilang pengguna. Kerusi yang sesuai harus dicipta untuk menepati ciri-ciri tersebut. Ini perlu bagi menghasilkan suasana kerja yang kondusif dan produktif. Kerusi makmal biasanya perlu disesuaikan untuk pelbagai jenis tubuh. Ini kerana dalam suasana makmal, kerusi berkenaan akan digunakan oleh ramai pekerja yang berlainan waktu kerja, berbanding dengan pekerja yang bekerja di pejabat, dimana paea pekerja biasa nya tidak perlu berkongsi tempat duduk untuk bertugas. Jadi keperluan ergonomik untuk tempat kerusi makmal cukup penting.

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## **CHAPTER 1**

#### INTRODUCTION

#### **1.1 BACKGROUND**

Design and fabricating adjustable lab chair with back rest is the title of my final year project that have been suggested to me by my supervisor, Ms Miminorazeansuhaila Binti Loman. This projet focuses on designing and fabricating adjustable lab chair with back rest. The adjustable lab chair with back rest must fulfill the scope of the project such as can be use in any kind of laboratories. All final year diploma student have been allocates with a duration of one semester to complete their final year project.

In order to complete the project, the student have to applied all their knowledge that they have learn during their studies in Universiti Malaysia Pahang for the past two and a half years. This include analytical skill, and skills to handle mechanical engineering related machine such as bending machine, shearing machine, drilling machine, grinding machine and others.

Most of Universiti Malaysia Pahang's lab chair doesn't have a back rest so from that problem, the idea to create an adjustable lab chair with back rest have been generated.

#### **1.2 OBJECTIVE**

The objective of this project is to design an Adjustable Lab Chair with Back Rest and to fabricate a new concept of user friendly Adjustable Lab Chair with Back Rest.

## 1.3 PROBLEM STATEMENT

After a few discussion with my supervisor, I come out to the conclusion that most lab chair are either build with the back rest fixed to the chair and cannot be separated from the seat and it also can be adjust according to the user's comfort, or doesn't have any back rest at all.

#### 1.4.1 SCOPE

- i. This adjustable lab chair with back rest can be used in any kind of laboratories such as science lab or mechanical lab.
- ii. The maximum weight that the chair can support is yet to be determined but I expect the maximum weight that this lab chair can sustain is more than 100 kg.
- iii. Sitting height range : 450mm-500mm
- iv. Expected working height range : 490mm-600mm

## **CHAPTER 2**

#### LITERATURE REVIEW

#### 2.1 INTRODUCTION

A lab chair is a chair that is commonly used in laboratories such as chemical laboratories and computer laboratories. The common design that have been used by a certain company is a lab chair with no back rest. This is because by buying a lab chair with back rest, they can cut the cost that they have to spend in their budget.

A lab chair or preferably called lab stool, is just the same with the offices chair. The only difference is the lab chair height is more higher thank ordinary offices chair. This is because most of the table in the laboratories are high range table. Sometimes, a lab chair also doesn't have any back rest, arm rest like the offices chair. However, some additional features have been added to lab chair such as foot rest. This is maybe because of the height of the lab chair is higher that office chair.

In late 90's, most industrial laboratories and factories used a lab chair that is made using steel and wooden plate and is not adjustable. Nowadays, with the awareness of some company about the importance of comfortabality while at work, more company have invested their money to buy a lab chair that is complete cushioned seat.

#### 2.2 TYPES OF ADJUSTABLE CHAIR.

In general, an adjustable lab chair is a chair that can be adjusted according to the users comfortabality. However, every adjustable chair have its limit in adjusting the height of the chair. And this limit is vary depending on the manufacturer of the chair, the function, and the purpose of the chair. For example, lab chair maximum height is higher than office chair maximum height. This is because the working environment is different between these two chairs.

#### 2.2.1 Office Chair

The 2-piece shell allows backrest and seat flex separately, so the chair moves naturally with user and provides good lower back support for every work posture. Sleek profile and basic ergonomic features makes the economic chairs series for today office.



Figure 2.1: Office chair

Source : http://www.eurochairs.com/

## 2.2.2 Adjustable Height Lab Stool Without Back Rest

This adjustable height lab stool without backrest is perfect for applications in the science lab, classroom, or cafeteria. It is made from 1" thick wooden seat measures 12.25" in diameter and the frame is black powder coated steel.



