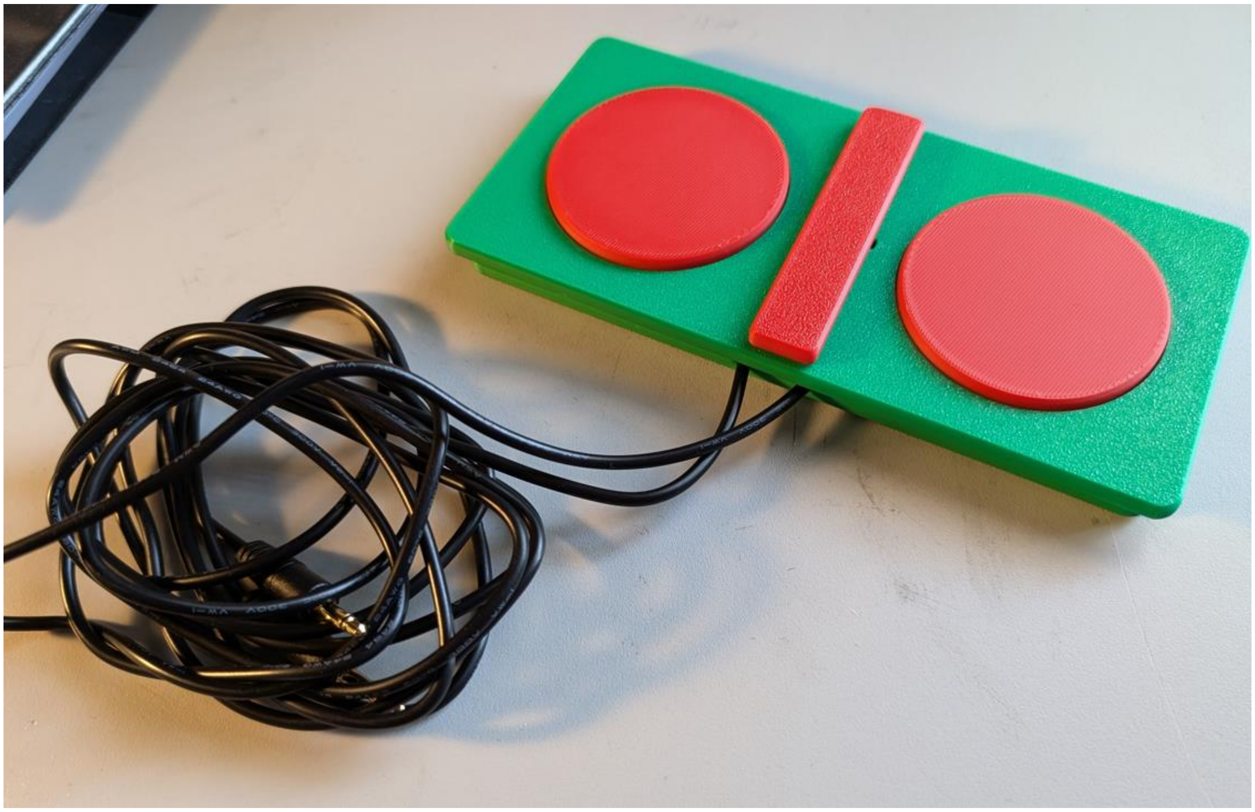
Open Rocker Switch
DESIGN RATIONALE

Overview

The Design Rationale is intended to provide designers and maker information about the design process and design decisions behind the development of the Open Rocker Switch, a dual action rocker switch that is comparable in size, activation force, and travel to the discontinued AbleNet Rocker Switch



Contents

Open Rocker Switch
DESIGN RATIONALE

Introduction

This design rationale is being put together for V2.2 of the device, and some information from the development has been lost.

A user of the AbleNet Rocker Switch was looking for a replacement switch after the one they were using was broken, but AbleNet had discontinued the switch. The Open Rocker Switch was developed as a open source replacement to meet the users needs.

The Open Rocker Switch is a low profile, low force switch that allows for controlling a device that requires multiple inputs, such as a scanning device or morse code input.

Requirements

Goals

G01	Open source switch comparable to the AbleNet Rocker Switch

Functional Requirements

F01	Same profile as the rocker switch
F02	Same activation travel
F03	Same activation force

