

Slingshot

The Wonder Factory STEM Display F7

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1.0 BACKGROUND

1.2 Introduction

In 2014, a total of 357 Flagstaff citizens were interviewed on the suitability of children play facilities in Flagstaff. Out of those 357, 71% of them said that what current Flagstaff attractions offered was not suitable to meet children's needs, mostly due to the lack of interactive displays. Eighty-four percent of those interviewed also said if something like The Wonder Factory was available, they would visit it and 58% said they'd visit monthly. Additionally, The Wonder Factory visitation can also come from the 4.7 million tourists traveling to Flagstaff each year, 23% of which bring children with them and have no children's-style attraction to visit in Northern Arizona. It is on the basis of these findings that our project was conceptualized.

This project aims at initiating a product to be used in the Wonder Factory where learning can be generated through play. Wonder joy believes that the next generation must be given opportunities for hands-on, interactive experiences to take their positions as the thinkers, the makers, and the creators of the future. Specifically, our project focuses on designing, developing and commissioning a device that can be part of the wonder joy factory. The device has to meet all the required specifications and requirements so as to be able to solve the solution at hand.

1.2 Project description

In this project we will be designing and developing a game for children that will work by it own without human assistance. In this game, children will be able to come and indulge themselves into play without requiring an instructor or guardian to assist them in the play. It will be simple, efficient and infective and most of all interesting for kids to play with. The client needs were at the core of developing this project each and every detail was crafted after a clear consultation with the client so that at the end of it all, we could deliver and meet the client expectations.

By coming up with a device that required minimal or no supervision, the wonder factory efforts could be focused into something else since they would not be required to man the device. At the same time, the children would be able to play safely while ripping maximum benefits. This way, the project will have saved a lot of time and finances.

1.3 Original system

Various slingshot designs exist and every one of them is different from the other reliant with the need being addressed. For instance, if the necessity is sideways shooting and aim easily while at the same time wanting to uphold a wrist neutral position, one with a modified or canted triangle handle on it would be preferred. If the necessity is to shoot at a high speed with truncated weight ammo while at the same time being less disposed to to handslap, then one will need to possess the aptitude to shoot Through the forks (TTF); so that the forks will have to be either common or one of the TTF only kinds. If the necessity is to shoot with a tweak grip then one will have to go with the suitable forefinger and thumb inletting. If forefinger and thumb hammer or braced grip in its place then that kind of handle is best. Similarly, if the necessity is to have a slingshot which is back pocket pleasant, then it has to be a maximum of 4 inches in width by 7 inches in length by 1 inch in thickness.

The standard type nevertheless comprises of a Y-shaped frame that is held in the offhand, with two natural-rubber bands bound to the uprights. The other trimmings of the bands go back to a pocket that grips the projectile. The prevailing hand holds the pocket and draws it back to the wanted degree to offer power for the projectile—up to a maximum duration of the arm with adequately long bands. Whereas early slingshots were greatest allied with young vandals, they were as well able to hunt arms in the arms of an expert user. Firing projectiles, like the lead musket balls, steel ball bearings, buckshot, air gun pellets, or minor nails, the original slingshot was adept of taking creatures such as quail, rabbit, pheasant, squirrel and dove. Placing numerous balls in the pouch yields a shotgun outcome, like firing a dozen BBs at a period for hunting small animals. With an extra suitable rest, the slingshot could as well be utilized to fire arrows, enabling the shooting of medium-sized game at petite ranges.

2.0. REQUIREMENTS

In order for our project to be useful and solve an already existing problem, it was important to consult with other relevant stakeholders that were being to be affected in one way or another by this project. Key of these stake holders was the Wonder Joy who was our client. We were designing a product that was going to be used by kids and as such, certain requirements has to be met so as to make sure the interests of the user, the kids in this case, were well incorporated in the project. Additionally, we had to meet the needs of our client while at the same time achieving other goals such as compatibility with any existing regulations, minimal budget and high efficiency. It is for this reason that we came up with the engineering requirements that would ensure that our project was acceptable even by local and international standards.