Figure 2.2 : Adjustable height lab stool without back rest

Source : http://www.calibex.com/adjustable-stool/

#### 2.2.3 Lab Chair With Glides

This Lab chair with glides has the ergonomic features of a task chair and the stability of a standard lab stool. Adjust the seat height to fit any application. The vinyl seat and back are a cinch to wipe clean, and the steel foot ring adds strength to the base. Glides won't scratch floors and move easily on carpet. This deluxe chair has adjustable back height and angle. Choose from several vinyl colors.



Figure 2.3 : Lab chair with glides

Source : http://www.bristol.com.my/

## 2.2.4 Adjustable Stool with Backrest

Made of 7/8 inches outside diameter, 18-gauge steel tubing, this sear is a full 14 inches diameter and an 11/12 inches diameter masonite board is recessed into the pan and will not chip or crack. The footrings is are welded to each leg with 4 contact point at each leg for added rigidity. The backrest is 6 inches high and 12 inches wide and can be adjusted.



Figure 2.4 : Adjustable stool with backrest

Source : http://www.everythingofficefurniture.com

#### 2.2.5 Contoured Fabric Drafting Stool with Adjustable Arms

The smoothly designed Contoured Fabric Drafting Stool with Adjustable Arms brings comfort and efficiency to your office. The adjustability of this seat ensures this unit is perfect for persons of any size. The chair has contoured back and seat help to relieve back-strain.



Figure 2.5: Contoured fabric drafting stool with adjustable arms

Source : http://www.cymax.com/

However, plan for this project is to make the prototype only. So the material that will use is different from the original plan. The different will show at a table below.

Part	<b>Original Part</b>	Prototype Part
Backrest	Plastic	Aluminium
Holder	Wood & sponge / metal &	Aluminium
	sponge	
Glides & base	Molded plastic and metal	Glides from used chair

 Table 2.1: Material used for each parts

#### 2.3 FABRICATION PLANNING PROCESS.

#### 2.3.1 Bending

Bending (also known as flexure) characterizes the behavior of a slender structural element subjected to an external load applied perpendicularly to an axis of the element. The structural element is assumed to be such that at least one of its dimensions is a small fraction, typically 1/10 or less, of the other two. When the length is considerably larger than the width and the thickness, the element is called a beam.

A closet rod sagging under the weight of clothes on clothes hangers is an example of a beam experiencing bending. On the other hand, a shell is a structure where the length and the width are of the same order of magnitude but the thickness of the element is considerably smaller. A big but thin short tube supported at its ends and loaded laterally is an example of a shell experiencing bending. In this project, bending process is use to bend the a mild-steel used to make a connecting bar from the seat and the back rest..



Figure 2.6: Bending

#### 2.3.2 Shielded Metal Arc welding

Shielded Metal Arc welding is the process of joining two metal pieces using a flux covered electrode which is melted in an electric arc and becomes a fused part of the pieces being welded. This article will describe the use of flux-coated welding rods and a simple, transformer type cracker box welding machine.



Figure 2.7 : Shielded Metal Arc welding

Source : http://www.ehow.com

An electric arc is formed at the tip of the welding rod when a current passes across an air gap and continues through the grounded metal which is being welded. Here are some of the terms and their descriptions used in this article:

- i. Welding machine. This is the term used to describe the machine which converts 120-240 volt AC electricity to welding voltage, typically 40-70 volts AC, but also a range of DC voltages. It generally consists of a large, heavy transformer, a voltage regulator circuit, an internal cooling fan, and an amperage range selector. The term welder applies to the person doing the welding. A welding machine requires a welder to operate it.
- ii.
- iii. Leads, or Welding leads. These are the insulated copper conductors which carry the high amperage, low voltage electricity to the work piece that is being welded.
- iv. Rod holder is the device on the end of the lead that holds the electrode, which the person welding uses to accomplish the welding task.
- v. Ground and ground clamp. This is the lead that grounds, or completes the electrical circuit, and specifically, the clamp that is attached to the work to allow the electricity to pass through the metal being welded.
- vi. Amperage, or *amps*. This is an electrical term, used to describe the electrical current supplied to the electrode.
- vii. DC and reverse polarity. This is a different configuration used in welding with an arc/electrode system, which offers more versatility, especially in overhead welding applications and for use welding certain alloys that do not weld easily with AC voltages. The welding machine that produces this current has a rectifier circuit or has the current supplied by a generator, and is much more expensive than a typical AC welder.

viii. Electrodes. There are many specialized welding electrodes, used for specific alloys and types of metals, such as cast or malleable iron, stainless or chromolly steel, aluminum, and tempered or high carbon steels. A typical electrode consists of the wire rod in the center covered with a special coating (flux)which burns as the arc is maintained, consuming oxygen and producing carbon dioxide in the weld area to prevent the base metal from oxidizing or burning away in the arc flame during the welding process

