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JUDUL: **DEVELOPMENT OF PROJECTILE LAUNCHER FOR LEARNING PURPOSE.**

SESI PENGAJIAN: 2007/ 2008

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Alamat Tetap:
No 10.Jalan Kenanga 22,
Taman Satria,
70450 Senawang,
Negeri Sembilan Darul Khusus.

Nama Penyelia: Mohd Fadzil Faisae B Ab.Rashid.

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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 : ....
Name of Supervisor: MR.MOHD FADZIL FAISAE B AB.RASHID
Date : ..20 NOV 2007.....

DEVELOPMENT OF PROJECTILE LAUNCHER FOR LEARNING PURPOSE

AIDA AZWA BT A.HALIM

A project report submitted in partial fulfilment of the
requirements for the award of the Diploma
of Mechanical Engineering

Faculty of Mechanical Engineering
Universiti Malaysia Pahang.

NOVEMBER 2007

DECLARATION

I declare that this report entitled "*Development of Projectile Launcher for learning Purpose*" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature: ....Aida..........
Name : AIDA AZWA BT A.HALIM
Date : ....20 NOV 2007..........

DEDICATION

First of all, I would like to show my expression of gratitude to Allah s.w.t whose guidance, help and grace was instrumental in making this humble work a reality. This dedication goes to my beloved father Mr A.Halim bin Hj Md Hussain. Also thank to my supervisor Mr. Mohd Fadzil Faisae bin Ab.Rashid that graves me motivation and guide me to finish this project. Thanks a lot to my university (Universiti Malaysia Pahang) and my friends in their support and advice towards this project. Thanks to all for your enduring patience and continuous encouragement.

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It is extremely difficult to communicate my heartfelt gratitude to my thesis supervisor Mr . Mohd Fadzil Faisae Bin Ab. Rashid 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 emerged successful in translating my long cherished aspirations into an ever lasting entity, in the form of the present work.

I also feel indebted to Mr Hazami , Dean, Lecture Of Mechanical Engineering for the very kind support he has been extending to me through the entire tenure of my work. I am also thankful to my colleagues Mr. Maaruf b Muhammad , Ms Nur Hamizah B Minhat , and many others for helping, guiding and encouraging me during my work.

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School of Mechanical Engineering were equally helpful in every sense of the work. I thank them all.

Finally, I express my thanks and immeasurable gratitude for every kind of support that I received from my parents, brother and sisters during my work which otherwise might not have been possible to undertaken by me.

ABSTRACT

Idea to design and fabricate a projectile motion is come from a supervisor that gives a task and a title for this project. To design and fabricate this projectile motion it must compare with the other product that available in laboratory. To make sure the idea to design and fabricate the projectile launcher that can be used for projectile experiment the information about current design for projectile motion must search or get from the internet. Form there the information and idea to design and fabricate a projectile motion can be created. It includes many things about projectile motion design that wanted to gather accurate flight time data for projectiles. From there the efficiency of projectile motion analysis equation being determine. Whole of the project involve various methods like the concept design, the designing and also the fabrication process. After the assemble process complete the projectile launcher is tested to gather the flight time data for projectiles. Then the projectile motion analysis equation is solve from the time data. From the results the projectile launcher for projectile experiment was achieves the objective successfully. Overall in this project can bring a motivation and experience to conduct the various type of machine, train to work under the pressure, and also soft skill ability like time management, planning the task, negotiation skill and sell out the idea especially during work progress presentation.

ABSTRAK

Idea untuk merekabentuk dan menghasilkan projektil telah dikeluarkan oleh penyelia yang memberikan tugasan. Untuk merekabentuk dan menghasilkan projektil ianya hendaklah dibandingkan dengan rekabentuk yang lain yang terdapat dipasaran. Informasi tentang rekabentuk- rekabentuk baru diperolehi melalui pencarian di laman web- laman web, ianya untuk memastikan projektil tersebut boleh digunakan semasa eksperiment projektil. Dari situ juga segala maklumat tentang rekabentuk dan idea- idea tentang penghasilan projektil dapat dilahirkan. Ianya mengandungi semua maklumat yang diperlukan untuk mendapat masa penerbangan yang tepat . Oleh itu, keberkesanan projek ini telah analisis menggunakan formula telah terbukti. Keseluruhan projek melibatkan pelbagai proses seperti konsep rekabentuk, merekabentuk dan juga proses merekabentuk. Selepas proses penyambungan lengkap , uji projektil tersebut untuk mendapatkan data masa penerbangan .Selepas itu , dari data masa yang dikumpul analisis menggunakan formula projektil diselesaikan. Keputusan projektil untuk eksperiment projektil berjaya menepati objektif . Selain itu projek ini dapat memotivasikan diri dan memberi pengalaman dalam cara pengendalian pelbagai mesin, melatih bekerja di bawah tekanan dan juga dalam keupayaan kemahiran insaniah seperti pengurusan masa, merancang tugasan dan kemahiran mempertahankan idea terutama ketika pembentangan perkembangan kerja.

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CHAPTER 1

INTRODUCTION

1.1 Introduction

The project involves designing and fabricating an instrument for projectile launcher experiment. This instrument could be use by the other student in order to test the projectile motion which according to the syllabus. As the Diploma final year project allocates the duration of one semester, this project only focused to provide the instrument for projectile in laboratory.

The project will be funded by student final year project funding, UMP short term project funding as well as sponsorship attained from industrial sponsors in terms of equipments, products and also monetary funding.

1.2 Project Synopsis

The project title is Development of Projectile Launcher for Learning Purpose. The project involves the launcher platform with different energy setting. Besides, the platform angle must be adjustable to get different launching angle with concerns regarding strength, durability and the dynamics of structure. The fabrication is required to provide the instrument for projectile launcher. Modifications are required to improve appearance, comfortable and suitable with the student. The projects prerequisites are

Dynamic and Strength of Material. Overall, also will acquire the skills of design, analysis, fabrication and testing.

1.3 Project Objective

1.3.1 General objective

Diploma final year project objective is to practice the knowledge and skill of the student that have been gathered before in solving problem using academic research, to born an engineer that have enough knowledge and skill.

This project important to train and increase the student capability to get know, research, data gathering, analysis making and then solve a problem by research or scientific research.

The project at another way will educate the student in communication like in a presentation and educate them to defend their research in the presentation.

The project also will generate students that have capability to make a good research report in thesis form or technical writing.

This project otherwise can produce and train student to capable of doing work with minimal supervisory and more independent in searching, detailing and expanding the knowledge and experiences.

1.3.2 Specific Project Objective

Basically this project is base on these objectives:

i. To design and fabricate a projectile launcher that can be used for projectile experiment .
ii. To gather accurate flight time data for projectiles.
iii. To determine the efficiency of projectile motion analysis equation

1.4 Project Scope of Work

The project scope of work in this project is to develop a projectile motion for laboratory uses. Then, minimize the maximum and minimum angle of projectile. Beside that, manage the maximum and minimum energy setting for projectile.

1.5 Project Planning

This project is begun with made a research and search for information via internet, books, supervisor, and others relevant academic material that related to the title, this literature review takes about a week. The findings of information not stop there. It continues along the way of this project because knowledge is so many to learn.

At the same week have do schedule management for the project which included schedule management namely as Gantt chart (time management) and also flow chart (process management). This is done using Microsoft Office Excel using Gantt chart system.

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The first week also had to arrangement several meeting with my supervisor to be clearly about the scope of title, synopsis from previous research and tool requirement.

The second week, have to submit the project title acceptance form and continue research in literature review of projectile and the instrument for the experiment, the information was are more details on projectile launcher experiment and the research of information, its takes more from previous research which similarity with my project title, this takes a week to be done.

The title are well clear at week third, it consist of scope and objective for the project. At this week, the meeting with supervisor only focused to choose the right design which is suitable for use in Universiti Malaysia Pahang (UMP) lab and also quite strength, durability , accurate and versatile for a learning purpose of projectile launcher .

At this week the sketch should finish with the right dimension and have to be approved by the supervisor. The engineering drawing was use Solidwork software to generate 3D model to design the model of project.

The sketching of the project takes about 2 weeks to be done. It complication because of what are the available material at the lab and another else the problem should consider what are the appropriate method to be machining. At the week fourth also should to find the material which right and suitable on design and machining. Actually the materials at the lab mostly under name by specific supervisor, for some of my project material are available at different supervisor it is need to discus with them whether allowed to take his material or not.

The week fifth is preparation of project progress, progress report writing and mid term presentation, these tasks take one week to be done. At this week the progress mid term presentation and progress report should be approved and submit to supervisor. At the same way it should to prepare the speech for the presentation and double checked the report that has to be submitted. Also done on this week is discussion with the other supervisor to allow taking the material

The fabrication process is schedule to takes on the week sixth but because of several material arrival delayed the fabrication process has been postponed. On this week have to prepared more for mid - term presentation, it's consist content, design and further information about the project.

Week seventh, this week are time for mid - term presentation. The main objective for that presentation it's about to show to the panel how the far the work progress especially for individual project. In this week also it was started the fabrication, begun with cut the core material which used bend saw machine.

Next it's about further to the machining, milling, lathe, grinding, drilling, tapping, shearing and assembly. This task scheduled to take time about the rest of weeks. The model design for project around this time was change due to complication in machining, at first in follow the design, all the core material use several chunk bar mild steel due the complication in machining with milling machine to use bar shape and another to use rod shape.

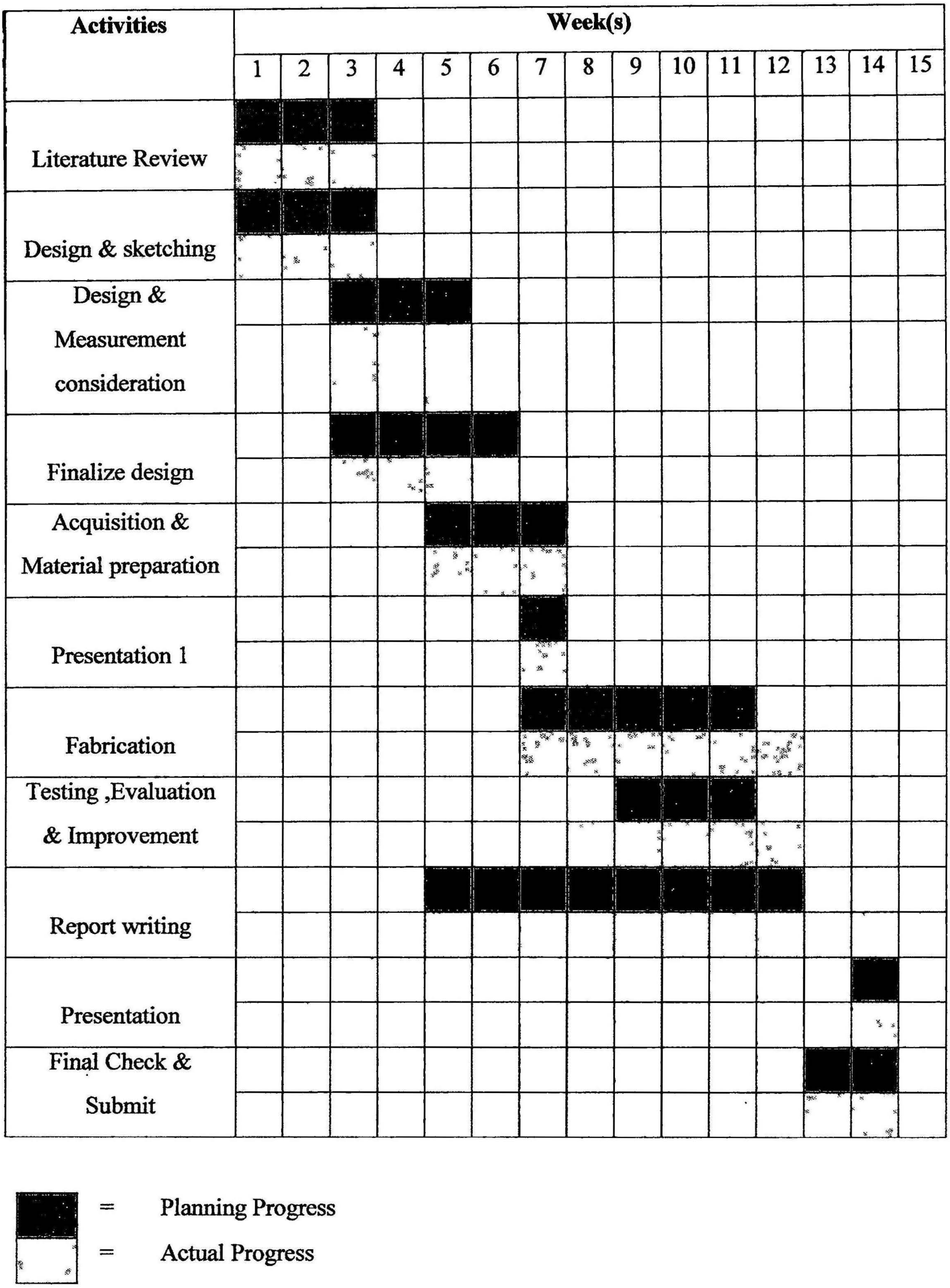

Figure 1.1: Gantt chart process planning

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Firstly the concept from the research force, angle and gravity is a laboratory test used to find the incline free flight projectile motion and to determine law of gravity through experiment.

