

# Adaptive Violin: Bow Grip

## Documentation

### Ideation

#### Goal

**Design an AT that will support her hand/wrist, so that she can learn, practice, and maintain a proper bow grip.**

- As a result of muscular dystrophy (MD), she has inverted thumbs = Improper bow grip
  - She has hand braces
    - Wears them at night
    - Pulls out the thumbs
      - Still working with that to help improve finger dexterity
  - Possible solutions include
    - [Elastic bow grip](#)
    - [Existing bow modifications](#)
    - [A design similar to the Bass bow](#)
      - Ask Ty what his experience was
      - Found a girl with a similar device:  
<https://youtu.be/HFkHxQKRA9Y>

#### Intro to Rose

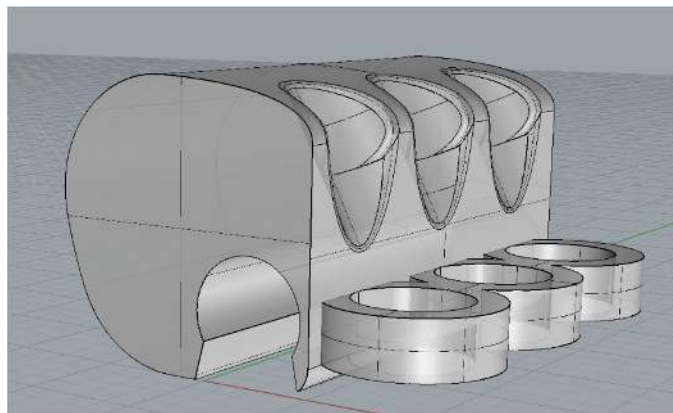
- She likes to dance
- She likes to play violin
- She likes Veggie Tales
  - Named the assistive device “BOB” (Better-grip On Bow)
    - In reference to her favorite character, Bob the Tomato

#### Ideas

A glove that attaches to the bow



- Tape to hold the bow





#### Tension Lock

It is very easy to adjust the length with the tension lock, you can adjust the length of the backpack chest strap according to your needs.



#### Nylon Material

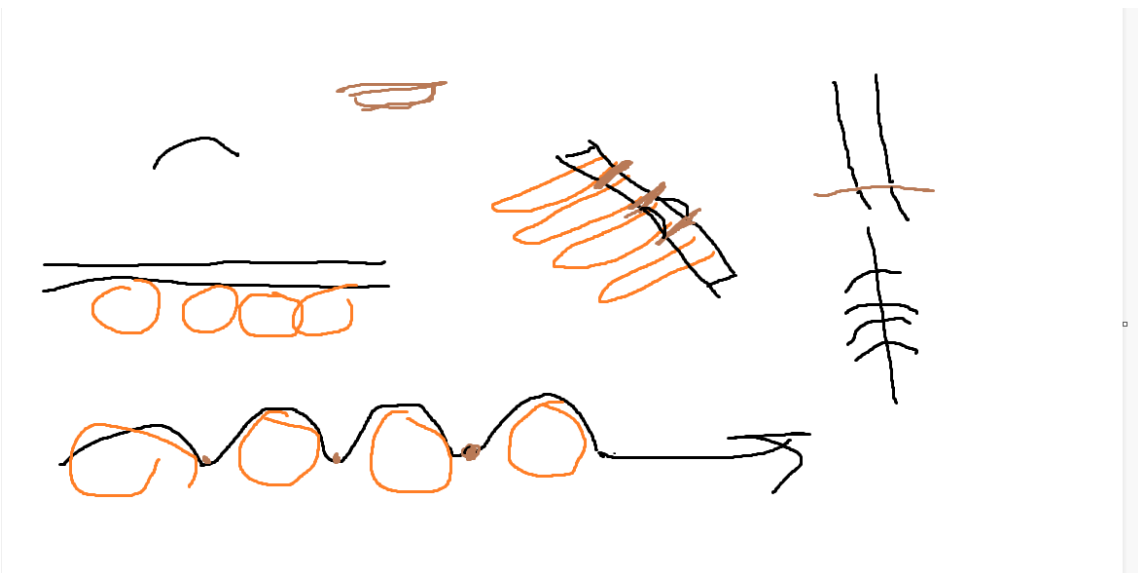
The backpack strap is made of high-quality nylon material, which is very durable and comfortable.



#### Quick Release Buckle

With this durable quick release buckle, your backpack chest strap will be very easy to buckle and unbuckle.

