Project: Wonder Factory (Words)
Team 2-A

Midpoint report

Bader Alshammari

Mohammad Alsaidi

Shamlan Alshammari

Mohammad Alotaibi

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Instructor: Sarah Oman

Client: Wonder Factory

Disclaimer

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Executive Summary

In this report, the project has presented about the Wonder Factory. Wonder Factory is place for kids to get entertainment and education at the same time through innovative ideas. Word Puzzle is the final product we have selected to make for the Wonder Factory. To select the final design, lot of Research has done and different existing designs have found in the research. All the existing designs were consisting of cards etc. For the project, want to implement such a product which is attractive and kids like to play with it. Therefore, it has decided to generate our own ideas and select final design from the ideas we have generated. Before that we have identified CR's and ER's according to the information provided for the project. Customer requirements have identified from the information provided by the client and engineering requirements have determined from CR's. Both CR's and ER's have mentioned in House of Quality chart. HOQ has shown the relation between CR's and ER's and it has shown the priority list of ERs'. Then different design ideas have generated for the project according to the CR's and ER's. To select the final design, we have used two different methods, Pugh chart method and Decision Matrix method. These two methods have narrow down the result from 10 designs to 1 design. One final design has obtained and that was catapult design. In this design, a playing arena has developed, that will cover the complete area, and there is a wall on which alphabets are displaying. There is a booth with one side opening and other side has opening window as well placed in front of alphabet wall with the distance of 3 meters. Kid will come into the booth, will take the catapult, and then hit the alphabet. Kid will have 30 seconds to a minute to play with it and determine the complete word. A complete breakdown structure has presented to identify all the parts of project and made the Bill of Materials. Budget of the project has identified as well and then presented the implementation details. After that testing has done for the successful working of project.

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1. Background

1.1 Introduction

Wonder Factory is a platform for displaying interactive items related to children. Wonder Factory is currently present at Flagstaff and it provides the entertainment to the children through different interactive displays. Wonder Factory was founded by Jackee and Steve Alston and their mission is to generate learning through entertainment. In the Wonder Factory, unique and creative products put for displays, and these products are based on the STEM. STEM stands for Science, Technology, Engineering, and Mathematics. So, Wonder Factory is essentially a space for children education with innovation.

In this course, we are working on the project which will exhibit in Wonder Factory, so this project will help our mentor and client in their vision and this project will be based on STEM and our client can present it to the children in the Wonder Factory. This project will get a place in the Wonder Factory and will be an interactive display for the Wonder Factory and for the children as well. We are going to build word Puzzle in this project. This project will play an important role for Education of children as it is word Puzzle so this project will deal with the "Words" and this will increase the dictionary of children, therefore, it will be useful for children learning.

1.2 Project Description

This project is about the learning of children and require such a product which can display in the Wonder Factory and provide the education to the children's. That's why we are going to implement word because it is useful for learning. In word Puzzle, alphabets will interchange their position and make new words. So, word will help in good learning and will increase the dictionary of students. A word where we will have a letter covered in Velcro material and that will be the learning phase.

1.3 Original System

There was no system made before by the time when this project has started so this is a new and original system. The design of this system is original and there is no existing system for this project.

"This project involved the design of a completely new fun playing apparatus for children. There is no original system when this project begins."

2 Requirements

Client has provided the description about the project and from that description client requirements and engineering requirements have induced which were showing in the next section.

2.1 Customer Requirements (CRs)

Customer requirements are those requirements which has provided directly by the client and we should develop the project according to these customer requirements.

1. Safe to Operate
   The device must be safe to operate and it will not hurt any children.
2. Child-like wonder
   Final product must a "wow factor" when the children look at it.
3. Tactile, Auditory, and Visual
   Final product must be appealing and must be easy to see from all sides.
4. Simple to Operate
   Working of the device must be easy so that any children can easily play with it.
5. Portable
   It must be portable so that it can carry to any location.
6. Project Themselves into the role
   Product shows what is the working and use device.
7. Feel smart
   Using the product will give the feeling of smartness.
8. Multiple visitors
   Size of the product is enough so that multiple visitors can see it at any instant of time.

2.1 Engineering Requirements

Engineering Requirements have obtained from the customer requirements. Client has described that each design must be safe, so it must not have any sharp edges. All the engineering requirements are presenting in table 1.

Table 1: Engineering Requirements

Engineering Requirements	Targeted value	Tolerance
Size	3x3 feet	2%
Weight	100 lb.	10%
Bulb Capacity	20 watt	5%
Safe, No Sharp Edge	-	-
Number of words	4	10%
Range	3 feet	3%

Size

Size is the area of word puzzle, which must not be larger than 3 x 3 feet.

Weight

Weight of the product must be less than l00 lb. so it can easily carry and moveable as well.

Bulb Capacity

Bulb which will turn on when the correct answer will get, and the energy of bulb must be lesser than or equal to 20 watts which will turn on using the battery power source.

Safe, No Sharp Edges

This is the important factor to consider as well because safety is important so the project must be safe to operate and must not have any sharp edge as well.

Number of Words

Number of words which will appear in the word puzzle must be less than or equal to 4 at maximum. It can be 1 word, 2 words, 3 words or 4 words but it cannot exceed this value.

In the above engineering requirement "Number of Words" is not clear, it means number of words for any guessing word and its limit is 4 but alphabets can increase to 7 8 as well so it means this engineering requirement has the tolerance of 10% at least.

2.3 Testing Procedures (TPs)

Testing procedures can be done easily to determine the requirements are achievable and correct or not. So, the procedure which can use to test each requirement is presenting below:

Size

Size of the project can determine by scale and measure the length and width. So, size can test through scale

Weight

It can determine through the weight scale which determines the weight of any item. So, placing the project in the weight scale will tell its total weight so in this way weight of product can test.

Safe, No Sharp Edges

Sharp edges can determine by simply testing each edge whether the edge is sharp or not.

Number of Words

Counting the words and it will test whether it is obeying the engineering requirement target value or not for testing purpose.

2.4 House of Quality (HoQ)

HoQ is the chart which compares the customer requirements and engineering requirements. Purpose of HoQ is to get the relation between CR's and ER's and find the priority list of ERs' according to the importance of each ER. If the ER has maximum importance in the project it has highest value of RTI and if the ER is effect the product at minimum level, then its RTI value is minimum. HoQ is showing in the table 2.

