Reimagining Assistive Devices to help Children with Cerebral Palsy (CP) Communicate

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INTRODUCTION

The ability to **communicate thoughts**, **feelings** and **information** is **essential** to the well-being of a child and their family. Many children with CP have **challenges communicating with speech** and too often it is **assumed** that a child who does not speak is **unable** to connect with or **understand** the **world** around them.

With appropriate **materials** and **focused activities** (interventions) the child with CP can become more able to communicate **thoughts and feelings** and eventually learn how to better **process** these **emotions** in a safe and non-stressful environment. One major problem facing families and therapists is that the children with CP have **unique** sets of abilities and **challenges** which **limits** their ability to **function** in general.

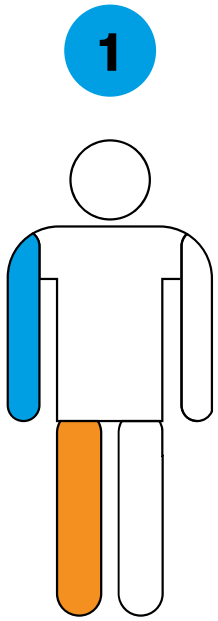
WHAT IS CEREBRAL PALSY?

USER GROUP

CP is a group of disorders that affect a person's ability to move and maintain balance and posture.

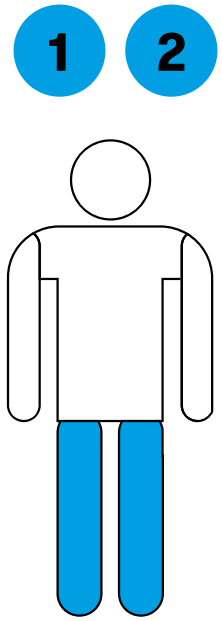
USER GROUP

PARTS of the BODY



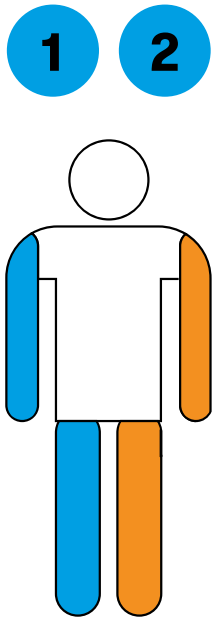
MONOPLEGIA

one arm or
leg affected



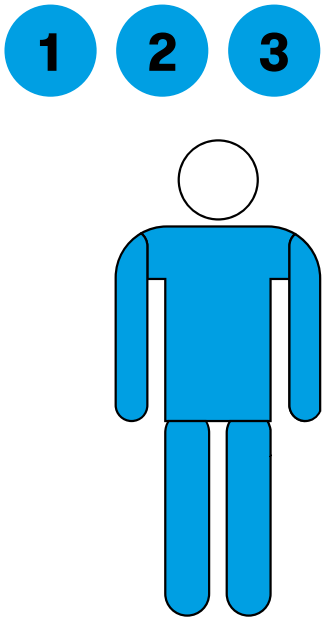
DIPLEGIA

both legs
affected



HEMIPLEGIA

one side of the
body affected



QUADRIPLEGIA

entire body
affected

cerebral palsy can affect different parts of the body

USER GROUP

PARTS of the BODY

About 75%-85% children with CP have spasticity (i.e. tightness of, or inability to control muscles).

USER GROUP

ASSOCIATED IMPAIRMENTS

1 in 4
is unable to walk

1 in 4
is unable to talk

3 in 4
experience pain

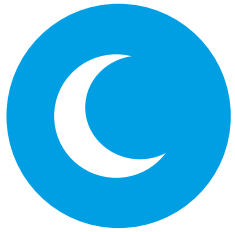
1 in 4
has epilepsy

1 in 4
has a behaviour problem

1 in 2
has an intellectual disability

1 in 10
has severe vision impairment

1 in 4
has bladder control problems

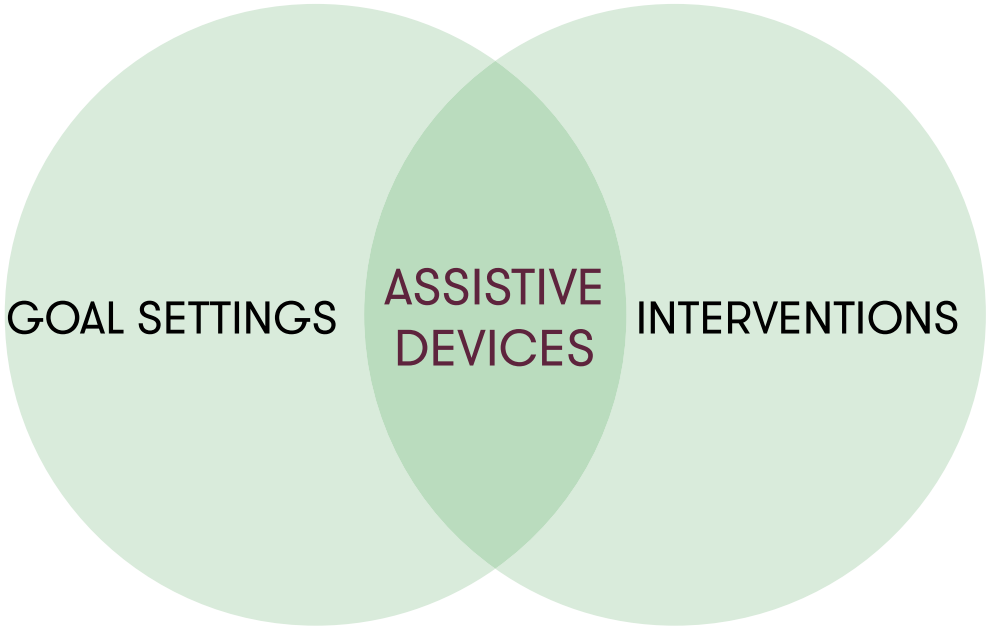


1 in 5
has a sleep disorder

1 in 4
has saliva control problems

children with CP may also have a range of physical and cognitive impairments

USER GROUP



GOAL SETTINGS

INDEPENDENCE
FUTURE EMPLOYMENT
COMMUNICATION
ACTIVITY OF DAILY LIVING
MOBILITY

ASSISTIVE DEVICES

AUGMENTATIVE AND ALTERNATIVE COMMUNICATION (AAC) devices, systems, strategies and tools that replace or support natural speech for persons who have difficulties communicating vocally.

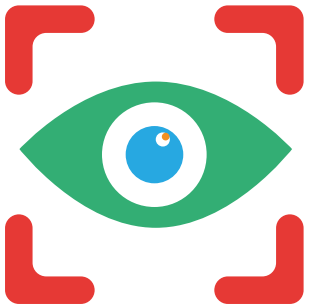
INTERVENTIONS

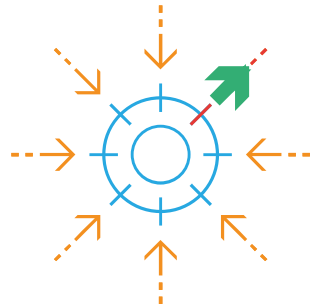
PHYSIOTHERAPY
SPEECH THERAPY
OCCUPATIONAL THERAPY
MUSIC THERAPY
ART THERAPY
HIPPOTHERAPY

Assistive Devices can provide a catalyst to achieve goals through intervention.

PRIMARY RESEARCH

The aim of this research is to find out more about how non-speaking children with CP socialise and communicate in their daily life.





Primary Research Methods

Empirical Data: Observation

Semi-structured Interviews w/SMEs

Subject Matter

Non-Verbal Children with CP

Parents / Caregivers

Subject Matter Experts

Research Focus

Communication & Activities

PRIMARY RESEARCH

Empirical Data Summary

Retro Fitted ACC Tools

Attractive assistive devices that appeal to a child's senses.

Lack of Focus

Intuitive and easy to use thus encourging independent activity.

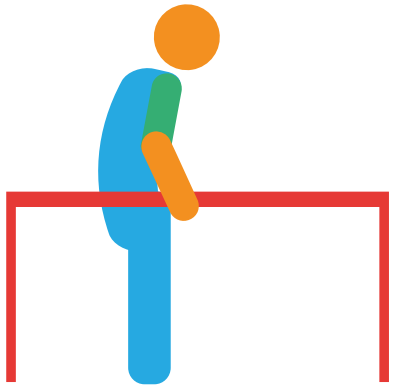
Varied Student Abilities

Tailored to each child's ability level.

https://www.austinmonitor.com

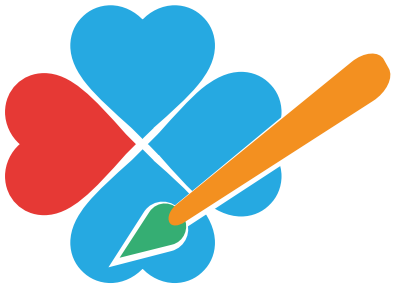
SECONDARY RESEARCH

Subject Matter Expert Interviews

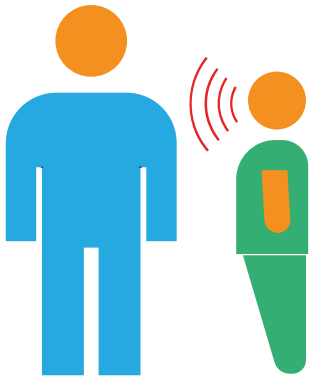


PHYSIOTHERAPIST

OCCUPATIONAL THERAPIST



ART THERAPIST



SPEECH THERAPIST

Secondary Research Methods:

Set of Questions
Oral and Written Responses
Snowball Sampling Method

Research Focus

Daily Communication & Activities

SECONDARY RESEARCH

SMEs Interviews Summary

Adapt Therapy to Child's Interests & Needs

Talk to parents and therapists as well as personal interaction.