Non-functional Requirement

NF01	All parts must be available from the same supplier

Constraints

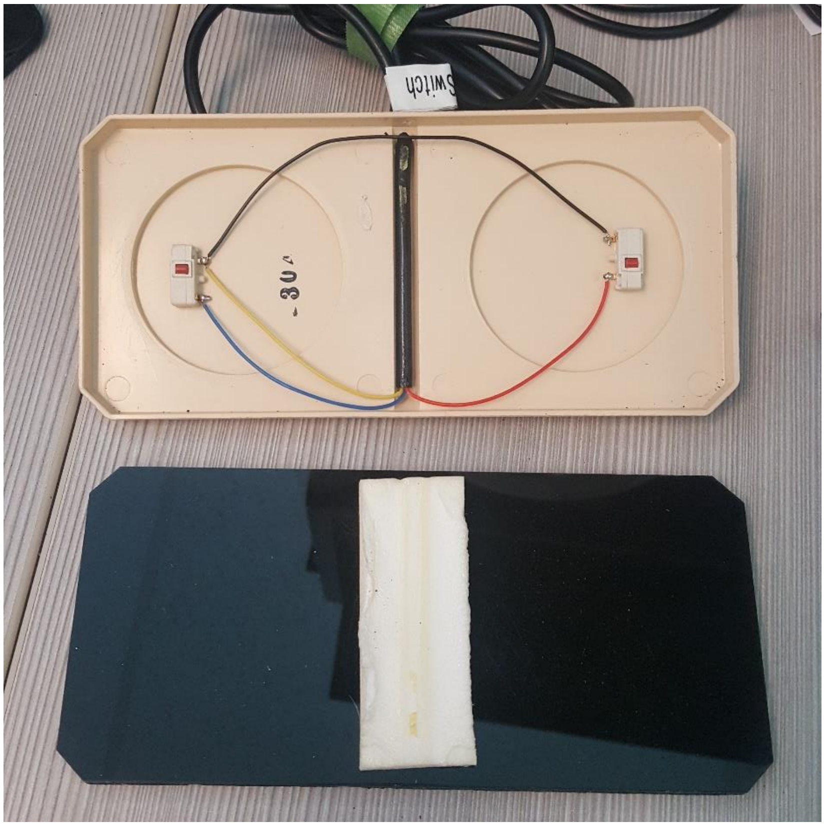
C01	Must be 3D printed
C02	Must be manufacturable with common hand tools

Commercially Available Options

Options that can be purchased but not made by a maker.

AbleNet Rocker Switch

Title / Name of device	Rocker Switch
Link	Discontinued
Author	AbleNet
Cost	$110 USD



The Rocker switch consisted of a base piece of acrylic, with a piece of two sided tape that acted as both an axle and a fixture for both sides. Two small switches were placed on the top under the buttons, and a stereo cable carried the signal out of the device.

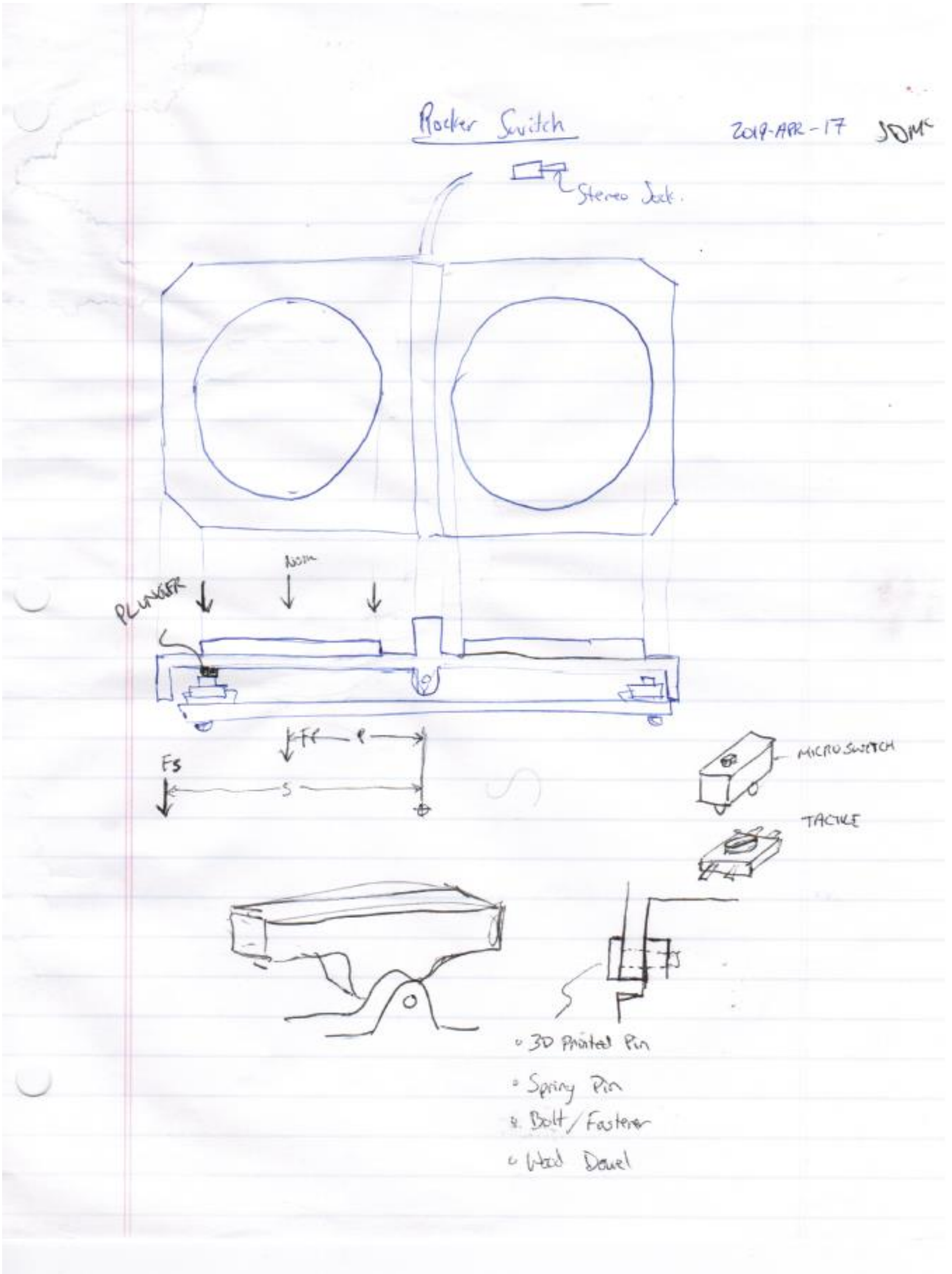
Requirements Met	Requirements Unmet
The design of this device drove all requirements for the Open Rocker Switch	Availability

