SYDE 361 Group 3
Accountability Log

Hayes, Jeffrey, Jessie, Josh, Ken, Seb

Colour Codes

Research

In Class Work (Google Sprint, Lecture, etc.)

Miscellaneous

Team Work Sessions and Decisions

First Day

- The six dimensions of music

Timbre: - Seb

- Pronounced “Tamber”
- The quality associated with a sound due to its overtones [https://www.merriam-webster.com/dictionary/timbre].
- The texture of the music
- Not related to pitch or volume

In class:

- “The characteristic of the sound”
- “Composition of frequency components is what determines the sound”

First Day (cont.)

Loudness: - Seb

- A property of sound that depends on the amplitude of the associated waveform, being perceived as an audio sensation with magnitude proportional to the aforementioned amplitude
- [https://www.merriam-webster.com/dictionary/loudness].

In class:

- Intensity you hear the sound at
- Measured logarithmically → in DBs
- Perception of how loud something is
- Related to frequency
- Low freq sounds w high amplitudes may still have low loudness

First Day (cont.)

Gesture: - Hayes

- Any physical or mental movement required to produce sound
- The human expression used in creating sound

Rhythm: - Hayes

- Regular recurring motion
- “movement marked by the regulated succession of strong and weak elements, or of opposite or different conditions”

First Day (cont.)

Pitch: - Jessie

- The quality of a sound governed by the rate of vibrations producing it; the degree of highness or lowness of a tone. [https://www.merriam-webster.com/dictionary/pitch]
- Perceived lowest high peak

Language: - Jessie

- Most music is written in Italian
- The method of human communication, either spoken or written, consisting of the use of words in a structured and conventional way. [https://www.merriam-webster.com/dictionary/language]
- Musical language
- Languages revolving around musical sounds, either replacing or adding to articulation [https://en.wikipedia.org/wiki/Musical_language].

First Day (cont.)

List instruments with clear digital improvements (# of votes)

- Bagpipes (i.e. chanter) (6)
  - Curb the learning curve by making chanter sound more like bagpipes
  - Connect to headphones
- Cajon (6)
  - Ergonomic improvements?
- Rain stick (3)
  - Rotate rain stick with a motor for people with hand disabilities
- Lute
- Ocarina
- Alpine horn
- Drum machine extension for beatboxing (2)
- Banjo
- Vuvuzela
- Kazoo (3)

First Day (cont.)

Narrowed down instrument choices to bagpipes and cajon

Upcoming tasks:

- Prepare research on both instruments, list improvements (by May 9) (Whole Group)
- Interviews completed by thursday (by May 10) (Whole Group)

Cajon Ergonomic Problems

- Back pain
- Sore fingers and hands from striking instrument
- Inflexible playing positions
- http://www.c7drums.com/cajon-news/2016/7/31/ergonomics-for-drummers

Reflection:

- From research found that playing the cajon for extended periods of time may cause soreness in the back and wrists/hands
- As the cajon is a simple instrument, there can be many ergonomic improvements to the instrument without affecting its sound

Bagpipe Problems

- “Bagpipe lung” - inflammation of lungs caused by fungal growth in bagpipes (https://www.theguardian.com/science/shortcuts/2016/aug/23/bagpipe-lung-a-new-name-for-a-very-old-disease)
- High maintenance instrument (http://www.expertpiper.co.uk/7.html)
- Sore cheeks/jaw (inferring since it is wind instrument with reed, seen on some forums)

Reflection:

- The bagpipe is a complex instrument that requires high maintenance - simplify the design?
- Playing wind instruments for an extended period of time causes sore cheeks/jaw (from research and personal experience), how to improve this?

Research Day

Cajon:

- https://patents.google.com/patent/US7482522B2/en
- https://patents.google.com/patent/US8481834B2/en
- https://www.researchgate.net/publication/322998685_Co-design_of_a_Smart_Cajon
- http://delivery.acm.org/10.1145/1510000/1501879/p429-kanebako.pdf?ip=129.97.124.26&id=1501879&acc=ACTIVE%20SERVICE&key=FD0067F557510FFB%2E9219CF56F73DCF78%2E4D4702B0C3E38B35%2E4D4702B0C3E38B35&__acm__=1525875428_577425f88c9d054d78a3f779198f2b46

Research Day (cont.)

Bagpipe Modification

- Frankenpipe - https://dl.acm.org/citation.cfm?id=1279805
- Documents the design of a bagpipe that puts signal into computer and used as controller for RC car
- Uses photoresistors under the finger holes and pressure sensor in the bag

Research Day

Bagpipes Instrument article:

- “An Electronic Bagpipe Chanter for Automatic Recognition of Highland Piping Ornamentation”
- Abstract: Presents a means of analyzing a player’s technique via sensor data that’s obtained from a virtual bagpipe chanter
- Method: IR emitter and detector (photodiode) for each chanter whole.

Reflections:

- Digitization examples for the bagpipe have kept the physical identity in-tact
- Same instrument
- Same play style

Deciding Between Cajon and Bagpipes

Cajon problems:

- Posture problems
- Wrist strain → Carpal tunnel
- Hand injuries for beginners due to sharp corners
- Sound limiting (only certain amount of sounds available)
    - Expression improvement
- Shorter people may have issues
    - Design automatic

Deciding Between Cajon and Bagpipes

Bagpipe problems:

- Really loud
- Very steep learning curve

Upon discussion about potential improvements and the associated feasibility, the group has unanimously decided to pick the Cajon.

Potential interview candidates:

- Musician at Laurier
- Presish from BME 2020

In Class Work Session

- Completed Team Submission of SYDE 361 User Research Summary
- Each of us presented our individual persona and user interview to get a sense of commonalities and differences, which were written down in point form
- Interview Synthesis was planned out and written together in Google Docs
- Instrument Functional Diagram was drawn out

In Class Google Sprint

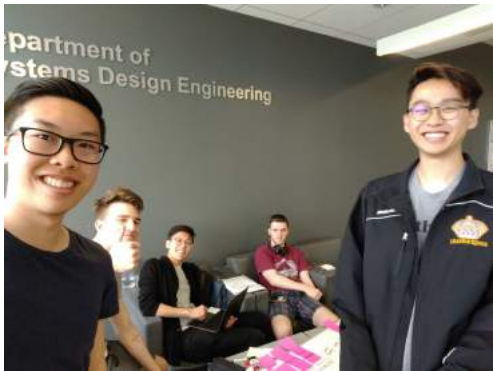
Google Design Sprint

- We all created sprint questions, personas and then a map
- We interviewed each other and developed how might we statements individually
- We voted for our top 3 HMW statements

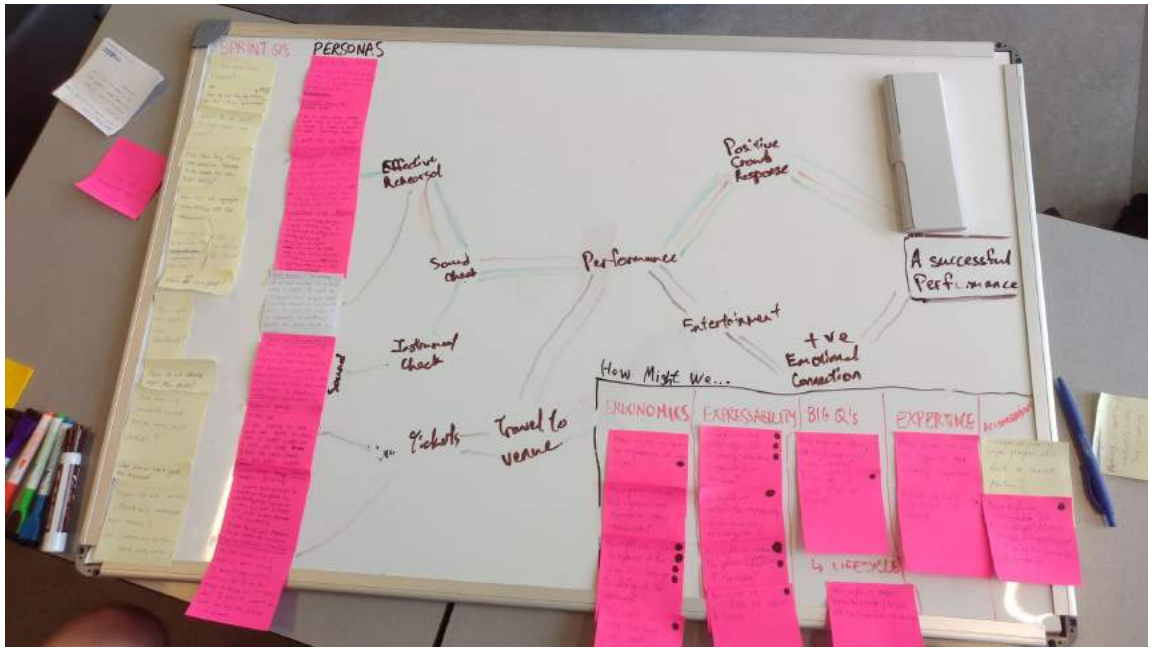
Outcome:

- Target Event: Effective Rehearsal / Target User: Professional Musician
- “How might we improve the ergonomics of the cajon without removing the identity of the instrument?”

Learnings: There are a plethora of ergonomic issues associated with the cajon.