This project is provided the instrument for testing the projectile to which can explore of considered of great significance in improving the knowledge of time and how far ball fall being force- a condition that is prevalent in most laminated web or skin.

This chapter is summarizing of all the literature review gathered from many academic resources.

2.2 Paper Review

2.2.1 Pre review

The projectile launcher illustrates the idea that motion in different dimensions is absolutely independent. A good launcher not only illustrates this non-intuitive idea, but it can be used to describe the exact motion of the projectile as well. PASCO has precision-engineered projectile launchers that are accurate, durable and give repeatable results. In addition to the Short Range Launcher, a Long Range Launcher and a Mini (tabletop) Launcher are available.(ME-6800 Projectile Launcher (Short Range) - PASCO scientificp, http://www.pasco.com/)

The Projectile Launcher features have a flexible ranges which offers launchers for all classroom arrangements. That also Flexible Launch Positions, stable stand offers horizontal and variable angle launching positions. Also Fixed Firing Height at Any Launch Angle, able to firing height of the ball is the same for any launch angle. The Spring Mechanism ensure fully enclosed for safety. (G U NT Equipment for engineering education – EM 027, Projectile Launcher)

The features of the projectile is complicated to build, there is a need for a more comprehensive understanding of their behaviour in construction applications in order to provide some standardized design method. Research and construction projects are underway at the federal and state level, and at several universities. This project was partially conceived in support of that effort.

2.3 Formula

General formula which relate to this project:

Horizontal motion:

$$v = v_0 + a_c t$$

$$x = x_0 + v_0 t + \tfrac{1}{2} a_c t^2$$

$$v^2 = {v_0}^2 + 2a_c(s - s_0)$$

For a projectile, there is no horizontal component of acceleration after the gun is fired. The only acceleration is due to the gravitational attraction of the earth (vertical). Hence, the equations above become:

$$v_x = (v_0)_x$$
$$x = x_0 + (v_0)_x t$$

Vertical motion:

$$v = v_0 + a_c t$$
$$y = y_0 + v_0 t + \tfrac{1}{2} a_c t^2$$
$$v^2 = v_0^{\,2} + 2a_c (y - y_0)$$

Since the positive y axis is directed upward, then

$$a_y = -g$$
$$v_y = (v_0)_y - gt$$
$$y = y_0 + (v_0)_y t - \tfrac{1}{2} g t^2$$
$$v_y^{\,2} = (v_0)_y^{\,2} - 2g(y - y_0)$$

Conservation of energy states that the total amount of energy in an isolated system. remains constant, although it may change forms. In projectile launcher, energy from launcher spring is converted to kinetics and potential energy of the ball.

$$E_{spring} = E_{kinetics} + E_{potential}$$
$$E_{spring} = \tfrac{1}{2} m v_0^{\,2} + mg\Delta h$$

Therefore,

$$v_0 = \sqrt{\frac{2E_{spring}}{m} - 2g\Delta h}$$

2.4 Test procedure.

Do the following

Firstly, set the projectile launching angle at 30°. Secondly set the spring set at 1 joule energy. Then measure the height from the floor to projectile launching platform. Next, start launching and measure the distance of from projectile launcher to the point where the ball landing horizontally. As soon as the ball is launched, measure the flying time until the ball hit the ground. After that, repeat the experiment for three times and calculate the average of distance and flying time. Then repeat the procedure (1) until (5) by changing angle to 45 ° and 60 ° and fill in the table with the experimental and calculation result. Besides that, set spring energy to 1.5 joule and perform similar experiment starting with launching angle 30°. Lastly fill in table with result from energy setting 1.5 joule.

2.5 Experiment and component

i. Projectile launcher set
ii. Plastic ball with mass = 10 grams
iii. Measuring tape (10 meters)
iv. Stopwatch

2.6 Current Technology

➔ ME-6800 Projectile Launcher (Short Range)

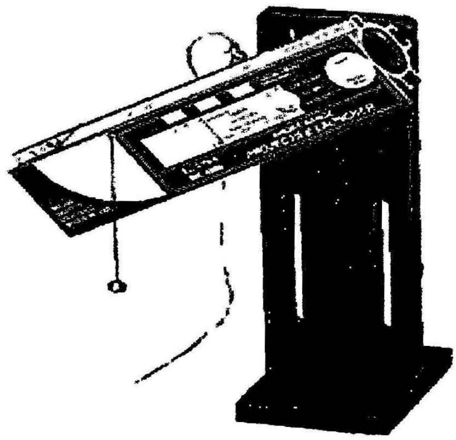

Figure 2.1 : ME-6800 projectile launcher (Short range)

This projectile launcher is lightweight. It also accurate, versatile, durable and easy to store. Beside that, it also easy to handling. This projectile common use in dynamic lab for experiment.

➔ **ME-6801** Projectile Launcher (Long Range)

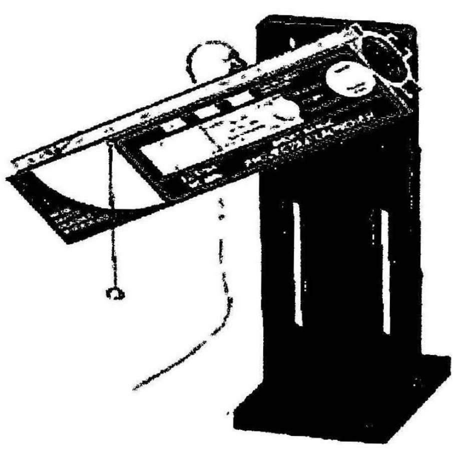

Figure 2 .2: ME-6801 Projectile Launcher (Long range)

Have a long range stand and it can be used to describe the exact motion of the projectile as well condition, stable and easily to handling.

➔ MVC-298F

Figure 2.3 : MVC-298F

This projectile is very stable because near with the ground. It capable to get the accurate result during the experimental. That uses the rubber to get free the force.

➔ P103 Projectile

Use the current power supply and controller to setting the ball launching. This projectile is very accurate and suitable to use than other projectile because we must setting the angle first then the ball will launcher after push the button where connected with the electric .

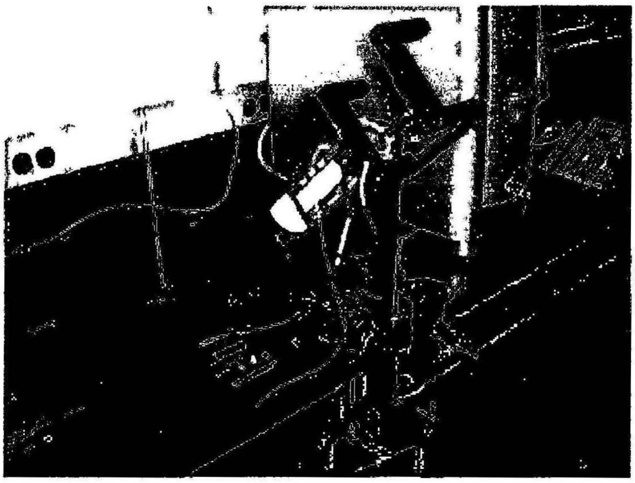

Figure 2.4: P103 Projectiles

CHAPTER 3

METHODOLOGY

3.1 Project Flow diagram

From the diagram above, the project starts with literature review and research about the title. These tasks have been done through research on the internet, books and others sources.

After gathering all the relevant information, the project undergoes design process. In this step, from the knowledge gather from the review is use to make a sketch design that suitable for the project and applicable used in UMP lab. After several design sketched, design consideration have been made and one design have been chosen. The selected design sketched is the transfer to solid modelling and engineering drawing using Solidworks software.

After the engineering drawing finished – include detail design and approved by supervisor, the drawing was used as a reference for the next process which is fabrication process. This process is consists fabricate the parts that have design before by following the dimension using various type of manufacturing process. The manufacturing process included in the process is cutting, drilling, roughing, and finishing surface. For through all this fabrication process, it used varied machine such as bend saw machine, milling machine, lathe machine, shearing machine, grinding machine and drilling machine.

During the fabrication process, if there is something wrong occur such as not balance dimension so the process stop and go back to previous step, check the drawing back. For this project, the earlier design was changed when it go for fabrication processbecause the difficulty to fabricate using the available machine, the change of design around 60 % from earlier design.

After the fabrication process, comes testing process. The testing is to gathered information about strength, durability, crash safety, design that has been fabricated. The test process just to testing whether the instrument are functioning or not. If this shear testing rig is working, its will go through the next process that is report process. And if the projectile is not working properly there should begun again with the design process. Based on this project the testing process was success where this projectile available to give inclines free flight motion. The projectile occurs in some angle at testing ball.

After the process mentioned above is done. All the material for report writing is gathered. The report writing process will be guided by the UMP final year project report writing. This process also included the presentation slide making for the final presentation of the project.

The project ended after the submission of the report and the slide presentation has been present.

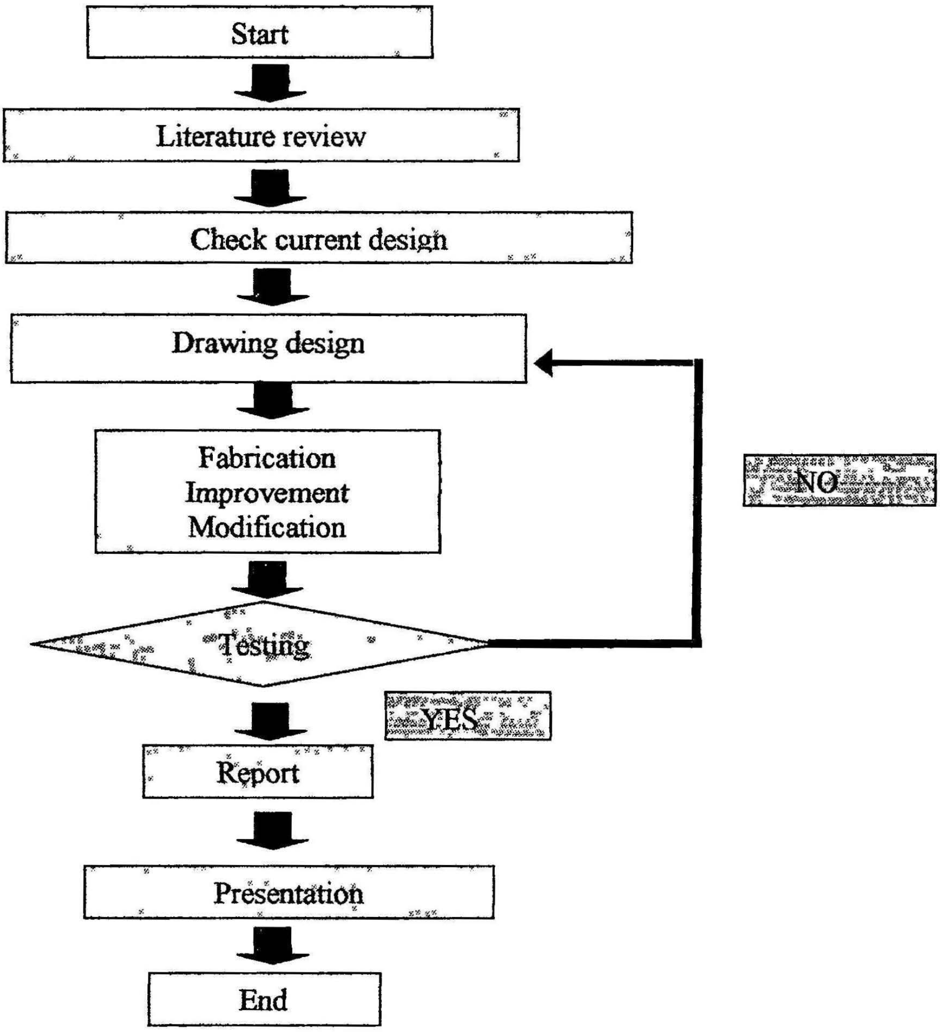

Figure 3.1 : Project Flow Diagrams

Figure 3.2: Stock raw material

3.2 Design

3.2.1 Introduction

The Design of the projectile launcher must be compliance to several aspects. The design consideration must be done carefully then the design can be fabricated and the system is functioning. Firstly the projectile must have the durability to endure continuous force from during experiment. The force comes in compression mode. Then the toughness of the projectile will be the most important criteria in designing; the rod as it will goes highly force acting in order to compress spring on the experiment. Another than that, material availability will be one of the challenges in the design consideration. The design must fix with the design .Since this projectile will be use in UMP lab material, so the design of the system should have the good appearance and suitable with the current technology.

3.2.2 Design specification

The design must consider it can endure this specification list. Firstly the maximum load make sure 50 KN. Then the core material uses are mild steel, aluminum alloys and aluminum sheet metal.

