DEVELOPMENT OF LIFT MACHINE (USING CABLE AND PULLEY)

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A project report submitted in partial fulfillment of the
Requirement for the award of the Diploma
Of Mechanical Engineering

Faculty of Mechanical Engineering
University Malaysia Pahang

NOVEMBER 2008

SUPERVISOR DECLARATION

I hereby declare that I have read this project report and in my
Opinion this project report is sufficient in terms of scope and
Quality for the award of the Diploma in Mechanical Engineering

Signature : …….
Supervisor name : EN. ZULKIFLI BIN AHMAD @ MANAP
Date : …….

DECLARATION

I declare that this thesis entitled “development of lift machine (using cable and pulley)”is the result of my own study except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree

Signature : ……

Name : ZAIHIN BIN MOHD ZAHIB

Date : ……...

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 and finish this final year project. I also would like to express my thanks to my supervisor Mr. Zulkifli bin Ahmad @ Manap whose help, guidance and advice me for the whole time during the process in finish this final year project. Without him, this project will not be completed.

I would also like to thank to my beloved mother and my father, Mrs. Endon binti Eshak and Mr. Zahib bin Dagan, without them, my pursuit of higher education would not have been possible and I would not have had the chance to study in mechanical course. Thanks a lot to my university and friends too in their support and advice towards this project. Last word from me, thanks to all for your enduring patience and continuous encourangment.

ACKNOWLEDGEMENTS

In the praise of Allah, the Beneficent the 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.

It is extremely difficult to communicate my heartfelt gratitude to my thesis supervisor Mr. Zulkifli bin Ahmad@Manap who has devoted countless of days and weekend hours to the creation of the present work and participated with dedication in the process of its refinement. I sincerely express my thanks to him for his most valuable auspices, incessant encouragement and constant help which he bestowed on me to demystify the hurdles falling on my way. The encouragement and help I received from him has been simply beyond description. Through his expert guidance and esteemed supervision I merged successful in translating my cherished aspirations int an ever lasting entity, in the form of the present work.

ABSTRACT

Idea to development of lift machine (using cable and pulley) is come from the FKM lecturer that gives a task and a title for this project. This project focuses in design, fabrication and analysis the mechanical part of machine and the system at the lift machine body. To achieve this project objective, this lift machine body structure and pulley system need to concern some other criteria such as strength, safety and ergonomic design. This project flow must start from design, analysis, and lastly fabrication process

Before develop the lift machine (using cable and pulley), it must compare with other product (forklift) in market. It is because to study the customer need and to create a new design with new feature.

Diploma Final Year Project will cover for the whole last semester, before go to the industrial training to complete this project. This is an individual task and must do by ourselves. This is also one of opportunity to student to show or to apply their knowledge also skill in using manufacturing process and mechanical design software in complete this project. Time management and a good planning also important to make sure the entire plan are in their way. Lastly, discipline needed to complete this project.

ABSTRAK

Idea untuk membangunkan mesin pengangkut barang (menggunakan kabel dan pulley) datang daripada pensyarah FKM yang memberi tugasan dan tajuk untuk prjek ini. Projek ini memberi tumpuan kepada mereke cipta, memasang dan menganalisis mesin bahagian mekanikal dan sistem yang terdapat pada badan pengankut baran tersebut. Untuk mencapai objektif projek ini, struktur badan dan system yang terdapat pada badan pengankut barang tersebut haruslah berkaitan dan memenuhi beberapa criteria seperti kekuatan, keselamatan dan reke bentuk yang ergonomic.

Sebelum pembangunan pengangkut barang di mulakan, ia mestilah di buat perbandingan di antara produk yang telah sedia ada di pasaran. Ini kerana untuk mengkaji tentang keperluan pengguna dan untuk menghasilkan bentuk baru dengan cirri-ciri yang baru.

Projek tahun akhir diploma ini akan meliputi sepanjang semester akhir sebelum pergi ke latihan industri untuk di siapkan. Ini adalah tugasan individu dan harus di siapkan sendiri. Projek ini juga salah satu peluang untuk pelajar menonjolkan diri mereka dan menggunakan ilmu serta teknik mereka dalam menggunakan proses pembuatan dan software mekanikal yang telah mereka pelajari untuk menyiapkan projek tahun akhir ini. Pengurusan masa dan perancangan yang baik juga penting untuk memastikan setiap yang dirancang berjalan mengikut jadual. Displin dan dedikasi juga diperlukan untuk menyiapkan projek ini.

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CHAPTER 1

INTRODUCTION

1.1. PROJECT SYNOPSIS

The project contains of designing the mechanical part of machine and to fabricate the mechanical part of the system of the lift machine. There are difference between this lift machine and the current lift machine in market. The design of this lift machine will be more user friendly in handling and use. To achieve the objective of this project, it need a lot of knowledge and skills such as solid works 2006, MDsolid software, welding skill, drilling, grinding, and fastener.

1.2. PROJECT PROBLEM STATEMENT

According to the market lift machine, basically the lift machines nowadays are provided using the hydraulic system and other complex system. What try to do in this task is try to develop lift machines that not use the hydraulic system but more to the conventional system. The system that will use is only use the pulley system to lift the material. The problem statements as follows:

a) The emplacement of forklift not portable because difficult to move and not adjustable
b) many product (lift machine) designing in a big range of load
c) The maintenance of forklift is high cost and take time
d) The system of other forklift are complex and difficult to maintenance

1.3. PROJECT OBJECTIVE

The purpose of this project is to practice a student that has be been gathered before in solving problem using academic research and also to gain knowledge and skills. This project also important to train and increase the student capability to get information, research, data gathering and then solves a problem by doing the calculation. The final year project also will generate students that have capability to make a good report in thesis form or technical writing. It also can train student to create in design, fabricate and analysis a new thing. The other thing, final year project will teach student to doing a task with independently in searching and expending the experience and knowledge. So the objectives of this project are:

a) To design and development lift machine (using cable and pulley)
b) To lift a material (load) to other place
c) To fabricate and make analysis to the body of lift machine including analysis of mechanical part of machine and the system of mechanical part.
d) To lift a load not more than 20 kg.
e) To apply the knowledge and skill manufacturing process
f) To modification of lift machine structure

1.4. PROJECT SCOPE

From the title that has been given, the development of this project must include how to design the mechanical part of machine and how to fabricate the system of this mechanical part. It also needs some knowledge and skill to finish the project. There is some other guide must followed to finish this project.

a) Literature review – including all the information from internet that is related with this project. Such as;

i. The history of forklift

ii. The type of forklift
iii. The pulley system
iv. Machinery process used

b) Design concept

i. Sketch the new design of forklift (consists of 3 designs). It base on customer needs
ii. Evaluated the designs and come out with the new design (final concept)
iii. Using the solidwork software, make the isometric, orthographic and 3D drawing

c) Fabrication

i. In fabricate the forklift, the material used ; steel bar, hollow, pulley, rope, wheel, bearing

ii. the process used in fabrication :
- Welding: in this process, it uses to combine many part of material in the forklift fabrication
- Drilling: to make a hole on the material
- Fastening: combine some other part such as between the engsel and the hollow steel bar using screw, bolt

d) Report writing

i. Report writing will covered for the whole work progress from start until the end of the work

