

Project: Wonder Factory
Team 2-A

Final Report

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Disclaimer

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Executive Summary

In this report the project has presented about the Wonder Factory and word puzzle is the product developing for Wonder Factory. Wonder Factory is place for kids to get entertainment and education at the same through innovative ideas. Research has done on the design project and different existing designs have found. Along with customer requirements and engineering requirements have mentioned with HoQ. Then different design ideas have presented as well and the final design has selected using the Pugh chart method and decision matrix method. Final design which has selected is the that there is a playing arena in which a front wall has alphabets and children will go inside the arena and hit the alphabets using the water gun to select the word. Children will have 30 seconds to guess the correct word.

ACKNOWLEDGEMENTS

During one of our Staff meetings with our instructor, she has given us some ideas of how to hit the target by considering the factor safety; therefore, we thought of using a sticky arrow that when it hits the target it stays attached to it and there is no sharp edges on this arrow.

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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 has developed by Jackee and Steve Alston and their mission is to generate learning through play. 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 Puzzle because it is useful for learning. In word Puzzle, alphabets will interchange their position and make new words. So word puzzle will help in good learning and will increase the dictionary of students. A word puzzle will have a box, inside the box, alphabets will display in some disorder form. There will be a word hidden in the box which will find by the children and that’s 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 begin.”

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 have to 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 voice producing 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 actually 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 100 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 and 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.

Bulb Capacity

Capacity of output power obtained from the project can determine through the voltmeter equipment by placing positive knob with positive side and negative knob with negative side to determine the output voltage and then calculating the output current. After that using the following formula

$$P = VI$$

Power of the system can determine and check if it is feasible or not.

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 ER's

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: HoQ

Engineering Requirements		Importance	Weight less then 10 lb	No Sharp Edge	Area less then 3 x 3 feet	Supply 20 Watt Power	Number of Words	Range		
zz										
	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%		
Technical 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 have 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 has done for finding existing designs in order 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 design will help us in building our project. These are presenting below.

3.2.1 Existing Design # 1: Butterfly Puzzle

This design consist 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

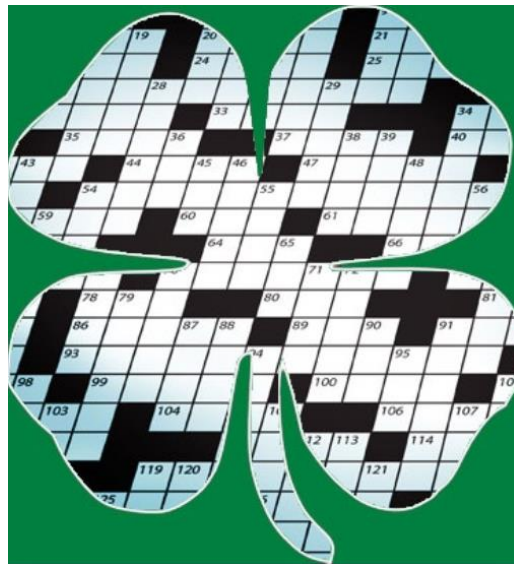


Figure 1: Butterfly Puzzle [2]

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:

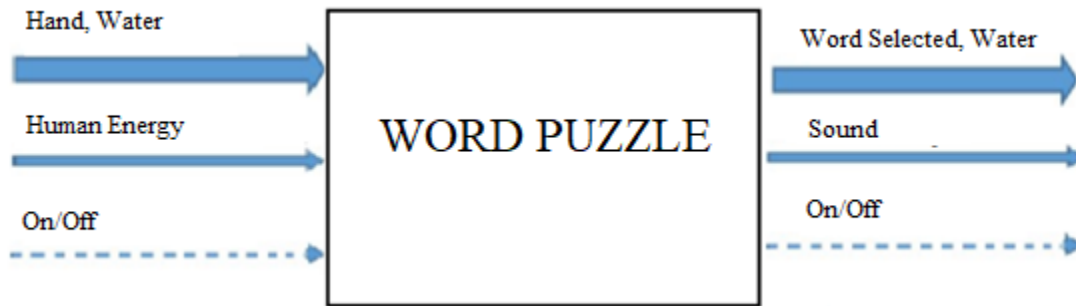


Figure 4: Black Box Model

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.

