PERPETUAL MOTION MAGNETIC ELEVATION TOY

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UNIVERSITI MALAYSIA PAHANG

BORANG PENGESAHAN STATUS TESIS

JUDUL **PERPETUAL MOTION MAGNETIC ELEVATION TOY**

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PERPETUAL MOTION MAGNETIC ELEVATION TOY

MUHAMAD SAHDDAM BIN MOHD ROZANI

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

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

JANUARY 2012

SUPERVISOR DECLARATION

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

Signature : …….

Name of Supervisor : Mr. NASRUL HADI BIN JOHARI

Date : 10 JANUARY 2012

STUDENT DECLARATION

I declare that this thesis entitled "**Perpetual Motion Magnetic Elevation Toy**" is the result of my own research except as cited in references. The thesis has not been accepted for any diploma and is not concurrently submitted in candidature of any other diploma.

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Name of Candidate : MUHAMAD SAHDDAM BIN MOHD ROZANI

Date : 10 JANUARY 2012

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ABSTRACT

Perpetual motion magnetic elevation (PMME) toy is a smart toy which combines two mechanical systems to works. Perpetual motion and magnetic elevation system was introduced since hundred years ago. This toy usually used as office desk decoration and it function is limited. Although this toy has been introduced, but not everyone knows how it is made and works. This report will explain the investigation of the mechanical system behind this toy and the process in making this toy. At the end of this project, we will know how this toy has been made and what materials involved. We will also know how the mechanical systems can create the movement on this toy. Ultimately, perpetual motion magnetic elevation toy is not just a toy to be played by children and as a desk decorative but it can be source of ideas to create a new technology which can save our planet that has long been desired by the peoples.

ABTRAK

Alat permainan pergerakan terus angkatan magnet adalah sejenis alat permainan pintar yang menggabungkan dua system mekanikal untuk berfungsi. Sistem pergerakan terus dan angkatan magnet telah diperkenalkan sejak beratus tahun yang lalu. Alat permainan ini biasanya digunakan sebagai alat perhiasan meja di pejabat dan fungsinya terhad. Walaupun alat permainan ini telah lama diperkenalkan, tidak semua orang tahu bagaimana ia dibuat dan berfungsi. Laporan ini akan menerangkan penyiasatan sistem mekanikal disebalik alat permainan ini dan proses pembuatan alat permainan ini. Pada akhir projek ini, kita akan mengetahui bagaimana alat permainan ini dibuat dan bahan-bahan yang terlibat. Kita juga akan mengetahui bagaimana system mekanikal boleh menggerakan alat permainan ini. Akhir kata, alat permainan gerakan terus angkatan magnet bukan sahaja alat permainan untuk dimain oleh kanak-kanak dan perhiaasan meja, bahkan ia boleh menjadi sumber idea untuk menghasilkan sebuah teknologi baru yang boleh menyelamatkan planet kita yang telah lama diidamkan oleh orang ramai.

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CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

For this chapter, we will discuss about the project background, problem statement, objective of the project, and scope of the project.

1.2 PROJECT BACKGROUND

Perpetual motion magnetic elevation toy is a combination of two systems which produce a mechanical system to make it work. Magnets has two functions which is to float the object and as a source of energy to move the object continuously. The example for this toy which already sold in market is levitator strobe (figure 1.1). This toy looks simple but the system behind this toy makes it known as a smart toy. This toy has been sold in the market but it seems to be the same design from the past till the present and the price is quite high. However, this toy remains an attraction to children or adults.

This project is supervised by Mr. Nasrul Hadi bin Johari who give advices during carry out this project. This project is to fabricate a perpetual motion magnetic elevation toy and make improvement with the existing toy in the market. It is also to investigate how mechanical system works behind this toy.

Figure 1.1: Levitator strobe

1.3 PROBLEM STATEMENT

Although these toys have long been introduced and are readily available in the market, but the design has not changed much from the beginning it was introduced until now. These toys are usually used as decoration for table and the price is quite expensive. While, many people still do not know how the system works behind this toy, which enable it create an interesting movement. So, what modification should be done to meet the customer need and how the mechanical system behind this toy works? Is this system has potential to be developed for the benefit of mankind?

1.4 OBJECTIVE

The objective of this project is:

1) To fabricate perpetual motion magnetic elevation toy with new characteristics.
2) To study the mechanical system behind the toy and how it can be developed to benefit of mankind.

1.5 PROJECT SCOPES

To ensure to project is under control and stick with the title, the scopes of project is discussed. Every scopes of this project are the task of the student and it is under student responsibilities.

This project covers:

i. Fabricate perpetual motion magnetic elevation toy.
ii. Investigate the mechanical system works behind the toy.

1.6 PROJECT FLOW CHART

Project flow chart (figure 1.2), is a graphical representation of a process or system that details the sequencing of steps required to create output.

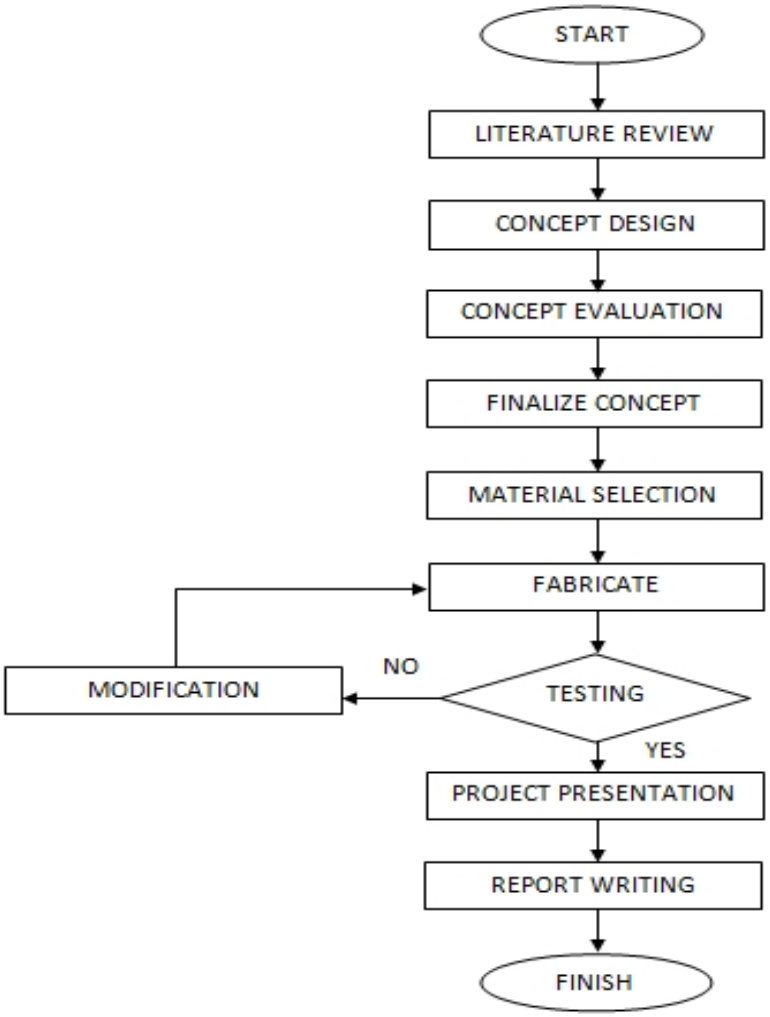


Figure 1.2: Project flow chart

CHAPTER 2

LITERATURE STUDY

2.1 INTRODUCTION

This chapter consists of further information about perpetual motion magnetic elevation toy. There are two main systems which are perpetual motion and magnetic elevation combined in this toy to make it work. As we know, perpetual motion is ability to moves continuously and the magnetic elevation is ability to float by help of magnetic force. This chapter will explain these systems work in this toy.

2.2 PERPETUAL MOTION MAGNETIC ELEVATION (PMME) TOY

2.2.1 Common Perpetual Motion Magnetic Toy

The perpetual motion magnetic elevation toy (figure 2.1) is a combination of the two systems which are perpetual motion and magnetic levitation (maglev). The magnetic field produced will repels the both parts each other then it will make the upper part to float or suspend. When a force is applied on the float part, it will generate the momentum to keep moving. The reaction of poles on the magnet allows the part rotates on fix position.

Figure 2.1: Common perpetual motion magnetic elevation toy

2.2.2 Other Perpetual Motion Magnetic Elevation Toy

The other example of perpetual motion magnetic elevation toy which does not use battery or electric energy to move is Magic UFO (figure 2.2). This toy uses a large round magnet as it base and a small magnet as the UFO. The UFO must be rotated faster to make it float on air with stable.

Figure 2.2: Magic UFO

2.3 PERPETUAL MOTION

2.3.1 Perpetual Motion History

Perpetual motion is referring to something that move continuously when a force is applied on it. The perpetual system has been discovered since hundred years ago and it is used to invent perpetual motion machines. The first documented

perpetual motion machines were described by the Indian author Bhaskara (c.1159) which called Bhaskara's wheel (figure 2.3). This wheel contains with mercury around its rim. As the wheel turns, the mercury is supposed to move within the containers in such a way that the wheel would always be heavier on one side of the axle. Perhaps this is not so much a practical proposal as an illustration of Indian cyclical philosophy. The idea reappears in Arabic writings, one of which contained six perpetual motion devices. From the Islamic world the idea reached Europe.

