

DEVELOPMENT OF PORTABLE DESK FOR BIOMECHANICS
EQUIPMENT

SHAHREN ABD MANAP

UNIVERSITI MALAYSIA PAHANG

UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS ♦

JUDUL : DEVELOPMENT OF PORTABLE DESK FOR BIOMECHANICS EQUIPMENT

SESI PENGAJIAN: 2012/2013

Saya, **SHAHREN ABD MANAP (921221-10-5663)**

mengaku membenarkan tesis Projek Tahun Akhir ini disimpan di perpustakaan dengan syarat-syarat kegunaan seperti berikut:

1. Tesis ini adalah hakmilik Universiti Malaysia Pahang (UMP).
2. Perpustakaan dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. **Sila tandakan (√)

SULIT

(Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di dalam AKTA RAHSIA RASMI 1972)

TERHAD

(Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi / badan di mana penyelidikan dijalankan)

TIDAK TERHAD

Disahkan oleh:

(TANDATANGAN PENULIS)

(TANDATANGAN PENYELIA)

Alamat Tetap:

NO. 31 JALAN 2/6
BANDAR SUNWAY SEMENYIH
43500 SEMENYIH
SELANGOR DARUL EHSAN

ZULKIFLI BIN AHMAD @ MANAP
(Nama Penyelia)

Tarikh: **18 JUNE 2013**

Tarikh: **18 JUNE 2013**

CATATAN: * Potong yang tidak berkenaan.

** Jika tesis ini SULIT atau TERHAD, sila lampirkan surat daripada pihak berkuasa/organisasi berkenaan dengan menyatakan sekali tempoh tesis ini perlu dikelaskan sebagai SULIT atau TERHAD.

♦ Tesis dimaksudkan sebagai tesis bagi Diploma secara penyelidikan atau disertai bagi pengajian secara kerja kursus.

DEVELOPMENT OF PORTABLE DESK FOR BIOMECHANICS EQUIPMENT

SHAHREN ABD MANAP

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

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

JUNE 2013

SUPERVISOR'S DECLARATION

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

Signature:

Name of Supervisor: EN ZULKIFLI BIN AHMAD @ MANAP

Position: LECTURER

Date: 18 JUNE 2013

STUDENT'S DECLARATION

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

Signature:

Name: SHAHREN ABD MANAP

ID Number: MB11256

Date: 18 JUNE 2013

ACKNOWLEDGEMENTS

I am grateful and would like to express my sincere gratitude to my supervisor En Zulkifli Bin Ahmad for his germinal ideas, invaluable guidance, continuous encouragement and constant support in making this research possible. He has always impressed me with his outstanding professional conduct, his strong conviction for science, and his belief that a Diploma program is only a start of a life-long learning experience. I appreciate his consistent support from the first day I applied to graduate program to these concluding moments. I am truly grateful for his progressive vision about my training in science, his tolerance of my naive mistakes, and his commitment to my future career I also sincerely thanks for the time spent proofreading and correcting my many mistakes.

My sincere thanks go to all my lab mates and members of the staff of the Mechanical Engineering Department, UMP, who helped and give more idea to me while make this project and made my stay at UMP pleasant and unforgettable.

I acknowledge my sincere indebtedness and gratitude to my parents for their love, dream and sacrifice throughout my life. I acknowledge the sincerity of my parents, who consistently encouraged me to carry on my higher studies in Malaysia. I cannot find the appropriate words that could properly describe my appreciation for their devotion, support and faith in my ability to attain my goals. Special thanks should be given to my committee members. I would like to acknowledge their comments and suggestions, which was crucial for the successful completion of this study.

ABSTRACT

The objective of this project is to design and fabricate a portable desk and camera stand. Portable desk main function is it can place the biomechanics equipment into it. Besides that, it can place the desktop so that the high speed camera can be attach into it during outdoor session. For the camera stand, it mainly function is to attach the high speed camera from top view. Tripod camera that have been sell in market can be a camera stand that can take a picture from bottom and front view. The material that have been used to fabricating the portable desk is mild steel while material used to fabricating the camera stand is aluminum. The portable desk have wheel so that the portable desk can be brought anywhere easily. The process that involved to fabricating both portable desk and camera stand is welding, drilling, grinding, cutting and riveting. There are also several problems faced during the fabrication process. Material selection was one of the biggest problems. In order to find the most suitable raw material for the portable desk and camera stand, research and information are searched through reliable source. Wrong selection of material will cause a lot of difficulties during fabrication process and will lead to more trouble in the future. The problem is counter by make some research from the internet and book. Lastly, the objective of this project has been achieved where the portable desk can be brought anywhere easily while the camera stand can be used to attach the high speed camera into it. The experiment can be conducted during outdoor session.

ABSTRAK

Objektif projek ini adalah untuk mereka cipta dan mereka bentuk meja mudah alih dan batang kamera. Fungsi utama meja mudah alih ini adalah untuk meletakkan peralatan biomekanik ke dalamnya. Selain itu, komputer meja juga boleh diletakkan di dalamnya untuk digunakan bersama kamera mengesan kelajuan tinggi semasa experiment dijalankan di luar makmal. Kegunaan utama batang kamera adalah untuk meletakkan kamera mengesan kelajuan tinggi untuk mengambil gambar dari pandangan atas. Batang kamera yang telah dijual di pasaran boleh dijadikan batang kamera untuk mengambil gambar dari pandangan bawah dan depan. Bahan yang telah digunakan untuk membina meja mudah alih adalah keluli lembut manakala bahan yang digunakan untuk membina batang kamera adalah aluminium. Meja mudah alih mempunyai roda supaya ianya boleh dibawa ke mana-mana sahaja dengan mudah sekali. Proses yang terlibat untuk pemasangan meja mudah alih dan batang kamera ini adalah kimpalan, penggerudian, menggiling, memotong dan rivet. Terdapat beberapa masalah yang dihadapi semasa proses mereka cipta ini dijalankan. Memilih bahan adalah antara masalah terbesar. Untuk memastikan bahan yang sesuai dalam mereka cipta meja mudah alih dan batang kamera adalah dengan membuat kaji selidik. Jikalau bahan yang dipilih salah maka masalah yang lebih besar yang perlu dihadapi di masa hadapan. Masalah ini dihadapi dengan membuat beberapa kajian dengan merujuk bahan-bahan di internet dan buku bagi mengelakkan masalah yang lebih besar. Akhir sekali, objektif projek ini telah dicapai di mana meja mudah alih boleh dibawa ke mana sahaja dengan mudah manakala batang kamera boleh digunakan untuk meletakkan kamera mengesan kelajuan tinggi ke dalamnya. Eksperimen boleh dijalankan luar daripada makmal.

TABLE OF CONTENTS

	Page
BORANG PENGESAHAN STATUS TESIS	i
COVER PAGE	ii
SUPERVISOR'S DECLARATION	iii
STUDENT'S DECLARATION	iv
ACKNOWLEDGEMENTS	v
ABSTRACT	vi
ABSTRAK	vii
TABLE OF CONTENTS	viii
LIST OF TABLES	xi
LIST OF FIGURES	xii

CHAPTER 1 INTRODUCTION

1.1	Introduction	1
1.2	Project background	1
1.3	Problem statement	2
1.4	Objective	3
1.5	Scope	3
1.6	Project gantt chart	4
1.7	Thesis organization	5

CHAPTER 2 LITERATURE REVIEW

2.1	Introduction	6
2.2	Product Review	6
	2.2.1 Product A	7
	2.2.2 Product B	8
	2.2.3 Product C	9
2.3	Fabrication Equipment	11
	2.3.1 Shearing Machine	11

2.3.2	Angle Grinder	12
2.3.3	Gas Metal Arc Welding	13
2.3.4	Drilling	14
2.3.5	Rivet	15

CHAPTER 3 METHODOLOGY

3.1	Introduction	16
3.2	Synopsis	16
	3.2.1 Project Flow chart	17
	3.2.2 Methodology Flow Chart	18
3.3	Concept Design	20
	3.3.1 Concept A	20
	3.3.2 Concept B	21
	3.3.3 Concept C	22
3.4	Evaluation Process	23
	3.4.1 Concept Screening	23
	3.4.2 Concept Scoring	25
3.5	Finalize Concept	27
3.6	Bill of Material	29
3.7	Fabrication Process	30
	3.7.1 Material Selection	30
	3.7.2 Cutting Process	31
	3.7.3 Welding Process	32
	3.7.4 Drilling Process	33
	3.7.5 Grinding Process	34
	3.7.6 Rivet Process	34
	3.7.7 Filling Process	35
	3.7.8 Finishing Process	36