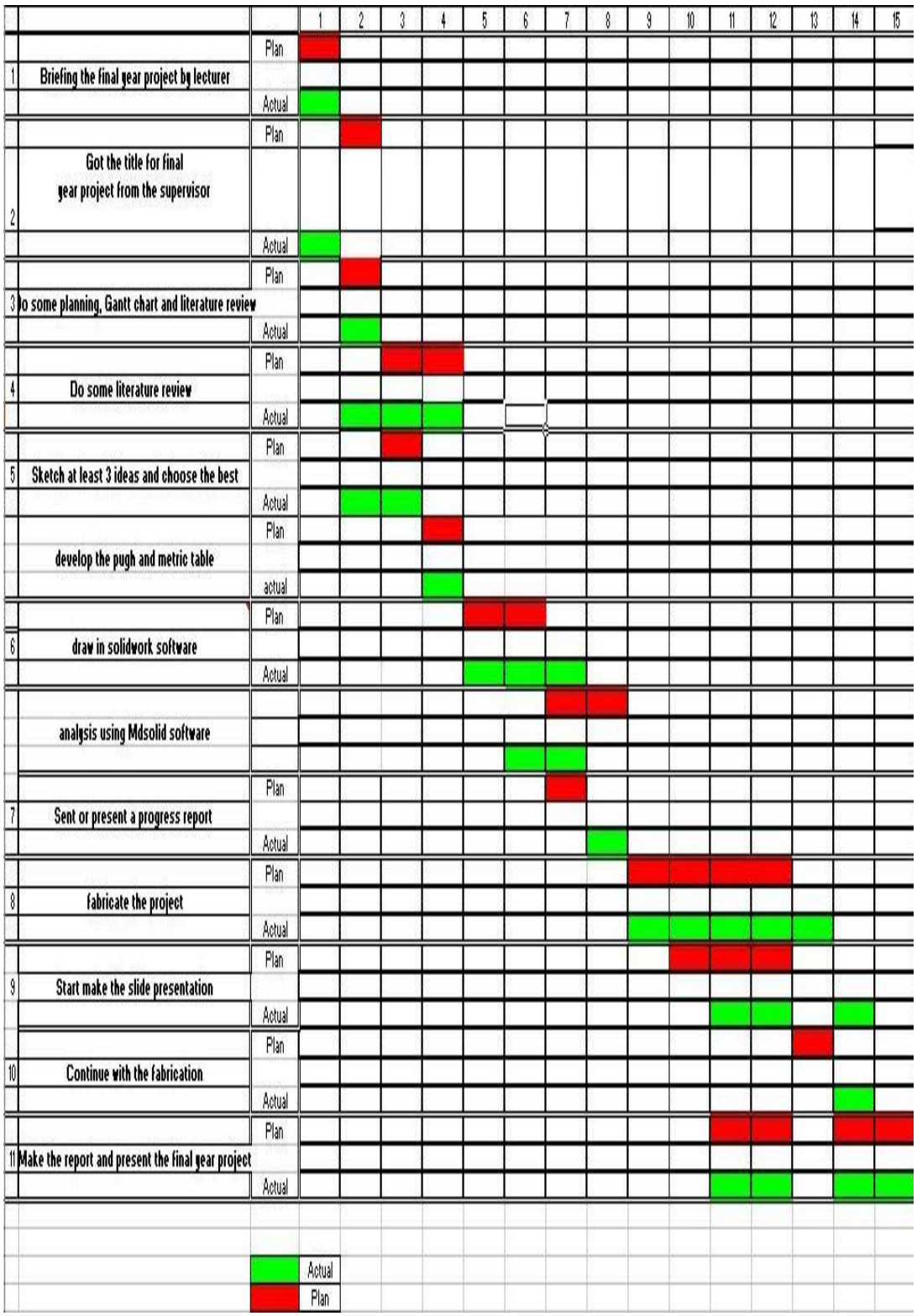
1.5 PROJECT BACKGROUND

Basically, the purpose of development of lift machine is too used to lift and transport a material to other place. Lift machine also called a forklift, lift truck, a high/low, a stracker-truck or a side loader. The modern in lift machine was developed in the 1920s. The lift machine has since become an indispensable of equipment in manufacturing and warehousing operation.

In this final year project, the design of this lift machine should be creative, simple, user friendly and use the minimum cost especially the material cost.

1.6 PROJECT SCHEDULE

Table 1.1: Gantt chart



Referring the gantt chart in **table 1.1**, this final year project (FYP), start with some introduction or briefing by supervisor. Beginning week, need to do some schedule management for this project that covered for the whole week. It will be apply in Microsoft excel to make a gantt chart.

After that, this project continuing with some literature review about the title. In this literature review, it is about to find or to gather all the information related with this project. Find the type, design, and the system used on the development of lift machine (forklift). It is also including the differences for each design in marketing. All the information gathers from internet, journal, reference book and people.

The project continued with design the concept of lift machine. The designs come out using from all data collection, Pugh concept and metric link before this. Try to evaluate or analysis the mechanical part of machine and the system for each design come out. From the all source, develop (engineering drawing) the final concept. Once again make an analysis to the final design body and to the pulley system.

After all information, data and detail drawing are improved, the fabrication process stage start. As the reference, we look at detail drawing to fabricate. The dimension and the material are already list on the drawing. In the fabrication of the lift machine, it's need us to apply many knowledge and skills such as; welding, fastening, drilling and cutting the material.

Lastly, the final report writing and prepare the final 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

A Forklift truck also called a lift truck, a high/Low, a forklift, a stacker-truck, or a sideloader is a powered industrial truck used to lift and transport materials. The modern forklift truck was developed in the 1920s by various companies including the transmission manufacturing company Clark and the hoist company Yale & Towne Manufacturing.[1] The forklift truck has since become an indispensable piece of equipment in manufacturing and warehousing operations.

2.2 HISTORY

a) THE BEGINNING – 1945-1964

In 1929, Hyster Company is already built. This company is one of the earlier company that make the lift machine with the original machine were steel and lumber carries. The lumber carries is a version of a straddle truck that continued in production, with upgrades of course.

The first actual lift machine was built is in 1935 based on a reversed tractor chasis. The range was broadened again with the “Karry krane”. It used during world war 2 by American.

Figure 2.1: YT40 truck

The other popular truck of the day was the YT40. These forklifts could lift almost 2000kg and were great general purpose trucks

Figure 2.2: This old forklift surviving shows the 1954 Christmas party at Gough's Auckland branch in Stanley Street

Figure 2.3: Old Hyster

In **Figure 2.3**, the old Hyster, reports that it's still on the original engine

Beginning in 1947, Gough Gough & Hamer also started importing Hyster-Ransomes Electric forklifts. Formed after Hyster took over the British Ransomes company, Hyster-Ransomes became a popular addition to Gough's product lineup. When Hyster started designing and manufacturing its own electric forklifts in 1964, the Ransomes name disappeared. The first New Zealand Hyster-Ransomes customer was Christchurch's D.H. Brown, who operated a flourmill on Moorhouse Ave. In 1947, they took delivery of a Hyster Ransome TE1H 1 Ton Platform Truck.

Figure 2.4: The electric forklift in 1947

b) 1964 till present day

Figure 2.5: The earlier engine

According to the **Figure 2.5**, here is the earliest known photograph (although undated) of Hyster manufacture in NZ. An engine and drive train is being assembled for installation into an H50F, a model built between 1965 and 1972.

Figure 2.6

Figure 2.7

According to the **Figure 2.6** and **Figure 2.7**, the containers of forklift Components arriving at Ensors Rd are unpacked by an H50F

Figure 2.8

At the **Figure 2.8**, a lineup of trucks inside the brand new site at Hornby includes a couple of H275H 12 tonners, as well as a fleet of 4 tonne "XL's".

c) Forklift Trucks— the Backbone of the Industry

Around the time of the First World War, machines were designed with an electrical platform that could be raised or lowered. The war effort sprouted other new innovations, including a bomb-handling crane with a power lifting mechanism, considered to be the first electric lift truck.

Figure 2.9: Bomb crane

At the **Figure 2.9**, the Baker Rauch & Lang Company developed and built a bomb-handling crane with a power lifting mechanism—the first electric lift truck. Designed to handle large artillery shells, these trucks represented the dawn of a new era and industry. 1915 (photo courtesy of Linde Baker)

2.3 PRODUCT REVIEW

a) Design type

The following is a list of the more common lift truck types. It is arranged from the smallest type of lift to largest:

i. Hand pallet truck
ii. Walkie low lift truck (powered pallet truck, usually electrically powered)
iii. Rider low lift truck
iv. Towing tractor
v. Walkie stacker
vi. Rider stacker

b) Lift machine type

i. Manual pallet jack

A pallet jack, also known as a pallet truck or pump truck, is a tool used to lift and move pallets. The front wheels are mounted inside the end of the forks, and as the hydraulic jack is raised, the forks are separated vertically from the front wheels, forcing the load upward until it clears the floor. The pallet is only lifted enough to clear the floor for subsequent travel. A manual pallet jack is a hand-powered jack.

ii. Powered pallet jack

Powered pallet jacks are motorized to allow lifting and moving of heavier and stacked pallets.