Autonomy/Respect for Their Dignity

Stigma free Assistive Communication Devices can be used by all children

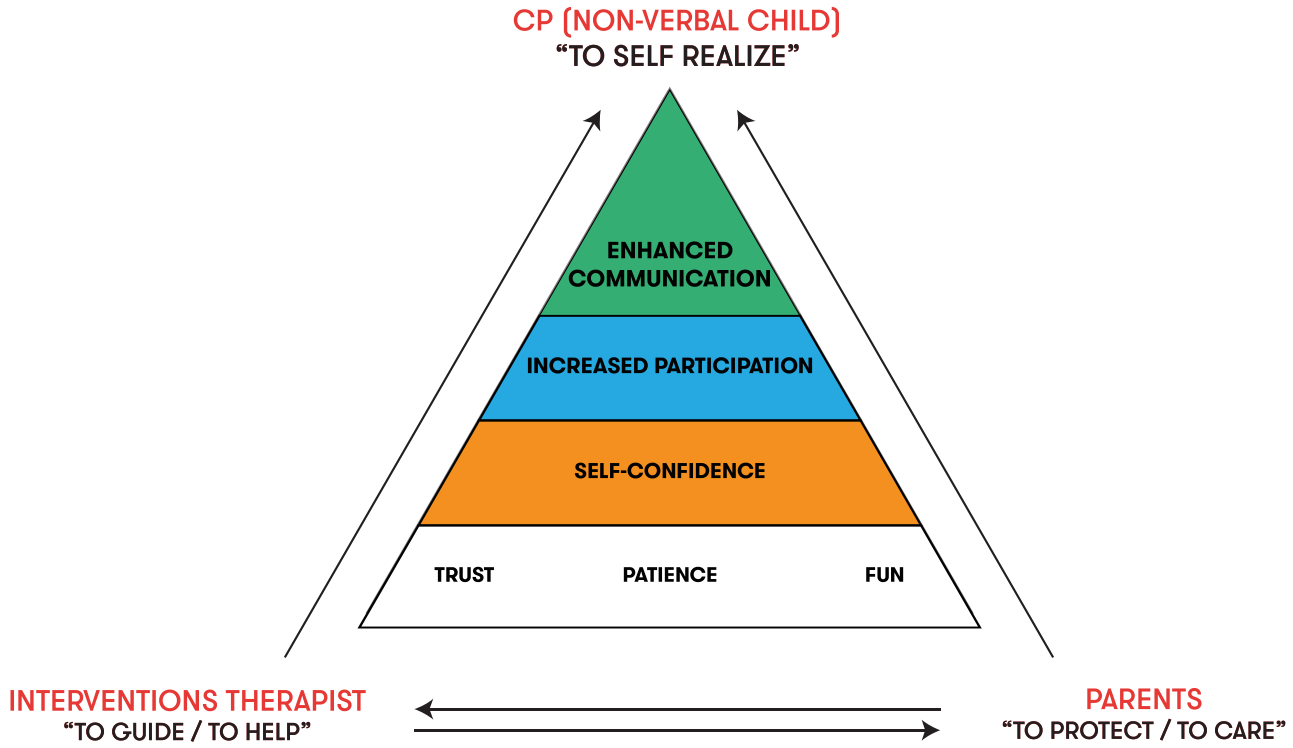
Be Patient as the Child Processes Information

Children with DDs may require more processing time.

https://cerebralpalsynewstoday.com

RESEARCH SYNTHESIS

The users of the product must include not only the children with CP who will use it to achive goals for rehabilitation purposes, but also the stakeholders who will play an important role in facilitating the child's use of the product.

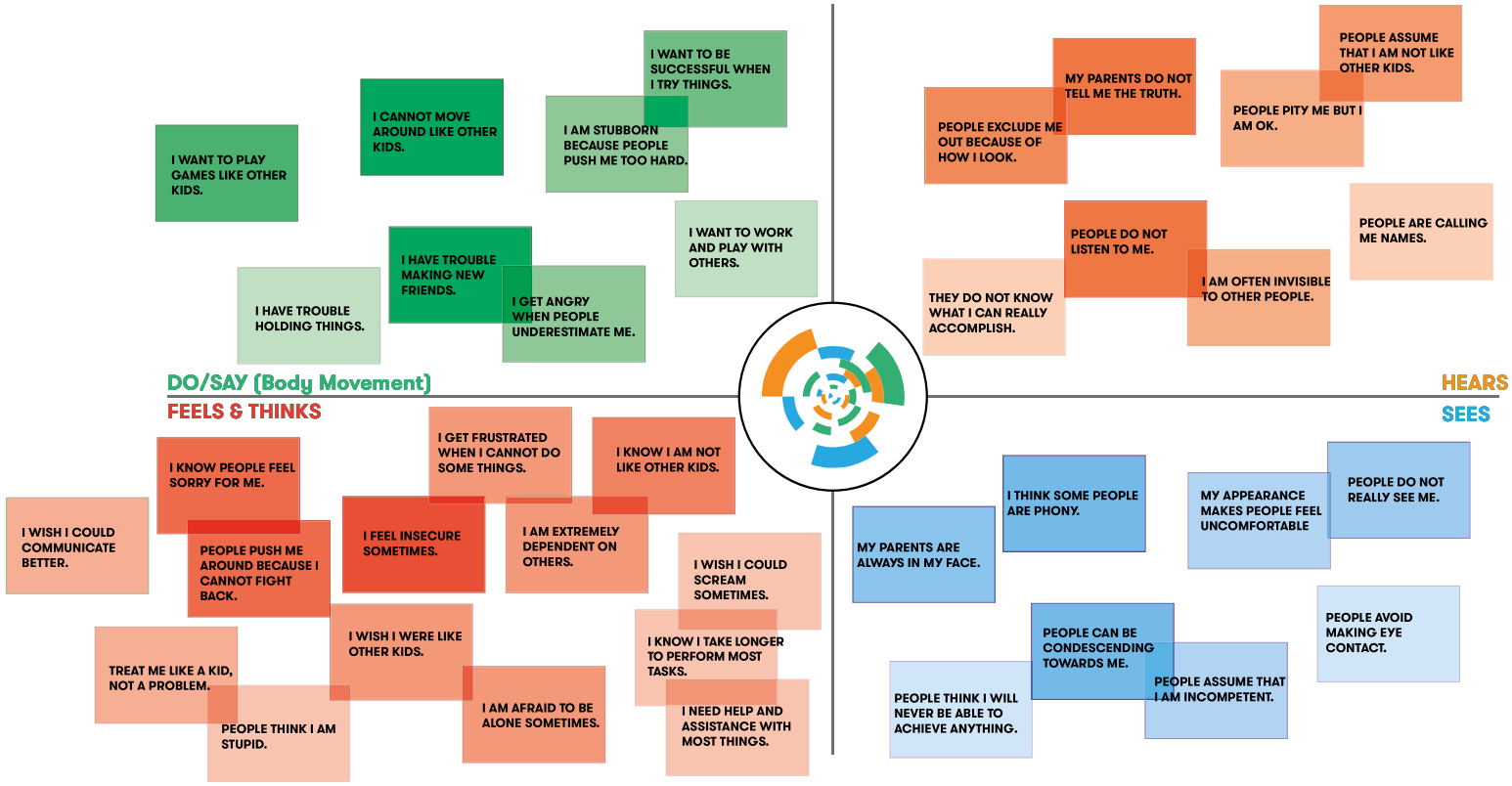


PROGRESS SIGNIFICANTLY CORRELATED WITH PARTICIPATION

I believe that if I can change one aspect daily life it will assist them and their care-givers and allow them to move forward in other areas. Small steps will lead to bigger and better results overall.

EMPATHY MAP

NON-SPEAKING CHILDREN (BOYS/GIRLS) AGED 4-16, WITH PHYSICAL AND MENTAL DISABILITIES.



GAIN :
I like it when i can learn to do things quickly.
I enjoy bright colours and shapes.
I like to try new things.
I like to use things that other kids can use.
I am happy when i succeed.
I like it when i can do things by myself.
I feel proud when people tell me that I did well.

PAIN :
I get frustrated when i forget how to do things.
I am sad when I cannot perform tasks like other kids.
My body won't let me do some things.
I hate it when people see me as different.
I know people think i am not capable.
People assume that i cannot always see, hear or understand them.

GOAL :

- **THE NEED FOR ACDs TAILORED TO EACH CHILD'S ABILITY.**
- **INTUITIVE TO USE, FUN AND ENGAGING.**
- **SELF-CONFIDENCE INCREASES PARTICIPATION AND ENCOURAGES SOCIAL COMMUNICATIONS**

PRIMARY OBJECTIVE

My aim is to design and create a learning tool that will stimulate eye-hand coordination, improve fine motor skills and enhance communication skills for non-Speaking children, aged 4 to 14, with CP. With this tool, it is hoped that children will participate more actively, act independently and improve their self-confidence and self-esteem.

LOCATION & CONTEXT

www.perkinselearning.org

www.perkinselearning.org

www.cerebral-palsy-dreamstime

For use in Intensive Support Programs (ISPs) with classroom students who have behavioral, communication, intellectual, or physical needs.

- Responsive
- Experimental
- Discursive
- Commercial

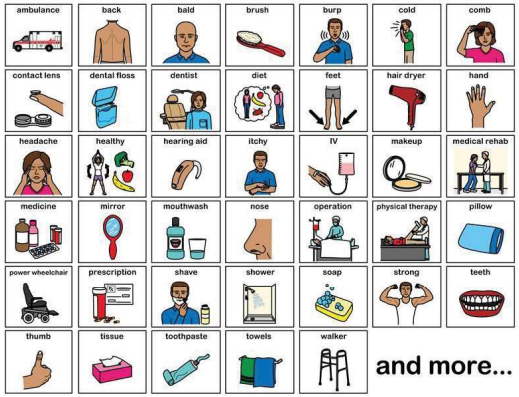
Because it is aimed to be highly personalized and adaptive device it is difficult to envision mass production or significant commercial gain.

FIELD RESEARCH

What is Out There ?

Dynavox **$5000 +**

32 Message Communicator
$399



PCS™ ThinLine: Set 1
$150 (PC/MAC not included)

4 Plate Communicator Say It Play It
$165

iPad Speech only Case
(software and ipad are not included)
$500

many AAC devices are not mass produced and are often very expensive

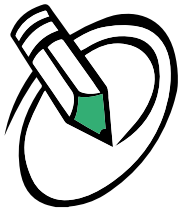
PROPOSED SOLUTION

In order to provide a low cost and simple communication board to replace expensive tablets or confusing picture cards, I am going to make a more flexible, child centered communication device that will encourage independent decision making.

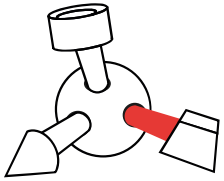
By creating objects that appear to be toys or games that have universal application, it is hoped that the child with CP would find these attractive and worthy of their curiosity.