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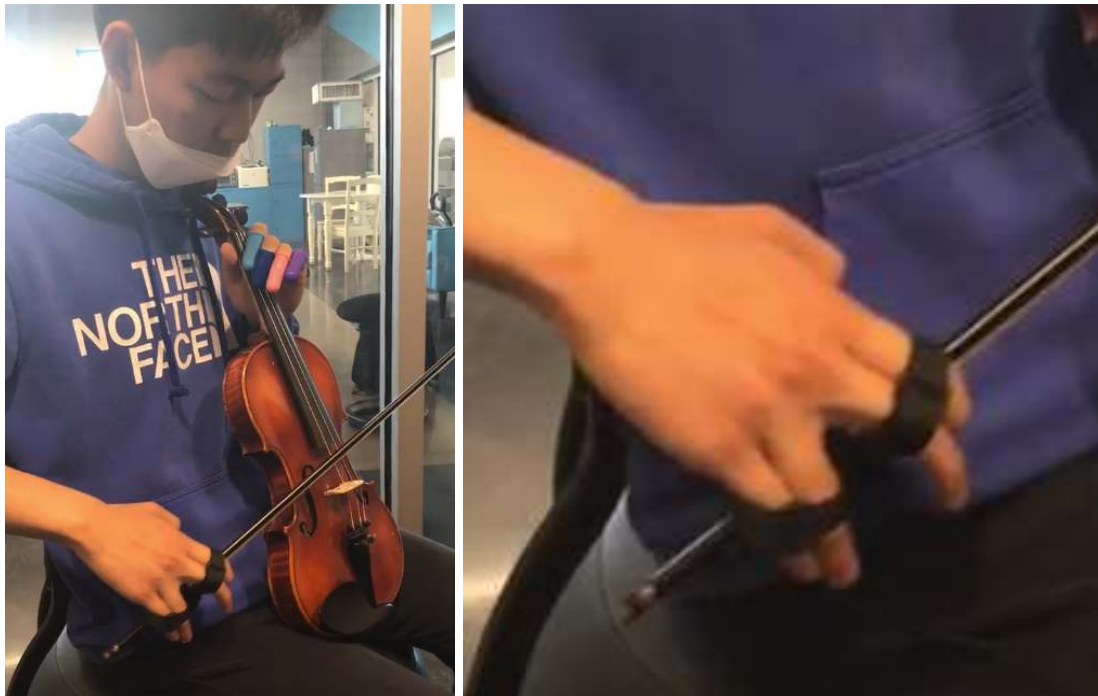
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- Wrist strap for velcro tightening/connecting to bow(?)



## Prototype 1

### Prototype Photos



- Used velcro straps to attach fingers to the user's bowing hand

## Concerns

- Uncomfortability within the hands
  - Due to force on just the fingers
  - Due to awkward finger positioning

## Prototype 2

### Bill of Materials

- Velcro Straps → tightening
- Conforming stretch gauze bandages
- String/Yarn
- Other durable, thick fabrics
- Tape

### Prototype Photos

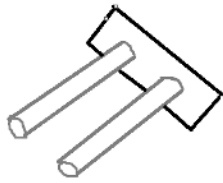
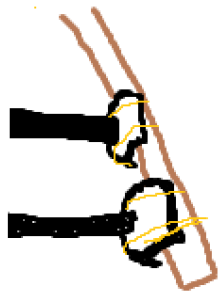