Table 2: House of Quality

Engineering Requirements / zz	Importance	Weight less then 10 lb	No Sharp Edge	Area less then 3 x 3 feet	Supply 20 Watt Power	Number of Words	Range		
Safe to Operate	9	3	9	1	3				
Child Like Wonder	3	3	9		3	1	1		
Tactile, Auditory and Visual	3	1	1		1	3	3		
Simple to Operate	9	9	3	3	3	3			
Portable	9	9	3	9		1	1		
Project themselves into the role	1		1				3		
Feel Smart	1			3		9	1		
Multiple Visitors can attend	3	1		9	3	1			
Technical Importance: Raw Score		204	166	147	75	60	25		
Technical Importance: Relative Weight		**30.1%**	**24.5%**	**21.7%**	**11.1%**	**8.9%**	**3.7%**		
Techanical Target Value		10	-	9	50	4	3		
Upper Target Limit									
Lower Target Limit									
Units		lb	-	Sq. ft	Watt	-	ft		

Result of HoQ are showing that minimum is the most important ER to follow and after no sharp edge is important and the least is range.

3 Existing Designs

Different existing designs have found after the research over the internet. Different designs which have implemented before having found in this section and these designs will help us in implementing our project. For doing the research different libraries have used including the Google.

3.1 Design Research

All the design research was done for finding existing designs to take some help from them. These existing designs are presenting in the next section.

3.2 System level

After the research has done, few existing designs have found which are closer to our project. These designs will help us in building our project. These are presenting below.

3.2.1 Existing Design # 1: Butterfly Puzzle

This design consists of a butterfly with boxes in it. Concept of paly is to make the meaningful words in it. This design is useful for learning as children like butterflies so they will love to play this game and when they will play this game, they will learn English vocabulary. The puzzle has shown

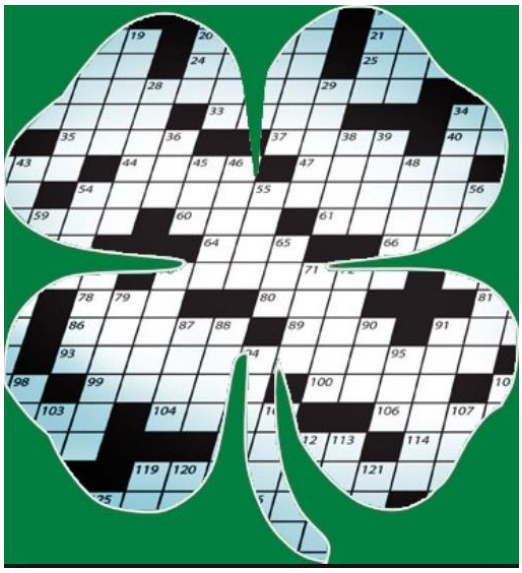

Figure 1: Butterfly Puzzle [2]

3.2.2 Existing Design # 2: Stairs Design

In this design, the idea is to join different cut boards and make the words in meaningful way. All the cut boards are in connector form so they can interconnect with each other in easy way. This is an interesting game and children like to play this game because it is interconnecting the patches to make the words and when children play this game they learn. Design is showing below

Figure 2: Stairs Design [3]

3.2.3 Existing Design # 3: Giant Puzzle

In this game, a giant puzzle has formed on the paper chart and with the cutting paper box on which alphabets have written, uses for making the meaningful words. This game is like a wonder, and not only the children but also young people like to play this game because of its creative and attractive idea. The design is showing below:

Figure 3: Giant Puzzle [4]

3.3 Functional Decomposition

A project can decompose into many sub-parts and functional decomposition of any project means identify the functionality of project through its inputs, outputs and the operations performing inside the product. The Black Box model and hypothesized model are the presenting in the next section.

3.3.1 Black Box Model

This model basically tells the system information which is only limited to the inputs and output of the system. A Black Box model of our project has shown below:

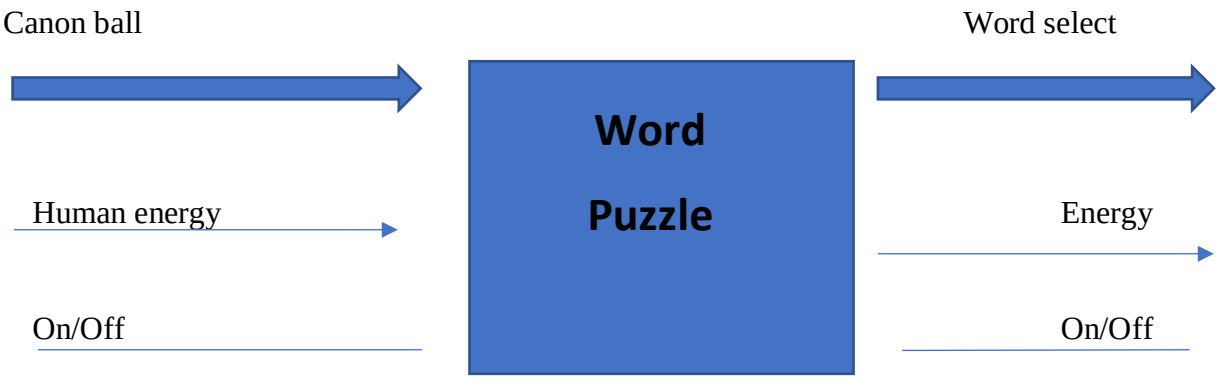

Figure 4: Black Box Model

3.3.2 Functional Hypothesized Model

Hypothesize model explains the internal working of the project. All the working which will be done in the system will explain in this model as the model is presenting down.

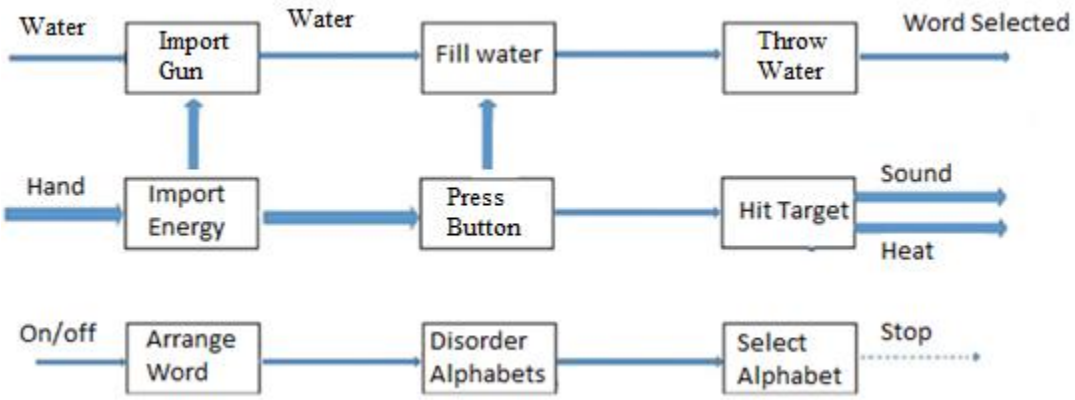

Figure 5: Hypothesized Model

3.4 Subsystem Level

Sub-system level is about the parts of project and their existing design. In this section, we are going to discuss our three-sub system for the project.

