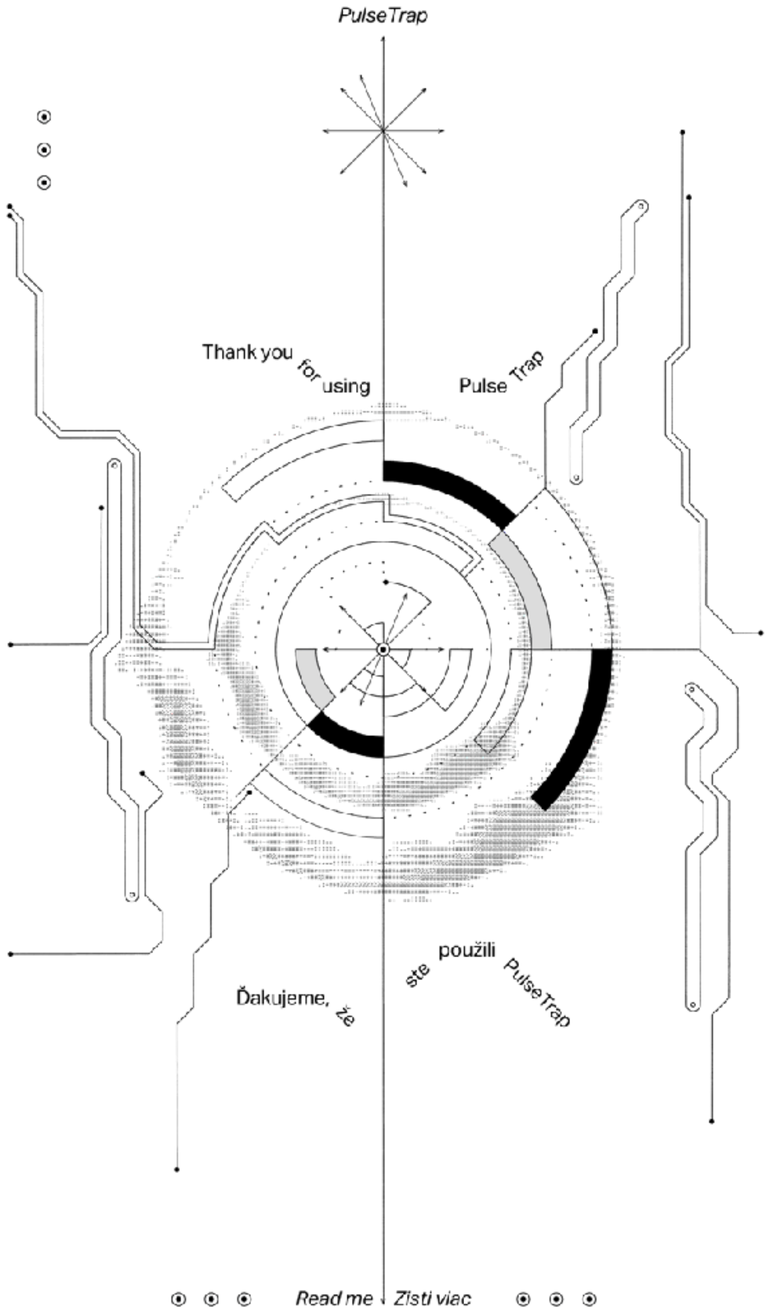
David Krajčík
Florian Zwietnig
CAP-22C
PUSH2 - Workbook
1356 Words

