

# Paint a Little Picture for Me

## Acceptance & Delivery Review

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- Individuals with spinal cord injury (SCI) and limited mobility may have difficulty holding paintbrushes/creating art through traditional means
  - Current mouth painting solutions are tiring and uncontrollable



## Problem Statement

- Engineer a mouth-based assistive device to ease mouth painting
  - Relieves weight
  - Increases control
  - Allows individuals to express themselves creatively



**Goal**

## MOBILE PAINTING DEVICE

- Compatible

- any level of mobility

- Bright art

- Low cost

- Cannot see the art while creating it

- Less control than traditional brush

- Lots of space and cleanup



## BLICK EGG HANDLED PAINT BRUSH

- Can be reused

- Is easy to use and clean

- Can be used like a regular paintbrush

- Not

- compatible with all levels of injury

- Handle may not be comfortable



# Competitors

# Level 1 Requirements

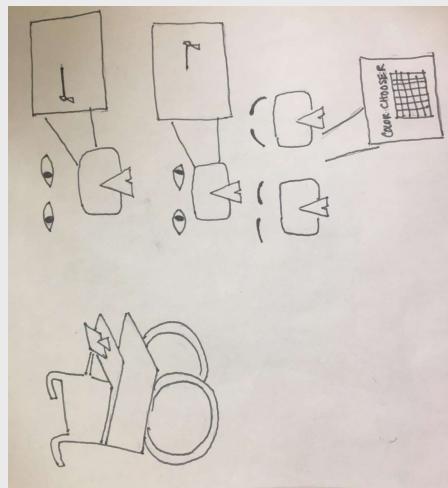
#	Level	Type	Requirements statement
1	1	User	The device is the user's preferred method of painting
2	1	Functional	The device shall be compatible with paint
3	1	Functional	The device shall function without the user needing to use their hands
4	1	Functional	The device shall be able to create art based on the users input
5	1	Functional	The device shall include a user manual
6	1	Functional	The device is stable and durable for the length of one paint session
7	1	Functional	The device shall fit comfortably for people with different face and body shapes
8	1	Functional	The device shall pivot at least 10 degrees from horizontal
9	1	User	The user shall be able to move the part of the body necessary to use the device
10	1	Physical	The device shall not contain sharps or other dangerous parts
11	1	Physical	The device shall be made of a nontoxic material

## Other Requirements

#	Level	Type	Requirements statement
12	2	Functional	The device shall be compatible with at least three types of brushes
13	2	User	The user shall be able to set up the device independently
14	2	Functional	The device can be set up, on average, in under five minutes
15	2	Functional	The device shall be able to be sanitized easily
16	2	Functional	The device shall save and display the art created
17	2	Functional	The device shall be portable
18	2	Functional	The device shall be compatible with optional mediums such as clay
19	2	Cost	The device shall be made of less than \$20 of materials
20	3	Physical	The device shall be less than 750 grams
21	3	Physical	The device shall be no more than 20 centimeters on each side

## Design 1: Facial Tracking for Digital Paintbrush

- Nose tracking device would translate movement to a digital paintbrush
  - Gestures would change other features (colors, brush size)



## Design 2: Facial Tracking for x-y Table

- Nose tracking device would translate movement into an x-y table

**PDR:  
Adding  
Digital  
Elements  
to Art**

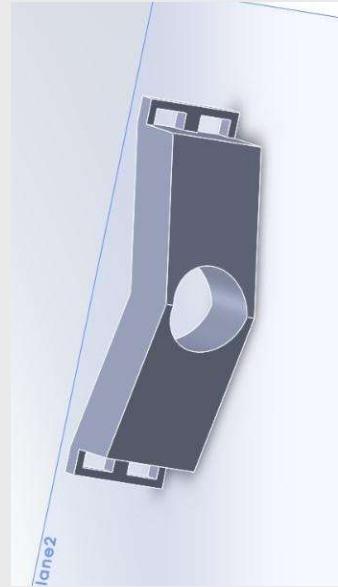
### Design 3: Headband Mount

- Headband wrapped around forehead with velcro that will hold the paintbrush outward towards the canvas



### Design 4: Mouth Mount

- Mouth mount wrapped around the lower part of the face with velcro will hold the paintbrush outward towards the canvas