3.4.1 Subsystem # 1: launchers

Launcher is a sub-system which will use to select the word, as there are multiple types of launchers, which have already available in the market so this part is about the existing designs which have made for the launchers.

3.4.1.1 Existing Design # 1: Toy Catapult

The toy catapult can be found in many toy stores and it can be used as a launching device in the project by pulling the lever back and release it to shoot.

Figure 6: Catapult

3.4.1.2 Existing Design # 2: Trebuchet

Another type of existing design is already available in the market which is about the Trebuchet. This design can also use for our project as well.

Figure 7: Trebuchet

3.4.1.3 Existing Design # 3: Cannon

Cannon is another existing design available in the market which can use in our project. This existing design has higher range then other two existing design useful for our project as well. The design has shown

Figure 8: Cannon

3.4.2 Subsystem # 2: Board

Another subsystem of our project is the board on which the alphabets will hold and this is the base of our project. There are multiple of boards which can use for this project. And some of the existing designs the board are presenting in this section.

3.4.2.1 Existing Design # 1: Wooden Board

Wooden boar is the good option to use for this project because it is safe to use and it will be hard and strong as well when the arrow will hit the alphabet it will not breakdown as showing in the following figure

Figure 9: Wooden Board [8]

3.4.2.2 Existing Design # 2: Plastic Board

Plastic board can also use for the base, and inside the board alphabets can place as well. it is light weight therefore it is useful for our project as showing in the figure.

Figure 10: Plastic Board [9]

3.4.2.3 Existing Design # 3: Steel Board

Steel board can use for our project but it is hard and holding item on the board is difficult. The existing design for the steel board is showing below

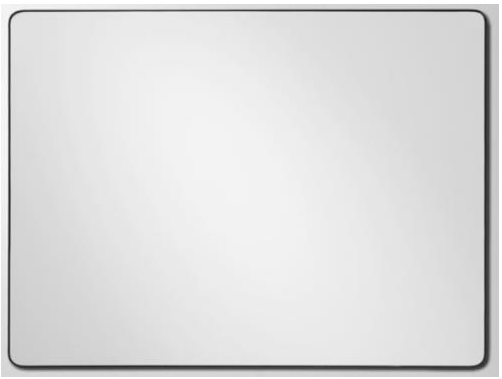

Figure 11: Steel Board [10]

3.4.3 Subsystem # 3: Alphabets Icons

One of the major part of our project is the icons of alphabets which will display on the board and the children will hit those icons throw the arrow. There are different existing designs for making the alphabets icons.

3.4.3.1 Existing Design # 1: Paper icons

Paper can use for making the icons and then the icon will display on the board with the help of gum. As the basic purpose is to make the big icon which easily hit from the arrow so making the icon with paper will easy and these can replace any time as well, as showing below.

Figure 12: Paper icons [11]

3.4.3.2 Existing Design # 2: Cardboard icons

Cardboard can use for making the icons and these icons are strong and have long life comparing to the paper icons. These can also use in our project as showing below

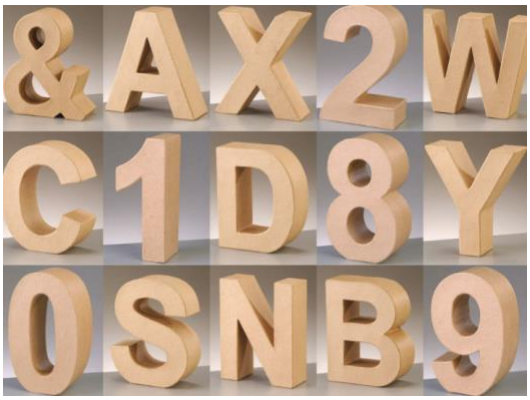

Figure 13: Cardboard icons [12]

3.4.3.3 Existing Design # 2: Plastic Icons

Plastic can also use for the icons and this existing design is useful for our project as well.

Figure 14: Plastic Icons [13]

4 Designs Considered

For doing any project it is important to consider multiple design options and then finalize one of the design which is fulfilling all the requirements of clients. In this part, different designs have considered.

4.1 Design # 1: Ball hitting Board

In this design, the idea is to hit the ball on the icon and in this design, kid will find the alphabet. Concept is that the kid will hit ball one by one to each alphabet and find the complete word. The idea has shown

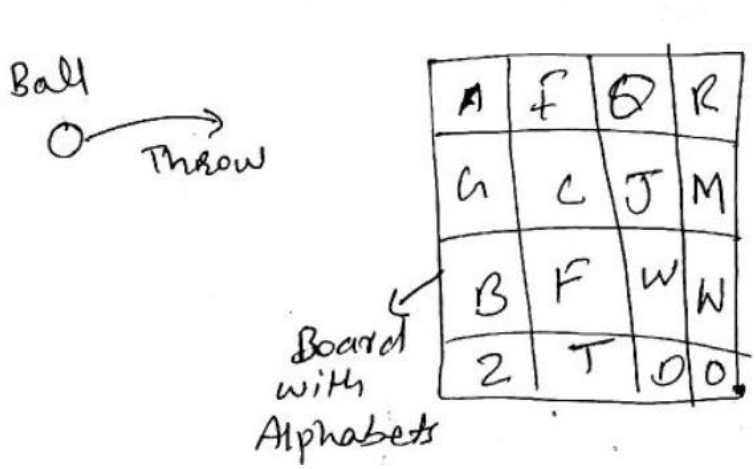

Figure 15: Ball hitting Board

Advantages

- Edges are blend
- Easy to play
- Ball can bounce back
- Safe
- Easy to Set-up

Disadvantages

- Time consuming
- Difficult to identify impact of ball.

4.2 Design # 2: Board on ground

The idea is to place the board on the ground and the kid will throw the arrow in the air which will drop on the board and in this way kid will find the word.