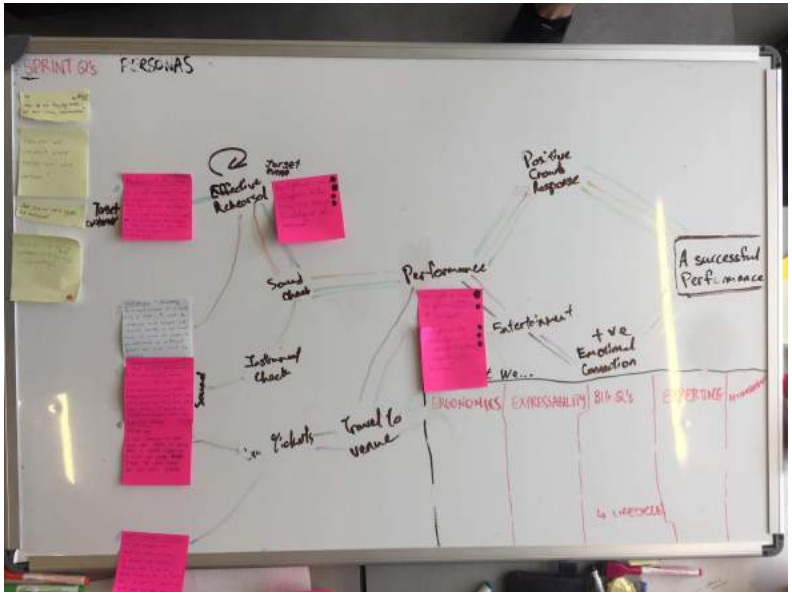


In Class Google Sprint (cont.)

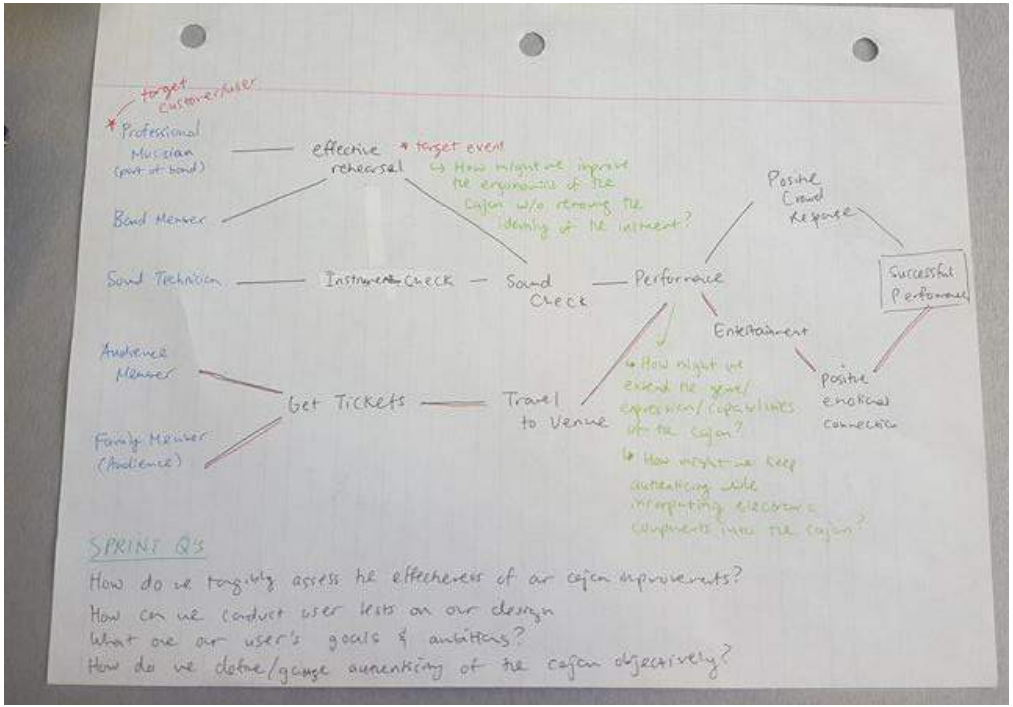


In Class Google Sprint (cont.)

Final simplified board, with only components relevant to our target



Redrawing


target customer/user
Professional Musician (part of band)
effective rehearsal
* target event
Band Member
Positive Crowd Response
Sound Technician
Instrument Check
Sound Check
Performance
Successful Performance
Entertainment
Audience Member
Get Tickets
Travel to Venue
Positive emotional connection
Family Member (Audience)
SPRINT Q's
How do we tangibly assess the effectiveness of our cajon improvements?
How can we conduct user tests on our design
What are our user's goals & ambitions?
How do we define/gauge authenticity of the cajon objectively?

Google Sprint Day 2

Presented our researched products

- How can they give us ideas for our own project
- Came up with possible solutions and sketched them

Learnings:

- A lot of products that involve physical user interactions have similar ergonomic issues
- Can reference ergonomic improvements of chairs, wrist guards etc. to get an idea of how the ergonomics of the cajon can be improved (can draw parallels)

Lightning Demo Research - Jeff

http://www.ergosonicpercussion.com/

Researched the ErgoSonic drum

- Modified the position of the playing surface of the traditional bass drum
- Improved comfort and ease of play for bass drum player, reducing arm stress

Takeaways

- Problem similar to cajon back bending
- Can modify the playing surface to have Cajon surface easier to play without stress on the back
- Learned that modifying the playing surface itself can also help ergonomics, will not only focus on seating features to improve posture

Lightning Demo Research - Josh

https://store.steelcase.com/seating/office-chairs/gesture

Researched the Steelcase Gesture

- Adjustable ergonomic office chair
  - Adjustable seat height + tilt, depth of seat
  - Adjustable back height + tilt, lumbar support
  - Adjustable arm - 3-axis
- Back and seat move as one to provide comprehensive support
- Chair arms move similarly to natural positions of human arms

Takeaways

- Flexible sitting positions
  - Designing for comfort and full support of the user's back and lower body regardless of their seating position
- Adjustable to fit all body types
  - An adjustable size and form to fit varying body sizes and proportions
- Form mimics natural human body positions
  - Allow for natural supporting positions and comfortable resting positions

Lightning Demo Research - Seb

Researched the kneeling chair

- Motivation: Lessen the long-term back strain and other back ailments that occur through poor sitting posture
- Target users:
  - anyone who sits for prolonged periods of time
    - Programmers
    - Project Managers
    - Designers
    - Lawyers
  - Individuals with coccyx and tailbone pain
- How it works:
  - Divide's person's weight burden to buttocks and knees
    - Thighs are dropped to a 60 - 70 degree angle from the vertical
    - No back support - individual must support themselves

https://www.relaxtheback.com/media/catalog/product/cache/1/image/9df78eab33525d08d6e5fb8d27136e95/j/o/jobri-wooden-kneeling-chair.jpg

https://en.wikipedia.org/wiki/Kneeling_chair

Lightning Demo Research - Hayes

Researched The Helping Hand and Carpal Tunnel Wristbands

- For people dealing with wrist injuries or conditions such as carpal tunnel, stroke etc...
- Helps immobilize hand but also allows the wearer to continue use of their hands for grasping

https://www.mycarpaltunnel.com/wrist-support-straps-wrist-pain-supports-braces-splints-carpal-tunnel-support-ergonomic-computer.shtml

Takeaways

- Repeated strain on wrists/hands when playing the cajon
- Elastic material provides flexibility
- Reduces fatigue in the hands
- Can add some sort of wrist support to the cajon to reduce fatigue and prevent repetitive strain

Lightning Demo Research - Jessie

Researched the Desk Foot Rest

- Footrests are great for shorter folks - similar potential problem in the cajon
  - On ergonomic chair, best position is feet flat on the floor, but not possible if short
- Reduces pressure on legs
- Encourage active sitting - rocking motion in the footrests
- https://www.thehumansolution.com/blog/top-5-reasons-why-you-need-a-footrest/
- Benefits:
  - Posture: Hips should be slightly higher than knees
  - Movement improves circulation
  - Back: Reduces risk of injury, encourages full contact to backrest of the chair

https://www.steelcase.com/products/computer-support/footrest/

Takeaways

- Very similar problems / solution for ergonomics
- Cajon acts as a “chair”, playing surface is similar to that of a “desk”

Lightning Demo Research - Ken

Researched The Bambach Saddle Seat

- For improving and forcing proper posture while sitting
- Initially created for people with physical disabilities

Takeaways

- Way of forcing correct posture without back rest
- Improvements for lower back support, but increases discomfort around thighs and hips