PROTOTYPE DEVELOPMENT

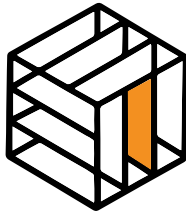
Phase of Development



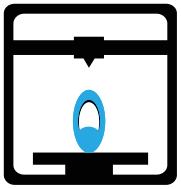
SKETCHING



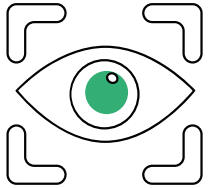
PROTOTYPING



3D RENDERING



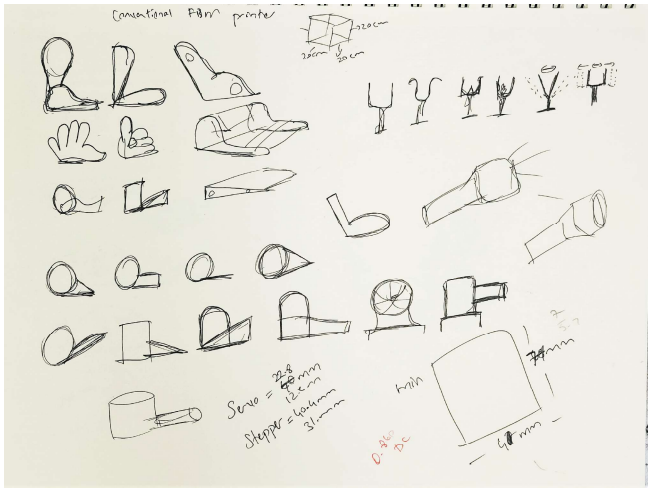
3D PRINTING

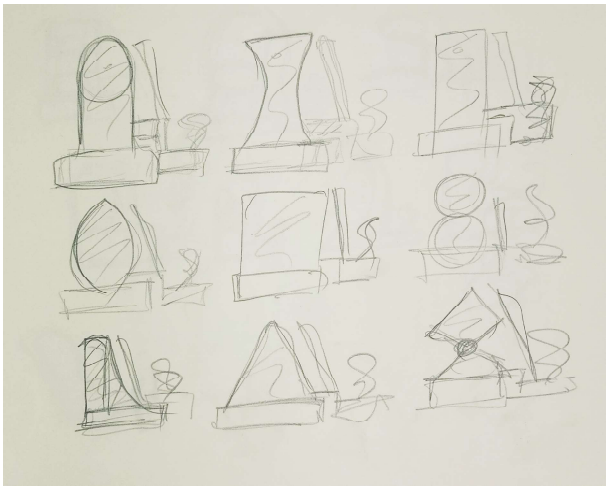


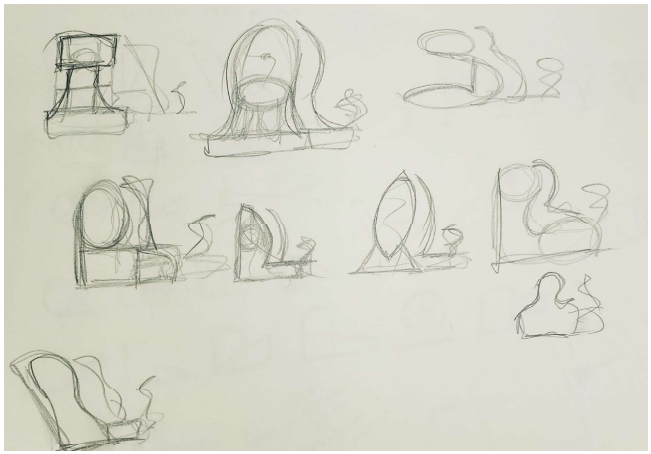
TEST & FEEDBACK

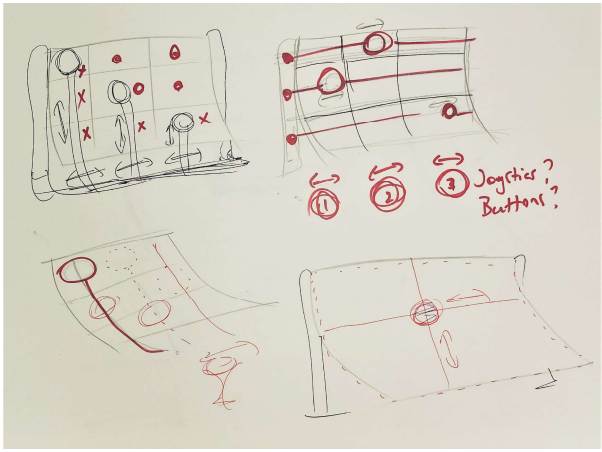
MUST HAVE	Adaptable to different physical and intellectual levels. Affordable. Attractive and child frienly to encourage participation. Portable and light weight to be used on different surfaces.
COULD HAVE	Some IOT entegration Multi sensory applications such as, sight-sound-touch. Attractive game like qualities.
SHOULD HAVE	Intiutive to use. Be sizable and modular. Should coordinate with learning objectives. Easily and safely stored when not in use.
WON'T HAVE	It won't be very expensive. It won't be obsolete after one use. It wont't be complex to use. It won't be high tech

Sketches



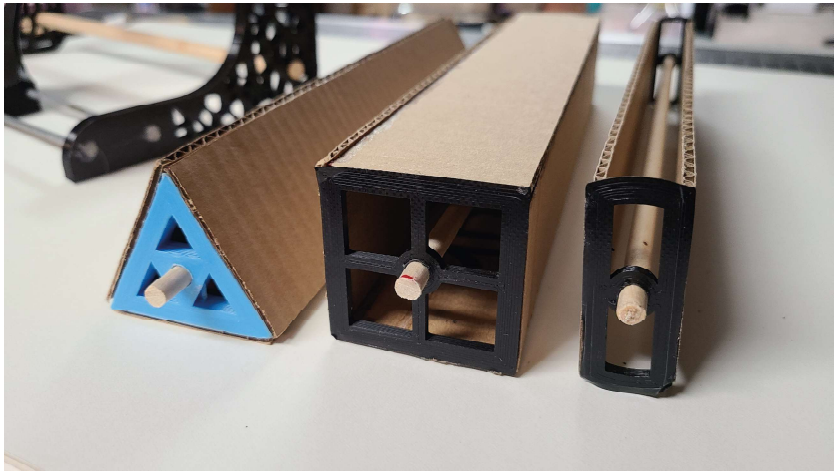


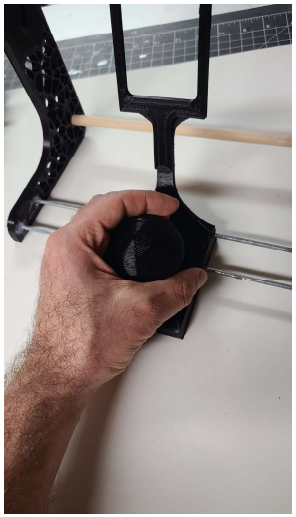


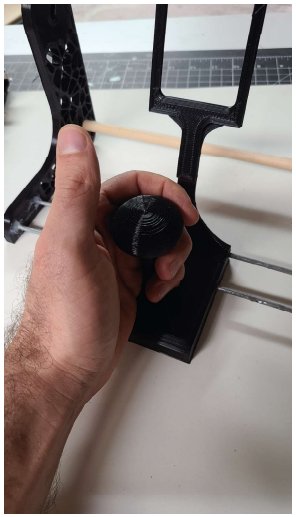


PROTOTYPE DEVELOPMENT

Prototype Testing

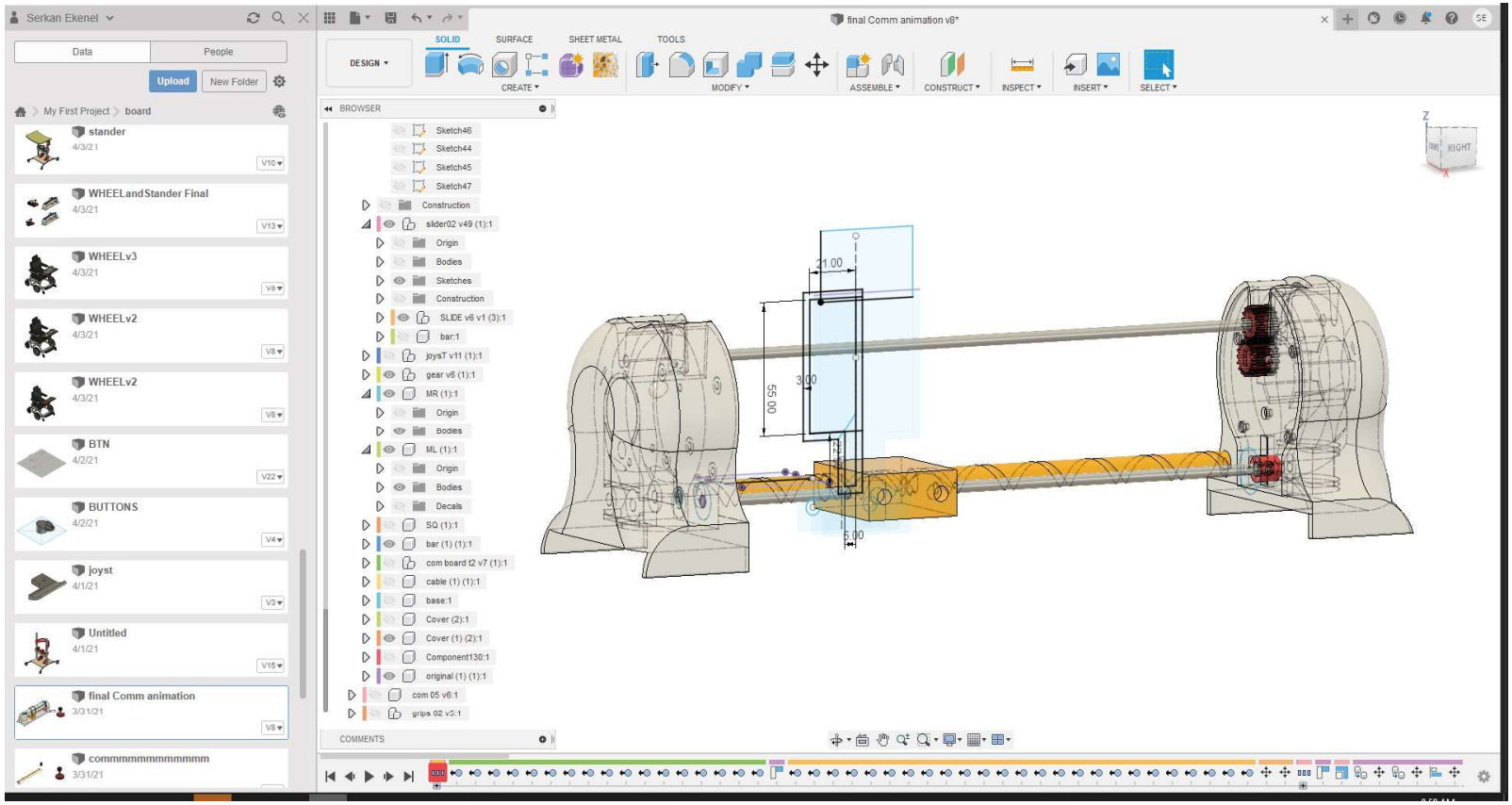






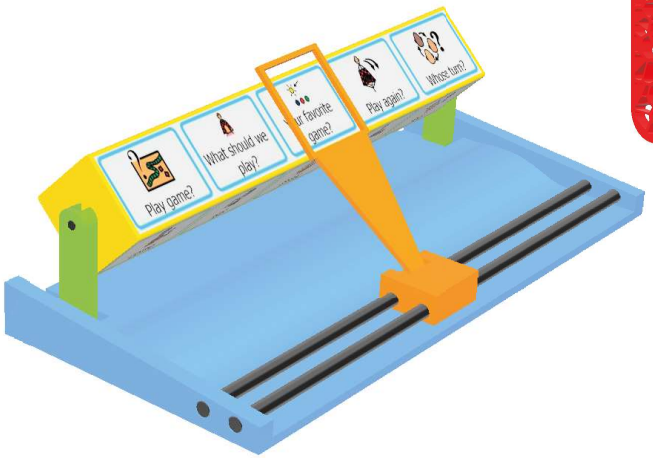
PROTOTYPE DEVELOPMENT

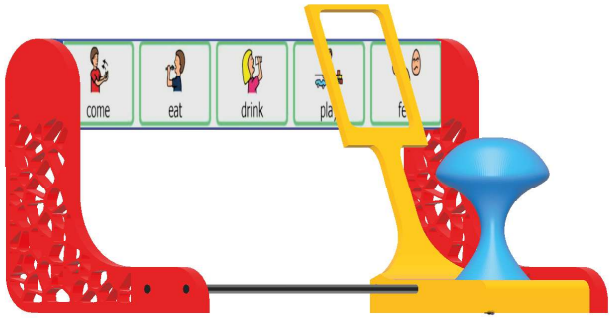
FUSION 360 Parametric Sketch & Modelling