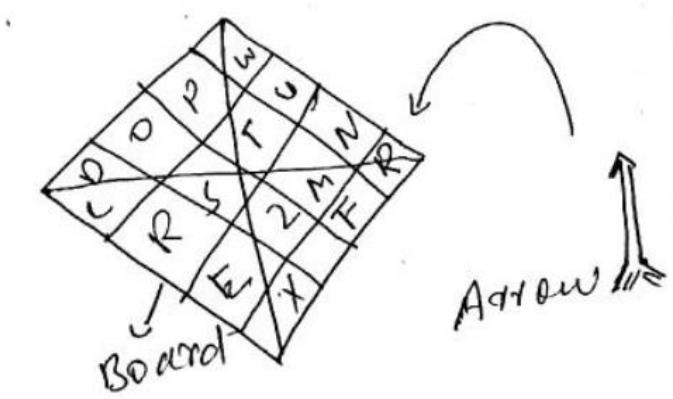

Figure 16: Board on ground

Advantages

- Moveable
- Safe and no sharp edge
- Portable
- Easy to set up

Disadvantages

- Difficult to play
- Difficult to keep placing it on the ground.

4.3 Design # 3: Water Gun to hit board

Idea behind this is design is that a kid will fill the arrow with water and the board will place in front of it. Then the kid will throw the arrow toward the board and kid will identify one word, now fill the arrow again and judge the next word. The water will tell which alphabet has hit and is it correct or not. The game is to play this task in 30 seconds and then see if the kid makes it or not.

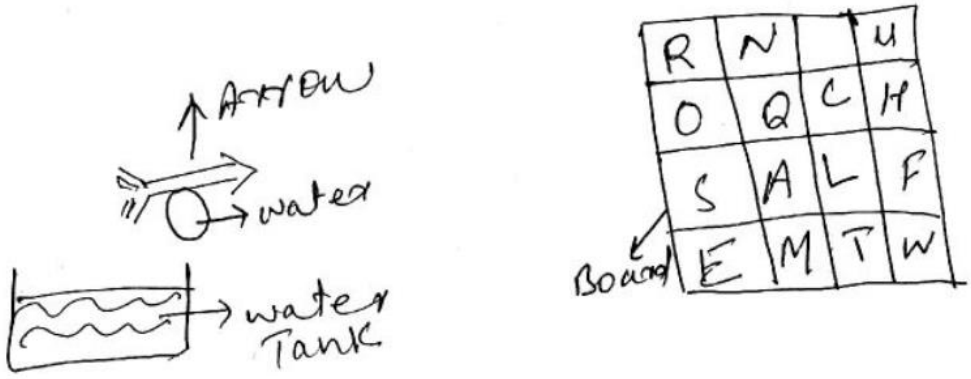

Figure 17: Water hitting

Advantages

- Moveable
- Easy to use
- Moveable

Disadvantages

- Time taking

4.4 Design # 4: Rotating Wheel

The idea is to make the rotating wheel which will rotate and then the kid will stop the wheel and the alphabet in front of arrow head will be the one which has selected and repeat this step until the complete word has found.

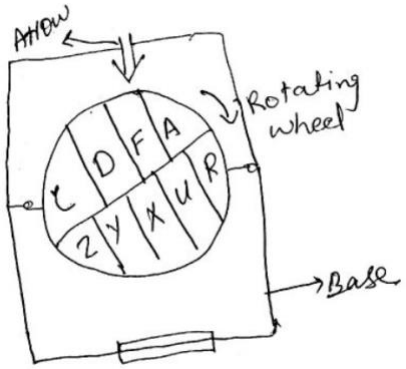

Figure 18: Rotating Wheel

Advantages

- Easy to use
- Portable

Disadvantages

- Difficult to run the wheel by kid

4.5 Design # 5: Stairs board

The idea is that kid will stop the ball on the row in which correct alphabet is present and then it will take that alphabet and put it down in the lowest free area to make the complete word, as showing below in the figure.

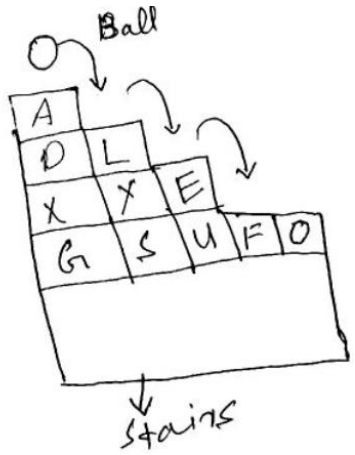

Figure 19: Stairs board

Advantages

- Moveable
- Easy to use

Disadvantages

- Cannot handle the correctly

4.6 Design # 6: Rotating Flower

This design is about the flower, which is in rotating form and the kid will hit the flower with correct point to find the alphabet. As it is showing below.

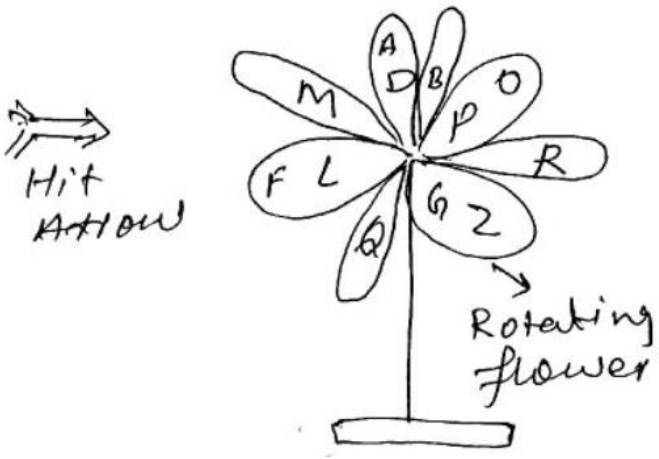

Figure 20: Rotating Flower

Advantages

- Easy to use
- Portable
- Entertaining

Disadvantages

- Difficult to find the correct word while the flower is rotating.

4.7 Design # 7: Box Puzzle

In this design, the concept is that a box with enclosed alphabets which can read from the closed box, kid will tell the correct word and the box will open else it will not open. The design is showing below in the figure.