CHAPTER 4 RESULTS AND DISCUSSION

4.1	Introduction	37
4.2	Results	37
4.2.1	Product Specifications	43
4.2.2	Welding Analysis For The Portable Desk	44
4.2.3	Camera Stand Analysis	46
4.2.4	Cost Analysis	49
4.3	Discussion	50
4.3.1	Advantages and Disadvantages	50
4.3.2	Type of Defect	51
4.3.3	Problem Faced	51

CHAPTER 5 CONCLUSION AND RECOMMENDATION

5.1	Introduction	52
5.2	Conclusion	52
5.3	Recommendation	53

REFERENCES	54
-------------------	-----------

LIST OF TABLES

Table No.		Page
2.1	Comparison between existing products	10
3.1	Concept screening	24
3.2	Concept Scoring	25
3.3	Bill of Material	29
4.1	Product specifications for portable desk	43
4.2	Product specifications for camera stand	43
4.3	Price estimation	49

LIST OF FIGURES

Figure No.		Page
1.1	Project gantt chart	4
2.1	Product A	7
2.2	Product B	8
2.3	Product C	9
2.4	Shearing Machine	11
2.5	Angle Grinder	12
2.6	Gas Metal Arc Welding	13
2.7	Drilling	14
2.8	Rivet	15
3.1	Project Flow Chart	17
3.2	Methodology Flow Chart	18
3.3	Concept A	20
3.4	Concept B	21
3.5	Concept C	22
3.6	Finalize Concept for Portable Desk	27
3.7	Finalize Concept for Stand Camera	28
3.8	Hollow Square	30
3.9	Hollow Aluminium	30
3.10	Sheet Metal	31

3.11	Shearing Machine	31
3.12	Hands Saw	32
3.13	Welding Process	32
3.14	Drilling Process	33
3.15	Grinding Process	34
3.16	Rivet Process	34
3.17	Filling Process	35
3.18	Finishing Process	36
4.1	Portable Desk	38
4.2	Portable Desk	38
4.3	Welding Part	39
4.4	Rivet Part	39
4.5	Screw Part	40
4.6	Camera Stand	41
4.7	Camera Bracket	42
4.8	Lower Part of Camera Stand	42
4.9	Torsional Welding Properties	44
4.10	Frustum Diagram	48

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

The purpose of this chapter is to explain about the project background, problem statement, project objectives, project scopes, flow chart of the project as well as Gantt chart to present the flow and overall process for this project.

1.2 PROJECT BACKGROUND

Nowadays, there are various type of portable desk that have been invented. It comes with many design. Some have round shape, square shape and many more. Portable desk specially design for bring any item that can bring it anywhere. Besides that, the item can be safely store in it. Portable desk mostly have wheel that can pull and push so that it is easily to bring anywhere.

However, the portable desk has its own advantages and disadvantages. Even though, the portable desk have wheel that will facilitate the owner but when it comes to difficult situation it will trouble the owner. For example, the portable desk have wheel that can pull and push it anywhere but the problem is when it comes to stairs. The owner need to carry the portable desk upstairs or downstairs.

Therefore, biomechanics equipment need a portable desk that can bring it anywhere so that the experiment can be conducted outdoor. Some of biomechanics equipment is high speed camera, electromyography (EMG), echocardiography (ECG), accelerometer, gyro meter etc.

1.3 PROBLEM STATEMENT

One of biomechanics is high speed camera. A high speed camera is a device used for recording fast-moving objects as a photographic image onto a storage medium. High speed camera need three stand camera for place it in front, top and bottom. For camera in front and bottom view can be place using a tripod camera. The problem is when the camera need to take a picture in top view. The high of tripod camera is about 1 m to 1.5 m. Tripod stand for top view need at least 2 m to 3 m.

Besides that, high speed camera can be detected using a desktop only. So, without desktop the high speed camera cannot be running. High speed camera cannot be detected using a laptop. There is no problem if the experiment is being held indoor. The problem is when the experiment is being held outdoor. The portable desk is needed to bring desktop anywhere so that the experiment can be conducted outdoor.

1.4 OBJECTIVE

1. To fabricate a portable desk that can place the biomechanics equipment to bring anywhere easily.
2. To make sure the experiment can be conducted in outdoor session using both desktop and high speed camera.
3. To fabricate the stand camera that exceed the high limit to take a picture from top view.

1.5 SCOPE

1. Portable desk is fabricating using a hollow square and sheet metal.
2. Material used for both hollow square and sheet metal is mild steel.
3. Size for hollow square is 1 inch while sheet metal is 2 mm.
4. The material used for camera stand is aluminium.
5. The size used is hollow aluminium $\frac{1}{2}$ inch, $\frac{3}{4}$ inch and 1 inch.
6. Camera stand can exceed high limit about 3 m length.

1.6 PROJECT GANTT CHART

Task		W1	W2	W3	W4	W5	W6	W7	W8	W9	W10	W11	W12	W13	W14	W15
Literature Review	Plan	■	■													
	Actual		■													
Problem identification	Plan		■													
	Actual		■													
Concept Design	Plan			■	■	■										
	Actual			■												
Finalize Design	Plan			■	■	■										
	Actual			■	■											
Analyse Structure	Plan				■	■	■									
	Actual				■	■										
Mid Presentation	Plan						■	■	■	■						
	Actual								■							
Fabrication	Plan							■	■	■	■	■	■			
	Actual									■	■	■	■			
Testing & Improvement	Plan											■	■	■		
	Actual											■	■			
Final Report Preparation	Plan												■	■	■	■
	Actual													■	■	■
Final Presentation Preparation and final presentation	Plan												■	■	■	■
	Actual													■	■	■

Figure 1.1: Gantt chart

1.7 THESIS ORGANIZATION

Chapter 1 will explain about the introduction, project background, problem statement, objective, scope, project flow chart and project Gantt chart. This chapter planned about the flow of my project.

Chapter 2 which is the literature review mainly will explain about the advantages and disadvantages of market existing products and also the comparison between these products.

Chapter 3 which is the methodology and this chapter will explain about the concept design and also the finalize concept of the design. It also explains about the fabrication process and machining used.

Chapter 4 which is the results and discussion and this chapter will explain about the finalize product that have been made. The product is then being tested to find out its effectiveness in solving the problem statement.

Chapter 5 mainly explains about the conclusion and recommendation that can be made to the product.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter will explain about the literature review of all the market existing products. However these existing portable desk that have been sell in market have their own advantages and disadvantages.

2.2 PRODUCT REVIEW

This topic explains about the existing products in the market and comparison about their advantages and disadvantages.

2.2.1 PRODUCT A



Figure 2.1 : Product A

Advantage :-

- It is light
- Easy to bring anywhere because have wheel.
- It is also easy to assemble.
- Can used anywhere for example office or home.

Disadvantage :-

- No surface cover so the probability of the item to fall down is high.
- The table is small and just enough to put a desktop but no space for other item.

Material used :-

- Steel is used in framework part.
- Plastic is used to cover the surface.

2.2.2 PRODUCT B



Figure 2.2 : Product B

Advantage :-

- Space is larger so can put many item above it
- Comfortable
- Item can put a safe condition

Disadvantage :-

- Completely used at home
- A bit heavy
- A bit difficult to carry it anywhere because have no wheel.

Material used :-

- Mostly material used is wood.
- Glass only used to cover the surface

2.2.3 PRODUCT C



Figure 2.3 : Product C

Advantage :-

- Easy to bring anywhere because the table can be pull or push.
- Top of the table can be closed. The function is to prevent the item from fall down during the table is moved. Besides that, it also can avoid dust from the item. So, the table can be closed after using it.
- Have large surface so many item can be place.

Disadvantage :-

- A bit heavy.
- Table too large to bring it anywhere.

Material used :-

- Mostly material used is wood.
- Stainless steel is used for make the leg of the table

Table 2.1 : Comparison between existing products

Aspect	Product A	Product B	Product C
Easy to bring anywhere	Yes	No	Yes
Ease of use	Yes	Moderate	Yes
Save cost	Yes	Yes	No
Comfort ability	No	Yes	No
Size	Small	Medium	Big
Durability	No	Yes	No

Table 2.1 shows the comparison between existing products that shown in figure 2.1, figure 2.2 and figure 2.3. This table have shown that Product A, Product B and Product C has its own advantages and disadvantages.