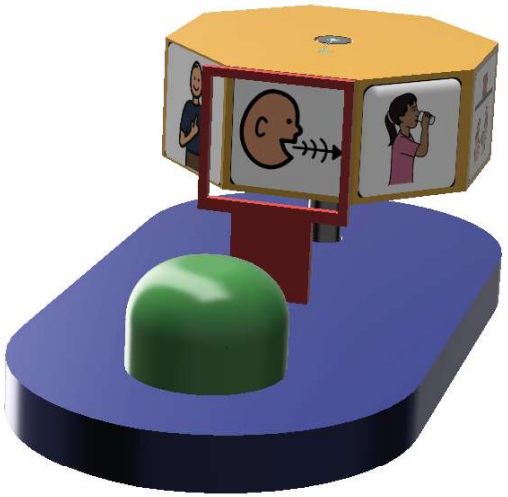


PROTOTYPE DEVELOPMENT

Forms

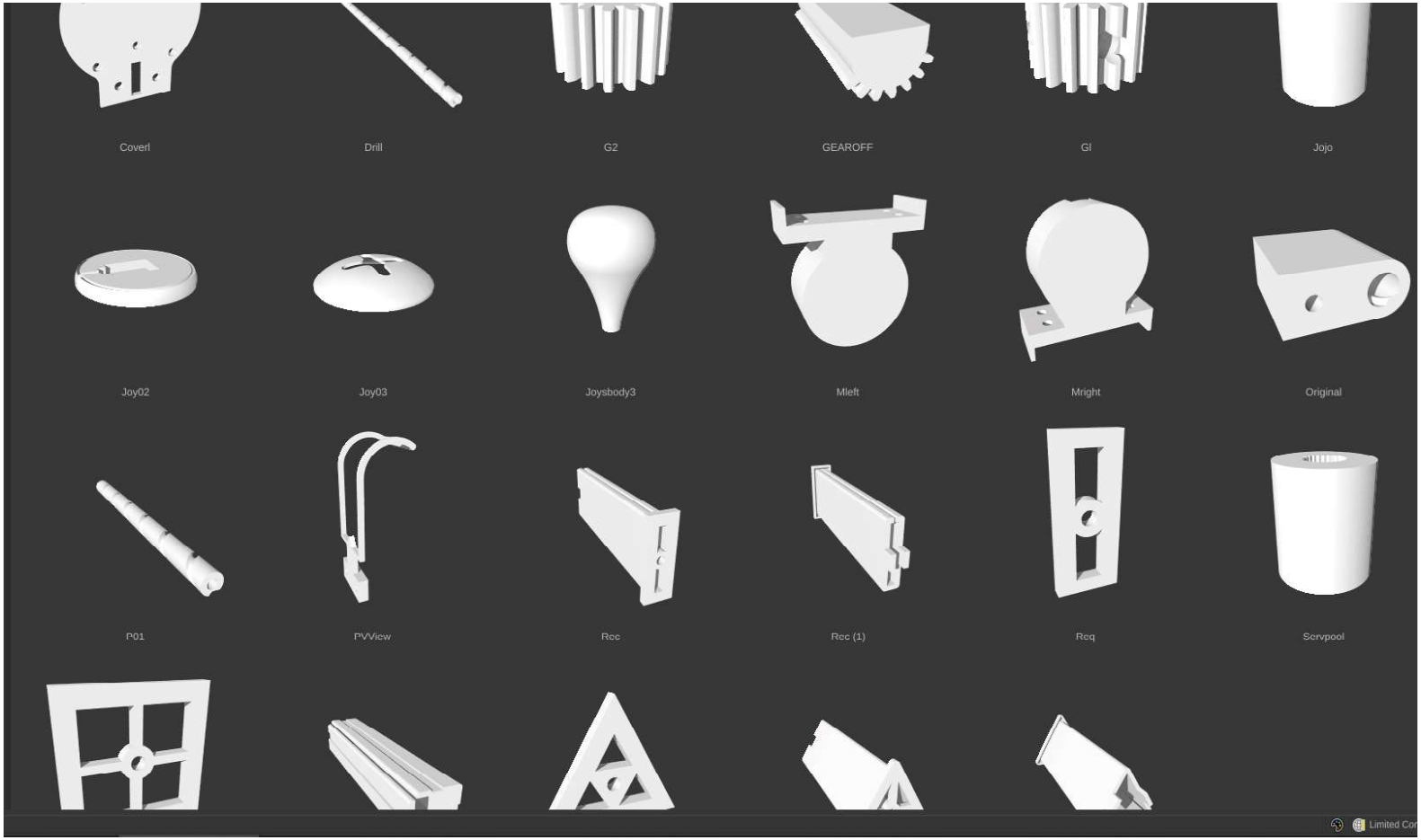






PROTOTYPE DEVELOPMENT

3D Printed Parts

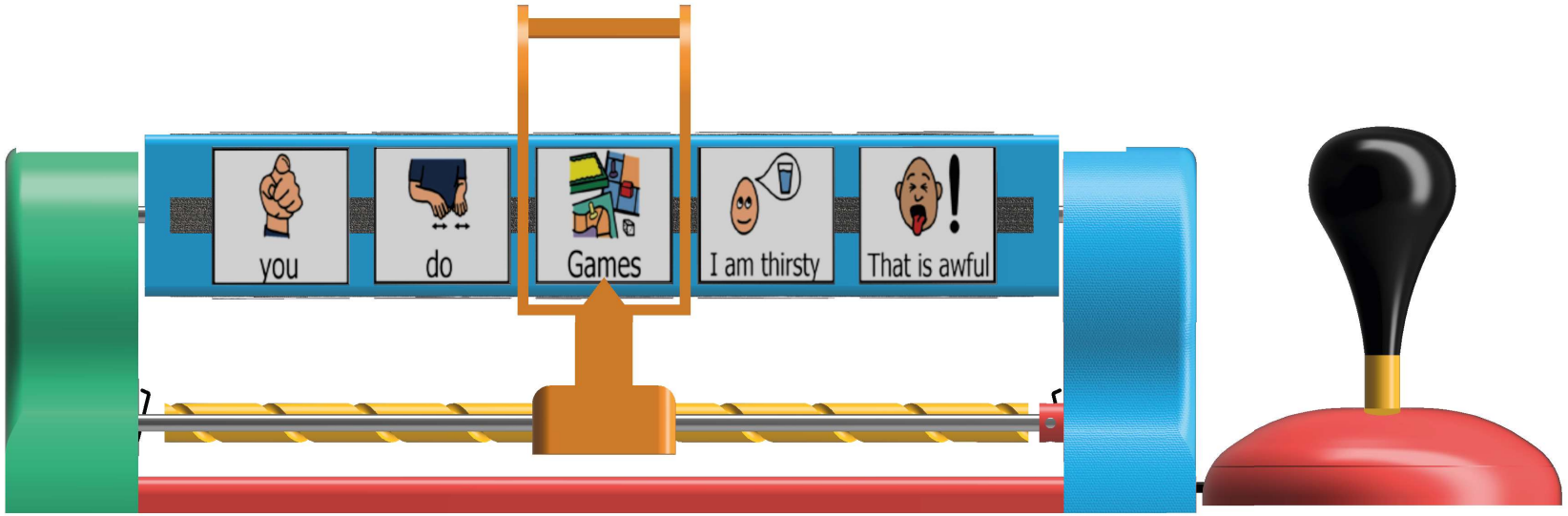


GLIDE

3D MODEL ANIMATION

https://www.youtube.com/watch?v=9gl12eyVrSI&t=2s

PRODUCT FEATURES

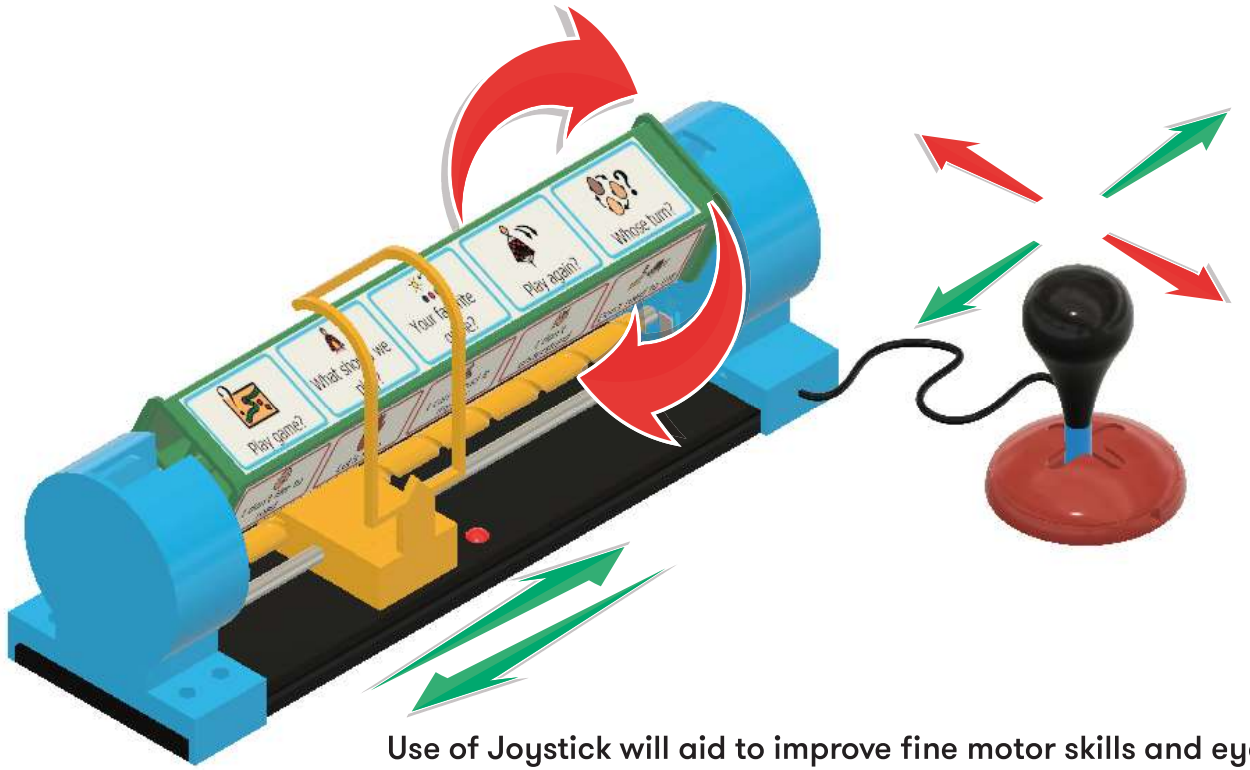


Glide is a highly personalised multi-activity platform geared to the individual needs and abilities of non-Speaking children with CP in a classroom setting.

DESIGN INTENT

Active Participation:

Device requires active participation and involvement, while encouraging increased cognition and fine motor skills.

