Marshall Class Room for Disabilities

Preliminary Proposal Report 2017-2018

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2017-2018

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Executive Summary

This report is generally concerned with the designing of the wheel chairs for the incapacitated individuals. It begins with the essential presentation about the wheel chair and its significance for the destitute individuals which experience the ill effects of specific incapacities. After the presentation, the undertaking format is quickly portrayed in the report. The structure, operation and execution of the first framework were portrayed under partitioned headings. After the best possible clarification of the item to be composed, extraordinary light is showered upon the clients' needs keeping in mind the end goal to make the holder as close with regards to the real prerequisites of its clients. The client prerequisites, the designing necessities and the place of value are explained in detail under this heading. At that point the current outline of Wheel chair was examined. Existing plans are clarified alongside their pictorial perspectives for better understanding. The practical disintegration of the gadget is likewise done in this report and a black box is made for recognizing certain information the hand-made figures of every one of these plans are additionally incorporated into their particular headings. Toward the finish of the report, the chose configuration is talked about in detail. The reasons of the determination of this outline are completely examined under the heading of the method of reasoning of the chose plan. Toward the finish of this report, our real outline is clarified. The plan computations of the spring instrument utilized as a part of the Wheel chair are likewise the piece of this report. The 3D model of the Wheel chair is appeared toward the finish of the report from various isometric perspectives for better comprehension of the chose outline.

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1 Background

1.1 Introduction

Disabled children face different kind of challenges in their life when they are in a school; as they need to perform certain tasks which require constant movement. Consequently, it tires them so quickly because they burn lot of energy during various manipulation exercises while using normal chairs and desks [1]. Consequently, they perform poorly in academics and thus denying them access to higher levels in the society. Children with disorders in sensory processing lead them to have a distorted sense of their localities, which at most times disturbs their exploration and learning of their world. Sensory incorporation is our brain's aptitude is to interpret, comprehend and respond to sensory information. Individuals with sensory processing disorder at most times have trouble assimilating and retorting to this information.

Using sensory incorporation products is one main way to assist children with sensory disorder observe and make sense of the world; moreover, these products are perfect for children who lacks sensory processing capabilities, and can aid kids in attaining important growing milestones. One of such sensory incorporation product is a sensory board. It has a task to model a unique device that will have all possible requirements of a disabled child contained in one place so as to minimalize the movements. Precisely, we will design a sensory board that is going to be useful in teaching a disabled child several activities such as pulling, pushing, twisting, switching things on and off and so on. The device will also have a micro-phonic and speaker devices whereby an audio response will be generated for each activity done. For instance, if a child executes a certain task correctly, say pushing a button, the device will generate a sound saying, "well done" and so on. Several versions of a sensory board can be adopted but to best that is effective and meets the purpose, we have to consult with the relevant stake holders including the consumer and the manipulators. Basically, the sensory boards could be standalone boards, amalgamated in the walls or even on the desks.

The team pursues to smear different skills and information in developing the new system. We have number of targets to achieve, including a better functioning model that is attractive and effective. The design will be comfortable, robust and eye-catching making the children yearn to learn. In addition, electrical engineering work will also so be added, so as to make the design function better.

1.2 Project Description

The proposed design will ensure that it meets all the clients' standards. For instance, the client, Marshall Elementary Cross-Categorical Program requires a learning device for the schoolroom. It helps one or more disabled children during a school day. However, the design should meet a range of customer needs including a sensory board, containment, comfortable, durable, adjustable and easily operate-able. Based on these customer requirements, the team devised engineering requirements so as to provide a design and its development particulars. In order to cope with a design that fits the client's needs the team held numerous meetings to brainstorm and exchange probable ideas.

The disabled children in a learning institution like this require a good device to empower them to perform everyday activities without much struggle or using too much physical energy. Therefore our design will help to address all those issues and hence enable them enjoy learning just like normal children. Additionally, it is worth noticing that the design will not only be useful to the children with sensory disorders, but also to the children with some physical disabilities such as walking. This is because the device will attract even these kind of children and make them stand on their feet as they operate the sensory board. This way, they will be capable of doing some physical exercises making their legs to grow stronger.

1.3 Original System

As an engineer one should be able to crop up with a distinctive device that is able to assist disabled students while they are in diverse settings such as hospitals, schools, sports, homes and even in businesses. In that light engineers have ventured in a variety of fields and come up with designs that will be capable of to assist the disabled perform their activities. In the market there are a wide range of assistive devices for the disabled including adaptive switches which make it probable for a children with inadequate motor skills to play with toys and games [1].

1.3.1 Original System Structure

The original system structure entailed a normal board with basic functions. Basically it involved a manual structure that did not require any electrical input. Additionally, the design

was portable and kids could go with them from place to place. They were tactile boards which offered a sensory experience to kids to calm or soothe them when all at once feeling nervous, or could stir them when feeling inactive via the sense of touch. The boards worked because whereas the child is touching the texture, the tactile input could elicit a body response such as awakening or calming.

2 Requirements

By the end of the project the team will have ensured that both the customer and the engineering requirements are met. These requirements will be contained in the final design system to facilitate effective functioning and also guarantee that the customer necessities are met.