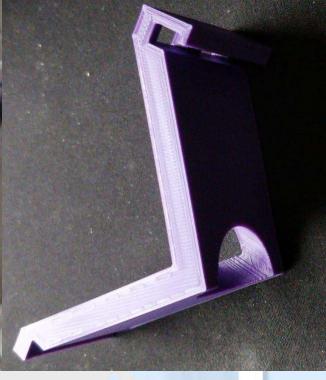
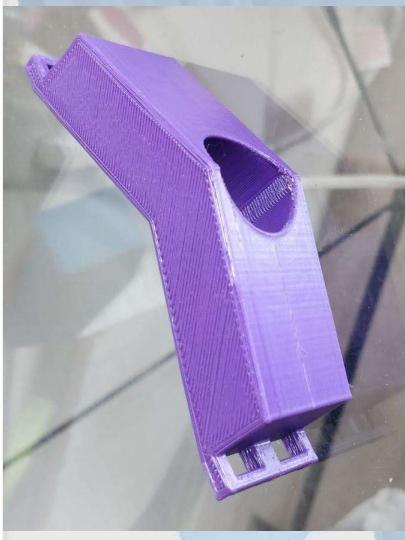
- Pursuing the mouth mount
- Client was most interested in and familiar with non-digital art
- Fulfilled more requirements than headband



CDR

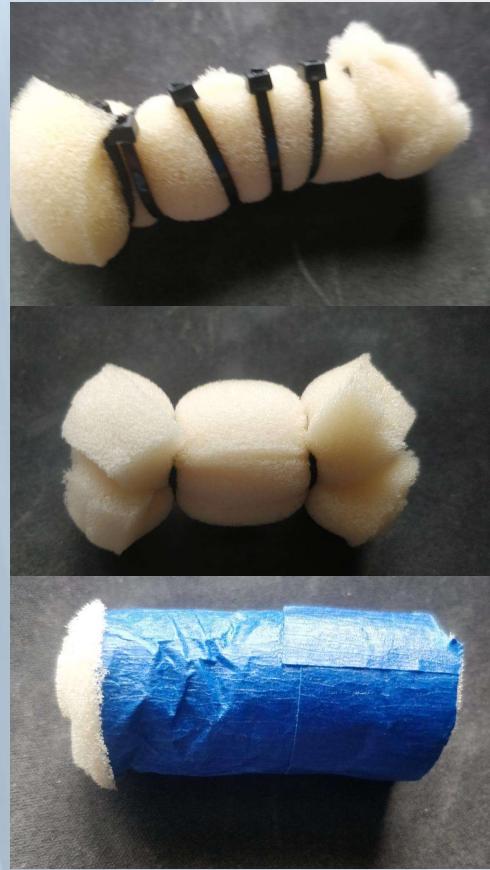
# CDR

- Since PDR, printed 3 prototypes
  - Mount 1: extremely blocky and uncomfortable
  - Mount 2: increased slope of sides but mount is still uncomfortable
  - Mount 3: even greater increase of slope but still uncomfortable
- Still needed to address the issue of securing a paintbrush



# **Build Process: Testable Prototypes**

- 2 comfortable mounts and 3 foam methods for attaching paintbrush
  - Mounts differ by the slope of their sides
  - Foams are all made out of insulation foam with either zip ties or tape
- Can be interchanged, leading to 6 testable prototypes