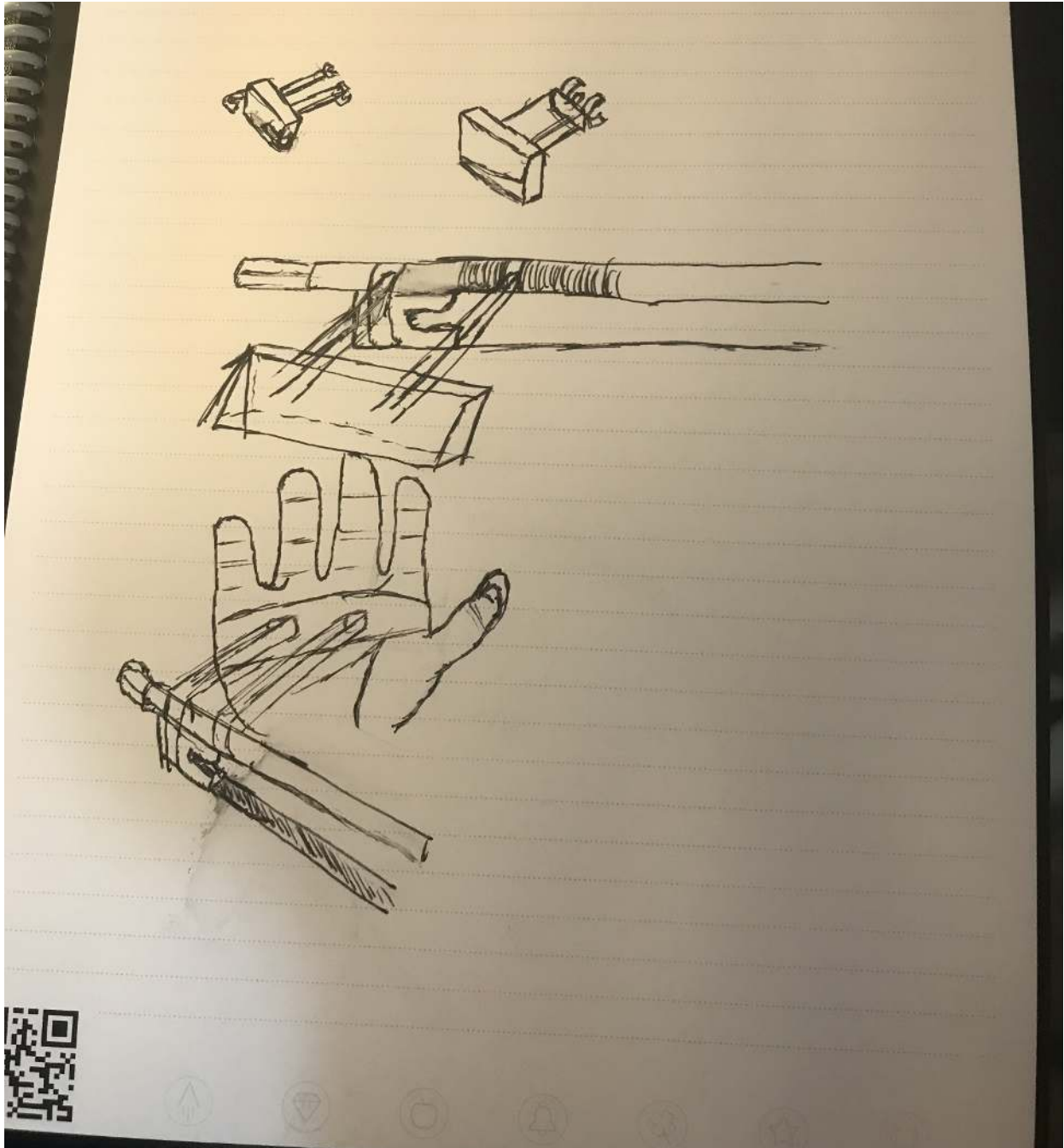
## Prototype 3

### Brainstorming Sketches







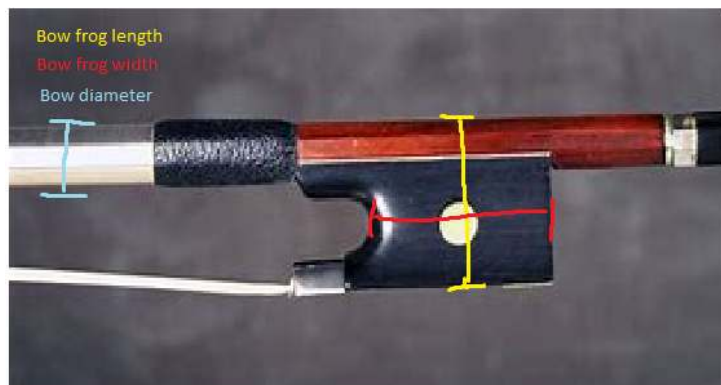
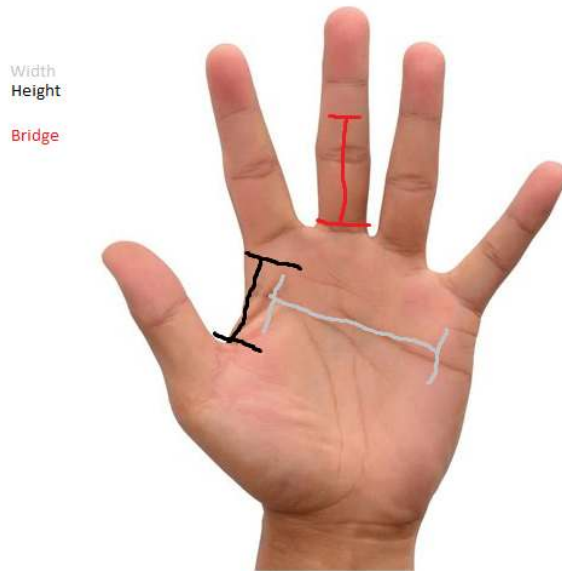


## Bill of Materials

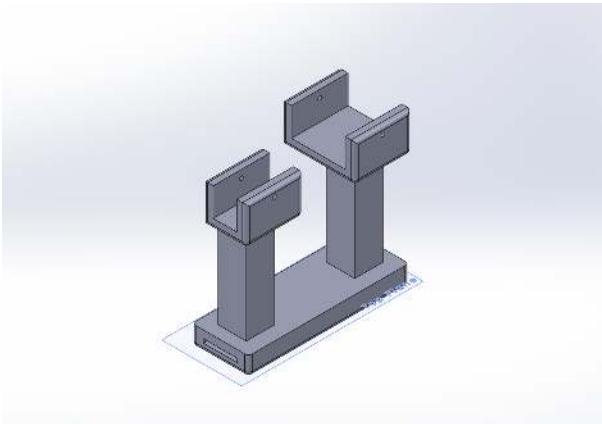
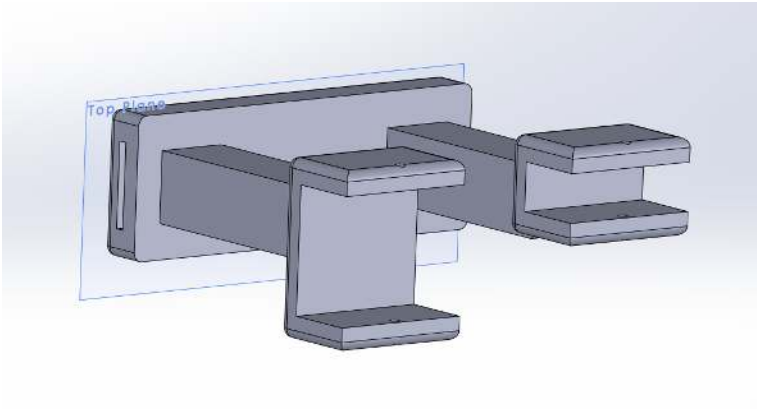
- PLA
  - 3D print assistive bow holder
- Velcro
  - To attach hand to hand grip  
<https://www.billyboxes.com/product/20-cinch-strap/>