2.1 Customer Requirements (CRs)

Customer requirements include the requests which were given by both the consumer and the operators. In this case the client is Marshall Elementary Cross-Categorical Program while the users are the disabled students. These are the right people to give the requirements they want since they interact with the devices on a regular basis and hence they exactly know what will best suit them and the necessary adjustments which need to be done include operations which are needed to be added [2]. Their views on how they want the original device improved will be translated into customer requirements as shown in the Table 1 below.

Table 1: Customer Requirements

Customer Requirements	Description of customer requirement
Improve the original system	An area for sitting which is comfortable and also have wheels to facilitate movement.
Flexible design	The design should be adjustable to fit people of various sizes, bulkiness and disabilities.
Sensory board	To guide students on various operations.
Containment	Include an entertainment teaching device
Device Strength	Strong materials should be used to ensure the device lasts longer.
Comfortable design	The sitting area should be easy and the writing board at the user's level.
Durable design	The material used should be durable

In the above table, customer requirements have been presented as per the specifications of the

client. They will be followed by the team when they will be designing the device. The original system will be amended by ensuring that the board has an electrical component so it can produce lighting and sound. The design will be flexible to suit various sizes of the disabled students. This way, its location which is on the wall could be adjusted which solely depends on the height of the user. Strong plastic will be used to guarantee that the device is strong and durable. It will also have a containment so as to entertain the users while they are operating the device.

2.2 Engineering Requirements (ERs)

From the customer necessities which were got from the specifications of the client so as to improve the original design, they were then rendered into various engineering requirements. This is very crucial since it ensures that the requirements are translated into aspects which are definite and determinate for later analysis and interpretation. The engineering requirements are as shown in Table 2 below.

Table 2: Engineering Requirements

Engineering Requirements	Targets
Flexible design	Adjustable to a length ranging from 5cm to 15cm
Strength of the device	Yield strength of at least 6Mpa.
Soft material	Low pulling force of below 5 Pascal

The design that our team intends to make should be flexible so that it is able to fit individuals of different heights. Therefore the device will have an adjustment knob so as to adjust the height accordingly. The device will also be strong such that it will yield strength of 6Mpa. It will also be soft and hence soft material will be used. In this instance, the soft material will be the one with a pulling force of less than 5 Pascal. The device will also have a containment so as to keep the student with disability busy and entertained as well as teaching at the same time like playing 40-50 educational songs. They will also have a sensory board to guide the students through various operations like 10-20 lights indications and/or a voice prompt.

2.3 Testing Procedures (TPs)

- Flexible to a length ranging from 5cm to 15cm with tolerance limit of 0.5 cm.

  The adjustment mainly entails the writing board and the height of the seat. In this situation the seat and the writing board were accustomed to the lowest position possible and measurements taken. Then they were attuned to the highest position possible and measurements taken. This enabled the team to get the range of 5 to 15 cm.

- Yield strength of at least 6MPa ± 1KPa.

  To test material's yield strength, the team subjected it to a force. A clamp and several weights of about 50Mpa ± 5KPa were required. Using the clamp, the material was first clamped with the clamp and weight was then positioned over the material. After the test the material did not give in to the weight.

- Soft material.

  The measure for the softness of a material is the force vital to break a fiber. In order to measure the breaking force of the fiber, the material was tied on one end to a firm position while the other end was tied to a spring balance. Spring balance's end was pulled and readings made. Before a reading f 5N was attained the fiber snapped. A soft fabric should not exceed a toughness of 5 newtons.

- Containment.

  A device which was to teach the students with disabilities on how to count numbers and the months of the year was fixed and tested for its effectiveness.

- Sensory board.

  The sensory board was supposed to have instructional lights and voice prompts to guide the student with some ability on various operations.

2.4 House of quality

There will be application of HOQ so that it assists in analyzing gadgets given various

parameters. Its major aim is to investigate the plan that the tea will select to assist them in settling on the most suitable plan. This will involve integration of the requirements which have been discussed above the requirements include, a device that is flexible, strong, comfortable, light, durable, and simple to operate [2].The HOQ enabled the team to improve the original design to come across the engineering requirements.

Table 3: House of quality

Customer Requirement	Weight	Engineering Requirement	Yield strength of at least 6Mpa	Adjustable to a length ranging 5cm to 15cm	Use soft fabric	Containment	Sensory board
Should be flexible	4			5	4	5	6
Should be strong and durable	5		4				
Comfortable design	4				5		
Containment	5		4			8	9
Sensory board	4		4			8	9
Absolute Technical Importance (ATI)			10	10	8		
The Relative Technical Importance (RTI)			9	9	7		
Target(s), with Tolerance(s)			6±1	5±2	30±5		
The Testing Procedure (TP#)			1	2	3	6	6

3 Existing Design

Variety of devices have been designed to assist the disabled in carrying out various day to day operations. In this regard, the team has made an extensive research so as to check and compare the various devices which are available to help the disabled. The key focus was on a device that will assist the disabled by meeting their proposed customer requirements. In order to recognize the various aspects required to improve the design's performance the team embarked on looking into a range of already existing designs.