2.1 Customer Requirements

According to our client, the basic requirement for device was that it must have a “wonder factor”. Aside from the kids coming to play with the device without any assistance, the device should be able to trigger the kid’s mind and be fascinated by perhaps the simplicity yet the effectiveness of the device. Additionally, since the device had to be operated by kids without any assistance that meant that it had to be simple. Other customer requirements were as summarized in the table below;

Table 1: Customer needs summary

Customer Requirements	Description of customer requirement
Safety	Every exhibit should be safe to operate .
Wow factor	Every exhibit is a celebration of child-like wonder , (i.e. have a wow factor)
Simplicity	Exhibits should be as simple to operate as possible.
Reality	Exhibits should be places where a visitor can project themselves into the role of that reality as much as possible. (i.e. They should see themselves as an engineer, a scientist, a storyteller, a medical professional, naturalist, or an artist.)
Empowerment	Exhibits should empower visitors to " feel " smart so they will excel in perpetuity
Entertaining	Exhibits should be able to entertain multiple visitors

2.2. Engineering requirements

The engineering requirements came both from our team and also as guided by the customer requirements. Key to this was safety. All materials used in the design had to embrace safety of the user and also of the team building the design. Other engineering requirements included; weight that should be met and strength of device. The engineering requirements are summarized in the table below.

Engineering requirements	Description
Strength of the device	Yield strength of at least (8Mpa)
Sensitivity	Every exhibit should be as tactile, auditory, and visual as possible
Weight limit	Exhibits must have a weight restriction under (20 kg) for each part of the design
Sounds	Exhibits will make sound of ringing when the child hits the ring no more than
Plastic fence	The plastic fence will increase the safety to another level.
Operation steps	It will be 3 steps, will take the ball and put in into the slingshot, then we will drag the rubber to generate the tightening force than shot the ball, then you will drag the ball back by pulley and start the operation again.
No game operator	We design it that everything will work without help of game operator. (Zero game operator)
No sharp edges	We will design the fence to not have sharp edges all edges has (1/7" radius)
Wooden pole	We will design the wooden pole to not rotate or move when the ball is hitting it or the balls that dangling from it.
Easy to move	To move it from location to other
Disassemble	The part of each design is easy to disassemble. At least (6 parts)
Assemblage	The part of the designs is easy to assemble to safe time and efforts

2.3. House of Quality and Back Box

The customer needs and the engineering requirements comprise the two main parameters for our design. The two result to dissimilar effects and impacts on the design. The HOQ will be useful in the planning process for our design, which will start with the voice of the customer. Basically, it will enable us to think together.

These parameters possess different weights that they enforce on the exhibit when they reweighed relative to each other. HOQ is comes in handy when weighing the parameters that are in the HOQ relative to one other. From this evaluation it can concluded that the parameters are most significant to contemplate when doing the design process.

House of Quality (HoQ)														
	Weight	Engineering Requirement	Strength of the device	Sensitivity	Weight limit	Sounds	Plastic fence	Operation steps	No game operator	No sharp edges	Wooden pole	Easy to move	Disassemble	Assemblage
Customer Requirement														
1.Safety	5		3		3		9			9	9			
2.Wow factor	4					9		3	3					
3.Simplicity	4			3	9		3	9	3			9	3	9
4.Reality	3			3		3								
5.Empowerment	3			9		9		9	3					
6.Entertaining	4			3		9		9	3					
Absolute Technical Importance (ATI)			15	48	51	72	57	111	45	45	45	36	9	36
Relative Technical Importance (RTI)			8	5	4	2	3	1	6	6	6	7	9	7
Target ER values			Mpa		Kg		m	#		Rad				
Tolerances of Ers														
Testing Procedure (TP#)														
Approval :														
Team member 1: Mobarak Alsubaiee														
Team member 2: Fahad Alotaibi														
Team member 3: Abdullah Alzafiri														
Team member 4: Dhary Aldhafeeri														
Team member 5: Abdullah Howishel														
Client Approval:														