2.3 FABRICATION EQUIPMENT

There are various types of machining that will be used in carrying out the fabrication process. Below are details about the machining equipment used.

2.3.1 Shearing Machine



Figure 2.4 : Shearing machine

Source: <http://image.made-in-china.com/2f0j00dMLaHqyUkZkF/Shearing-Machine.jpg>

Shearing machine also known as die cutting machine. Shearing machine is used to cut sheet metal without the formation of chips or the use of burning or melting. A blade is used to push the workpiece against the die which is fixed. This action will cause the material to experience shear stresses between the punch and the die.

2.3.2 Angle grinder



Figure 2.5 : Angle grinder

Source: <http://metalworkingmachine.net/wp-content/uploads/2011/02/angle-grinder-.jpg>

Angle grinder is also known as disc grinder which is a power tool used for cutting, grinding and polishing. Angle grinders can be powered by an electric motor, petrol engine or compressed air. The motor drives a geared head on which is mounted an abrasive disc. Angle grinders usually have an adjustable guard and a side handle for two handed operation.

2.3.3 Gas Metal Arc Welding



Figure 2.6 : Gas Metal Arc Welding

Source : http://en.wikipedia.org/wiki/Gas_metal_arc_welding

Gas metal arc welding (GMAW), sometimes referred to by its subtypes metal inert gas (MIG) welding or metal active gas (MAG) welding, is a welding process in which an electric arc forms between a consumable wire electrode and the workpiece metal, which heats the workpiece metal, causing them to melt, and join. Along with the wire electrode, a shielding gas feeds through the welding gun, which shields the process from contaminants in the air.

2.3.4 Drilling

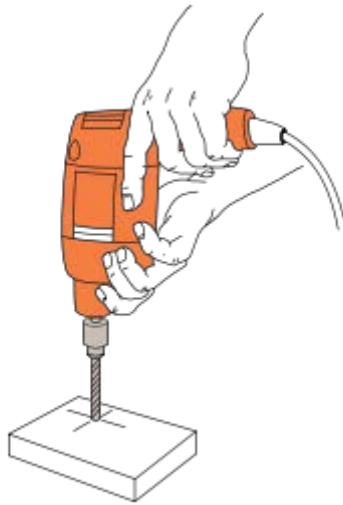


Figure 2.7 : Drilling

Source : <https://en.wikipedia.org/wiki/Drill>

A drill is a tool fitted with a cutting tool attachment or driving tool attachment, usually a drill bit or driver bit, used for drilling holes in various materials or fastening various materials together with the use of fasteners. The attachment is gripped by a chuck at one end of the drill and rotated while pressed against the target material. The tip, and sometimes edges, of the cutting tool does the work of cutting into the target material.

2.3.5 Rivet



Figure 2.8 : Rivet

Source: <http://img.ehowcdn.com/article-page-main/ehow/images/a07/67/m1/arrow-rivet-tool-instructions-800x800.jpg>

Rivet is a permanent mechanical fastener. A blind rivet is one of the types of rivet. The rivet assembly is inserted into a hole drilled through the parts to be joined and a rivet gun is used to draw the mandrel into the rivet. There are three types of rivets size available in the market which is the aluminium blind rivets size 1/8", 3/32" and 1/16".

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will explain about the concept design that has been made in order to solve the problem statement. This chapter also will explain about how all the concept design being evaluate in order to get the finalize concept. Material selection and fabrication process also being discuss in this chapter about how the raw material being cut and shape into desired design.

3.2 SYNOPSIS

This topic will explain about the flow or step involve in designing out the finalize concept. The flows of the project methodology are as follow:

- i. Identify the problem statement and find the solution
- ii. Concept design and evaluation
- iii. Finalize concept
- iv. Material selection
- v. Fabrication process and finishing

3.2.1 PROJECT FLOW CHART

Figure 3.1 shows the project flow chart which indicates the overall flow in conducting out this project.

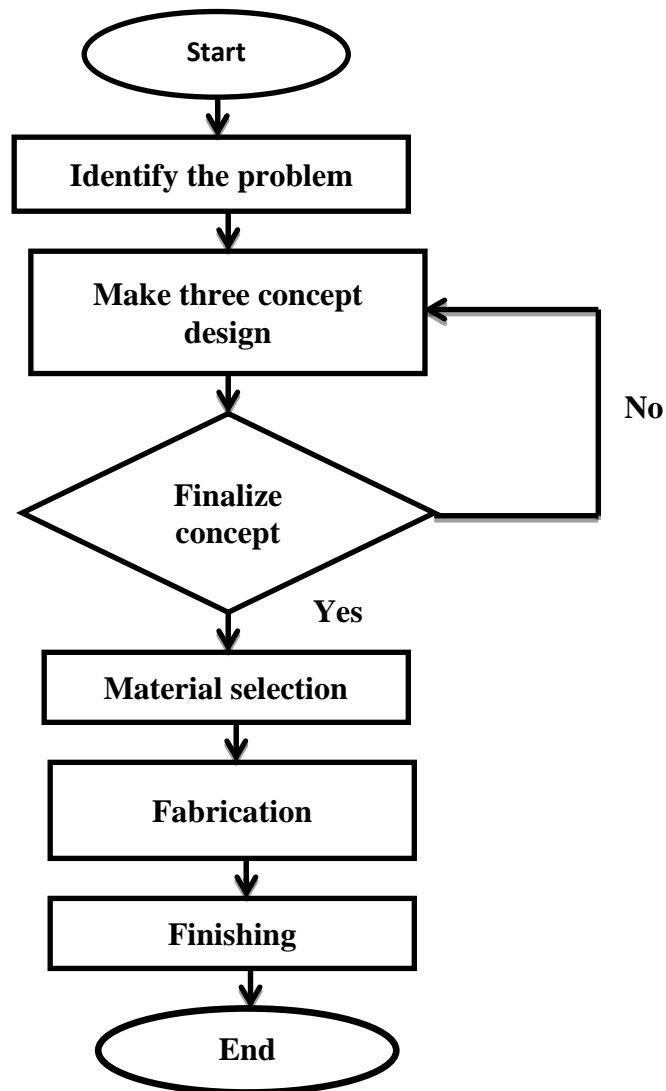


Figure 3.1: Project flow chart

3.2.2 Methodology Flow Chart

Figure 3.2 shows the methodology flow chart which indicates the overall flow in conducting out this project.