3.2.3 Design selection

The design is separate into three phases. The, first phase is sketch as many propose design can be produce. Then, select one of it and do its detail drawing and the engineering drawing, and the last phases are design back according to problem occur during fabrication process.

3.2.4 Propose design

Design 1

This design has a short range of stand which is so flexible to support the project from falling down during experiment. This use a light material and easy to carry and store. The advantage in this design is easy to fabricate because less the core material used and the design is simple only consist few parts. The advantages this design is difficult to setting to get the accurate results.

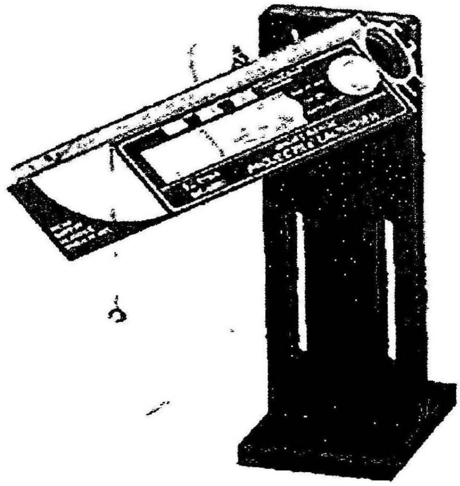

Figure 3.3: ME-6800 Projectile Launcher (Short Range) – PASCO scientific

Design 2

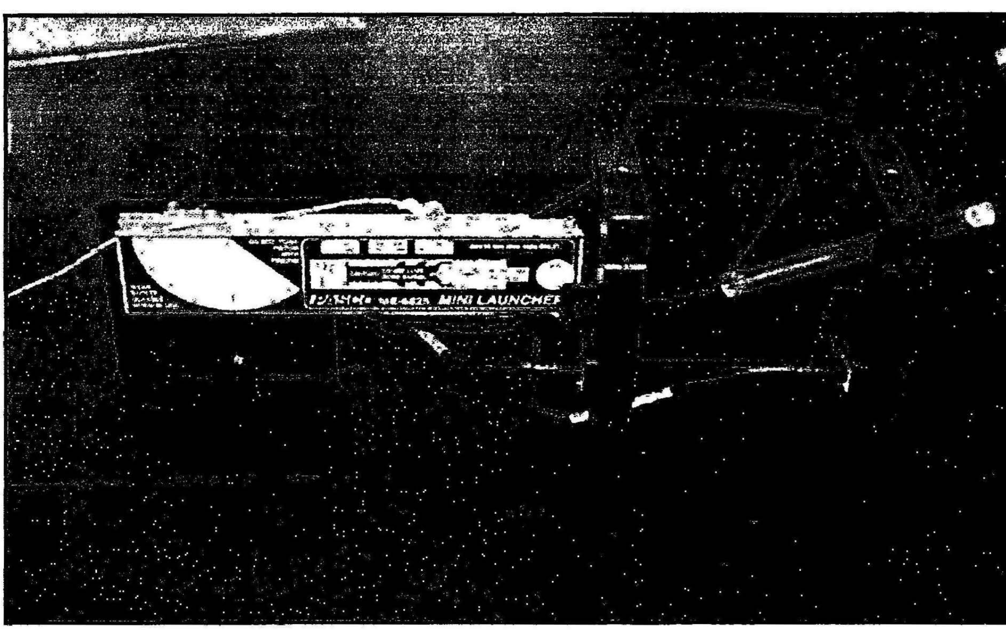

Figure 3.4: Mvc- 6744

Projectile Launchers designs are accurate, durable and give repeatable results. Its lightweight which easy to handling and comfortable to use during the experiment. It also easy to storage after use .Its design more versatile and follow up the new technology which use the electronic system. The advantage of this design is getting the more accurate result during experiment. The disadvantage of this product is difficult to make the electronic system during fabricate.

3.3 Suggestion design

3.3.1 Design selection

After several design consideration conducted, a design have been selected to be the Projectile Launcher which will be used in UMP Material Lab. The design that has been selected is "Design 1" the selection of this design is because this design is efficient, well distribute the force and most important suitable being person. Then, the core material for all part will be easily found at UMP Mechanical Laboratory. Beside that, this design use simple joining and only used conventional machine. This design only uses conventional lathe, milling, and grinding, shearing and drilling machine.

3.3.2 The Engineering Drawing

After a design has been selected, the next step in the designing process is dimensioning. The design is separated into parts and followed the dimensioning process. The dimensioning of the parts should suitable with spring has.After dimensioning, the engineering drawing of the design is drawn using Solidworks application, this software are used to build the solid model. Part by part solid modelling created according to the dimension done before, after all part created, the 3D model is assembled with each other base on the design. All parts is converted into orthographic view to get its engineering drawing detail after assemble process is done.

3.3.3 The part design

The design consists of:

i. Five bar of aluminum alloys
ii. Two bar of the mild steel
iii. Two aluminium sheet
iv. One rod aluminum

3.3.4 Overall view of the design

Design Description

This design is instrument to test the inclined free flight projectile motion. The first part is two rectangular medium of aluminum bar which joint with two spring and two rod by screw. This able to support the plate, and avoid it take out from the position. Then, the part two is rectangle bar of aluminum which also connects with two rectangular aluminum . During testing this part will distribute the forces to the launch ball. Next part is screw adjustable, this part able to adjust the some angle of the projectile in experiment. It use the lay and key to fix it from joggle during the experiment.

The concept to investigate the inclined free flight projectile motion will be easy to testing. Beside that, the small rectangular of aluminum bar (adjustable force bar) function is to pull the spring with the rod belonging to present time pull it. Then, if the small rectangular of aluminum bar get free the force will retract to first position. Another than that, is two stainless steel bar which use to be the leg of the design. That prefers to support the design during the experiment because it's very stable and flexible to handling.

Correction design

After design has been selected and the engineering drawing of the system have been produce, the fabrication process is the next process. During the fabrication process, the design encounters several problems that will discuss in the other chapter. Because of these particular problems the design must be redesign.