Figure 3: HOQ model

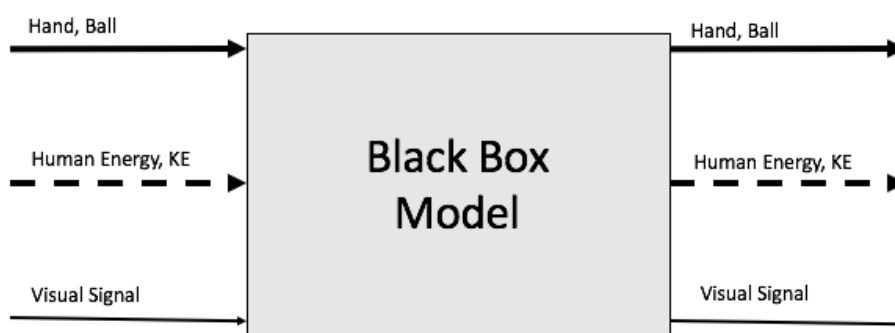


Figure 4: Black Box

3.0. EXISTING DESIGNS

For a long time, kids have taken Y-shaped piece of branch, overextended some surgical tubing or a heavy rubber band over it, and shoot away at tin cans, birds, and windows on

reckless buildings. Ideally, slingshots have existed before. However, our design has been customized to have additional features that did not exist in previous designs. Common to all existing designs is that they focused on the materials. They needed to be light but not too light. They need to be strong but not brittle, and they need to be able to be formed into somewhat complex shapes. Last the materials need to have an attractive finished look.

3.1 Design Research

Design research is fundamental to making services, products, and systems that answer to human requirements. In the international and public development sectors, comprehending and meeting human requirements are precarious for better livelihoods and improved governance [1]. In our case, design research will provide engineering insights that focus on design analyses of previous models and existing designs.

We conducted a primary research fundamentally so as to generate new data to comprehend our client as well as end user well with concerning their needs and what we would possibly plan on designing. It enabled us to validate our thoughts with our users and design a further eloquent solution for them. We collected this kind of data via interviews with surveys, individuals, and questionnaires. Basically, our main interview was done with our client so as to understand their basic requirements to their dream exhibit. It is upon this interviews that we came with a set of customer needs as listed in Table 1. Surveys were done in several children play grounds to see what kind of play facilities were available for children to play. However, we were not successful in finding any slingshot play devices in any of the grounds. Nevertheless, typical Y shaped slingshots were found with some boys and they could use them for shooting at birds for fun

We additionally conducted a secondary research utilizing prevailing data including internet, articles, books, to back our design choice and the perspective behind our design. Secondary research is as well used as an approach to further authenticate user comprehensions from the primary research and generate a stronger case for the whole design [3]. This research helped us to identify and analyze several designs as will be described in detail in the system level below.

3.2. System Level

System-level design is a procedure where the engineer takes accountability for all the constituents of a system when scheming the solution [4]. For the slingshot, for example, the system designer considers the functionality of the device, the different parts that make up the slingshot, as well as the materials used to make the different parts.

3.2.1. Design 1: The Scout Slingshot

This Slingshot is a 100% American finished, high-quality hunting slingshot. It's made ultra-tough from a contemporary polycarbonate material that is utilized in the firearms industry. The Scout comprises the best performers among hunting slingshots, offering sufficient power, precision, and robustness to fulfil anyone requirements. It obtains it's power for shooting from heavy duty flat bands. Its glass filled nylon frame renders it lightweight, yet robust to the roughest usage. One feature that stands out about this slingshot is it's simplicity. Nearly nothing can go erroneous with it considering it's simple, yet functional build.



Figure 1: Scout slingshot [6]

3.2.2. Design 2: Torque Slingshot

This is a solid choice from Simple Shot, and is made from ultra-strong glass packed nylon. This kind is nearly unbreakable. Indeed, it's manufactured to the utmost standards of quality in the USA. It is one of the tiniest hunting slingshot choices in the market and its compact size and lightweight makes it perfect for carrying in the pocket as well as putting it in a bug out bag. Its simple design tells volumes as far as design goes. This model was conceived by Simpleshot with assistance of Mark Seljan, an industrial designer. It's modest, sturdy, and functional. The Slingshot comes equipped to shoot with 2040 twisted tubes, but it can as well handle powerful flat bands. This can simply be changed out through its fork slots.