3.1 Design Research

A range of designs have been created to help the disabled. However, the designs are normally improved as time goes on so as to suit the needs of the users. The team analyzed a wide range of existing designs in the market so as to come about with an appropriate design.

3.2 System Level

The assistive devices for the individuals with disabilities such as wheel chairs have evolved over the course of several years to suit the needs of the user. The changes are attributed to the technological advancements which have occurred over the years. In this project the proposal is a device which resembles a wheel chair but with a multiple of improvements to make it appropriate. The team will acquire some basic knowledge from the pros and cons of the already existing designs so as to make their design a success.

3.2.1 Existing Design #1: Walgreens Ultra Weight Transport Chair

Walgreens ultra-weight transport chair is a strong chair which can support up to 300lbs, it has remove able foot rests, a seat belt and wheel locks for extra safety. Also, it has angled armrests to enhance access to counters tables, and desks. In addition it has washable stain-

resistant nylon fabric that is inherently and brakes lock for safety [3].

Figure 1: Walgreens Ultra Weight Transport Chair [7]

3.2.2 Existing Design #2: Viscco Wheel Chair

Figure 2: Viscco Wheel Chair [7]

Viscco wheel chair comprises of a removable eating and writing board. Also it has a strong metal frame which is able to endure rough conditions. It has special sealed bearings used for smooth movement hence adding to the comfort of the user. In addition it has a seat made of double bonded Vinyl Fabric with upholstery for comfort and durability [3].

3.2.3 Existing Design #3: Wheel Chair with a Lap Hugger

The lap hugger is very crucial since it enhances the security of the user by preventing

him from falling forward. It is also crucial for appropriate support to the upper body. In addition, it makes the wheel chair stronger as it is made up of durable foam padding covered with vinyl.

Figure 3: Wheel Chair with a Lap Hugger

3.2.4 Existing Design #4: Wooden Sensory Board

This Sensory can teach kids the basic things in life such as, counting, adding, subtracting, zipping, stapling, etc. This is very vital since it makes them independent and can do maximum of the stuff themselves. In addition to that, the size of this kit is very small to facilitate the kid can spend some time figuring out some materials alone. Studies show that some kids need to spend some time alone when studying to avoid any distractions [4].

3.2.5 Existing Design #5: A Stand Sensory Board

The only difference between this design and the previous one is that this design has wooden legs. This design is significant because it enables instructors to teach a group of students at the same instance. It exactly works like a regular board. The instructor, then, can show each student how to use the materials and it can make them practice in front of all the others. When practicing in classroom settings, the student can barely forget what they learned [4].This is because they saw their friends practicing the materials upon they started playing with the board.

3.3 Functional Decomposition

In this project, the major aim is to design device which can be used by the students with disabilities while they are taking their studies in class. Our functional decomposition will be a device which is strong durable, light-weight and easily operate-able.

3.3.1 Black Box Model

After analyzing the original design, the team realized that there were problems with the general operations due to limited functionality. In this regard, the team made a decision of including a black box so as to improve on its performance. The black box will be used to store data. It will also help in coordinating other purposes such as movement with minimal efforts. The major setback of the black box is that it is expensive and needs regular maintenance.

3.3.2 Functional Model/Work-Process Diagram/Hierarchical Task Analysis

To ensure that the team does not deviate from the objectives of the project, they will make use of a functional model which will act as a guide. The model will have the engineering and customer requirements which will be fulfilled.

3.4 Subsystem Level

After carrying out a thorough research it is evident that when devices are designed in a better approach they are capable to meet customer requirements. This is accomplished by using proper gadgets [5].

3.4.1 Subsystem #1: Containment

Having a variety of containment such as numbers, texture board and pillows which enabled the users to learn new things and feel entertained and comfortable.

3.4.1.1 Existing Design #1: Numbers Containment

The numbers improve the learner's knowledge by making them know how to count

numbers and hence keep them busy and informed.

3.4.1.2 Existing Design #2: Texture Board Containment

It enables the students with severe disabilities such that they will be able to differentiate between various textures feels.

3.4.1.3 Existing Design #3: Positioning Pillows Containment

It entails positioning pillows which are made from a strong and a washable fabric.

3.4.2 Subsystem #2: Sensory Boards

Since the device will be used for teaching the students with disabilities how to perform various activities such as how to pull, push, twist, switch etc. a wheel chair with an appropriate sensory board can be adopted.

3.4.2.1 Existing Design #1: Sensory Simulation Tray

The design involves a sensory stimulation tray whose purpose is to entice the vision and sense of touch of the user.

3.4.2.2 Existing Design #2: Audio Sensory Board

The design entails a sensory board with digital controls and voice prompt to guide the user on various actions.

3.4.2.3 Existing Design #3: A Stand Sensory Board

The design has legs that can be used in regular classroom for teaching materials.

3.4.3 Subsystem #3: Safety

The device should ensure the safety of the user at all times.

3.4.3.1 Existing Design #1: Wheel Locks

They make sure that the device is steady when the student is stationary on a desk.