There are some advantages and disadvantages in using shielded metal arc welding:

- a) The advantages of shielded metal arc welding
  - i. Versatility readily applied to a variety of applications and a wide choice of electrodes
  - ii. Relative simplicity and portability of equipment
- iii. Low cost
- iv. Adaptable to confined spaces and remote locations
- v. Suitable for out-of-position welding
- b) <u>The disadvantages of shielded metal arc welding</u>
  - i. Not as productive as continuous wire processes
  - ii. Likely to be more costly to deposit a given quantity of metal
- iii. Frequent stop/starts to change electrode
- iv. Relatively high metal wastage (electrode stubs)
- v. Current limits are lower than for continuous or automatic processes (reduces deposition rate)

## 2.3.3 Hand Grinder.

A hand grinder as is a tool which rotates a grindstone but in this case the grinding medium is a thin disc that can be used for either grinding or cutting metal. It is usually used for cutting off material after a welding process or cutting off burrs. Although it is a convenient tool, it is a dangerous tool like the bench grinder. Again, eye protection should be worn when using a hand grinder.



Figure 2.8 : Grinding machine

#### 2.3.4 HOLES PREPARATION

The holes preparation is the most important aspect during fastening process. A hole in a solid body can be produced by using several type processes such as punching and drilling, but to select the right method is depend to the type of materials, properties and thickness, the diameter of the tool or fasteners too.



Figure 2.9 : Drilling machine



Figure 2.10 : Portable hand drill

#### 2..3.5 Cutting Process

The cutting process is also one of the important processes where all the material that will be use to the parts of the digester body into it desired shape according to it specific dimensions. This process is carry out by using cutting machine such as pneumatics or hydraulic cutting machine and also by using disc cutter and divide all the materials one by one to be parts by parts. The machine uses is according to the types of materials that need to be cut into desired shape following the specific dimensions.

Type of Cutter:

- 1) Steel vertical bend saw

Figure 2.11: Steel vertical bend saw

## 2) Shearing machine



Figure 2.12: Shearing machine

## 3) Disc cutter



Figure 2.13: Disc cutter

## **CHAPTER 3**

#### METHODOLOGY

#### **3.1 PROJECT FLOW CHART**

The first thing that I have done upon receiving the title of my final year project is researching some info regarding the available lab chair. This is as you know, is done with the help of the some information from books and internet and with some help from my supervisor. This process involved finding the right material to be used for the project, literature review and the objective of the project takes about three weeks to be completed. After all the above stated information is obtained, I continue with the scope of the project. This is important in order for me to achieve the objective of the project.

The next thing that on my to-do-list is sketching and designing process. My sketching should meet the requirement of my project before it can be fabricated. At this time, many sketch have been produced with some idea that I have got from my fellow friend and of course, my supervisor herself. Many design concept have been produced but only 4 will be choosen to be finalize. In order to choose the finalize design, I have to list down the advantages and disadvantages of each sketch and do the screening method. And finally from this, I get the final design of my project.

After the finalize design have been completed, now I can start with fabricating process of my project.

When the fabrication process is done, the next process is to find out the result of my project. In result and discussion, the draft report and all the related article is gathered and handed over to my supervisor to be check out. Should there be some error on the report, I have to correct it. The final product is to compared with the report to ensure there is no mistake between both the project and the report.

After the product and the draft report is completed and have been approved by my supervisor, the draft report is then will be rearrange and printed out to be submit to my supervisor, project coordinator and Faculty of Mechanical Engineering. In this stage also, the final presentation will be held to let the student to present about their findings on their final year project to the selected panel that have been appointed by the project coordinator



Figure 3.1: Flow Chart

#### 3.2 Design

The design for the project must consider all the aspects and be done carefully to make it easy to fabricate and to ensure that all the parts are functioning. The aspects that must be considered in designing the concept for the adjustable lab chair with back rest are:

- i. Easy to use
- ii. Safe
- iii. Durable / long life time
- iv. Lightweight
- v. Comfortabality
- vi. Easy to move
- vii. Low cost
- viii. Strong

#### 3.3 Drawing

The drawings are divided into two categories which are:

- i. Sketching All the ideas for the biogas digester are sketched on the paper to ensure that the ideas selection can be made after this.
- SolidWorks Software The selected design or selected concept that have been sketched is then transfer into 3D solid modelling and engineering drawing by using SolidWorks software.