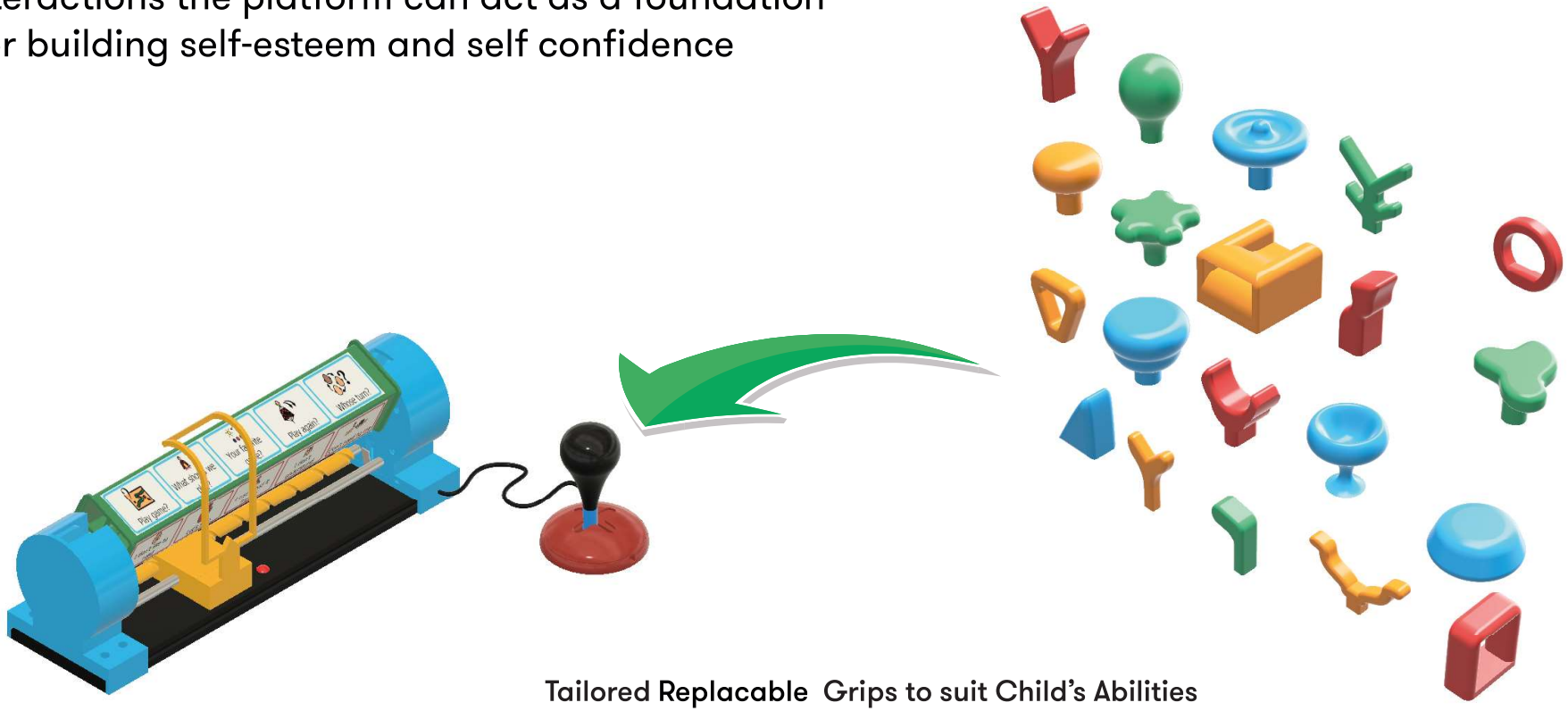


Use of Joystick will aid to improve fine motor skills and eye hand coordination.

PRODUCT FEATURES

Tailored to specific needs and abilities:

By providing adaptability for successful initial nteractions the platform can act as a foundation for building self-esteem and self confidence



Tailored Replacable Grips to suit Child's Abilities

PRODUCT FEATURES

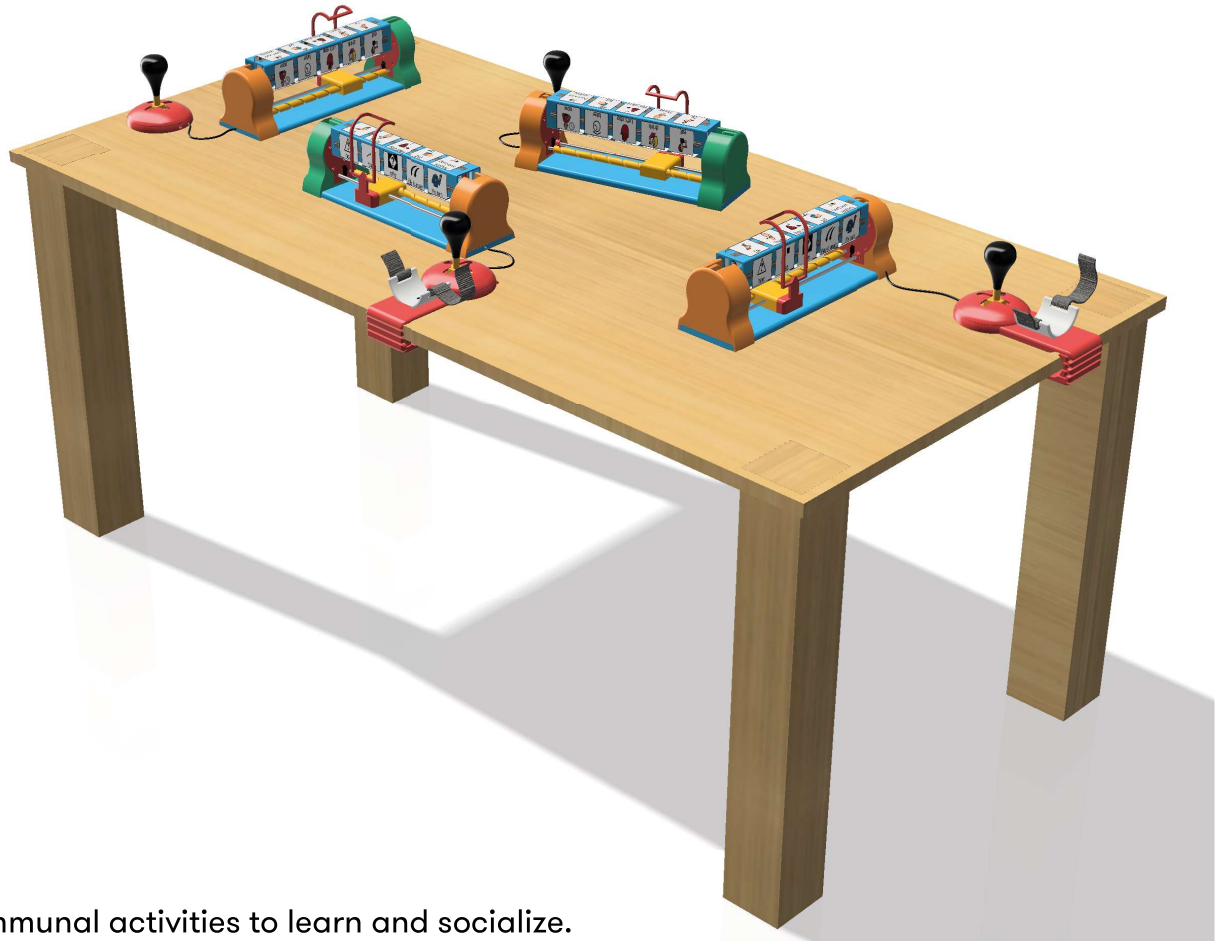
Adaptable Accessories for Wheelchair and Vertical Standers:

Adaptability and accessibility is a key issue need to be addressed. Understanding child's physical abilities and their body posture will successfuly help child to engage with the product.

Placement on a Wheelchair or Vertical Standing Tray for individual activities.

PRODUCT FEATURES

Encourages Socializing:

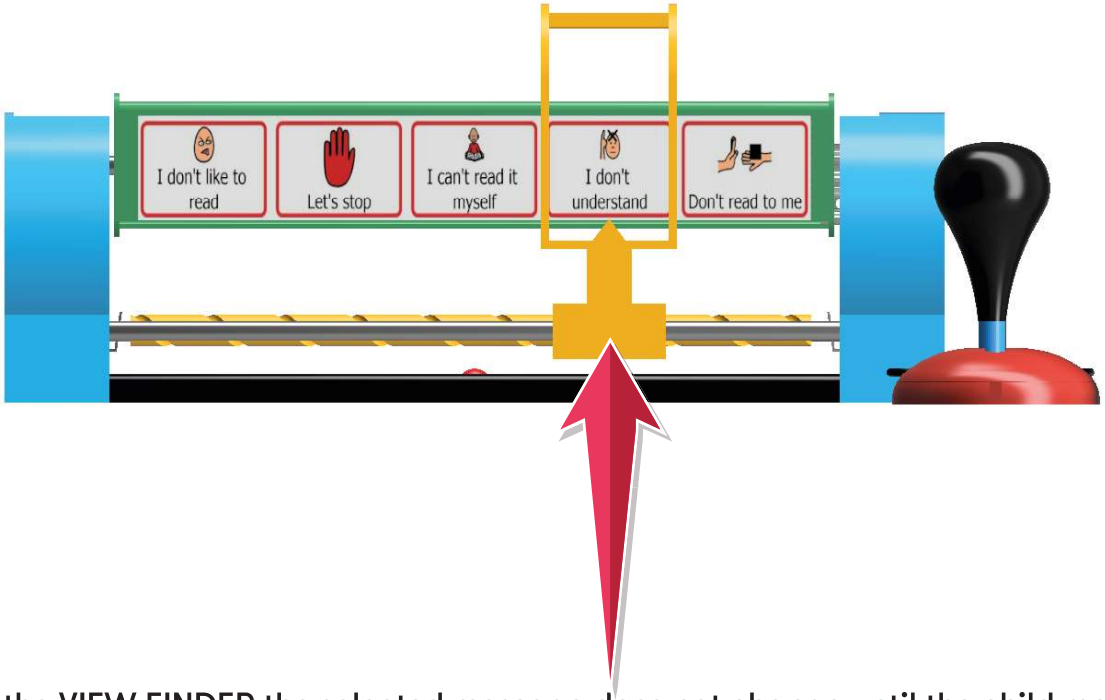


Single or communal activities to learn and socialize.

PRODUCT FEATURES

Continuous Highlight Feature:

Child's choice remains static until the message has been received eliminating potential miscommunication and encouraging independent decision making.

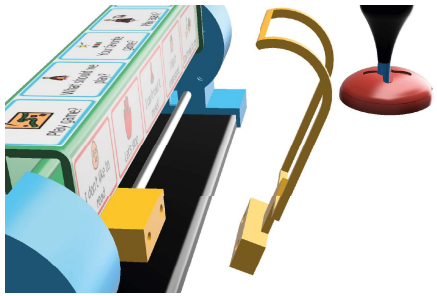


After navigating the VIEW FINDER the selected message does not change until the child moves the Joystick.