3.4.3.2 Existing Design #2: Angled Armrests

They enhance access to counters tables and desks.

3.4.3.3 Existing Design #3: Break Locks

They enhance safety of the operator by locking the braking system.

4 Designs Considered

The team produced a wide range of designs during the brainstorming process which were parallel with the various customer and engineering requirements. Various aspects of design were considered and improvements made on the already existing designs. Some designs which selected are as follows.

4.1 Design #1: Wheel Chair with a Desk

The device has a board which can be utilized for writing and eating purposes. This will ensure that students carry out their tasks of readings and writing tasks easily by placing books

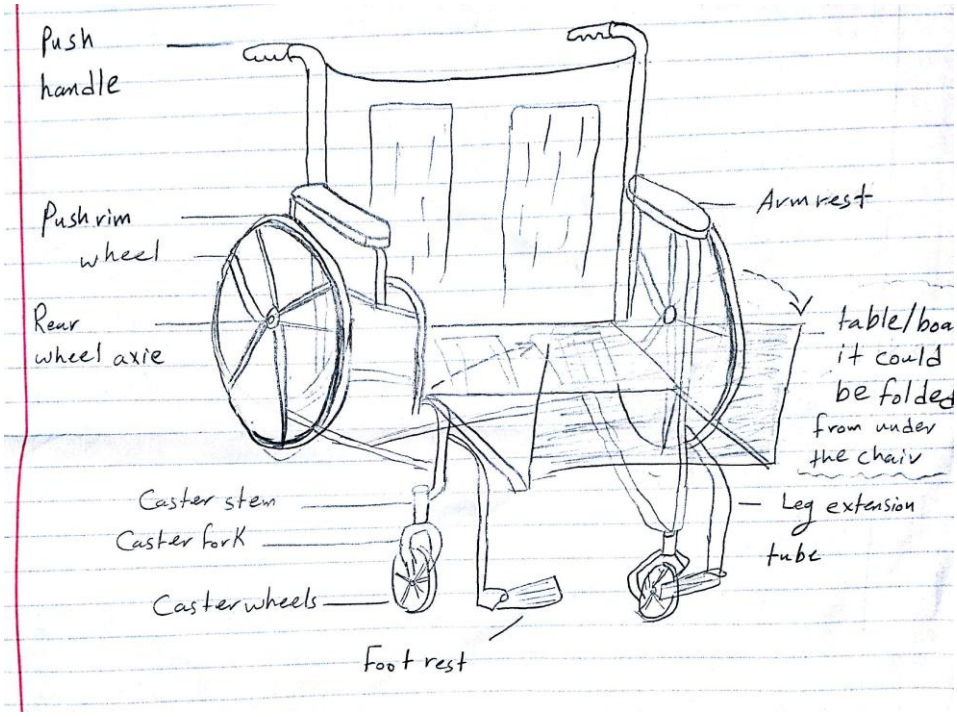


Figure 4: Wheel Chair with a Desk

on this board. It also has wheels to facilitate motion from one place to another. The major challenge with the board is that it must be removed every tie the user is not using it.

4.2 Design #2: Lap Hugger

The lap hugger provides an appropriate upper body support and also prevents the user

from leaning forward. The hugger is made up of durable foam padding covered with vinyl hence making it easy to clean. It also has a clear window for storing reading material.

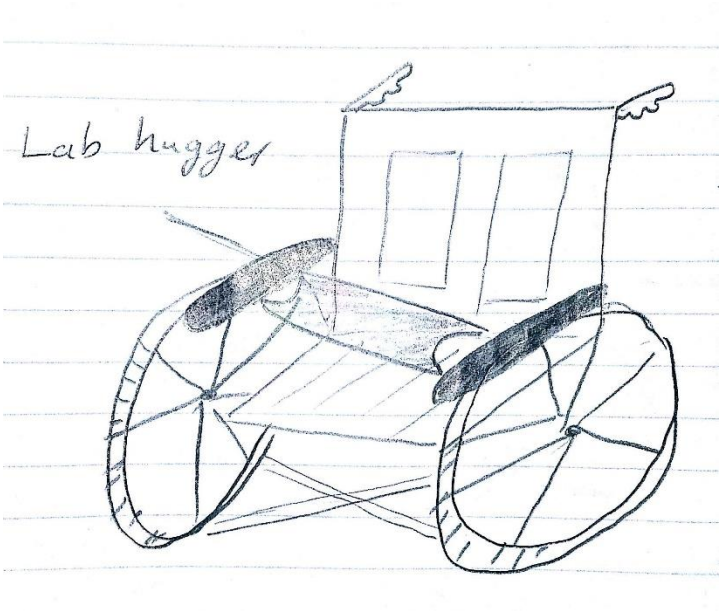


Figure 5: A Lap Hugger

4.3 Design #3: Wheel Chair with a Seat Belt

The design comprises of a safety belt which is fastened around the waist. This is beneficial in that it prevents falls, prevents forward sliding, it has a soft breathable