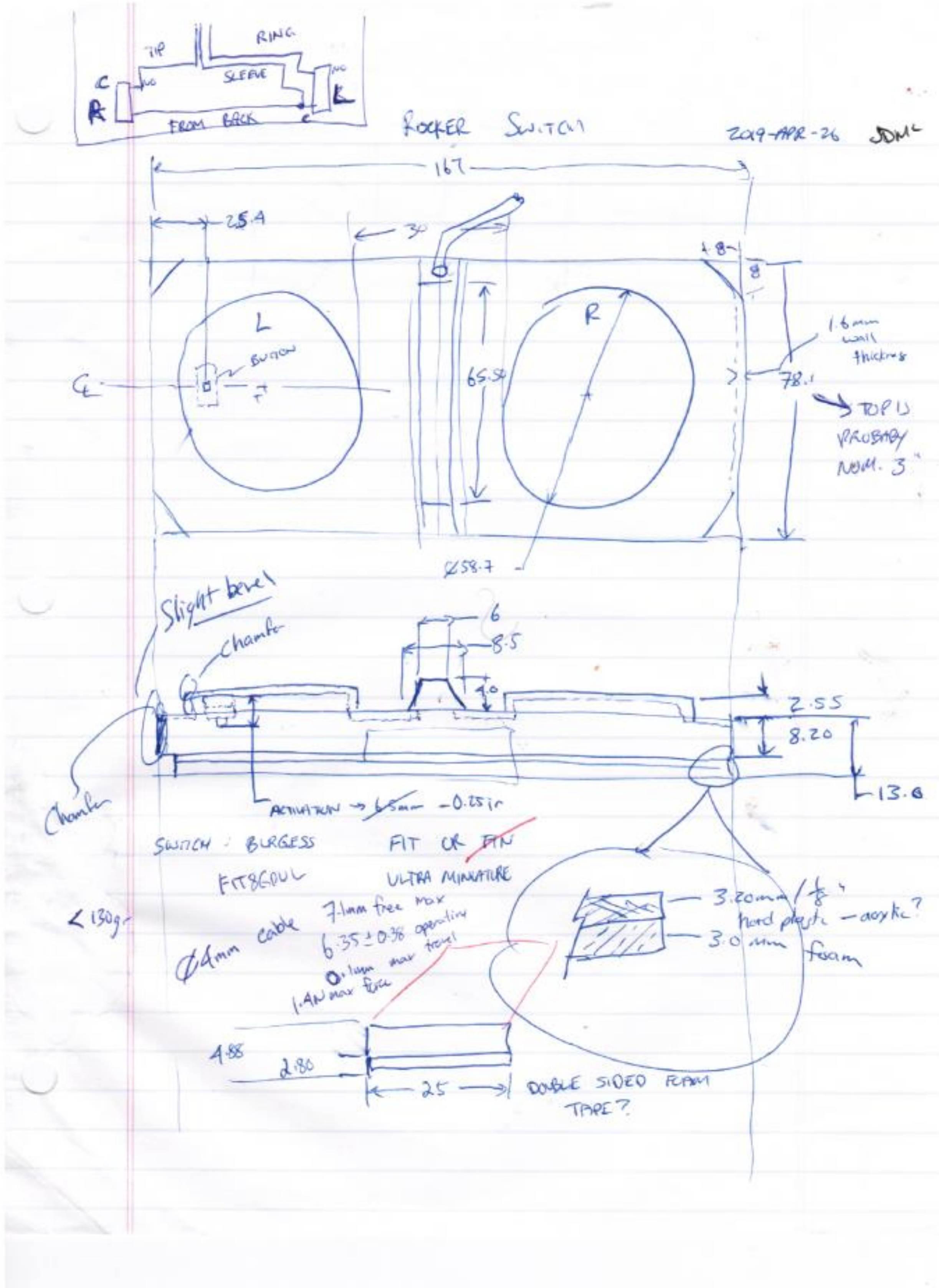
Useful Design Features

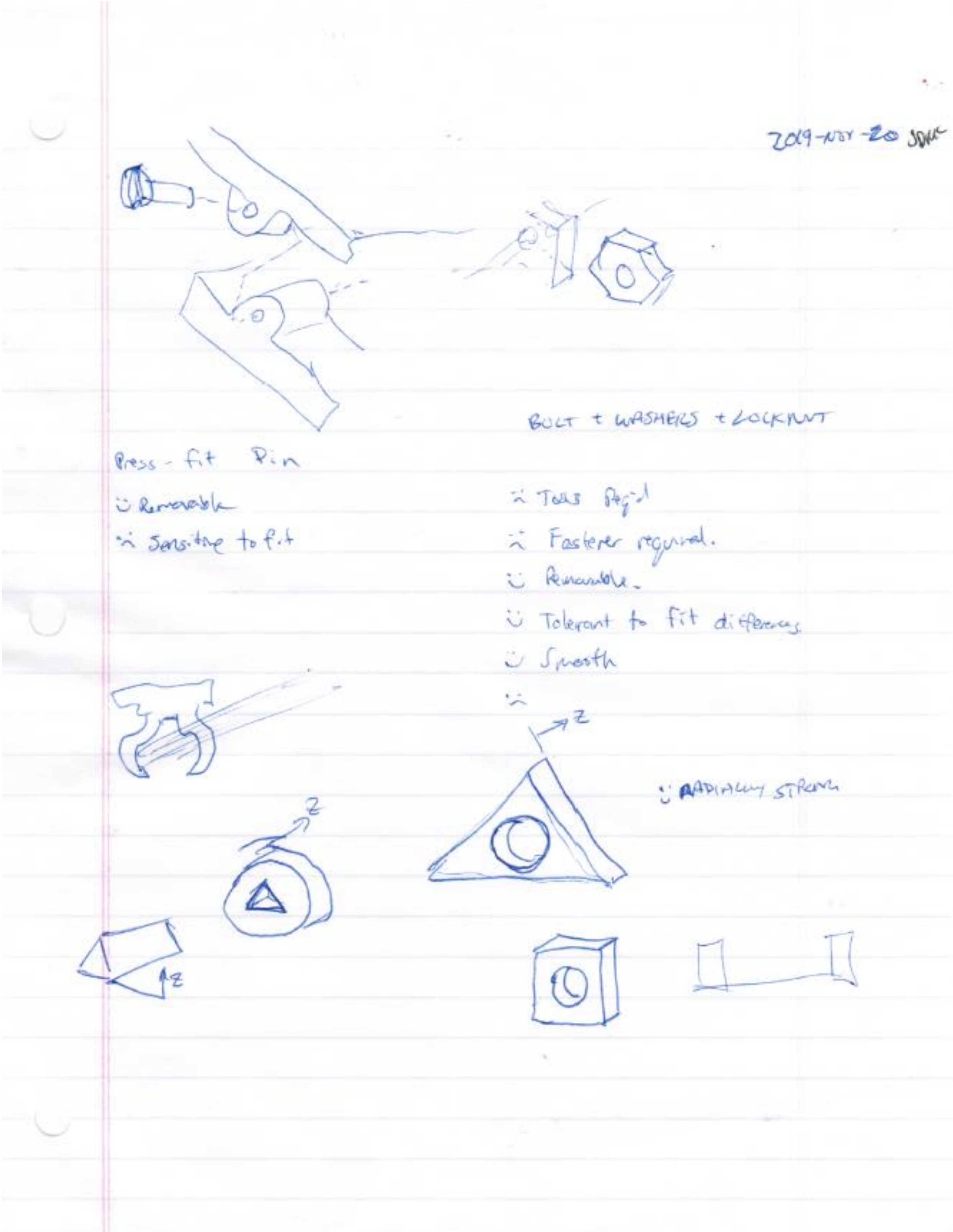
The user liked this device because it was low profile and low force, with two switch outputs.

