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**PRINCE MOHAMMAD BIN FAHD UNIVERSITY**

**College of Engineering**

**Department of Mechanical Engineering**

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**Senior Design Project Report**

# **Adjustable Single Weight Lifting Machine**

In partial fulfillment of the requirements for the  
Degree of Bachelor of Science in Mechanical Engineering

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## **Abstract**

This project is very helpful because Weight lifting sport is the most popular sport among bodybuilders and fitness trainers. Most weight lifting machines contains lots of metal weights to have adjustable weights for the trainers which makes it heavy and expensive. This project will be done by a group of engineering students who have thought of how this problem could be solved using physics theory, a design has been prepared to build an advanced light weight lifting machine that works with one weight bar and give the trainer an adjustable weight from 5 to 80kg. This project shall be in the domain: A body building machine that can be implemented in gyms designed for weightlifters works with one weight bar. This project enables us to make an easier to change weights, cheaper, lighter, and a less space equipper weight lifting machine.

## **Acknowledgment**

This project was done under the supervision of Prince Mohammed bin Fahad University, Khobar, Saudi Arabia. Many Thanks go to the Mechanical Engineering Department which prepared us to be qualified mechanical engineers and gave us all the tools needed to serve our community well and contribute our best in the industry. We especially extend our appreciation to our advisor Dr. RaguramanKannan and co-advisor: Dr. Nader AlSawalhi for teaching, helping, and supporting us in our senior project. Their valuable comments and feedbacks helped us to improve the quality of our senior project. Besides that, we express our gratitude to our out of campus consultant Eng. Ahmad AlShammari, Saudi Aramco Employee, who had kept supporting us during the whole semester regarding any manufacturing advice.

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# **CHAPTER 1**

## **Introduction & Project Objectives**

## **Chapter 1: Introduction**

### **1.1 Project definition**

Bodybuilding sport is highly diffused between people in all ages starting from 16 years old; to play this sport and start building muscles heavy weights should be lifted. Bodybuilders don't have the same power to lift the same weights; it depends on their strength, energy and experience. In order to give the trainer adjustable weights to make him or her choose the proper weight a lot of metal should be used in the training machine either for the weights them self or for the other components to hold the weights. These machines are so heavy, expensive, occupy a lot of space and are hard to be moved from a location to another. As a group of mechanical Engineering students we thought of a solution for this problem, The Single Weight Adjustable Weight Lifting Machine is the solution. Single Weight Adjustable Weight Lifting Machine is a machine that allows the trainer to lift between 5kg to 80kg by using one weight bar of 20kg only. The concept design of this machine was adopted from the idea of bicycle gears. Depending on the gears ratio the load on the user will change from lower to higher to make him or her feel the difference in the work they apply to train.

### **1.2 Project Objective**

#### **1.2.1 Inventing a New Idea Replaces the Physical Weight Addition Method:**

The main objective of building an “Adjustable Weight Lifting Machine” is to find a new idea of changing the weight rather than the traditional one which we have in gyms nowadays. The system will be designed based on different gear ratio concept; the new mechanism enables the user to play with 1:4 ratios to increase or decrease the exercising weight.

#### **1.2.2 Decrease the Cost of Manufacturing:**

For one individual machine it may not look feasible to use an adjustable lifting machine depends on gear ratio concept instead of applying different physical weights, however when we look at

the idea from a mass production view, we notice that it will save a lot of money.

### **1.2.3 Lightweight machines which can be carried everywhere:**

Machines which we see in gyms around the world are difficult to be moved from one place to another because of the weights attached with the set. Even if we dismantle the exercise machine, we will need to put extra efforts to carry the weights separately; which will take more time. However the new system will be much lighter and easy to carry everywhere.

### **1.2.4 Avoid injuries which may occur while changing the weight:**

Using this concept will decrease the chance of hand injuries which may be caused by the frequent applying of the machine weight. In the traditional method, the trainee needs to change the weight pin in each set which is very close to the arrayed weights; the trainee finger may get stuck in between the weights, or any other people who is nearby the lifted weights. However in the new approach everything will be covered and away from any touch which causes injuries.

### **1.2.5 Decrease the Space Used for Gym Equipment:**

Weightlifting equipment occupies most spaces in gym centers, which is a disadvantage especially to small space places. This project aims to build a smaller machine, with high performance. So we can save more space to be utilized in other things.

# **CHAPTER 2**

## **Literature Review**

## Chapter 2: Literature Review

### 2.1 Background

#### 2.1.1 Sport types and exercise mechanism

As we know the sports activities are very important to anyone and we can do the exercise everywhere. Such as, exercise at home, at work, and at Gym. In this project we bring a new concept where anyone can change the weight and train with little effort. We created a light weight lifting machine that varies the weight between light and heavy without the need of changing weights.

There are seven types of machines that can be used for lifting Weight. Each one of us can have his own plan and daily activity from the network or any institute. But, unfortunately without certified trainer and programming director that can have side effect injury and no benefit from this program. We study 7 Gym Machines for Weight lifting. Figures 1 to 7 show some examples.



**Figure 1 (Horizontal Seated Leg Press)**

This exercise focuses on quads, gluts, hamstrings, calves. All of the trainers we spoke with agreed this was their go-to lower-body machine. “If people use this with correct technique, it can help you move toward squats off the machine,” Munro says.

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**Figure 2 (Lat Pull-Down)**

This exercise focuses on latissimus dorsi ("broadest muscle of the back"), shoulder girdle. It will build back muscles and start activating the entire posterior chain.



**Figure 3 (Cable Biceps Bar)**

This exercise focuses on biceps topical to swinging activities.

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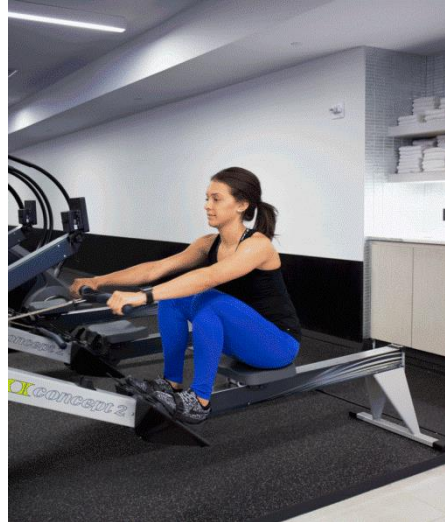
**Figure 4 (Cable Triceps Bar)**

Pull-down or the cable biceps bar, it help to keep this move varied and building strong triceps are important for push-ups, pull-ups, and for maintaining balanced strength in your arms.



**Figure 5 (Chest Press)**

Chest press focuses on chest, biceps, and triceps. “The chest press machine is a similar motion to a push-up,” Munro says.



**Figure 6 (Rowing Machine)**

Rowing machine focuses on total body, particularly the posterior chain, and building cardio endurance, while there's nothing wrong with a treadmill, the rowing machine can be a great way to change things up, Marietta says. "It's got the upper body and lower body aspect of resistance training and will help balance the whole hunch-forward-from-sitting-at-computers,"

### **2.1.2 Five benefits of using weightlifting machines**

- Controlling mechanical overload and path of motion
- Placing resistance specifically on the contractile element of muscle
- Creating metabolic overload
- Time-efficient solution for circuit training
- Focus on developing definition in specific muscles

## **2.2 Previous Work**

### **2.2.1 History of Exercise equipment**

The history of fitness goes back to early man's need for physical strength and speed while hunting. As the centuries carried on and individual cultures developed, human beings became more sedentary. This leads to an interest in fitness not as a necessity of survival, but as an important aspect of a long, and healthy life. Fitness equipment has been key to this change,

helping generations of people from around the world to shape and condition their bodies.