The design before correction

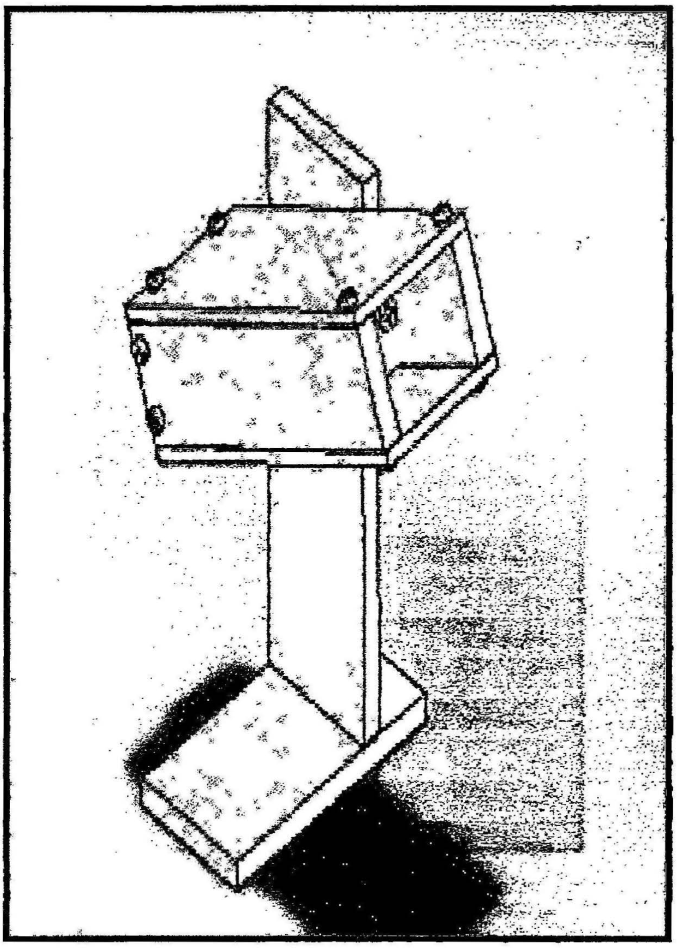

Figure 3.5: Full assemble before correction

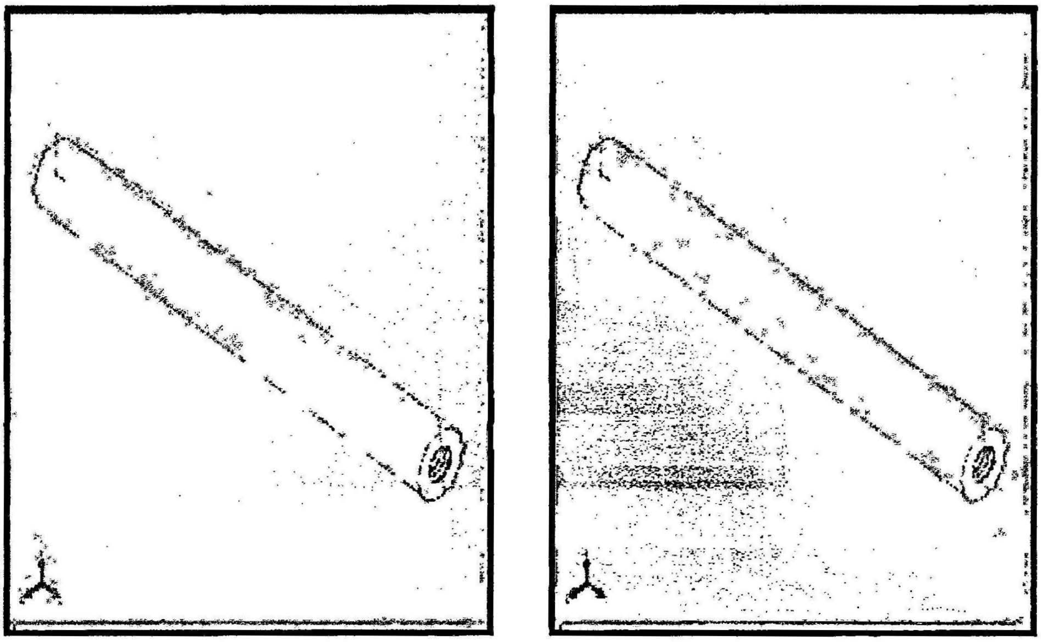

Figure 3.6: Two aluminum rod

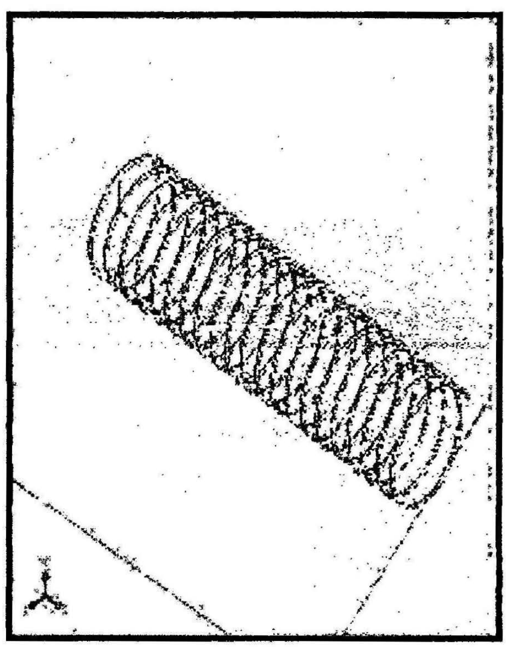

Figure 3.7: Two Spring

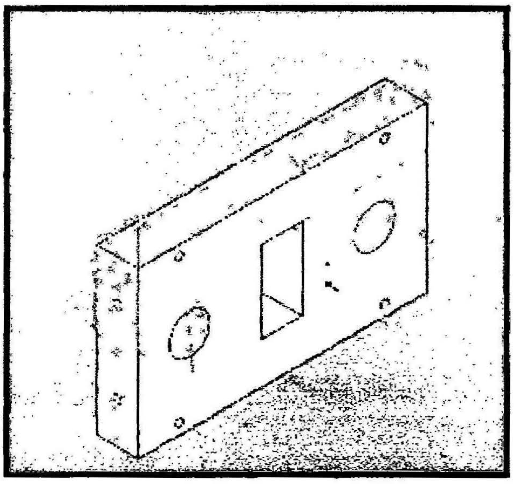

Figure 3.8: Back part

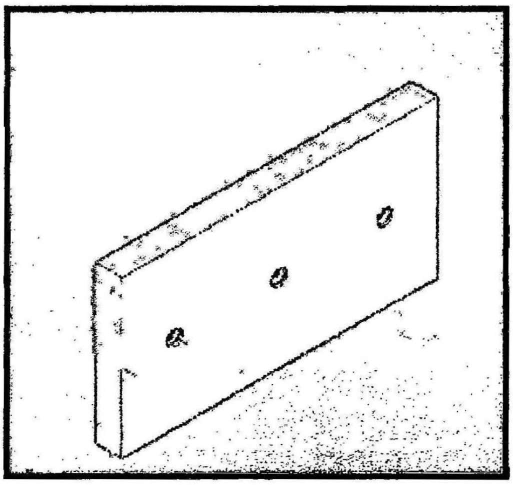

Figure 3.9: Front part

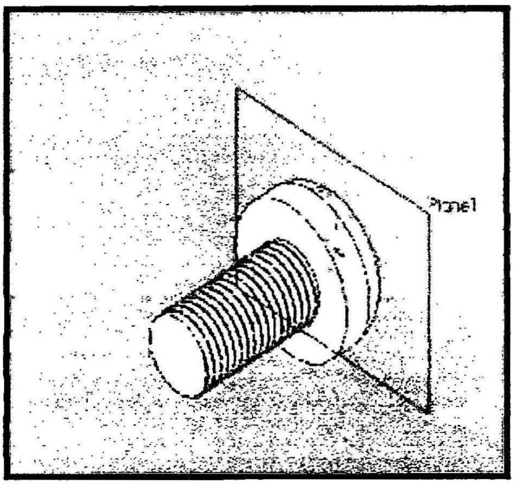

Figure 3.10: Screw adjustable

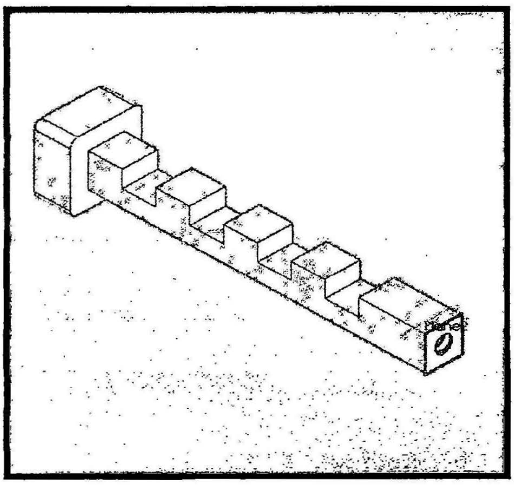

Figure 3.11: Adjustable force bar

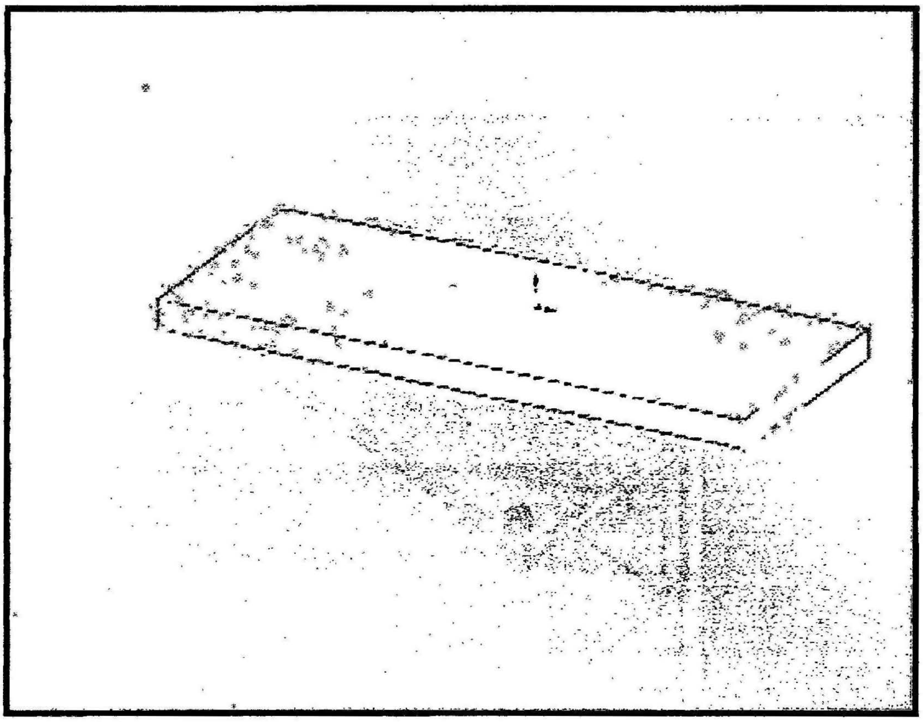

Figure 3.12: Ground

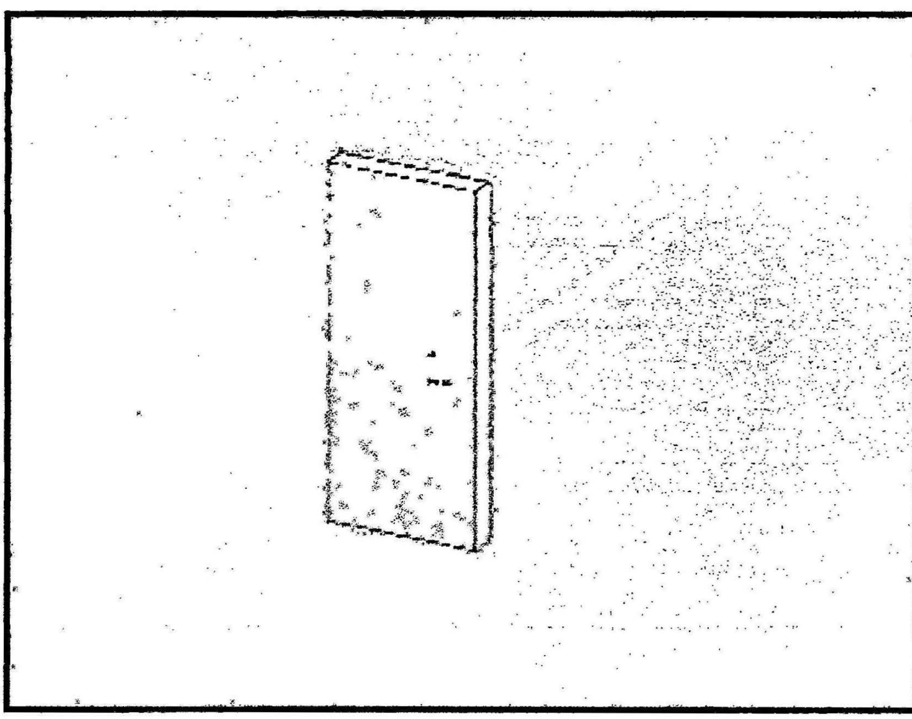

Figure 3.13: Stand

The design after correction

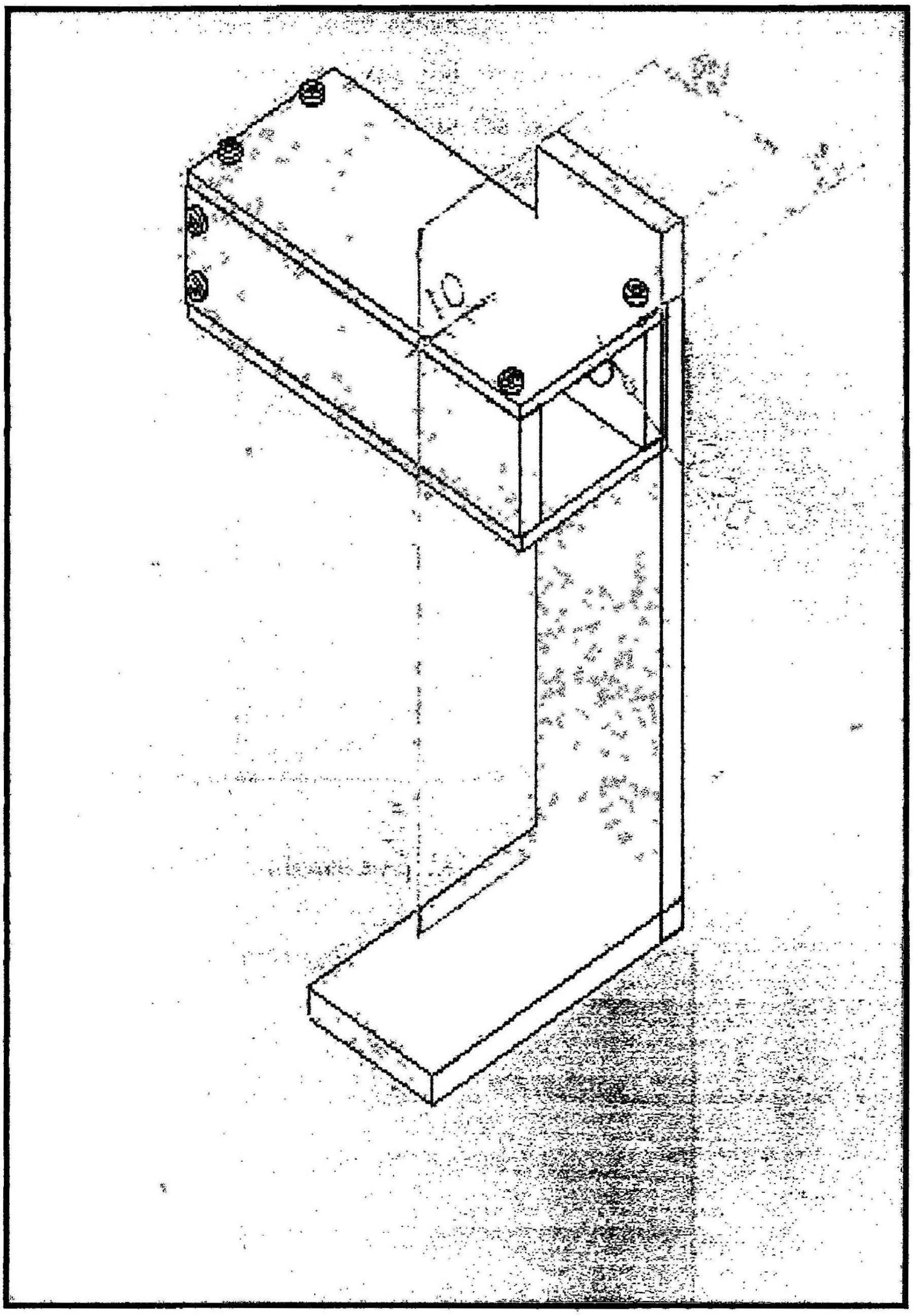

Figure 3.14: Full assemble of the project – after correction.

After several redesign consideration, the design have been redone in engineering drawing. The design is the final design and has been fabricated. Although the design has been redone its still have the same advantages like the design before redesign. This design consists of one spring and one rod, four rectangle aluminum, two rectangular stainless steel. The design advantages are the raw material is easy to find, easy to fabricate, functioning, and suitable to fabricate with available machine at UMP Mechanical Laboratory.