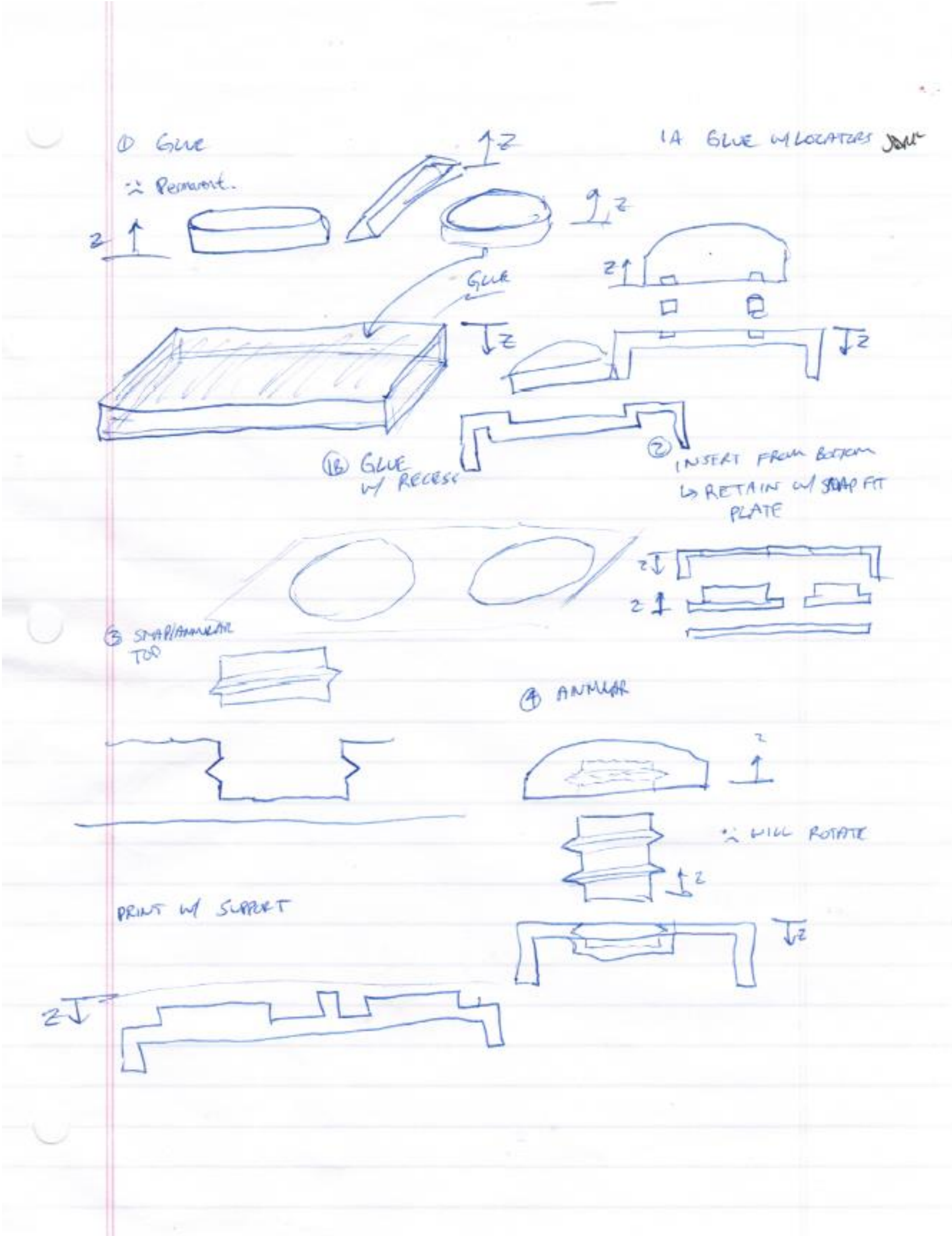
Ideation

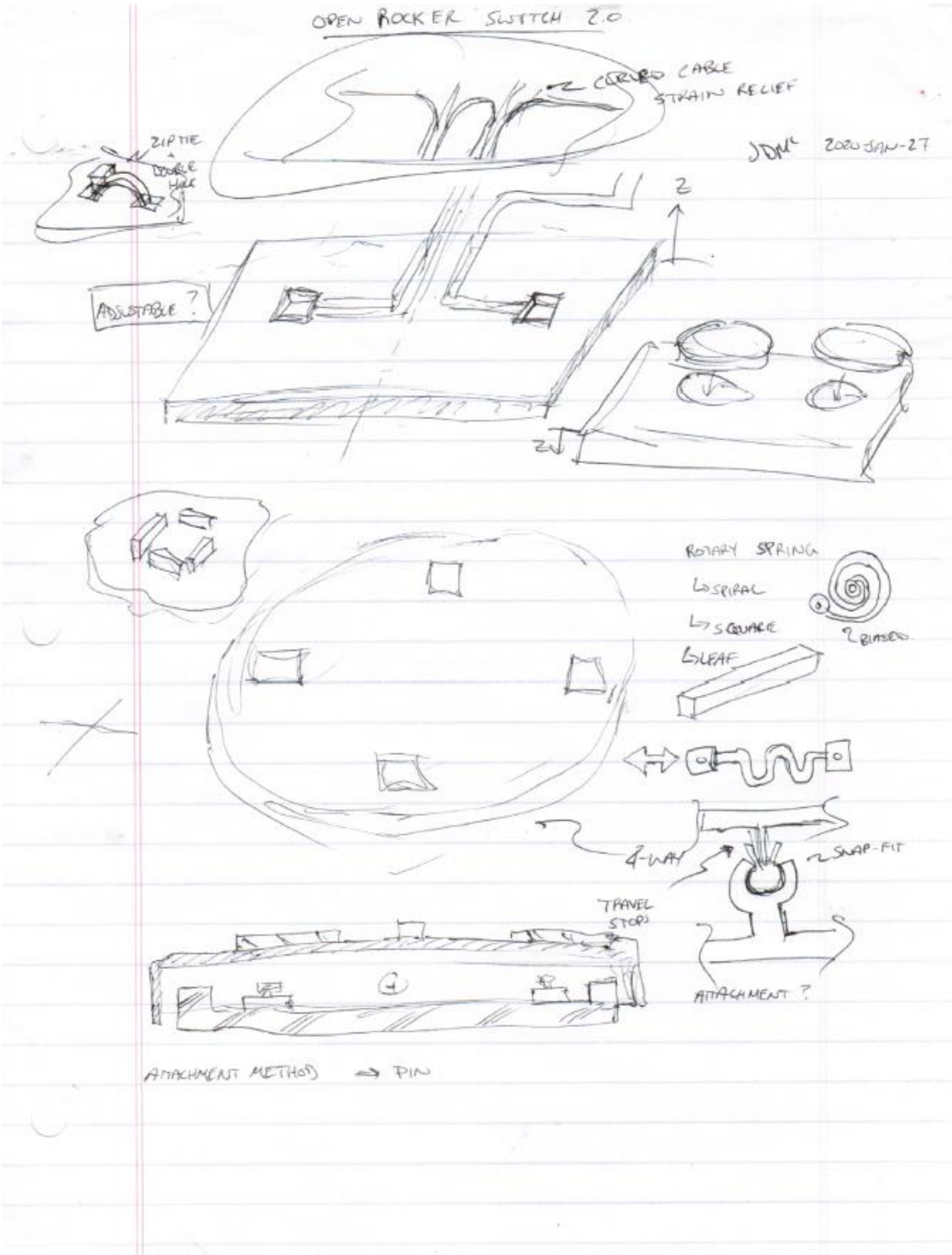
The following is a compilation of all documents found in the ideation folder for this device.


Rocker Switch
2019-APR-17
Stereo Jack.
PLUNGER
MICROSWITCH
TACTILE
Fs
s
3D Printed Pin
Spring Pin
Bolt/Fastener
Wood Dowel


TIP
RING
SLEEVE
FROM BACK
ROCKER SWITCH
2019-APR-26
167
25.4
30
1.8
8
L
R
BUTTON
65.5
78.1
1.6mm wall thickness
TOP IS PROBABLY NOM. 3"
Ø58.7
Slight bevel
Chamfer
6
8.5
2.55
8.20
13.6
Chamfer
ACTIVATION → -0.25 in
SWITCH : BURGESS FIT8GPUL
FIT OR FIN ULTRA MINIATURE
< 130g
Ø4mm cable
7.1mm free max
6.35 ± 0.38 operating
3.20mm / 1/8" hard plastic - acrylic?
3.0 mm foam
4.88
2.80
25
DOUBLE SIDED FOAM TAPE?


