



Musical Tunnel : Improving postural stability in children

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Children with **postural control problems** receive physical therapy to improve functional skills. They use a “**tunnel**” to provide **support** encourage **independence**. They **cruise** around the edge of the tunnel which can help improve posture.

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Problems With Current Device



Not Interactive

The children get bored easily with the current set up



Unmotivating

There is no reward or consequence for completing therapy successfully



Sitting

Some of the children have a tendency to sit down in the tunnel during therapy

PROJECT GOAL

Design an activity that can be added to the tunnel to make it more exciting to use and keep the children's attention while in use.

Client Abilities

- can stand and turn with help
- interact with noises and sounds
- Agreeable

Client Limitations

- Not attracted by the tunnel and gets tired easily
- Bobby is about to have back surgery
- Non verbal with slow reaction
- Must be put into the tunnel with assistance
- Beth has caudal regression
- Beth has G-tube inserted through abdomen
- Intellectually disabled/speech disorders

**Client
Description:
Bobby &
Beth**

An illustration of six people (three men and three women) sitting around a long table, viewed from behind. Above them is a large yellow lightbulb with a brain inside, connected by dashed lines to various circular icons representing business concepts like a mail envelope, a rocket, a coin, a magnifying glass, a refresh symbol, a document, a calculator, a cloud, a checkmark, a gear, a clock, a group of people, a speech bubble, a bar chart, and a cloud.

have the kids sit down, and keep attention of children.

Design Category	Classifier
Standing Function	1
Attraction	2
Safety	3

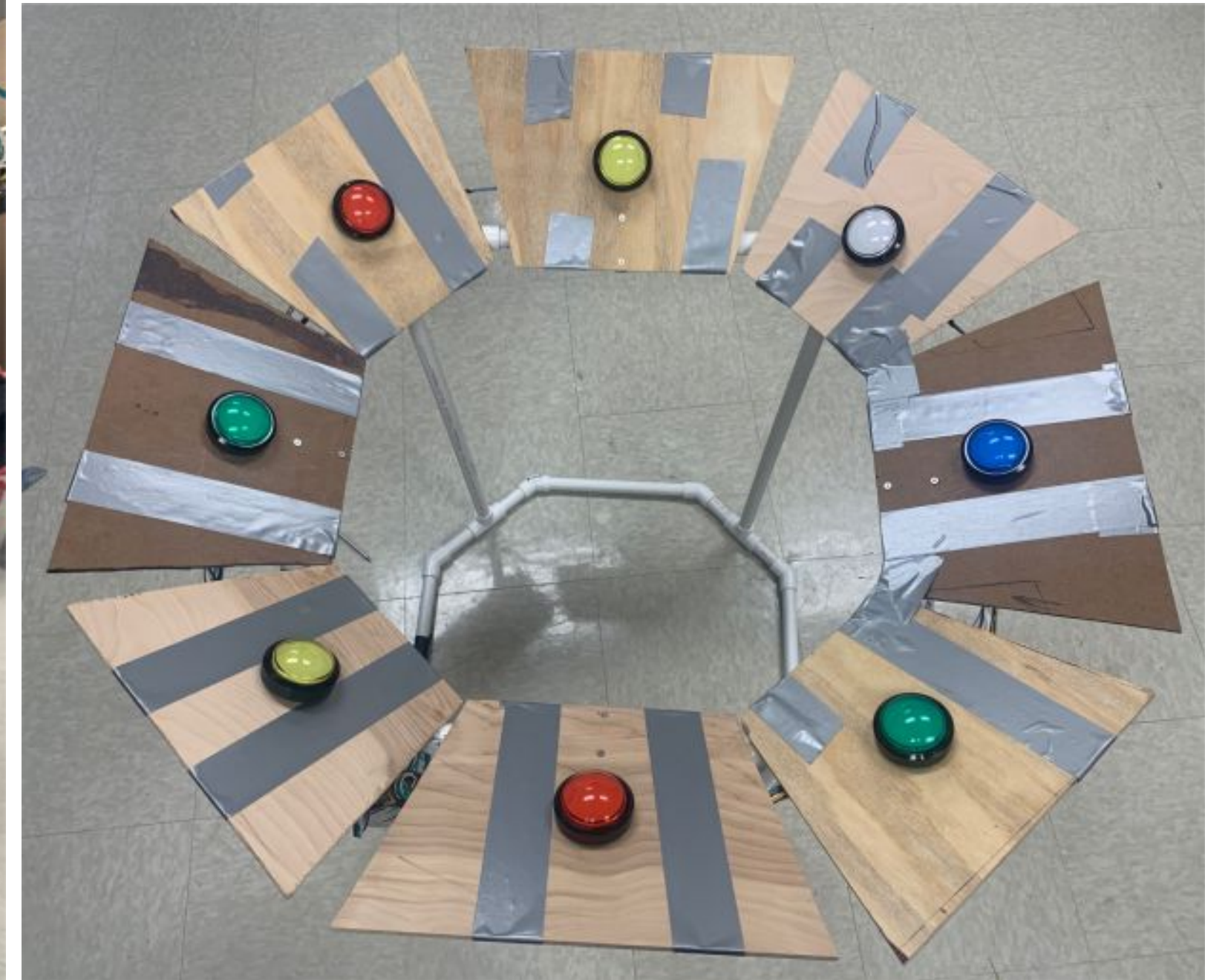
Scoring Scale	
	1 least likely
	3
	9 most likely