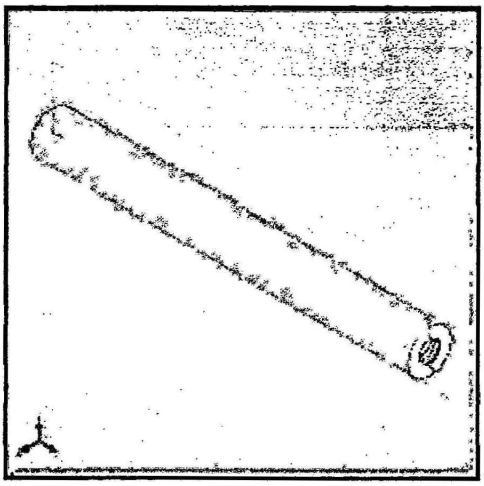

Figure 3.15: One aluminium rod

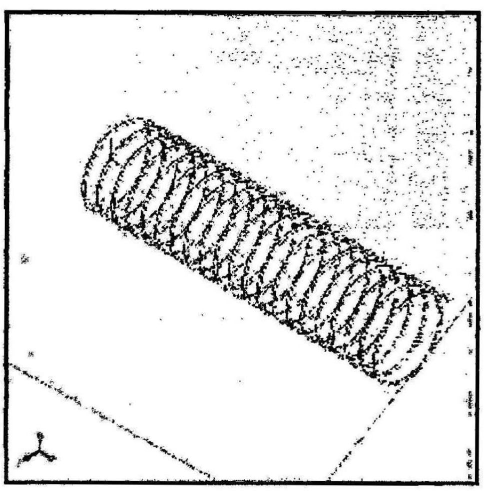

Figure 3.16: Spring

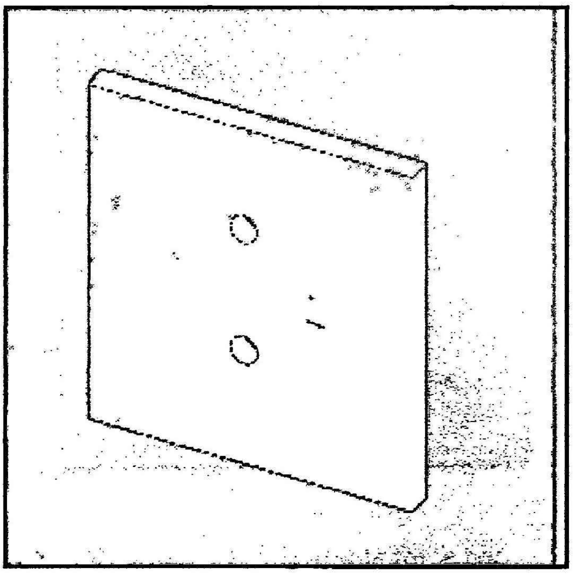

Figure 3.17: Front parts

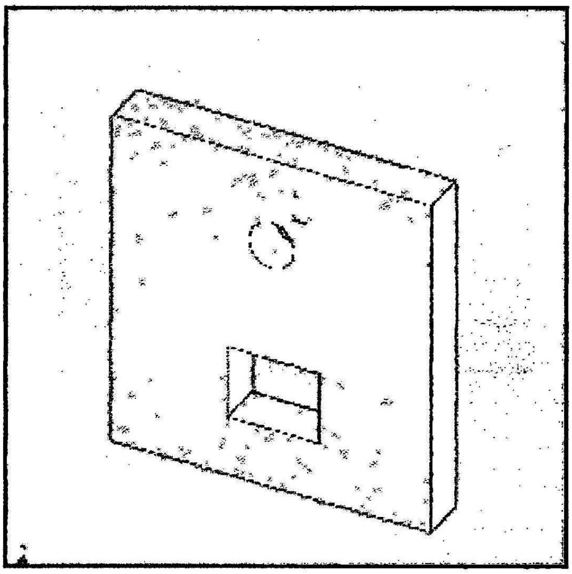

Figure 3.18: Back part

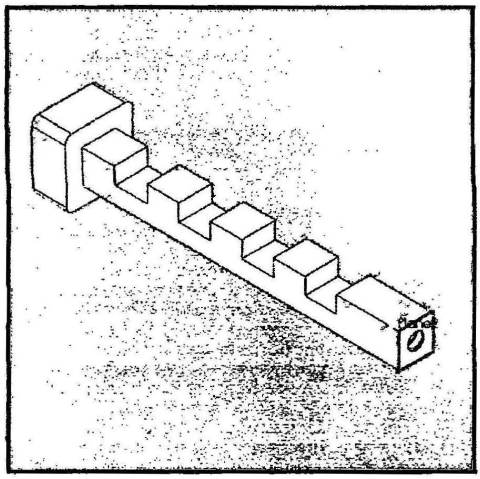

Figure 3.19: Adjustable force bar

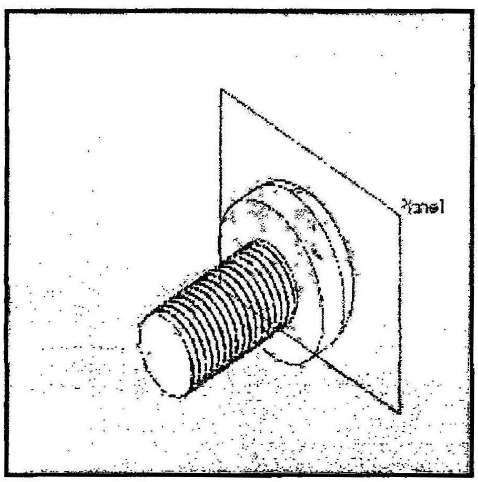

Figure 3.20: Screw adjustable

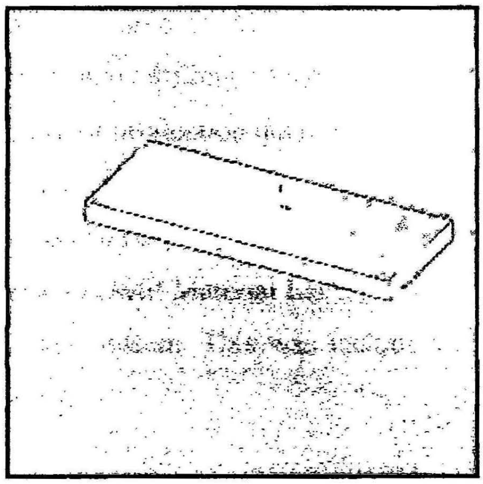

Figure 3.21: Ground

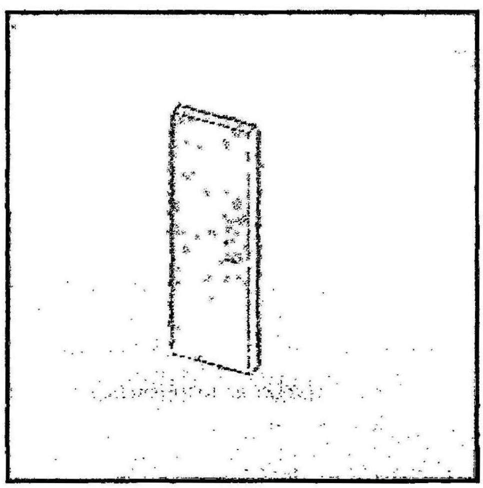

Figure 3.22: Stand

3.4 Fabrication Process

3.4.1 Introduction

The fabrication process is followed from the designing process. These processes are about material Selection and fabricate the product base on the design and the detail dimension. Many methods have used to fabricate this project, like cutting, finishing, grooving, turning, grinding and drilling. Fabrication process is difference from manufacturing process in term of production quantity. Fabrication process is a process to make only one product rather then manufacturing process that focus to large scale production. In the project fabrication process needed to make the projectile launcher for purpose study which will use in UMP Material Laboratory, fabrication process was used at the whole in the production system. This was include part by part fabrication until assembly to others component.

3.4.2 Process Involve

In making the engineering design become a reality, several processes have been used to fabricate the rig for test shear, which is;

i. Cutting

Cutting the material into part according to dimension needed

ii. Measuring

Measuring the material into dimension needed

iii. Marking

Mark the material after measuring it

iv. Milling

Milling the surface of raw material into the needed dimension

v. Lathe

Turning and facing the surface raw material into the needed dimension

vi. Shearing

Cut the surface of raw material into the needed dimension

vii. Finishing

Cut the surface of raw material into the needed dimension

viii. Drilling

Process of making holes

ix. Tapping

Process makes threading

x. Filling

Process make smooth surface.

xi. Welding

Join the raw material

xii. Assembly

Assemble parts to another part

3.5 Step By Step process.

The fabrication process is start with measuring and marking the raw material into the dimension needed. The measuring process firstly done with rectangle bar mild – steel, the bar was measured and marks to be cut around 245mm of length ,70 mm width , 12 mm thickness and 155mm of length , 70mm width and 12 mm thickness. Then measure and mark the rod aluminum – alloys, this rod to fabricate as base that the measure of this rod is 50 mm x 100 mm each. After that, the rectangle bar aluminum – alloys, the bar was measured and marks to be cut around 110 mm x 50 mm x 50 mm, 74 mm x 75 mm x 15mm, 65 mm x 75 mm x 15 mm and 215mm x 75mm x 75 mm of each two.

After measuring and marking process, the marked materials follow this process cutting. Firstly the rectangle bar aluminum cut with dimension needed into four part and mild to be cut according with dimension needed into two parts. Then cut again with the angle needed. This process goes through by using horizontal bend saw .After finish, rectangle bar mild – steel, was cut around 245mm of length, 70 mm width, 10 mm thickness and 150mm of length, 60mm mm width and 10 mm thickness. Then , the rod aluminum – alloys also cut at dimension around 50 mm x 90 mm each while the bar aluminum – alloys be cut around 100mm x 20 x 10 , 70 mm x 70 mm x 10 mm , 60mm x 60 mm x 10 mm , and 70mm x 70mm x 210 mm of each two.

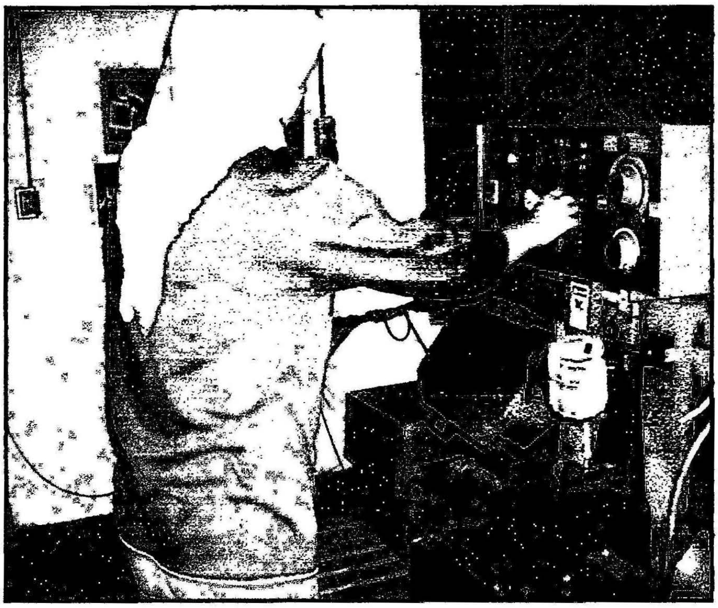

Figure 3.23: Cutting process by Horizontal bend saw machine

After the cutting material by using the horizontal bend saw the cutting process is continue by using the shearing machine. Firstly setting the electronic panel with insert the value needed which around 210mm of length and 80 mm of diameter. Then push the button by using leg until the machine cutting the material.

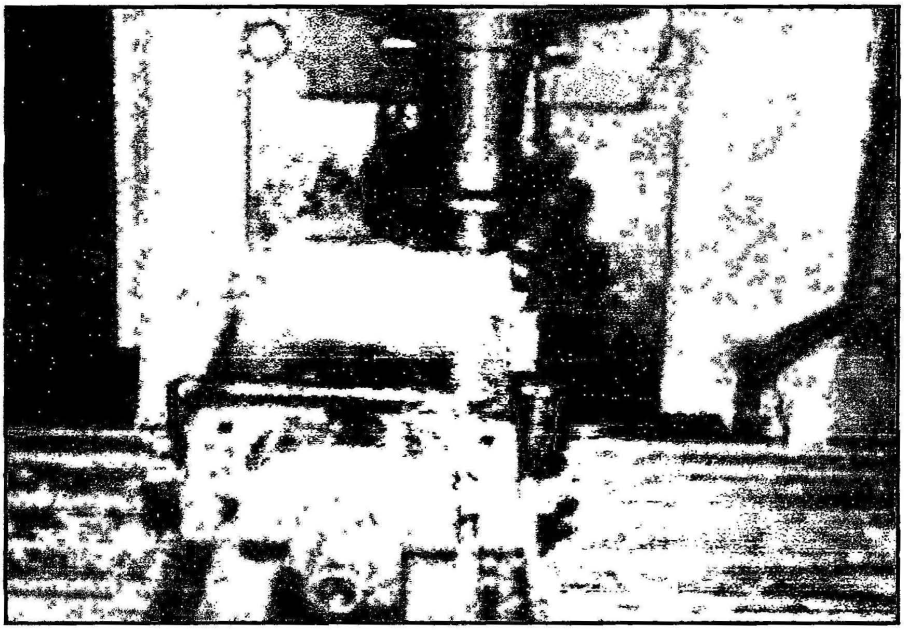

Figure 3.24: Roughing the material using the milling machine

Next step is milling process, in this project the rectangle bar mild –steel at first around is 245mm x 70 mm x 12 mm milling the surface to become 240 mm x 60 mm x 11mm and then 155mm x 70mm x 12 mm become to 150mm x 60mm x 11 mm. Then cut the rectangle bar aluminum – alloys which has dimension 74 mm x 75 mm x 15mm to become 70 mm x 70 mm x 10 mm and 65 mm x 75 mm x 15 mm to become, 60mm x 60 mm x 10 mm and 215mm x 75mm x 75 mm to become 70mm x 70mm x 210 mm of each two. After that , milling the rectangle bar aluminum – alloys was measure around 110 mm x 50 mm x 50 mm to become around 100mm x 20 x 10 . Then facing this bar with end mill Ø12, and make 4 slot which has gape 10 mm .The finishing process in this part was done with very carefully, it should accurate as much as possible All the milling process is done by using arbour, collets , chuck adapter , vases , parallel bar , end mill Ø12 , vernier calliper and gear tooth angle cutter.

Figure 3.25: Finishing the stainless steel using the grinding machine

The finishing process is followed after the milling process, in this process the rectangle bar mild –steel should be smooth with a file to remove the small chips which able to injury of hand. The rectangle bar mild –steel at first at around 240 mm x 60 mm x 11mm is finishing the surface to become 240 mm x 60 mm x 10 mm. Then finishing the rectangle bar mild – steel with dimension 150mm x 60mm x 11 mm to become 150mm x 60 mm x 11 mm. The milling process is done by using vernier calliper.