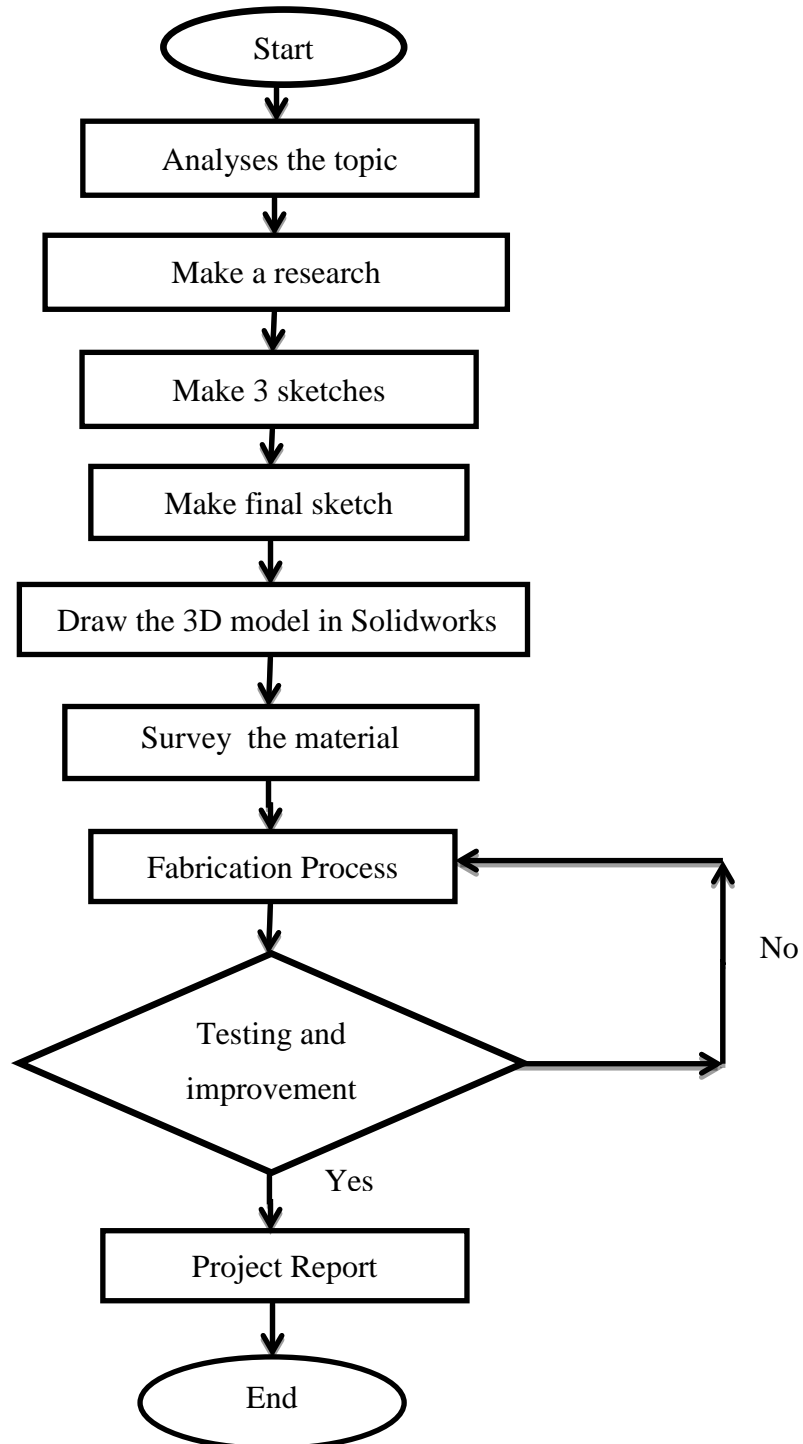


Figure 3.2: Methodology flow chart

From the methodology flow chart in Figure 3.2, the project has starts off with analyses the topic of this project which this project need to fabricating a portable desk and camera stand. After that, need to make some research from the internet about some design that have been sell in market which have advantages and disadvantages. From the research, three design have been sketches to make a comparison. After compare the three sketches finally, final sketches have been made based on criteria that have been combined from the three sketches. Then, the final sketches have been draw in 3D model using a Solidworks software.

After that, survey have been made to make sure the best material to fabricating the portable desk and camera stand. Mild steel is the best choice to fabricating the portable desk compared to the stainless steel because stainless steel price is three times higher than mild steel. After the survey have been made, fabrication process is then carry out. Here several of tool and machining process is carry out like cutting, welding and much more. The product need to make a test and need to make an improvement if the product fail to achieve the objective that have been set up from the beginning. Finally, make a project report based on the project during project have been running.

3.3 CONCEPT DESIGN

3.3.1 Concept A

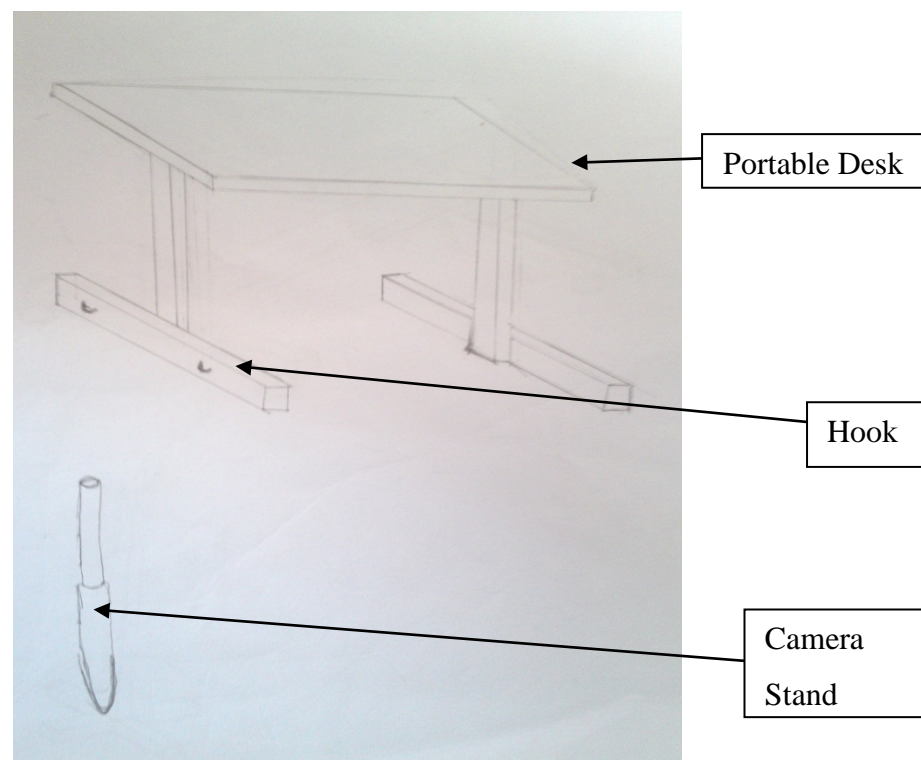


Figure 3.3 : Concept A

Figure 3.3 shows the first concept design. The size of portable desk is small. It has hook besides the leg of portable desk so that the camera stand can be placed during the portable desk is lift up. The advantage of the portable desk is it is light than other portable desk. Besides that, the material used to fabricate this portable desk is aluminium. Because of that the portable desk is lighter than other portable desk. While the disadvantages of the portable desk is it has low durability. There is no place to keep the biomechanics equipment safely. The camera stand is invented specially for outdoor experiment. The stand camera is erected on the land. The disadvantages is when there is no land.

3.3.2 Concept B

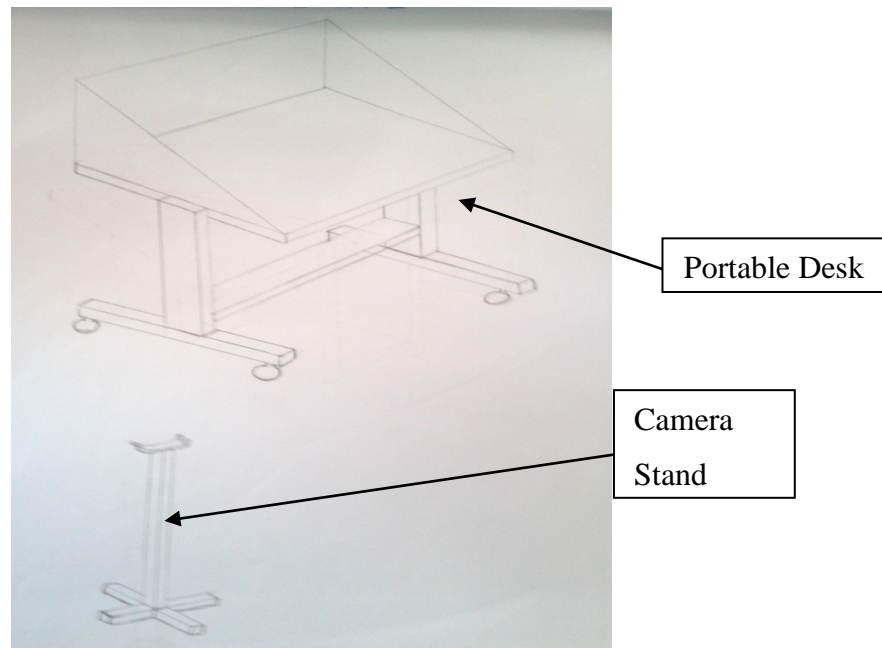


Figure 3.4: Concept B

Figure 3.4 show the second concept design. The size of this portable desk is medium. The material used to fabricate this portable desk is mild steel same with camera stand. So, both of portable desk and stand camera is a bit heavy. The portable desk have wheel so that it can be pull and push. Because of that, the portable desk can bring anywhere easily. For the camera stand, the camera stand cannot be adjusted. The high limit is fixed. So, it is difficult to bring it anywhere because of its high and weight. It also have less stability because of its leg.