Figure 2: Torque Slingshot [7]

3.2.3. Design 3: Outdoor Life Stainless Hunting Slingshot

This is a flexible design that can be adjusted and offers a completely adjustable solid steel frame. It is heavier than other designs, but it's however super strong and gives a bit of customization with the position of the fork. It is assembled with a solid steel frame which enables fork position tunings to deliver the best shooting position. Additionally, it can be adjusted on the fly quite easily with a single big steel screw. This as well makes it more adaptable if it is necessary to add longer or shorter bands. The ergonomic precast handle is non-slip and provides the grip required in whichever conditions. One thing to note is that it weighs more than other models as a result of its steel frame and bigger molded handle.



Figure 3: Outdoor Life Stainless Hunting Slingshot [9]

3.3. Functional Decomposition

The functional decomposition describes a set of steps in which the overall function of a device, system, or process is broken down into its smaller parts (Bechtel & Richardson, 2010). This is usually accomplished through thoughtful analysis and team discussions of project information and the result is a chart that describes the problem and or solutions in increasing detail.

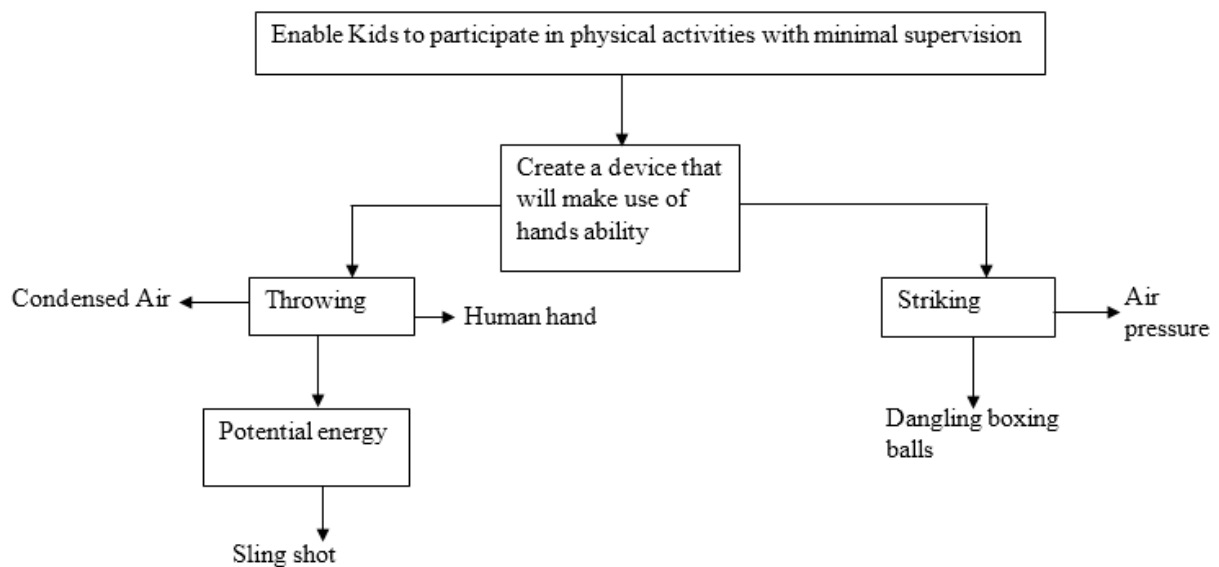


Figure 4: Slingshot functional decomposition

The sole aim of the device is to enable kids to play with minimal supervision while efficiency is achieved. For this to happen, our device will be able to employ two functionalities at ease. This will be the throwing and striking functions. Mechanical energy will be employed via the human hand to stretch the sling shot holding the ball. This will build up potential energy that will see the ball move towards the target when released. The dangling boxing balls possess potential energy which will be used to hit the approaching ball building up pressure which will direct the balls to the pulley system.

Before the drawing of our functional decomposition chart, the problems, processes, and the overall projects seemed intricate. However, this complexity vanished as soon as we took a closer look and broke them down into meeker portions. Comprehending the precise functions and sub-functions which made up the system made it easier for more effective organization and enhanced planning. Additionally, each function could be viewed as an independent unit, making it conceivable to restrict problems at the lowest level.