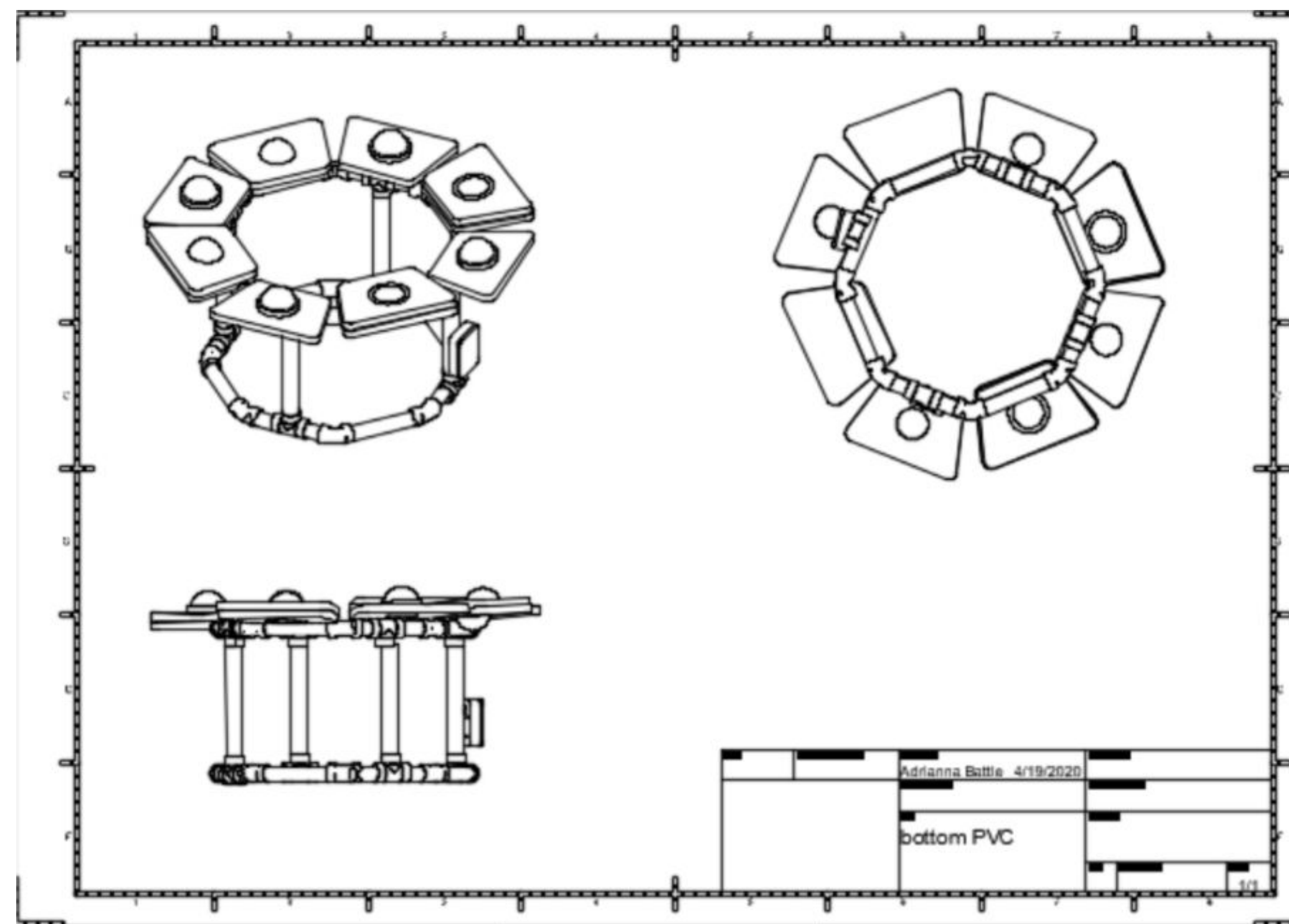
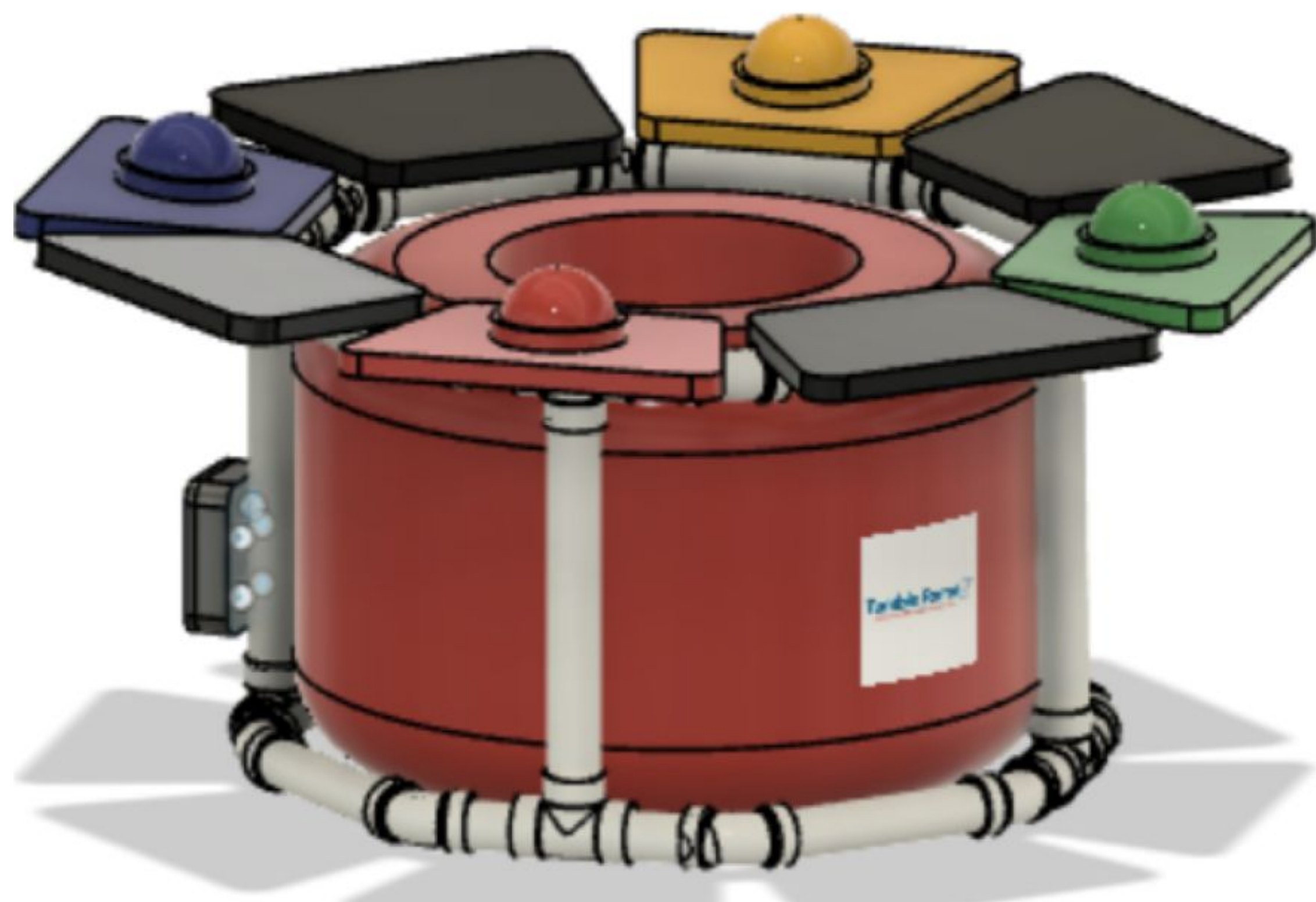
Idea Number	Design Category	Solution	Feasibility	Effectiveness	Safety	Overall Score
14	1	Tubes with adjustable length extending outside the tunnel with screens on				0
112	1	Baby walking device				0
16	1	Stimulation	1	1	1	1
17	1	Glue	1	1	1	1
110	1	shock to keep them standing	1	1	1	1
11	1	Strings to straighten their legs	3	1	1	1.5
13	1	Umbrella with suspended strings	3	1	0	1.9
111	1	alarm that tells them to keep standing	3	1	0	1.9
114	1	Supporting loop outside the tunnel	0	1	0	3.4
12	1	Decrease the diameter of the tunnel	0	3	1	4.4
16	1	Ropes to grasp	0	3	3	4.5
116	1	Weight sensor	3	3	0	3.3
117	1	System shut off if sit	3	3	0	4.8
115	1	Two part to adjust height	1	0	3	6.7
113	1	Motion sensor/tracker	1	0	0	7
15	1	Two holes that they can put their legs in	0	0	3	8.7
19	1	magnet metal to determine if standing	3	0	0	7.5
122	2	Buttons to push				0
126	2	musical chairs				0
128	2	different instruments				0
129	2	ball attached to tree thing that follow				0
133	2	piano				0
134	2	animal noises				0
135	2	xylophone				0
139	2	telephone game				0
147	2	Button will light up when tapped				0
148	2	All buttons on and the child tap them to turn them off. a song feedback.				0