- Rubber Band/Fishing Line
  - To fasten bow to bow grip

## ***Measurements for Prototypes***



# CAD Models



**Prototype Photos**





## Advantages

- Allows Rose to grip the bow without strain/pressure on her fingers
- Allows Rose to have a traditional bow grip

## **Disadvantages**

- Possible difficulty in attaching hand to assistive device
- It might induce strain on the palm and cause slight awkwardness when bowing the violin

## **Prototype 4**

### **Prototype Updates**

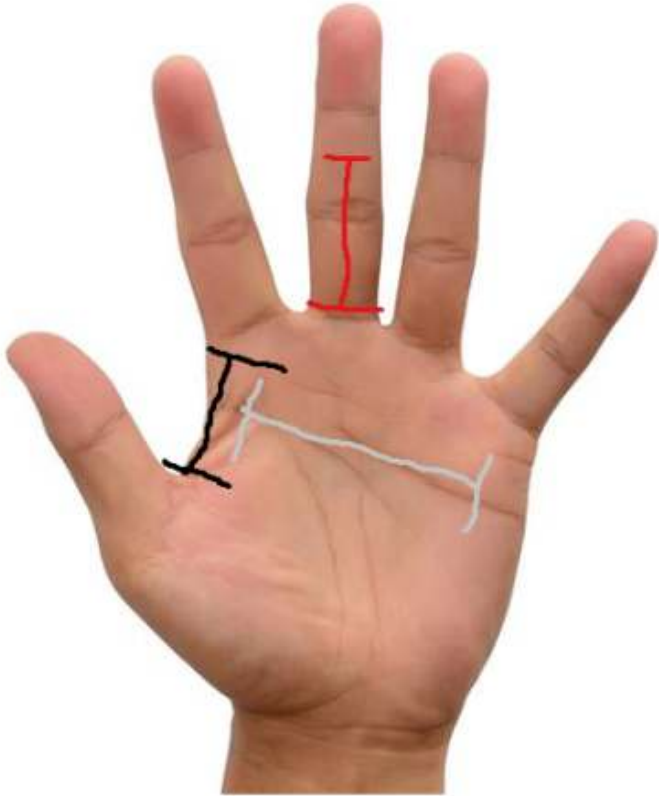
- Added chamfers to all 90-degree angles
- Shortened the length of the bridge (by 25 mm) and made them flushed with the top of the bow grip
- Connected the tops of the bow grip so it becomes one solid piece
- Added a semicircle to the hand grip, making it more comfortable as it fits into the palm
- Fastened bow to the bow grip via a rubber band

### **Bill of Materials**

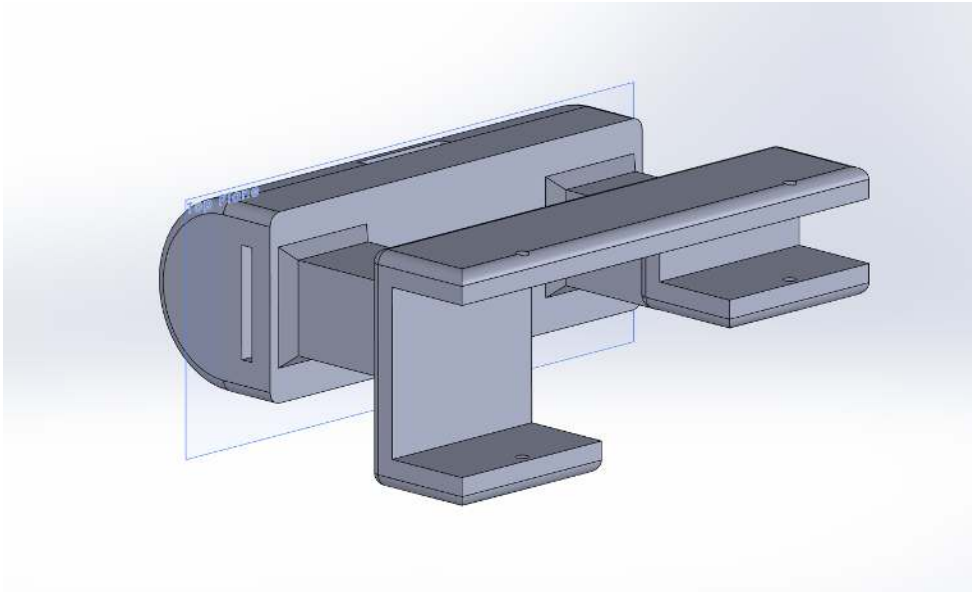
- PLA
  - Filament for 3D printing assistive device
- Velcro
  - To secure and tighten the user's hand to the hand grip
- Rubber Band
  - To fasten the violin bow to bow grip
  - Prevents the violin bow from falling out of place in both the x and y-direction