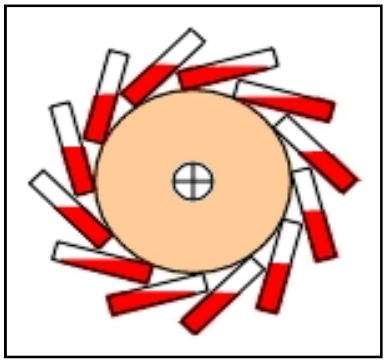


Figure 2.3: Bhaskara's wheel

Another inventor that was developed this system is Leonardo da Vinci (1452-1519). The machine invented by Leonardo had purpose to pump the water. Many of Leonardo's drawings of machines were impractical or even unworkable as he depicted them. Most were never built or tested by him. Some were not his original ideas, but were commonly known in his time and earlier times. We often cannot determine whether a particular device included in his notebook was his own design, or of someone else, and we cannot always know whether Leonardo considered it workable or practical. Figure 2.4 shows the Leonardo's drawing of perpetual motion wheels.

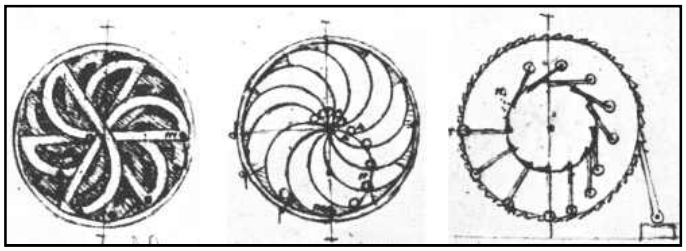


Figure 2.4: Leonardo's drawing of perpetual motion wheels.

2.3.2 Perpetual Motion and Physics

Perpetual motion machine produces more work or energy than it consume, whether they might operate indefinitely or not. The machine can operate by itself which produce useful work without energy input. That means the machine is 100% efficient and no energy lost on the system. This statement has been a mystery among scientists whether they have violated the laws of thermodynamics or not.

The first law of thermodynamics is the law of conservation of energy applied to heat engines. It states that the work output from an engine cannot exceed the energy input. The perpetual motion machine described above violates the first law of thermodynamics. The generator portion generates efficient electricity to run other devices as well as power the generator. Hence once this perpetual motion machine is set in motion, it produces useful work without any energy input. Free work out with no energy in violates the first law of thermodynamics. Energy is being created from nothing.

First law thermodynamics equation:

$$\Delta U = Q - W$$

Change in internal energy — Heat added to the system — Work done by the system

The second law of thermodynamics says that an engine or process of any type must always have an efficiency of less than 100%. A perpetual motion machine that uses a generator to power the motor that runs the generator requires both the generator and motor to operate with 100% efficiency. This type of perpetual motion machine does not violate the first law of thermodynamics, but violates the second law of thermodynamics. It is a perpetual motion machine of the second kind because it violates the second law of thermodynamics. Figure 2.5 shows the energy conversion of heat engine in thermodynamics theory.

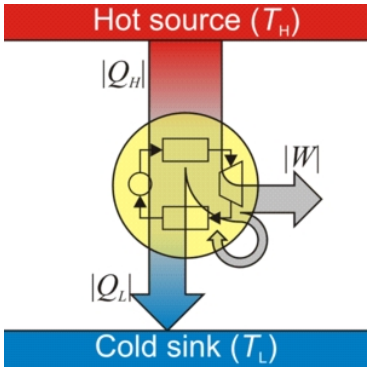


Figure 2.5: Heat engine diagram

In term of that, no engineer or inventor cannot build a perpetual motion machine because it would violate either the first or second law of thermodynamics, which are fundamental laws of physics.

However, this does not mean that we cannot strive to come close to perpetual motion and it definitely does not mean that some of these machines would not have the potential to produce energy without the use of fossil fuels. Some perpetual motion device use get the energy from gravity and magnet. The example of perpetual motion device that use gravity as source of energy is Bhaskara's wheel (figure 2.6). The motion is done by making the moment due to gravity on one side of a wheel greater than the moment due to gravity on the other side. The wheel would have equal masses surrounding it and gravity remains constant.

Figure 2.6: Bhaskara's wheel

To make the wheel spin the sum of the moments must not equal zero, the only way to ensure this happens is to change the radius. This is the example of force and moment calculation on Bhaskara wheel that use gravity force as source of energy to move the wheel. Figure 2.7 shows the calculation of each ball on Bhaskara's wheel:

Force = (Mass)(Acceleration)

Moment = (Force)(Radius)

Mass of each ball = 1kg

l_i= 0.5m

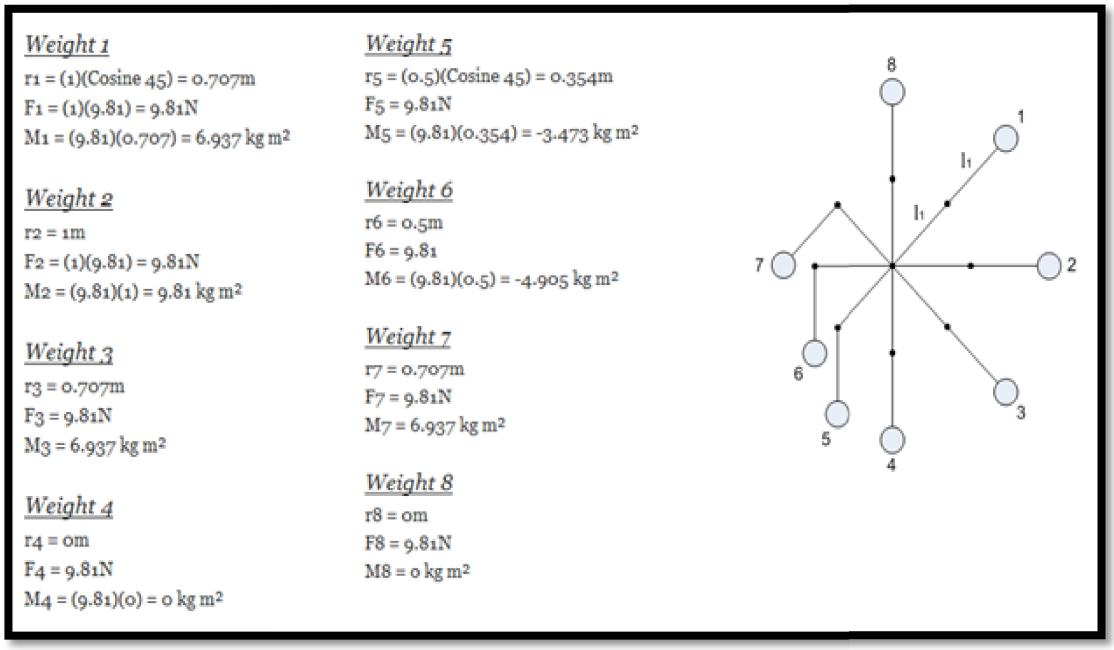


Figure 2.7: Example of calculation on Bhaskara's wheel

Sum of the moments

ΣM = 6.937 + 9.81 + 6.937 + (-3.473) + (-4.905) + (-6.937) = +8.369

There is a clockwise moment of **8.369 kg m².**

2.3.3 Perpetual Motion Toy

The example for perpetual motion toy is Nowton's cradle (figure 2.8). This perpetual motion toy does not use magnet to move. The pendulums are tied on the frame with a same length. The same momentum force allows the pendulums to move continuously.

Figure 2.8: Newton's Cradle

2.4 MAGNETIC ELEVATION

2.4.1 Magnetic Elevation History

Magnetic elevation or synonym with magnetic levitation (maglev) is a form of system that suspends, guides and propels the suspended object using magnetic forces. This system was developed since 1905 by Alfred Zehden from German which was invented linear induction motor (LIM) for driving trains or lift. Alfred Zehden was awarded U.S. Patent 782,312 (21 June 1907) and U.S. Patent RE12, 700 (21 August 1907). Figure 2.9 shows the LIM pattern.

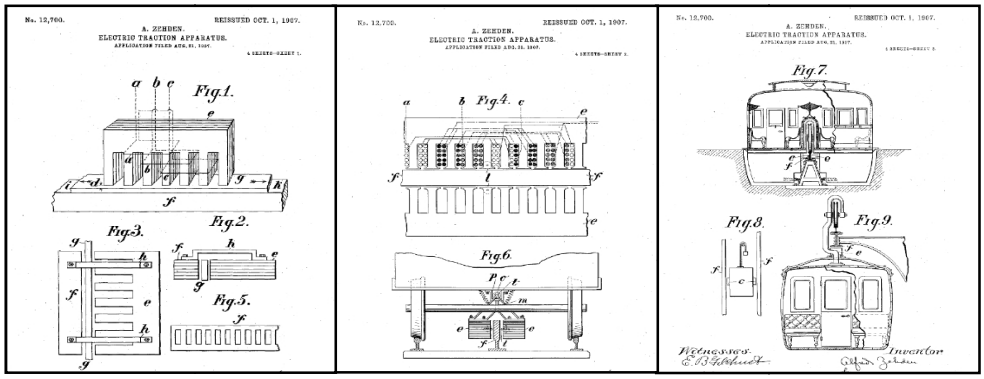


Figure 2.9: First LIM patent by Alfred Zehden

2.4.2 Application of Magnetic Elevation

Maglev technology commonly used in constructing a high-speed train. The magnetic field between the train and track make the train suspended and linear induction motor (LIM) is mounted to the track to propel the train forward. This system is called Electro Magnetic Suspension (EMS). EMS would be able to continually switch poles and keep the train moving while the trains will always be suspended on the track. Figure 2.10 details the explanation.