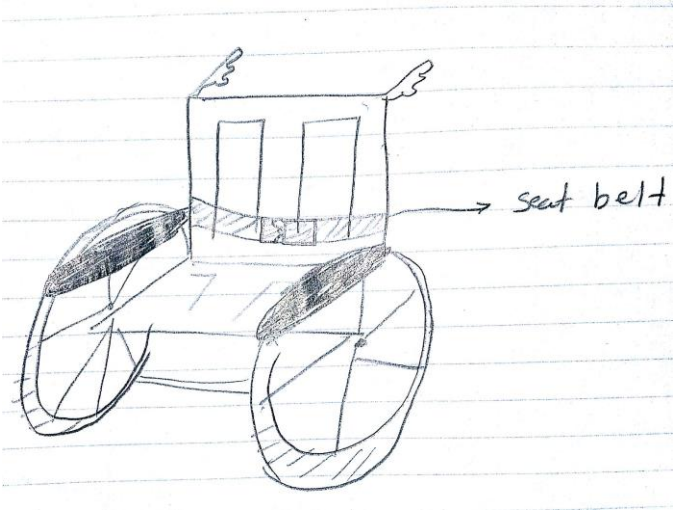


Figure 6: Wheel chair with Seat Belt

foam to facilitate comfort. Also, the closer is capable to be positioned for self-

releasing or even more restrictions.

4.4 Design #4: A Hexagonal Containment

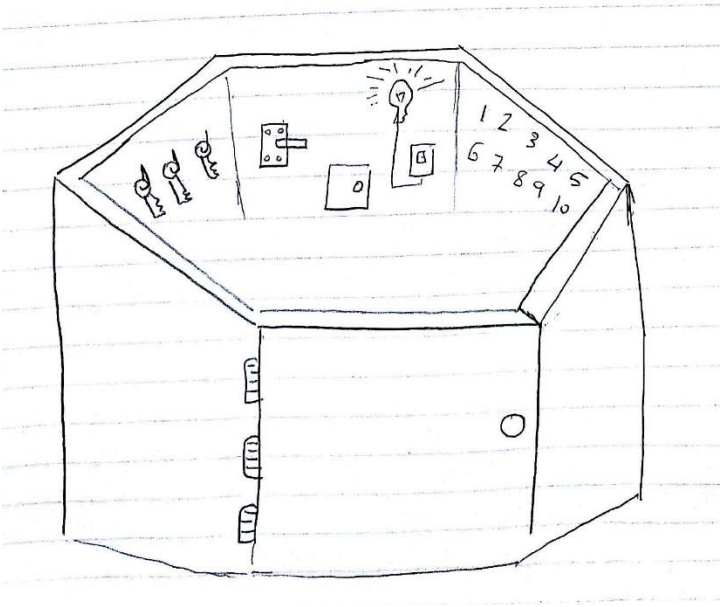


Figure 7: Hexagonal Containment

A hexagonal containment that has a door. Once the child is in, he can play around with a sensory board surrounding him.

4.5 Design #5: A Hexagonal Containment Sensory Board with Wheels

A hexagonal containment made of word and it has door which enables the child to get in inside. Once the child touches the wall and play with the materials, the wheels will rotate. Consequently, energetic kids do not fell board because they move from one place to another but

inside the hexagonal.

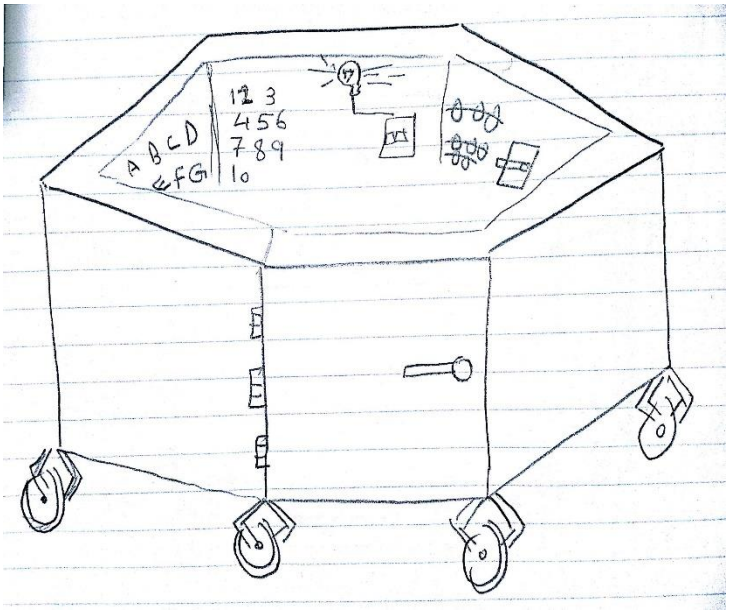


Figure 8: A Hexagonal Containment Sensory Board with Wheels

4.6 Design #6: Trampoline Containment Sensory Board

A hexagonal containment has a door and it is made of wood. The base of it is a trampoline shaped. This can entertain the child while he is learning the hexagonal.