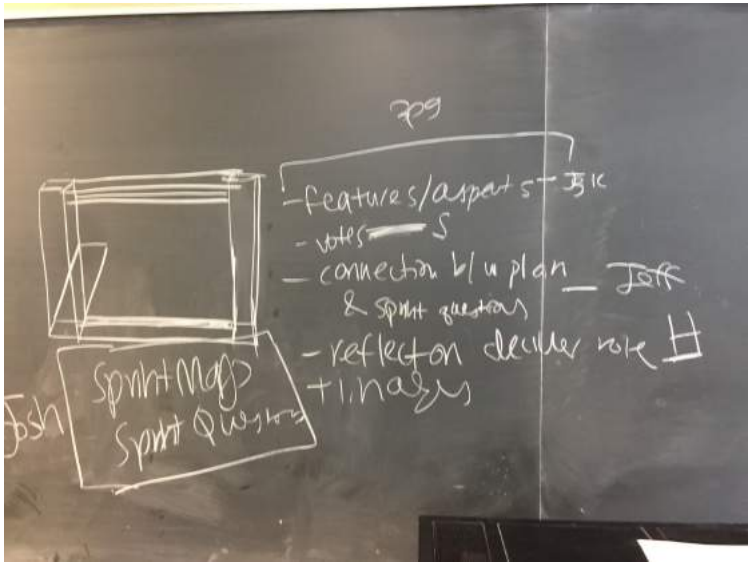
http://www.bambach.com.au/

Google Sprint Day 3

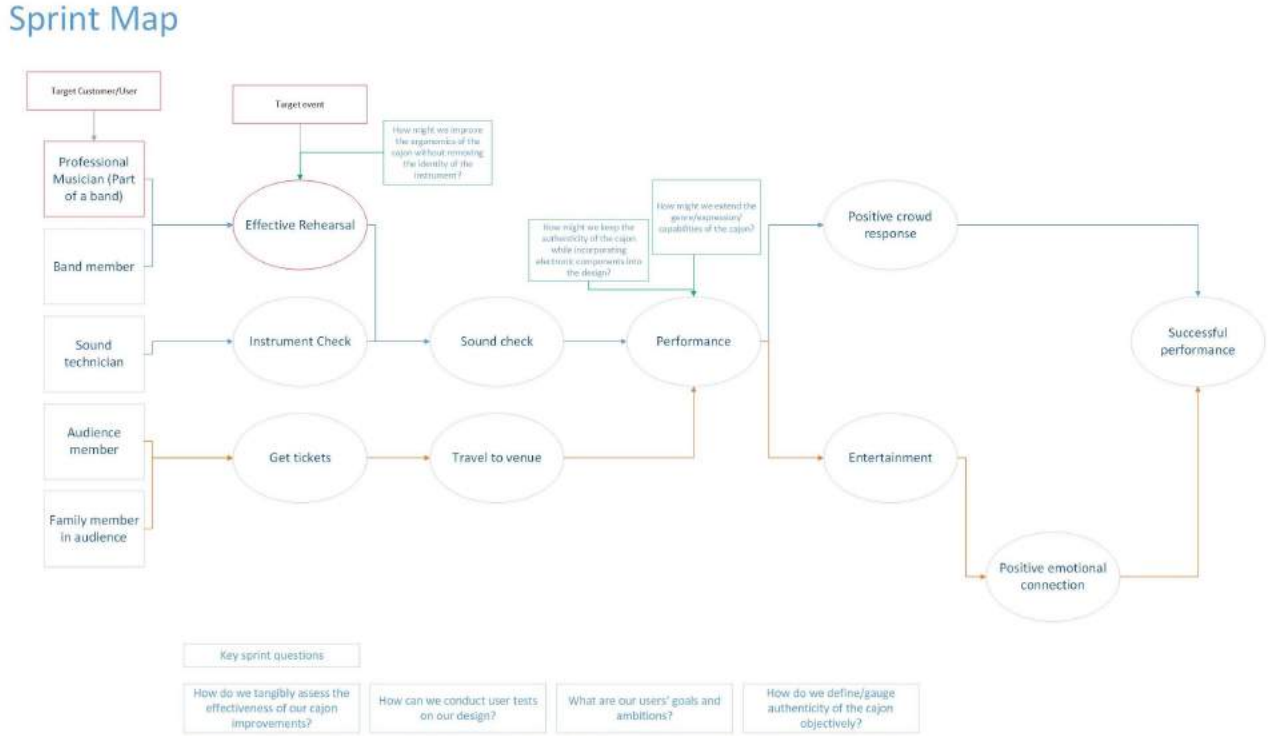
- Presented and discussed our individual solutions and parts
- Decided on our LFP - Post Cajon
- Ergonomic enhancements for the back, legs, and wrists
- Back support → Jeff, Hayes
- Adjustable height (back support) → Jeff
- Curved top of tapa (wrist support) → Hayes, Jessie
- Seating cushion (back + legs support) → Josh
- Adjustable (tiltable and liftable) playing surface → Jeff

After Class Work Session

- Worked on Sprint Document #1
- Unfinished tasks divided as in picture



Digital Sprint Map



Google Sprint Day 4 - Prototype Week Plan

- Makers: Ken, Jeffrey, Hayes
  - Constructed the Post Cajon prototype in the machine shop with the acquired materials and design
- Writers: Josh, Seb
  - Wrote user interview script and updated sprint questions
- Stitcher: Jessie
- Collector: Seb

External User Interview

Interviewee: Yamen Mouhanna

Interview Transcript:
https://docs.google.com/document/d/1RAOdsky2JZ-MmlcMrmNSUQ1eRAjAyAPl2wWjc3nOEaE/edit

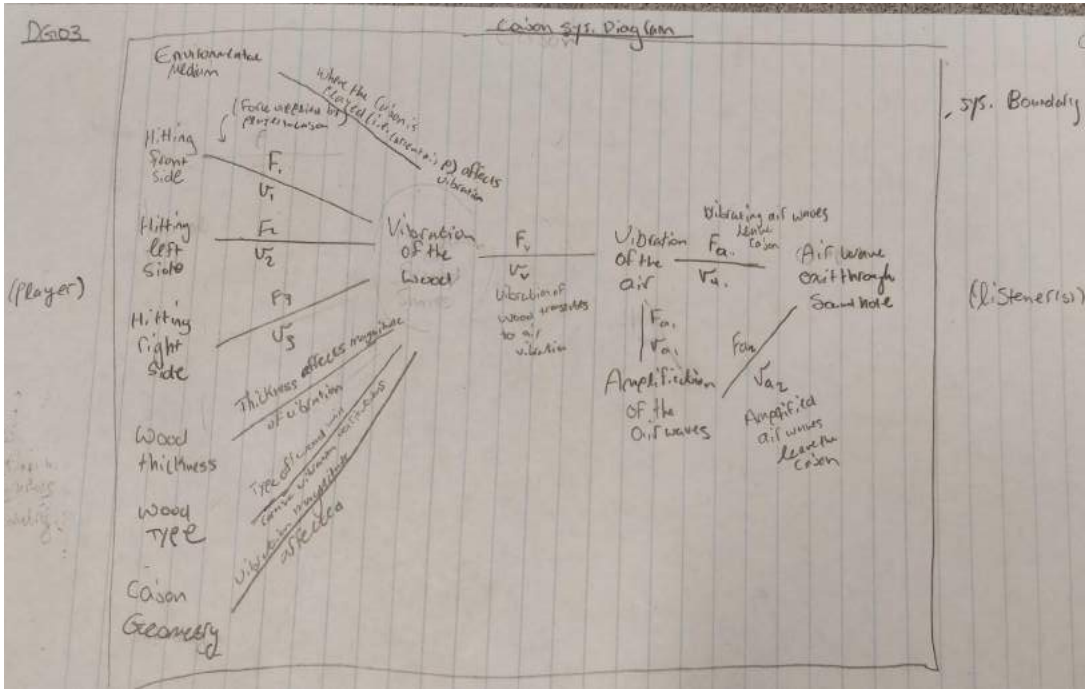
Interview Recording: https://drive.google.com/open?id=1m3H23l4ujYebLm1ior4YrTw_h6A0tcBf

External User Interview (cont.)

Insights and Highlights

- Lower back strain when bending down to reach lower areas of the cajon
- Some cajons have cushions built in and it was comfortable
- Some wrist support would be beneficial for long period of time
- Does not see value in footrest
- Handlebars for portability would be nice
- Q: What is a cajon to you? A: Sitting on it while hitting it
- Djembe is a more flexible instrument → we can look into it - material of skin?
- Pedal/latch to change tuning/sound mid-song would be nice
- Cajon could have a looper - box-shape is limiting because with other drums, people add things like shakers to their feet to add to the music

Lecture (System Diagram Synthesis)



Cajon system diagram first iteration

Drawer: Seb

Collaborators: Ken, Josh

Seat Surface Ergonomic Ideas

- Mathematical model to identify seat surface angles
  - https://ieeexplore.ieee.org/document/5203146/
- Seat surface design for long distance travel (trains) - section 4
  - http://journals.sagepub.com/doi/full/10.1155/2014/524802#_i22
- Xsensor (pressure imaging tool)
  - Seat surface should minimise areas of high pressure while seated
- Using cork as an inexpensive, lightweight, natural seat surface material

Reflection

- Seat surface should balance the pressure experienced on the buttocks and legs
- Seat should be slightly tilted back with different areas of the seat with different hardness of materials

Looking Forward

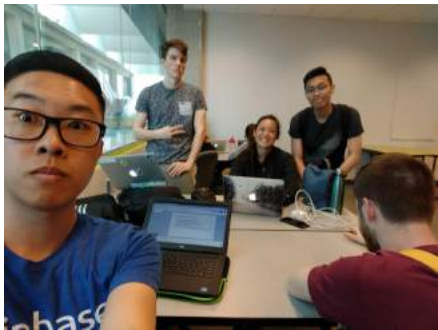
Did user testing today for two users (SYDE 2022 students)

Upcoming tasks:

- Wednesday May 30 - test more users
- Thursday May 31 - meeting to complete sprint document 2
- Sunday June 3 - Redesigns for Sunday + meetup to split groups + make plan going forward

Tentative group distribution:

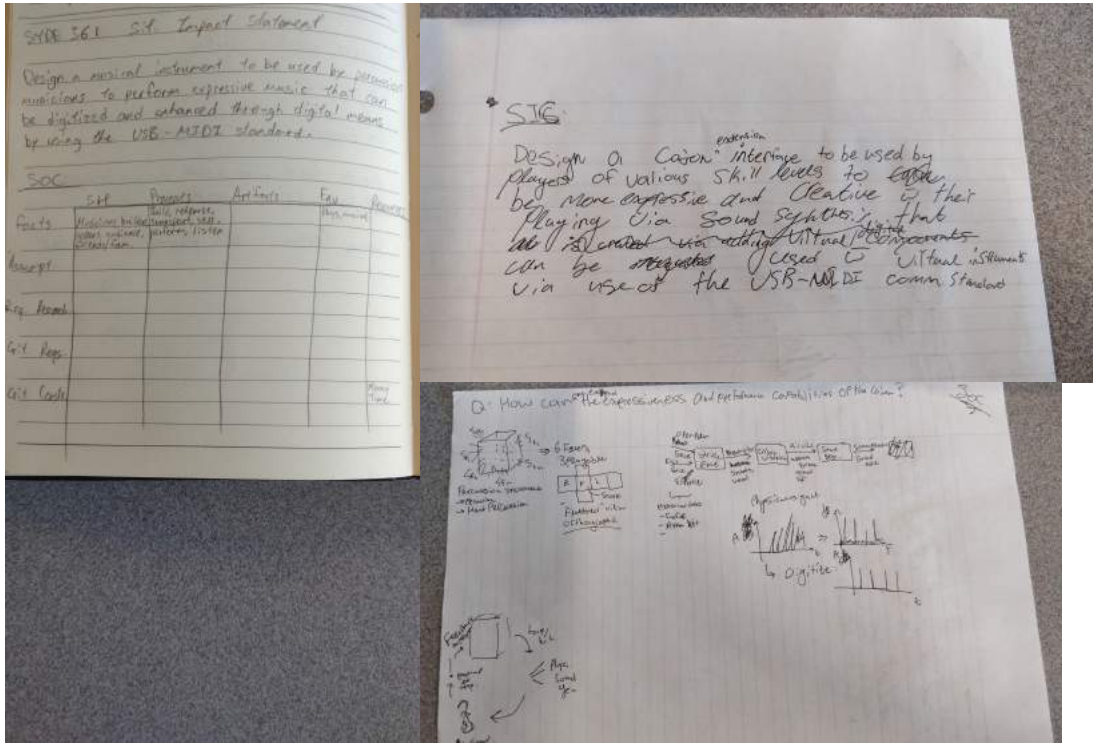
- Software: Seb + Jeff
- Electronics: Ken + Hayes
- Ergonomics: Jessie + Josh