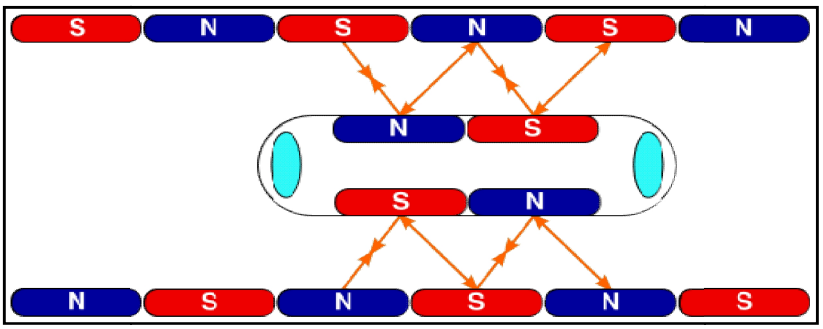


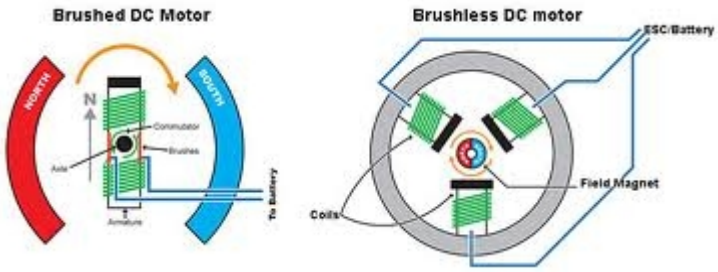
Figure 2.10: Electro Magnetic Suspended (EMS) system works

This system was used on Maglev Train (figure 2.11) at German and Bullet Train (figure 2.12) at Japan. This system supports the object without physical contact which can prevent frictions force between the moving object.

Figure 2.11: German's Maglev Train

Figure 2.12: Japan's Bullet Train

Another example using magnetic elevation is electric brushless motor (figure 2.13a). This motor is more efficient compared to electric brushed motor (figure 2.13b) because it has less frictional force hence reducing the heat when operate.



(a) (b)

Figure 2.13: Application of magnetic elevation. a) Brushed motor; b) Brushless motor.

2.4.3 Magnetic Elevation Toy

There are many types of magnetic toy sold in the market. The magnet is use either to move the toy or to float the toy. The example of magnetic toy is antigravity globe (figure 2.14). The magnet on this toy is used to levitate the globe and let it to float. There is no contact between the globe with the base hence let the globe to spin freely.

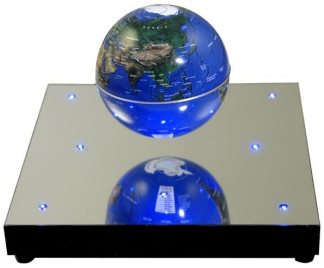


Figure 2.14: Antigravity globe

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

In this chapter, the work progress that involved in this project will be showed. The steps involved in this chapter are classification, concept design and evaluation, material selection, fabrication and bill of materials.

3.2 PRELIMINARY CONCEPT

The concept of toys to be made must meet the criteria. The main criteria's are perpetual motion and magnetic elevation. The example of toy which exists in current market and meets the criteria is levitator strobe (figure 3. 1). The toy will be selected as datum concept during designing the new concept.

Figure 3.1: Levitator strobe

3.3 CONCEPT SKETCHING

3.3.1 Concept A

Concept A (figure 3.2) has a small stationery pocket. This concept is thicker than datum concept. The floating part is same like datum concept.

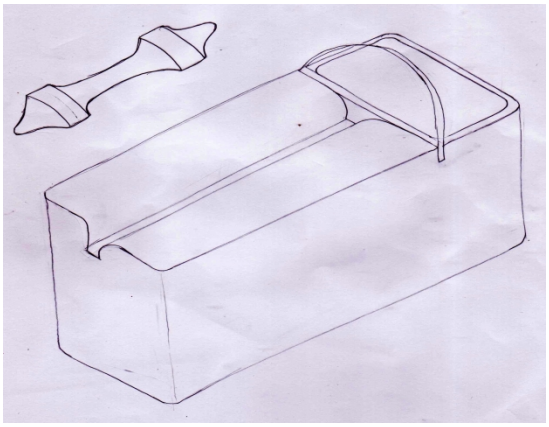


Figure 3.2: Concept A

3.3.2 Concept B

Concept B (figure 3.3) is modification from concept A. The pocket is replaced to at the long side of the base part. The floating part is designed as a rocket.

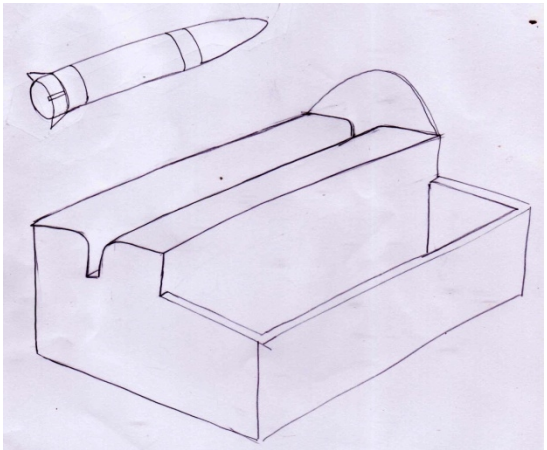


Figure 3.3: Concept B

3.3.3 Concept C

Concept C (figure 3.4) is designed like ‘X’ letter. This concept is thinner than concept A and concept B. The floating part is same like datum concept.

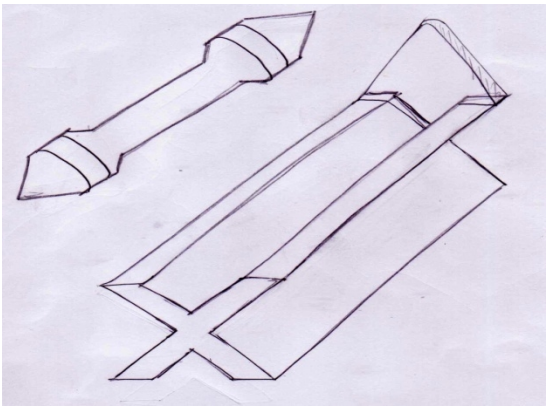


Figure 3.4: Concept

3.4 CONCEPT EVALUATION

3.4.1 Concept Screening Matrix

Concept screening matrix (table 3.1) shows the comparison between each concept. The concepts are evaluated with datum concept which already sold in the market.

Table 3.1: Screening concept matrix

Selection criteria		Concept variants		
		Concept A	Concept B	Concept C
Safe for kid		0	0	-
Stability		0	0	-
Aesthetically pleasing		0	-	-
Cost		+	-	+
Durability		0	0	-
Stationery pocket		+	+	0
	Plus	2	1	1
	Same	4	3	1
	Minus	0	2	4
	Net	2	-1	-3
	Rank	1	2	3
	Continued	Yes	Yes	No

From the concept screening matrix, concept A and B has been chosen to continue to next step. The next step is concept benchmarking matrix.

3.4.2 Finalize Concept Sketching

Datum concept is combined with concept A to get a finalize concept (figure 3.5). This concept has thinner base part and has a stationery pocket at the side of this part. The concept is evaluated in concept benchmarking matrix.

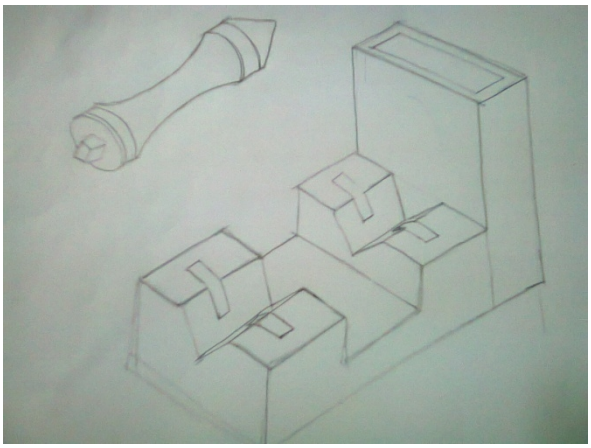


Figure 3.5: Finalize concept

3.4.3 Concept Benchmarking Matrix

Concept benchmarking matrix (table3.2) will review the scoring of the concept. Concept A will combined with datum concept to get a better design.