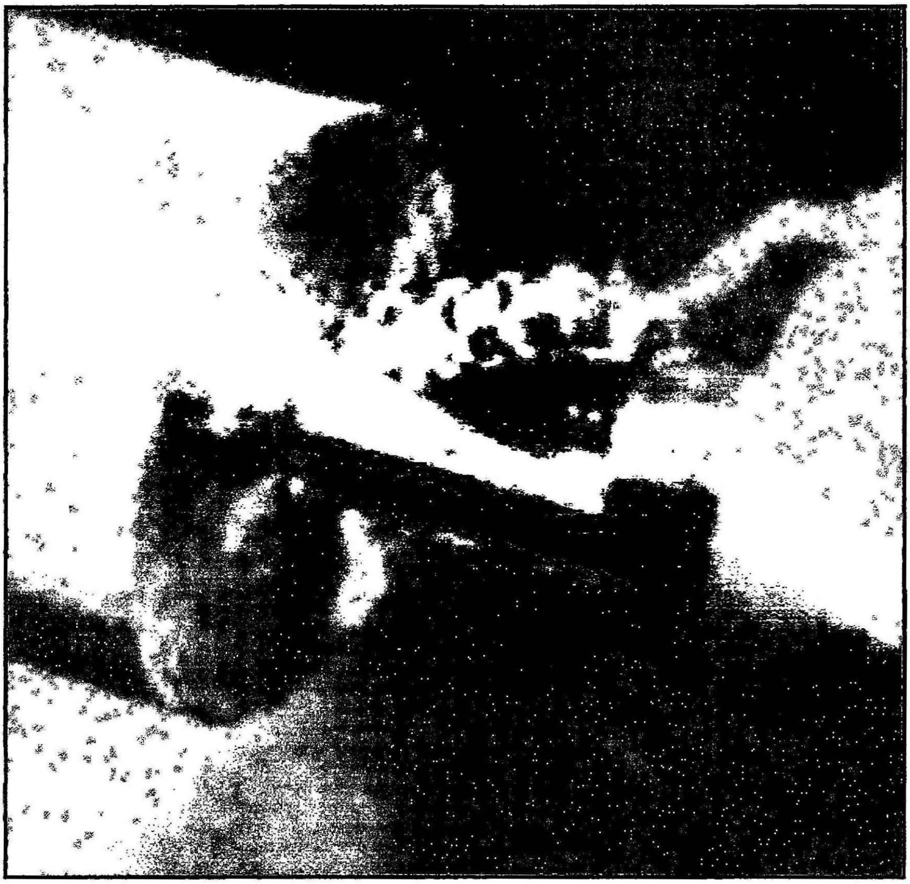

Figure 3.26: Finishing the aluminum alloy using lathe machine

Then finishing the rod aluminum – alloys, to finishing this part has to used lathe machine fabricated it to become around 90 mm x Ø 10 mm. In order to follow the model engineering design, the finishing process in this part was done with very carefully, it should accurate as much as possible because these parts have to attach with spring. Then make a hole with diameter 3.5 using Ø3.5 drill. The lathe process is done by using vernier calliper.

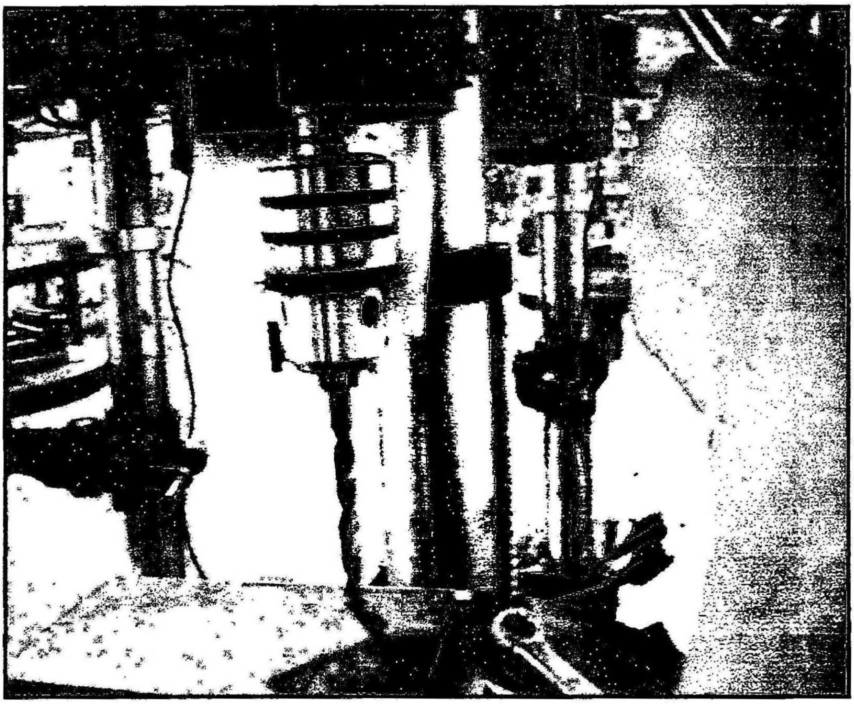

Figure 3.27: Making hole by using the drilling machine

After the finishing process was done the parts should go for another process, drilling process. This process used drilling machine. In this process, the rectangular mild-steel, all the rectangular aluminum – alloys and mild-sheet steel should have drill to make hole. In drilling process, first should start with marking the dimension and start with centre drill then follow the bigger and above. I use to drill with the 12mm in diameter for the rectangle bar mild – steel with dimension 150mm x 60mm x 10 mm. First drill using centre drill, then followed by 6 mm, 8 mm 10 mm and 12 mm. Then drill with the 10 mm in diameter for the rectangle bar aluminum 70mm x 10mm x 210 mm. The drill using centre drill, and then followed by 6 mm, 8 mm and 10 mm . Next, drill with the 2 diameter for the 70 mm x 70 mm x 10 mm and, 60mm x 60 mm x 10 mm and 70mm x 50mm x 210 mm of each two.

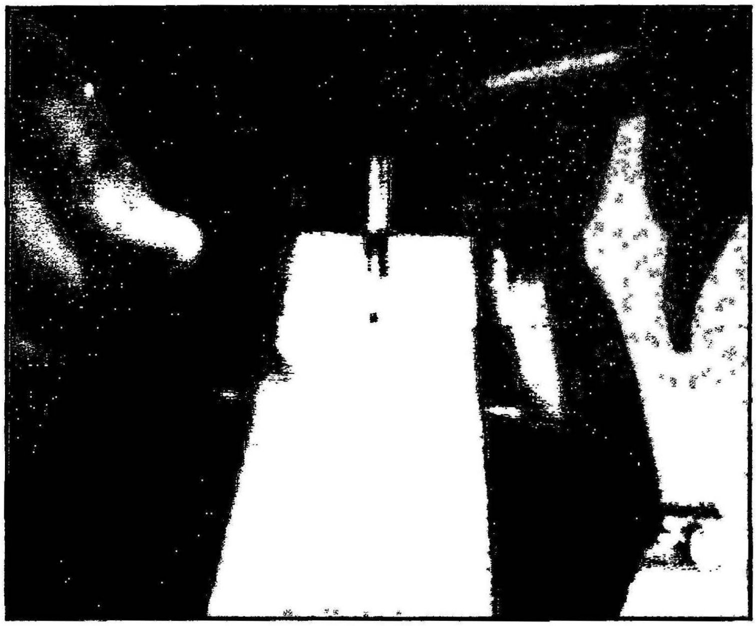

Figure 3.28: Making a tapping process

When the drilling process is finish, go to for tapping process. In this process I use to tap with the 12 mm diameter for 70mm x 5mm x 210 mm.

Figure 3.29: The filling processes

Then filling these materials using the file to with a rough surface with file, to remove all chips which will make injury of hand when hold it .

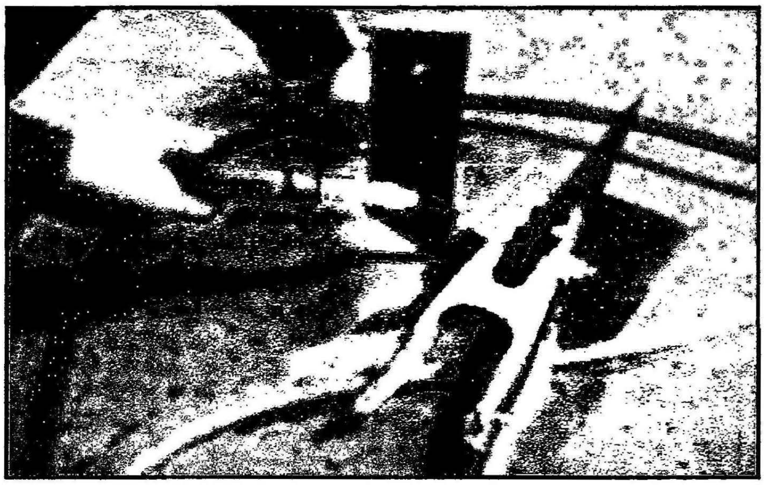

Figure 3.30: Joint both two the stainless steel by using the welding process with the MIG machine

After that, go to the welding process .In this process using the MIG type of the welding machine. These process to joint two the rectangular mild-steel in parallel position.

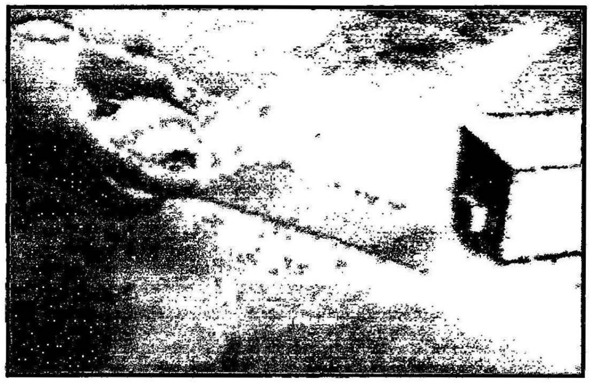

Figure 3.31: Spray all the part by using silver and black colour

Then assemble the part by using the hexagon Ø 4 mm x 4 mm and Ø 12 mm x 15 mm. Lastly spay the part with black and silver color of spray .After through all of above fabrication process included after make experiment, this project can consider it was successfully finish

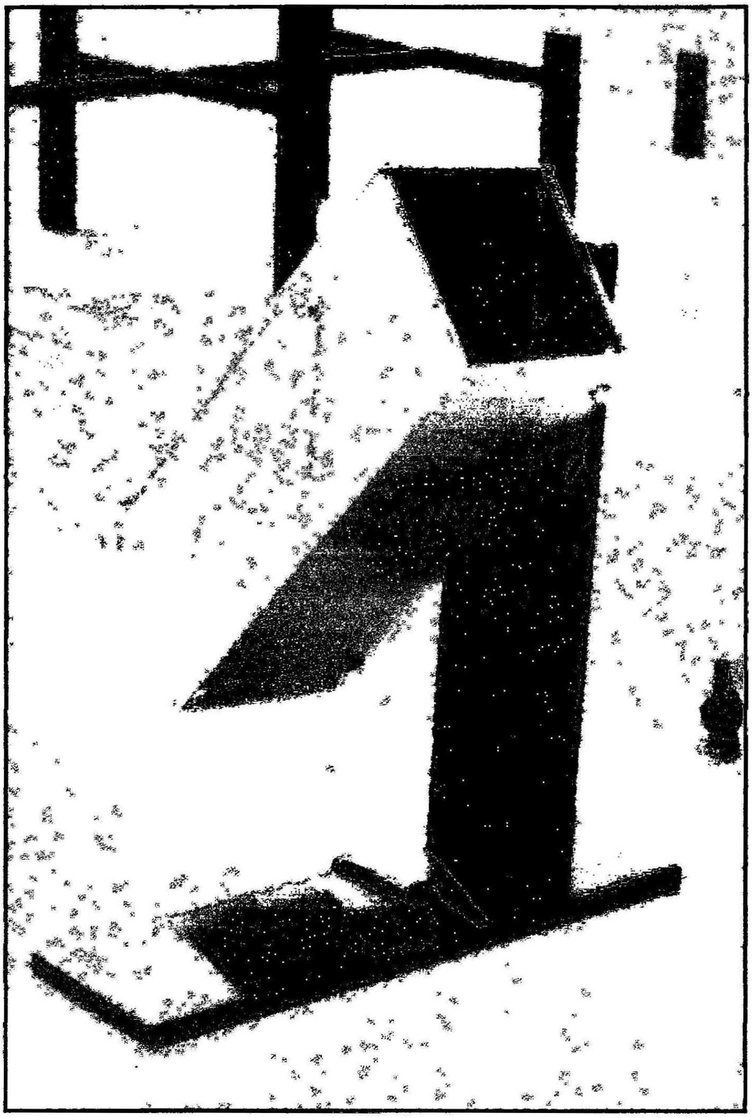

Figure 3.32: The full assemble part

CHAPTER 4

RESULTS AND DISCUSSION.

4.1 Introduction

This chapter is about to show the data collection of the experiment which collected in progress of the project before and after the project. Another else, will discuss the problems have been made about this project. Problems that will be discussed here are the prominent problem encountered in every stage in the progress project.

4.2 Data collection

4.2.1 Hooke's Law and Potential Energy Experiment

4.2.2 Objective

The main general objective of this project is to become acquainted with Hooke's Law for springs and to see how we can describe the behaviours of a spring in terms of the energy stored in a spring (potential energy). And to investigate Newton's Laws and the operation of a spring scale

4.2.3 Apparatus

The equipment uses to running this experiment are spring, rubber band, ring stand, Ring-stand clamps, c-clamp, spring scale, ruler or meter stick and set of known masses

4.2.4 Safety

During do these experiments keep feet out of the area in which the masses will fall if the spring or rubber band breaks. This is because possibility to get injury is high. Another than that, be sure to clamp the ring stand to the lab table, or weight it with several books so that the mass does not pull it off the table. Then, need to hang enough mass to the end of the spring to get a measurable stretch, but too much force will permanently damage the spring.