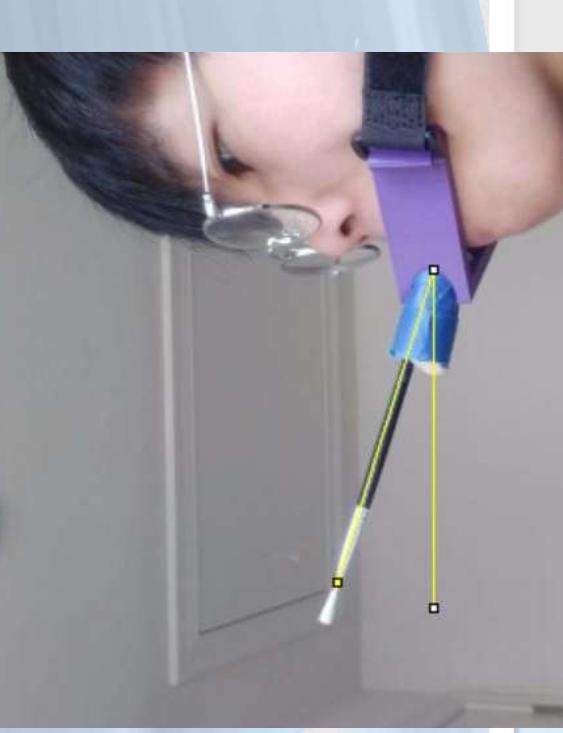
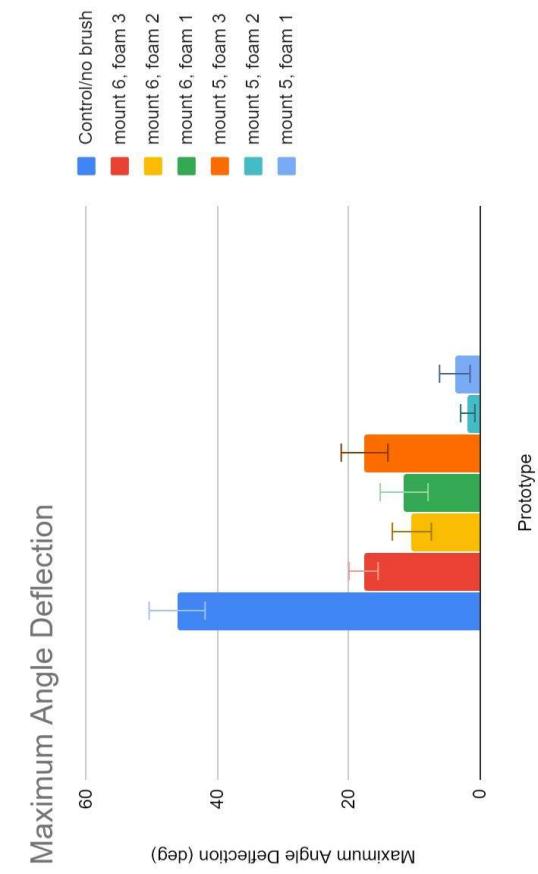
Foam 1      Foam 2      Foam 3



Mount 5,      Mount 6

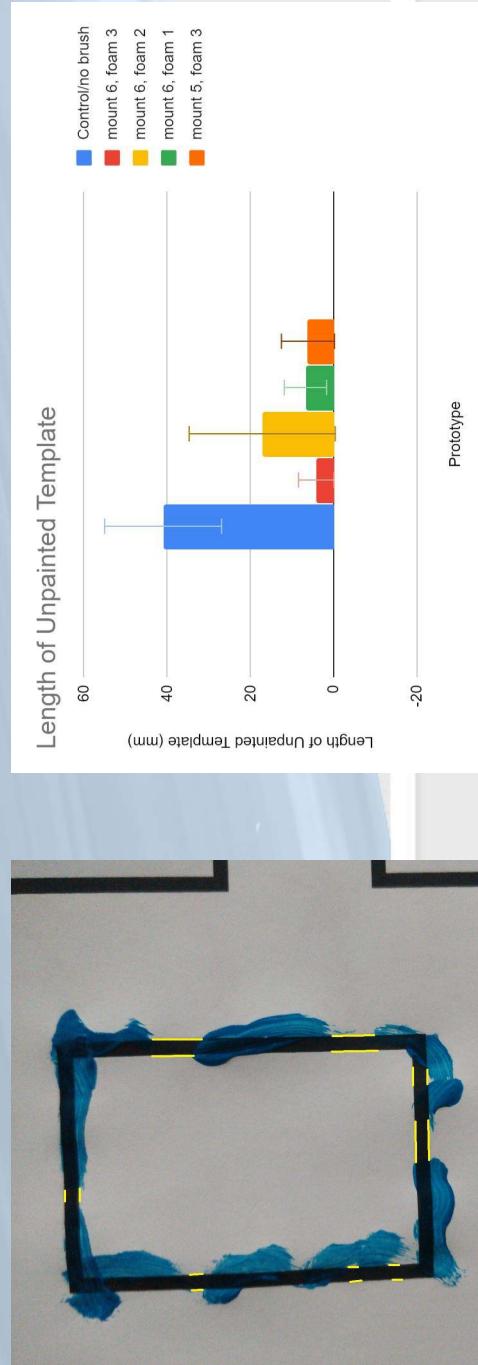
# Design Study 1: Paintbrush Mobility

- Measuring maximum deflection from horizontal
- Control has no resistance, leading to greatest deflection and little control
- Foam 3 performed well with a high level of control independent of mount
- Mount 6 performed better than mount 5 regardless of foam
- Mount 5 with foams 1 and 2 were eliminated after poor performance