3.4. Sub system level

The subsystem level comprises the smaller mechanisms of the design that have a critical role in the successful performance of the considered systems. Several sub systems were considered in this design as discussed below.

3.4.1 Rubber bands

The rubber bands can be regarded as the slingshot's soul. They stock and release the energy that utilized in propelling the ammunition. Bands can be replaced, and numerous of a slingshot's features change along with them. They can come in diverse forms dependent on design and material. For instance; Theraband are made by a superior quality rubber, to guarantee the best user experience. This elastic is available in a 6-yard length which enables consumers the suppleness to make custom slingshot band shapes and sizes. Wizard bands are intended for high speed, and reliably deliver distance and velocity. In our project, the durability of the bands will be an important aspect to consider. It must be of high quality and efficient while at the same time having a reasonable cost.

3.4.2: Frame

The frame is the part that is held by the shooter, and keeps the rubber bands in place. It is not as important as it seems, but it plays its part in keeping the shooting process comfortable and obtaining a good sight picture. Safety considerations are important when constructing the frame, as failure of this part can lead to severe injuries.

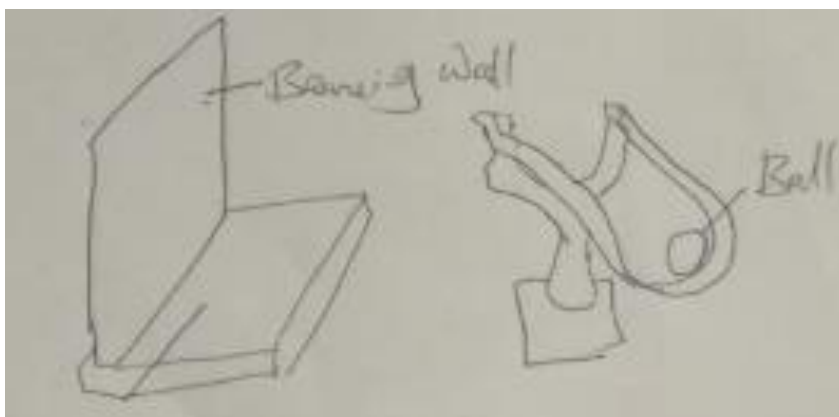
3.4.3: Pouch

A pouch is required to grip the projectile in place prior to and during the shot. Having it at the right weight and size is important to get a virtuous performance. Only scarce materials can endure the stress that the pouch undergoes during the shot, and as such leather is both cheap and affective for this task. It needs to be soft and supple, frivolous and robust. A typical choice is fragmented leather from cow or pig, with a thickness of 1-3mm for standard draw bulks. The best material however is a kangaroo leather. It endures a lot of pressure and strain whereas being soft, supple and lightweight.

4.0. DESIGNS CONSIDERED

4.1. Design #1:

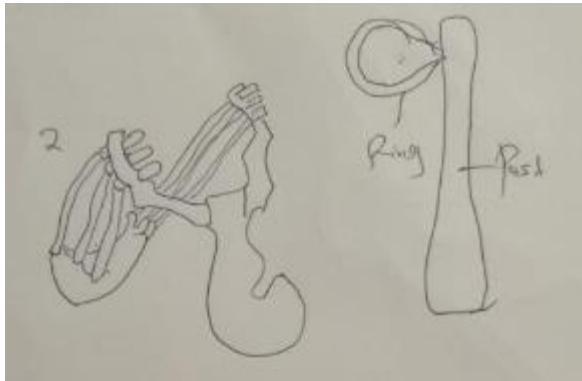
Made of ultra-tough from a contemporary polycarbonate material that is utilized in the firearms industry. This one comprises the best performers among hunting slingshots, offering sufficient power, precision, and robustness to fulfil anyone requirements. A stand will be made using ply wood which will form a bouncing wall to act as the ball target.