2019-NOV-20
Press-fit Pin
Removable
Sensitive to fit
BOLT + WASHERS + LOCKNUT
Tools Req'd
Fastener required.
Removable.
Tolerant to fit differences
Smooth
Z
RADIALLY STRONG
Z
Z


① GLUE
☹ Permanent.
1A GLUE W/ LOCATORS
GLUE
1B GLUE W/ RECESS
② INSERT FROM BOTTOM
↳ RETAIN W/ SNAP FIT PLATE
③ SNAP/ANNULAR TOP
④ ANNULAR
☹ WILL ROTATE
PRINT W/ SUPPORT


OPEN ROCKER SWITCH 2.0
CURVED CABLE STRAIN RELIEF
ZIP TIE + DOUBLE HOLE
JDM 2020-JAN-27
Z
ADJUSTABLE ?
ROTARY SPRING
SPIRAL
SQUARE
LEAF
BIASED
4-WAY
SNAP-FIT
TRAVEL STOPS
ATTACHMENT ?
ATTACHMENT METHOD → PIN

List of Changes

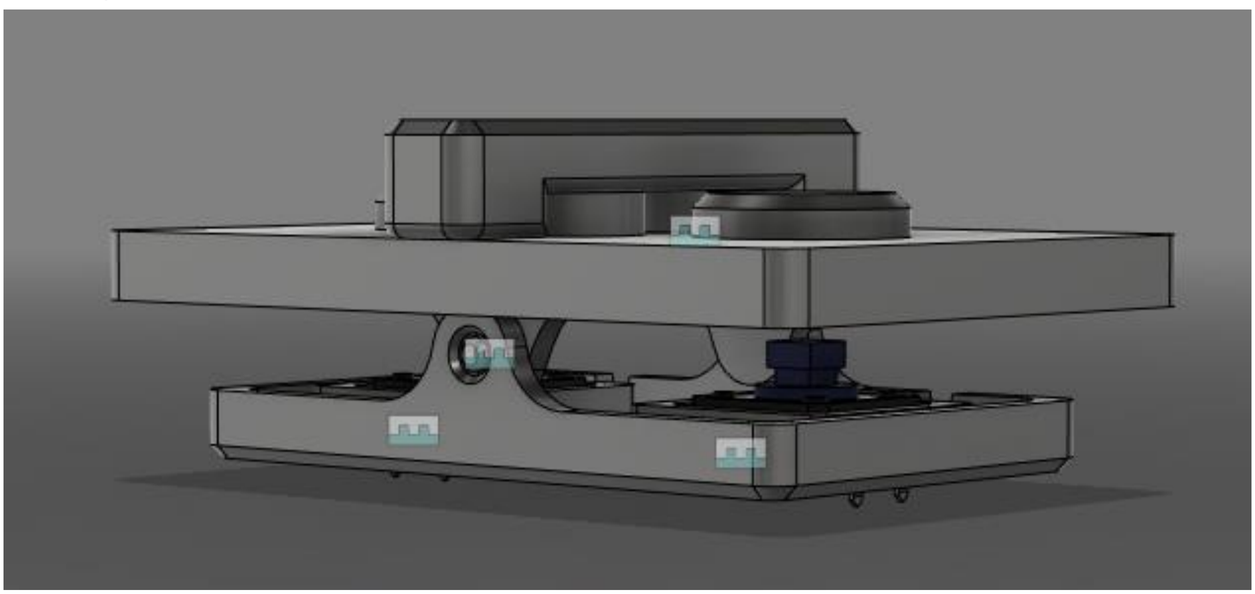
- Optimize for 3d Printing
- Two separate mono cable instead of single stereo cable
- Better hinge
    - Easier to assemble (and disassemble)
- Cable strain relief