Sprint Reflection

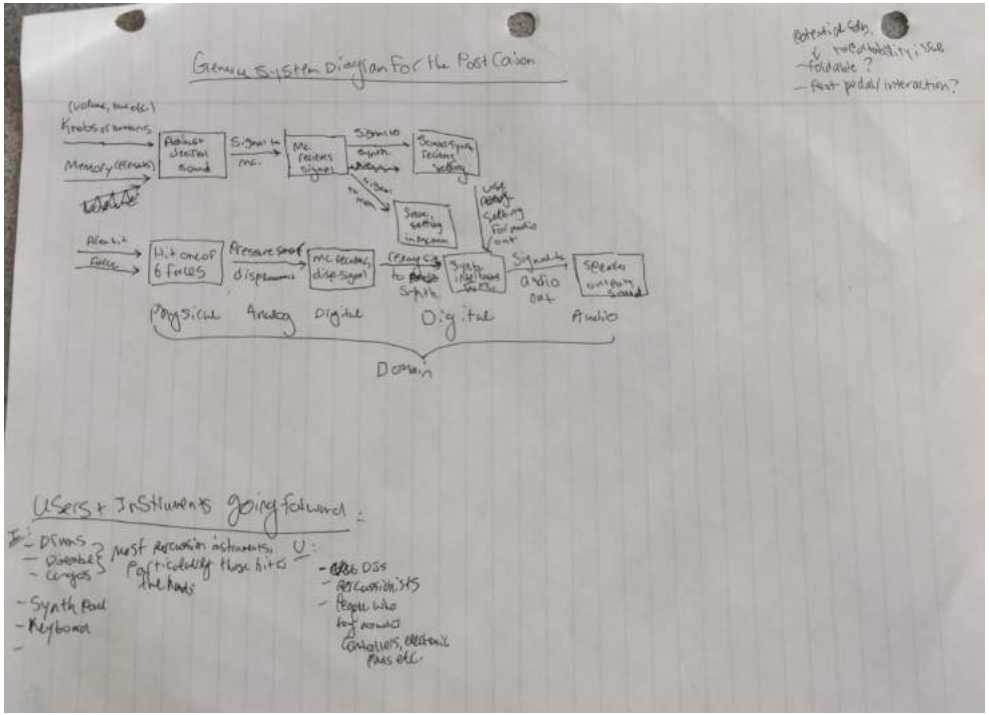
- Most important things learned from the sprint process:
- Individual ideation + culminating those ideas >> group thinking / brainstorming
- User testing provides a lot of unexpected insight
- Not getting things perfectly right is okay
- Iteration is what makes the Sprint so powerful

SOC Map and SIS



Jeff was present for the bulk of the class and group work. He's not in the picture because he left early later due to feeling ill.

General System Diagram



Work Session

- Meeting after class to work on Sprint Document 2
- Whole group to work on Sprint Document until 6pm
- Hayes, Jeff, and Jessie to work on Sprint Document 6-7pm
- Ken, Seb, and Josh to work on Sprint Document 9pm+

Post Google Sprint (GS) Iteration

- Ideas provided by all members pictured; written down by Seb
- One synth pad, continuous sound in 2D
  - Fallback: discrete grid
  - Get hit pressure/force, (x,y) coords, and time inputs → input into f(x,y,p,t)
    - t allows us to account for delta t for how long hand is on pad
  - f(x,y,p,t) function outputs corresponding frequency for the sound along w tone etc
- Software side:
  - Assume a micro controller (MC) is getting f(x,y,p,t) input (i.e. analog) from the interface
    - Reference MB's code and/or 3rd party library that creates continuous sound
  - MC digitizes data + makes it conform to the MIDI protocol
  - MC relays conditioned data to audio out
- User interviews:
  - Laurier professor → creates digital instruments
  - Synth pad player

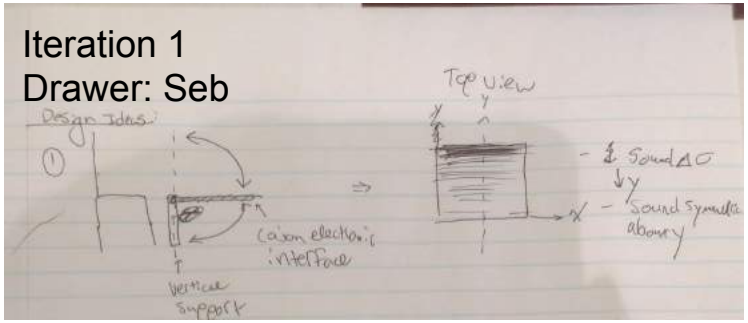
Post GS Iteration (cont.)

- Ergonomics
  - Adjustable playing surface height-wise
    - Make it slidable on rails
    - Make it rotatable on a hinge
- Ideal Deadlines:
  - Have LFP of the physical design by June 25th

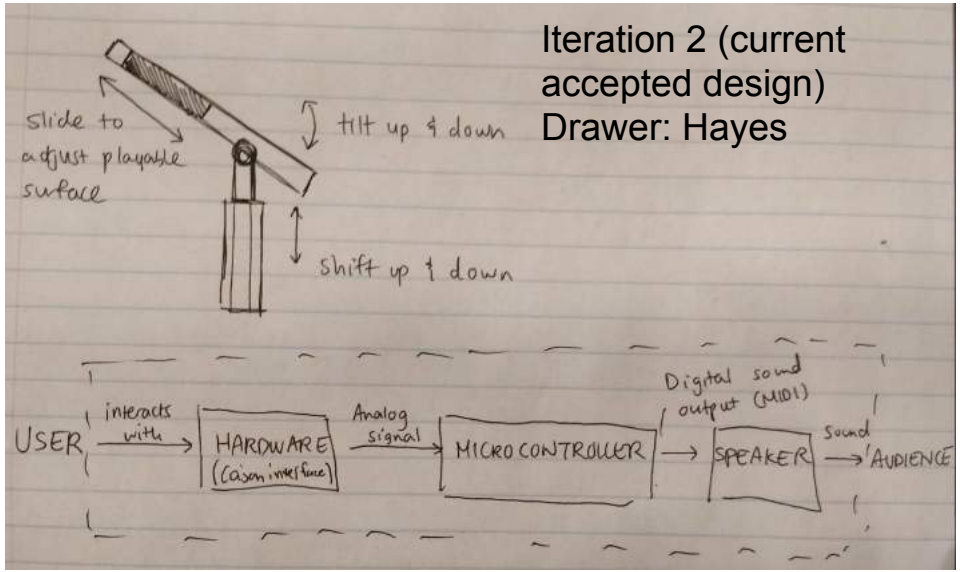
Post GS Design Iteration

- New iteration design ideas + system diagram

Iteration 1
Drawer: Seb



Iteration 2 (current accepted design)
Drawer: Hayes



User Interview - Colin Labadie

3rd Party Libraries:

- Max/MSP is a great software used to synthesize sound
  - Has whole range of instrument samples and signal processing capabilities
  - Analog from instrument, to digital for processing, to analog for output
  - Free version: Pure Data (PD)
- KVR Audio
  - .vst files; plugins

Existing products for inspiration:

- Cajon sensor on the market, outputs cajon sounds to audio port
- Mandala drum, like pressure pad we wish to use for digitization of sound
- Slap top cajon
- Bongo cajon

Bongo Cajon

https://www.interstatemusic.com/17175-Meinl-Professional-Ebony-Bongo-Cajon-PBCA1NT-EBKM.aspx

Slap Top Cajon

https://www.gear4music.com/Drums-and-Percussion/Meinl-Turbo-Slap-Top-Cajon-Walnut/YUP

User Interview - Colin Labadie (cont.)

Aims with digitizing instruments:

- Having access to more sounds → weirder, more abstract sounds
- Recording and looping
- Creating sounds that haven't been heard before / unconventional sounds

Digitizing process:

- Solo process; just trying to improve the experience for himself
- Upon being inspired with an idea:
- Do research: Google what people have already done, 3rd party libraries etc., be resourceful

Challenges:

- Making it wireless (working with XB controllers that interface with an Arduino)

User Interview - Colin Labadie (cont.)

Thoughts on Cajon iteration 2 (current design)

- Would be nice to let users customize software side
  - Set ADSR
  - Configure cajon “synth pad” “zones” → i.e. logarithmic sound relation wrt. Coordinates vs. linear
- Likes idea of letting users change sound, so long as still “sounds good”
  - Change sound through “Patches” - group of sounds
- Have haptic feedback: i.e. make it still “feel” natural
  - Conduct user testing to test success of this
- Connection between cajon and speaker should be wireless ideally
- Needs to still:
  - Feel good
  - Sound good
  - Have interactions that make sense
- Consider sound categories: Regular cajon vs. digital drum kit etc.

User Interview - Colin Labadie (cont.)