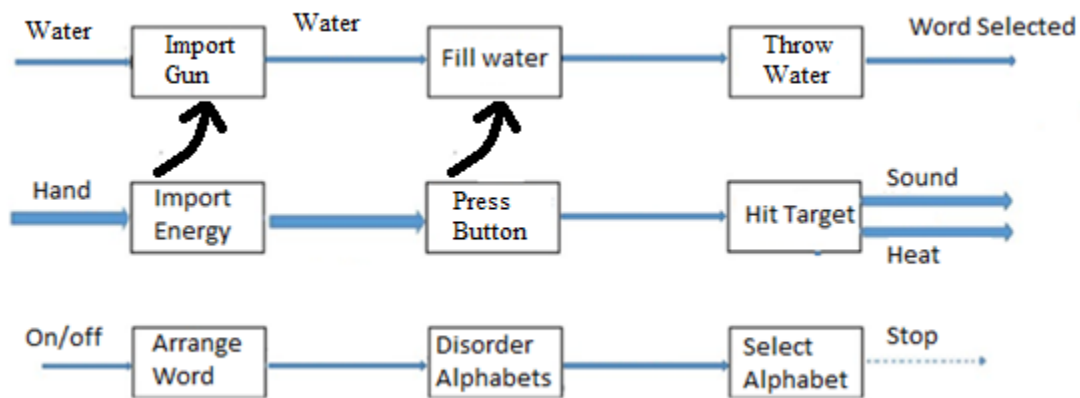


Figure 5: Hypothesized Model

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: Water Gun

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

3.4.1.1 Existing Design # 1: Plastic water gun

Plastic water gun has made already and available in the market. We are also planning to use water gun for our project therefore, this existing design can help in our project as well. Plastic water gun has shown



Figure 6: Plastic Water Gun [5]

3.4.1.2 Existing Design # 2: Water Rubber Gun

Another type of existing design is already available in the market which is about the rubber gun. This design can also use for our project as well. Currently rubber gun has shown



Figure 7: Steel Arrow [6]

3.4.1.3 Existing Design # 3: Water Aluminum Gun

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



Figure 8: Water Aluminum Gun [7]

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 board 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

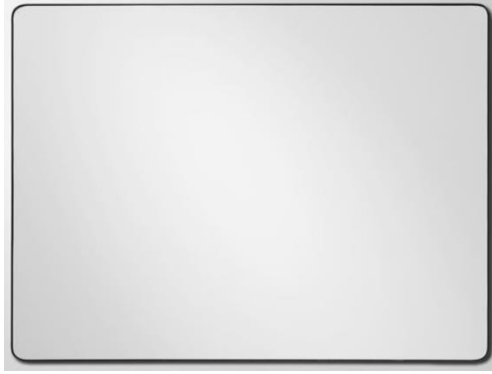


Figure 11: Steel Board [10]

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

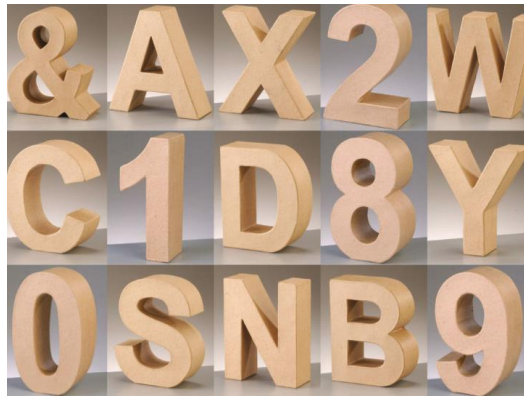


Figure 13: Cardboard icons [12]

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

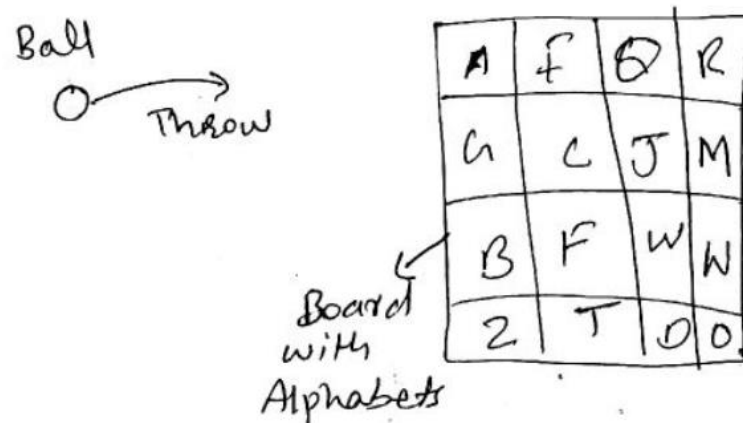


Figure 15: Ball hitting Board

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.