4.2. Design #2

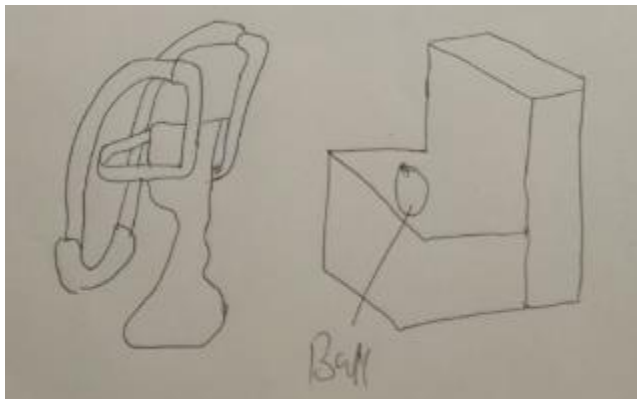
This one is made from ultra-strong glass packed nylon. This kind is nearly unbreakable. It is one of the tiniest hunting slingshot choices in the market and its compact size and lightweight makes it perfect for carrying in the pocket as well as putting it in a bug out bag. A customized

pole with a ring at the top comes with it and the aim of the game will to place the ball inside the ring using the slingshot.



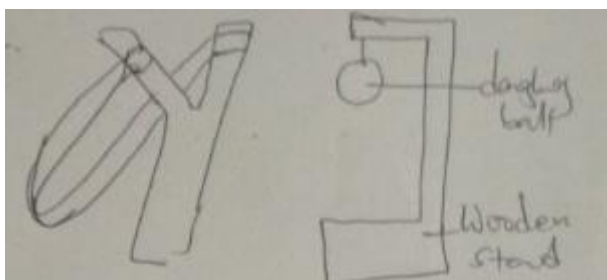
4.3. Design #3

This is a flexible design that can be adjusted and offers a completely adjustable solid steel frame. It is heavier than other designs, but it's however super strong and gives a bit of customization with the position of the fork. A wooden block comes with it acting as the target for the ball.



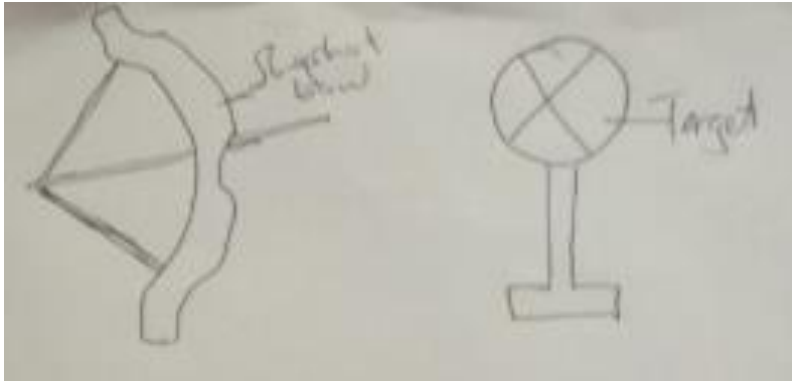
4.4. Design #4:

This incorporates the concept of the traditional Y shaped frame with rubber strips attached to the forks. Balls are then hang on a post to appear like dangling fruits which children can hit.



4.5. Design #5

This design is designed to shoot arrows. The main dissimilarity with the others is that they have an arrow rest and arrow nock. Arrow rests, like the whisker arrow rest, grip the arrow in place and enable the user to shoot with a high mark of accuracy. A dart like board hangs on a wall acting like the target.



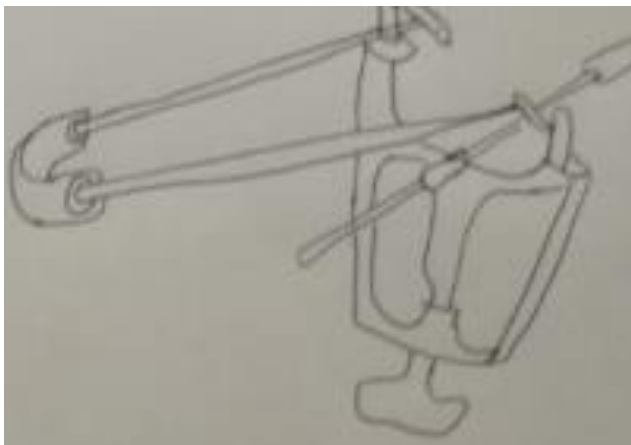
4.6. Design #6

This one is capable of being shot with or in absence of a wrist brace, as it provides the user with the chance to have one unit to support many shooting disciplines.