Table 3.2: Concept benchmarking matrix

Selection criteria	Weight	concept A + regular concept		concept B	
		Rating	Score	Rating	Score
Safe for kid	20%	4	0.8	2	0.4
Stability	15%	4	0.6	3	0.45
Aesthetically pleasing	15%	4	0.6	3	0.45
Slotted for round magnets	20%	5	1.0	5	1.0
Durability	15%	4	0.6	2	0.3
Stationery pocket	15%	4	0.6	3	0.45
	Total score	4.2		3.05	
	Rank	1		2	

From the concept benchmarking matrix, combination of concept A and datum concept has the highest score. This concept will be continued to fabrication process.

3.5 Computer Aided Drawing

3.5.1 Dimension

The dimensions of the parts are in millimeter unit. Part 1 (figure 3.6) and part 2 (figure 3.7) will combined together and part 3 (figure 3.8) is combination of wood and round magnets.

Part 1: Base part

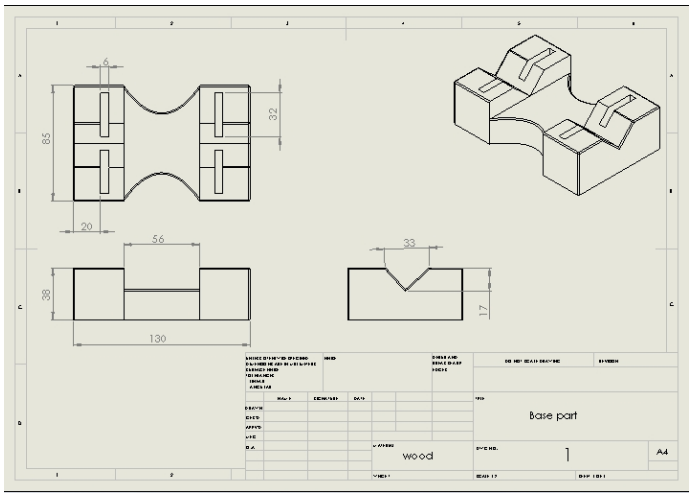


Figure 3.6: Base part dimension

Part 2 : Stationery pocket

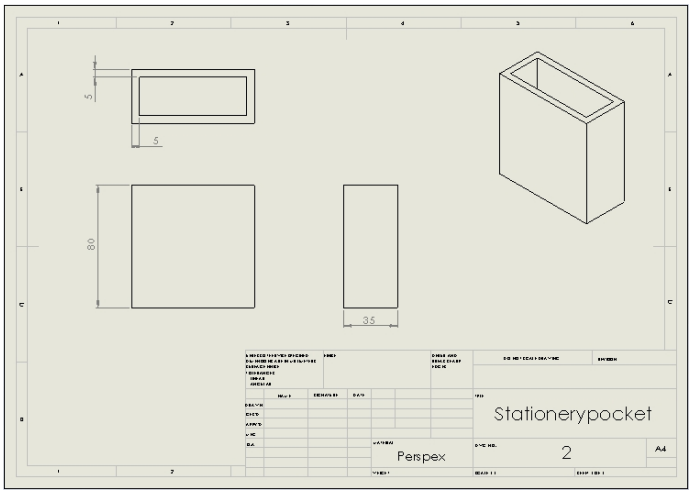


Figure 3.7: Stationery pocket dimension

Part 3: Strobe

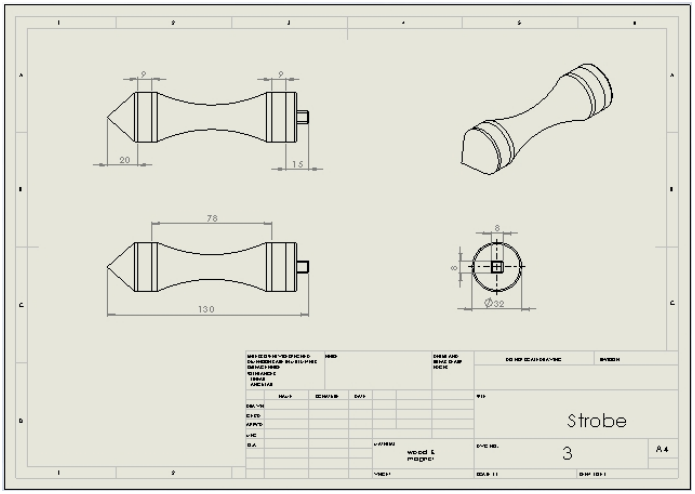


Figure 3.8: Strobe dimension

3.5.2 Isometric View

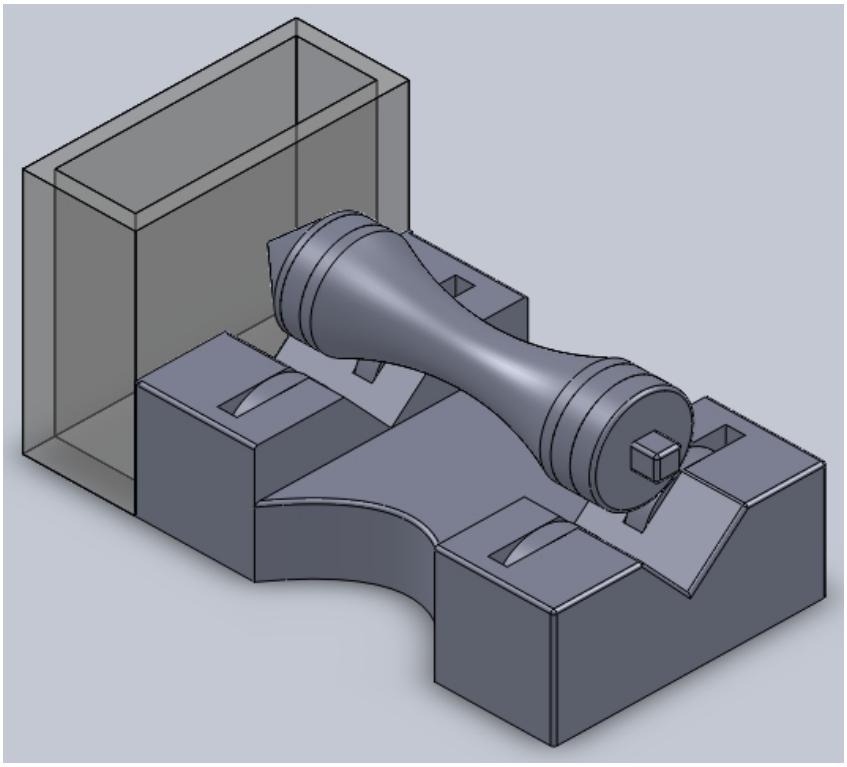


Figure 3.9: Isometric view

3.5.3 Exploded View

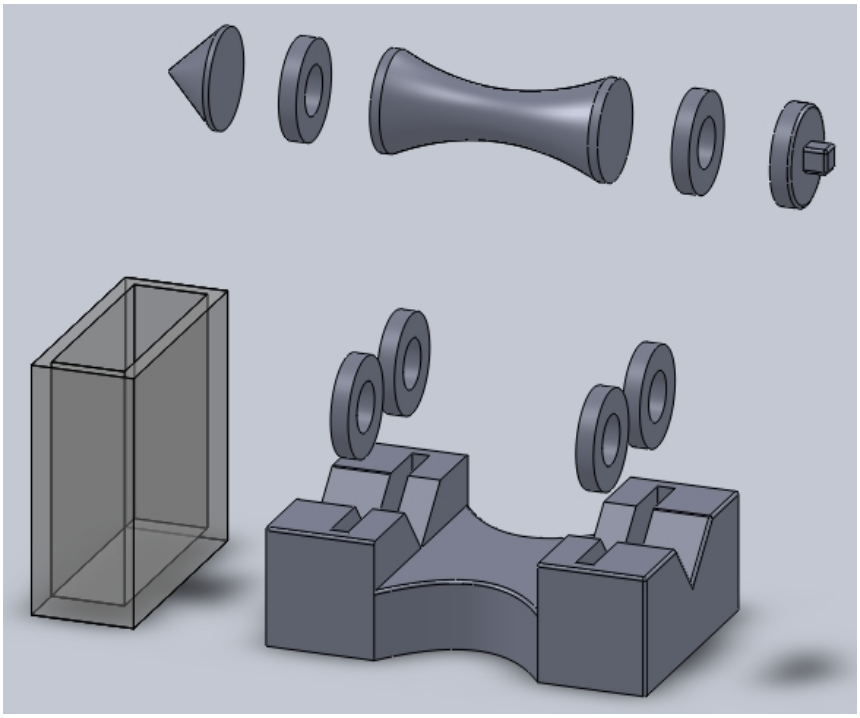


Figure 3.10: Exploded view

3.6 MATERIAL SELECTION

3.6.1 Material Criteria

For the material selection, there are 5 criteria must be considered:

i) Suitability material for children

This toy is designed for children and adult. The material must be safe for children to avoid from injuries. The material must not easy to crack and non-poisons.

ii) Durability material

Durability of material is important to produce a high quality product. Hence, it will give confidence to customers.

iii) Suitable for magnetic toy

The material use must not influence the magnetic fields. Avoid from using material that can be attracted by the magnet such as iron.

iv) Weight

The weight must be considered to make sure the toy can works properly. Floating part must not too heavy to elevated by magnets.

v) Cost

Costs must not be too expensive and affordable to everyone. The quality must balance with the cost.