# Hand Measurements Needed

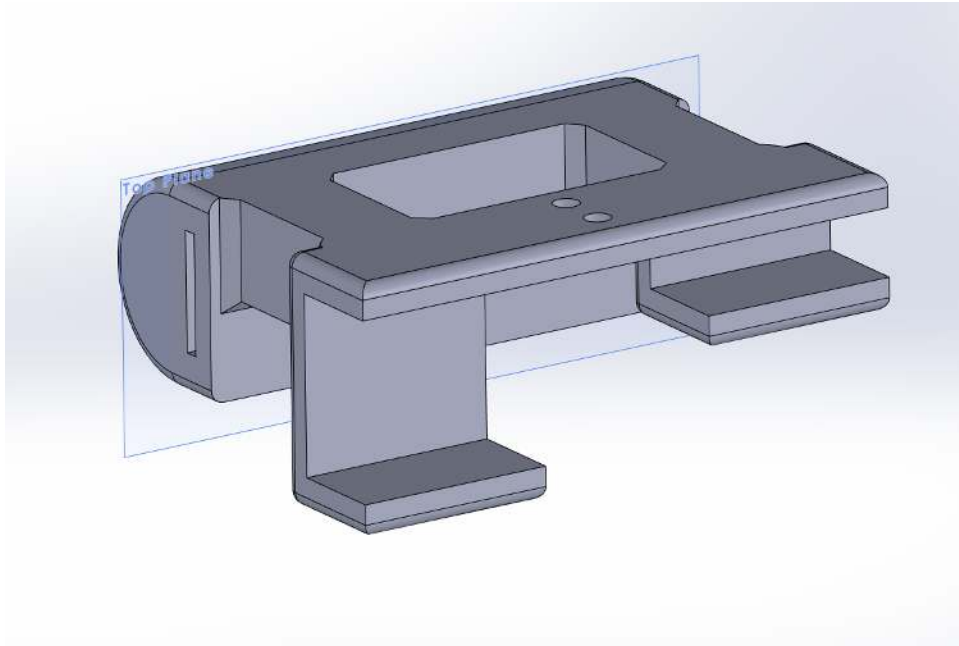
Width  
Height  
Bridge



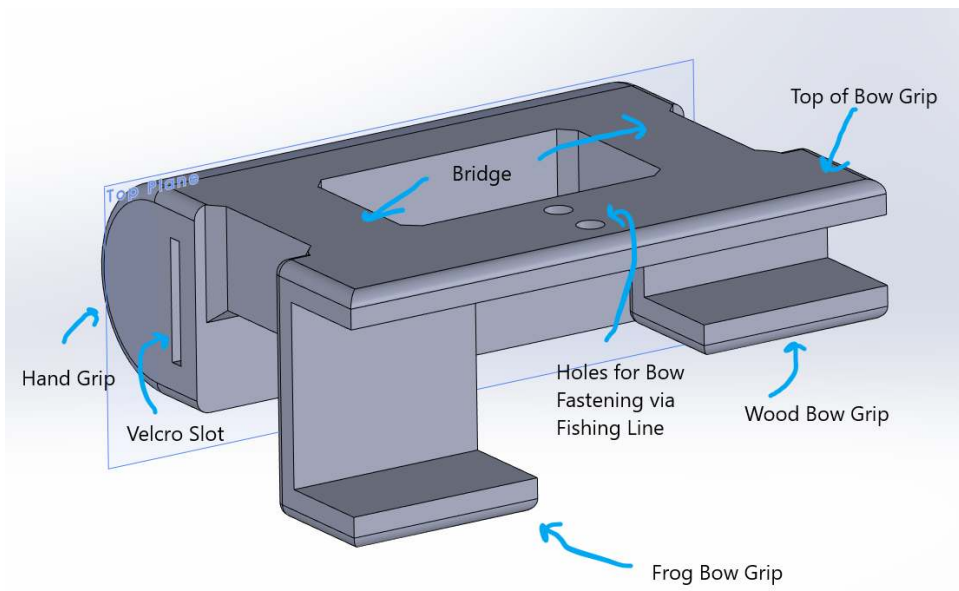
# CAD Models



(Version 1)



(Version 2)



Version 2)

(Annotated

Prototype Photos



# Test Plan

## ***General Notes***

- Ask for consent to record and take photos
- Bring rubber fingertips to possibly test out note playing AT
- Ask Rose's dad about AT music device

## ***Measurements Needed***

- Palm width
- Palm height
- Bridge length
- Bow frog height
- Bow frog width
- Bow radius

## ***Questions***

[Questions before testing]

- How are you feeling today
  - Good breakfast?
- Hobbies
- Can we record and take pictures?
- Would you like to name the device?
- Do you need device adjustments?
- Do you want to start playing the violin in the upward position again or keep playing it like a cello?
- Is the device comfortable? Are there any adjustments we can make to the looks/comfort? (I.e loose, unstable)

[Questions during testing (like between each set)]

- Do you feel fine to play another set right now
- How long have you been playing the violin
- How long can you play the violin without pain?

[Questions after testing]

- Overall, did it feel easier to play with the device than without?
- Did the device cause any discomfort in your hand?

- Is there any sharpness when gripping the device
- Is it hard to hold the device
- Does the velcro strap cause discomfort?
- Too heavy? Too bulky?
- Did you feel the bow sliding around in the device?
- Are there any particular strings that were harder/more uncomfortable to play than others?