These generally contain a platform for the user to stand while hauling pallets around a warehouse or loading/unloading trucks. The powered pallet jack is generally moved by a throttle on the handle to move forward or in reverse and steered by swinging the handle in the intended direction. Some contain a type of deadman's switch rather than a brake to stop the machine should the user need to stop quickly or leave the machine while it is in use.

iii. Quick lift pallet trucks

Figure 2.10: Quick lift pallet trucks

The lift machine shown in **Figure 2.10** above has a simple design and it's easy to user in handling this lift machine type.

The features of this lift machine are the maximum capacity of this lift machine to load the material is around 2500 kg or 5500 lbs. It's also has a perfect ergonomic design handle offers excellent and comfortable grip in all situations and temperatures. This lift machine also has a good outstanding maneuverability with 220 degree turning angle even in the tightest space such as inside trailers.

Beside that, this product also low weight and makes the pallet truck very handy to use. And the last one, this lift machine is completed with overload relief valve. This is for safety if there are too many loads and it's to prevent damage to equipment

iv. Lift table

Figure 2.11: Lift table

The lift machine in **Figure 2.11** also known as lift table. It's design to work in heavy-duty steel construction. It made from strong metal wheels with polyurethane.

This lift table machine is completed with two fixed wheels and two swivel for easy maneuverability. Beside that, it's also installed with two wheel brakes operated by foot pedal to easy the user to control during do a work. This lift table available with 6 different lifting capacities from 150 kg until 1000 kg and it lift heights up to 1500mm.The dimensions for this lift table is 905x512x55 mm and the net weight is 113 kg

v. Power pallet truck

Figure 2.12: power pallet truck

The lift machine in **Figure 2.12** above also knows as power pallet truck. It completed with some other criteria and feature suitable with their function as a lift machine.

The first feature that it have is has a good acceleration enhances efficient pallet entry and exit to increase the productivity. It is also have a good smooth travel and lift combined with excellent control to reduce the product damage during operate this lift machine. Has a high quality hydraulic pump assure very low noise and has a maximum efficiency also durability. The capacity for this lift machine is around 1500 kg. The lifting height and the minimum height are 205mm and 85 mm.

This power pallet truck has 1150mm fork length and 520mm for fork width. It is easy to lift the material because it has an enough space to put the material. The powers for this power pallet truck are come from battery 07KW.

2.4 PULLEY SYSTEM

a) Introduction

The pulley is a simple machine that consists of a grooved wheel and a rope. Like a lever, it provides a mechanical advantage in lifting a heavy load. There is a direct relationship between the number of ropes that form the pulley and its resulting advantage.

There are two basic types of pulleys. When the grooved wheel is attached to a surface it forms a fixed pulley. The main benefit of a fixed pulley is that it changes the direction of the required force. For example, to lift an object from the ground, the effort would be applied downward instead of pulling up on the object. However, a fixed pulley provides no concrete mechanical advantage. The same amount of force is still required, but just may be applied in another direction. Another type of pulley, called a movable pulley, consists of a rope attached to some surface. The wheel directly supports the load, and the effort comes from the same direction as the rope attachment. A movable pulley reduces the effort required to lift a load.

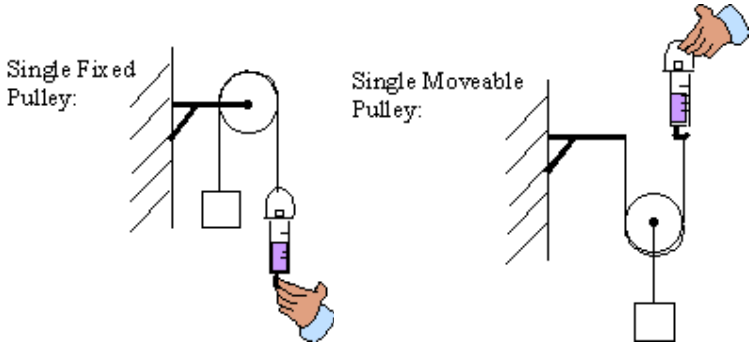


Figure 2.13: Pulley system

A pulley system is simply a fixed and moveable pulley put together. The pulleys are used to increase the mechanical advantage of the system. A pulley system's mechanical advantage (MA) is equal to the number of supporting ropes.

b) Fixed pulley

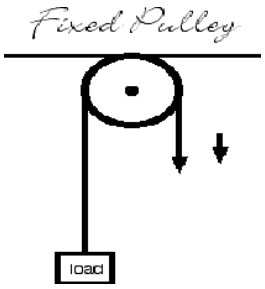


Figure 2.14 Fixed pulley

In **Figure 2.14**, a fixed pulley is a pulley in which the wheel does not move. Fixed pulleys change the direction of the effort force. It does not increase the size of the effort force. The effort force is equal to the resistance force in a fixed pulley; therefore, the mechanical advantage (MA) of a fixed pulley is equal to 1.

c) Moveable Pulley

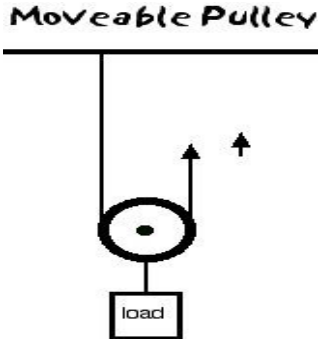


Figure 2.15 Moveable Pulley

In **Figure 2.15,** a moveable pulley does not change the direction of the effort force but does increase the size of the force. When you pull on the rope, the pulley and the load come up. You can find the mechanical advantage (MA) of a moveable pulley by counting the number of ropes that lift the load.

d) Pulley systems mechanical advantage

To calculate the effort required to lift the load we divide the load by the number of ropes (do not count the rope that goes to the effort). The image on the below shows a four pulley system. The person lifting the 200kg load experiences a pull equal to only 50kg (200kg/4).

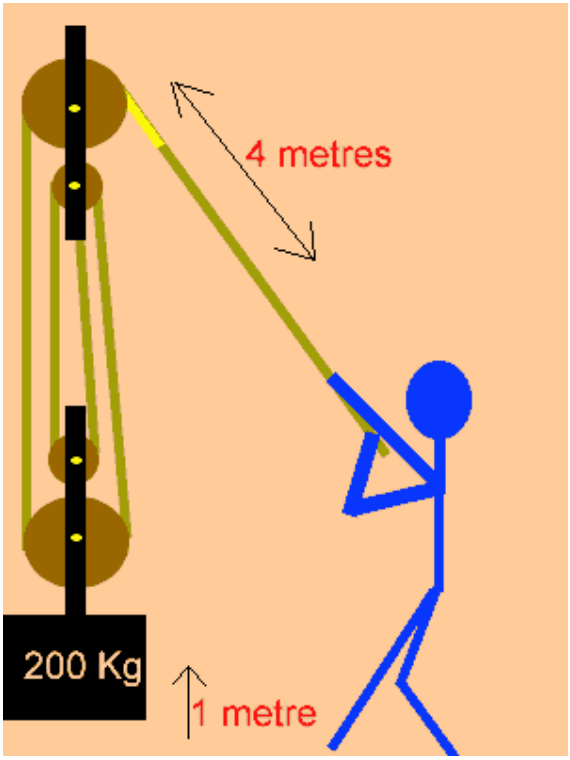


Figure 2.16: Mechanical Pulley system

Using the four pulley system on the right, the person certainly experiences an advantage. We call this advantage the mechanical advantage

and are calculated by dividing the load by the effort (load/effort). The pulley system offers a mechanical advantage of 4.