4.2.5 Theory

In this part of the experiment we will test whether a spring obeys Hooke's Law. According to Hooke's Law,

$$F = -k\,|x - x_o|,$$

where F is the size of the force necessary to cause a distortion (stretch the spring in this case), k is the elastic (or spring) constant, x_o is the position of the end of the spring when it is unscratched, and x is the position of the end of the spring when it is stretched or compressed. Note that $x - x_o$ is the measure of the distortion (the distance the spring is stretched in this case). If the spring does obey Hooke's Law, we will determine the constant,k.(http://www.cc.gatech.edu/computing/classes/AY2001/cs4451_spring/projects/Three/theory.html)

4.2.6 Procedure

A spring is mounted such that it hangs vertically from a support above the table. Weights will be attached to this spring. A ruler is attached next to the spring such that the position of the lower end of the spring can be measured.

Record the position, x, of the lower end of the spring for different applied masses starting at 10 grams, then 100 grams, then increasing the mass by 100 grams each time up to 1000 grams. Note that in equilibrium the spring force, F, balances the weight, W ($W = mg$) so that $F = W$.

4.2.7 Results

Hooke's Law data table.

TABLE - 4.1
Spring constant, k_1.

No	Spring load in grams (suspended mass, M)	Trial 1 Pointer Position (in cm)	Trial 2 Pointer Position (in cm)	Trial 3 Pointer Position (in cm)	Average Pointer Position (in cm)	Extension ΔL(in cm)
0	0	8.8	8.8	8.8	8.8	0
1	5	9.6	9.5	9.6	9.6	0.8
2	10	10.4	10.4	10.3	10.4	1.6
3	15	11.3	11.2	11.3	11.3	2.5
4	20	12.1	12.1	12.0	12.1	3.3
5	25	12.9	13.0	12.9	12.9	4.1
6	30	13.6	13.7	13.7	13.7	4.9

W =(mg) Use $g = 9.8\ m/s^2$

$F = -\ k\,|x - x_o|$,

$x_o =$ 8.8 cm.

TABLE – 4.2
Spring constant, k_1.

No	Spring load in grams (suspended mass, M)	Force	$x - x_o$ Extension ΔL(in cm)	Spring constant, k1. (N/m)
0	0	0	0	0
1	5	0.49	0.8	-60
2	10	0.98	1.6	-61.3
3	15	1.47	2.5	-58.8
4	20	1.98	3.3	-60
5	25	2.45	4.1	-58.8
6	30	2.94	4.9	-60

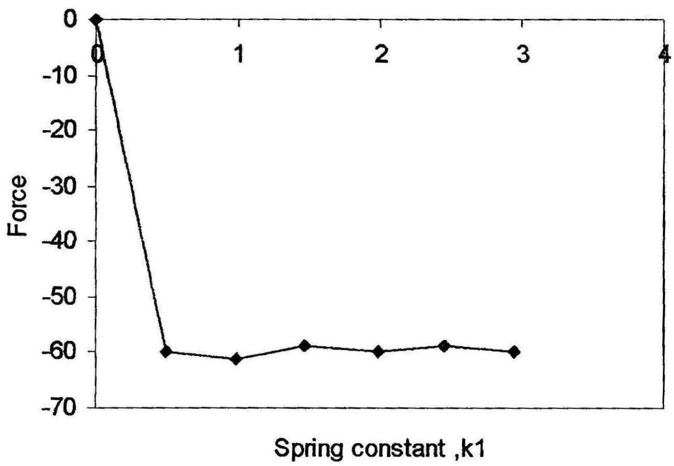

Figure 4.1: The force versus spring constant k1.

Work of spring force

US = - (½ ks 2^2 - ½ ks 1^2)

Spring force Fs = ks

Table 4.3 – Spring force

No	**Spring load in grams(suspended mass, M)**	**Spring constant, k1 (N/m)**	**Work of spring force US(J)**
1	20	-60	0.2
2	30	-60	0.3

4.2.8 Conclusion

Hooke's Law says that the stretch of a spring is directly proportional to the applied force. In symbols, F = -kx, where F is the force, x is the stretch, and k is a constant of proportionality. From the graph of the force vs spring constant is a near to straight line which same results with the theory. This experiment also to identify how work of spring force stretches from s1 to a further position s2 .

4.2.9 The relation between Hooke's Law and Potential Energy Experiment with project.

The energy stored in the compressed spring is used to accelerate the ball in the projectile experiment. With this experiment we done investigate the objects only change their motion due to forces. Another than that , the change in their motion can be represented as an acceleration; and the forces that cause accelerations are a result of the object interacting with other objects in the Projectile Launcher experiment. These experiments identify this experiment able to identify how work of spring force will be use in the Projectile Launcher experiment. That's, data able be reference to design the projectile.

4.2.10 The projectile Experiment

4.2.11 Objectives

The main general objective of this is should be able to:

- Investigate inclined free flight projectile motion
- Determine law of gravity through experiment

4.2.12 Theory

Free falls

The motion of objects under the influence of gravity near the surface of the earth has been one of the outstanding problems. The solution that once air resistance is ignored, all objects near the surface of the earth accelerate uniformly towards the earth marked the beginning of modern physics. A consequence of this physical fact is that the acceleration of a projectile is independent of the force that launches the projectile, but the trajectory depends on the exit velocity of the projectile.

Projectile motion is an example of motion with constant acceleration. In this experiment, a projectile will be fired from some height above the floor and the position where it lands will be predicted. To make this prediction, one needs to know how to describe the motion of the projectile using the laws of physics. By measuring appropriate quantities, one can predict where the projectile will strike the floor. The kinematics of projectile motion can be resolved into x (horizontal) and y (vertical) components.

Horizontal motion:

$$v = v_0 + a_c t$$
$$x = x_0 + v_0 t + \tfrac{1}{2} a_c t^2$$
$$v^2 = v_0{}^2 + 2a_c(s - s_0)$$

For a projectile, there is no horizontal component of acceleration after the gun is fired. The only acceleration is due to the gravitational attraction of the earth (vertical). Hence, the equations above become:

$$v_x = (v_0)_x$$
$$x = x_0 + (v_0)_x t$$

Vertical motion:

$$v = v_0 + a_c t$$
$$y = y_0 + v_0 t + \tfrac{1}{2} a_c t^2$$
$$v^2 = v_0{}^2 + 2a_c(y - y_0)$$

Since the positive y axis is directed upward, then

$$a_y = -g$$
$$v_y = (v_0)_y - gt$$
$$y = y_0 + (v_0)_y t - \tfrac{1}{2} g t^2$$
$$v_y{}^2 = (v_0)_y{}^2 - 2g(y - y_0)$$

Conservation of energy states that the total amount of energy in an isolated system remains constant, although it may change forms. In projectile launcher, energy from launcher spring is converted to kinetics and potential energy of the ball.

$$E_{spring} = E_{kinetics} + E_{potential}$$

$$E_{spring} = \tfrac{1}{2} m v_0^{\,2} + mg\Delta h$$

Therefore,

$$v_0 = \sqrt{\frac{2E_{spring}}{m} - 2g\Delta h}$$

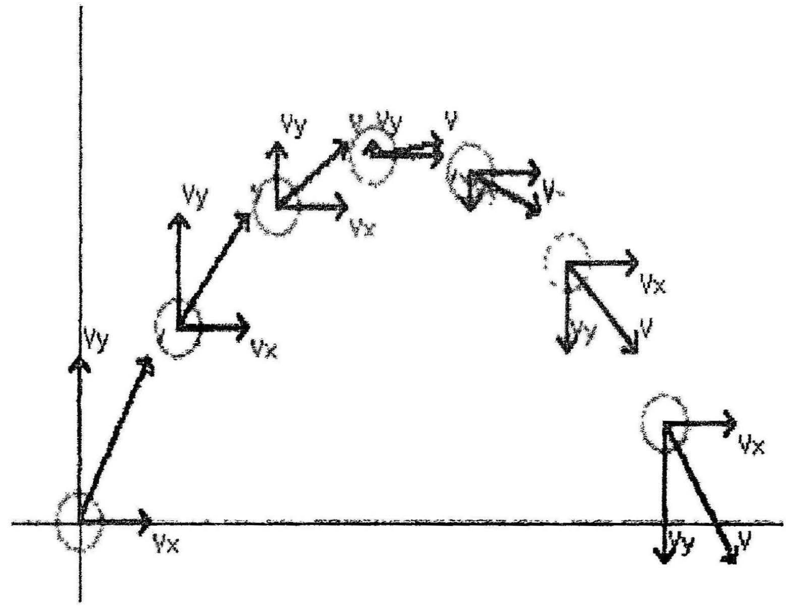

Figure 4.2: Kinematics of projectile motion

4.2.13 Experiment Set-up

Equipment and Components

Figure 4.3: Equipment and component

1. Projectile launcher set which comprises of stand, screw clamp housing, locking screw and angle scale.
2. Plastic ball with mass 10 grams
3. Measuring tape (10 meters)
4. Stopwatch
5. Marker pen.
6. Lay and key size 20 mm.

4.2.14 Experimental steps.

Firstly set the projectile launching angle at 30° and spring at 0.2 Joule energy. Then, start launching and measure the distance from projectile launcher to the point where the ball landing horizontally. As soon as the ball is launched, measure the flying time until the ball hit the ground After that ,repeat the experiment for three times and calculate the average of distance and flying time. Repeat the procedure (1) until (5) by changing launching angle to 45° and 60°. Next, fill in the Table 1 with experimental and calculation results. After finish use 0.2 Joule energy set spring energy setting to 0.3 Joule and perform similar experiment starting with launching angle 30°. Lastly ,fill in Table 2 with results from energy setting 0.3 Joule.

4.2.15 Results

Table 4.4 – Energy setting 0.2 Joule

Launching angle (°)	Trial 1		Trial 2		Trial 3		Average		*x* from calculation (m)
	x_1 (m)	t_1 (s)	x_2 (m)	t_2 (s)	x_3 (m)	t_3 (s)	$x_{average}$ (m)	$t_{average}$ (s)	
30	0.062	0.50	0.060	1.00	0.060	0.63	0.063	0.70	0.087
45	0.060	0.69	0.050	0.50	0.063	0.75	0.062	0.65	0.083
60	0.050	0.60	0.070	0.70	0.047	0.50	0.049	0.60	0.066

Table 4.5 – Energy setting 0.3 Joule

Launching angle (°)	Trial 1		Trial 2		Trial 3		Average		y from calculation (m)
	x_1 (m)	t_1 (s)	x_2 (m)	t_2 (s)	x_3 (m)	t_3 (s)	$x_{average}$ (m)	$t_{average}$ (s)	
30	0.099	0.66	0.094	0.78	0.095	0.60	0.096	0.68	0.096
45	0.095	0.65	0.095	0.47	0.088	0.70	0.093	0.60	0.093
60	0.059	0.60	0.051	0.56	0.068	0.62	0.059	0.59	0.059

4.2.16 E_{spring} Data calculation

$$E_{spring} = E_{kinetics} + E_{potential}$$

$$E_{spring} = \tfrac{1}{2} m v_0^{\,2} + mg\Delta h$$

Table 4.6 – Energy spring at 0.2 Joule.

No	Launching angle (°)	y from calculation (m)	E_{spring} (J)
1	30	0.32	0.063
2	45	0.46	0.090
3	60	0.48	0.094

4.2.17 Discussion

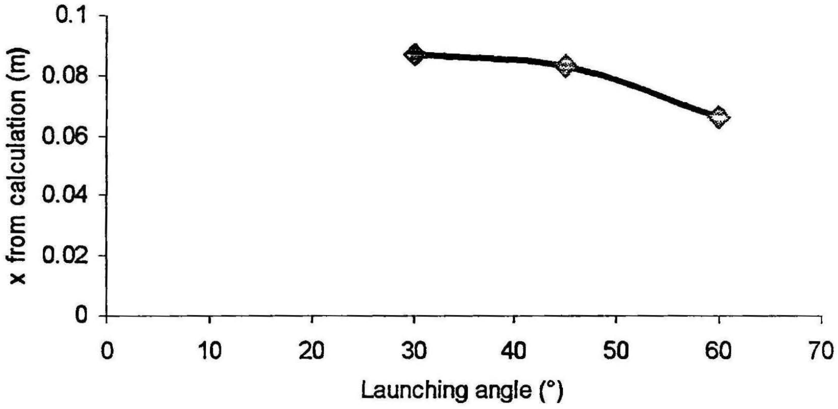

Figure 4.4 – Launching angle (°) vs x from calculation (m)

When increase the launching angle from 30° to 45 ° and finally 60 ° the horizontal distance is decrease. It shows that, the launching angle and distance are related because their influences by the bouncing force movement. A force is only required to maintain acceleration.