## ***Testing Procedure***

Explaining how the assistive device works to Rose and her parents

- Without the assistive device
  - Play all open strings (G, D, A, E)
    - Full bows x5 each string
    - 2 total sets
      - 30 second rest for each set
  - (Optional) Play a scale
  - Play any song you'd like
  - **Things to observe**
    - Check bow position on string
    - Wrist and elbow mobility & flexibility
    - Where fingers are placed on the bow
- Wait 5-10 mins in between playing
- With the assistive device
  - Play all open strings (G, D, A, E)
    - Full bows x5 each string
    - 2 total sets
      - 30 second rest for each set
  - (Optional) Play a scale
  - Play the same song as before
  - **Things to observe**
    - Check bow position on string
    - Wrist and elbow mobility & flexibility
    - Where fingers are placed on the AT
- Ability to play the violin (any strain/pain)

<b>Open String</b>	<b>Scale (will be tested eventually)</b>	<b>Song</b>
<u>Pros</u> <ul style="list-style-type: none"> <li>- Helps isolate the effect of the adaptive bow grip on Rose's playing</li> <li>- Can be used to test total play time without tiredness more accurately</li> </ul> <u>Cons</u> <ul style="list-style-type: none"> <li>- Not as realistic in simulating playing style</li> </ul>	<u>Pros</u> <ul style="list-style-type: none"> <li>- More accurate to actual playing</li> <li>- A mix between song and open string</li> </ul> <u>Cons</u> <ul style="list-style-type: none"> <li>- Remembering to press notes</li> </ul>	<u>Pros</u> <ul style="list-style-type: none"> <li>- The point of the project</li> <li>- Needs to be tested</li> </ul> <u>Cons</u> <ul style="list-style-type: none"> <li>- Remembering lyrics</li> <li>- Remembering to press notes</li> <li>- Sheet music/books</li> </ul>

***Possible concerns/things to have on hand***

- Rubber bands
- Longer velcro straps
- Note playing devices and supports as extras
- How long can she play with adjustments(see if it's better)
- Note what Rose and what her parents think

**Test Results**

***Measurements***

- Palm Width
  - 46.3 mm
- Palm Length
  - 30.4 mm
- Bridge
  - 31.8 mm

## ***Observations/Notes***

- Rose had trouble communicating discomforts and issues the prototype had
  - Didn't necessarily know how to answer particular questions
- Using assistive device helped Rose play the violin
- Rose remembers notes best through numerical metric (0 fingers, 1 finger, 2 fingers, etc.) rather than note names (A, B, C, D, etc.)
- Strain on Rose's hand when playing open string, applying too much pressure on string
- Breaks are needed when playing without "BOB" to give Rose rest

## ***Prototype Feedback***

- Rose's hand was smaller than prototype was designed for
  - Extended fingers did not cover the entire bridged
  - Difficulty in tightening prototype to Rose's hand
- Prototype relieved the strength needed to hold the bow
  - Rose didn't need to apply as much pressure to the string, improved quality of sound
- The area of the device where the thumb rested caused discomfort
  - No filet on edge of the device
  - Thumb was in awkward position causing cramping
- Placement of the rubber band could be improved (see first photo under "Pictures")

**Testing Pictures**





## Prototype 5

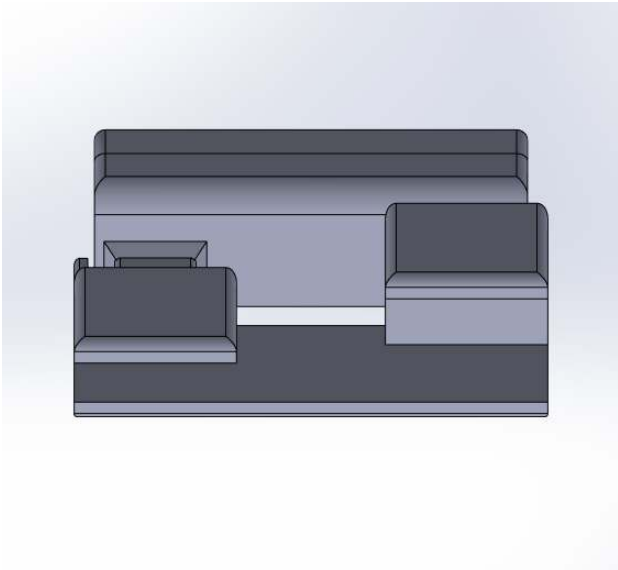
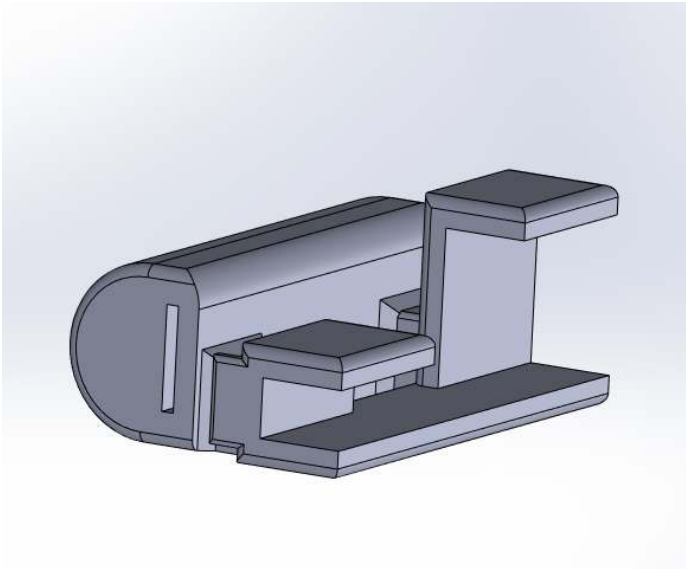
### Prototype Updates