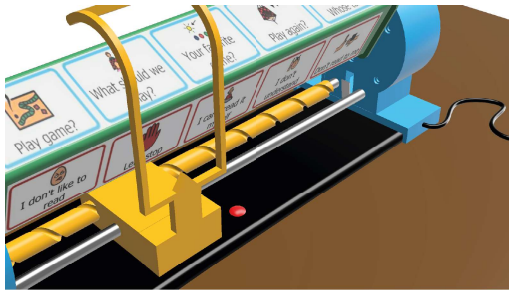
PRODUCT FEATURES

Multi-activity Platform:

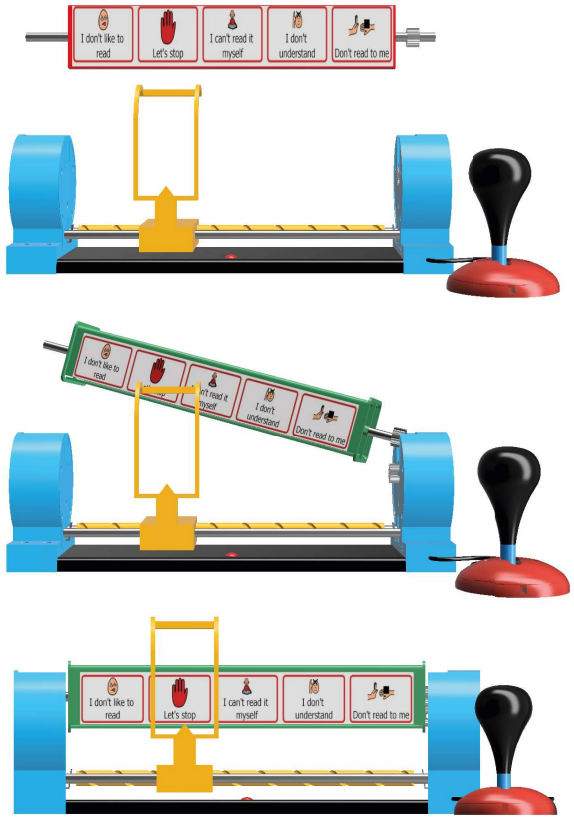
Can be used as a Game Board, Communication device, Mathematics teaching tool, and Vocabulary builder while also enhancing sensory and fine motor skills.



Removable View Finder adapts to each child and can be magnified for the vision impaired.



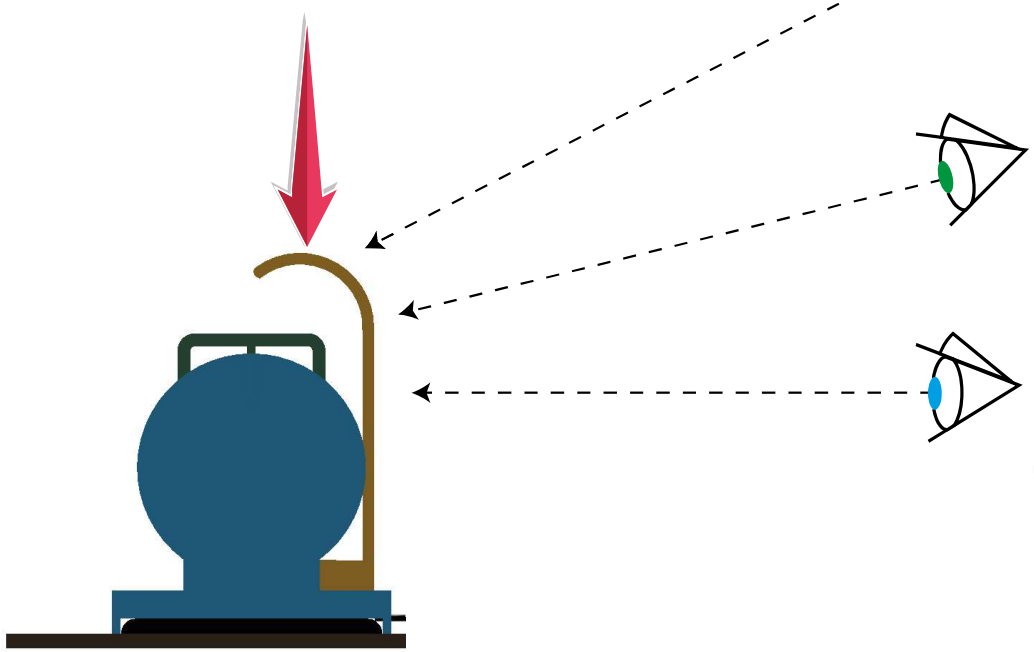
Limit Switch and View Finder Lights to help child with sensory stimuli.

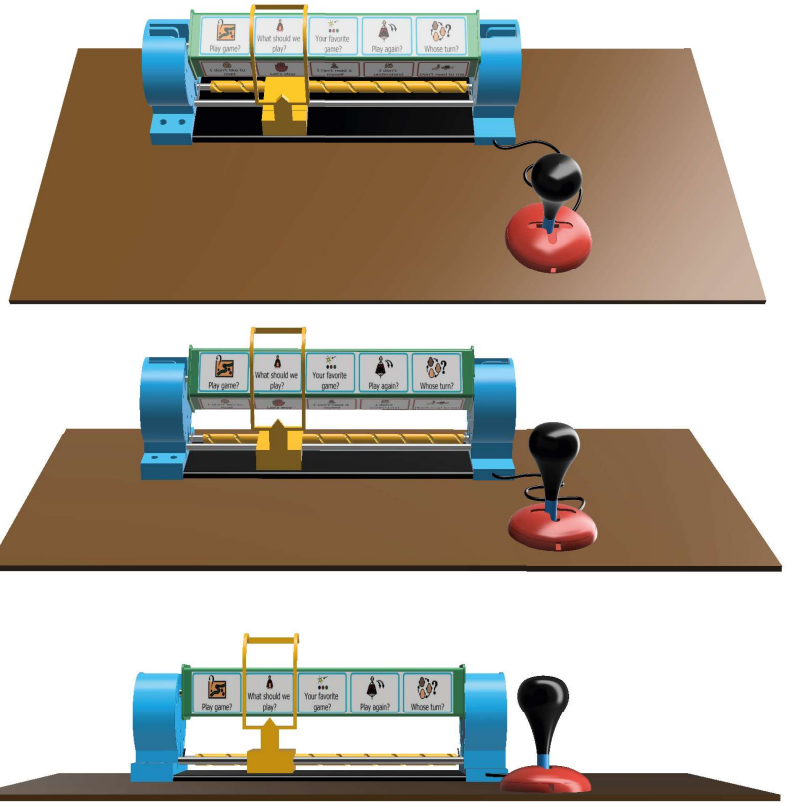


Easily swappable Blocks to prepare activities.

PRODUCT FEATURES

The shape of the View Finder designed to provide clear views in any posture.



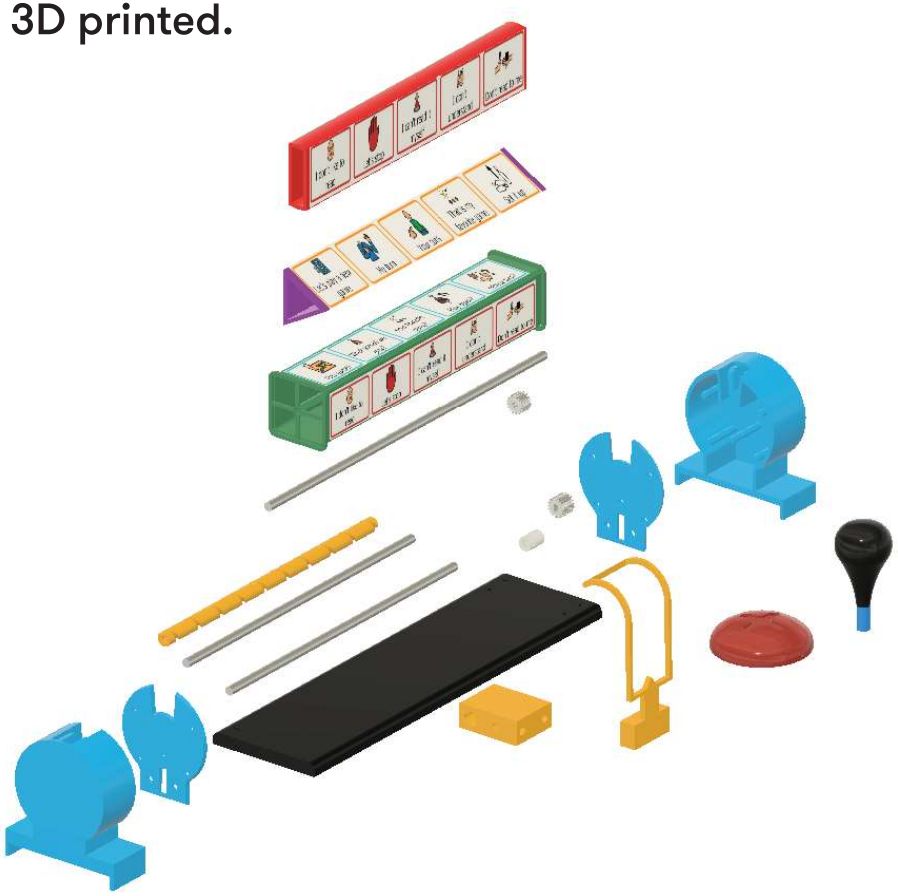


Blocks turns in 5 Degree increments and provides a clear vantage point from child's sitting/standing position

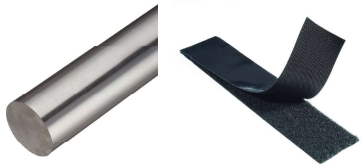
TECHNICAL

Assembly

Most of the parts are 3D Printed. Parts are designed to be easily 3D printed so not much work needed to assemble after 3D printed.