2.5 MACHINING PROCESS

a) Welding process

In this project, more than 70 percent use the welding process to complete this lift machine. Basically the welding process use usually to join a material from steel. During the welding process, a filler material will be added to the steel to form a pool of molten material (weld puddle) that cool to become a strong joining.

i. Gas Metal Arc Welding (GMAW)

Gas metal arc welding or famous as GMAW sometimes referred to by it subtypes metal inert gas or MIG welding. Beside that it is also known as metal active gas or MAG. This is a semi –automatic or automatic arc welding process in which a continuous and consumable wire electrode and a shielding gas are fed through a welding gun. A constant voltage, direct current power source is most commonly used with GMAW, but constant current system, as well as alternating current

b) Method joining of mechanical fastening

i. Hole preparation

An important aspect of mechanical fastening is hole preparation. A hole in a solid body can be produced by several processes, such as punching, drilling chemical and electrical means, and high energy beam. The selection of this process depends on types of material; it is properties and the thickness. For improved accuracy and surface finish, many of this hole-making operation may be followed by finishing operation, such as

shaving, reaming, and honing. Because of the fundamental differences in their characteristic, each of the hole making operations produces holes with different surface finishes, and surface properties.

ii. Threaded Fasteners

Bolts and nut are among the most commonly used threaded fastener. Numerous standards and specification (including thread dimension, dimensional tolerance, pitch, strength, and the quality of the materials used to make this fastener) are described. Bolts and screw may be secured with nut or self tapping. The self tapping method is particularly effective and economical in plastic product where fastening does not require to tapped hole or a nut. In **Figure 2.17** the example for the process.

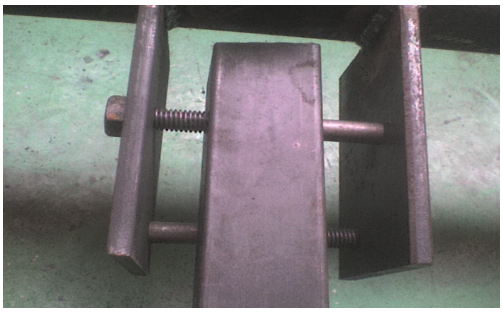


Figure 2.17: threaded fattener (bolt and nut)

c) Drilling machines

Drilling machines are used to make a holes, tapping, reaming, and small diameter boring preparations. The most common machine used is drill press. The work piece palace on an adjustable table, either by clamping it directly into the slots and holes on the table or using a vise. The drill is lowered by manually and starts to make a hole. The process shown in **Figure 2.18**.

Figure 2.18: drilling machine

CHAPTER 3

METHODOLOGY

3.1 PROJECT FLOW CHART

Referring the flow chart in **figure 3.1**, this final year project (FYP), start with some introduction or briefing by supervisor. Beginning week, need to do some schedule management for this project that covered for the whole week. It will be apply in Microsoft excel to make a Gantt chart.

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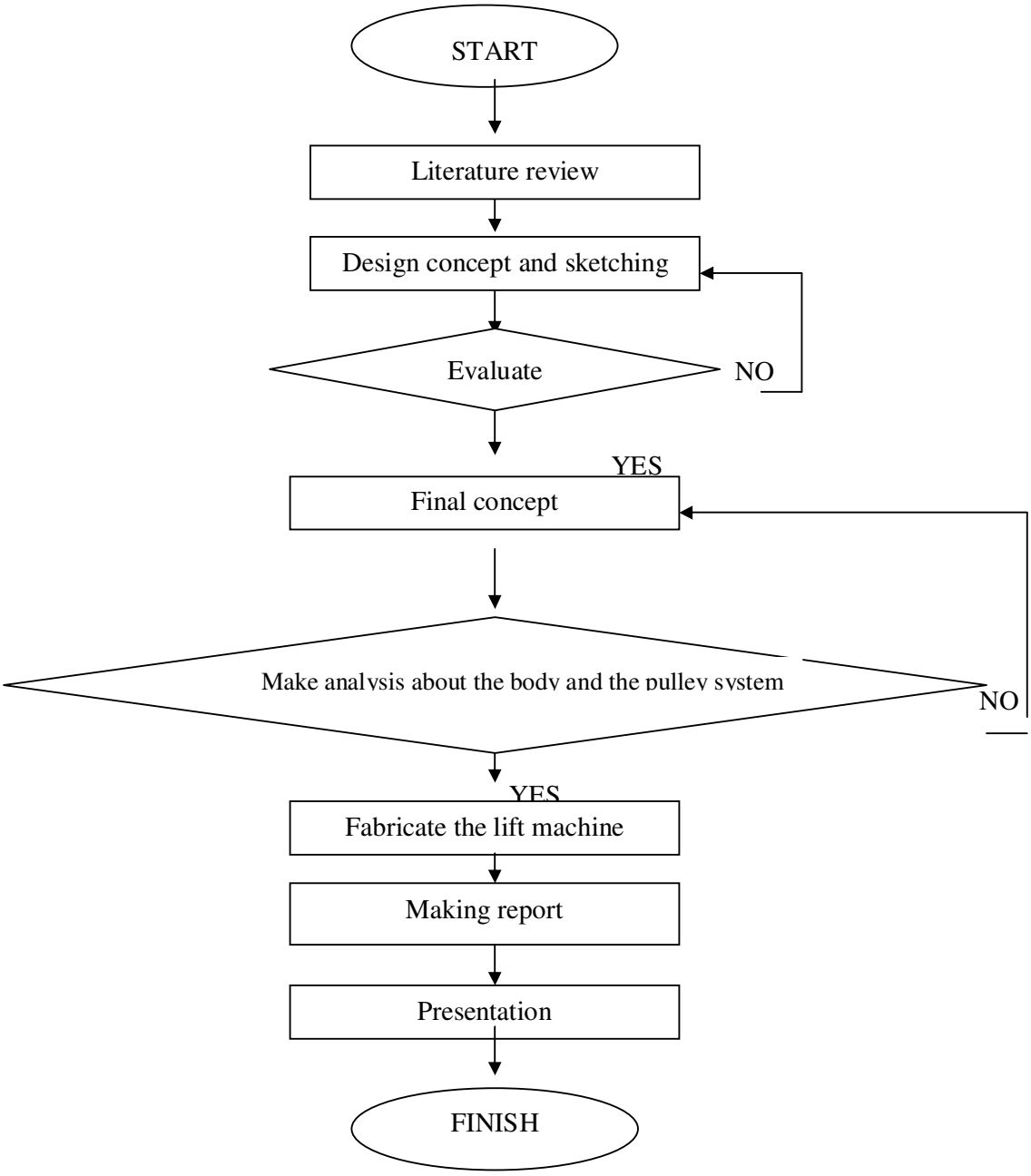


Figure 3.1: Project Flow Diagram

3.2 DESIGN

The design of a lift machine (using cable and pulley) must be completely with several aspects. The design consideration must be done carefully because it can effect during the fabrication process and how the system functioning. The aspect that must be considered in designing the lift machine (using cable and pulley) is this lift machine must be design that can lift the load below than 20 kg. From material aspect, the lift machine must be strength enough to lift the load. The toughness of this lift machine is very important criteria in designing that must be considered. The cost for the whole system must not exceed budget that has been given and must reasonable. During the designing process, the cost also must be considered whereas the cost must be efficient and reduce the waste also the losses. The design can be considered as three phase in this task. The first phase on this project is drawing how many designs and selects the one from the design as the finale design. The second phase is analysis and the last phase is fabrication.