150	2	Button light randomly				0
123	2	Wheels			1	0.05
130	2	volleyball	1	1	1	1
137	2	bingo game	1	1	0	1.4
149	2	scrabble	3	1	0	1.9
127	2	tree thing	1	3	0	2.8
142	2	Detachable mat with options for games	1	3	0	2.8
145	2	Play mobile	3	3	0	3.3
131	2	rotating iPad screen/game	3	3	1	4.4
120	2	Add another layer to the top of the tunnel (sand pool that they can put their hands in while cruising)	0	3	3	4.5
121	2	Painting/drawing board	0	3	3	4.5
140	2	Sensory toys circle	0	3	0	4.8
144	2	Digital coloring toy	0	3	0	4.8
124	2	Toys generated at the bottom and blow up for them to grasp	1	0	1	6.6
136	2	toy bank teller	1	0	3	6.7
119	2	Projection that play their favorite cartoons etc.	1	0	0	7
132	2	DDR buttons on the edge	1	0	0	7
138	2	basketball game	3	0	1	7.1
118	3	Piano/sound	3	0	0	7.5
125	3	Buttons change color and make sounds depending on what settings you put	3	0	0	7.5
143	3	Wooden block roller coaster	0	0	0	7.5
146	3	On the top of the tunnel, build buttons which can make different tunes. Some simple songs can set so child can tap them to finish the song.	3	0	0	7.5
141	3	Simon says game	0	0	0	9
161	3	Break on the tunnel to keep it straight up	3	0	0	7.2
152	3	Weights added to the bottom of the tunnel	0	0	0	9