## **2.2.2 Machines Types**

### **Resistance Machines**

After the development of free weights, it took hundreds of years for a major advancement in resistance training to occur. In the 1950s, American fitness guru Jack Leanne invented several pieces of equipment that have been widely used ever since. Leanne developed the first cable-pulley machine, the Smith machine and the first leg extensions machine. The mechanical principles behind these three pieces of equipment can be found in equipment in gyms around the world.

### **Cardiovascular Equipment**

The most popular piece of cardiovascular exercise equipment, the treadmill, was first introduced in 1875, but it wasn't used for exercise, it was used for manufacturing. In 1952, University of Washington in Seattle doctor Robert A. Bruce began using treadmills for human stress tests. This inspired businessmen to turn the treadmill into a consumer exercise device that would allow someone to run or jog naturally while staying in place. By the 1960s, treadmills were common in homes and gyms. Elliptical machines, which are similar in function to treadmills but place less stress on the lower body, were first released in the mid-1990s and have rivaled treadmills in popularity ever since.

### **Resistance Bands**

Resistance bands, which are essentially strips of elastic that create progressive resistance as they are stretched, were first used by former football coach Dick Hartzell for functional training in 1980. Since then, manufacturers have modified resistance bands by attaching handles and creating anchors that allow resistance bands to mimic almost any gym exercise that can be performed with free weights, but without the bulk, making them much more portable than free

weights.

### **2.3 Pulley**

A pulley is a wheel with a section along its edge for holding a rope or link. It is a straightforward machine that alters the course and purpose of utilization of a pulling power. Pulleys are generally utilized as a part of sets intended to lessen the measure of drive expected to lift a heap. The extent of compel is decreased; however it must act through a more drawn out separation. Subsequently, the measure of work important for the heap to achieve a specific stature is the same as the measure of work required without the pulleys.

#### **History of Pulleys:**

Just like the case with all the straightforward machines, the cause of the pulley is obscure. At the point when early people groups lifted substantial protests by tossing vines or other unrefined ropes over tree appendages, they utilized the possibility of a solitary settled pulley to alter the course of a compel. Be that as it may, since there was no wheel to turn, this utilization brought about extensive grating. It is trusted that by 1500 B.C.E. individuals in Mesopotamia utilized rope pulleys for raising water.

#### **Types of pulleys:**

Fixed or class 1 pulley has a settled pivot. That is, the hub is "settled" or tied down set up. A settled pulley is utilized to divert compel in a rope (called a belt when it goes in a full circle. A settled pulley has a mechanical preferred standpoint of one.

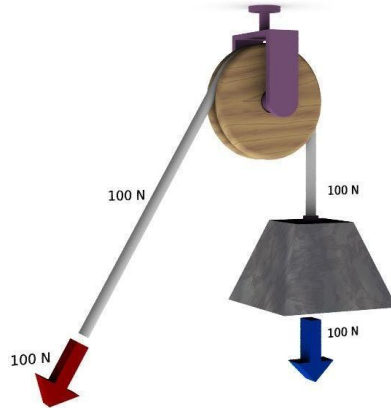


Figure 7 (Fixed Pulley)

Movable or class II pulley has a free pivot. That is, the hub is "free" to move in space. A portable pulley is utilized to change powers. A versatile pulley has a mechanical favorable position of two. That is, whether one end of the rope is secured, pulling on the flip side of the rope will apply a multiplied compel to the protest appended to the pulley.

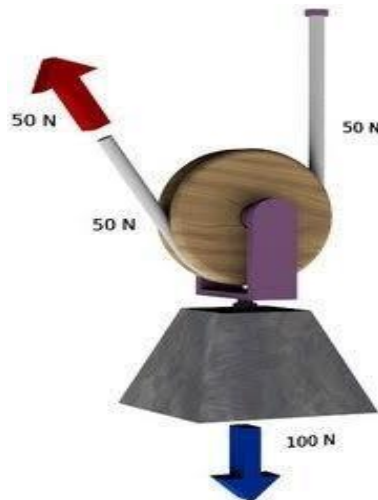


Figure 8 (Movable Pulley)

Compound a compound pulley is a mix of fixed and movable pulley framework. Block and tackle - A piece and handle is a compound pulley where a few pulleys are mounted on

every axle, additionally expanding the mechanical favorable position, also Pulleys can alter the course of the constraint.

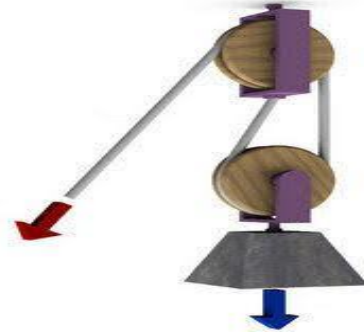


Figure 9 (Practical compound pulley)

A practical compound pulley, we think this tool is very important to our gym machine to lift the weight.

## 2.4 Bicycle Gears

The thought behind different gears on a bicycle - whether it's a more seasoned "10-speed" bicycle or a current mountain bicycle with 24 gears - is to give you a chance to change the separation that the bicycle pushes ahead with each pedal stroke. For illustration, a typical bicycle has wheels that are 26 crawls in width. The "most reduced" gear proportion on the bicycle may be a front chain wheel with 22 teeth and a back gear having 30 teeth. That implies that the gear proportion is 0.73-to-1. For each pedal stroke, the back wheel turns 0.73 circumstances. At the end of the day, for each pedal stroke, the bicycle advances around 60 inches (around 3.4 mph/5.4 kph at a 60-rpm accelerating rate). The "most astounding" gear proportion on the bicycle may be a front chain wheel with 44 teeth and a back gear having 11 teeth. That makes a 4-to-1 gear proportion. With 26-inch wheels, the bicycle pushes ahead 326 creeps with each pedal stroke. At a 60-rpm accelerating rate, the speed of the bicycle is 18.5 mph (30 kph). By multiplying the

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accelerating rate to 120 rpm, the bicycle has a most extreme speed of 37 mph (60 kph). A scope of 3.4 mph to 37 mph is awesome, and it gives the rider a chance to climb the steepest slope gradually or race nearly as quick as an auto! That is the reason a bicycle has gears.

The front gears are named the **chain wheels**. Most bikes and motorbikes have three or two chain wheels that look like:



Figure 10 (Bicycle Gears)

Attached to the back wheel is the **free wheel**, and it looks like:



Figure 11 (Rear Bicycle Gears)

The free wheel has between nine and five gears on it, depending on what type the bike. A freewheel rotates easily in one way and locks in the other. That lets the rider pedal or not pedal when not pedaling, the bicycle **coasts** (another feature that tricycles and penny-farthing bike lack). To adjust the gears, a bike has front and back **derailleur**. This is the rear derailleur:



Figure 12 (Bicycle Gears)

The back derailleur has two minor cogs on it that both spin easily. The arm and lower cog purpose of the derailleur is to **tension** the chain. The cog and arm are linked to a spring so the cog pulls backward every time. As if you change gears, you will see that the direction of the arm

changes to take up or let out slack:



**Figure 13 (Bicycle Gears)**

The upper cog is near to the free wheel. When you change the gears with the lever on the handlebar, this cog changes to a different place on the free wheel and drags the chain with it.



**Figure 14 (Bicycle Chain)**

Why this part? We choose it because the chain logically slips from one gear to another as you turn the wheels.

## **2.5 Aluminum**

Mechanically, chemically and physically aluminum is a metal similar to steel, metal, zinc, copper, lead or titanium. It can be liquefied, thrown, shaped and machined much like these metals and it channels electric current. Truth be told frequently a similar gear and creation strategies are utilized.