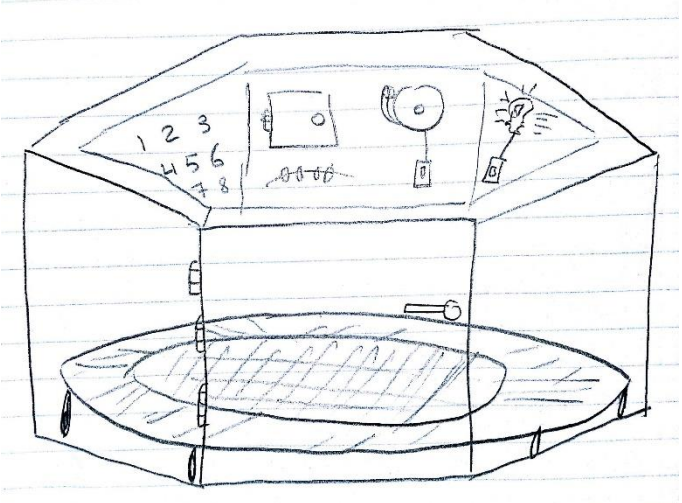


Figure 9: A Trampoline Containment Sensory Board

4.7 Design #7: Sensory Board to the Wall

Sensory board that is mounted to a wall. This design can enable all kids in the schoolroom use this available learning tools.

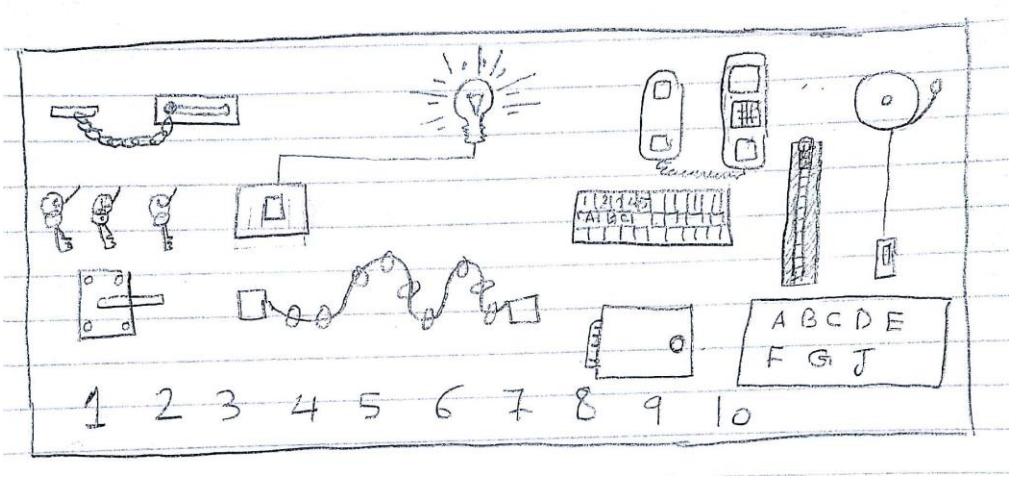


Figure 10: Sensory Board to the Wall

4.8 Design #8: Cubic Sensory Board

The design comprises of a sensory board which has digitalized controls. The board has a wide variety of buttons, door knobs, and some puzzles. Also, the sensory board has different lights which blink followed by a voice prompt either to caution or assuring the user of the correctness of performing a particular action. The unique about this design is that it has wheels which facilitate moving it around the class without exerting any efforts. In addition to that, we are incorporating in this design a stand that can help a disable child to get used to stand up and play with the board because of some of the kids we observed struggle when getting up. The cubic sensory board will attract them, and therefore, help them strengthen their knees.

Figure 11: Cubic Sensory Board

4.9 Design #9: Rotating Circular Sensory Board

This design comprises of different kinds of audios that can teach disable children how to read letters, numbers, days, and months. Kids, in general, don't like to be forced when learning, so we will make this more attractive by making the circular sensory board flashing while rotating. In this situation, the disabled kids are more into learning because it is a game for them.

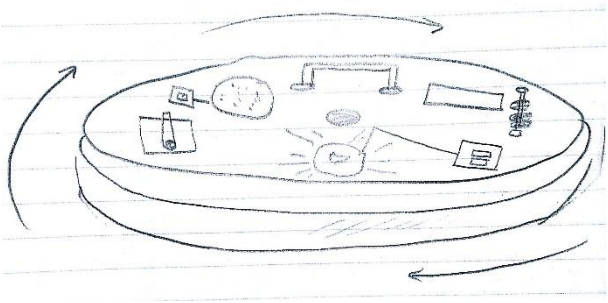


Figure 12: A Circular Rotating Sensory Board

4.10 Design #10: A Folded Sensory Board

The purpose of this design is also to teach disable childeren life's skills such as, pulling with some resistance, pushing, twisting, switching lights on/off, and zipping. However, the significant thing about this design is that it can be folded and taken away using a handle so that