ARDUINO

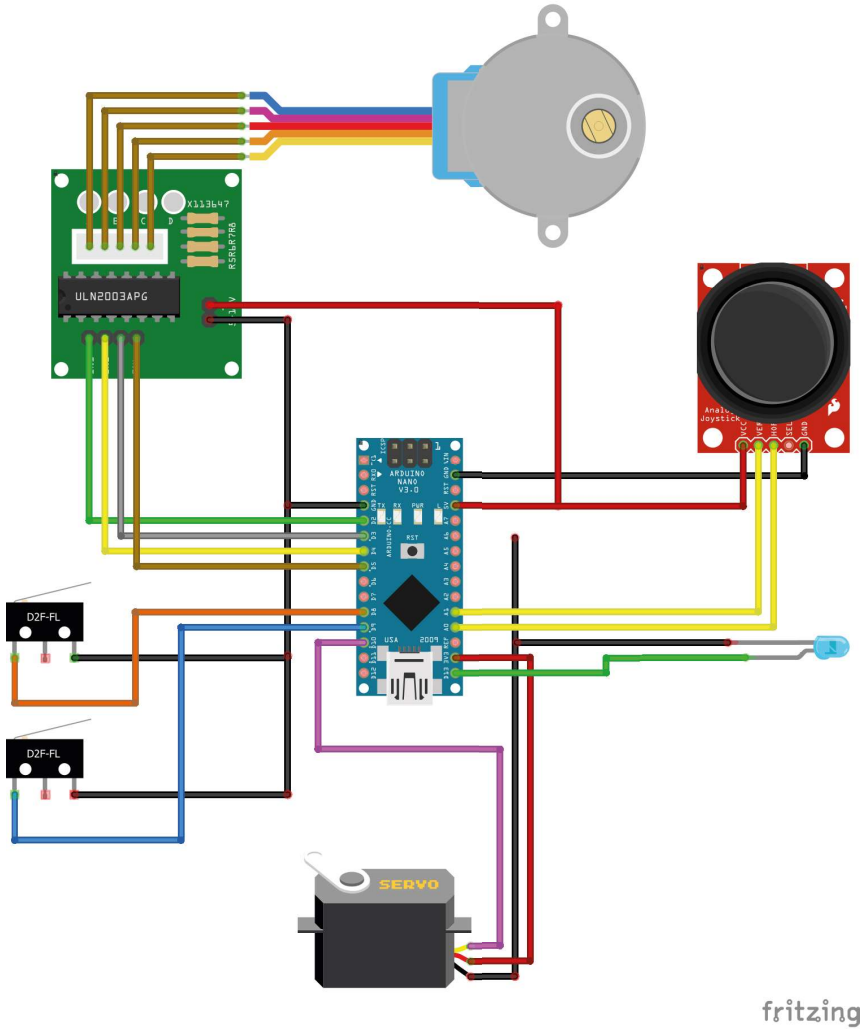


AFFORDABLE AND EASILY AVAILABLE MATERIALS

Ardruino Uno
Stepper Motor
Servo Motor
5/8” Steel Round Rod
Velcro

TECHNICAL

Electronic Parts & Code

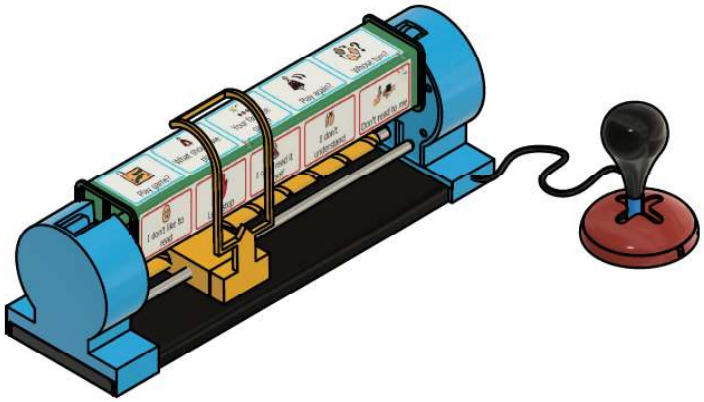


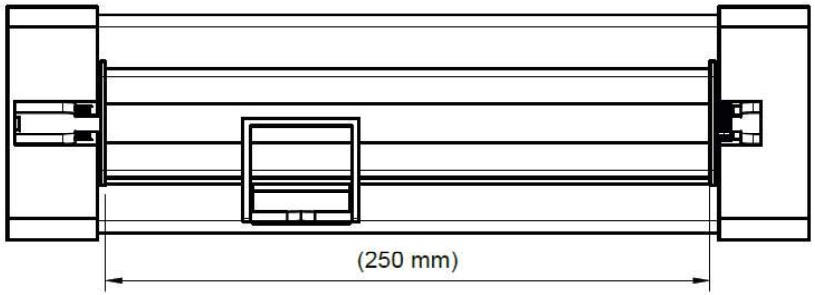

```
/*
 Controlling a servo position using a potentiometer (variable resistor)
 by Michal Rinott <http://people.interaction-ivrea.it/m.rinott>

 modified on 8 Nov 2013
 by Scott Fitzgerald
 http://www.arduino.cc/en/Tutorial/Knob
 */

#include <Servo.h>
#include <Stepper.h>

#define STEPS 64

#define IN1  2
#define IN2  3
#define IN3  4
#define IN4  5



Stepper stepper(STEPS, IN1, IN3, IN2, IN4); // stepper motor sequence 1-3-2-4

int potState = 0;
int stepperS = 520;
int backSW = 300;


Servo servo;  // create servo object to control a servo
int yPin = A1; //X-axis attach to A0
int yValue;  //intialaze a varibale to save the data from the X-axis from the joystick

int joypin1 = A0;  // analog pin used to connect the joystick
int val;    // variable to read the value from the analog pin



// global variables (constants) to represent direction of servo rotation
const int COUNTER_CLOCKWISE = 1000;
const int STOPPED = 1500;
const int CLOCKWISE = 2000;
//limitSwitch

int Lswitch1 = 8;
int Lswitch2 = 9;
int flag = 0;
int flag2 = 0;

int led = 13;

void setup() {
 Serial.begin(9600);
 servo.attach(10);  // attaches the servo on pin 9 to the servo object
 pinMode(Lswitch1, INPUT);
 pinMode(Lswitch2, INPUT);
 pinMode(led, INPUT);

}

void loop() {


SerialLprint("X = ");
SerialLprint(analogRead(val));
delay(20);

//SERVO MOVEMENT
 val = analogRead(joypin1);          // reads the value of the potentiometer (value between 0 and 1023)
 val = map(val, 0, 1023, 0, 180);    // scale it to use it with the servo (value between 0 and 180)
 servo.write(val);                   // sets the servo position according to the scaled value
 delay(15);                          // waits for the servo to get there


//LED

 if (analogRead(val) < 499 && analogRead(val) > 480)
   {digitalWrite(led, HIGH);}


 else
   {digitalWrite(led, LOW);}

/
```

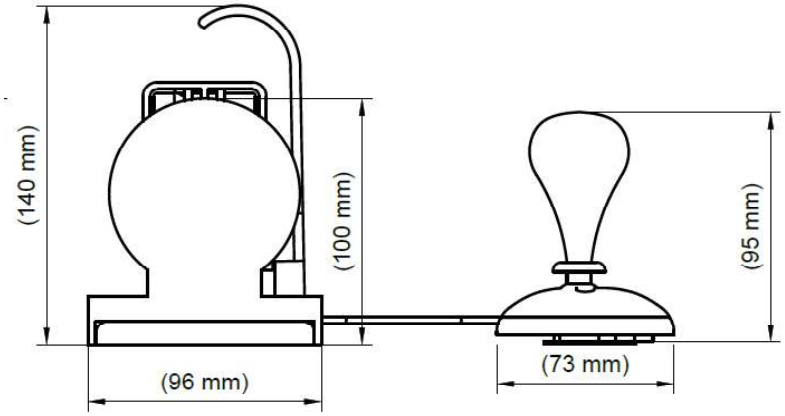
```
//STEPPER MOVEMENT


        Serial.print(" | Y = ");
        Serial.print(analogRead(yPin));

potState = analogRead(A1); //reads the values from the potentiometers


 Serial.println(potState); // sends joystick data to serial port for debuging
 stepper.setSpeed(stepperS);


 if (potState > 600){  //all code below controls movement down
   stepper.step(STEPS);
 }

 if (potState < 200){
   stepper.step(-STEPS);
 }


//LIMIT_SWITCH 01
 {
  if( (digitalRead(Lswitch1) == LOW) && (flag == 0) )
  {
   Serial.println("L1 is closed");
flag = 1;

  }

   if( (digitalRead(Lswitch1) == HIGH) && (flag == 1) )
  {
   Serial.println("L1 is opened");
flag = 0;

  }

  if ( flag == 0 )
  {
   servo.writeMicroseconds(STOPPED);
   delay(1000); // allow to rotate for 5 seconds
//    servo.writeMicroseconds(COUNTER_CLOCKWISE);
//   delay(1000); // allow to rotate for 5 seconds
   servo.writeMicroseconds(CLOCKWISE); // stop rotation
   delay(150);
  }

  digitalWrite(Lswitch1, HIGH);

}


//LIMIT_SWITCH 02
 if( (digitalRead(Lswitch2) == LOW) && (flag2 == 0) )
 {
  Serial.println("L2 is closed");
flag2 = 1;
delay(20);
 }

  if( (digitalRead(Lswitch2) == HIGH) && (flag2 == 1) )
 {
  Serial.println("L2 is opened");
flag2 = 0;
delay(20);
 }

 if ( flag2 == 0 )
 {

    servo.writeMicroseconds(STOPPED);
   delay(1000); // allow to rotate for 5 seconds
   servo.writeMicroseconds(COUNTER_CLOCKWISE);
   delay(150); // allow to rotate for 5 seconds
//   servo.writeMicroseconds(CLOCKWISE); // stop rotation
//   delay(100);

 }


  digitalWrite(Lswitch2, HIGH);

}
```