a) Concept A

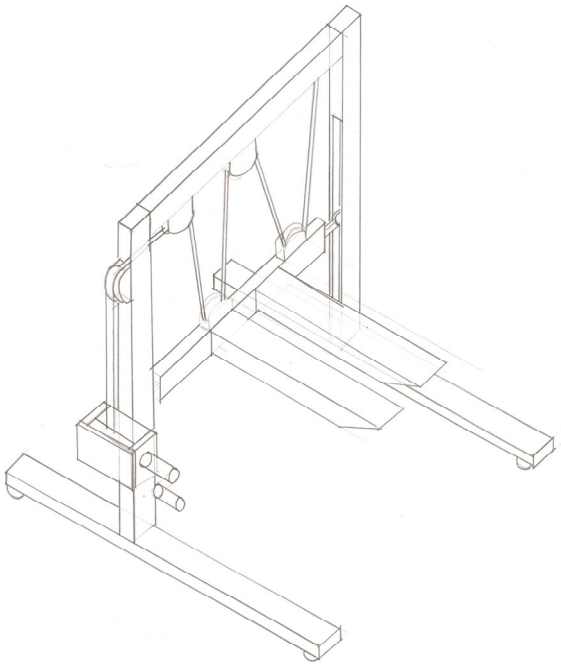


Figure 3.2: Design 1

The advantages of the design shown in **Figure 3.2** are, this design lift machine is come out with the moveable jaws that allow and easy to lift the load. This lift machine also has a good pulley system to easy the user which is no need to use more power to lift the load. Beside that, this lift machine also is come with wheels for easy to user to move at other place.

b) Concept B

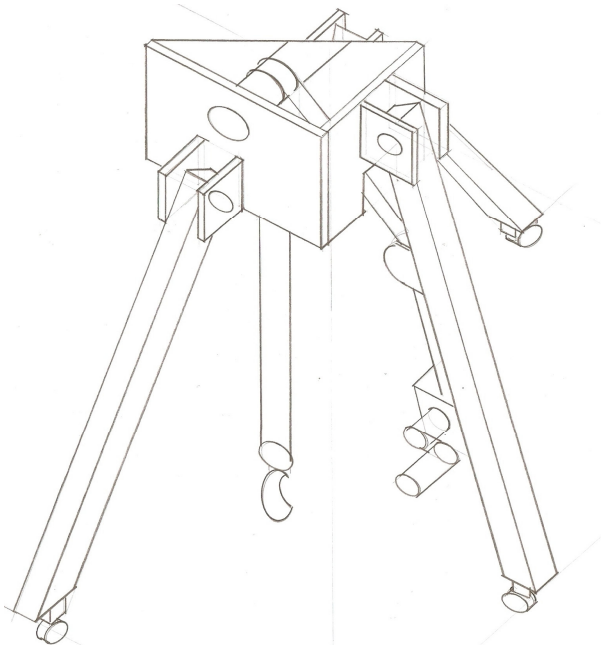


Figure 3.3: Design 2

The advantages of the lift machine in **Figure 3.3** above are this lift machine is design with portable feature. The shape of this design concept is more practical and strong enough in heavy duty.

It is completely comes with wheel to easier the lift machine to move. Beside that, this lift machine also portable whereas user easy to keep this lift machine in a limit space.

For the disadvantages of this lift machine is, this lift machine using a little pulley compare with the first design. So, when using this lift machine, we need to use more power to lift the load.

c) Concept C

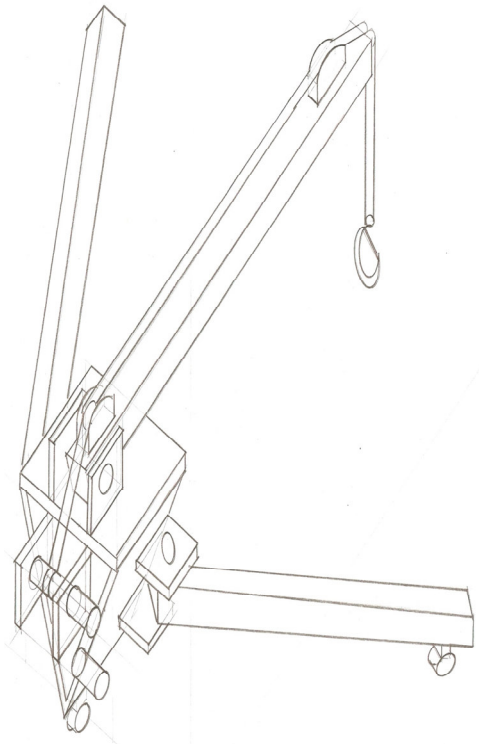


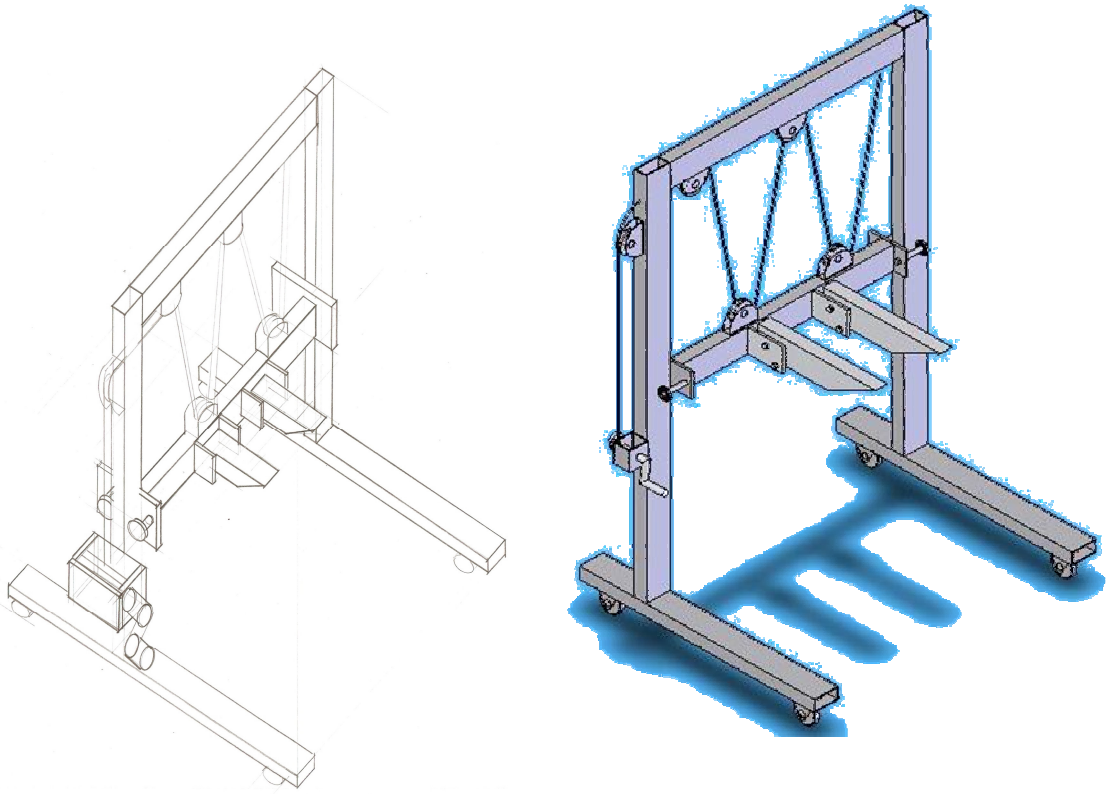
Figure 3.4: Design 3

The advantages of the lift machine in **Figure 3.4** above are this lift machine is design with new feature. Basically this design comes out from the second design. It's look similar with the second design and the features also are more likely similar between the second and third.

The first advantage for this design is portable. The user easier in keep this lift machine at a limit space. After that, it is easy to handle and moveable. It is come with wheel to easier this lift machine move.

The disadvantage is, this lift machine is designing using only a little pulley. And for lift the load using this lift machine, the power required to lift the load are bigger.

d) Finalize Design (concept D)



i) Sketch ii) Solid works

Figure 3.5: Final design (Design 4)

Referring the **Figure 3.5** above, there are the drawing for the finalize design of lift machine. Basically, this finalize design are come out with combination from the all concepts have drew. The are have some of advantages where it is all combination from the concepts.

The first advantage for this design is it has a moveable lift jaw that can allow and easy to lift the load. These finalize design also has a good pulley

system. This feature is very important in development of this lift machine. Beside that, it also has completely with wheel to easy moving the lift machine.