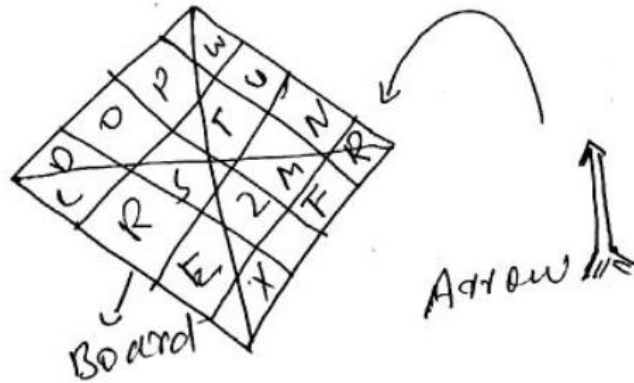


Figure 16: Board on ground

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 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.

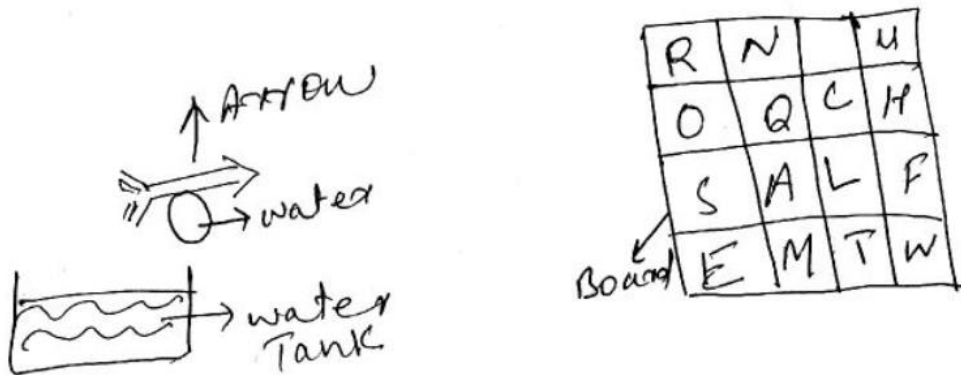


Figure 17: Water hitting

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.

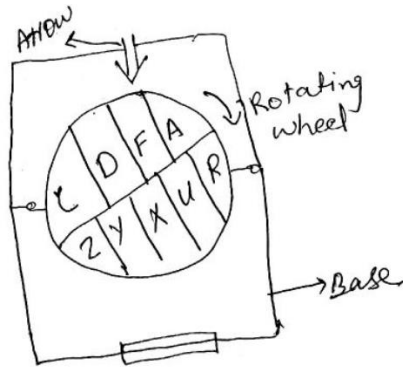


Figure 18: Rotating Wheel

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.

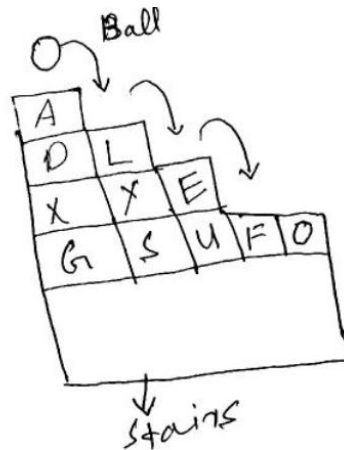


Figure 19: Stairs board

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.