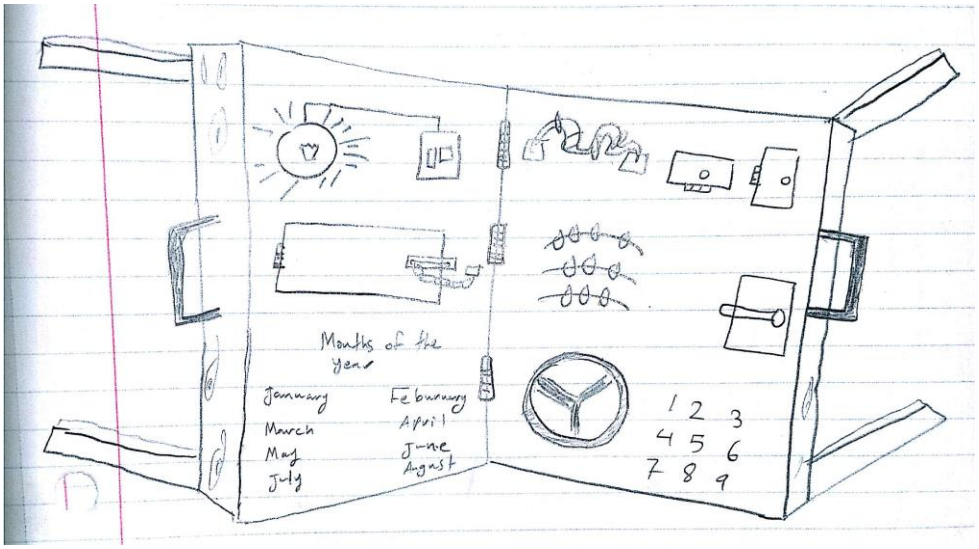


Figure 13: A Foldable Sensory Board

kids do not play with it without their instructors' permission. Also, this folded sensory board can be turned to a desk. The unique about this device is that it can serve many several things at the same instant.

5 Design Selected

This design is ought to be taken after what the client needs and connected our building prerequisites. As we did in configuration considered for the 10 outlines. Everyone has distinctive thought and diverse approach to utilize. So we have to make sense of which one is better and can take after our client needs. The best design we may take after from the aforementioned designs is Design 11. From the above mentioned designs, design 11 is the most appealing one in contest of price and complexity so we are willing to work with it.

5.1 Rationale for Design Selection

These Standing Boxes are remotely controlled that give full help to clients while standing who are trying to remain standing after a long time. Spring locks on the entryway make the Standing Boxes additional protected and secure, and the entryway swings open to 180 degrees for simple passage and exit. The base outline keeps the stander from tipping, keep the client securely standing.

Figure 14: Selected Design [8]

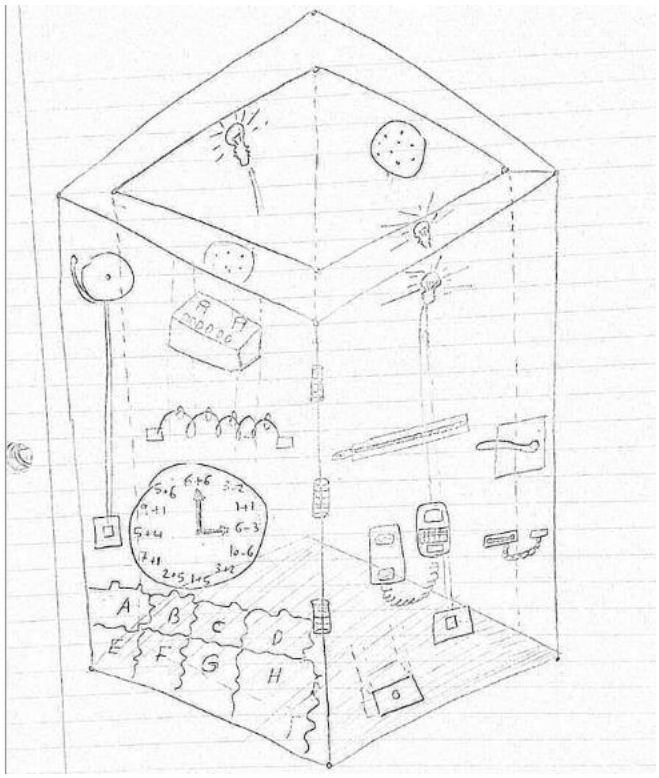


Figure 15: Sketch of Selected Design

Benefits of this design:

- Entryway swings 180 degrees
- Whole unit is set on a base intended to avert tipping
- Highlights an elastic secured, in a flash flexible foot stage
- Assists with a patient's initially attempt at working in a standing position
- Spring lock furnishes greatest security with one simple change

This is a fundamental cut out table for the patient's initially attempt at working in a standing position. The standing box includes an elastic secured, in a split second customizable foot stage. The elite Bailey outlined spring lock furnishes most extreme security with one simple modification. The whole unit is set on a base intended to avoid tipping. Entryway swings 180 degrees.