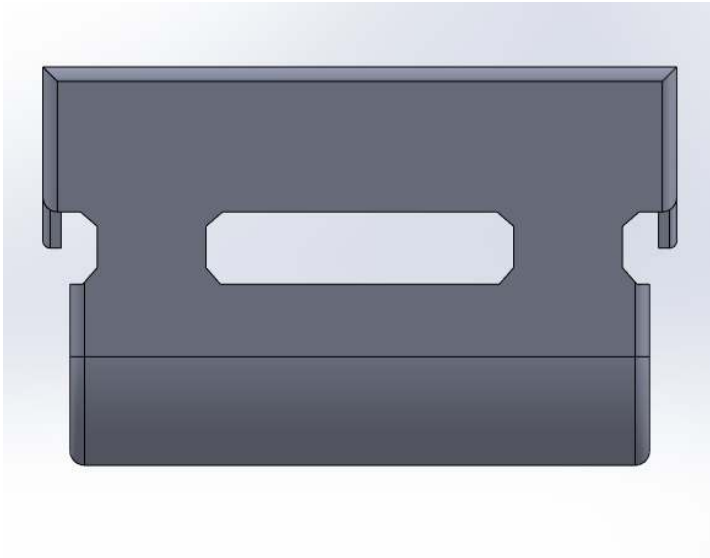
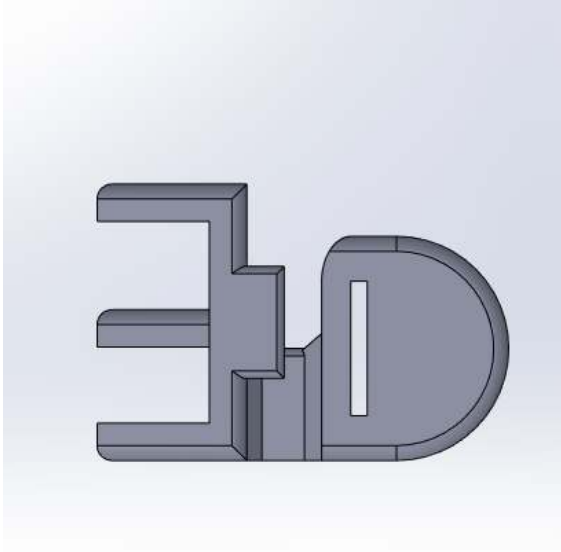
- Filet sharp edge to relieve thumb pain
- Shorten the bridge so fingers can reach edge easier
- Find longer velcro straps to attach Rose's hand to