#### **3.4** Sketching and Drawing Selection

The purpose of this project is to design adjustable lab chair with backrest which can be use in any type of laboratory or workplace. It is also should look more efficient than existing product on market. The motivation for this project is to improve the design of the existing lab chair available on the market that most of it have no back rest.. So the new design should have a backrest in order to give the user the comfort needed in order to complete their work more efficiently. Those are the datum and new design of small adjustable lab chair with back rest.

## 3.4.1 Datum



Figure 3.2 : Datum

## Advantage:

- i. High esthetic value
- ii. Full cusioned seat

## Disadvatage:

- i. Difficult to manufacture
- ii. Despite the facts that this lab chair is fully cusioned seat, the user might experienced pain in the back or their body or might feel uncomfortable.
- iii. Low working height range

## 3.4.2 Concept A



Figure 3.3 : Concept A

## Advantage:

i. The backrest is adjustable and can be turn  $100^{\circ}$  and can be locked.

## Disadvatage:

- i. Medium working height range.
- ii. The backrest might be unstable or snatch of from the chair.

## 3.4.3 Concept B



Figure 3.4 : Concept B

## Advantage:

- i. Cusion seat
- ii. The back rest can be dismantle from the chair.
- iii. High working height range.
- iv. The back rest is adjustable in height.

## Disadvantage:

- i. Doesn't have any rollers.
- ii. The design is like any other lab chair available in the market

## 3.4.4 Concept C



Figure 3.5 : Concept C

## Advantage

i. Easy to manufacture.

## Disadvantage:

- i. The backrest is not high enough
- ii. The adjustble system is not very practical.

## 3.5 DESIGN SELECTION

After design concept, study the best design and relate it with criteria selection. Then make decision which design is the best. For this project, concept A design is the best after consider the criteria selection.

This is a table which use to select which criteria is the best.

Selection Criteria	Concepts			
Selection Chiefia	А	В	С	D
				(Datum)
Easy to use	-	+	-	0
Safe	+	+	+	0
Durable / long life time	-	0	+	0
Lightweight	+	+	+	0
Comfortabality	-	+	0	0
Easy to move	-	-	-	0
Low cost	-	+	-	0
Strong	-	+	+	0
$\Sigma^+$	2	6	4	0
$\Sigma 0$	0	1	1	0
Σ-	6	1	3	0
Net Score	2	6	4	0
Rank	3	1	2	4

Table 3.1: Concept Screening Table





Figure 3.6: Final Concept

Concept B have the higher net score than the other concept. So this concept had been chosen to be the final concept and will be fabricate. For the proper function, the design had been improved by changing the base of the chair using roller.



Figure 3.7 : 3D model

#### **3.6 MATERIAL SELECTION**

For this project, I plan to make a full scale prototype. It is because for the real product, the base is made using mold. However, for the prototype, the material for the seat is aluminium and mild steel sheet to make the stick to connect the seat and the backrest. The glides and the base of the chair is taken from used adjustable chair.

Part	<b>Original Part</b>	<b>Prototype Part</b>
Backrest	Plastic	Aluminium
Holder	Wood & sponge / metal &	Aluminium
Glides & base	Molded plastic and metal	Glides from used chair

 Table 3.2 : Materials for each parts

#### 3.7 FABRICATION PROCESS

This process use the materials that selected, make the product base on the selected design and then followed by the selected dimension. In this process, many methods are used in order to make the design become reality. The fabrication starts with the dimensioning by using marking and measuring process until finishing. The processes involve are as below.

- i. Marking and Measuring: Make mark on the materials to show the dimensions location and give precise dimensions.
- ii. Cutting: All the materials are been cut into the pieces desired.
- iii. Drilling: The marked holes are drilled to make holes for screw.
- iv. Bending: The material is bend using pneumatic bending machine.
- v. Joining: All the materials are joined by using welding, and screws.
- vi. Finishing: Remove all the rough surface and finish painting.

## 3.7.1 Marking and Measuring Process

Before the cutting process can begun, the material must be measure according to the dimension that have been decided. The measuring process is done by using a sciber, steel rule, and measuring tape.

## 3.7.2 Cutting Process

、

After the measuring process have been done, the cutting process can be started. The tool and machine used to cut the material is shearing machine, steel vertical bend saw and disc cutter



Figure 3.8 : Cutting using disc cutter



Figure 3.9 : Cutting using shearing machine

## 3.7.3 Drilling Process

The holes for fastening is drill using hand drilling machine and vertical drilling machine.