4.7. Design #7.

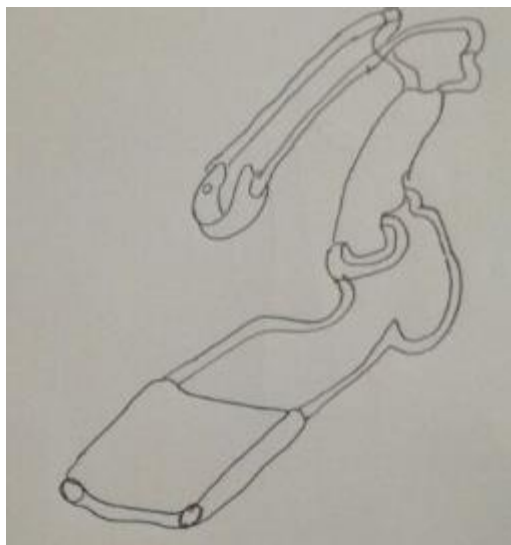
This one is designed to hold a Mini Maglite 2AA flashlight and is known to shoot day or night with bulls-eye precision and accuracy. At night the light can be switched on providing clear visibility for the target. Indeed it possess optic sensors that capture light rays that make the red and green sights glow for better accuracy for shooting.



4.8. Design #8

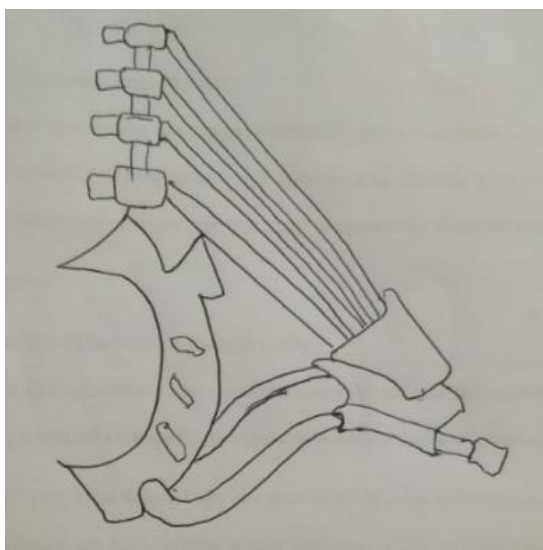
Designed for easy keeping and fetching and has a hinged arm support that folds for appropriate storage. It also comes with a molded finger pleated grip for extra comfort,

hardened steel yoke as well as an arm support, utmost quality hollow thrust bands of shoots 1/4" and 3/8" steel shot.



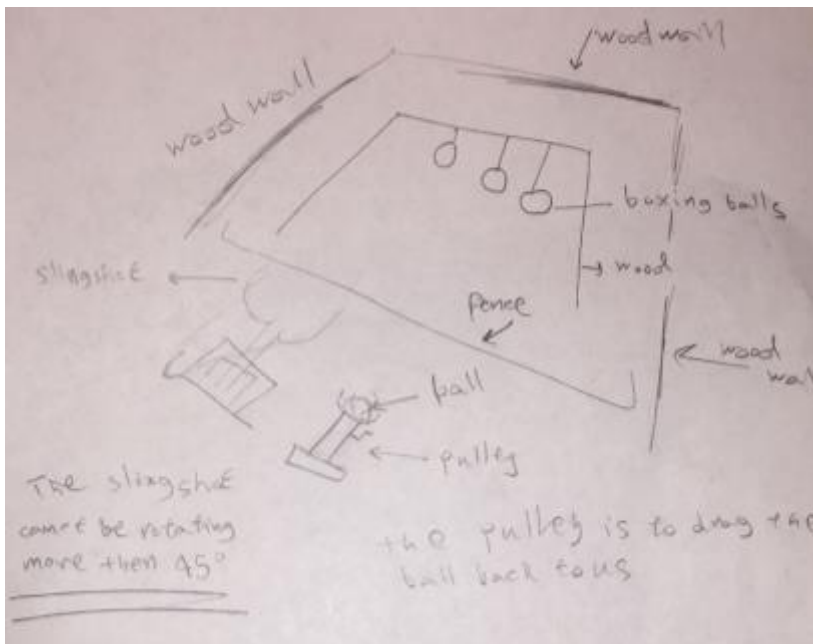
4.9. Design #9

This comes with an adjustable wrist brace including a golden proportions making precision excellent in hunting. This slingshot is particularly good for a beginner. Its high Speed, precise and powerful magnetic leather renders it possible to reload bullets fast.