### **2.5.1 Light weight:**

Aluminum is a light metal with a particular weight of 2.7 g/cm<sup>3</sup>, about a third that of steel. For instance, the utilization of aluminum in vehicles decreases dead-weight and vitality utilization while expanding load limit. Its quality can be adjusted to the application required by changing the synthesis of its composites.

### **2.5.2 Corrosion Resistance:**

Aluminum normally creates a defensive oxide covering and is very erosion safe. Distinctive sorts of surface treatment, for example, anodizing, painting or lacquering can additionally enhance this property. It is especially valuable for applications where assurance and protection are required.

### **2.5.3 Recyclability:**

Aluminum is one hundred percent recyclable with no minimizing of its qualities, so it's friendly to the environment.

Why this part? We choose this metal because it's much lighter than iron and other metals also there are big difference in their price because aluminum is much cheaper and that what we need for our final project.

# **CHAPTER 3**

## **System Design**

## **Chapter 3: System Design**

### **3.1 Design Constraints**

#### **Economically**

One of the main objectives of our project is to reduce the cost of gym machines by reducing the metals used in regular gym machines. In this case one of the constraints in our design is to reduce the cost of manufacturing gym machines as low as possible. The following are some points that should be under consideration in terms of the market of our project in future:

- **Marketing analysis** – size of market, distribution, market segments
- **Design costs** – design team computing, information retrieval
- **Development costs** – design detailing, supplier costs, testing costs
- **Manufacturing cost** - tooling, labor, overhead, assembly, inspection
- **Distribution costs** - packing, transport, service centers, spare parts, warranty
- **Resources** – time, budget, labor, capital, machines, material

#### **Manufacturability**

When the project is in the manufacturing level, there are a lot of things needed to be available. The first thing is to find a factory to produce the project parts. Another thing is to make sure that these parts can be purchased as spare parts if needed. Another thing to put it under consideration is to find workshops or factories to assemble the parts together to produce the final machine.

#### **Safety**

As we all know, safety is always first. Our project consists of only one weight bar only so the dangerous level is very lower than regular gym machines. But also there are some things should be taken care of like the operational factors, for example the rotation movement of parts and the

movement of other parts. All parts should be perfectly assembled to avoid injuries if a failure occurs. .

### 3.2 Design Methodology

Our design consists of two major parts as shown in figures 15 and 16, Steel Box and Weight Stand. There are also sub-parts such as aluminum cones, 20kg bar, 3 in bars and pulleys, and rubber belts.

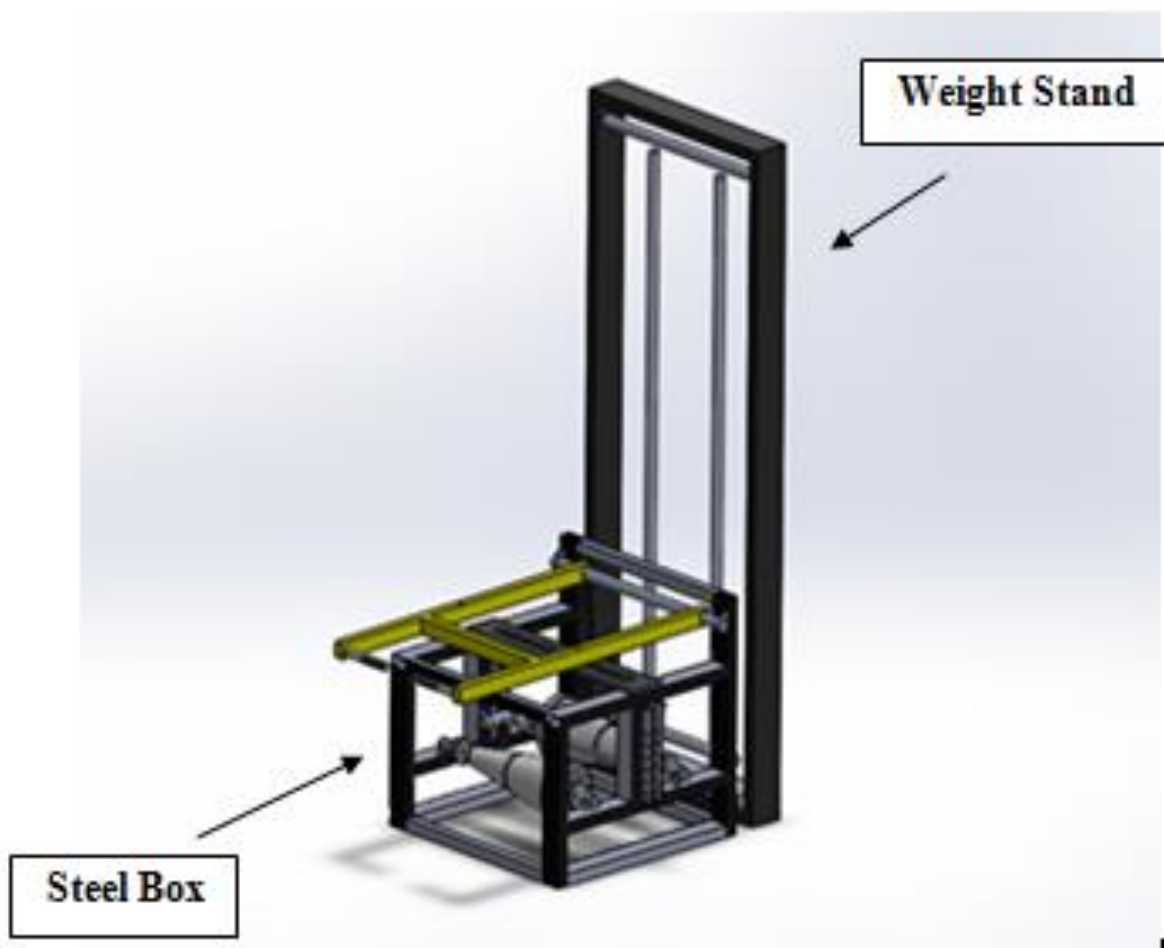


Figure 15 (System Basic Design)

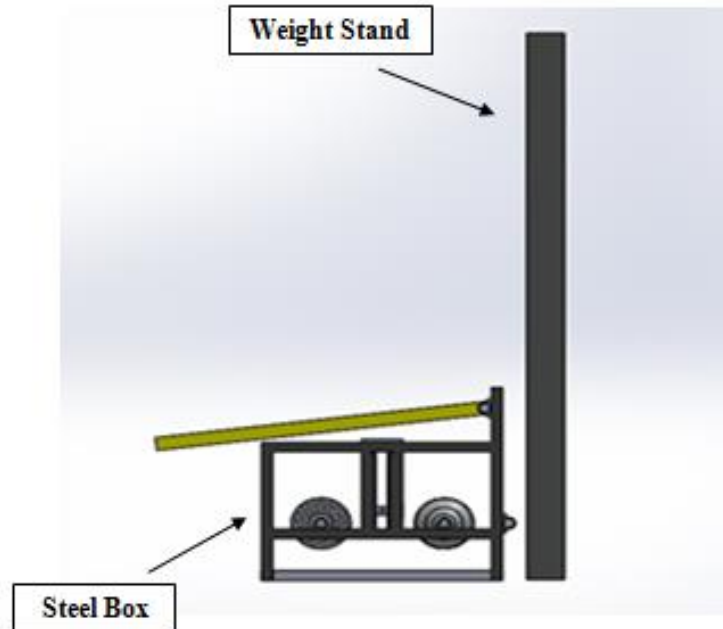


Figure 16 (System Basic Design)

The trainer can change the belt location to get different ratio which will vary the load aspects. When the user pull the driver cone, the driven cone will rotate and lift the hanged bar. By controlling the ratio we can play with the weight he feels.