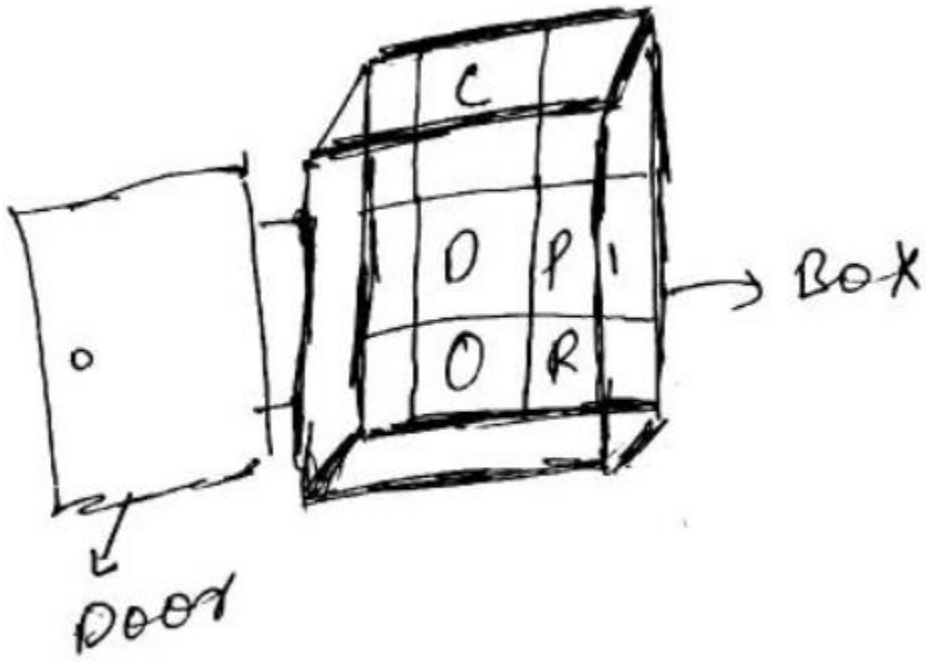

Figure 21: Push Wall with Baby Walker

Advantages

- Easy to use
- Entertaining
- Sound motivations
- Portable

Disadvantages

- Control for the kid is not possible

4.8 Design # 8: Mobile Board

The idea is to make the mobile board which will have the keypad and kid will enter the correct word, one by one alphabet and it will determine the correct word until then it will keep telling the kid you are entering wrong. The idea is showing in the following figure.

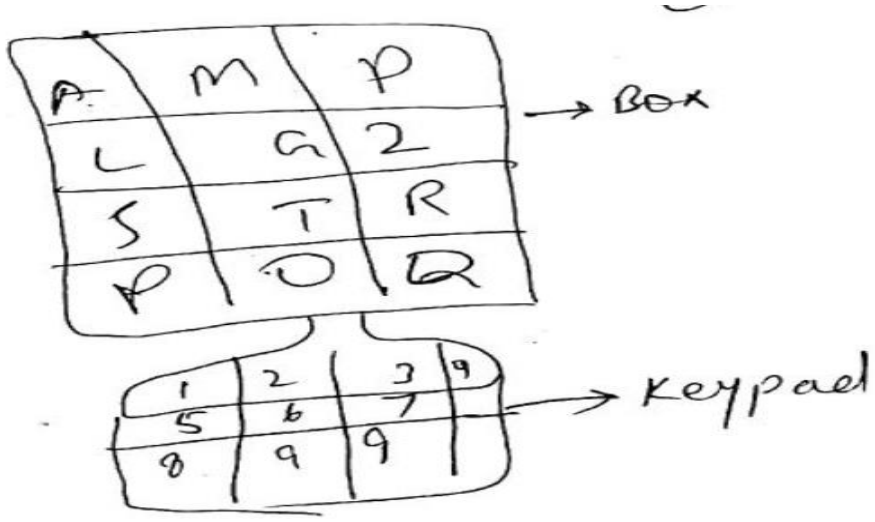

Figure 22: Mobile board

Advantages

- Easy to use

Disadvantages

- Difficult to handle by the kid.

4.9 Design # 9: LED based Puzzle

The idea is that a ball will throw to each alphabet and the LED will show green light if the correct alphabet has hit, in this way kid will keep hit the board with ball and find the correct word as the figure is displaying the idea.

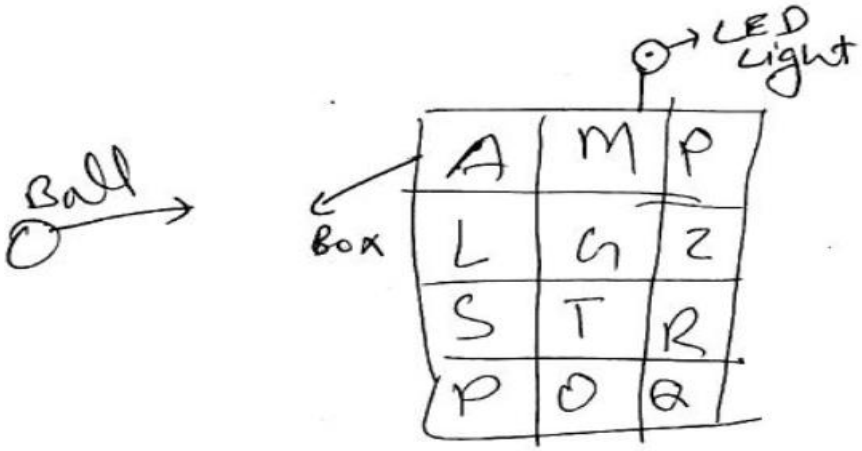

Figure 23: LED based Puzzle

Advantages

- Easy to use

Disadvantages

- Controlling LED is difficult

4.10 Design # 10: Dropping Cards

The idea is that children will drop each alphabet by hand which is wrong, so the correct one will keep remain in the board and the correct word will determine as showing below

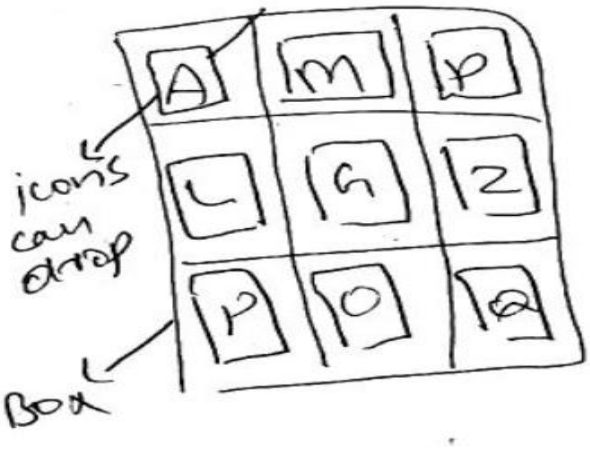

Figure 24: Dropping Cards

Advantages

- Easy to use

Disadvantages

- Not safe
- Any card can hit the children

5 Design Selected

This chapter is about the selection criteria and explaining different ways to select the final design. There were two methods available for the selection of design. These methods were Pugh chart and Decision matrix. These two methods are using below for the selection of final design.