3.3.3 Concept C

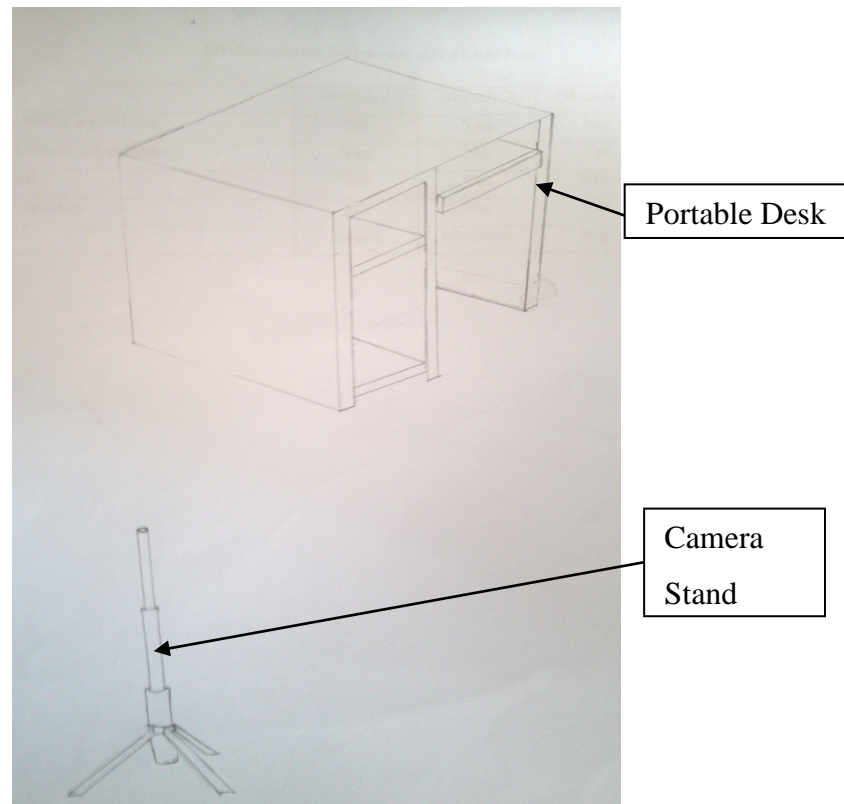


Figure 3.5 : Concept C

Figure 3.5 shows the last concept design. The size of the portable desk is also medium. The material used to fabricate the portable desk is wood while the stand camera is aluminium. There is no wheel in portable desk so, it is difficult to bring it anywhere. Its weight is not as heavy as shown in concept B. It have safe place to keep the item safely during the portable desk is lift up. For the stand camera, it is light because the material used is aluminium. It has three leg same with tripod stand camera that have been sell in the market. The high of the stand camera can achieved 3 m high and have high stability.

3.4 EVALUATION PROCESS

After three concept designs have been sketch out, the next process will be evaluation process to sort out the criteria of each concept. After screening concept is done the evaluation process is then further to scoring process. At here, the process will determine which concept designs are to be developed

3.4.1 Concept Screening

Table 3.1 the concept screening process. Each concept design will be evaluate according to the selection criteria which is ease of use, safety user, durability, safety item, size, stability of camera stand, adjustable camera stand and appearance. Figure 2.2 which is the portable desk that have been sell in market is taken as the reference in screening out the design concepts. Design concept that has the same selection criteria to the reference will be given a (0) sign, (-) is given to the design that has bad criteria than the reference and (+) is given to the design that has better criteria than the reference. Then the sum of (+), (-) and (0) is calculated. Net score is obtained by minus away the (+) sign with the (-) sign then the concept is ranked. Here concept design C ranked the first followed by B and finally A. Design concept B is then combined with design concept C and is called design concept D. Design concept A and D will continue to the scoring process.

Table 3.1 : Concept screening

	Concepts			
Selection criteria	A	B	C	Ref
Ease of use	+	+	-	0
Users safety	+	+	0	0
Durability	0	+	+	0
Safety items	-	+	+	0
Size	+	-	+	0
Stability of the camera stand	-	-	+	0
Adjustable camera stand	+	-	+	0
Appearance	0	+	+	0
Sum +'s	3	5	6	
Sum 0's	0	0	0	
Sum -'s	2	3	1	
Net score	1	2	5	
Rank	3	2	1	
Continue?	YES	COMBINE	COMBINE	

3.4.2 Concept Scoring

Table 3.2 : Concept Scoring

		Concepts			
		D		A	
Selection criteria	weight	Rating	Weighted score	Rating	Weighted score
Ease of use	20%	4	0.8	4	0.8
Safety Users	10%	4	0.4	3	0.3
Durability	10%	4	0.4	3	0.3
Safety items	25%	3	0.75	4	1
Size	5%	3	0.15	3	0.15
Stability of the camera stand	10%	4	0.4	2	0.2
Adjustable camera stand	15%	4	0.6	1	0.15
Appearance	5%	4	0.2	3	0.15
Total score		3.7		3.05	
Rank		1		2	
Continue		Develop		No	

Table 3.2 above shows the concept scoring process. Here, concept design B and C is being combined due to its certain criteria where concept design B have wheel for the portable desk while concept design C does not have. Besides that, for camera stand the concept design C can adjust its height while concept design B cannot. Furthermore, concept design C have some space to put the item in the desk. The combined concept design B and C is named as concept design D. Next, concept design A and concept design D is being evaluate under certain criteria where all the criteria is given weight and rating. Weight is given based on percentage and rating is given out of five stars. Then the weighted score is then calculated by multiply the weight with the rating. Total score is then calculated by adding up all the weighted score then the concept designs are ranked. Here the combined concept D has the highest total score and ranked the first. Thus it will be develop as the finalize concept.

3.5 Finalize Concept

Finalize concept is develop after the screening and scoring concept. Finalize concept is the concept that has taken all the criteria into consideration. Figure 3.5 and figure 3.6 below have shown the finalize concept.