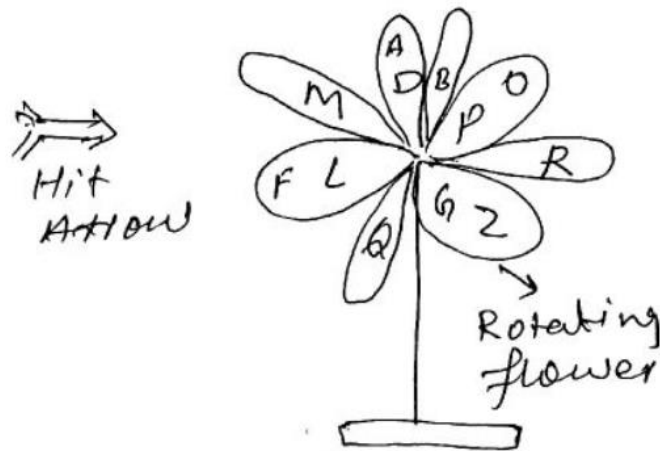


Figure 20: Rotating Flower

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.

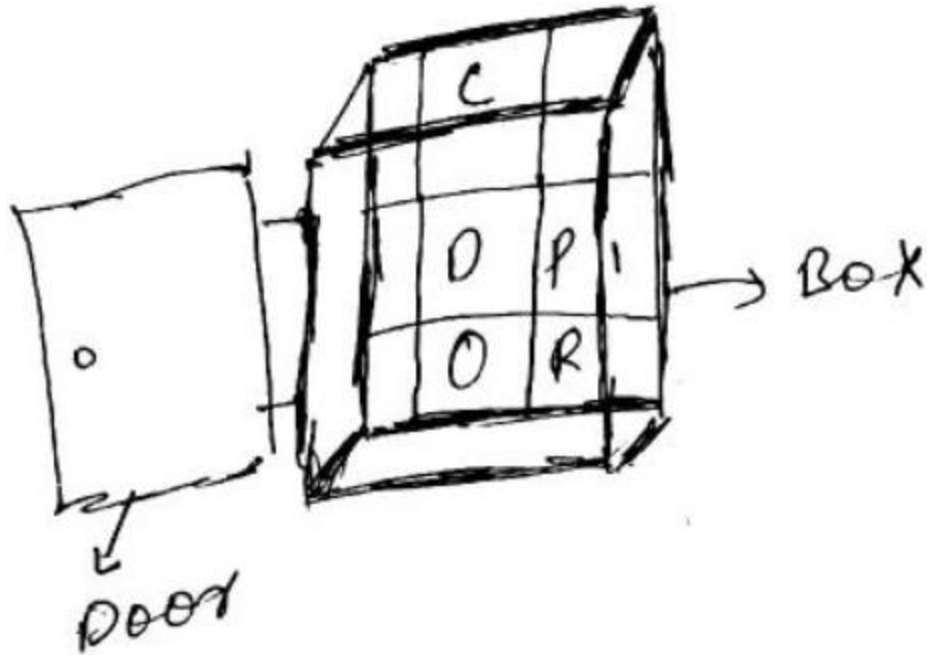


Figure 21: Push Wall with Baby Walker

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.

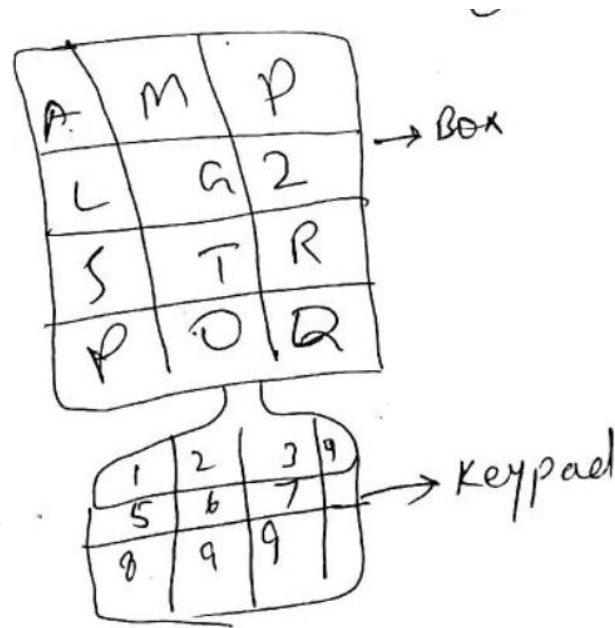


Figure 22: Mobile board

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.