The weighted average of the scores was the final score for each idea.

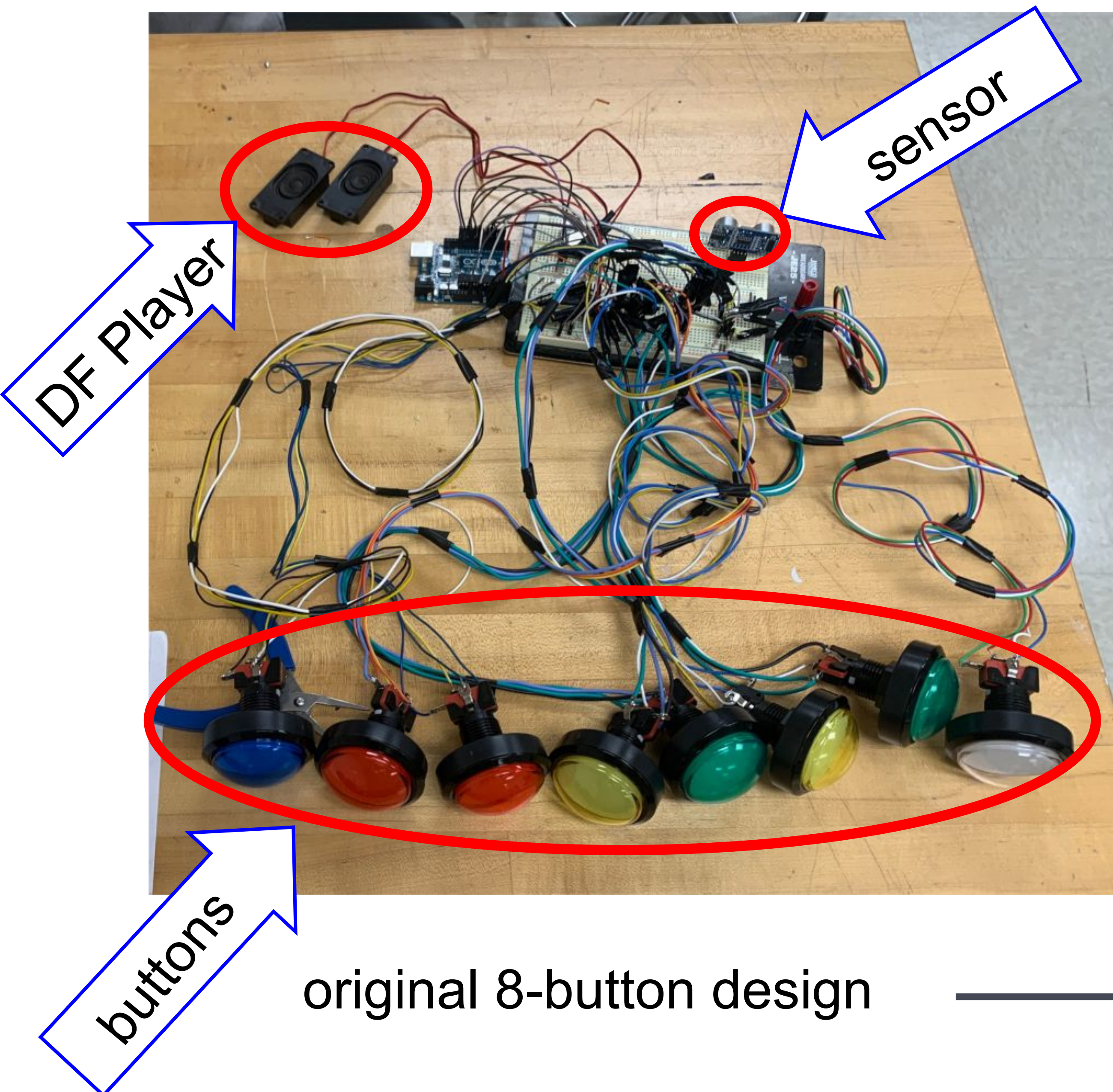
Then for each design category, the top three scores were chosen from each as the best ideas to continue with.