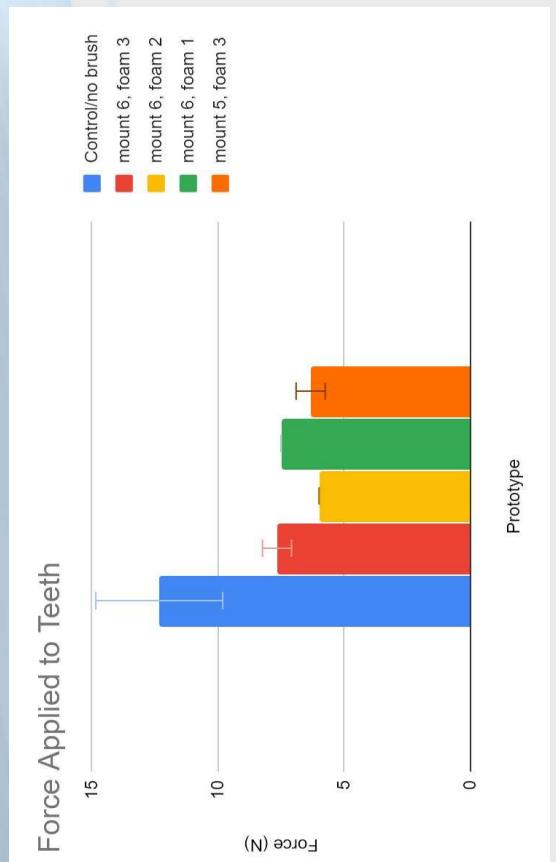
## Design Study 2: Accuracy

- Focused on the ability of paintbrush to paint a predetermined shape
- Used a ruler to measure each part of the shape that went unpainted (outlined in yellow)
  - A greater measurement meant less of the paint made contact with the template
- Average measured distance remained less than 10% of template's perimeter for all devices, so no mount was eliminated



## Design Study 3: Fatigue

- Developed a mathematical way to quantify the effort needed to paint
- Originally tried human testing, but too much variance
- Created a system to show amount of force absorbed by the device
- Measured the stress applied to the teeth from a 130 gram weight
- Use of any type of device clearly takes stress off of the artist



- In all studies, no brush was out of control and painful
- Mount 6 better sloped against the side of the face
- Foam 2 consistently came in contact with the mouth
- Foam 1 was difficult to use and keep consistent



## Design Studies: Qualitative Data

- In all studies, the control performed visibly worse than any of the devices
- Mount 6 with foam 3 performed the best quantitatively and qualitatively

## **Design Studies: Conclusion**

# Final Requirements (level 1)

#	Level	Type	Requirement	Mount 6, Foam 3	Mount 6, Foam 2	Mount 6, Foam 1	Mount 5, Foam 3	Mount 5, Foam 2	Mount 5, Foam 1
1	1	User	User's preferred method of painting	Pass	Pass	Pass	Pass	Pass	Pass
2	1	Functional	Compatible with paint	Pass	Pass	Pass	Pass	Pass	Pass
3	1	Functional	Function without the user needing to use their hands	Pass	Pass	Pass	Pass	Pass	Pass
4	1	Functional	Create art based on the user's input	Pass	Pass	Pass	Pass	Pass	Pass
5	1	Functional	Include a user manual	Pass	Pass	Pass	Pass	Pass	Pass
6	1	Functional	Stable and durable for the length of one paint session	Pass	Pass	Pass	Pass	Pass	Pass
7	1	Functional	Fit comfortably for people with different face and body shapes	Pass	Fail	Pass	Fail	Fail	Fail
8	1	Functional	Pivot at least 10 degrees from horizontal	Pass	Pass	Pass	Pass	Fail	Fail
9	1	User	User can move the part of the body necessary to use the device	Pass	Pass	Pass	Pass	Pass	Pass
10	1	Physical	Does not contain sharps or other dangerous parts	Pass	Pass	Pass	Pass	Pass	Pass
11	1	Physical	Made of a nontoxic material	Pass	Pass	Pass	Pass	Pass	Pass