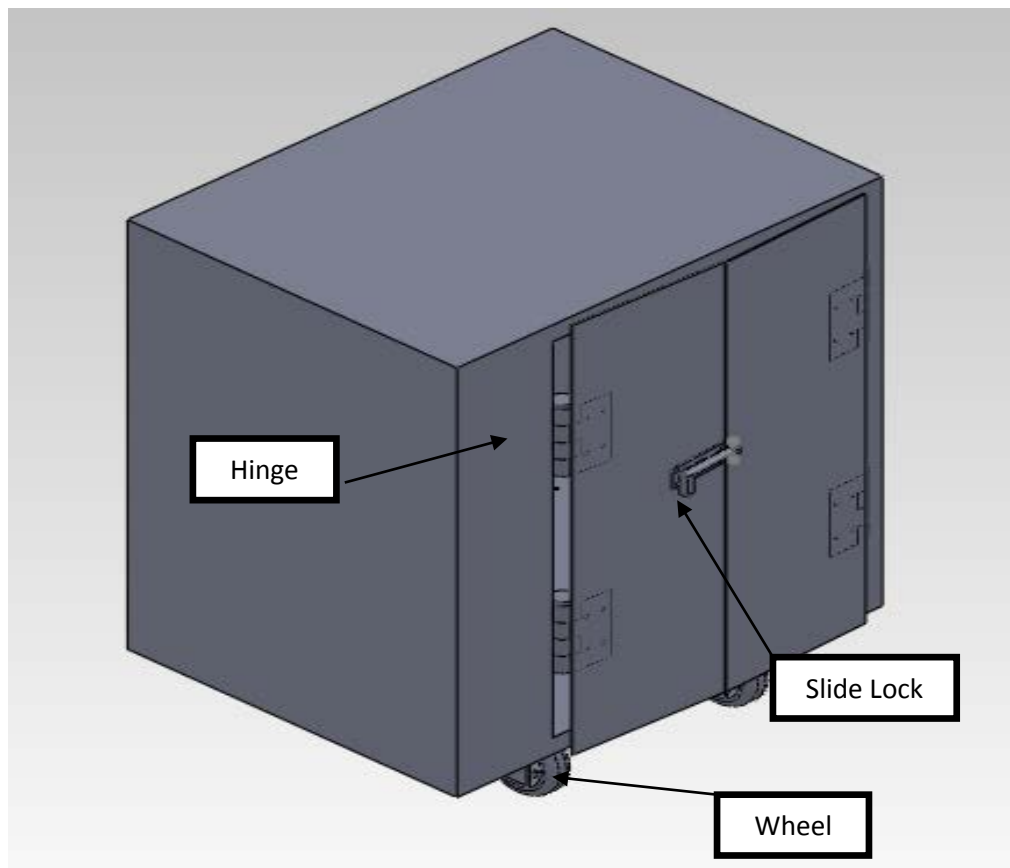


Figure 3.6 : Finalize Concept for portable desk

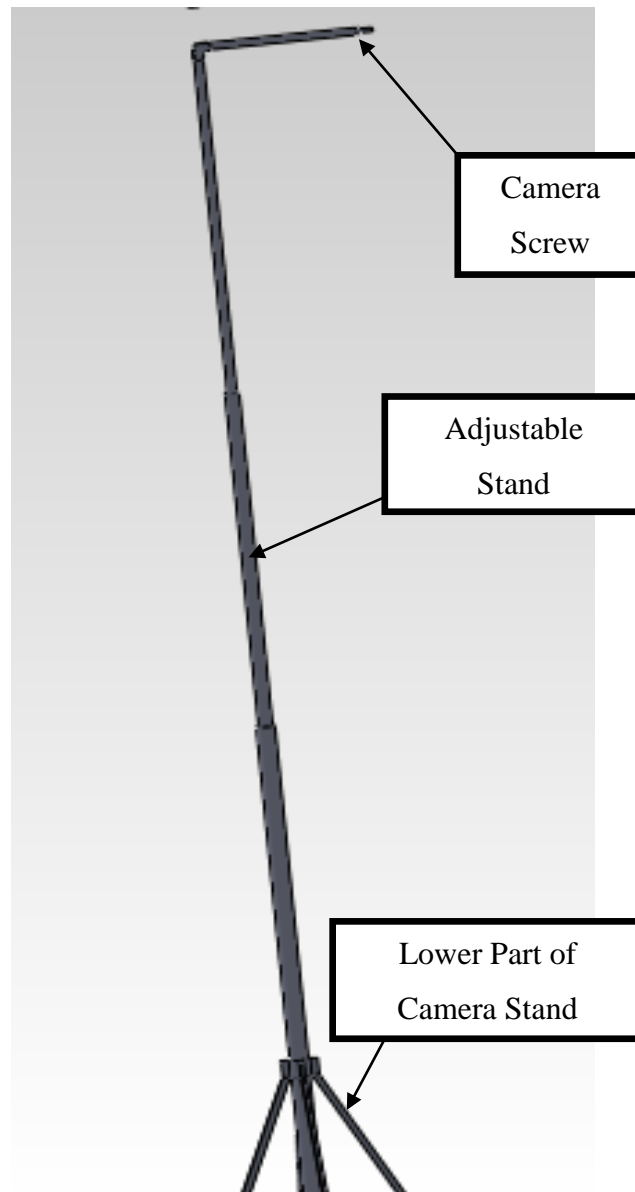


Figure 3.7 : Finalize concept for stand camera

Figure 3.6 shows the finalize concept of portable desk that has been developed. The finalize concept for portable desk is it have a door that can be open and close. It also have slide lock to lock the door after the door have been closed. Besides that, the portable desk have wheel that can easily bring it anywhere. Figure 3.7 shows the finalize concept of stand camera. It has adjustable stand that can adjust its height and it can reach 3m height. Besides that, it have screw camera with standard diameter which is M10. It can be attach to the camera easily. For the lower part of camera stand is three leg that can support the camera stand during camera is attach into it.

3.6 BILL OF MATERIAL

Bill of material is to show the materials needed and also its size and quantity.

Table 3.3 : Bill of Material

Parts	Material / Size	Quantity
1	Hollow square (Mild Steel) / 1 inch	1
2	Hollow Aluminum / 1 inch	1
3	Hollow Aluminum / ½ inch	1
4	Hollow Aluminum / ¾ inch	1
5	Camera Bracket	1
6	Wheel	4
7	Hinge	4
8	Slide Lock	1
9	Sheet Metal (Mild Steel)	1

3.7 FABRICATION PROCESS

After finalize concept and bill of material have been determined, the next process is the fabrication process. This process is about how a raw material is being transform into a product which is the finalize concept. There are many method used in fabricating the product. The processes are as shown below.

3.7.1 Material Selection



Figure 3.8 : Hollow square



Figure 3.9 : Hollow Aluminium



Figure 3.10 : Sheet Metal

The material that have been used for fabricating the portable desk is hollow square that have been shown in figure 3.8. Material used is mild steel. Hollow square is used to make a frame of the portable desk. Besides that, sheet metal in figure 3.10 is used to make a wall around the portable desk. For the hollow aluminium that have been shown in figure 3.9 is used to make the camera stand.

3.7.2 Cutting Process

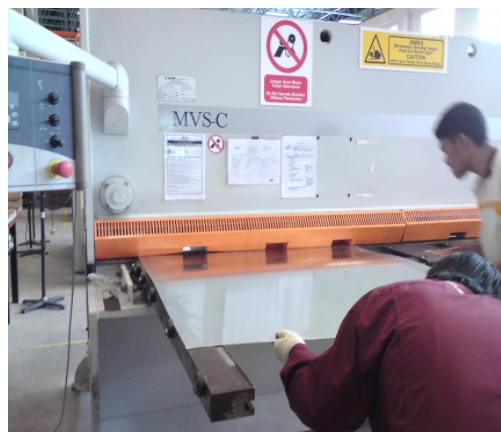


Figure 3.11 : Shearing Machine



Figure 3.12 : Hand Saw

The large sheet metal is then measure and mark according to the dimension that have been set up. The sheet metal is then cut according to required size by using the shearing machine that have been shown in Figure 3.11. Hand saw in figure 3.12 is used to cut the hollow square and hollow aluminium.

3.7.3 Welding Process



Figure 3.13 : Welding Process

Welding process that have been shown in figure 3.13 is the process to joint the sheet metal to the hollow square. This process is done in fabricating a portable desk.

3.7.4 Drilling Process



Figure 3.14 : Drilling Process

Figure 3.14 shown the drilling process that have been done during fabrication process. Both portable desk and camera stand use the drilling during fabrication process.

3.7.5 Grinding Process

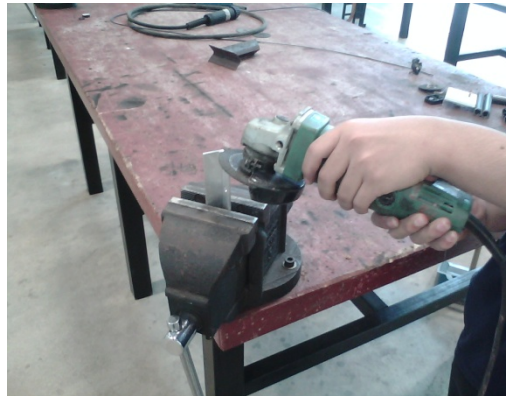


Figure 3.15 : Grinding Process

Figure 3.15 shown the grinding process is then carry out to remove away the burr which is also called a deburr process. Grinding process is also used to remove small portions or parts of the material.

3.7.6 Rivet Process



Figure 3.16 : Rivet Process

Based on figure 3.16, rivet process is used to joint the sheet metal that have been cut to make the portable desk. Hollow aluminium also used a rivet process to make a camera stand

3.7.7 Filing Process



Figure 3.17 : Filing Process

Filing process that have been shown in figure 3.17 is also carried out in the fabrication process. Filing process is used to remove the burr and also as part of the finishing process.

3.7.8 Finishing Process



Figure 3.18 : Finishing Process

Finishing process as shown in figure 3.18 is then carried out. A spray is being used to make the product more attractive and to cover the product from rust.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 INTRODUCTION

This chapter will further verify about the fabricated finalize concept. Explanation regarding about design of the product with more specific data such as details like weight and its working mechanism is provided as well. The analysis will be explained in this chapter for portable desk and camera stands.

4.2 RESULT

Portable desk is painted in black mist. The function of the desk to save the biomechanics equipment. Then, it also can be use in put the desktop . While the camera stand will be use in the setup of the high speeds camera. The result as shown in the picture.