Figure 3.10 : Drilling process

## 3.7.4 Bending Process

The bending process is done by using pneumatic bending machine.





Source : http://www.bombayharbor.com/

## 3.7.5 Joining Process

The joining process is then done by using welding and screws.



Figure 3.12 : Welding

## 3.7.6 Finishing Process

The product is then be painted white and all the sharp edges will be grind. A cusion is add to the seat and the back rest to give comfortabality to the user.



Figure 3.13 : Final product

## **CHAPTER 4**

## **RESULT AND DISCUSSION**

## 4.1 INTRODUCTION

The result of the project is achieved after the fabrication process have been completed. The result will be use to find the ways to solve the problems and make some improvements to the product.

## 4.2 Designs in SolidWork.

After choose the selected design for the project, the early sketch is transfer to the engineering drawing and also for the solid modelling by using the SolidWorks software to show the actual design for the mini biogas digester.



Figure 4.1 : 3D model



Figure 4.2 : Rear view of the 3D model

#### 4.3 OVERALL DESIGN VIEW

#### 4.3.1 Design Descriptions

The design shows the final idea for the Adjustable Lab Chair With Backrest. Most of the parts are made by using aluminium steel, and the roller, the glides is from used material. The reason why the steel is use it because of better properties which are strong which is important in making a chair like this.

From the result after drawing, sketching selection, generate and evaluate the concept selection, the Concept B is the best design for this project to be fabricate.

#### 4.3.2 Material

The Adjustable Lab Chair parts are made from aluminium sheet with a thickness of 3 mm. The other material are:

- i. Sheet metal
- ii. Bolts
- iii. Nuts
- iv. Used glides
- v. Used roller

## 4.3.3 Method of Joining

All the body parts are joined using Shielded metal arc welding and using fasteners such as bolt and nuts.

## 4.3.4 Special Feature

This Adjustable Lab Chair with Back Rest has a backrest that can be dismantle if the user don't want to use it. It also have a roller to make the user move easily without getting up from the chair.

## **CHAPTER 5**

#### CONCLUSION AND RECOMMENDATION

#### 5.1 INTRODUCTION

This chapter is mainly described about all the problems that have been faced during running the project from start until finish. In this chapter will discuss about the project conclusion for the whole of this project too. All the right action that needs to do before, present and after the project are stated in this chapter.

#### 5.2 **PROJECT PROBLEMS**

- Literature Review: The ideas and the concepts that review for this project are very vast it make me hard to choose the suitable ideas because we have so many types of industrial lab chair that is available in the market.
- Materials preparation: Some of the materials were not supplied by the university and the students needed to buy the materials at the city and get the materials from the supplier there.
- 3) Fabrication Process: The time needed by the students should be more to finish the project because of the slackness of training, so the finishing of the product was not so good but yet still can be reliable and same with the design.

#### 5.3 CONCLUSION

The project managed to be completed in the time given and also successfully reaches the objective and the target of the project, and they are achieved. The product is more friendly to the users. The result of the Adjustable Lab Chair with Backrest is hope to be a success in the market..

## 5.4 **RECOMMENDATIONS**

The project planning should be start and done before the project start, do all the process on time according to the Gantt chart, so that all the process can be completed. The skills in fabrication process such as welding must be improved and well train before running the project. For addition, the project should be improve by using the materials that more light and have better properties, so they can give the best performance, the great features and more ergonomic value to the project. The time also must be managing wisely, so, all the progress on the project can be done on time. The materials that need to be use to fabricate the project must be prepare after the concept selection and designing the concept selected.

#### REFERENCES

This thesis is prepared based on the following references:

Adjustable Chair Manufacturer http://www.cymax.com/ http://www.eurochairs.com/ http://www.bristol.com.my/

Step-by-step Procedure and Guideline on Metal Shielded Arc Welding http://www.wikihow.com/ http://www.ewi.org/blog/ http://www.esabna.com/euweb/awtc/

Investigating The Right Material For The Project http://www.wlfuller.com/html/steel\_types.html http://en.wikipedia.org/wiki/Steel

Invetigating The Properties Of Aluminium Sheet Metal http://www.metalweb.co.uk/

Universiti Malaysia Pahang on Thesis Writing Guide http://www.ump.edu.my/

## **APPENDIX A1**

## **GANTT CHART**



Planning

Actual

## **APPENDIX A2**

## **ORTHOGRAPHIC VIEW**





## EXPLODED VIEW

APPENDIX A3

## APPENDIX A4

## **PRODUCT TESTING**