- Consider allowing users to sample sounds
- WRT reducing design to 1 side → “what you lose in sound, you gain in ergonomics”

Metrics for design success:

- Sound quality
- Does interaction make sense / feel natural?
- Can be funky, but does it still sound good?
- Unpredictability with sound is actually interesting, keeps things fresh

Takeaways:

- There is value in experimenting with unconventional sounds with the cajon
- Potentially give users ability to further customize experience via custom samples and sounds

Member(s): All June 7, 2018

AL Submission Work Session

- Meeting to polish SYDE 361 submission
- Discuss and share findings from user interview with Colin
- Plan future work sessions
    - Finalized meeting with Kate Mercer for Monday June 11th at 4pm
    - Everyone finds 3 good sources over the weekend
    - Meet after classes to finalize next weeks plan

MFP Plan

Design Loop Feedback: Friday, July 6th (20%)

MFP: Thursday, June 28th

Testing: July 2-4th

Components of MFP:

- Physical (Josh, Jessie): Adjustable stand, playing surface
- Hardware (Ken, Hayes): Drum pad, sensors
- Software (Jeff, Seb): Synthesis of sound
- Focus is physical component and stand, hardware and software is secondary, only to replicate cajon sound

Work Session: June 22nd after class - have all materials by then

Member(s): All June 11, 2018

Meeting With Kate Mercer

- Concerns:
  - Improvement is effectively a synth drum pad now. How do you differentiate from this?
  - 90% of her issues would be solved if it still looked like a box
- Takeaways:
  - Instrument doesn't matter, the process does!
  - Limits to how much we can replicate the natural acoustics of the cajon
  - Idea: Cover pad with wood veneer to retain cajon look and get haptic feedback
  - Have good answer to:
    - How it's different than a synth drum pad
    - Why we moved away from it still being a box but with sound synthesis
    - Why we're not just building a cajon raiser
  - Make it still looks like a cajon. As simple as the look; as complex as the feel.
    - Idea: Even if it's just unplayable materials on the sides
  - Idea: Consider haptic feedback on the chair with the new design
    - Vibrations on chair to replicate sitting on the cajon
  - Questions for users:
    - What do you miss the most about the original cajon (to gauge if need to add more original cajon features)
    - 3 things you like, 3 things you'd change (NOT 3 things you don't like)
    - Do you miss it feeling like a box

Meeting With Kate Mercer (cont.)

- Bibliography Feedback
  - Not restricted to journals etc.: need to just justify source in any case
  - Note who wrote it, why they're relevant
  - Find forum etc discussing the history of the instrument (i.e. can be an informal link)
  - Critique the articles, don't just summarize
    - Why it's a good source, justify methods (do google scholar search on method, see if it's well accepted etc.)
  - Point of AB: scope knowledge for someone else
    - Basically a reading list
  - Not just summarizing, using them for what you need to get out of them
  - At least one source on:
    - Ideal back posture
    - Ideal arm posture
    - Acoustics of a drum
    - Haptic feedback
    - Synthesizers
  - Looking to see that you did your due work: so have some sources for every aspect, even if focus is ergo.
- Sources:
  - "Co-design of a smart cajon" (Luka Turchet; https://doi.org/10.17743/jaes.2018.0007)
    - Email author to get access

Meeting With Kate Mercer (cont.)

- Get annotated bibliography draft to Kate on thursday before 10PM to get feedback

Cajon Structural Design Planning

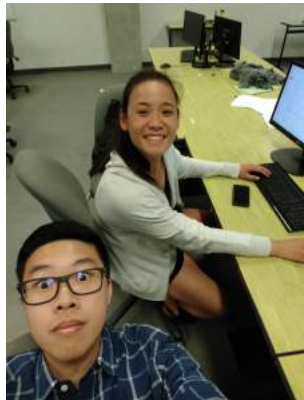
- Met to talk about structural design of MFP
  - Have plan for structure, but need dimensions before consulting with a professor for technical advice (ex. Validate our blueprint, best materials to use, etc.)

Plan (todo by Thursday):

- Define measurements of proposed solution - do research on ergonomics
  - Length x width of cajon playing surface
  - Height adjustability of cajon (minimum and maximum)
  - Comfortable arm extension position for location of surface
- Further research on playing areas of tapa to map sounds

Greatest Takeaways:

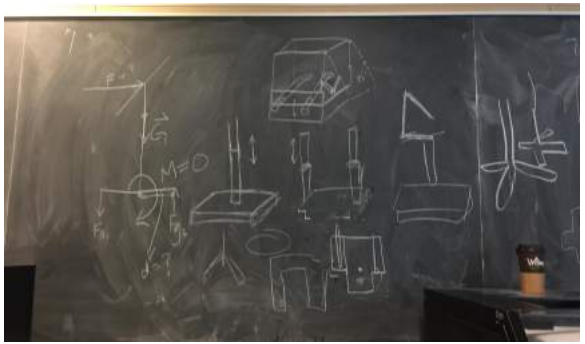
- Want a “feel” and “look” of a cajon despite synthesized sound - should explore wood as a potential material rather than metal

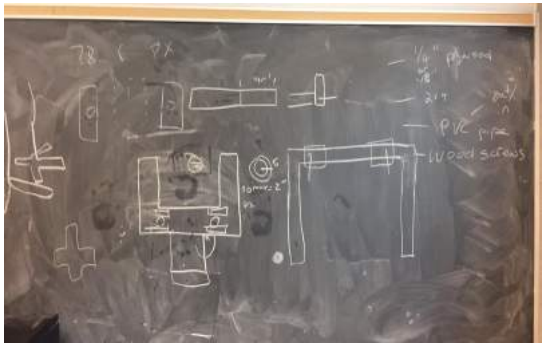


Member(s): All June 21, 2018

Cajon MFP Planning

- Meeting to plan the MFP structural design and construction
- Individual team meetings to discuss MVP requirements for software and hardware





Software Discovery

- Someone asking how to convert piezo signals to midi
  - http://www.instructables.com/topics/DIY-MIDI-converter-for-drum-signals/
- Python library to encode a frequency to a MIDI message and send it to a port
  - http://mido.readthedocs.io/en/latest/
- MIDI messages and their functions
  - https://www.midi.org/specifications-old/item/table-1-summary-of-midi-message
- Python MIDI sound synthesis library
  - http://web.mit.edu/music21/doc/index.html

Team MFP Discussion

The following notes are the problems and requirements that the design team has come to a consensus on at this stage in the project. The problem statement that follows is a result of these identified areas.

Identified problems:

- Improper posture (sitting)
  - Back
  - Knees
- Arm / hand strain from repetitive hitting
- Portability
- Expressibility
  - Can’t be played as a solo instrument
  - Need different instrument to create a different sound
  - Dynamic snare adjustments

Team MFP Discussion

Requirements:

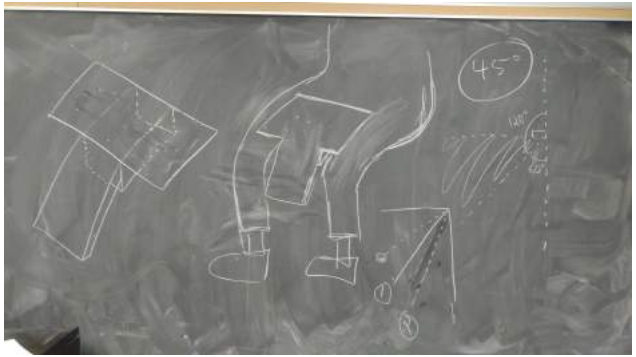
1. A design that suits 5th to 95th percentile heights
2. Enhance player's ability to play the cajon as a solo instrument
3. Increase ease of changing the sound of the cajon, as well as extending the range of sounds
4. More lightweight and portable than the original cajon
    a. Worst case: as lightweight and portable
5. Improves posture of all players
6. Reduces strain due to repetitive motion

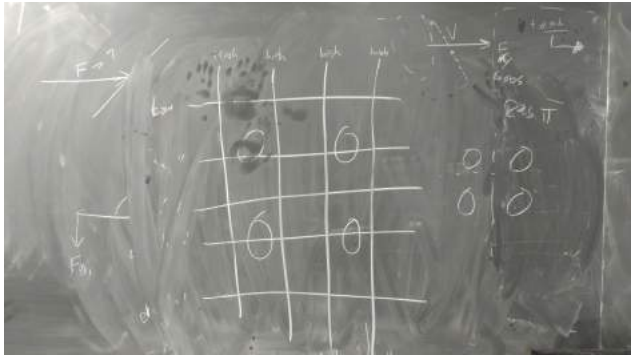
Re-clarifying design focus

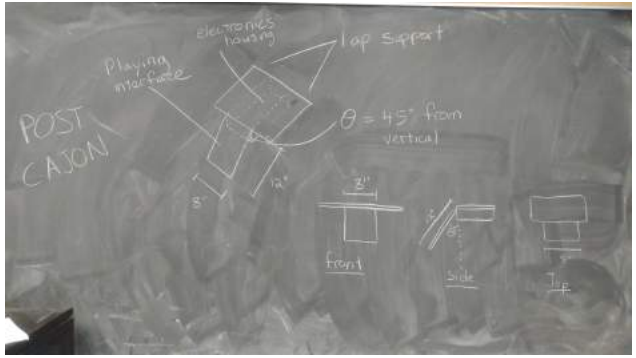
Problem Statement:

Develop an improved cajon that enhances the ergonomics of the playing experience with respect to posture and strain while increasing the portability and expressibility of the playing experience.