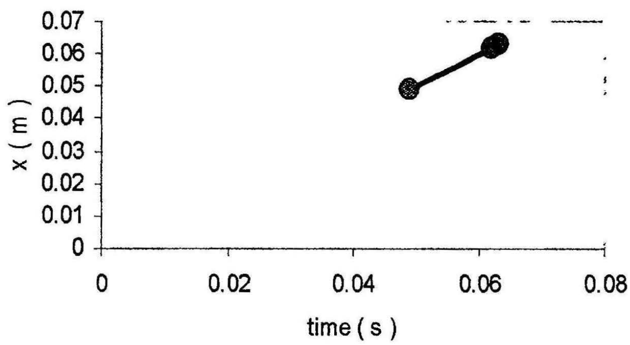

Figure 4.5: Distance (m) versus time (s).

The flying time also increase when decrease the launching angle from 30° to 45 ° and finally 60 °. This is because; the resistance of the air or variation with acceleration of gravity is taken during the ball falls from rest. The coordinate x of the projectile is equal at any instant to the distance travel by the platform and its coordinate y can be computed as the projectiles were moving along a vertical line.

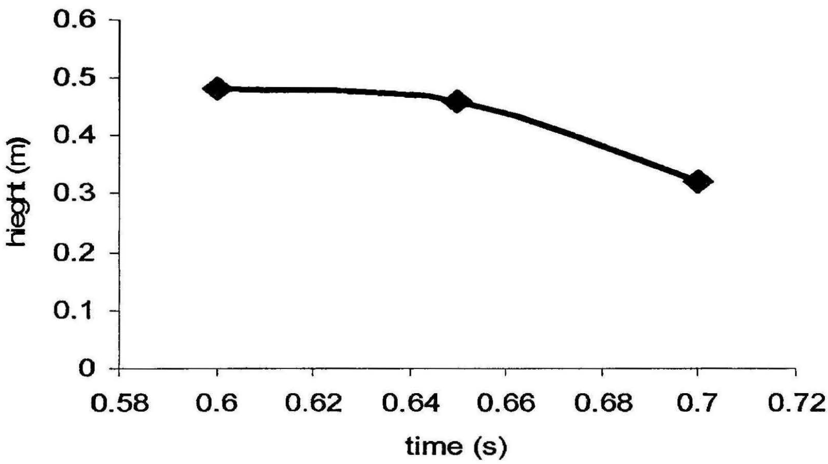

Figure 4.6: Height (m) versus time (s)

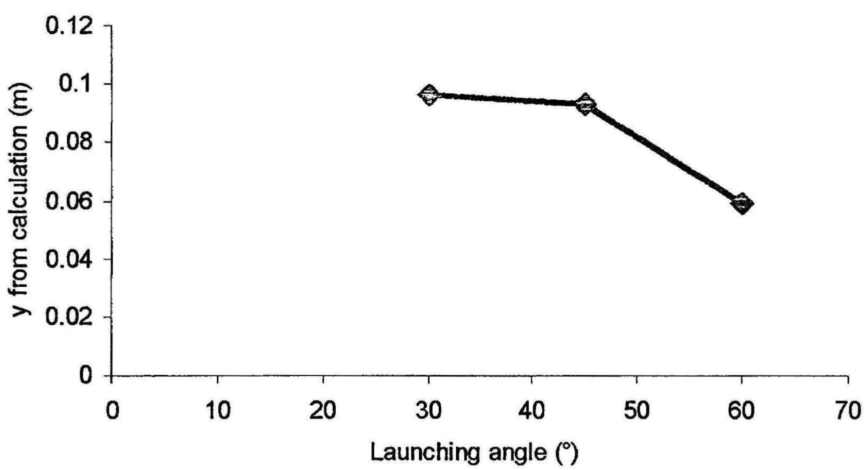

Figure 4.7: Launching angle (°) versus y from calculation (m).

The heights are increasing, when the angle becomes increase. Its show that the gravity acts to influence the vertical motion of the projectile, thus causing a vertical acceleration. Beside that ,the falling time of ping pong ball is decrease at height position. This because the gravity acts to influence the vertical motion of the projectile

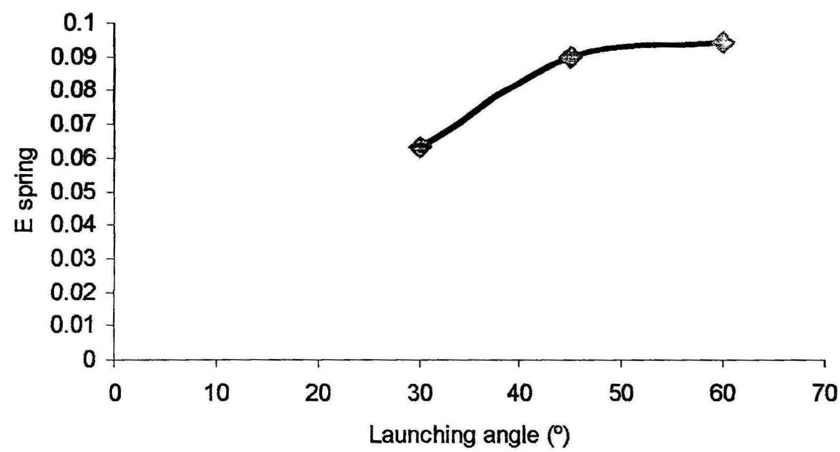

Figure 4.8: E *spring* vs launching angle (°)

The energy spring (E *spring)* increase, when the angle is increase. The spring needs more energy for ball to force the air resistance and downward force of gravity. The E *spring* more applied, when the ping pong ball bounce at height position.

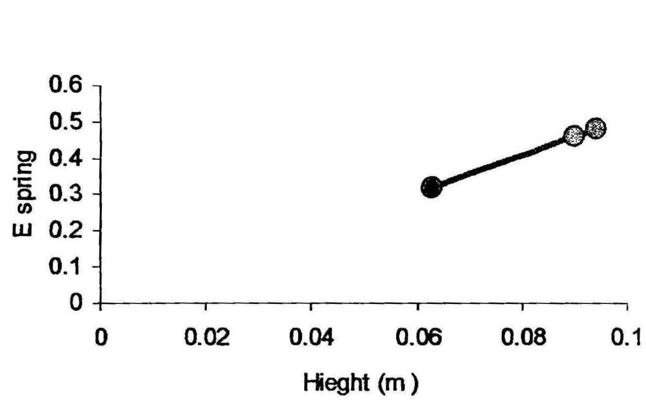

Figure 4.9: Height (m) versus E spring

Without gravity, an object will continue in motion with the same speed and in the same direction with gravity, a projectile falls below its inertial path. There are not horizontal forced needed to maintain the ping pong ball motion.

4.2.18 Conclusion

Conclusion of this experiment, a projectile is an object upon which the only force is gravity. Gravity acts to influence the vertical motion of the projectile, thus causing a vertical acceleration. The horizontal motion of the projectile is the result of the tendency of any object in motion to remain in motion at constant velocity. Due to the absence of horizontal forces, a projectile remains in motion with a constant horizontal velocity; horizontal forces are not required to keep a projectile moving horizontally. The only force acting upon a projectile is gravity.

4.3 Problem

4.3.1 Literature Review Problems

The problem during literature review is mainly about the difficulty to know well about the title such scope, concept and how to fabricate it into reality. To raw material also the problem encountered during this step because the raw material at UMP Mechanical Lab under certain supervisor – the problem more on get permission to used the raw material and the suitable material with the concept design -. And the problem is like, limited resources to get the relevant and suitable material such as books and internet connection problem.

4.3.2 Design Problems

The problems also occur at this step. The problems came during decision making to select the best system to fit with available machine in UMP Material Lab. During this period many concept design have to been find but when to choose one design that have all the criteria needed by the specification is hard. After a design is selected, another problem encountered is details dimensioning, the dimension should suitable to easy to handling.

Another problem encountered during design process is material selection, this problem as like which there are suitable material with design and how to fabricate it.

4.3.3 Fabrication processes problems

Problem during this stage is very critical that make the project schedule is delayed. First, the problem is to find the suitable material with the design then find the permission from the other supervisor because the suitable material for this project is not under this project's supervisor, this problem delay the fabrication process which can not be run according to schedule.

The problem also come during fabrication process, mainly is hard to fabricate the material with the available machine in Lab, as advised from instructor engineer ,the design was change in order to be easy in machining process. Another else, is the available cutting tool – actually it enough but the problem there many cutting tools broken. And machining time, it is because clash with the other class which used the same machine.

CHAPTER 5

CONCLUSION

5.1 Summary

The project involves designing and fabricating a projectile motion. Basically the entire projectile motion could be divided into 4 stages, which are concept review and development, designing, fabrication and testing. The drawings are divided into two categories, which are sketching and designing. The selected design or concept sketched is transfer to solid modeling and engineering drawing using Solidwork software. This projectile motion is fabricate and produce by using all necessary manufacturing process such as welding (using Gas Metal Arc Welding), cutting (using Floor Cutter Disc), hand grinding, drilling, milling , bending and etc. This projectile motion is testing to gather the accurate flight time data for projectiles and to determine the efficacy of projectile motion analysis equation.

The projectile motion has 3 transformations that make this projectile motion different form other in market. First and the more important is it can perform as a laboratory uses. This first formation is the scope formation and the main in this project. Second formation is it can minimize the maximum and minimum angle. The last formation is it can manage the maximum and minimum energy setting.

5.2 Conclusion

The conclusions of this project are:

i. The projectile launcher for projectile experiment was successfully develop
ii. The flight time data was a being testing.
iii. The efficacy of projectile motion analysis was a being determine.

5.3 Recommendation

Several recommendations are express base from fabricate this project for future final year project:

- Use variety of projectile launcher as comparison in term of effectiveness and quality.
- Perform testing for new design projectile launcher as comparison to the current design in lab.
- More time given to the project, it include the final year student should more focus on final year project only or give two semester to doing the final year project. This could make the result of the project finish on time and have better result.
- The budget must be prepared earlier to make sure no budget problem not occur during material buying process. Also include less procedure protocol should be make for material buying process.

5.4 Future works

The Future planning, this project can be use by the student to gain knowledge and understanding of the projectile launcher performs. To be more efficient, the upgrade should involve, using good material (example stainless steel – light and good strength). If the upgrade can be done the projectile launcher can have better performance, more accurate data, and life longer

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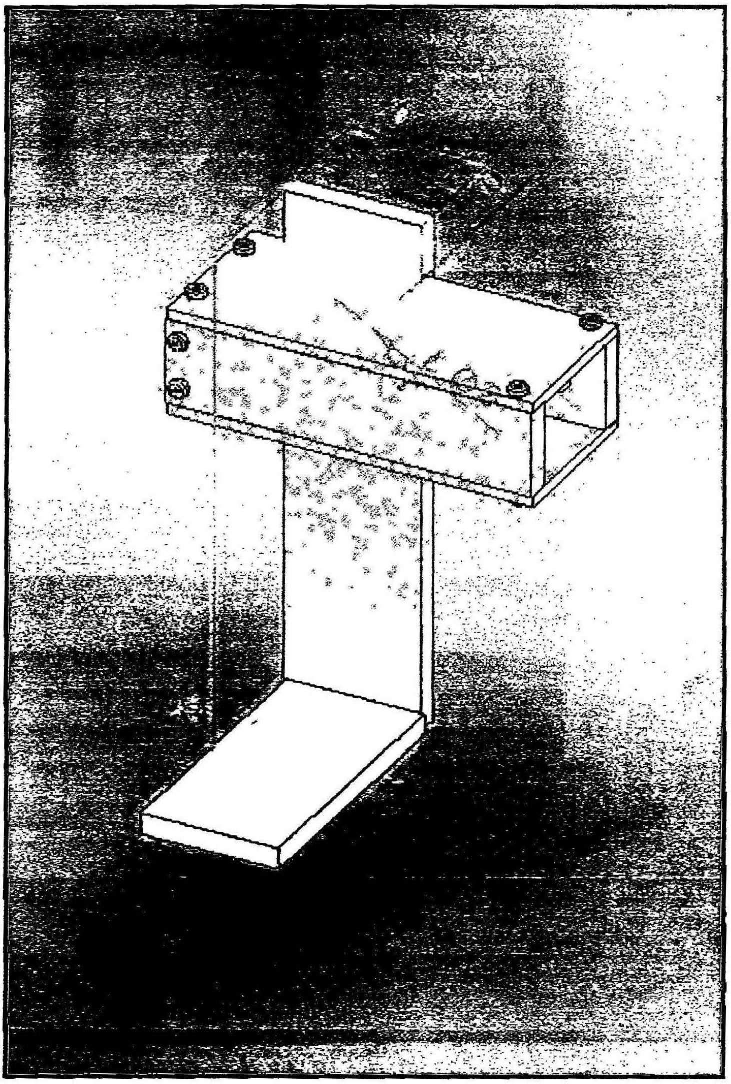
APPENDIX A

PART OF ASSEMBLY



The full assembly part

APPENDIX B

THE FULL ASSEMBLY PART