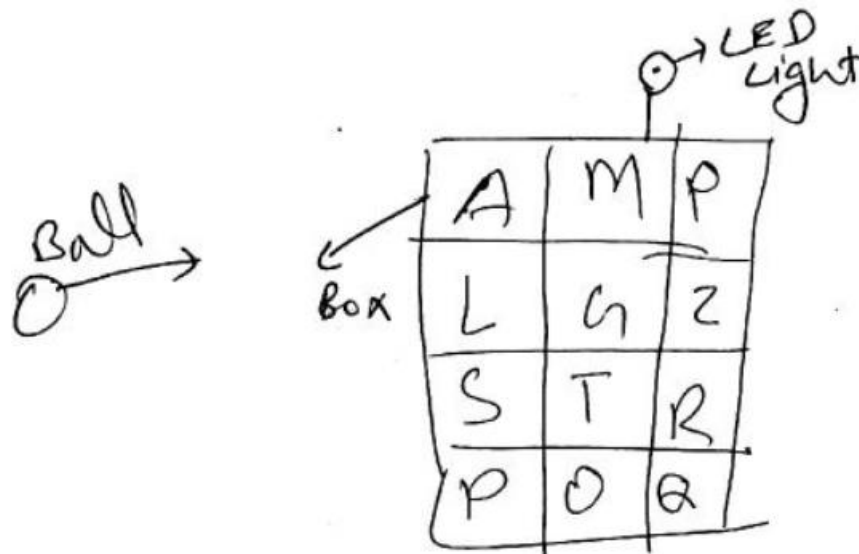


Figure 23: LED based Puzzle

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

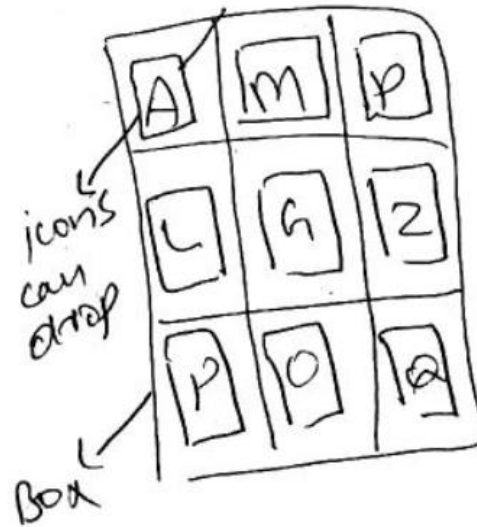


Figure 24: Dropping Cards

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 1: Pugh Chart

5 Designs for Fun Apparatus	Weightage	Ball Hitting Board	Board on Ground	Water Gun 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 “Water gun 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 3: 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	
Water Gun 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 “Water arrow 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 “Water Gun Hit” has selected our final design.

6 PROPOSED DESIGN

Final design has selected for the project which is water throwing from a distance and hit the alphabets. In the design there is a playing arena which have boundary as well. In that arena a hitting point is present and at the distance of around 3 meters there is a window placed in front. In the window all the alphabets have placed. Kid will stand at the hitting point and fill up the gun with water, then will fire the water and hit the alphabets. All the selected alphabets have water on them and kid will recognize the word. CAD model of this design has shown.

6.1 Bill of Materials

Bill of materials is present in Appendix A.

6.2 Budget and Cost

Budget of the product has presented in the table 4.

Table 4: Budget Cost

Parts	Cost
Window	\$20.87
Walls	\$50.55
Water Gun	\$2.99
Water Bowl	\$1.5
Timer	\$2.50
Bell	\$0.99
Alphabets	\$4.5
Standing Board	\$3.45
Total	\$87.37

7 CONCLUSION

This project is about the making of any device that can use by kids for playing. For this purpose, we have decided to make a unique design in which learning and entertainment both can be done at the same time. We have decided to make word puzzle game so that kids can like to play and while playing they find the words and their vocabulary will increase. We have developed a playing arena in which a window is present with alphabets fix in it and walls are present around the arena for safety measures. There is a standing board on which kid will stand and refill the water gun to hit the alphabets and kids have 30 seconds only to judge the word correctly otherwise bell will ring and time over for the game. In this game, entertainment and learning both are present.

References

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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 water 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	Water Gun	1	Water gun for throw	Water gun to throw the water towards the alphabet	Plastic	Plastic Deformation	6 in x 3 in
4	Water Bowl	1	Store the water	Water store in the water bowl for refilling the gun	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.