MFP Redesign







Software Research

High level to-dos:

- Figure out how to read voltage inputs
  - Find a suitable distribution that can:
    - Take these inputs
    - Work with python

Over the weekend:

- Research DIY projects doing similar things etc. to figure out the data conversion pipeline

Team Work Session

Software:

- Experimenting with the teensy + ableton to output different drum sounds

Physical:

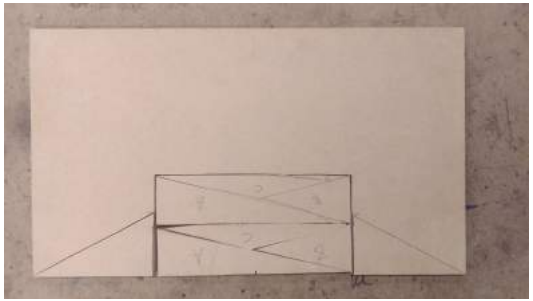
- See slides 63-65

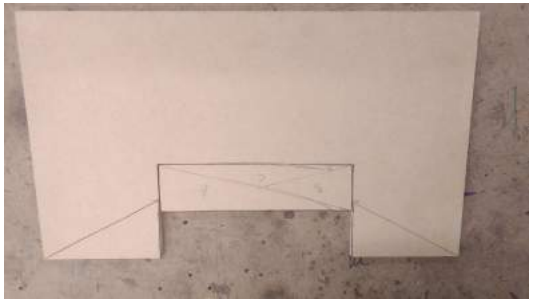
Hardware Research

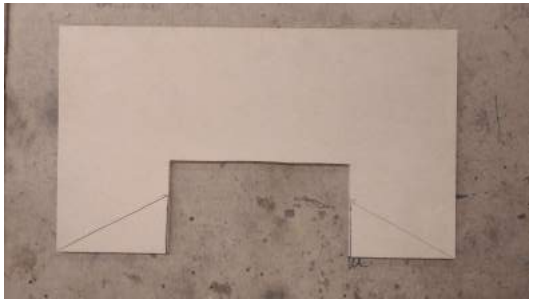
- Investigated XY sensing drum pads online. “The XY drum” (https://ocw.mit.edu/courses/music-and-theater-arts/21m-380-music-and-technology-contemporary-history-and-aesthetics-fall-2009/projects/MIT21M_380F09_proj_ssp_4.pdf) provided insights on existing techonlogy (though the artical is 9 years old).
- Spoke with Orion who outlined three possible courses of action
    - Wire grid that connects on hits. Location of connections provides XY data.
    - FSRs at each corner of the pad, triangulate to find strike location
    - Combing both approaches.

MFP Machine Shop Work Session 1

- Cut out top surface and playing surface
- Various cuts were made to determine which shape/size would work the best

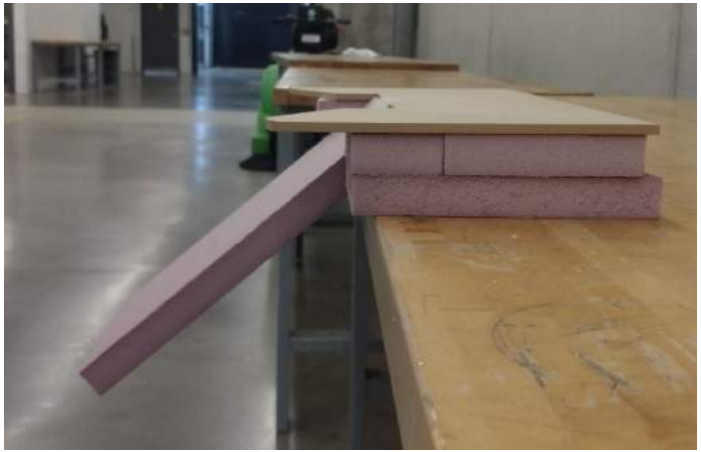






MFP Machine Shop Work Session 1 (cont.)

- A foam-like material was used under the top playing surface and as the playing surface
- The corners were rounded



MFP Machine Shop Work Session 1 (cont.)

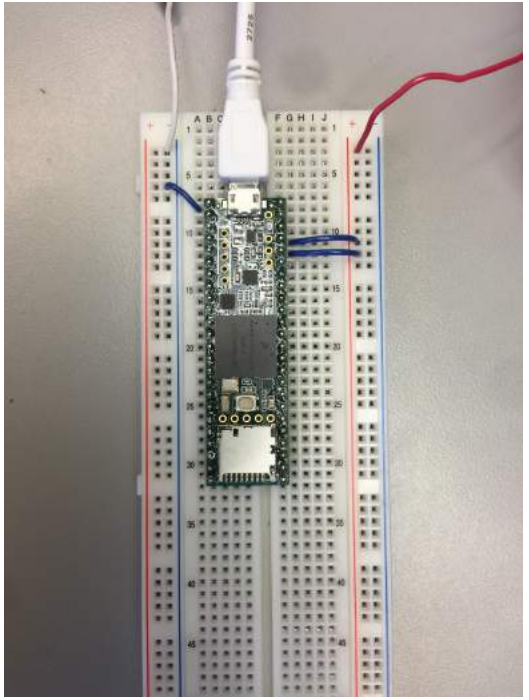
- With and without the foam cushioning under the top playing surface

Hardware Research and Equipment Gathering

- Spoke with professor Borland about possible hardware approaches. Suggested using the four corner FSR approach.
- Acquired piezoelectric sensors, FSRs, a multimeter and some leads from the SYDE Den to use in hardware testing.

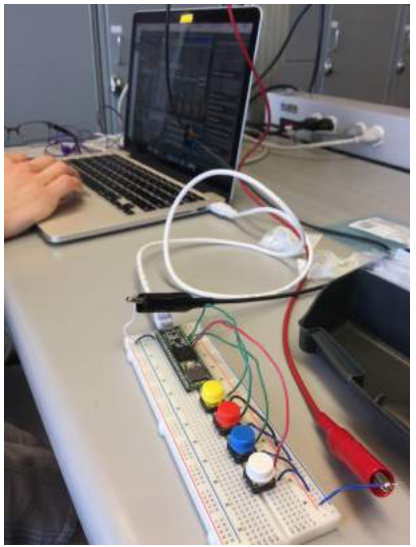
Software Work Session

- We wired the Teensy to a power supply
- Were able to:
  - Play 2 notes at once
    - send_now()
  - Read in and sanitize voltage coming into the Teensy in order to map them to a note
  - Notes passed into Ableton and played through speaker



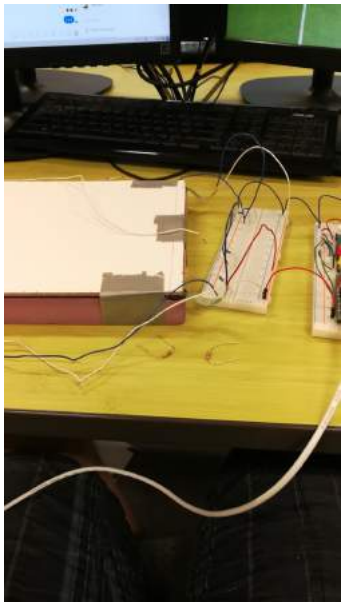
Software Work Session

- Wired buttons to inputs and were able to play multiple notes on Ableton
  - Implemented interrupts instead of polling
- Added functionality to change sound for expressibility
  - Created button to switch channels in Ableton
  - Able to play drum, and electronic sounds, among others
- Investigated Looping
  - Have questions for Professor Borland on Tuesday
- Wrote sections in design loop feedback submission



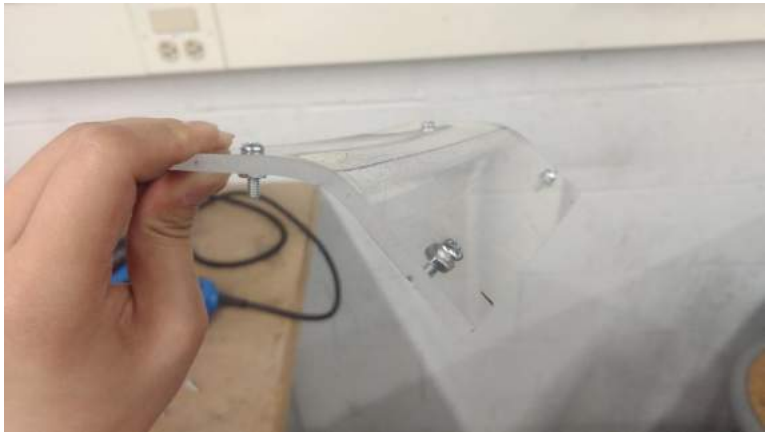
Hardware Work Session

- Began experimenting with the piezoelectric sensors and FSRs
- Created a circuit for both the piezoelectric sensor and the FSR to be measured by an arduino/teensy analog pin
- Constructed two mock playing surfaces, one with FSRs and one with piezoelectric sensors



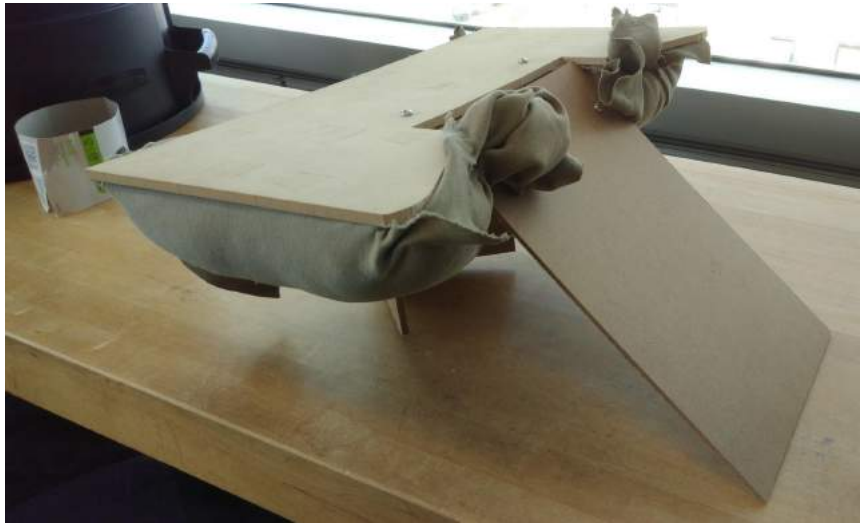
MFP Machine Shop Work Session 2

Created the connecting piece for the top surface and the playing surface out of acrylic