5.1 Rationale for Design Selection

In this project, we are going to implement the word puzzle, in which the design idea is to make such a word puzzle which is entertaining, safe and educational for children. Therefore 10 design ideas have created and these 10 ideas have narrowed down to 3 designs using Pugh chart.

In Pugh chart, all the customer requirements were tested for each design and evaluated the customer requirements. If the CR is present in the design plus sign put in the box otherwise minus sign was put in the box.

Table 3: Pugh Chart

5 Designs for Fun Apparatus	Weightage	Ball Hitting Board	Board on Ground	launcher to hit	Datum Design: Rotating Wheel	Rotating Wheel	Stairs Board	Rotating Flower	Box Puzzle	Mobile Board	LED based Puzzle	Dropping Cards
Safe to Operate	7	+	-	+	D	+	+	-	-	+	+	-
Child-like wonder	6	S	-	+	D	-	-	S	+	+	+	+
Tactile, Auditory and Visual	5	-	-	+	D	+	-	-	S	+	-	-
Portable	4	+	-	+	D	+	+	S	-	-	-	S
Project themselves into the role	3	-	-	+	D	S	+	+	-	-	S	S
Feel Smart	2	+	+	+	D	-	-	-	S	S	-	+
Multiple Visitors	1	-	+	+	D	+	-	-	-	S	S	-
Pluses		3	2	7	-	4	3	1	1	3	2	2
Minus		3	5	0	-	2	4	4	4	2	3	3

From the Pugh chart, we can see that there are three designs which are at the top, number one is "Launcher to hit" and second design is "Rotating Wheel" and the last one design is "Mobile Board". These designs have found as the top three because these three are fulfilling most of the customer requirements. As we see, the design at top is fulfilling all the requirements so it could be count as the final design but it is better to go with the second method and take the three top designs and narrow down the result to final design using the decision matrix. In decision matrix, each requirement has checked with each design and marks have given to each design for each requirement which multiplied with its weightage value and then sum up all the values to make the total score. Final design was the one which obtained maximum total score.

Table 4: Decision Matrix

	Safe to Operate	**Child-like wonder**	**Tactile, Auditory and Visual**	**Portable**	**Project themselves into the role**	**Feel Smart**	**Multiple Visitors**	**Total**
Weightage	7	6	5	4	3	2	1	
Launcher to hit	5x7=35	6x6=36	2x5=10	7x4=28	7x3=21	5x2=10	5x1=5	145
Rotating Wheel	4x7=28	5x6=30	3x5=15	1x4=4	2x3=6	4x2=8	2x1=2	93
Mobile Board	3x7=21	2x6=12	1x5=5	2x4=8	2x3=6	2x2=4	4x1=2	58

Decision matrix gave us the final design as the highest marks value is the "Launcher to hit" design because it is fulfilling all the customer requirements, not even a single requirement is missing from this design. It is easy to use, it is safe to operate, it is tactile, entertaining, and child-like wonder is present as well in this design that is why "Launcher to Hit" has selected our final design.

5.2 Design Description

Final design has selected which is catapult. It is a design in which alphabets will hit using catapult. catapult will shoot a ball toward the direction of the board. Kids will use the catapult and adjust the angle to choose which alphabet they want to hit. In this way, kids will have completed the word they want to hit and they would need to finish the required word from a given limited time which will be from 30 second to a minute. The words that the kids will hit will depend on the age of the kid that is shooting the target. If he is not able to finish the correct word in the given time, then his turn will be over and next kid will come and play in the same procedure as first kid has done. To understand the design completely, CAD model has developed which is showing below in the figures.