6 Final Device- External

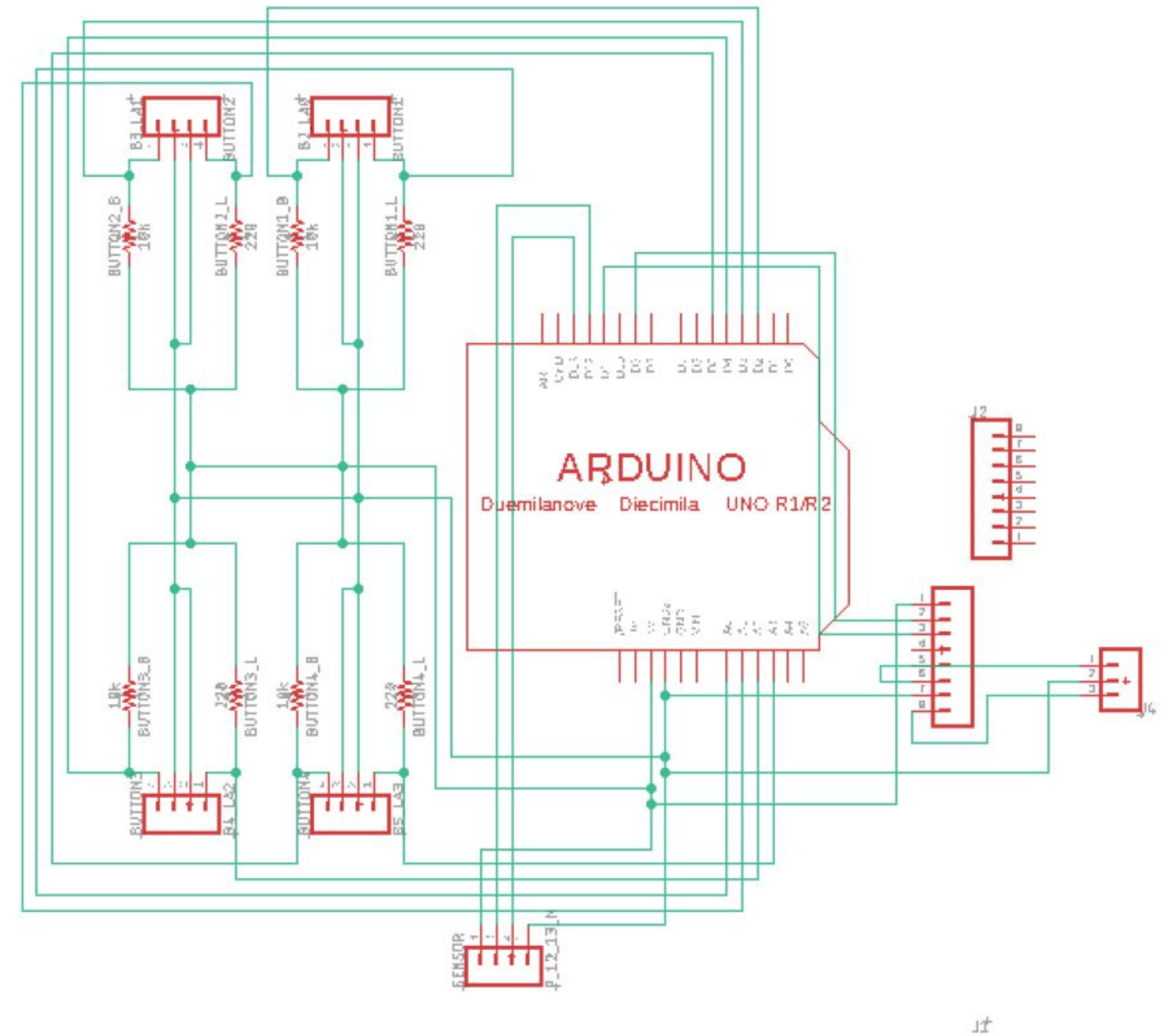