3.6.2 Selected Material

Table 3.3: Detail of selected material

Part	Material	Size (mm)	Quantity
1	Ring magnet	R16x8	6
2	Perspex	250x 85x5	1
4	Wood	140x130x50	1

3.7 TOOLS

The tools used to making perpetual motion magnetic elevation tot are:

i) Special knife

ii) Saw

iii) Abrasive paper

iv) Screw

v) Glue

vi) Drill

3.8 FABRICATION PROCESS

3.8.1 Wood Cutting Process

The wood is cut by using saw and knife into two parts according the size required for base part and strobe part. The base part is cut into length of 135 millimeter, width of 90 millimeter and height of 40 millimeter (figure 3.11). The strobe part is cut into diameter of 35 millimeter and length of 130 millimeter (figure 3.12).

Figure 3.11: Wood for base part

Figure 3.12: Wood for strobe part

3.8.2 Wood Forming Process

The wood will be formed as the design in drawing by using special knife (figure 3.13). Figure 3.14 shows the base part which in forming process and figure 3.15 shows the tail part of strobe.

Figure 3.13: Special knife

Figure 3.14: Base part

Figure 3.15: Strobe tail part

After finish the forming process, the parts surface are smoothed by using abrasive paper before will be joined.

3.8.3 Joining Process

The parts are joined using screw and glue. Figure 3.16 shows the parts that has been joined. The screw is used to joins perspex with wood and glue is used to joins the wood with magnet.

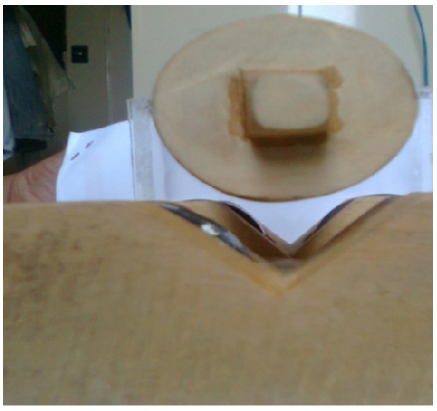
(a)

(b)

Figure 3.16: Joined parts; a) Joined by screw, b) Joined by glue.

3.8.4 Testing

After the joining process is done, the product will be tested to identify the problems presence. Modification will be made to solve the problems. Figure 3.17 shows the testing on the product.



(a)

(b)

Figure 3.17: Testing process; a) Elevation test, b) Spinning test.

3.8.5 Modification

After the testing process done, the problems presence is the strobe does not rotates smoothly. This problem may cause by unbalance shape on the strobe and it is heavy. Some modification has been made to the strobe. The strobe is reshape to get a balance shape and drill to reduce it weight as shown in figure 3.18. Figure 3.19 shows the modification has been made on the strobe.

Figure 3.18: Holes are drilled to reduce strobe weight.

(a) (b)

Figure 3.19: Modified strobe; a) Hole made to reduce weight, b) Strobe after modification.

3.9 BILL OF MATERIAL

The cost to produce this product can be reduced if it produced in a large quantity. The price of materials will cheap if it bought in large quantity. The bill of materials is shown in table 3.4.

Table 3.4: Bill of materials

Material	**Size (mm)**	**Quantity**	**Price**
Wood	140x130x50	1	RM 3.00
Magnet	R32xR18	6	RM 6.00
Perspex	250x 85x5	1	RM 5.00
		Total	**RM 14.00**

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

The purpose of this chapter is to discuss the result after fabricate the perpetual motion magnetic elevation toy. This chapter will show the finish product, functionality, capability, and problem encountered on this toy. This chapter also will discuss the investigation of the mechanical phenomena behind the system of the toy.

4.2 RESULT

4.2.1 Finish product

There are the photos taken from the actual finish product. Figure 4.1 shows the base part of the toy and figure 4.2 shows the elevated part which called levitator strobe. The levitator strobe will placed on the base part to float. Then the float levitator strobe will be rotated to move perpetually. Figure 4.3 shows the complete toy.

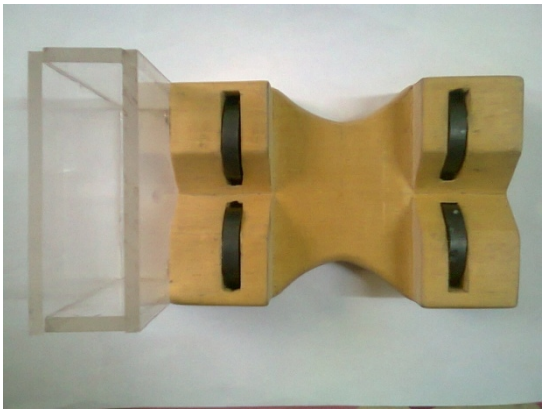


Figure 4.1: Finish toy base

Figure 4.2: Elevated strobe

Figure 4.3: Complete toy

4.2.2 Functionality

Perpetual motion magnetic elevation toy is a smart toy which applied of science knowledge. Cool movement created by this toy makes someone to be calm and relax. This toy provided with stationery pocket which suitable to be used at office and college table. The stationery pocket can loads 10 to 12 pens. Lightweight and durable material used is also suitable to be played by kids. Figure 4.4 shows the toy used on study table.

Figure 4.4: Toy used on study table.

4.2.3 Capability

From the testing that has been carried out, the toy can float above the base for more than 3 days without changes the gap distance between floated part with the base. From this test, its show that the magnetic force of this toy does not reduce with the situation. The testing also has record the spinning time period of this toy. This toy can rotates to almost 2 minutes with a good smooth rotation. However, the rotation period can be extended by reduces strobe weight and rebalancing the strobe shape.

4.2.4 Problem

The problem encountered during this project is the toy floats with unstable and the rotation period is less than 1 minute. The problem has been solved by replacing the magnet with same size and type. So, the magnetic force produce by the magnets are same and makes the toy float with stable. To increase the rotation period of this toy, the needle was securely installed on the rotated part which touches the perspex surface. The needle reduce the friction during it spins. Another improvement made is reducing the levitator strobe. Holes have been made on the strobe to reduce it weight.

4.3 DISCUSSION

4.3.1 Analysis of Perpetual Motion Magnetic Elevation Toy

The reaction of magnetic fields of each magnet allows it to float. This is a simple physics of magnet which same poles repels and opposite poles attract. The power of the north pole on a magnet has same strength as the power of the south pole. In reality, we can't achieve perfect unity. Unity just means getting out the same amount of energy as we put in. This was discussed in chapter 2 about thermodynamic theory. The first thermodynamics theory stated that, energy output can't exceed the energy input and the second thermodynamics theory stated that is impossible of any process to have 100% of efficiency. Although the toy called as perpetual motion, it does not means can spin permanently. But the spin period can be increased by improve the magnet performance, reduce the resistance such as friction and improve the design of the toy.

The reaction of magnetic field also makes it to spin. This toy is likely same with electric motor. The different is electric motor use electric energy to create electromagnet force and potential energy to rotate the rotor. This toy just gets potential energy from gravitational energy to make it spin perpetually. The concept of electric motor is shown in figure 4.5.

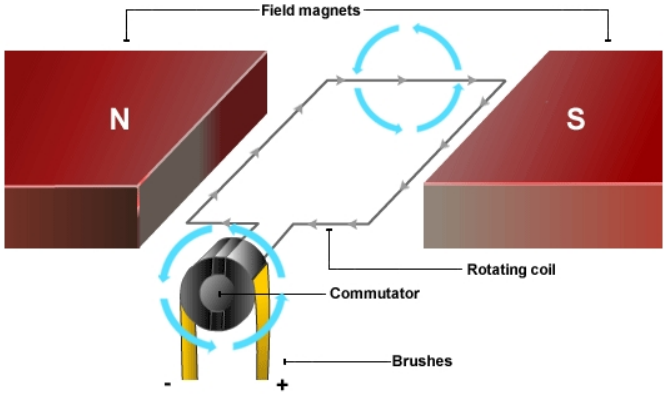


Figure 4.5: Electric motor diagram

4.3.2 Mechanical Phenomena of PMME Toy

As we can see, the mechanical phenomenon created behind this toy is on the system makes it to float and rotate. The system is also used in electric brushless motor where it is working in our lives. The different between these toys with electric motor is energy supplied to move it. Electric motor has supplied by electric energy which makes it rotate faster and powerful compared to perpetual motion magnetic elevation toy.

If we can make the true perpetual motion machine which has 100% in efficiency, it is able to changes people's lives in the future. There are no more nature pollutions resulting from nuclear reactor and burning of fossil fuel to generate electric power in our live. The perpetual motion can replace gas turbine to rotate the generator with no waste substances.

However, much research must be done on this system. The perpetual motion machine is always been a fantastic dream since hundred years ago. There are many attempts along history, but always the same ending. Perpetual motion continues being a legend.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

CHAPTER 5 is the conclusion and recommendation of this project. In this chapter, it will include the objective of this project is fulfilled and some weakness that need to be improve.