Figure 4.1 : Portable Desk

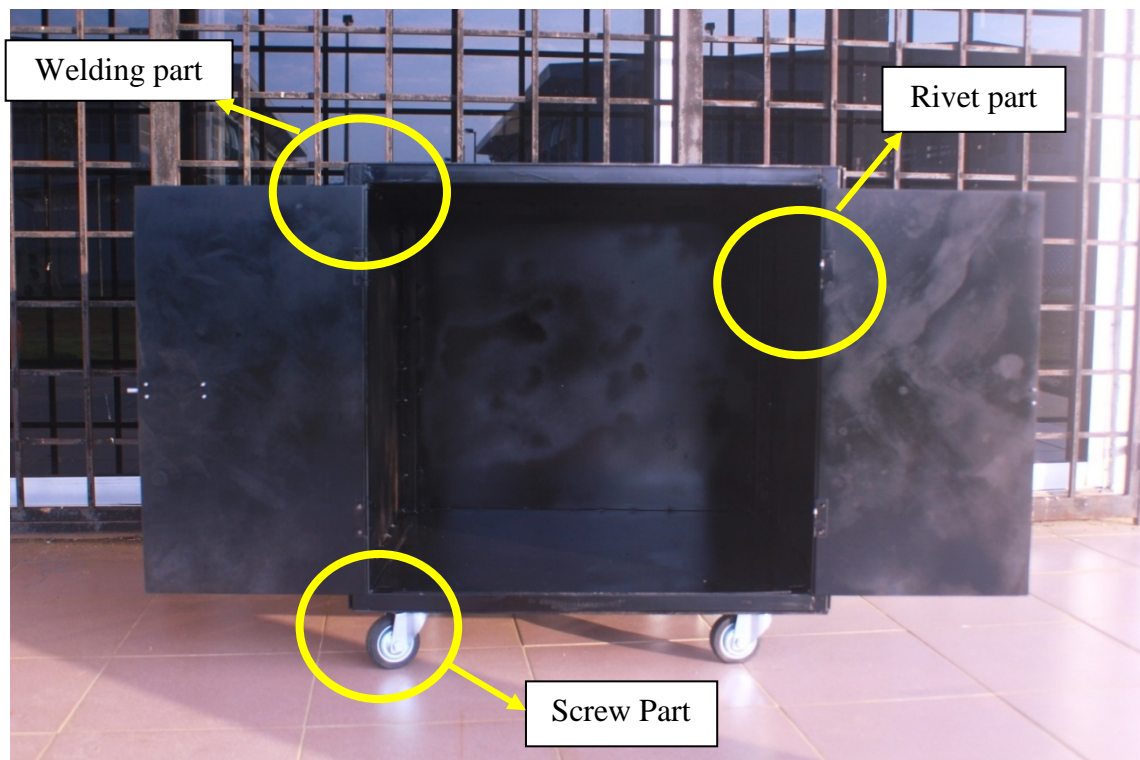


Figure 4.2 : Portable Desk



Figure 4.3: Welding Part



Figure 4.4: Rivet Part



Figure 4.5: Screw Part



Figure 4.6 : Camera Stand



Figure 4.7: Camera Bracket



Figure 4.8: Lower Part of Camera Stand

4.2.1 PRODUCT SPECIFICATIONS

The specifications of the product are as table below:

Table 4.1: Product specifications for portable desk.

Specifications	Results
Length	650 mm
Width	550 mm
Height	500 mm
Weight	50kg (real weight)
Colour	Black mist


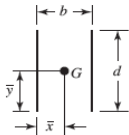
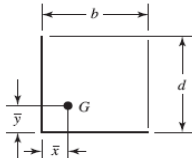
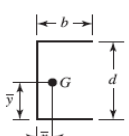
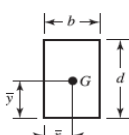

Table 4.2: Product specifications for camera stand.

Specifications	Results
Length	20 mm
Width	20mm
Height	2800 mm
Weight	5 kg (real weight)
Colour	Silver

4.2.2 WELDING ANALYSIS FOR THE PORTABLE DESK

- Welding is a fabrication process that joints materials by causing coalescence.
- This is often done by melting the work-pieces and adding a filler material to form a pool of molten material that cools to become a strong joint, but sometimes pressure is used in conjunction with heat to produce the weld.
- This is in contrast with soldering and brazing which involve melting a lower melting point material between the workpiece to form a bond between them without melting the workpiece.
- The welding the force we get above the weight

Torsional Properties of Fillet Welds*

Weld	Throat Area	Location of G	Unit Second Polar Moment of Area
	$A = 0.70hd$	$\bar{x} = 0$ $\bar{y} = d/2$	$J_u = d^3/12$
	$A = 1.41hd$	$\bar{x} = b/2$ $\bar{y} = d/2$	$J_u = \frac{d(3b^2 + d^2)}{6}$
	$A = 0.707h(2b + d)$	$\bar{x} = \frac{b^2}{2(b+d)}$ $\bar{y} = \frac{d^2}{2(b+d)}$	$J_u = \frac{(b+d)^4 - 6b^2d^2}{12(b+d)}$
	$A = 0.707h(2b + d)$	$\bar{x} = \frac{b^2}{2b+d}$ $\bar{y} = d/2$	$J_u = \frac{8b^3 + 6bd^2 + d^3}{12} - \frac{b^4}{2b+d}$
	$A = 1.414h(b + d)$	$\bar{x} = b/2$ $\bar{y} = d/2$	$J_u = \frac{(b+d)^3}{6}$
	$A = 1.414 \pi hr$		$J_u = 2\pi r^3$

*G is centroid of weld group; h is weld size; plane of torque couple is in the plane of the paper; all welds are of unit width.

Figure 4.9 : Torsional Welding Properties

Source: Richard G. Budynas and J. Keith Nisbett, Shigley's Mechanical Engineering Design Ninth Edition

From this table, we are using the two fillet weld. We are using the case-2 from figure 4.4

Load will cause the allowable shear stress

Given, $b = 50$ mm, $d = 30$ mm, $h = 5$ mm, $\tau_{\text{allow}} = 140$ MPa.

$$F = 0.707 hl \tau_{\text{allow}} = 0.707(5)[2(50)](140)(10^{-3})$$

$$= 49.5 \text{ kN}$$

The allowable load on the weldment

E7010 Electrode.

$$f = 102.52 h = 102.52(5) = 51.26 \text{ kN}$$

Shear stress in the throat

100 force add in

$$\tau = \frac{\sqrt{2}F}{hl} = \frac{\sqrt{2}(100)(10^3)}{5[2(50+30)]} = 177 \text{ MPa}$$

The safe bending force

Primary shear

$$\tau_y' = \frac{V}{A}$$

$$= \frac{F(10^3)}{1.414(5)(50+30)}$$

$$= 1.768 F$$

Secondary shear

$$J_u = \frac{(b+d)^3}{6}$$

$$= \frac{(50+30)^3}{6}$$

$$= 85.33(10)^3$$

Figure 4.4

$$J = 0.707hJ_u$$

$$= 0.707(5)85.33(10^3) = 301.6(10^3)$$

$$\tau_x'' = \frac{Mr_y}{J} = \frac{175F(10^3)(15)}{301.6(10^3)} = 8.704F$$

$$\tau_y'' = \frac{Mr_x}{J} = \frac{175F(10^3)(25)}{301.6(10^3)} = 14.51F$$

Maximum shear

$$\tau_{\max} = \sqrt{\tau_x''^2 + (\tau_y' + \tau_y'')^2} = F\sqrt{8.704^2 + (1.768 + 14.51)^2} = 18.46F$$

$$F = \frac{\tau_{allow}}{18.46} = \frac{140}{18.46} = 7.58kN$$

4.2.3 CAMERA STAND ANALYSIS

Bolt and screw analysis

Screw power

- A power screw is a device used in machinery to change angular motion into linear motion, and, usually, to transmit power. Familiar applications include the lead screws of lathes, and the screws for vises, presses, and jacks.
- A square-threaded power screw with single thread having a mean diameter d_m , a pitch p , a lead angle λ , and a helix angle ψ is loaded by the axial compressive force F .
- Imagine that a single thread of the screw is unrolled or developed for exactly a single turn.
- The angle λ is the lead angle of the thread.

Bolt shear

- Threaded fasteners are prone to fail when loaded in shear across threads plane
- If shear loading is absolutely required. Design for shear across shoulder cross-section

Bolt and screw analysis

- Size of bolt M10 x 1.5
- 30 mm thick AISI steel plate
- Sandwiches between two 10 mm thick aluminium plate

Nut height is $H = 8.4$ mm.

$$L > l + H = 50 + 8.4 = 58.4 \text{ mm}$$

Rounding up, $L = 60$ mm

$$L_T = 2d + 6 = 2(10) + 6 = 26 \text{ mm}$$

$$l_d = L - L_T = 60 - 26 = 34 \text{ mm}$$

$$l_t = l - l_d = 50 - 34 = 16 \text{ mm}$$

$$A_d = (10^2) / 4 = 78.54 \text{ mm}^2$$

$$A_t = 58 \text{ mm}^2$$

$$k_b = \frac{A_d A_t E}{A_d l_t + A_t l_d} = \frac{78.54(58.0)207}{78.54(16) + 58.0(34)} = 292.1 \text{ MN} / \text{m}$$