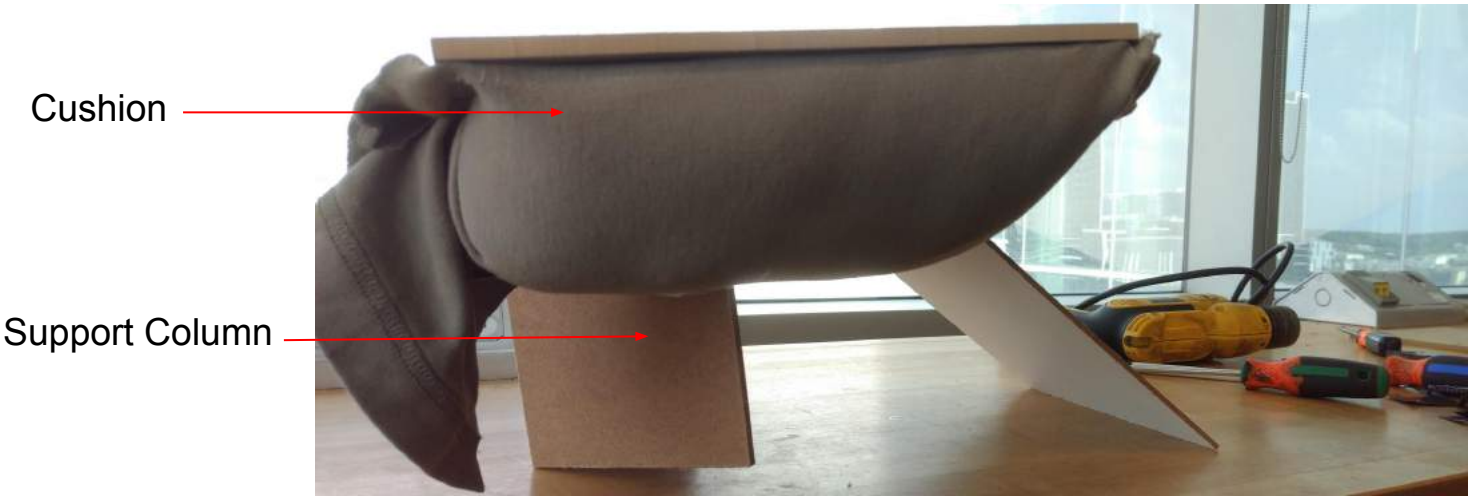
MFP Machine Shop Work Session 2 (cont.)

- Drilled holes into the two surfaces and assembled the MFP together using the acrylic piece
- Cut out various surfaces for testing (thick wood, thin wood, acrylic)



MFP Machine Shop Work Session 2 (cont.)

- Foam replaced with cloth + cotton to make cushioning
- Support column added to the back



Hardware Testing Session

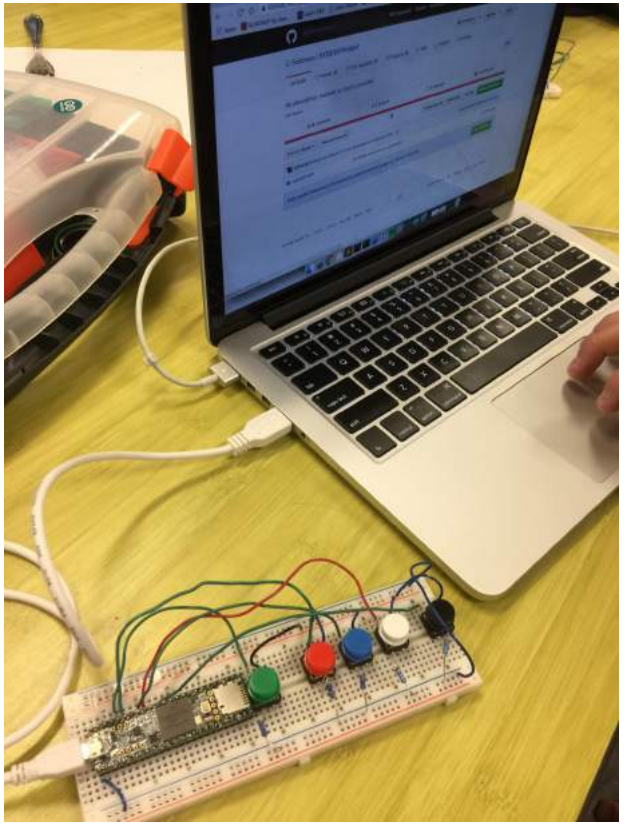
- The mock playing surfaces that were constructed last week were tested and results recorded in excel.
- Hits in different locations with different strengths were made on the playing surfaces, then the voltage at each corner sensor was measured.
- Both piezoelectric and FSRs had trouble sensing the the middle range of the playing surface
- FSRs were slightly more reliable at the top and bottom of the playing surface but are more expensive

Plan for HFP

- Iterations during next week's class
- If more time needed, July 14th weekend will be a team work session to build the HFP
    - Jessie will be absent so she will focus more on testing plans and the design

Software Work Session

- Instrument toggle functionality implemented (white channel switch button)
  - Goal: to see if expressibility can be improved by having non-conventional cajon sounds
- Three buttons for different types of sounds for each of the two instruments (green, red, and blue)
- “Effect” button that repeats a given note 5 times (black button)
  - Aims to gauge if testers can be more expressive with effects in general
- Implemented version control best practices with GitHub



MFP Software User Testing Results

- User testing was conducted on the software component of the Post Cajon MFP in isolation
  - Focus was to test the current expressibility of the features implemented
- Brief overview of the 5 testers:
  - **Tester 1**: No musical experience at all
    - Thought unconventional sounds would be good way to introduce kids to the instrument
      - Similarly, kids would love the sound effects but the parents may not
    - Should consider different Post Cajon alternatives for different sounds vs. one that does it all (subjective experience)
    - Should have one sound similar to the cajon, one completely different
    - Looping feature seems fun but complicated
    - Prefers changing instrument sounds on Ableton Live
    - Volume knob would be interesting, could add to “drama” of the playing experience
    - Prefers different instruments in different regions of playing surface versus toggle to change sound
  - **Tester 2**: Little musical experience (more than Tester 1, though):
    - Thought original cajon sounded better than synthesized counterpart
      - Loves sound of acoustic percussive instrument and the rhythm that comes with it
      - Enabling good rhythm may still be possible if the user interface is designed properly

MFP Software User Testing Results (cont.)

- **Tester 2** (cont.):
  - Synthesized sound did sound close enough to the cajon
  - Idea: “don’t take away from the cajon. Rather, make it a cajon with more”
  - Sound effects improve the playing experience
  - Would like bass control sound effect
  - Knobs preferred over buttons for effects for more continuous control
  - Likes vastly different sound setting
    - Can toggle with a button
    - Concern with cycling through different instrument sounds with one button (would take too long)
      - Solution: Consider using n buttons for n sound settings
  - Prefers all regions of playing surface to map to specific instrument
  - Likes idea of looping, but thinks it’s more suited to DJs / beat-makers
  - Volume fluctuation knob would aid expressibility; Would prefer changing instrument sounds on cajon vs AL
- **Tester 3**: No musical experience at all
  - Like the synthesized and original cajon sounds the same, can still hear percussiveness in both
  - Sound effects cool, interesting to have traditional instrument but have completely different sound
    - Echo, loop function are ideas of other effects to add

MFP Software User Testing Results (cont.)

- **Tester 3** (cont.):
  - Likes the variety of different instruments, would like more instrument sounds though
  - One large surface with same instrument sound preferred over regions with different instrument sounds
  - Looping good function for skilled musicians
    - Expressibility increased because can increase experimentation, adding layers of looping
  - Volume fluctuations are an odd parameter that adds to expressibility
  - Would rather change instruments on Ableton Live than the cajon to minimize controls
- **Tester 4**: has played the cajon casually for the past few years; owns a cajon
  - Likes idea of sound effects:
    - Repeated notes
    - Sustain control
  - Prefers natural wood sound of cajon versus synthesized sound
    - Consider recording actual cajon sounds and mapping to the Post Cajon
  - Looping: would be nice to change drum kits / sounds between loop tracks
  - Volume knob not necessary so long as have proper volume mapping with how hard instrument is struck
    - Volume knob could potentially aid in expressibility though
  - Prefers changing instrument sounds on Ableton Live versus the Post Cajon
  - Wants different drum kit sounds versus vastly different sounds like piano etc.

MFP Software User Testing Results (cont.)

- **Tester 5:**
  - Synthesized sound Red button has bassy sound that is different from cajon but is really enjoyable, compliments play style, Green button too snarey (snarey sound not like cajon), Blue button very hollow
  - Different sounds change mood of the sound
    - Would be interested in veering away from traditional general cajon sound
    - More than two sounds would be nice
    - Would like to customize instruments
  - Effects, likes it, improves expressibility
    - Sustain → would be really cool way to take advantage of digital domain cause can't do with original
  - Looping is desirable feature, no longer a dependency on other musicians, can experiment
    - Would like to change instruments between loops
  - Volume fluctuations depends on reliability of force sensors (in terms of convenience)
    - Probably don't need dial if above works
    - Minimize number of dials to keep simplicity

MFP Software Testing Results (cont.)