Constraints

- Same basic size and shape as original
- Switch type
- Activation force

Testing

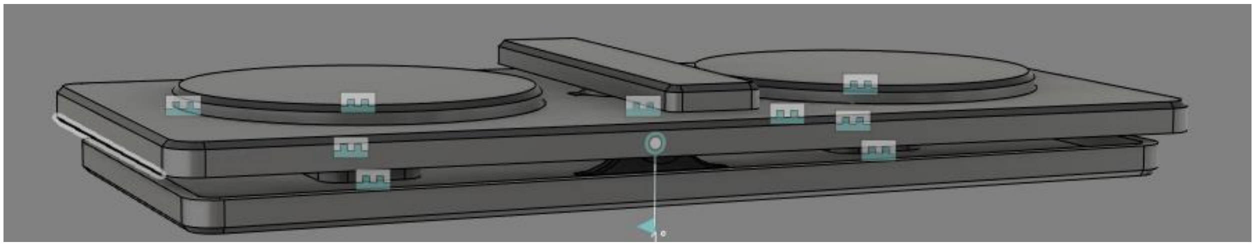
Testing Done on Version 1

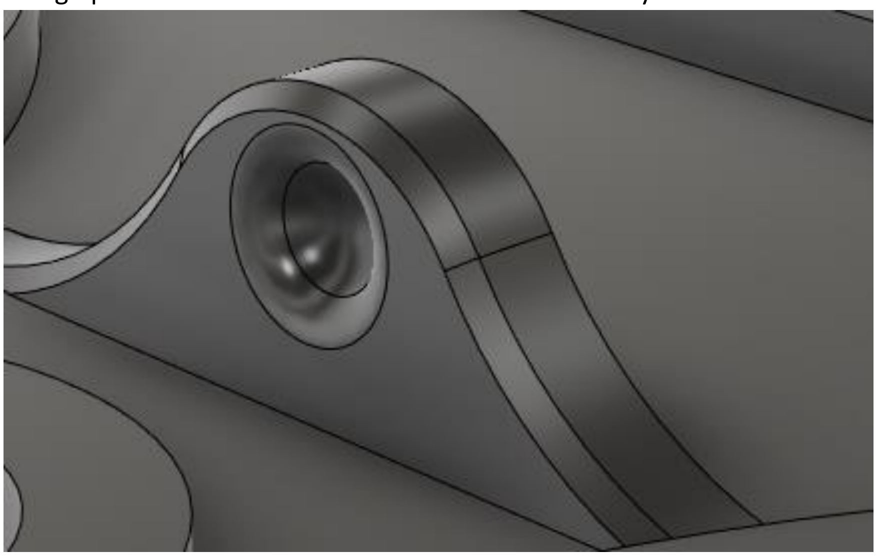


- Tested the viability of using springs as a means of the return mechanism
    - **Results: Failed**
        - Springs Made the overall system too high to match the requirement of maintaining the form factor of the original switch by AbleNet
    - **Changes**: Will use Switches as return mechanism used in V2
- Tested the rotation strength of a 3D printed axle

  - **Method:** tested the strength of the axle during rotation of the switch by doing both a fast switching of the two sides and smashing the sides and center of the switch
  - **Results** Failed
    - The Axle holds up to the pressing on either end but fails when smashed in the middle due to the pegs sticking out and causing a stress concentration
- Tested the strength of the Axle pieces for assembly
  - **Method**: Tested the bending strength of the axle parts to ensure that the parts can bend but not break to assembly the top and bottom
  - **Results:** Passed
    - Axle pieces hold up to assembly but need to test for upscaled version

Testing Done on Version 2



- Tested Previous Axle design on this version
  - **Results:** Failed
    - Axle breaks on assembly
  - **Changes:** changed to different design inspired from Simple switch tester clip
  - **Result from changes:**
    - Design proves to be better suited and makes assembly easier
    - 
- Tested new Axle design
  - **Method:** Tested the strength of the axle under normal operation and extreme operation by smashing the top surface of the switch.
  - **Results:** Passed
    - Easier to assemble and less prone to breaking and wearing out
- Tested Possibility of both buttons being pressed
  - **Method:** Apply force on both ends of the switch and using a switch tester to test if both buttons can be actuated
  - **Results:** Failed
    - Both buttons can be pressed because of the flexibility of the PLA top
  - **Changes:**
    - Different material?
    - Support to limit?
- Twist test

- **Method:** twisted the assembly to test the structure and see if it holds and if a button is not pressed when twisted
- **Results:** Failed
  - Assembly holds but one of the switches activates because of how close the top is to the switches
- **Changes:**
  - Tighter tolerance on the indents to limit the rotation of the assembly
  - Possibly change the shape

- Smash test and button tests
  - **Method:** Smashing the button with full force to test if the button is smashable
    - Tested the amount of force required to activate the button
  - **Results:** Passed
    - The switch can handle being smashed without pieces breaking.
    - Depends Heavily on strength of the switches
- Tested 3D printing Top piece without Support
  - **Method:** Using the Cura Slicer
  - **Results:** Failed
    - Axle does not print well and middle keyed hole for divider has webbing that interferes with the assembly
- Tested Gluing method comparing super glue to hot glue for mounting switches
  - **Method:** Compared hot glue to super glue by applying the glue to the switch mount cavity and testing the adhesion
  - **Result:** Passed
    - Hot glue is better for mounting the switches
  - **Comments:**
    - If possible, to get a tighter tolerance cut on the bottom of the switches, Super glue can be used.
- Tested Mounting method for securing for the 3.5 mm Plug wire
  - **Method:** Compared Hot glue to super glue tested by putting both only at exit area
  - **Result:** Passed
    - Super Glue holds better but a different design may change that
  - **Comments:**
    - Need to apply pressure until glue sets or else the wire comes loose
    - Better to apply super glue over the entire track
  - ***Changes?***
    - ***Improved Cable track***
    - ***Improve Cable track for easier gluing***
- Cable Tug Test
  - **Method:** Tested the cable in handling being tugged by hand and tugged out of a 3.5mm jack in a computer (I used my own desktop computer I/O)
  - **Results:** Passed