The main equation used in our project as the concept developed from is:

$$W = F \times D$$

W: Work

F: Force

D: Distance

As shown in figure 16, the training arm will be lifted in 60 cm by the trainer which will rotate the first cone in 37.5 cm as a rotation. If the belt was located in the ratio of 1:4 the first con will rotate the other cone 4 times the first con rotation distance of 37.5 which is 150 cm and that will

feel like lifting 80 kg. Whenever the trainer change the belt location the force needed to lift the 20 kg weight bar will be different depends on the ratio of the two cons as shown in table 1.

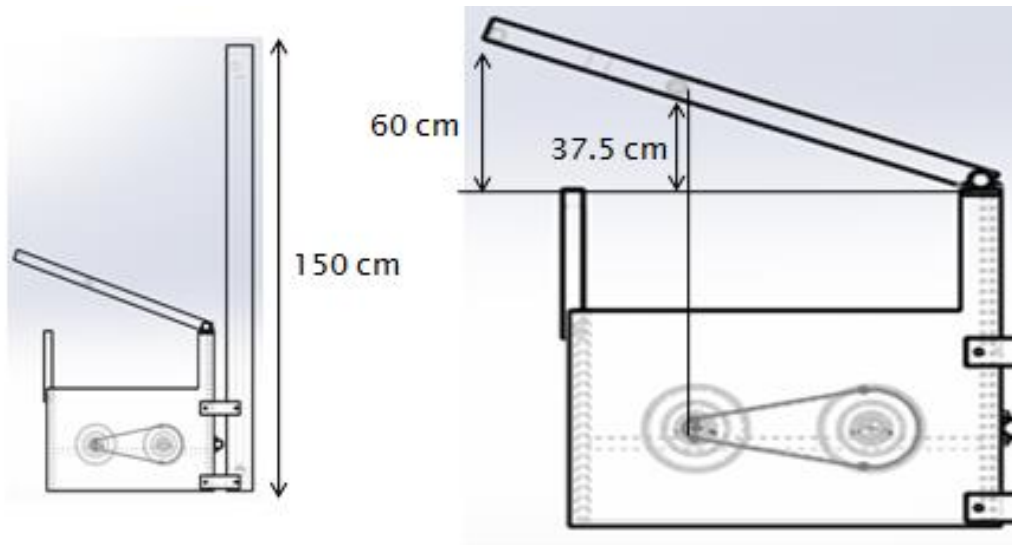


Figure 17 (Mechanism)

The training arm will be lifted up to 60 cm to rotate the shaft 37.5 cm which is 4 times the circumference (9.4 cm) of the shaft (4 turns)

Table 1 (Different Ratio Forces)

1:4	4:1	1:1
$37.5 \times F = 20\text{kg} \times 150\text{cm}$ $F = 80 \text{ kg}$	$37.5 \times F = 20\text{kg} \times 9.4\text{cm}$ $F = 5 \text{ kg}$	$37.5 \times F = 20\text{kg} \times 37.5\text{cm}$ $F = 20 \text{ kg}$

The following are some equations that we used in other parts of the project:

$$R = D_{\text{driven}} / D_{\text{driving}}$$

Where:

R = Ratio

$D_{\text{driven}}$  = Diameter of the driven shaft

$D_{\text{driver}}$  = Diameter of the driver shaft

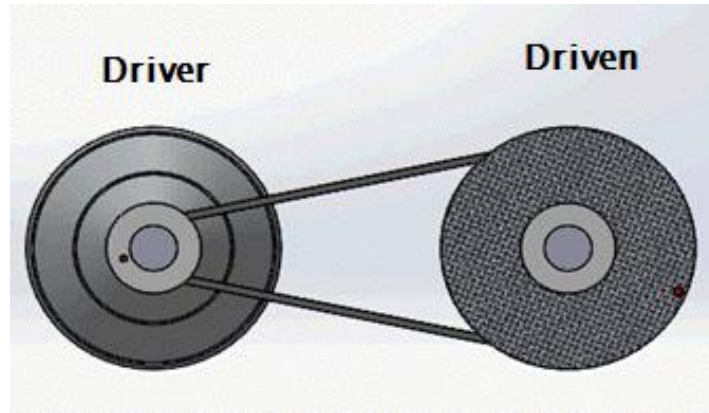


Figure 18 (Driver and Driven)

### 3.3 Product Subsystems and Components

Figure 19; shows the exploded view of our system and the systematic hierarchy of it.

ITEM NO.	PART NUMBER	DESCRIPTION	QTY.
1	Box5	Steel	1
2	Conical4	Aluminum	2
3	ArmBearing4	Inner Di 3 cm	10
4	RearShaft4	Steel hollow	1
5	Armshaft5	Steel hollow	1
6	Arm4	Steel	1
7	Tightingrod5	Steel	1
8	Weightstand4	Steel	1
9	Weight5	Steel	1

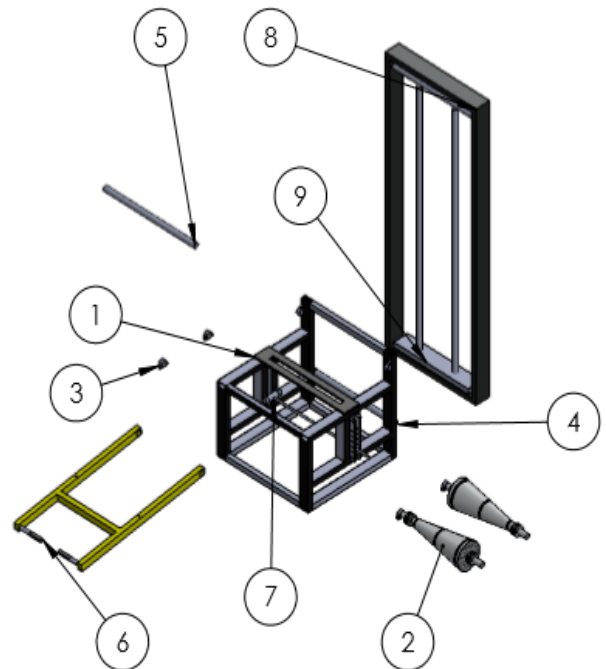


Figure 19 (System Components)

### **Item 1 (Steel Box)**

This is the bones of the project, inside the steel box there are the two identical cones which are installed by bearings. On the top of the box there will be the training arm installed with bearing also. In the back of the steel box we will find the weight stand. The box dimensions are 60x60x60 cm.

### **Item 2 (Aluminum cones)**

The aluminum cones are the heart of the project. These two identical cones are installed opposite to each other with a ratio of 4:1 connected by a belt to each other. The large diameter is 16 cm and the small diameter is 4 cm. The length of the cons is 40 cm from the bigger to the smaller diameter and overall length of 60 cm to fit in the steel box.

### **Item 3 (Arm Bearings)**

Those are the bearing of the training arm, those bearings are the same bearings used in every movable part in the machine.

### **Item 4 (Rear Shaft)**

This shaft is installed to be rotated with the movement of the ropes to lift the weight. This shaft is there to reduce the angle between the ropes and the upper pulleys to lift the weight.

### **Item 5 (Arm Shaft)**

This shaft is responsible of the arm movement.

### **Item 6 (Training Arm)**

This is the first step of the all mechanism of the machine. The training arm will be connected by a rope to the conical pulley to rotate it when the training arm is moved up and down. The length of the training arm is 80 cm.