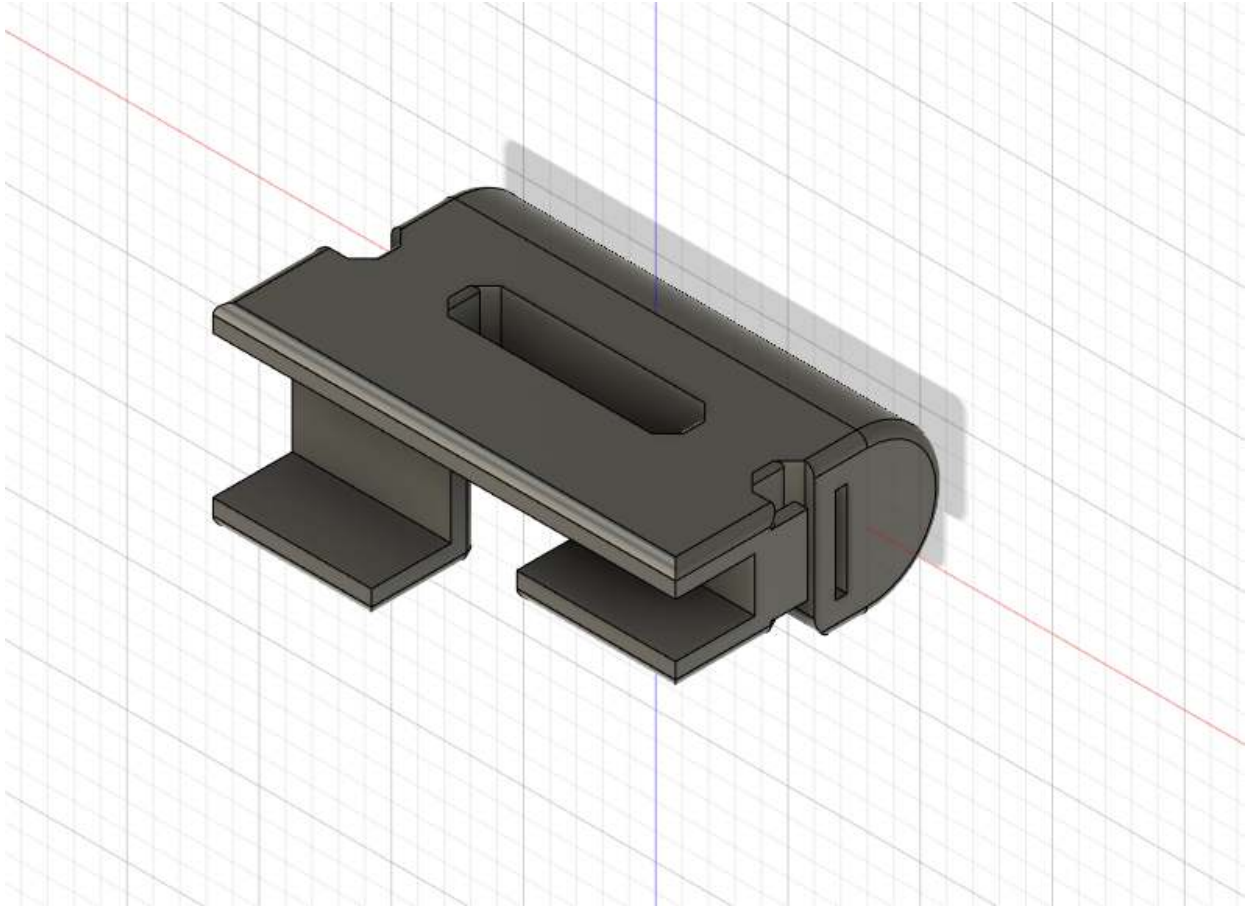
### Bill of Materials

- Foam padding
- Velcro straps

# CAD Images







*(On 07/23/2022 we recreated the adaptive bow grip in Fusion 360 and plan to use Fusion 360 from now on since it's more accessible to team members)*

## **Test Plan**

### ***Test Objective***

- See if the sizing and design of “BOB” are comfortable for Rose.
  - Cushioning
    - Foam, Memory Foam, etc.
  - Sharp Edges/Corners
  - Ergonomics
    - Sizing
    - Placement of hand/fingers
    - Thumb room (inverted thumb)
  - Strap length
    - How loose the device is
  - Weight
  - Breathability

- Durability
  - Flex/bends in the assistive device where there isn't supposed to be
- Test Materials
  - Prototypes (2nd and 3rd iterations)
  - Smartphone
  - Notebook
  - Foam
  - Pencils
  - Ruler/Caliper
  - Duct Tape
  - Box of Prototype Stuff (give to Carson)
  - Gifts for Rose and her siblings

## ***Test Variables***

- Difference in discomfort when playing on different strings
  - Subjective/Quantitative
- Comfortability
  - Filet where the thumb rests
    - Subjective/Quantitative
  - Length of the bridge vs length of fingers
    - Objective/Qualitative



- - Tightness and security of the velcro strap
    - Objective/Qualitative
    - Subjective/Qualitative
  - Seeing if cushioning where the palm rests would help
    - Subjective/Qualitative
  - The weight of the device
    - Objective/Qualitative
    - Subjective/Quantitative

## Test Procedure

- Improvements to be made
  - Knowing what things to observe as Rose plays
  - Having more detailed notes of the testing procedure
  - Creating a more friendly and open atmosphere as we talk with Rose
  - Give Rose and siblings another gift lol
- Introductory things
  - Introduce ourselves again
  - Ask permission to record videos, take pictures, and write notes
  - Introduce the prototype and changes we've made
- With previous device
  - Play open strings (5x each)
  - Play scale
  - Play a song
- With new device
  - Play open strings (5x each)
  - Play scale
  - Play a song
- Ask Rose (Compare response using old vs new device)
  - How comfortable it is to play on each string (1-10)
    - Very uncomfortable with lots of strain vs very comfortable without any strain
  - If the area where her thumb is is comfortable (1-10)
  - If the velcro is too loose or too tight
    - Observe how the tightness of the velcro strap affects Rose's playing
      - Loose: Play open string 3x
      - Tight: Play open string 3x
    - Does the velcro squeeze the back of your hand?
      - Observe if velcro leaves indents in the skin
      - Observe if the device wiggles when playing
  - If the palm rest area needs padding
    - Comfortability with and without the padding?
    - Picking padding?
  - If the finger bridge too long
    - Take pictures of her fingers extended along the finger bridge
  - If the device is too heavy (Compare with old device)
    - Feels the same vs much heavier

- Feels like there's no bow vs feels like your holding bow without the device

## **Survey**

	Old Device	New Device
How comfortable is it to play on each string?		
How comfortable is the thumb rest? (1-10)		
Does palm rest need padding?		
Is the finger bridge too long?		
Is the weight difference negligible?	XXXXXX	

## **Test Results**

### ***Prototype Feedback***

- The assistive violin bow grip was the right size for Rose's hand
- Adding filets to the edges of the device improved comfort
- Rose really liked the color of the device
  - Reminiscent of the character Bob from Veggie Tales, one of her favorite characters
- Improved quality of sound since Rose doesn't need to apply as much pressure or force when gripping the violin bow and playing

**Testing Pictures**