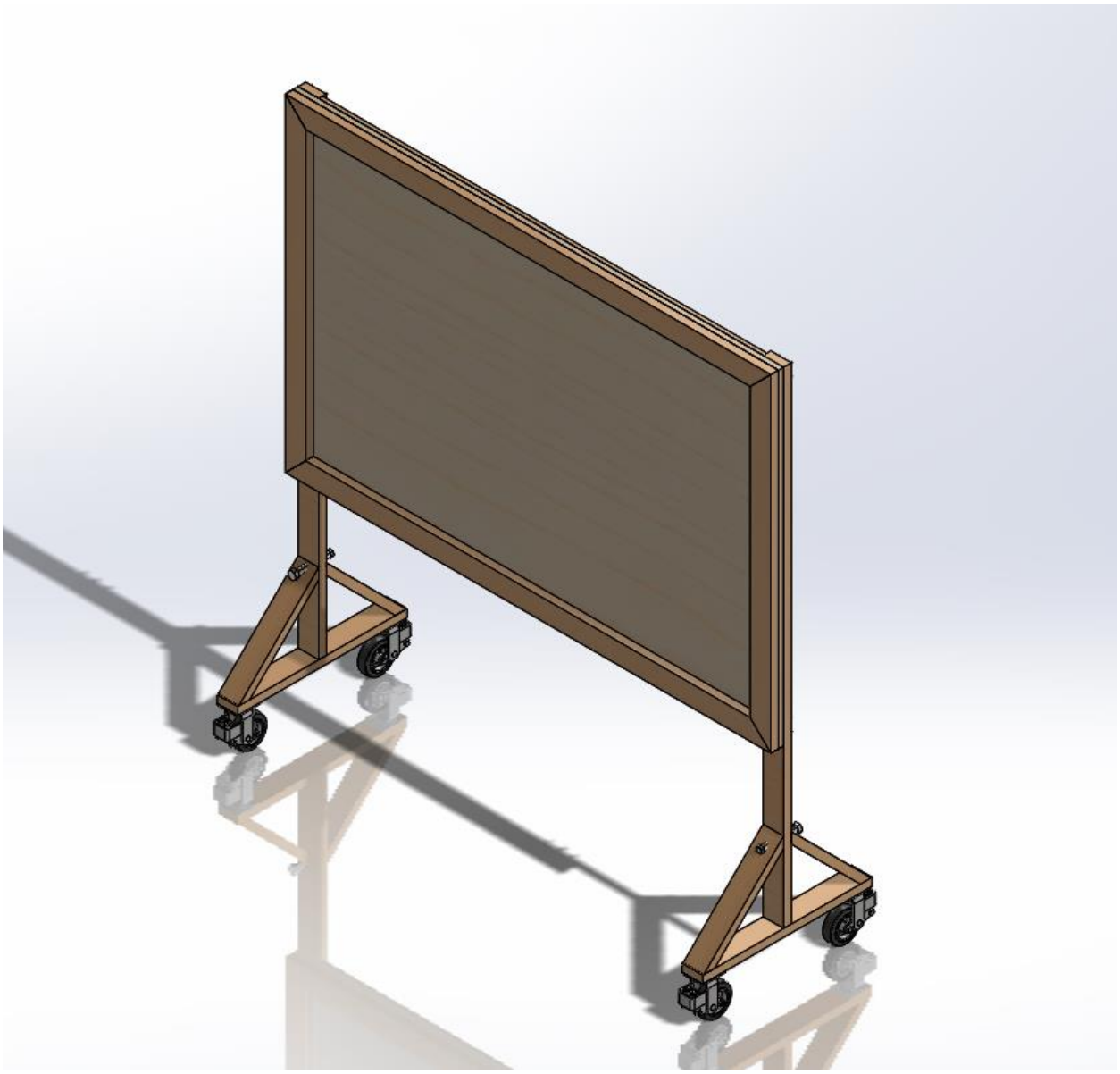

Figure 25: Final Design CAD Model board

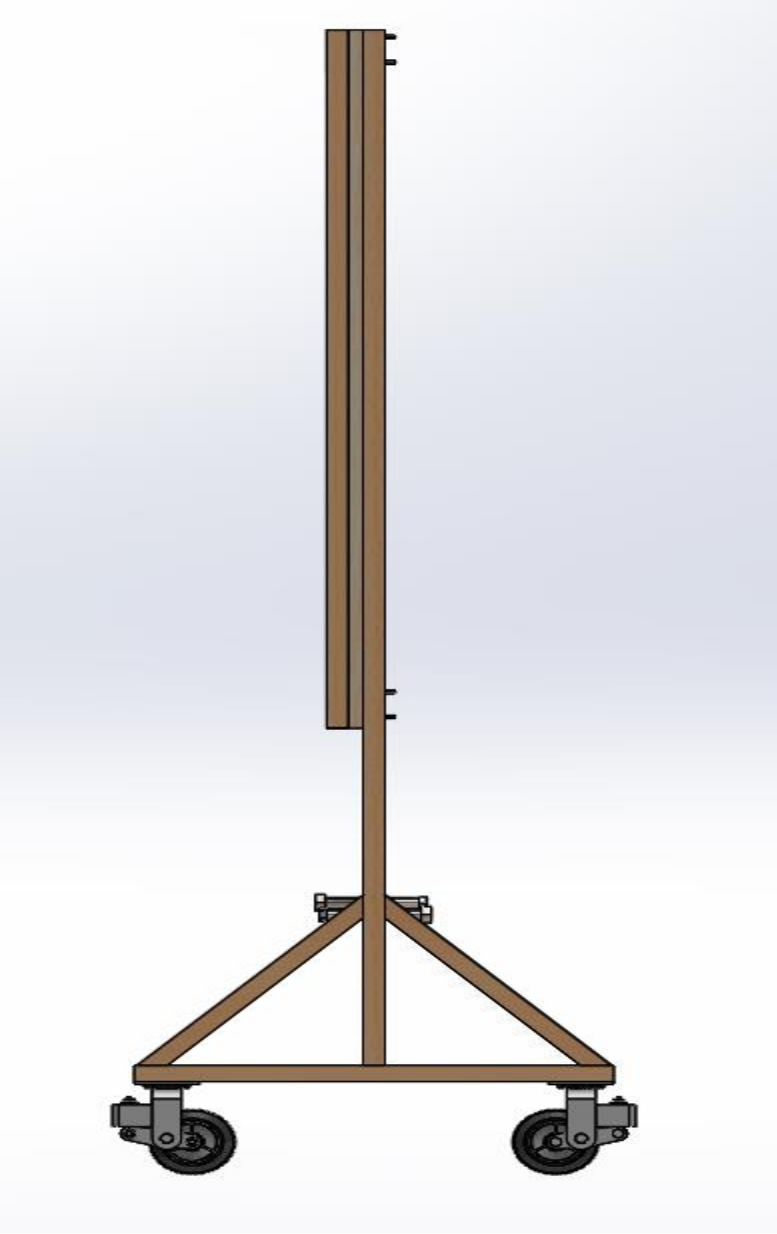

Figure 26: Final Design showing the side view of the board

In the above figures, you can see that wheels that are used to make the project portable. Attached with it is the load attached to the board. Also, we used Hex Bolts to keep the wood attached to the load coming from the board. We also used a 45-degree angle and drilled holes with the same diameters as the Hex Bolts. Also, on the wheels we used a specific kind of wheels which the caster wheels who can lock the wheels and keep them from moving. Furthermore, we choose the 90-pounds wheels to meet with the requirement that our client mentioned to us which must not go above the 100-pounds limit.

6 PROPOSED DESIGN

The proposed design has described complete in the previous section. It has the ground platform, alphabet wall, booth with one side open and there is an opening window in the wall. kid will mark the alphabets from the opening window. Distance between the booth and alphabet wall is around 3 meters. There is timer require in the project that will countdown the 30 seconds. A Catapult is needed as well for this project and a small ball container. The detailed breakdown structure has provided in BOM. And cost of the project has presented as well in next sections.

6.1 Bill of Materials

Detailed breakdown structure has provided in the Bill of Material. It has all the parts require building the project, their manufacturing process and their use as well. Dimensions of each part has mentioned as well in BOM. Bill of materials is present in Appendix A.

6.2 Budget and Cost

Budget of the product has presented in the Figure 27. Below you will find the cost that is used so far to build half of the project.