**Item 7 (Cones Shaft)**

This shaft is installed to tight the belt connecting the two cones together. This shaft will rotate with the belt while tighten it up.

**Item 8 (Weight Stand)**

The weight stand is a major part of the machine. It is the stand that holds the weight and it acts as the path of the weight to move up and down.

**Item 9 (20 kg Weight Bar)**

This is the weight bar used in the machine.

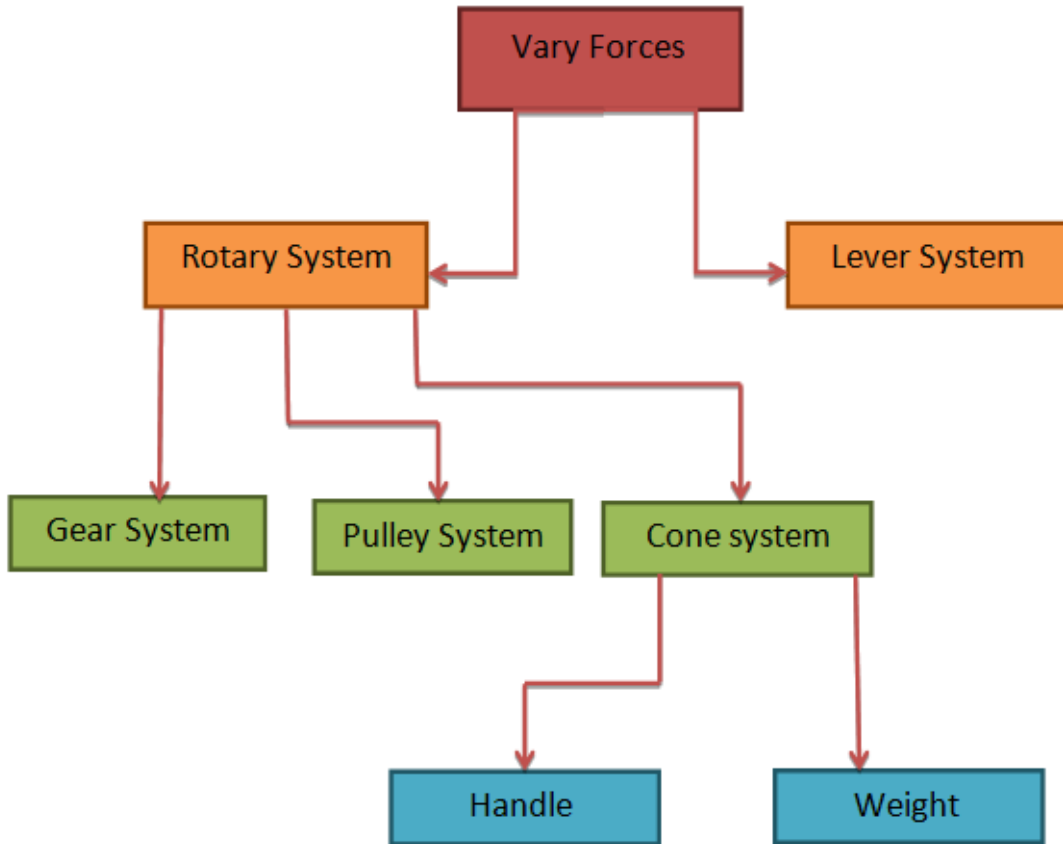


Figure 20 (System Components)

### 3.3.1 Pulley System:

Pulley Systems are used to give us a mechanical preferred standpoint, where the amount of information is duplicated to apply greater strengths on a load. They are normally used for pulling and lifting loads however also can be used to apply tension inside a framework, for example, in a Tensioned Line. This clarifies the basic standards of Pulley Systems and how they work.

### 3.3.2 Gear System:

Gears are utilized for transmitting power starting from part one in a machine then onto the next part, You can have any number of Gears associated together and they can be in various sizes and shapes. Each time you pass power starting with one Gear wheel then onto the next one, you can

do one of three things:

- Increase speed
- Increase force
- Change direction

But we're going to talk only about increase force because it's the main idea about our project.

Increase force:

If the second wheel in a pair of gears is bigger than the first wheel, however the movement of the gears will be slow but with more force.

Vary Force:

This is the main idea of our final project which is we don't change the weight but we change the force.

### **3.3.3 Rotary System:**

Rotary system works by rotational motion to vary forces to decrease the force or increase it without changing other functions such as the weight, material and size.

### **3.3.4 Lever System:**

Lever, Simple System consisting of a rigid bar that rotates about a settled point, named a fulcrum point. Levers effect the action, or force, expected to do a specific measure of work, and is utilized to lift big objects. A lever makes work simpler by decreasing the force expected to move a weight or load.

### **3.3.5 Cone System:**

The cone system is the system that we are going to use in our project, and it works by placed two cones in opposite positions and connect them by a belt. Moreover, when we place the belt in the right side the ratio is going to be 4 to 1 and the force will be high on the user to left the weight, and if we place the belt in the left side the ratio is going to be 1 to 4 and the force will lower than the first position. Furthermore, if we place the belt in the middle of the cones, the weight will be equal to the force which is 20 kg.

### **3.4 Implementation**

The following parts are available in the system:

#### **1) Steel Box**

- a. Aluminum Cones (2 pcs)
- b. Steel Shaft (2 pcs)
- c. Pulleys ( 4 pcs)

#### **2) Weight Stand**

- a. 20 kg bar
- b. Steel Shaft
- c. Pulleys (2 pcs)

There will be three rubber belts and a shaft installed horizontally in the steel box which allows the user to tight the belt after choosing the appropriate belt location.

# **CHAPTER 4**

## **System Testing and Analysis**



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Result:

When the end of the arm lifted to 60 cm, the following output where observed:

Table 2 (Testing Subsystem 1)

Trail #	Pulley Radius (cm)	Pulley Circumference ( $2 \pi r$ ) cm		Rope Material	Result	Comments
		For One Turn	For Four Turns			
		1	1.5			
2	Heavy Cotton	Fail		The rope was not rotating correctly around the pulley which resulted in some errors		
3	Heavy Cotton	Pass		Worked Perfectly		



Figure 22 (Testing Lifting Arm & Driver Cone)

## 4.2 Subsystem 2 (Driven Cone & Weight Bar)

Objective:

The driven should be able to lift the 20 kg weight bar when rotating in one direction, and lower the weight to the ground when rotating in the other direction.

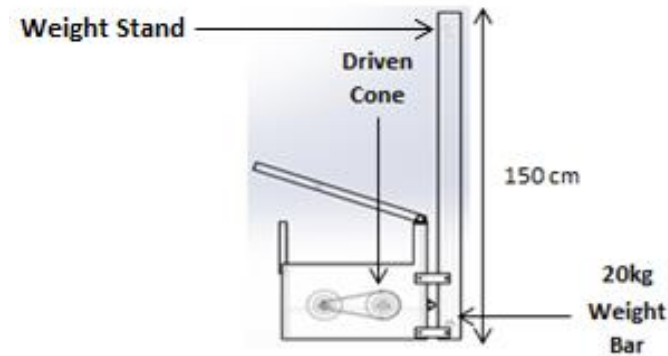


Figure 23 (Driven Cone & Weight Bar)

Setup:

The driven cone was connected to the 20kg weight bar by using a lifting rope passing through hanged pulleys which are fixed to the top of the weight stand.

Result:

The test was done successfully and smoothly.



Figure 24 (Testing Driven Cone & Weight Bar)

### 4.3 Subsystem 3 (Driver & Driven Cones)

Objective:

When the driver cone rotates, the driven cone should rotate as well.