        - May change but proven that a strain relief would be beneficial but not necessary and a strain relief may not fit in the form factor
- Drop Test
    - **Method:** Dropping fully assembled switch from various heights to test durability and activation of switches during drop
    - **Results:** Failed
        - Switches activate on a 1-inch high drop but do not activate if shaken around by hand
        - Dropped off desk at about 3ft high and assembly holds up
        - Dropped 6ft high and assembly holds up
- Crush Test
    - **Method:** Step on it and test the assembly without the switches
    - **Results:** Passed
        - Switch without buttons can withstand my weight on the switch
        - The only thing that breaks is the keyed part on the top but does not affect the functionality of the switch during normal operation
        - Divider becomes very loose
- Test slop with pins
    - **Method:** Test different heights of the pins to test the amount of play that can be had for the switch
    - **Results:**
        - Can be changed to increase the travel of the switch but when using the hard point limits, there is no difference and will be a hinderance and the switch travel distance cannot be changed with just changing the pins alone
- Tested Increasing width of axle location
    - **Method:** Test different spacing for the axle to test for better stability
    - **Result:** Failed
        - Both buttons can be pressed from the middle
- Tested Button Actuation
    - **Method:** Tested whether the button can be actuated when pressed at every angle of the button like the MC60 switch
    - **Result**: Failed
        - Current Design cannot be pressed from all angles
        - Changed buttons and top piece to have 4 points in the slot and changed hard stops to not interfere with the actuation
- Testing repair of broken axle
    - **Method:** Tested whether fixing a broken axle piece with superglue is effective
    - **Result:** Failed
        - The glue must set for the total time of 24 hours and is not good for a quick fix
        - The part is still volatile to breaking because the glue is trying to bond layers that are broken and delaminated

The current Open Rocker Switch has two primary problems that need a design rework. The current clip based connection is extremely stiff, resulting in the attachment points on the base occasionally breaking rather than clipping in, as well as cable routing/strain relief that can come undone easily and interfere with the motion of the switch.

Design Requirements

Design Requirement	Verification Test
All 3D printed parts are printed with 6 walls	Inspection Test: Verify that 3D printed walls on all parts have 6 wall perimeter
All 3D printed Parts are printed with support	Test case: Verify in print settings that Supports are generated
Height of Switch does not exceed 13mm excluding divider and button height	Test Case: Measure that the height does not exceed 13mm
3D printed hard stop pegs contact the bottom of the switch, but the tactile buttons can still be activated	Test Case: with buttons placed, ensure that the tactile switches are activated, and the hard stop pegs limit travel

Tested Clip Methods

In the previous development of the Open Rocker Switch, it appears that two different styles of clip were used to attach the top and bottom of the switch.

3D Printed Axle

The axle clip method uses a 3D printed axle to connect the two halves of the switch. Upon testing, this method was discarded due to fragility and replaced with the current clip design

Current Clip Design

The current clip design consist of two protrusions on the top and bottom halves, with a bump on the bottom clips and a recess on the top clips. The top clips are reinforced to reduce flexibility while the bottom clips are allowed to flex. Once clipped in place, the bump and recess allow the top to rotate around the bump.

Tested Cable Connections

As far as could be found in the existing design documentation, cable tracks with superglue were the only form of cable management/strain relief used in the original design

Prototyping

Clip

Since the functionality of the current clip is fine if it is successfully assembled, an effort was made to fix the current design before redesigning a new one.

To try and improve the clip, several versions of the bottom were printed with a looser tolerance between the bottom and top sections of the clip. This made it easier to clip the two halves together, but added an element of wobble between the two halves, where the two halves can be rotated roughly 5 degrees relative to each other. Adding a riding surface at the original spacing reduced this somewhat.

Another method of adding flex to the system was tested, by removing the rib on the top of the switch to increase its flexibility. This was found to be roughly the same as the looser tolerance version, but with the same amount of wobble as the original switch.

There was no scale available that could measure above 3kg, but the force required seems to be slightly above that with the tops clicking on shortly after the scale hit 3kg out. To attempt to compare the force required to clip each of the designs together, pairs of them were pressed equally with both hands, and comparing the force required for each of the. For the looser tolerance vs the removed ribs version, the looser tolerance clipped together at a slightly lower force than the removed ribs, and the original version took more force than the removed ribs version, roughly 3 times the difference in force between the tolerance version and the removed ribs version.

Cable Management

To provide strain relief, a cable tie slot was added to the base at the end of each cable channel. To secure the cable into the channel without the use of superglue, a top was added to the cable channel. However, this top interfered with the top half of the switch, so it was pared down to just the start and finish of the channel, which kept the cable in the channel just as well. The clip near the side of the switch where the cables exit was removed, and replaced with a zip tie for better strain relief and to accommodate different sizes of cable. The first zip tie holes were kept, though they are currently unused. If using a cable that is over or undersized and the clip at the end of the cable routing doesn't work, the second zip tie can be used to hold the cable in place.

Cotter Pin

An alternative version of the rocker switch was created to remove the flexure clip element entirely. A cotter pin was developed, and the bump/recess on the top and bottom of the switch was replaced with a hole on both elements, and they were thickened significantly to remove the flexure and improve the strength. There was enough clearance between the two halves of the switch that the pin could be inserted and the switch assembled without changing the clearance between the two halves. The final assembly has the same amount of wiggle as the original design, but with significantly less force required in assembly. The cotter pin was later modified to add a small handle for removing the pin, as well as a longer center pin to help with assembly and removal. Finally, the side prongs were turned 90 degrees at the end to prevent them from accidently being used as an axle and to aid in deflecting around the posts during assembly.

Buttons

The buttons were modified with more ribs to remove the overhand when printing with the button surface facing up. A lower surface facing the button was tried, but it was found the current distance was near the minimum distance possible before the buttons would be jammed in the pressed position on assembly. Detents were added to the buttons, and matching bumps to the top rocking surface to lock the buttons in place once they were assembled. This flipping of the print surface allows buttons to be designed with patterns and designs.