- **Key Insights:**
  - 60% of the users enjoyed the synthesized cajon sounds to the same degree as an original cajon
    - **Takeaway**: Current synthesized sound does alright job (other than the snares, those need to be configured further) of emulating the cajon - more configuration of AL should be done though
  - Unanimous approval of having various types of special effects
    - **Takeaway:** Implement controls on the Post Cajon that handle toggling between effects such as sustain, repeated notes, echoing, reverb, etc.
  - Unanimous agreement about having different instrument sounds available, but most testers want to configure these sounds on AL. Testers overly preferred having toggling the sound globally on the Post Cajon, versus on a per-region basis.
    - **Takeaway:** Provide a button interface where each button maps to a configured instrument on AL. Players can change / configure these sounds on AL (most testers preferred doing this on AL since there would otherwise potentially be too many controls on the Post Cajon). Number of buttons is currently set to 5.
  - 60% of testers believe that looping is a useful feature only for advanced users, while 100% of users believe that it would improve user playing experience and expressibility
    - **Takeaway:** Since the Post Cajon is being built for casual to intermediate musicians, the priority of this feature is decreased, would be a nice to have
  - Volume control knob not necessary if different volumes produced with different hit force
    - **Takeaway:** Implement proper volume fluctuation relative to hit force via pressure sensors + velocity

Ergonomic MFP User Testing

User 1 - Chris

- 1st Prototype (big wood)
  - Hit top surface first before hitting actual playing surface
  - Surface corners uncomfortable for wrist
  - Acrylic is too flexible but more quiet
  - Cushions are comfortable
  - Support in middle is good, a lot more comfortable than sitting on an actual cajon
- 2nd Prototype (small acrylic)
  - Moves around more, angle is too big and bends too far
  - Top surface is a little too small
  - Lighter weight is not good - less stable
  - No difference between thick and thin cushion
- 3rd Prototype (sit on small acrylic)
  - Likes it a lot better, more stability
  - Likes higher height more than low height

Ergonomic MFP User Testing (cont.)

User 2 - Krysia

- 1st Prototype (big wood)
  - Wondered about laying sides of cajon and stability
  - Leg column uncomfortable
  - Difficult to reach further parts of the surface
  - Wrist support is uncomfortable
  - Likes the feel of acrylic playing surface, does not care about flexibility of surface
- 2nd Prototype (small acrylic)
  - Feel and size is fine, but scratchy and sharp
  - Doesn't like as much because relying on arms to play it
- 3rd Prototype (sit on small acrylic)
  - Likes it a lot better, more stability
  - Lower so have to bend down more
  - Length and width feel good, perhaps wants wider

Ergonomic MFP User Testing (cont.)

User 3 - Steph

- 1st Prototype (big wood)
  - Anxious with wrists - too far to reach with the ends sticking out
  - Likes column and leg stability - wonders if long periods of time will make legs tired
  - Likes cushions
- 2nd Prototype (small acrylic)
  - Less stable, needs to put legs up - can be more expressive if no need to stabiliize
  - Lighter weight feels less secure and wants a leg column
  - Feels too low - lights more elevation (wants bigger cushions) - feels “lazy”
  - Doesn’t like bolts sticking out
- 3rd Prototype (sit on small acrylic)
  - Loves it! Solves her greatest concern for stability
  - More similar to original cajon

Ergonomic MFP User Testing (cont.)

User 4 - Dylan

- 1st Prototype (big wood)
  - “A bit too big for me” - hard to sit
  - Wants less “springy” playing surface
  - No preference for cushion size but likes big squishy one
  - Feels need to tiptoe to keep flat and stable
  - Likes acrylic texture and surface the most
- 2nd Prototype (small acrylic)
  - Feels very portable, but not sure how to sit with it since unbalanced
  - Not super comfortable because it slips
  - LIkes double acrylic thickness more than single
  - Likes lower height, but not that important
- 3rd Prototype (sit on small acrylic)
  - Very portable and much better
  - Sharp to sit on

Ergonomic MFP User Testing (cont.)

User 5 - Katy (experienced player)

- 1st Prototype (big wood)
  - Awkwardly “bound” because it’s too high
  - Would prefer straight arm vs bent arm
  - Thick cushioner is “so much comfortabler”, but it’s still too high
  - Want straight wrists still doesn’t like it - “Lounge chair cajon”
- 2nd Prototype (small acrylic)
  - Poorly weighted, doesn’t like stability
  - Feels like she’s scrunching up
  - Weird material but could get used to it
  - Length is good, but too narrow
  - Would rather SIT on it - prompted idea to retest all users with “3rd prototype”

Ergonomic MFP User Testing (cont.)

Key Insights

- The central support column was not well suited for users of different thigh angle/leg sizes but it provided stability due to its weight
- The corners of the top surface were sharp, pressing against the wrist uncomfortably when playing
- The thicker cushions were more comfortable
- Users prefer a playing surface with minimal flex
    - Users liked the acrylic texture but it was too flimsy
    - Many users like the thicker wood and the slightly-rough texture for grip
- **Stability** was a large issue → affected by cushion bounce/thickness, weight of the instrument, top surface size and support column

Button Interface Decisions

- Discussed best approaches to integrate looping, instrument toggling, and effect toggling buttons onto the Post Cajon
- A pedal was considered, but thereafter discounted as it would decrease the mobility of the instrument and associated wiring would be inevitably obtrusive
- For the sake keeping the interface minimal and intuitive, it was decided that three buttons would be used: 1 for cycling between 3 instrument channels, 1 for cycling through 3 effects, and 1 for toggling recording, as well as stopping and deleting said recordings thereafter
- User testing was conducted to determine the best placement of these buttons on the Post Cajon
    - Most testers prefered having the buttons on the bottom of the playing surface, on the side of their dominant hand

Hardware Impacts with Physical

There are hardware constraints that impact the physical team. These needed to be communicated and plan created to overcome then

Problem: Playing surface must be rigid so that all of the force from a strike is sent to hardware sensors regardless of location. It must also be light as sensors will be between two sheets which doubles the material needed
Solution: ¼ inch acrylic is rigid, light and easy to work with in the machine shop.

Problem: Playing surfaces must be held together with outside compression (ie, pushed) not inside tension (ie, pulled). A force pushing outwards from in between the two playing surfaces would make the sensors on the corners less accurate
Solution: Playing surface can be held together with bolts

Software Implementation Work Session

Seb:

- Added channel cycling functionality that cycles between three different channels on Ableton Live when a button is pressed
- Implemented delays with the `millis()` function to minimize repeated interrupt / poll function calls when a button is pressed

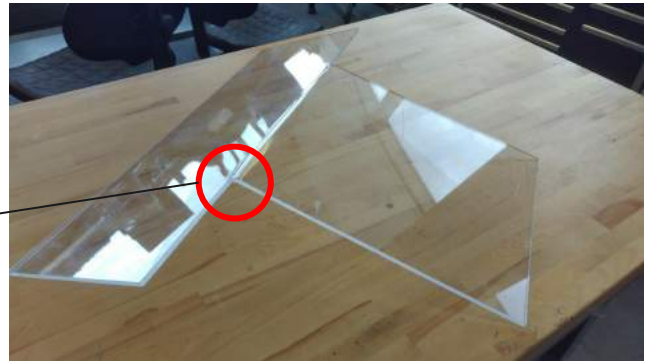
Jeff:

- Added multiple effects, by mapping different control MIDI messages to change different sound effects in Ableton
- Changed toggleEffect button to cycle between effects

Machine Shop Session

- Built a larger prototype (playing surface 12” x 14”) with the T-shaped leg support, similar to the MFP using thick sheets of acrylic
- KEY INSIGHT:
  - This design DOES NOT work when scaled - the acrylic is too brittle and cracks when sat on (T-shape support)
- New plan for HFP:
  - Reevaluate t-shaped support and methods to support body weight and have stability
  - Try a smaller version tomorrow - 10” x 12” playing surface without the T-shape
    - Add support if necessary but try just flat plane
  - Add additional “brace” underneath the curved area

Crack appeared when user sat on frame



Software Implementation Work Session

Seb:

- Integrated Bounce2 library into current codebase
  - Cleaned up note delay issues - outputted sound now maps directly to button presses without noticeable latency
- Refactored channel cycling logic to incorporate the Bounce2 library
- Continued working on looping functionality
  - Iterated on button interface: now doing 6 buttons in total
    - 3 on the bottom right side to control effect cycling, channel cycling, and removing effects
    - 3 on the bottom left side to toggle recording, playback, and deleting a loop on a given channel

Jeff:

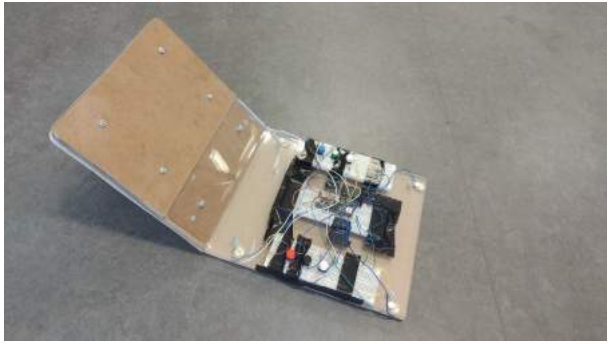
- Added effect cycling for each channel, MIDI mappings
- Added ability to clear effects
- Tuned sounds in Ableton for final product

Machine Shop Session

- Smaller acrylic frame was built, and without the “T” sitting surface
- Brace was also built to be layered underneath bend of acrylic frame
- In preliminary testing, this frame was much sturdier than the larger “T” acrylic frame, and much lighter
- Playing surface was also cut down to the right size and fixed onto the frame

Hardware Physical Integration

- FSR circuit was integrated into the HFP that was built earlier in the day.
- Circuit was unusable due to preloading on the FSR. The sensors were already experiencing the max force they could measure.
- Circuit was rebuilt and re-integrated with piezoelectric sensors.
- Sensors were calibrated with different threshold values to determine two types of hits (top/bottom) and two strengths of hits (hard/soft)
- Wooden sitting surface was attached to the frame



Software Hardware Integration

- Combined pressure pad input code with the sound synthesis and effects code
- Calibrated pressure pads and Ableton sounds
- Full software work history available on GitHub
    - https://github.com/Seabsaye/SYDE361Project
- Tuned sounds after integration on ableton and setup the final .ALS file
- Tested all effects and looping capabilities