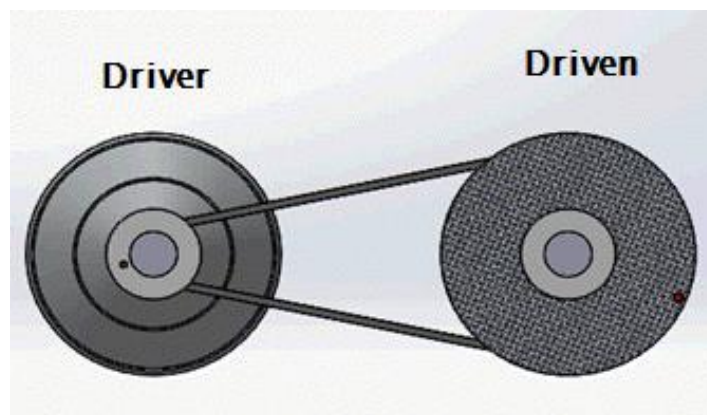


Figure 25 (Driver & Driven Cones)

Setup:

The ends of the two cones were connected to ball bearings to allow frictionless rotation for both cones and they were connected by a rubber belt as shown in the figure 26 below.

Result:

The driver con rotated the driven cone successfully.



Figure 26 (Testing Driver & Driven Cones)

#### 4.4 Overall Results, Analysis and Discussion

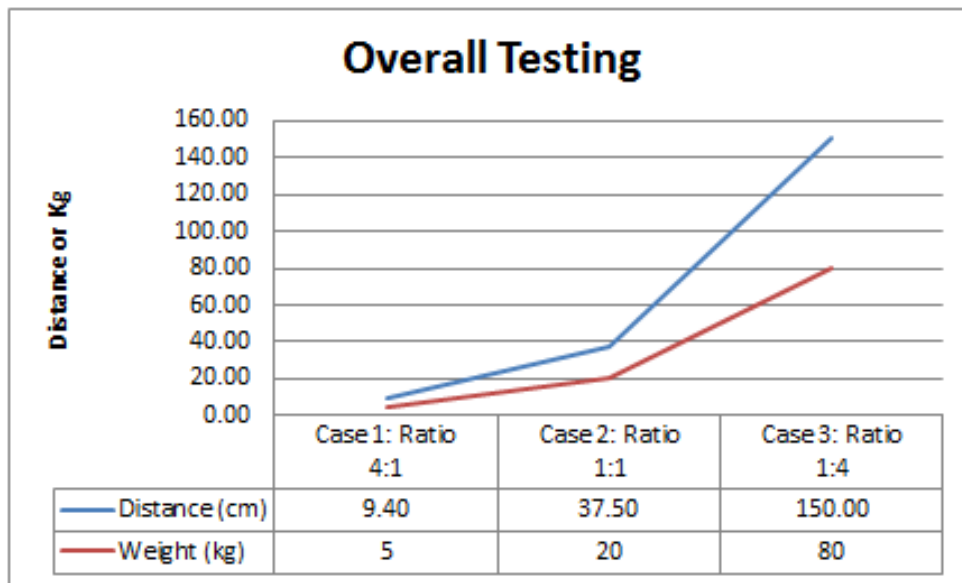


Figure 27 (Overall Testing)

**Case 1:** in this case, the ratio of the cones is 4:1, which means that the driver cone will rotate the driven cone only once. The 20kg bar rose up to 9.4 cm and required a work equivalent to 5 kg as shown in figure 27 according to the below equation.

$$W = Fd$$

Where

$W$  = the work applied in Joules

$F$  = the mass in kg multiplied by the gravity acceleration

$d$  = the distance in meter

$$W = (5 \text{ kg} \times 9.81 \text{ m/s}^2) \times 0.094 \text{ m} = 4.61 \text{ kg.m}^2/\text{s}^2 = 4.61 \text{ J}$$

**Case 2:** the ratio of the cones is 1:1, the driver and driven cones have the same rotations. The belt was placed in the center of the two cones to get the desired ratio. A work was applied equivalent to 73.58 J to lift the attached 20kg weight bar for a distance of 37.5 cm as shown in figure 27 and the below equation.

$$W = Fd$$

$$W = (20 \text{ kg} \times 9.81 \text{ m/s}^2) \times 0.375 \text{ m} = 73.575 \text{ kg.m}^2/\text{s}^2 = 73.58 \text{ J}$$

**Case 3:** in this case, the ratio of the cones is 1:4, which means that one turn of driver cone will rotate the driven cone four times. The 20kg bar lifted to a height of 150 cm and required a work equivalent to 1,177.2 J as shown in figure 27 according to the below equation.

$$W = Fd$$

$$W = (80 \text{ kg} \times 9.81 \text{ m/s}^2) \times 1.5 \text{ m} = 1,177.2 \text{ kg.m}^2/\text{s}^2 = 1,177.2 \text{ J}$$