Circuit Design



original 8-button design



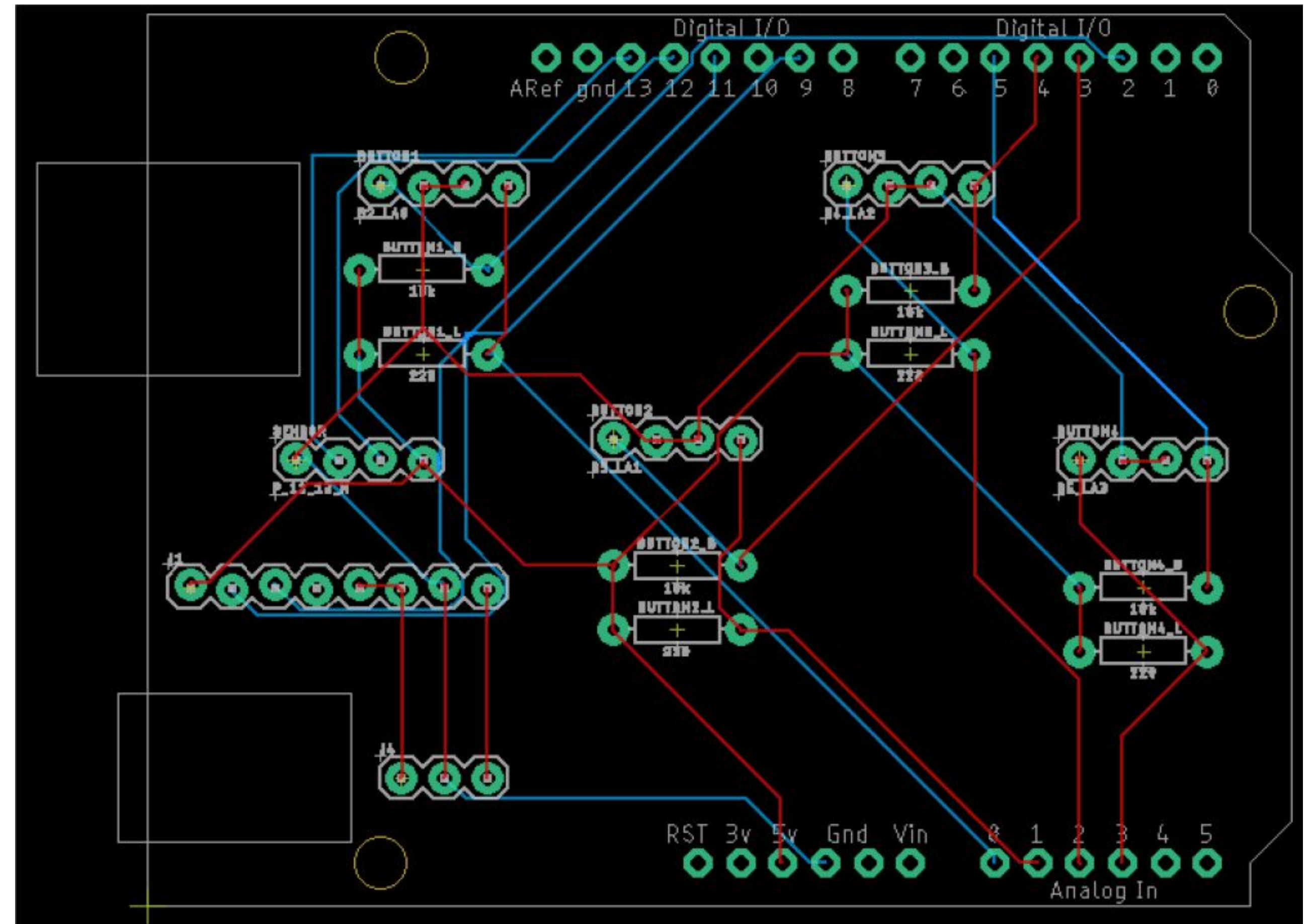