4.10. Design #10

This one is able to shoot a ball to into a target which is a ring that held on a wooden pole. Once the ball was shot into the target, a pulley is used to drag the ball back to the slingshot for it to be thrown again instead of someone going there to pick the ball.



5.0. DESIGN SELECTED

Selection of the final design lied upon a thorough analysis of all considered designs while assessing them against the HOQ. This gave the criterion that was utilized in the design selection. The identified criterions were utilized in the decision matrix to determine the best of the model amongst the designs considered. After a thorough analysis and evaluation of all the designs, we selected the tenth design since it had the most of the desired qualities.

5.1. Rationale for design selection

All the customer and engineering requirements discussed in Chapter 2 were assessed critically against the ten considered designs. Scores were assigned for each design as to the degree in which it satisfied each of the requirement. The selected design scored high in all these requirements and thus became the best choice.

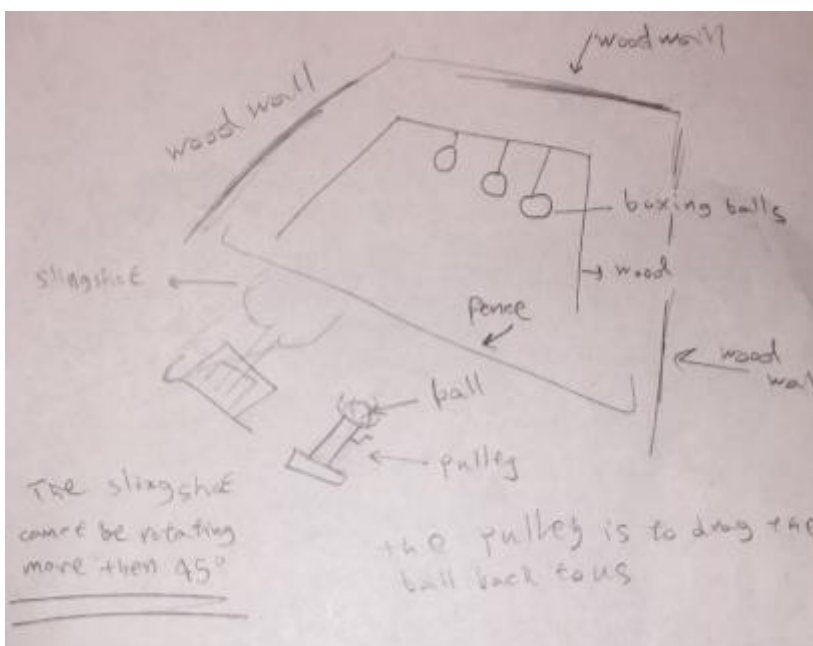


Figure 5: Selected Design

The figure above shows the chosen model through the decision making criterion. Our choice was a customized slingshot that would be able to throw a ball to into a target which is a ring that held on a wooden pole. Once the ball was thrown into the target, a pulley would be used to drag the ball back to the slingshot for it to be thrown again instead of someone going there to pick the ball. A cubic booth of three meters dimensions will be built of wood and in the middle of the booth a wooden pole will stand which will hold the dangling boxing balls. On the opposite side, a sling shot capable of rotating in 45 degrees will be built and the pulley will be connected from here to the pole in the middle of the both. The shooting ball will be covered with a net and a rope will be used to connect the rope with the ball. Finally, a plastic fence with blunt edges will be built in front of the slingshot so as to contain the ball and prevent it from getting lost.

The design won due to its additional customized features that made it fit for the task intended. Additionally, the materials used in this design were durable and of high quality yet cost effective and easily available in the market. Most of all, the design brought out the “wonder factor” in an outstanding way since it had customized features that were not available in any of the other designs. This would results to the kids yearning to play with the device while admiring it in awe.

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