# **CHAPTER 5**

## **Project Management**

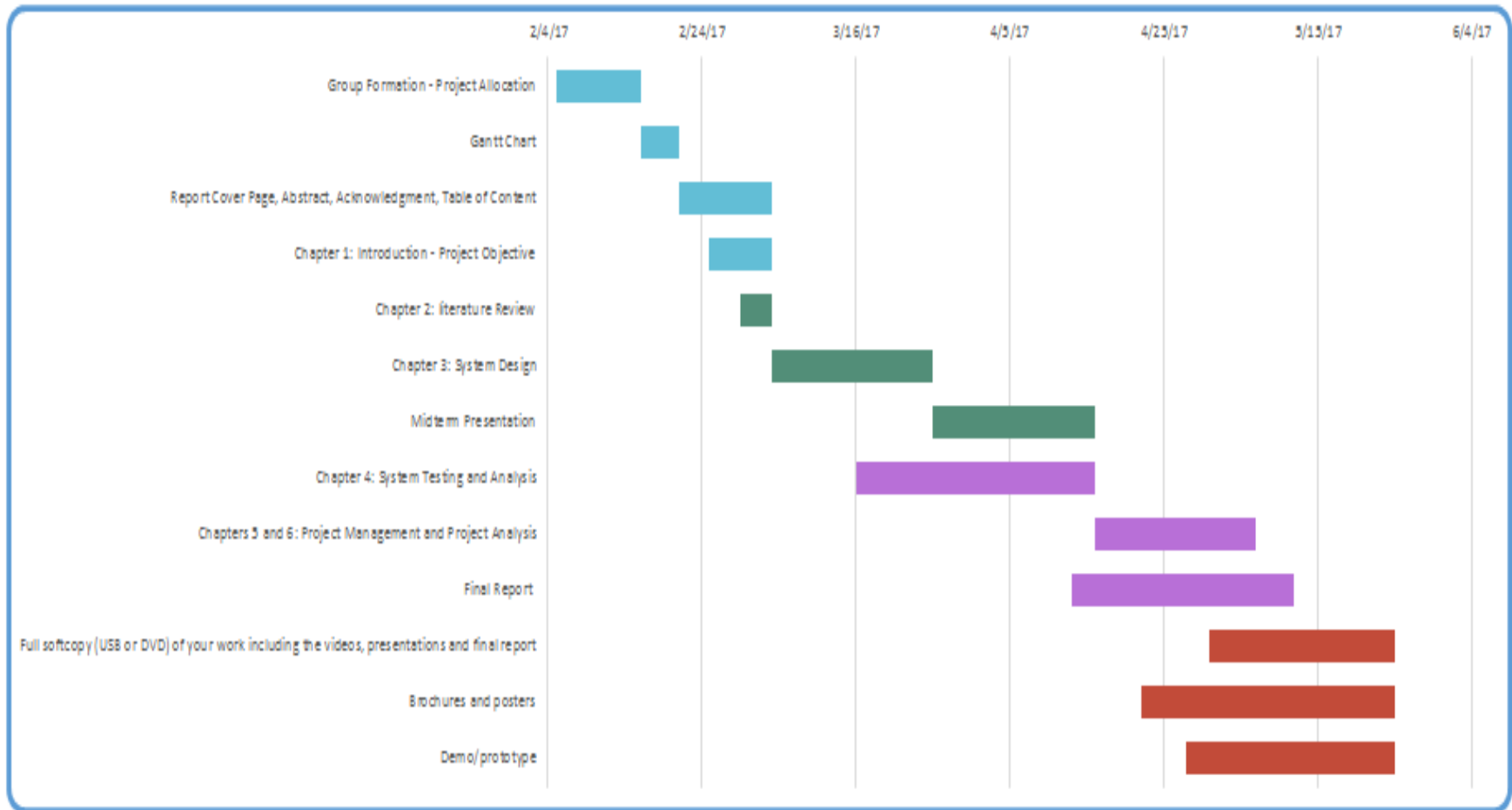
## Chapter 5: Project Management

### 5.1 Project Plan

Table 3 (Project Plan)

<i>Task</i>	<i>Team member</i>	<i>ETC</i>
Brain storming to Select the project	All	February, 2017
Take the approval from the advisor	AbdulazizAlbaker	February, 2017
Sketch the project	Mohammed alZahrani&AbdulazizAlbaker	March, 2017
Search for the materials	Mohammed al Quraisha& Abdulla al fenais	March, 2017
Search for Manufacturer	Mohammed al Quraisha& Abdulla al fenais	April, 2017
Manufacturing the parts	AbdulazizAlbaker&Mohammed alZahrani	April, 2017
Test the project	All	May, 2017
Transfer the project to campus	All	May, 2017

# Adjustable Single Weight Lifting Machine – PMU/ME



**Gantt Chart**

## 5.2 Contribution of Team Members

Table 4 (Group Contribution)

<b>TASK</b>	<b>TEAM MEMBER</b>	<b>CONTRIBUTION</b>
<i>Brain storming to Select the project</i>	<i>ABDULAZIZ AL-BAKER</i>	25 %
	<i>MOHAMMED AL-ZAHRANI</i>	25 %
	<i>MOHAMMED AL-QURISHAH</i>	25 %
	<i>ABDULLAH AL-FENAIS</i>	25 %
<i>Take the approval from the advisor</i>	<i>ABDULAZIZ AL-BAKER</i>	100 %
	<i>MOHAMMED AL-ZAHRANI</i>	0 %
	<i>MOHAMMED AL-QURISHAH</i>	0%
	<i>ABDULLAH AL-FENAIS</i>	0%
<i>Sketch the project</i>	<i>ABDULAZIZ AL-BAKER</i>	40%
	<i>MOHAMMED AL-ZAHRANI</i>	60%
	<i>MOHAMMED AL-QURISHAH</i>	0%
	<i>ABDULLAH AL-FENAIS</i>	0%
<i>Search for the materials</i>	<i>ABDULAZIZ AL-BAKER</i>	0%
	<i>MOHAMMED AL-ZAHRANI</i>	0%
	<i>MOHAMMED AL-QURISHAH</i>	50%
	<i>ABDULLAH AL-FENAIS</i>	50%
<i>Search for Manufacturer</i>	<i>ABDULAZIZ AL-BAKER</i>	0%
	<i>MOHAMMED AL-ZAHRANI</i>	0%
	<i>MOHAMMED AL-QURISHAH</i>	50%
	<i>ABDULLAH AL-FENAIS</i>	50%
<i>Manufacturing the project</i>	<i>ABDULAZIZ AL-BAKER</i>	50%
	<i>MOHAMMED AL-ZAHRANI</i>	50%
	<i>MOHAMMED AL-QURISHAH</i>	0%
	<i>ABDULLAH AL-FENAIS</i>	0%
<i>Test the project</i>	<i>ABDULAZIZ AL-BAKER</i>	25 %
	<i>MOHAMMED AL-ZAHRANI</i>	25 %
	<i>MOHAMMED AL-QURISHAH</i>	25 %
	<i>ABDULLAH AL-FENAIS</i>	25 %
<i>Transfer the project to campus</i>	<i>ABDULAZIZ AL-BAKER</i>	25 %
	<i>MOHAMMED AL-ZAHRANI</i>	25 %
	<i>MOHAMMED AL-QURISHAH</i>	25 %
	<i>ABDULLAH AL-FENAIS</i>	25 %

## 5.3 Project Execution Monitoring

The group members meet every week to follow up the progress of the team, it is the role of the leader to make sure that all individual tasks are done on time and try to merge them to get the final result. We also meet with our advisor Dr. RaguramanKannan biweekly to make sure that he is aware of our progress and get the benefits of his experience and advices. Off-set time is always added to tasks in case of any lateness occurred.

## 5.4 Challenges and Decision Making

Table 5 (Challenges)

<i>Challenges</i>	<i>Solving</i>
<i>Finding the proper materials</i>	<i>Search at the Dammam industrial city until we found them</i>
<i>finding a manufacturer</i>	<i>Found the aluminum specialized workshop and dealt with it</i>
<i>Some materials are expensive</i>	<i>Search and found the acceptable materials with good cost</i>
<i>Solidworks</i>	<i>ask a help from advisor</i>

## 5.5 Project Bill of Materials and Budget

This section explains the distribution of the actual cost for each category. It also shows the bill of material for each part or task done in our project. It varies between material, fabrication, and labor cost.

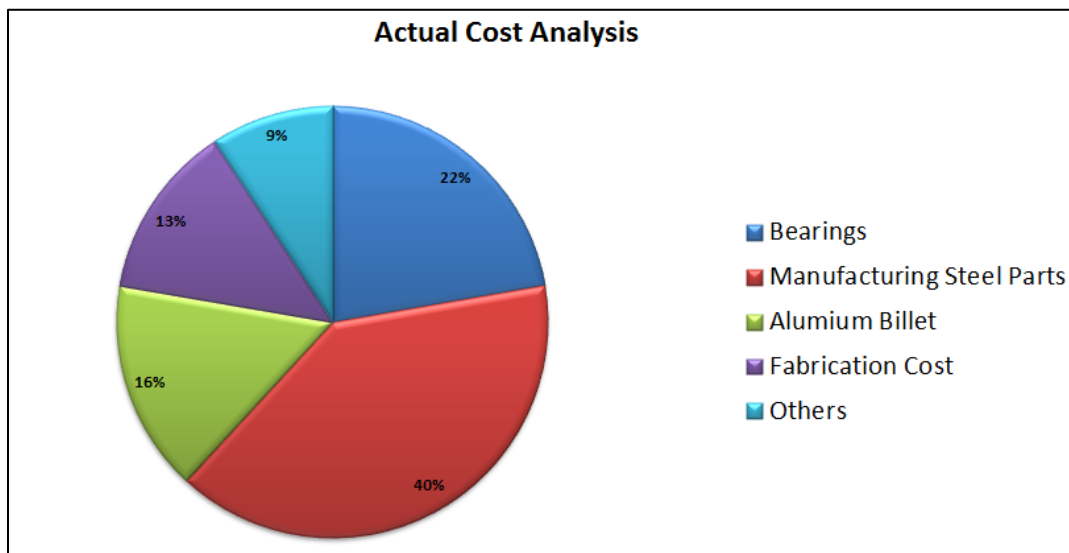


Figure 28 (Actual Cost Analysis)

**Bill of Material (BOM):****Table 6 (Detailed BOM)**

<b>Material or Task</b>	<b>Quantity</b>	<b>Budget (SR)</b>	<b>Actual Cost (SR)</b>
Bearings (ID 300 mm)	4	300	260
Bearings (ID 250 mm)	4	200	272
Bearings (ID 100 mm)	4	60	30
Steel Box	1	500	600
Weight Stand	1	300	250
Training Arm	1	200	150
Aluminum billets (1.2m of length x Diameter of 17cm)	1	300	400
Belt (95 cm)	1	15	22
Weight Bar	2	40	60
Ropes (100 m)	1	50	75
Additional Fabrication Cost		400	330
Shackles	2	10	2
Nuts and Bolts	16	40	60
Pulleys	2	20	14
<b>Total Cost</b>		<b>2435</b>	<b>2525</b>

# **CHAPTER 6**

## **Project Analysis**

## **Chapter 6: Project Analysis**

### **6.1 Lifelong Learning**

In this project hardware devices such as my RIO, Arduino, sensors, GSM, Wifi, Bluetooth, etc,, is not required. We use in this project one of the best and known software tools (Solidworks program), actually we took this course before with Dr. Nader but now we improve ourselves in this program.