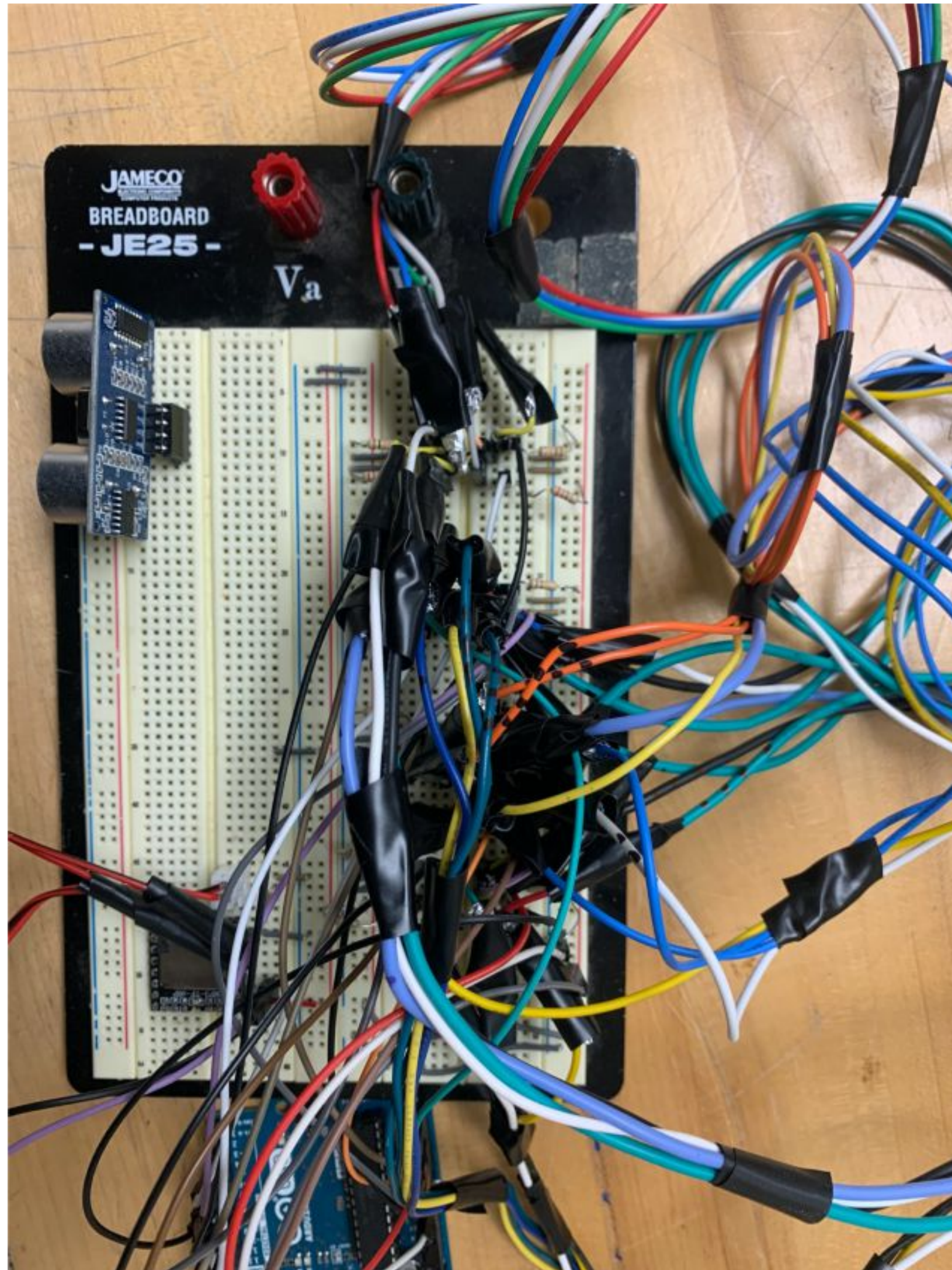
4-button simpler game