Table 4: Features of the Selected Design

Individual Child Standing Box	Individual Adult Standing Box
Top Measurements: 61 cm x 76.2 cm	**Top Measurements:** 76.2 cm x 76.2 cm
Height from Floor: 85 cm	**Height from Floor:** 137.2 cm
Foot Platform Adjusts: 3.8 cm to 29.2cm from floor	**Foot Platform Adjusts:** 3.8 cm to 29.2 cm from floor
Cut Out Size: 17.8 cm x 25.4 cm	**Cut Out Size:** 30.5 cm x 38.1 cm
Box Dimensions: 35.6 cm wide x 35.6 cm deep and 81.3 cm high	**Box Dimensions:** 40.6 cm wide x 35.6 cm deep and 137.2 cm high

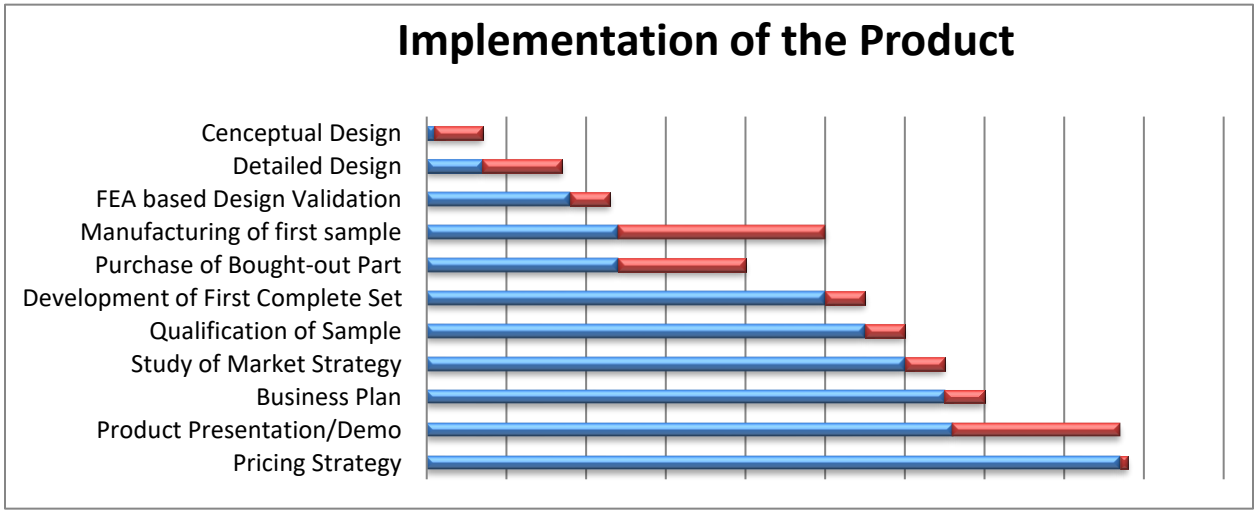
6 Proposed Design

6.1 Implementation Plan

The complete implementation plan of the Stick holder has been described with the help of the Gantt chart.

Table 5: Implementation Plan

Assignment	Beginning	Ending	Period
Design period			
Abstract	03-Nov-17	10-Nov-17	7
Detailed Design	11-Nov-17	18-Nov-17	7
Third party Validation of Design	19-Nov-17	24-Nov-17	5
Manufacturing Period			
Manufacturing of first sample	25-Nov-17	21-Dec-17	26
Purchase of Bought-out Part	21-Dec-17	10-Jan-17	16
Development of First Complete Set	11-Jan-17	25-Jan-17	5
Qualification of Sample	25-Jan-17	30-Jan-17	5
Planning Period			
Study of Market Strategy	30-Jan-17	05-Feb-17	5
Business Plan	05-Feb-17	10-Feb-17	5
Product Presentation/Demo	06-Feb-17	27-Feb-17	21
Pricing Strategy	27-Feb-17	28-Feb-17	1



6.2 Resources

The assets required to build up the task from its idea to its full development level incorporate the labor, starting capital cost to start the venture, Conventional machines to make the parts, throwing setups, materials to influence the parts and a get together to line if the parts will be made in extensive number of units. For manufacturing of parts we need access to Machine shop.

6.3 Bill of Quantities

Following is the detailed Bill of Quantities calculated against each item to be used in the design:

Table 6: Bill of Quantities

BOQ Level	**Item Number**	**Item Name**	**Item Category**	**Quantity**	**Status**	**Expenses ($)**
1	WH-001	Wood	Body	20CFT	Manufactured	Workshop
1	WH-002	Assistive Holder	Assembly	1	Manu.+ Bought	10
2	WH-003	Grabbers	Assembly	1	Manu.+ Bought	10
3	WH-004	Screws	Part	2	Bought	10
3	WH-005	Springs	Part	1	Bought	10
2	WH-006	Toys	Assembly	1	Bought	10
3	WH-007	Screws	Part	2	Manufactured	Workshop
3	WH-008	Springs	Part	1	Manufactured	Workshop
2	WH-009	Clamp Jaws	Assembly	1	Manufactured	Workshop
3	WH-010	Clamps	Part	2	Manufactured	Workshop
3	WH-011	Clamp spring	Part	1	Bought-out	10
3	WH-012	Bolt	Part	1	Manufactured	Workshop
2	WH-014	ARMS Assembly	Assembly	1	In progress	

7 References

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