For the project management skills and time skills was kind of difficult, but in the end we solve, for example: when we try to find a time fit all of us during the week days we finally organize our schedule all over or when we try to find a manufacture for our parts we divide the work between us so everyone have to search in certain area until we get what we want and we hope to keep up until the end of the semester.

### **6.2 Impact of Engineering Solutions**

Our project is making a big difference in society, especially to those who buy machine equipment. Moreover, our project which is a gym machine is doing the same job that other machines do, but what makes our project better is lightweight comparing to the other machines and the cost is much cheaper.

## **Chapter 7: Conclusions and Future Recommendations**

### **7.1 Conclusions**

Our project is Adjustable Single Weight Lifting Machine which can be used in any place for practicing and improving human being health. Our gym machine works basically on different gear ratio principle. The machine consists of two identical con pulleys that are made from aluminum, steel box, weight stand, lifting arm, bearings, rubber belt, and ropes. The machine gives the user the option to change the weight from 5 kg to 80 kg by changing the belt location which results in different gear ratio starting from 1:4 to 4:1 with using only a 20 kg steel bar. The project was a great opportunity for us as students to learn and show our capabilities as senior graduating students. The experience was not easy however we successfully over came all the obstacles which we faced. There were some challenges regarding the availability of a local workshop where we can work freely on our project. Another challenge was the cost of building the prototype is comparatively high for us as students. The availability of the raw material was also a challenge; it is limited to those who have accounts with the manufactures which hindered us from buying some raw materials. We learn that even if we have the proper design, and took all factors in consideration, we need to test the design physically to make sure that the idea is practical.

### **7.2 Future Recommendations**

- Improving the way of changing the belt location which connects the two aluminum con pulleys.
- Study on finding better materials which will minimize the total weight of the machine.

## References

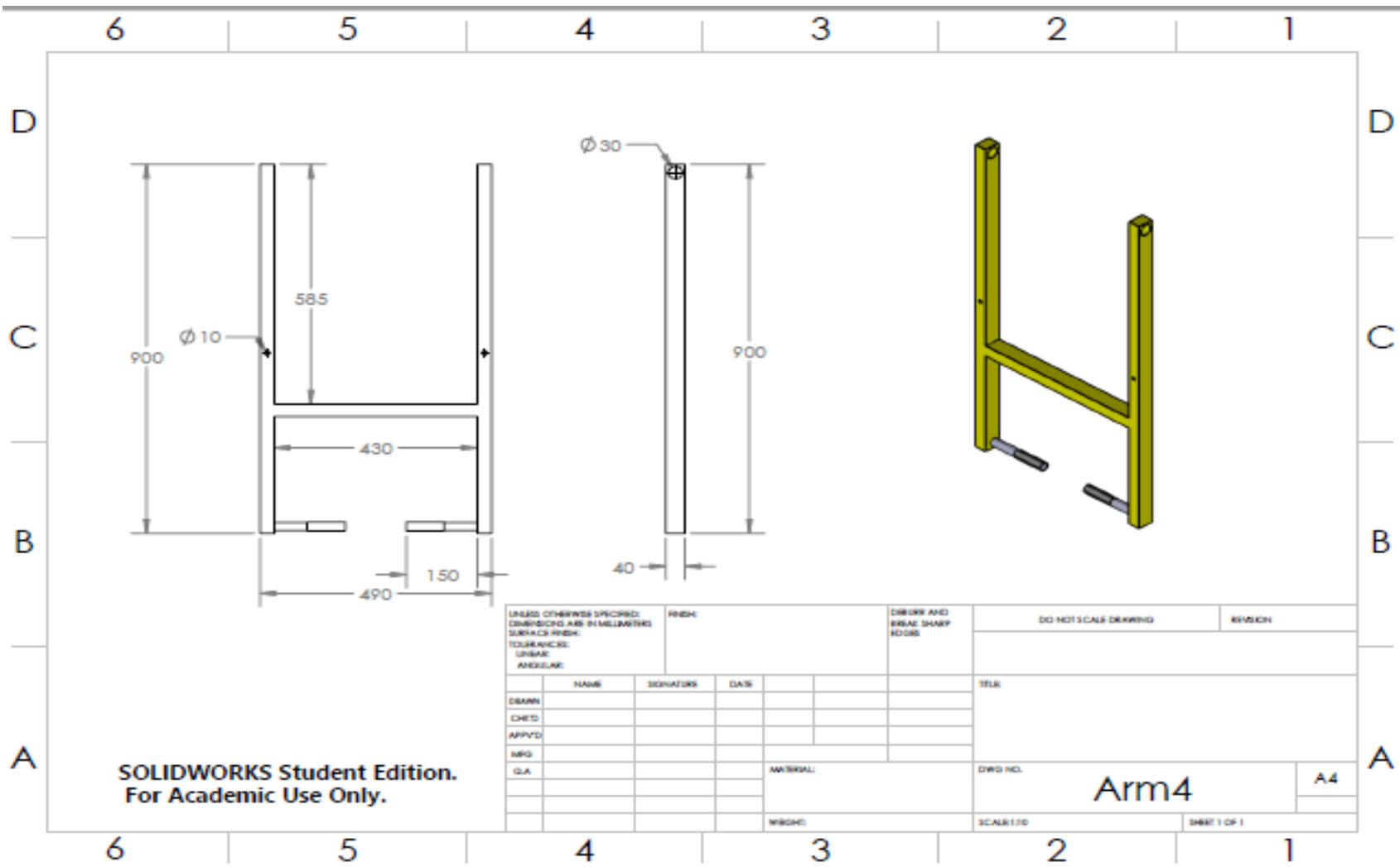
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# Appendix A: Part Drawings

ITEM NO.	PART NUMBER	QTY.
1	Box5	1
2	Conical4	2
3	Armbearing4	10
4	Rearhalf4	1
5	Armhalf5	1
6	Arm4	1
7	Lightingrod5	1
8	Weightstand4	1
9	Weight5	1

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UNLESS OTHERWISE SPECIFIED: DIMENSIONS ARE IN MILLIMETERS SURFACE FINISH: TOLERANCES: LINEAR: ANGULAR:		FINISH:	DROPPED AND BREAK SHARP EDGES		DO NOT SCALE DRAWING	REVISION:
DESIGN	NAME	SIGNATURE	DATE		TITLE:	
CHECKED						
APPROVED						
MFG						
D.A.				MATERIAL:	DWG. NO.	A4
				WEIGHT:	SCALE: 1:10	SHEET 1 OF 1

Arm4