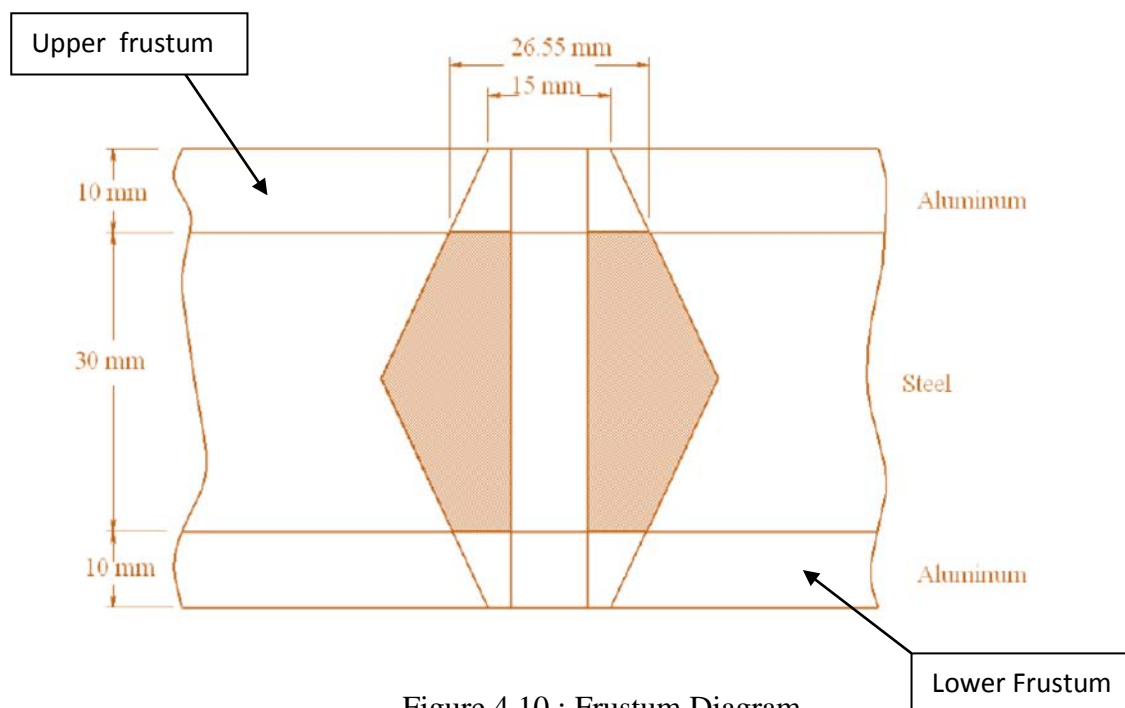


Figure 4.10 : Frustum Diagram

Source: Richard G. Budynas and J. Keith Nisbett, Shigley's Mechanical Engineering Design Ninth Edition

Figure 4.5 have shown the frustum diagram. Based on frustum diagram upper and lower frustums are the same. For the upper half,

Aluminium: $t = 10$ mm, $d = 10$ mm, $D = 15$ mm, and $E = 71$ GPa

$$k_1 = \frac{0.5774\pi(71)10}{\ln \frac{[1.155(10) + 15 - 10](15 + 10)}{[1.155(10 + 15 + 10)](15 - 10)}} = 1576 \text{ MN} / \text{m}$$

Steel: $t = 15$ mm, $d = 10$ mm, $D = 15 + 2(10) \tan 30^\circ = 26.55$ mm, and $E = 207$

$$k_2 = \frac{0.5774\pi(207)10}{\ln \frac{[1.155(15) + 26.55 - 10](26.55 + 10)}{[1.155(15) + 26.55 + 10](26.55 - 10)}} = 11440 \text{ MN} / \text{m}$$

For the top half

$$k'_m = \left(\frac{1}{k_1} + \frac{1}{k_2}\right)^{-1} = \left(\frac{1}{1576} + \frac{1}{11440}\right)^{-1} = 1385MN / m$$

For the bottom half

$$k_m = \left(\frac{1}{k'_m} + \frac{1}{k'_m}\right)^{-1} = \frac{k'_m}{2} = \frac{1385}{2} = 692.5MN / m$$

4.2.4 COST ANALYSIS

Cost analysis is an important analysis as this will determine the price of the portable desk and camera stands. The price of the produce is calculated by referring to material used for fabrication process excluding labour cost, machining cost and others. The estimated price is as below:

Table 4.3: Price estimation

Part	Dimension/Unit	Price
Hollow aluminium	1 inch	RM 30.00
Hollow aluminium	¾ inch	RM 20.00
Camera bracket	1 unit	RM 30.00
Hollow square (mild steel)	1 inch	RM20.00
Wheel	4 unit	RM 10.00
Screws	8 unit	RM 1.00
Sheet metal (mild steel)	2 mm	RM 20.00
Spray	3 unit	RM 20.00
Total price		RM 151.00

4.3 DISCUSSION

The advantages and disadvantages of the portable desk and stands will be listed down and be clearly explained, the problem faced during fabrication and defects that occurs during fabrication will also be specifically mentioned.

4.3.1 ADVANTAGES AND DISADVANTAGES

There are several advantages and disadvantages of the product. The advantages of the product are as below:

Advantages

- I. The portable desk easily to bring anywhere because it has wheel
- II. Easy to arrange the tools and equipment in an organized manner.
- III. The storage capacity is high deep so more tools and equipment can be placed.
- IV. The portable table have extension plugs which can be used at place where the power source is far from the working area.
- V. The camera stand easily will be use with the size that the people want to use especially in the setup of the camera stands.

Disadvantages

- I. The appearance of the portable desk not interesting to attract the customer to buy it

4.3.2 TYPE OF DEFECT

There are plenty of defects that occur during the fabrication of the portable desk. Some of the defects occur due to the error of machine while others are mainly due to lack of fabrication skills. The types of defects in the product are as below:

- i. The welding process cannot be carried out neatly as the electrode tend to stick with the sheet metal causing the welded part to been seen clearly even though finishing process is done. This problem mainly arises due to lack of welding skills and problem with handling the welding machine.
- ii. The finishing of the stands camera not smooth likes the professional stands.

4.3.3 PROBLEM FACED

There are also several problems faced during the fabrication process. Material selection was one of the biggest problems. In order to find the most suitable raw material for the smart rack gadget, research and information are searched through reliable source. Wrong selection of material will cause a lot of difficulties during fabrication process and will lead to more trouble in the future.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This final chapter emphasizes on conclusion and recommendation regarding about the fabricated project. The conclusion covers the throughout conclusion of all the process involved in producing the portable desk and camera stand and pictures the overall cycle of the project. Recommendations are given in order to improve the product in future.

5.2 CONCLUSION

As a conclusion, the objectives of this project are achieved as the designed portable desk is multifunction and portable as well. The portable desk will help to make the work in the biomechanics equipment . While the camera stands easily use in setting the high speeds camera. A lot of troubles and obstacles while trying to fabricate this smart portable desk. The breakdown of several important machines such as MIG welding machine and Bending Machine at Pekan Mechanical lab has given enormous amount of pressure. Struggling the time in order to finish up the project right on time. So far, all of hard work, knowledge that have gained during lecture session and some mechanical skills is apply to manufacture this product. A lot of mechanical skills that have been taught during fabricate this product.

5.3 RECOMMENDATION

There are some recommendations and ideas that can be applied onto the smart rack gadget in order to improve the function of the product and make the smart rack gadget more useful. The recommendations are as below:

i. Design

The design of the portable desk can be develop to make its appearance far better than now. The aesthetic value of the smart rack gadget can be increased by applying better paint and the smart rack gadget to make it more eye-catching. The size of the smart rack gadget also might be reduced so that it is lighter and easier to be managed. The design can be upgrade to attract the customer to buy it

ii. Raw material

The weight of the portable desk can be reduced if materials such as zinc or aluminium are used to make it. The durability and ability to withstand resistance can be increased as well. The screw and bolt are suitable is M12 it is because The higher the reaction external load bolt the suitable it will be used. The lower the fraction carried by member it more suitable.

iii. Function

The portable desk can be introduced extra function such as it can be we can put the chairs there a working table installed to the product.

REFERENCES

Books

1. Richard G. Budynas and J. Keith Nisbett, 2011. Shigley's Mechanical Engineering Design Ninth Edition

Websites

1. http://en.wikipedia.org/wiki/Portable_desk
2. <http://en.wikipedia.org/wiki/Tripod>
3. <https://www.google.com.my/search?q=portable+desk+with+storage&sa=X&biw=1241&bih=545&tbm=isch&tbo=u&source=univ&ei=IJS8UcTkG8WJrAfl-IGoBw&ved=0CEEQsAQ>
4. <http://www.ylcamera.com.my/product.php?snow=1&selcatid=10>