3.3 CONCEPT GENERATION AND EVALUATION

Four concepts for the lift machine were developed. The table below shows the evaluated against the datum (manual pallet jack) with the Pugh concept selection.

Table 3.1: Pugh Concept Selection

Selection of criteria	Design 1	Design 2	Design 3	Manual Pallet Jack
Ease of handling	+	0	-	0
Ease of use	+	+	+	0
Portability	0	+	+	0
Lightweight	-	+	+	0
Power	+	-	-	0
Shape	0	+	+	0
Ease to manufacture	-	+	+	0
Efficiency	+	0	0	0
Quantity of material	-	0	0	0
Strength	+	0	0	0
Moveable lift jaw	+	-	-	0
Pluses	7	4	4	
Same	1	5	4	
Minus	3	2	3	
Net	4	2	1	
Rank	1	2	3	

+ = Better than - = Worse than 0 = Same as

Table 3.2: Metric chart

Criteria	**Concept 1**	**Concept 2**	**Concept 3**	**Final Concept**
Portable	2	4	3	Concept 2
Lightweight	3	4	5	Concept 3
Safe in lift below 20 kg	5	2	3	Concept 1
Cable strength	3	1	2	Concept 1
Moveable lift jaw	4	1	0	Concept 1
Variety of gear speed	4	2	3	Concept 1
Available in different shape and size	2	4	3	Concept 2
Ease to manufacture	4	2	1	Concept 1
Easy to handling	4	2	1	Concept 1
Easy to use	3	5	4	Concept 2
Quantity of material	2	3	4	Concept 3
The material cost	2	4	3	Concept 2
Power and efficiency	4	2	3	Concept 1
Strength	3	4	2	Concept 2
Good pulley system	4	2	2	Concept 1
Total	49	42	39	

Notes: 1= very poor 2= poor 3= medium 4= good 5= very good

The highest best concept from sketching had been drawn is the concept 1 because it have the highest rating.

3.4 CONCLUSION OF SELECTED DESIGN

From the concept of selection table shown in **Table 3.1**, the advantages and disadvantages of the design are outlined. Criteria and the characteristic for the design concept to fabricate is the most important thing to be considered before the fabrication process. Eleven criteria are been chosen to be considered in this project. The important criteria are easy in handling, ease in use, portability, lightweight, power, efficiency, shape, easy to manufacture, the quantity of the material are use, strength and the moveable lift jaw.

According to the table, study of the concept selection shows that the Design 1 scores the highest positive sign. There is only 3 negative sign from 11 selection criteria in Design 1. Therefore Design 1 is the best concept to be produce. Design 1 is more functioning than other. Portable because the design completely comes with wheels to easy the lift machine to move everywhere.

Design 1 also is more efficient compare with the others design. As in design 1, it is use more pulley then the other designs. When use many pulley in a system, it can influence how many power that can apply to lift a load.

After that, according to metric chart in **Table 3.2**, the criteria will list and make a rating for each concept. For the poorest criteria, it will get 1 mark and for the good concept base on the criteria, it will get 5 marks. For the best criteria from any concept will be combined to come out with final concept.

3.5 PROCESS INVOLVED

In order to make the design comes true; the material needs to through processes that call fabrication process. The fabrication process starts from dimensioning of the raw material. All the process that involved is as shown in **Table 3.3:**

Table 3.3: Lift Machine process

PROCESS	DESCRIPTION
Measuring	This process is important to know the specific length or the diameter for the all raw material. The measuring must be measured based on the design specification.
Marking	After the process measuring, the materials that are already measured need to be marked to give precise dimension and make work easier.
Cutting	The material that already marked are will cut into part using disk cutter
Joining	After all the material have become into their part and in their length specification, it will joined by using welding process and some other part use bolt and nut.
Drilling	Use the drill to make a hole.
Finishing	Grind the part at welding process to get a smooth surface.

3.6 MATERIAL PREPARATION

Basically the preparation of material will be going after the design and the list of material process is done. In this process, material is chosen base on list material and suitable with material at mechanical laboratory.

Figure 3.6: Selecting the material

3.7 FABRICATION PROCESS

The fabrication process comes after designing process that come out with three basic designs and one final design. The process to fabricate this lift machine basically base on the final design and guided by the dimensioning to easy during the working process. The methods can be used during the fabrication are like welding, drilling, cutting, fastening and painting for the last process. Fabrication process and manufacturing process are difference in term of quantity. For the fabrication process is a process to produce only one product while the manufacturing process is a process to produce a product in a large quantity.

The fabrication process is start with measuring and marking the material. After that, cut the material base the length in the design dimension. The processes like in **Figure 3.7** and **Figure 3.8**. The disk cutter will use in this process to cut the

raw material into their component. And the measuring tape will use to measure the dimension

Figure 3.7: measure and marking process

Figure 3.8: Cutting process

After all the materials are already cut into their component, the fabrication continues with joining process through the welding process (refer **Figure 3.8**). Gas metal arc welding or MIG will use to joining this material. The welding machine must be set up first to make sure the result of the welding are satisfied. The safety equipment not forgotten to protect ourselves during the process welding is undergo such as face shield and apron.

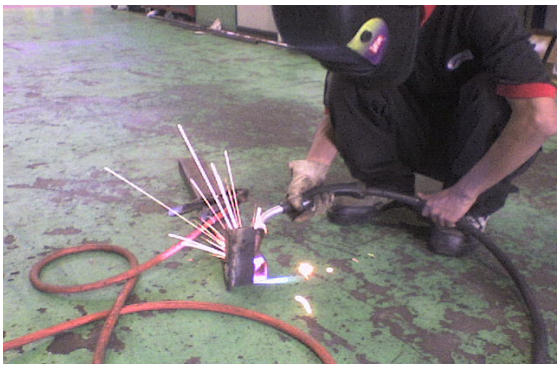


Figure 3.9: Welding Process

a) Equipment

b) welding Gas

Figure 3.10: MIG welding machine

Beside that, in this project also use the drill machine to make a hole with through the drilling process. Some other part needs to through the drilling process such as jaws part to use in fastening process. The drilling process shown like in **Figure 3.11.**

Figure 3.11: Drilling process

The fabrication processes continue with grinding process. The purpose of this process is to smooth the product surface and remove the bad condition affected during the welding process. It also can help remove any sharp edge. The process shown in **Figure 3.12**.

Figure 3.12: Grinding process

The last process to complete this lift machine is painting. The purpose is to make this lift machine is more attractive and can also cover the steel from rust. The process show like in figure below.

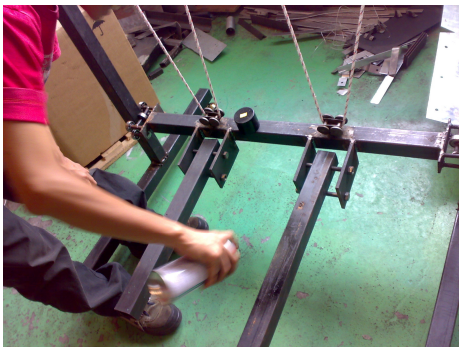


Figure 3.13: Painting process

3.8 RAW MATERIALS

The types of material that will use during the fabrication are very important to ensure this project is successfully. The material that will use in this fabrication process shown in **Table 3.4**. The material, dimensions and the quantity are in this table.

Table 3.4: Material Specifications

MATERIAL	DIMENSIONS	QUANTITY	PRICE
Rectangular Hollow Steel (50mm x 50mm)	1600mm x 50mm x 50mm 1000mm x 50mm x 50mm 900mm x 50mm x 50mm 500mm x 50mm x 50mm	2 3 1 2	-
Pulley	-	5	RM76.00
Rope	8 m	1	RM4.00
Bearing		10	RM45.00
Bolt and nut	Diameter 12	4	RM4.00
Wheel	-	4	RM10.00
Sheet Plate	130mm x 50mm x 5mm	2	-
Rod	Diameter 10mm x 50 mm	8	-

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

In this chapter, the product that will produce will be explain in detail on how the design and sketching of the lift machine need to undergo a several design aspect and the compliance of design need to follow step by step. During the process development of the design, each consideration must be done carefully and properly to make sure the design can be applied in fabrication process and the system will be functioning. In this chapter also will explain the final design had been chosen and all the fabrication process from beginning until the end of the fabrication process.