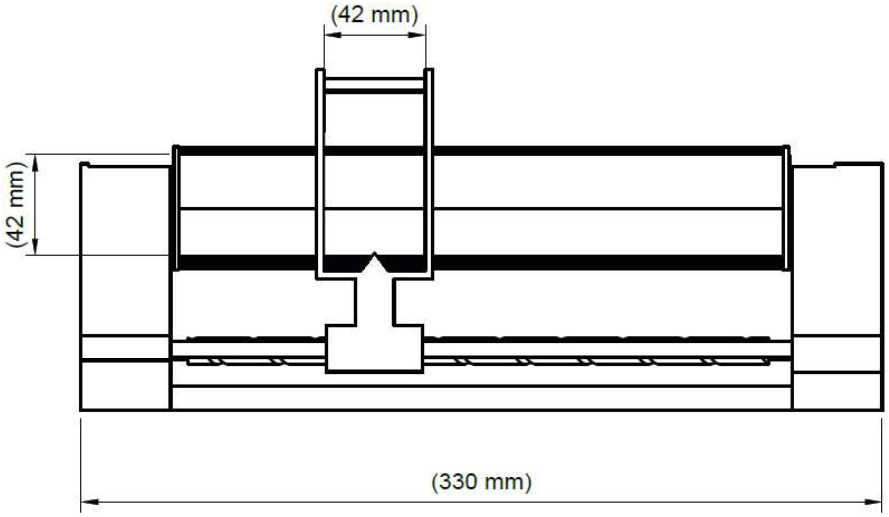
TECHNICAL

Drawing

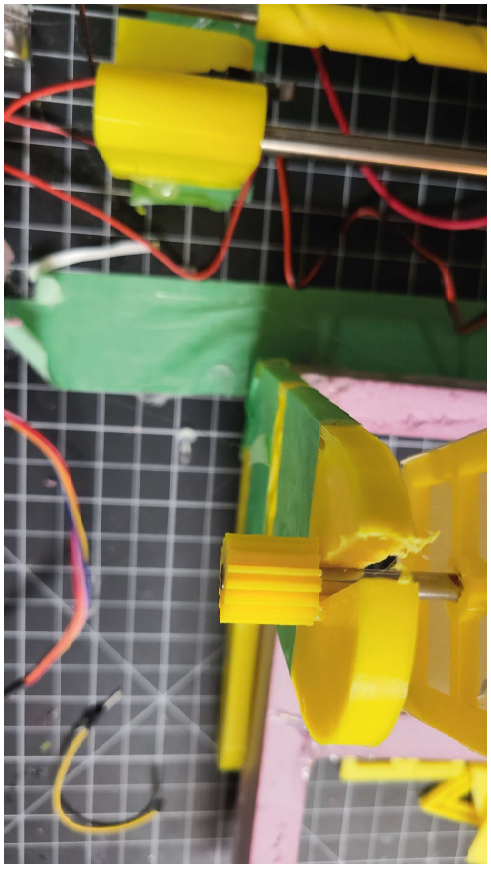


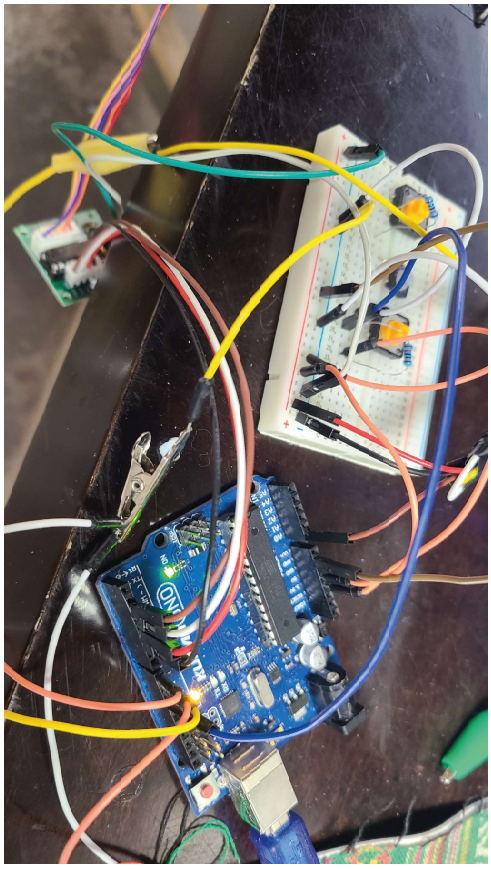


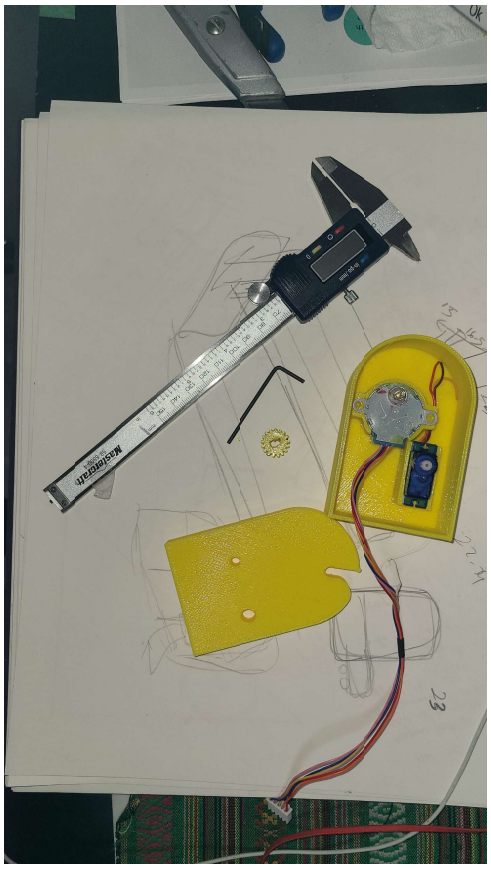


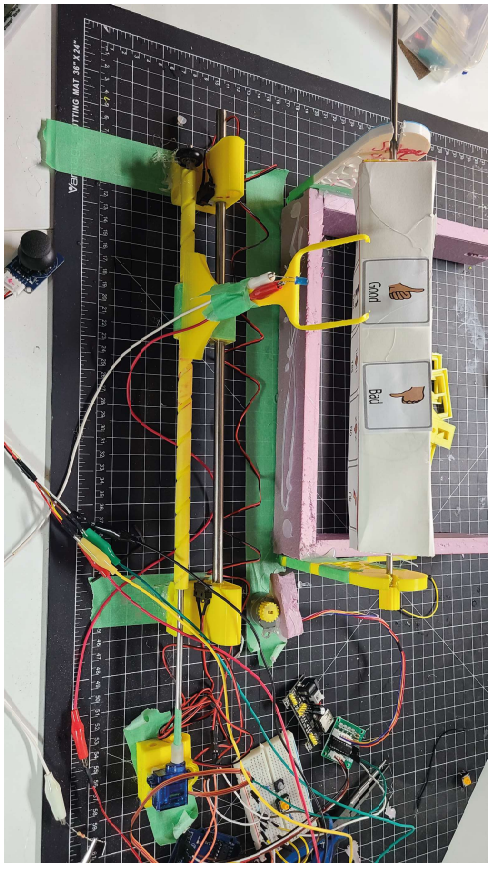


PROTOTYPE DEVELOPMENT

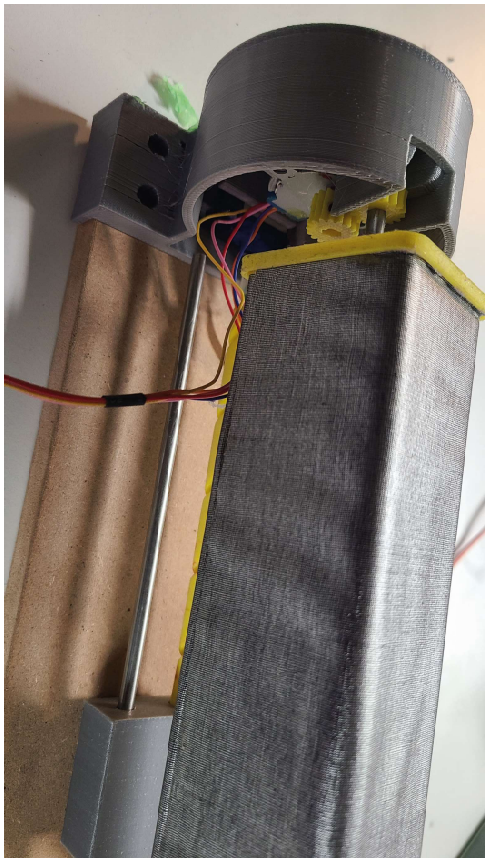


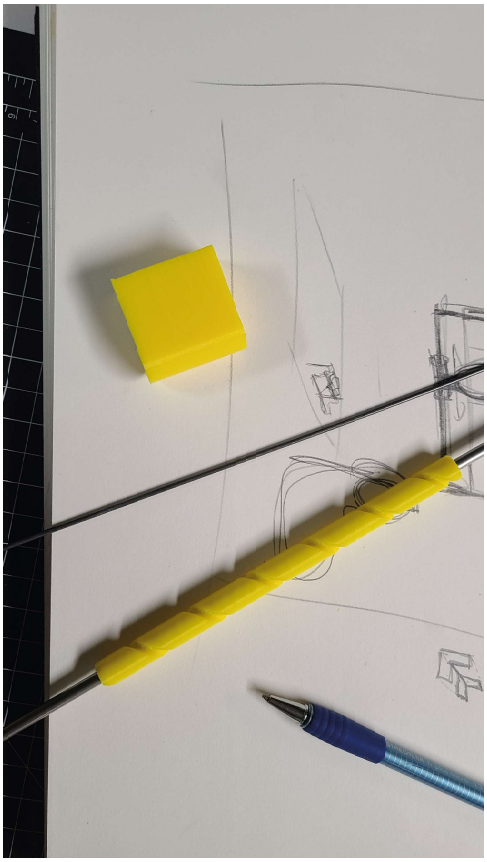


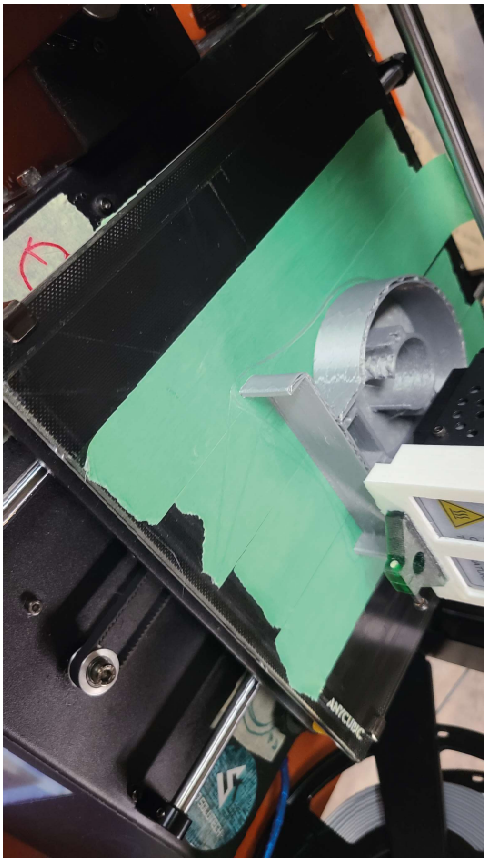




PROTOTYPE DEVELOPMENT







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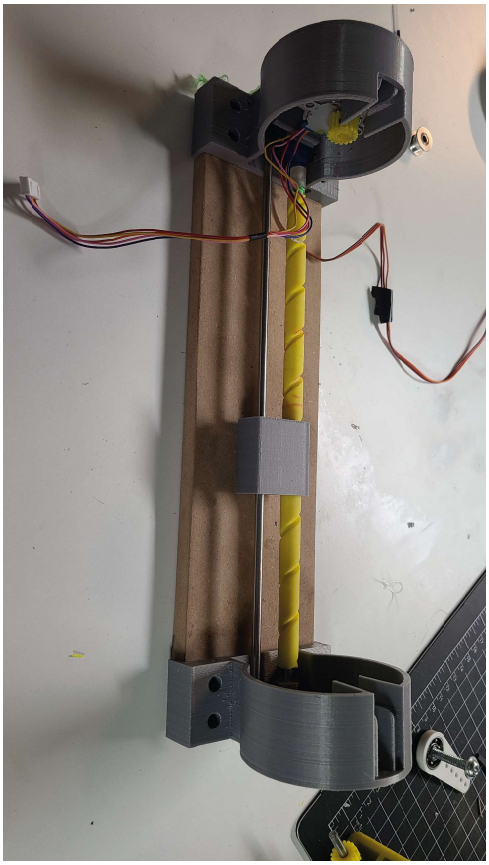
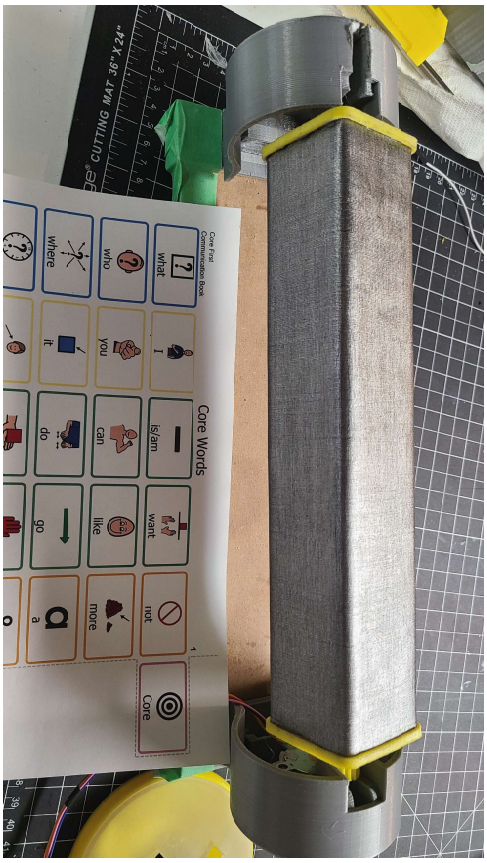


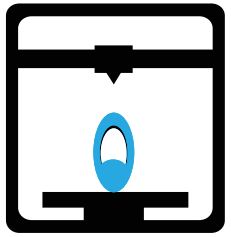


PRODUCT DEMONSTRATION

https://www.youtube.com/watch?v=5tMFQ6fO2eg

STRATEGIC PARTNERS

CAREGIVERS



3D PRINTING COMMUNITY

Strategic partners include, but are not limited to, School Boards, hospitals, special needs teachers, classroom assistants, parents and other caregivers who are directly involved with children exhibiting moderate-to-severe forms of Cerebral Palsy.

By canvasing the 3D Printing community on Social Media I hope to find volunteers who will print parts for my platforms.

www.pacificmedicallaw.ca

for all your help, thank you !!!