Bill of Materials						
Project Name				Wonder Factory Project (Words)		
Team				Team 2-A: Bader Alshammari, Shamlan Alshammari, Mohammad Alotaibi, Mohammad Alsaidi		
Part #	**Part Name**	**Quantity**	**Description**	**Material**	**Dimensions**	**Cost($)**
1	Hex Bolts	2	A bolt to keep the boards stick to each other	Steel	3/4-10"X8"	3.55 each
2	Plywood Board	2	A board to hold the Alphabatical boxes in it	Wood	1/4 in x 4 ft x 8 ft	26.92 each
3	Caster Wheels	4	To move the project from one place to another	Steel	2 in with 90 lb	3.98 a piece
4	Redwood Lunber	8	To cut and build the project from it	wood	2 in x 4 in x 8 ft	9.77/ PIECE
5	screws	45	To install and uninstall the wheels on the board and help board stick each other	Steel	5/16 in x 4 in	21.97 a pack
6	Trim Screws	100	To help in building the boards and place items to it	steel	8 x 1-1/2 in	6.97 a pack
7	plastic wood natural latex carpenter's wood filler	1	To help glew wood to each other	Fluid	N/A	4.18
Total Cost Estimate ($):						188.14

Figure 27: BOM (BUDGET & COST)

Schedule of the project has presented below in the Table 5.

Table 5: Schedule

Week	Date	Agenda Item
1	6/5	Team/Staff Meetings*
	6/6	Team/Staff Meetings*
2	6/12	Team/Staff Meetings*
	6/13	Team/Staff Meetings*
3	6/19	Hardware Review 1
	6/20	Hardware Review 1
4	6/26	Team/Staff Meetings*
	6/27	Team/Staff Meetings*
5	7/3	Team/Staff Meetings*
	7/4	Team/Staff Meetings*
6	7/10	Midpoint Presentation and HR 2 combined
	7/11	Midpoint Presentation and HR 2 combined
7	7/17	Team/Staff Meetings*
	7/18	Team/Staff Meetings*
8	7/24	Final Product Testing Proof
	7/25	Final Product Testing Proof
9	7/31	Final Presentation and Poster
	8/1	Final Presentation and Poster
10	8/7	Team/Staff Meetings*

In the above schedule, all the details about meetings and the project has presented.

7 IMPLEMENTATION

Implementation of this project will be done later, for the time being only CAD model has implemented which will then use to implement the actual product.

7.1 Manufacturing

For the manufacturing process is not completely done due to not finishing the second part of the project. We borrowed some tools from our friends to build this project. Such as; saws and other materials. The building and the material that were used was done by following the steps below:

1) Started by building the frame for the plywood.

•Placed plywood on saw horses

•Measured out 35 inches' width and 86 inches' height on plywood with chalk line and a measuring tape.

•Cut plywood with skill saw along chalk lines

2) 4 cedar 2 by 6s were used for the frame. Two boards were sawed at 94.5 inches with 45 degree cuts.

•All measurements were made using a

•Cuts were made using an electric miter saw

•The other two planks were cut also with 45 degree angles. All four board were running down a table saw to cut a 1/4-inch groove between the planks on the inside.

•A 1/4 groove was measured equal distance between the 1.5 inches' thickness of the board on the 2 by 6

3) Plywood wood was cut at 35 inches by 86 inches. Plywood board was then slid into the grooves on the frame.

•Hammer and mallet used to fit plywood board into grooves

4) Frame was screwed down with 5/16 inch structural screws.

•Before structural screwed were fastened into frame. Two predrilled holes every inch along the side on each 2 by 6 where the 45 degree angles intersect were made first so the screws have holes to line up the frame.

5) Wood putty used to fill gaps between the 45 degree angles.

6) Legs were cut at 61 inches' length wise to give support. Impact head Screws were used to attach legs to plywood frame. 8 total screws per leg.

7) Leg supports with wheels were cut at 32 inches long as to fit into a door frame. The 4 support legs cut at 22 inches and with 45 degree cuts used to support legs of frame.

8) 2 parts of 6-inch lag bolts were used to tighten support legs.

9)4 pieces of 90-pound locking wheels screwed down the bottom with 1/4 1.5-inch lag screws. All the parts were used to by using the following material and tools.

Materials used:

•1 4" by 8" by .25' birch plywood

•8 cedar 2' by 6' actual, 1.5' by 5.5' by 8"

•5/16th 4 inch structural screws.

•6-inch lag bolt with matching washer and nut.

•Natural color wood putty

Also, the tools that were used to do this first part of the project were:

Tools used:

•Ten-inch electric miter saw

•Electric drill

•Ten-inch electric table saw

•Six-inch electric Skill saw

•Electric Jig saw

•Two by three feet Saw horses

•Measuring tape

•Chalk line

•Pencil

•Marker

•Hammer

•Rubber mallet

•T square

•Ruler

•Four foot and eight-foot level

•5/16th inch wood drilling bit

•3/4th inch wood drilling bit

7.2 Design Changes

Following changes have made in the design:

1. Design has changed from the original design. Before that we were using the water arrow to hit the alphabet but before the implementation we have decided to change the design of it. catapult is cleaner to use by kids therefore we have decided to change the design from water arrow to the catapult.

2. Second change we have made in the design was making the playing area, before that the design was simple and there were no boundary walls around, so the design has changed to make it look like a proper gamming area so that kids will like to come into the playing arena.

3. Instead of using boxes for the letters in the board, Velcro material will be used to hold the ball coming from the catapult.

4. A ball will be used to hit the target instead of the water gun that we were thinking of using before.

5. Wheels will be used to make the project portable from one place to another.

6. The board itself will be used to adjust the height of the board.

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APPENDICIES

APPENDIX A: Bill of Materials

Item #	Part Name	Quantity	Description	Function	Material	Manufacturing Process	Dimension
1	Window	1	For placing alphabets	Alphabets will place in the window and hit by ball throw	Wooden	Wooden Cutter	2 x 2 ft.
2	Walls	3	Walls for boundary	Walls covers the playing arena	Aluminum	Aluminum Molding Formation	5 x 5 feet
3	Catapult	1	Catapult for throw	Catapult to throw the ball towards the alphabet	Plastic	Plastic Deformation	6 in x 3 in
4	Container	1	Store the balls	balls store in the container for reloading the catapult	Plastic	Plastic Deformation	1 ft. x 1 ft.

5	Timer	1	See the time	Countdown timer to ring the bell	Plastic	Plastic Deformation	4 in x 4 in
6	Bell	1	Ring the bell	Give the alarm for over time	Iron	Iron Molding Process	6 in
7	Alphabets	26	English Alphabets	Alphabets to stand in the window	Plastic	Plastic Deformation	2 in x 2 in
8	Standing Board	1	To stand for play	Kid stand over the board for playing the game	Plastic	Plastic Deformation	2 ft. x 2 ft.