5.2 CONCLUSION

This project is finish and the perpetual motion magnetic elevation toy can works as expected with new characteristics. The objectives of this project are achieved at the end of fabrication and analysis of the mechanical phenomena behind perpetual motion magnetic elevation toy.

5.3 RECOMMENDATION

The perpetual motion magnetic elevation toy has its weaknesses which will need to be improved to get a better result.

5.3.1 Material selection

The most suitable material to produce perpetual motion magnetic elevation toy is plastic. But the cost to produce the product using plastic injection moulding machine is high due to the cost to buy the machine.

5.3.2 Strobe Design

The most important part must be considered is levitator strobe. This rotated part must be designed with a balance to allow it rotate properly. Special machine need to be used in making the strobe to make sure it is balanced.

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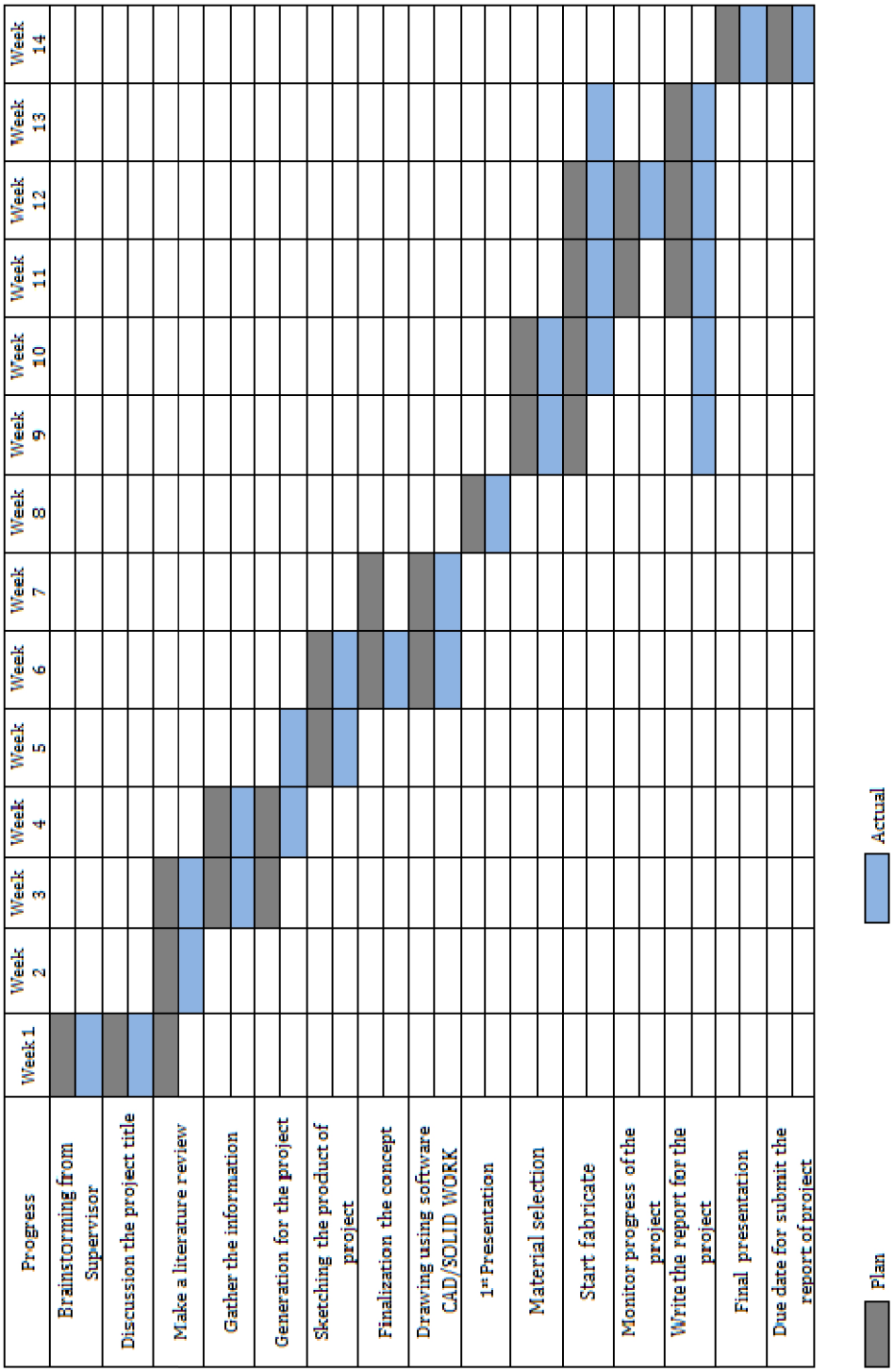
APPENDIX A