Beside that, this chapter also aims to analysis of the lift machine. Include the analysis at body of lift machine. For each critical place will be analysis to make sure this lift machine with not failed.

4.2 RESULT

a) Introduction

After all the fabrication was done, the product will be through the analysis process. In this chapter, all the information about this lift machine was gathered. It is important before it enter the market. The complete fabrication of lift machine was shown like in **Figure 4.1** until **Figure 4.3**.

Figure 4.1: Isometric view

Figure 4.2: Front view

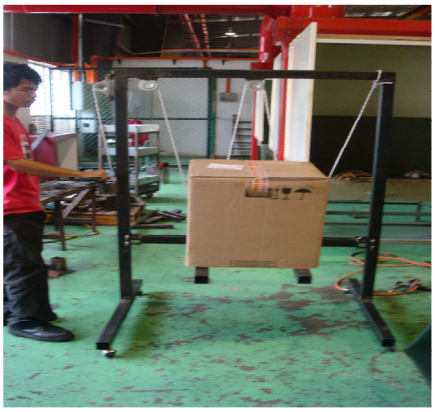


Figure 4.3: Taking a load

b) Product specification

After that, the product will be classify into several categories or their technical data. The product specification was shown in **Table 4.1** below.

Table 4.1: Product specification

NO	TECHNICAL DATA	SPECIFICATION
1	Maximum capacity	20 kg
2	Maximum height	1.4 meter
3	Lowered height	90 mm
4	Jaw lengths	500mm
5	Jaw width	50mm
6	Color	black

c) Type of Defect

After finish all the fabrication process, many types of defect were created. It effect by some other problem and weakness during using several machine and tool. The type of defect was shown in **Figure 4.4.**

i) Bead

Figure 4.4 is an example of defect from welding process. It occurs when the wire speed and the voltage are not match and less of experience to operate this machine.

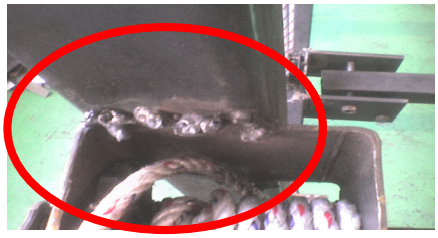


Figure 4.4: Bead defect

ii) Unparallel

In **Figure 4.5** is the defect where the jaw is unparallel. The defect happens because the arrangement of the pulley is not suitable. Beside that, some other pulley is not working during taking a load.

Figure 4.5: unparallel jaws

4.3 ANALYSIS

a) Bolt and nut

i) Problem Statement

Determine the shear stress in the bolts. The force applied to the connection and the bolt diameters are given. Input shown like in **Table 4.2** below:

Table 4.2: input analysis

Connection type	double shear
Number of bolts	2 bolts
Bolt diameter	12.0 mm
Force applied to connection	98.1 N

ii) Introduction

Bolted connections are an example of direct shear. For this type of problem, it is important to recall that shear stress acts on surfaces that are parallel to the direction of the applied force. To determine the surfaces upon which shear stress will occur, it is helpful to visualize how the connection would look if the bolts actually broke (i.e., fractured). The new surfaces that appear when the connection breaks are the surfaces that are subjected to shear stress.

An important consideration in connections is the manner in which the bolts are supported. If the bolts are supported by only one plate, the connection is termed a single shear connection. If the bolts fracture on the plane between the support and the axial member, the connection will be broken. If the bolt is supported by two plates, the connection is termed a double shear connection. For this type of connection to be broken, the bolts

must fracture on two planes. Since shear stress acts on two surfaces, this type of connection offers twice the strength of a comparable single shear connection.

iii) Calculation

The diameter of each bolt is 12.0 mm, and the cross-sectional area of each bolt is 113.1 mm². There are two bolts in the connection. Since this is a double shear connection, two cross-sectional surfaces on each bolt carry shear stresses. The total area subjected to shear stress is:

2 bolts × 113.1 mm² per bolt cross-section × 2 cross-sections per bolt = 452.4 mm²

The force applied to the bolted connection is 98.1 N.

The shear stress in each bolt is found by dividing the applied force by the total area in shear:

98.1 N ÷ 452.4 mm² = 0.2168 MPa

Note: Make the units consistent before performing the hand calculation. And the output showed like in **Table 4.3** below:

Table 4.3: output analysis

Bolt cross-sectional area	113.1 mm²
Total bolt shear area	452.4 mm²
Bolt shear stress	0.2168 MPa

b) Jaws analysis

The total magnitude of the distributed load in this region is 98.10 N/m, acting DOWNWARD. The area under the load diagram between x = 0.00 m and x = 0.15 m is -14.71 N (i.e., -98.10 N/m × 0.15 m). The change in shear between x = 0.00 m and x = 0.15 m is equal to the area under the load diagram between these two points. At x = 0.00 m, the shear force is 14.71 N. Adding -14.71 N to this value gives a shear force of V = 24.92E-06 N at x = 0.15 m.

The slope of the shear curve is equal to the magnitude of the distributed load w (i.e., w = -98.10 N/m). Since its slope is constant, the shear curve is linear in this region.

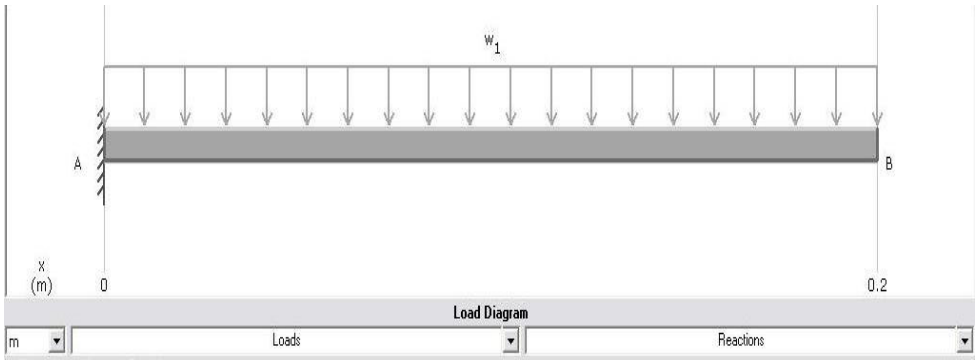


Figure 4.6: Load diagram

i) Shear Equation

For the shear discontinuity equation, the following units are displayed:

Length units = m
Force units = N
Moment units = N-m

Shear discontinuity equation using symbolic notations:

Shear = Ay<x-0.00>0 - w1<x-0.00>1 + w1<x-0.15>1

Shear discontinuity equation showing actual numeric values:

Shear = +14.72<x-0.00>0 - 98.10<x-0.00>1 +98.10<x-0.15>1

When using discontinuity functions, if the term in the < > brackets is negative for a particular value of x, the quantity in the < > brackets is defined to have a value of zero.

ii) Moment Equation

For the moment discontinuity equation, the following units are displayed:

Length units = m

Force units = N

Moment units = N-m

Moment discontinuity equation using symbolic notations:

Moment = Ay<x-0.00>1 -MA<x-0.00>0 - w1/2<x-0.00>2 + w1/2<x-0.15>2

Moment discontinuity equation showing actual numeric values:

Moment = +14.72<x-0.00>1 - 1.10<x-0.00>0 - 98.10/2<x-0.00>2 +98.10/2<x-0.15>2

When using discontinuity functions, if the term in the < > brackets is negative for a particular value of x, the quantity in the < > brackets is defined to have a value of zero.

iii) Result

The slope of the shear curve in this region is -98.100 N/m. The shear curve slope is defined as the change in shear divided by the change in distance. The point where the shear curve crosses the horizontal axis must be calculated. Starting at x = 0.00 m where V = 14.72 N, the shear must change by -14.72 N to reach the horizontal axis. Divide -14.72 N (i.e., the change in shear) by the slope -98.100 N/m to compute the distance from x = 0.00 m to the point of zero shear. This distance equals 0.15 m. A zero shear force occurs at x = 0.15 m. A relative maximum or minimum value of the bending moment corresponds to this location.