# Final Requirements

#	Level	Type	Requirement	Mount 6, Foam 3	Mount 6, Foam 2	Mount 6, Foam 1	Mount 5, Foam 3	Mount 5, Foam 2	Mount 5, Foam 1
12	2	Functional	Compatible with at least three types of brushes	Fail	Fail	Fail	Fail	Fail	Fail
13	2	User	User can set up the device independently	Fail	Fail	Fail	Fail	Fail	Fail
14	2	Functional	Can be set up, on average, in under five minutes	Pass	Pass	Pass	Pass	Pass	Pass
15	2	Functional	Easily sanitized	Fail	Fail	Fail	Fail	Fail	Fail
16	2	Functional	Device can save and display the art created	Pass	Pass	Pass	Pass	Pass	Pass
17	2	Functional	Portable	Pass	Pass	Pass	Pass	Pass	Pass
18	2	Functional	Compatible with optional mediums such as clay	Fail	Fail	Fail	Fail	Fail	Fail
19	2	Cost	Less than \$20 of materials	Pass	Pass	Pass	Pass	Pass	Pass
20	3	Physical	Weigh less than 750 grams	Pass	Pass	Pass	Pass	Pass	Pass
21	3	Physical	No more than 8 inches on each side	Pass	Pass	Pass	Pass	Pass	Pass

<https://www.instructables.com/id/Paint-a-Little-Picture-for-Me/>



The piece shown above is the final mouthpiece prototype. Many elements are still there from the first prototype, but many have been altered. The slope of the mouthpiece has been increased drastically for comfort, and the strap hooks have changed as well.

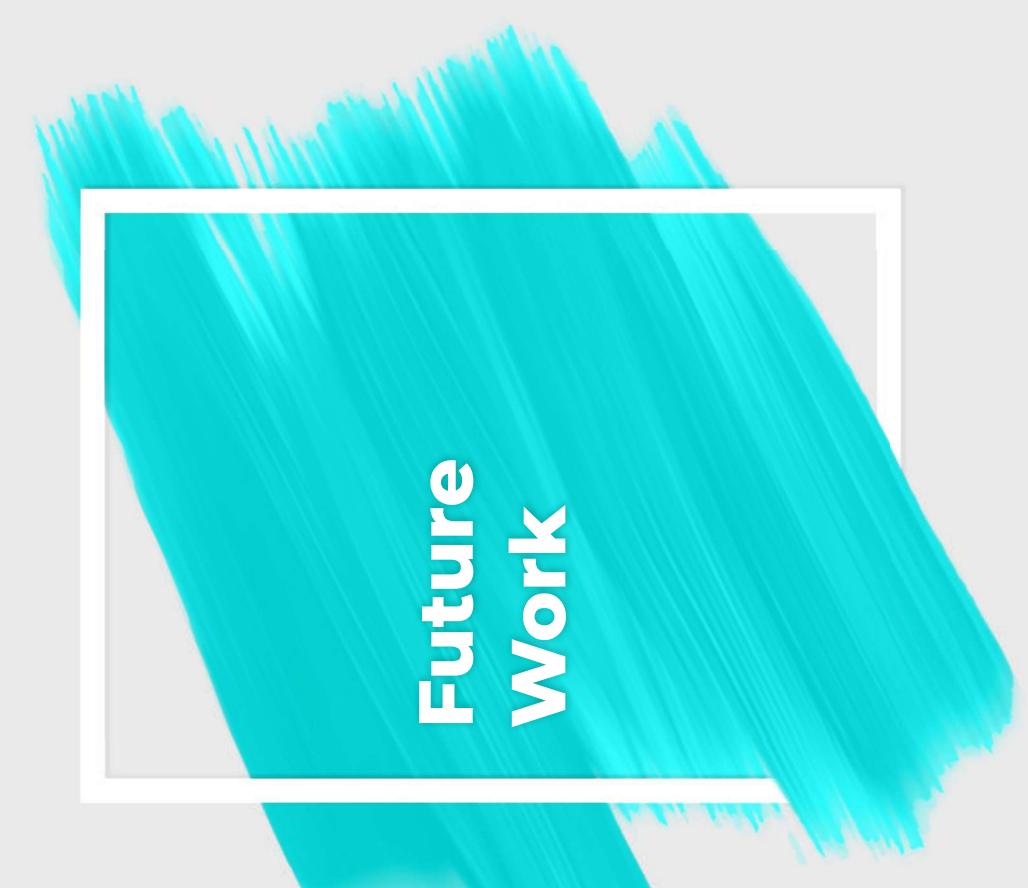
## Final prototype



This foam compression piece is the other half of the final prototype. It is sleek and consistent in its function.

Final  
prototype

- Other devices to make painting easier
  - Palette
  - Easel
- Brush washing
- Different methods to sanitize the device
- Create a method to rotate/spin the paintbrush
- Conduct testing with individuals at Seven Hills



**Future  
Work**