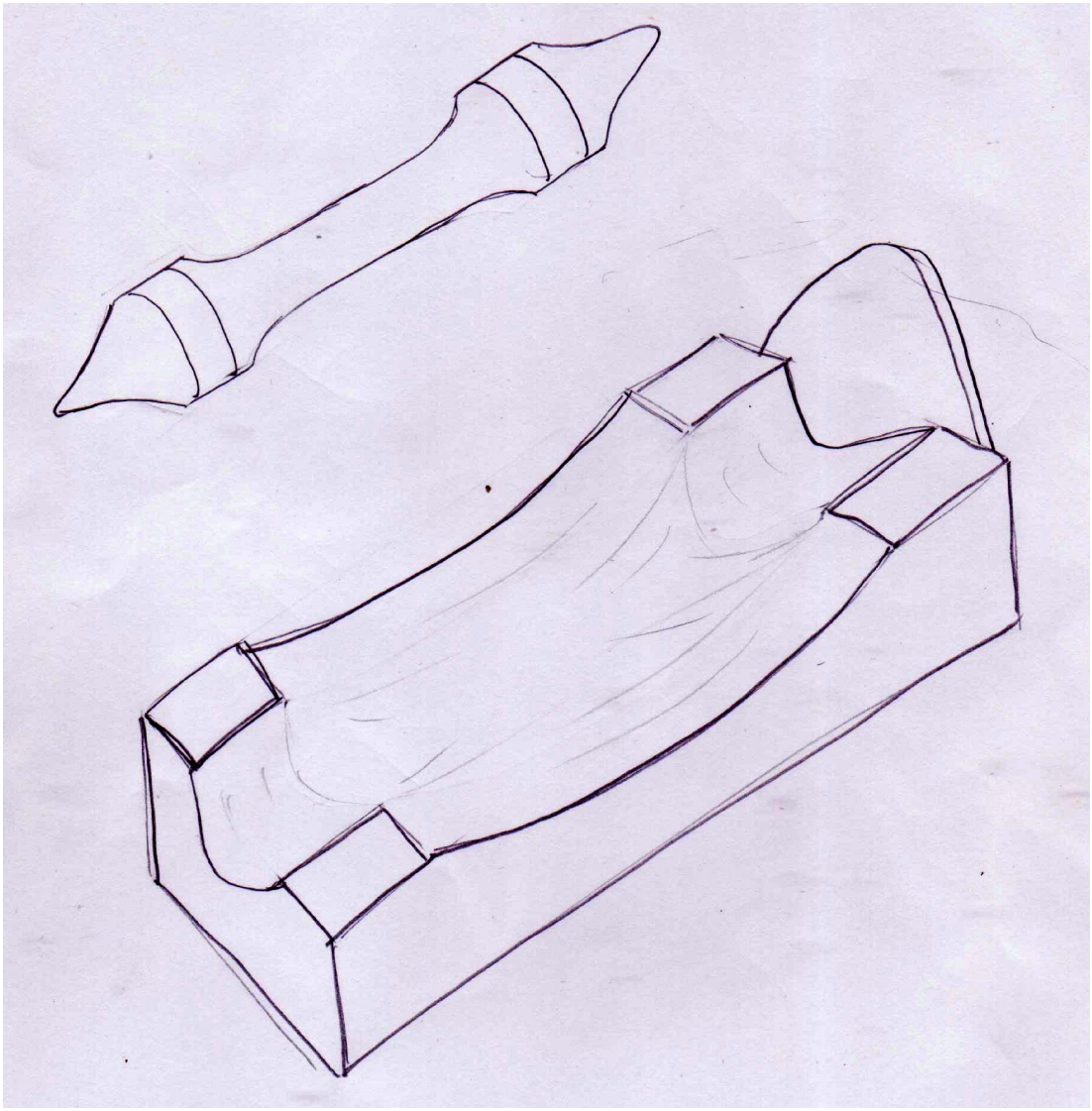
Gantt Chart



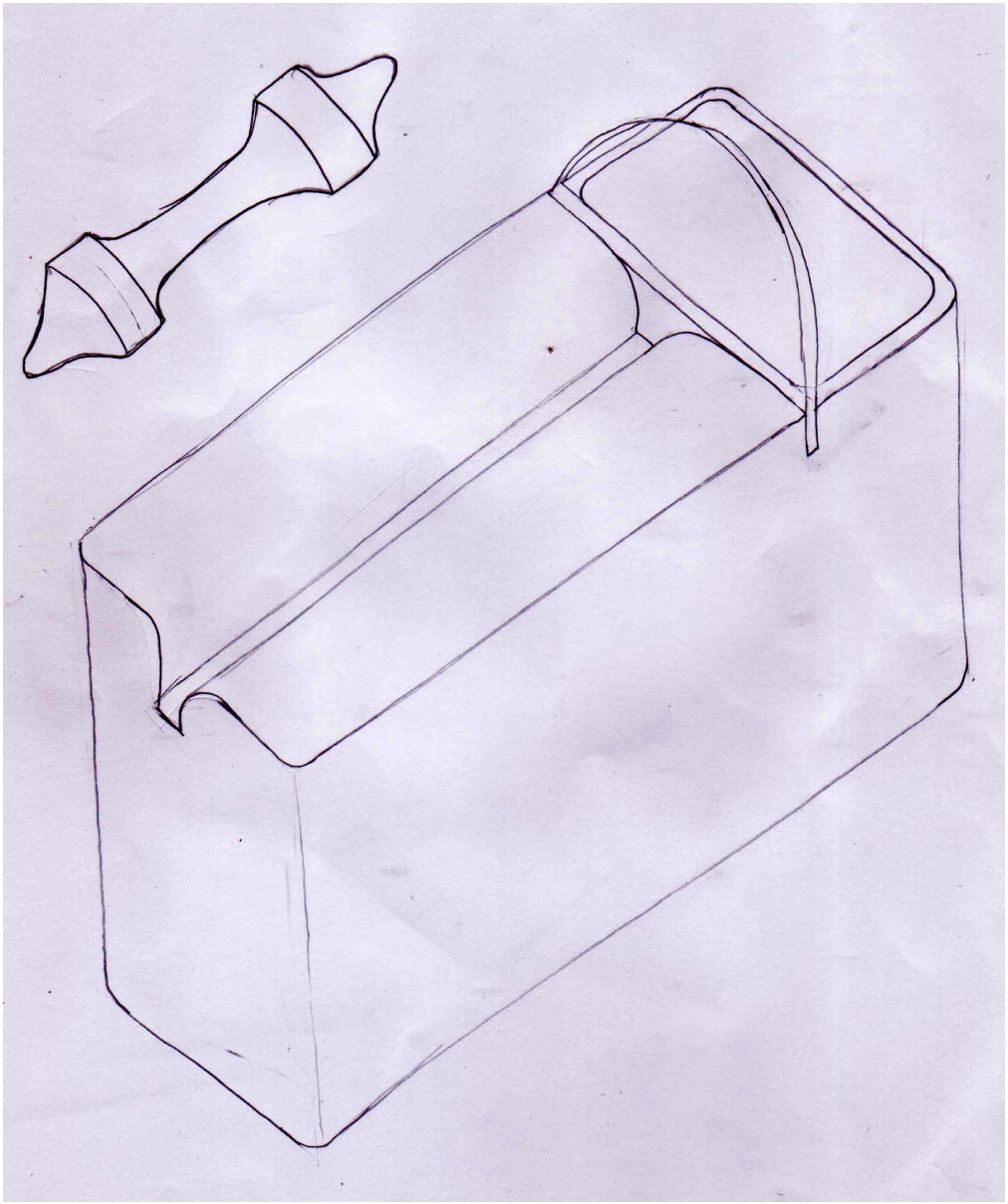
APPENDIX B

Concept Sketching

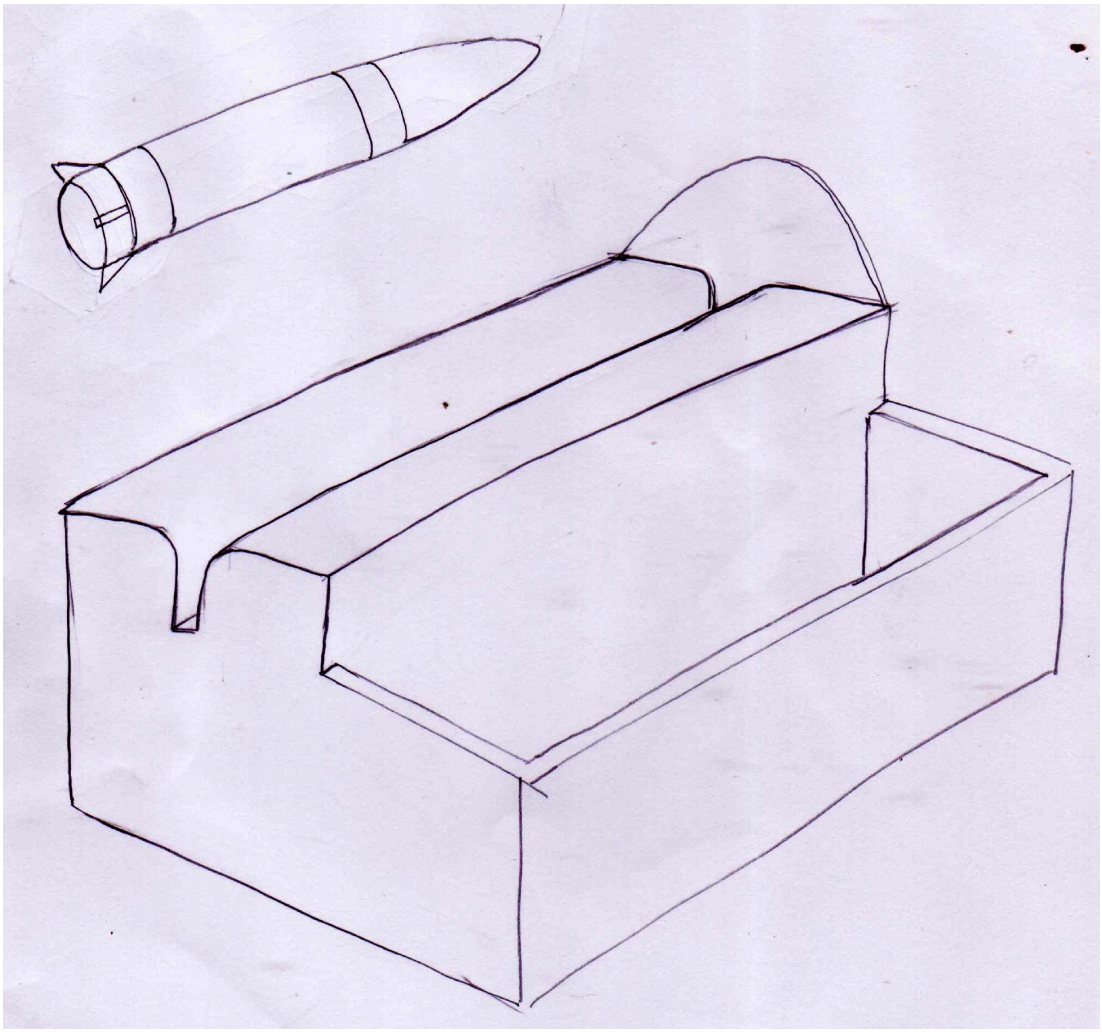
(Datum concept)



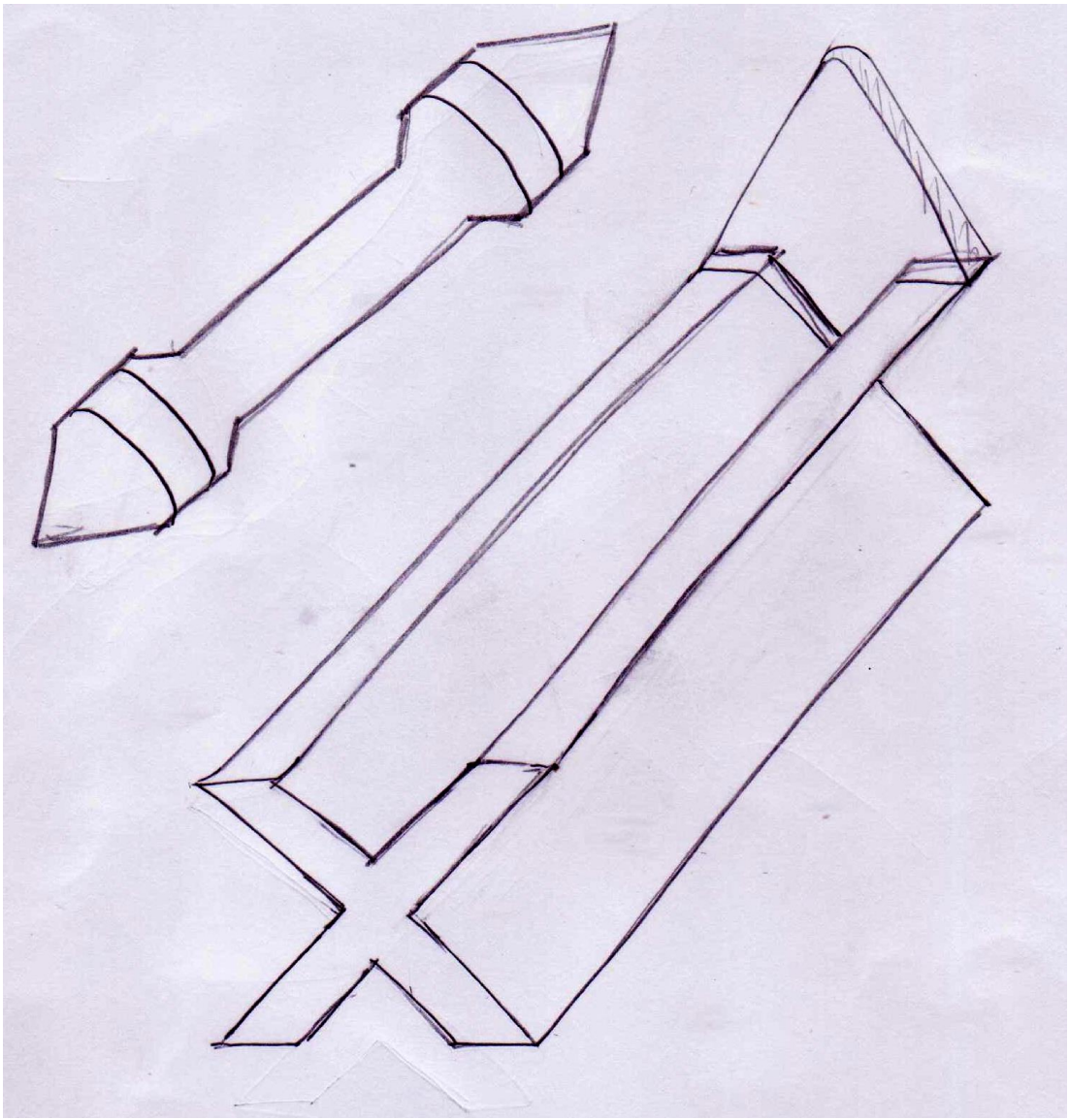
(Concept A)