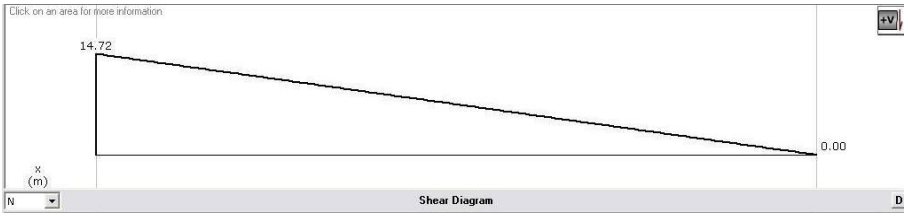


Figure 4.7: Shear diagram

The change in moment between two points on the beam equals the area under the shear curve between the same two points. The area under the shear curve between points x = 0.00 m and x = 0.15 m is 1.10 N-m. The moment at x = 0.00 m is -1.10 N-m. Adding the area under the shear curve (1.10 N-m) to -1.10 N-m gives a bending moment of 0.00 N-m at x = 0.15 m.

In this region, the moment curve is parabolic (i.e., 2nd order curve), starting with a relatively large positive slope and growing increasingly flatter.

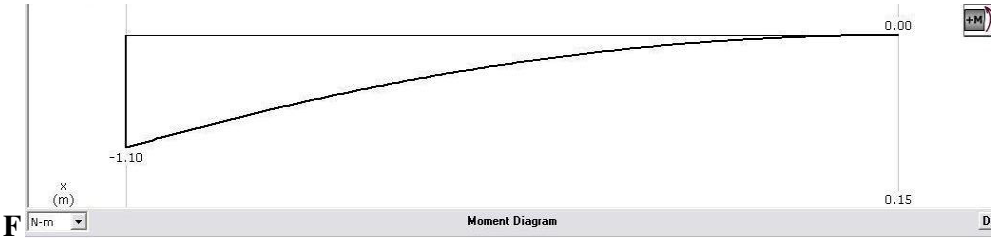


Figure 4.8: Moment diagram

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 SUMMARY OF THE PROJECT

The project includes designing and fabrication of lift machine. In this project, it can be dividing into 4 stages, including concept review, designing, fabrication and analysis or testing. The drawing can be divided into two categories which are including sketching and designing. The final design will transfer to solid modeling using solid work software. This lift machine fabricate by using all the manufacturing process such as welding, drilling and fastening

.

Basically this chapter will discuss about the conclusion for the whole work that have done. Beside that, it is also will discuss the recommendations of the project. The important things in this project about the problems encountered during the project also will discuss in this chapter. These will help student to think like an engineer thinking on how to solve the problems and make a conclusion from this project. Lastly, the recommendations are need from this project as the suggestion to improve this product.

5.2 SUGGESTION FOR FUTURE WORK

a) Pulley system

According from this project, the pulley system that use are not efficient. Where, the arrangements of the pulley are not suitable. During lift the load, one

of the pulleys is not functioning. The arrangements of the pulley must suitable to easier lift the load. Or can use the chain block to replace the pulley system.

b) Shape

The lift machine should not to fix with one shape only. The lift machine also can be fabricated in other variety shape such as triangle shape. It is stronger from others shapes.

c) Portability

The lift machine will be more interesting and innovation if the lift machine portable. Where, the lift machine can be put in any place and condition even though in a limit space.

d) Pulley

Use the same type of pulley to prevent the pulley not working as usual.

5.2 Future Work

For the conclusion, overall perception of the project carried out was good. Due to some problems, this project was started late but still finish on time. With help from supervisor and friends, this project is finish and functional.

5.3 CONCLUSION

In this project, the objectives of this project are achieved around 80 percent several objectives but 20 percent more several objectives are not achieved effect by some other problem.

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APPENDIX A

PART OF ASSEMBLY

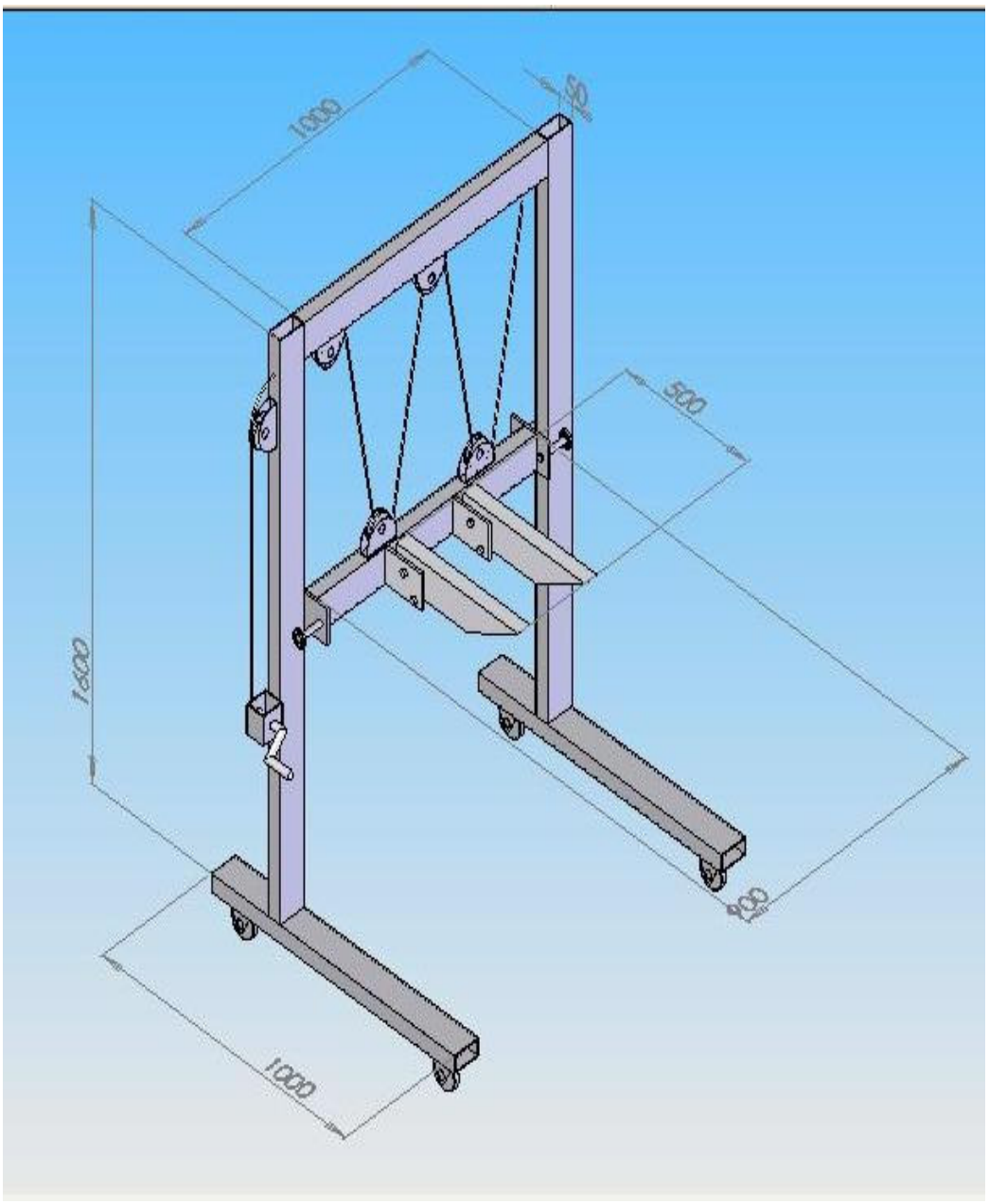

Figure A1: The full assembly part using Solid work

FULL ASSEMBLY

Figure A2: The result after fabrication