Video Demonstration





PCB Design



Hazard Analysis

Hazard	Potential Effect of Hazard	Severity	Occurrence	Assessment	Plan (Redesign, Guard, Warn)
Exposed wires	get an electric shock if there	4	4	2	Put wires inside the pipes
Exposed wires	users tripping over, broken	2	2	2	Warn: Kids should stop using the tunnel if wires
Sharp edges	cuts	2	2	3	Use tapes or covers to cover the sharp edges
Exposed Screws	cuts, broken fingers	2	2	3	File down. Use tapes or covers to cover the
Electronic components	get an electric shock if there	3	3	2	A protection box is built for the circuit.
Boards leaning/tilting	fall out	2	2	3	Warn: Kids shouldn't lean on the edge of the
Unstable pipes	parts falling to pieces and	2	2	3	Use glue to stick parts together.
Box falling off	broken device/exposed wires	2	3	3	Use screws and glue to stick the box from falling
Scared of the board	cry/fears	1	3	3	Decorate the boards
Scared of the sound/light	cry/fears	1	3	3	Test the levels of sound and light to make sure
Sticky/dirty materials	clothes get dirty	1	3	3	Sanding and cleaning device parts. Use covers
Pipes too close to the tunnel	Arms might get stuck	2	4	3	Leave enough space between pipes and the
Pipes break	fall out when trying to reach	2	4	3	Redesign: Use pipes made from harder material
Pipes break	cuts	2	4	3	Redesign: Use pipes made from harder material
connectors between	Someone trips on the broken	2	2	2	Use stronger glue for connectors. Redesign:
boards fall off	exposed wires	2	3	3	adjust)
Occurrence: 1 frequent					
Severity: 1 negligible					

Based on design purpose

Different requirements:

- Verification plan: Testing in the lab
- Validation plan: Testing with clients

Different aspects:

- Adjustability, duration, stability, power supply, body gesture, safety

Evaluation Plan

Testing- Verification Plan

Completed verification:

- Height of the buttons are adjustable.
- The stability and duration test passed.
- Power supply enough with a power bank.
- Safety test passed.

Barely completed:

- Sensor: Works but unable to adjust its position.

Testing- Validation Plan

Teacher's feedback after use:

- Kids were much attracted
- Able to stay for enough time
- Safe for kids. No contact or stimulation

Shortcomings:

- "Simon Says" a little complex. Need teacher's guidance
- Sometime hard to find buttons
- Sensor cannot work well

Production Cost

Item	Price	Quantity	Full Price
45° pipe fittings	\$ 0.39	16	\$ 6.24
3-way pipe fittings	\$ 1.98	8	\$ 15.84
PVC glue and primer	\$ 11.48	1	\$ 11.48
Plywood (4 x 10 " board)	\$ 13.98	1	\$ 13.98
LED buttons (package of 5)	\$ 12.99	2	\$ 25.98
wire (1 spool-100 ft)	\$ 4.50	1	\$ 4.50
pcb board	\$ 21.00	1	\$ 21.00
wire box	\$ 4.05	1	\$ 4.05
pipe straps	\$ 0.20	12	\$ 2.40
electrical tape	\$ 1.99	1	\$ 1.99
PVC (3/4 in dia x 10 ft)	\$ 2.54	2	\$ 5.08
Total Price			\$ 112.54

The tunnel meets most of the requirements:

- Both Bobby and Beth are able to spend more time in the tunnel for postural control therapy.
- Safe. Durable. Stable.

Needs to improve:

- Distance sensor still cannot work well on the tunnel
- Simon Says game may be hard for children

Conclusion

Next steps

- Improve the distance sensor or other ways to keep clients standing
- Simplify “Simon Says” game or other easier games for children
- More clients validating: Wider range of clients
- Design its appearance properly for kids
- Evaluation. Analysis. Patent.

Questions?

Thank you!