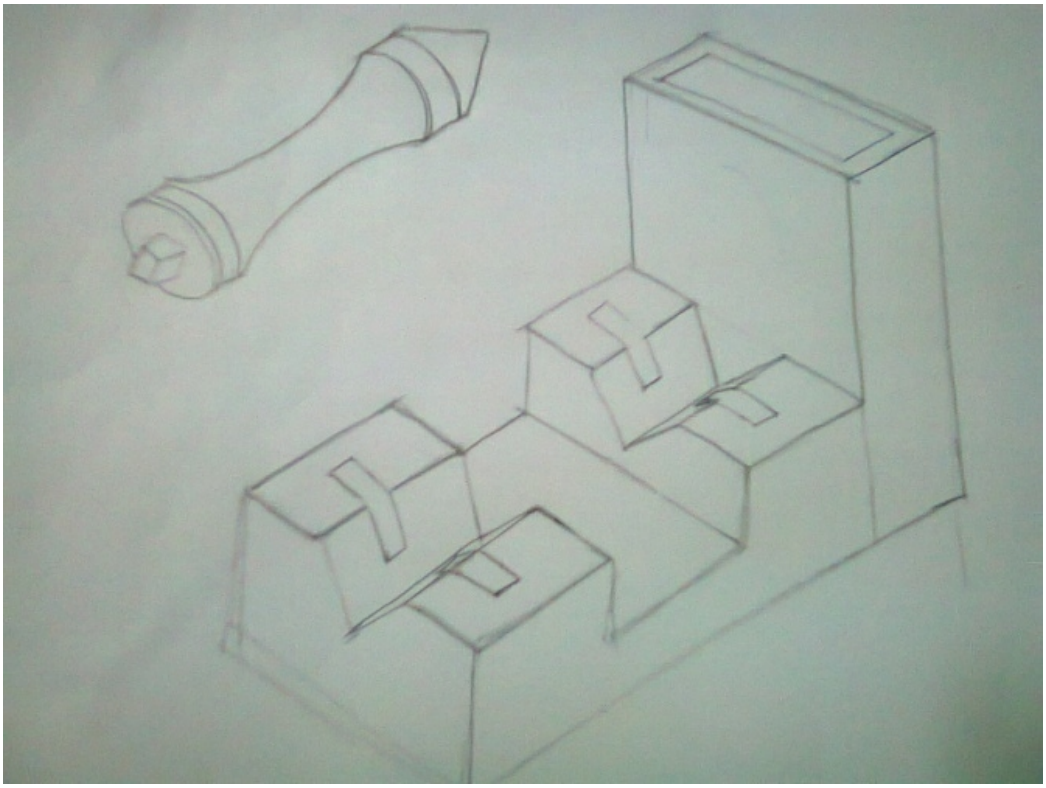
(Concept B)



(Concept C)



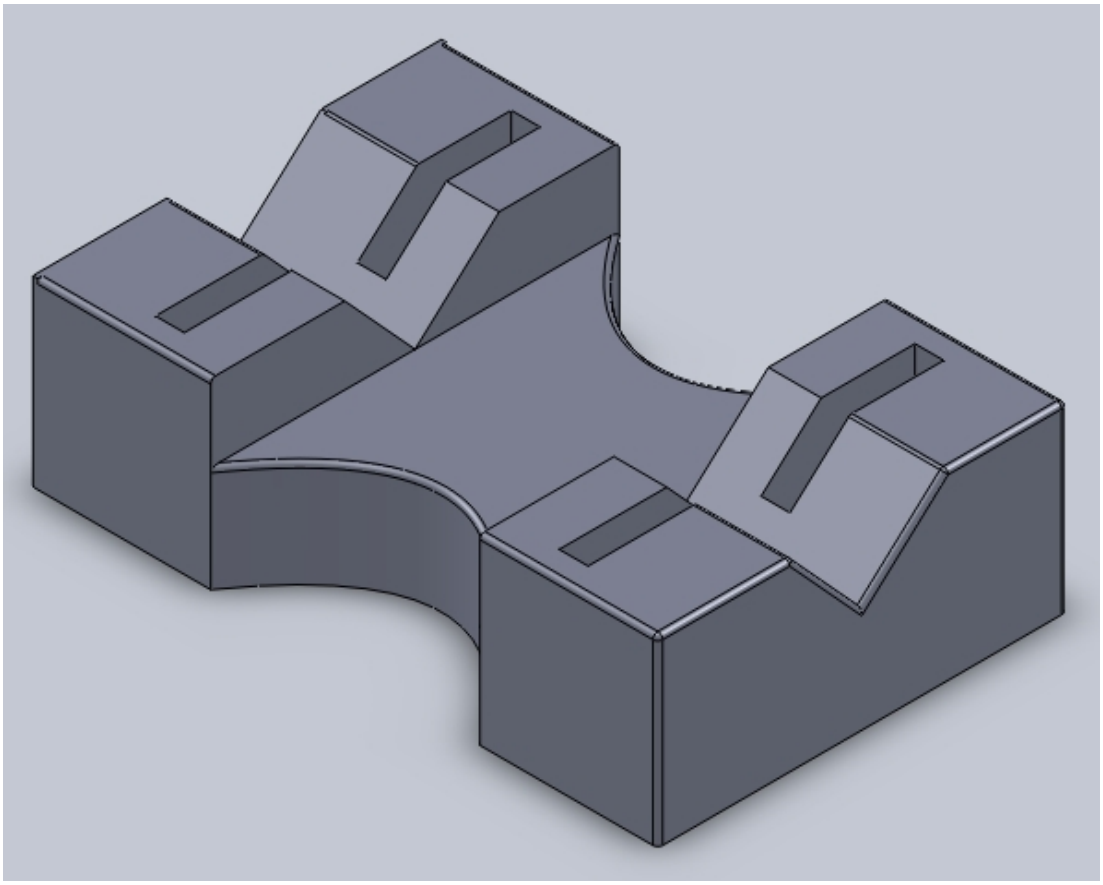
(Final concept)



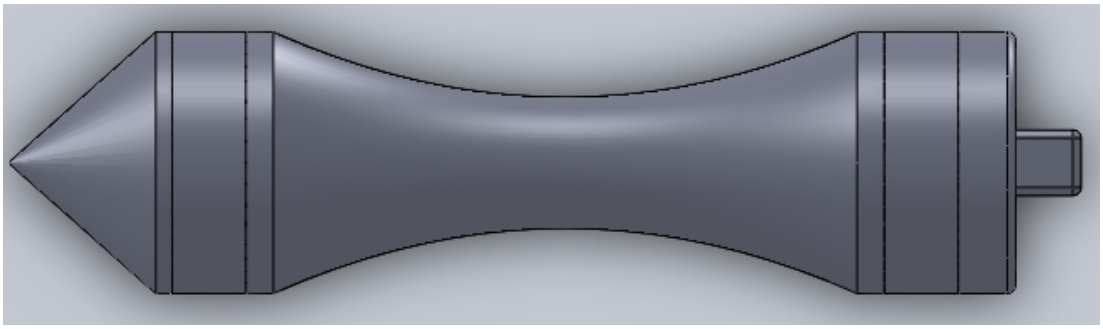
APPENDIX C

CAD Drawing

(Base part)



(Strobe)



(Stationery pocket)