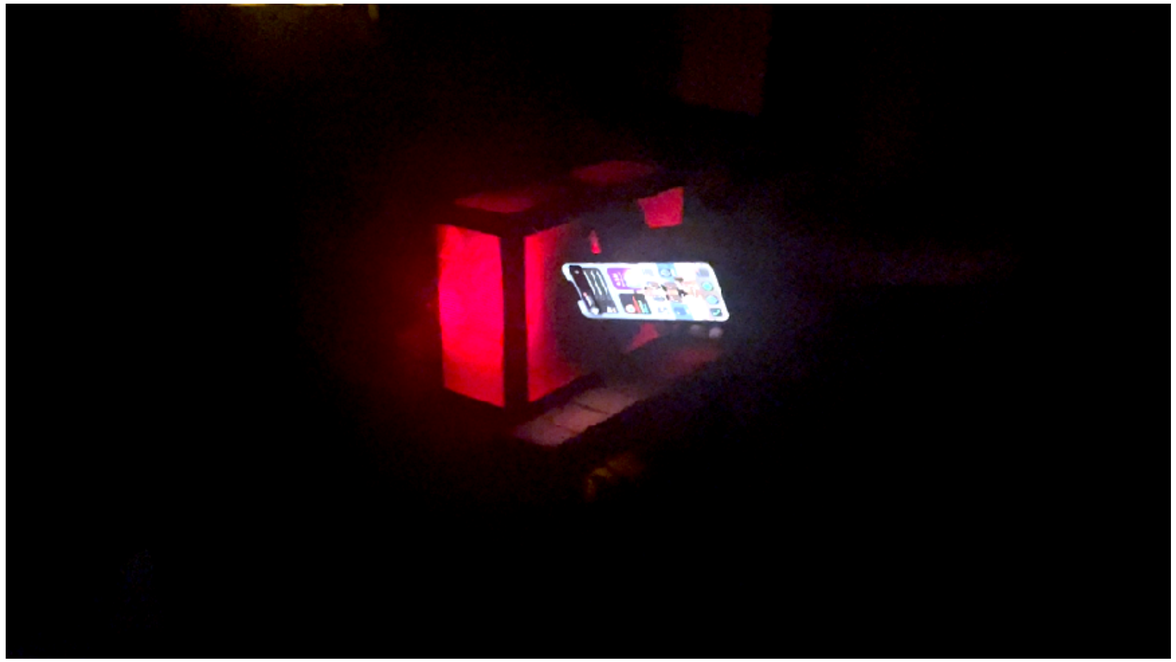
PulseTrap

Workbook



Content

Introduction



PulseTrap is an interactive sound installation that captures inaudible electromagnetic interference (EMI) emitted by smartphone antennas using analog circuitry. When an audience member scans the QR code attached to the installation, it acts as both a data collector and a trigger. A coil surrounding the QR code detects the smartphone's EM activity as it loads the website, and the captured EMI signal is amplified and processed in Ableton Live.

Each interaction contributes to the evolving soundscape, as every device emits unique signals, creating a constantly shifting auditory experience. The installation also features an LED system that responds in real-time to the EMI, merging sound and light.

PulseTrap explores hidden communication and data collection, revealing how easily information can be retrieved. The audience engages with a fictional product that generates sound from EMI, yet remains unaware of how their data shapes the composition —mirroring our limited understanding of real-world data collection.

I wanted to work with my hands this year—to build, solder, and experiment. PUSH123 was the perfect opportunity to push myself beyond my usual art forms.

Conceptualization

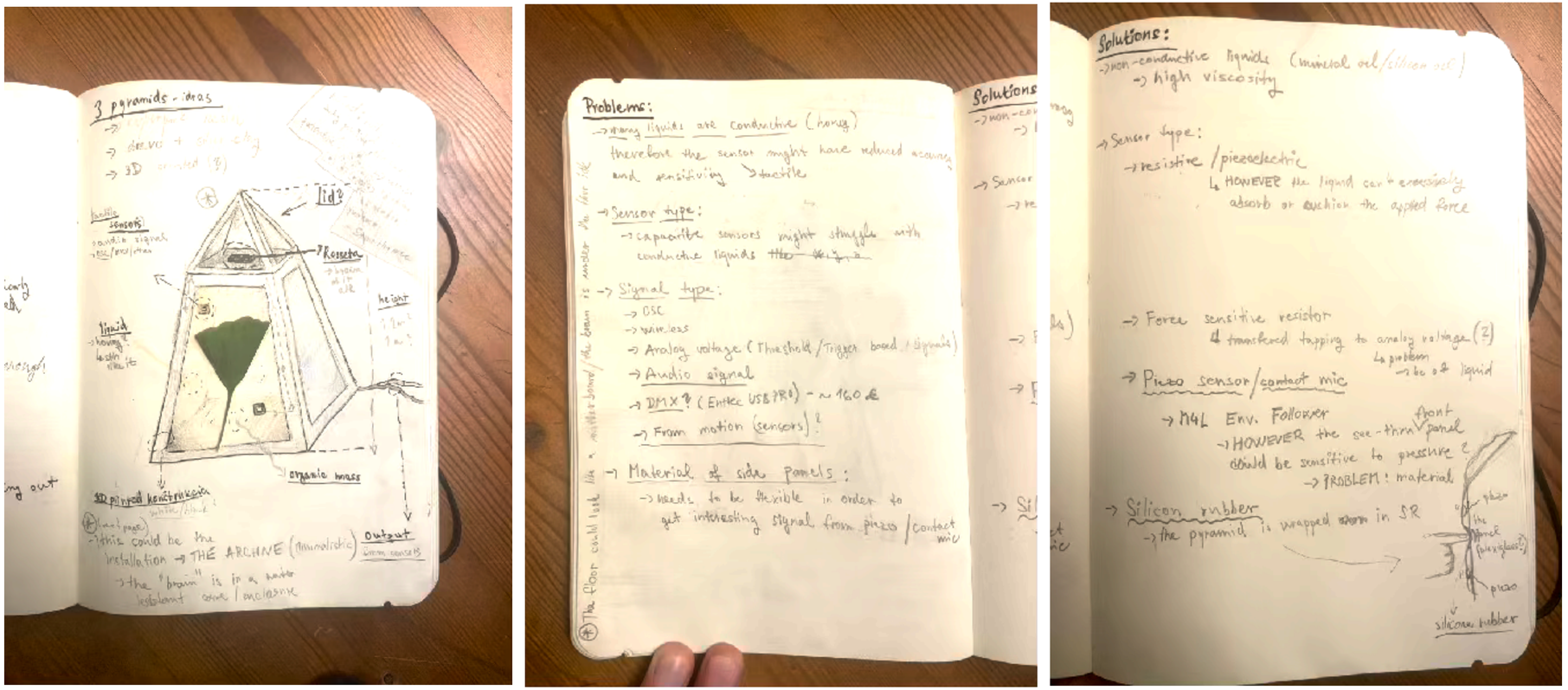
Initially, I researched insect communication, but the ideas seemed unachievable for this project. During the winter break, I realized that humans also communicate via antennas, primarily through digital signals. This led me to wonder: what does smartphone communication sound like? That's when I decided to use an EMI microphone.

A pivotal moment came after watching an interview with Alva Noto (Carsten Nicolai), where he discussed using CRT monitors and EMI microphones to translate visuals into audio. His work inspired me to explore hidden signals beyond human perception.

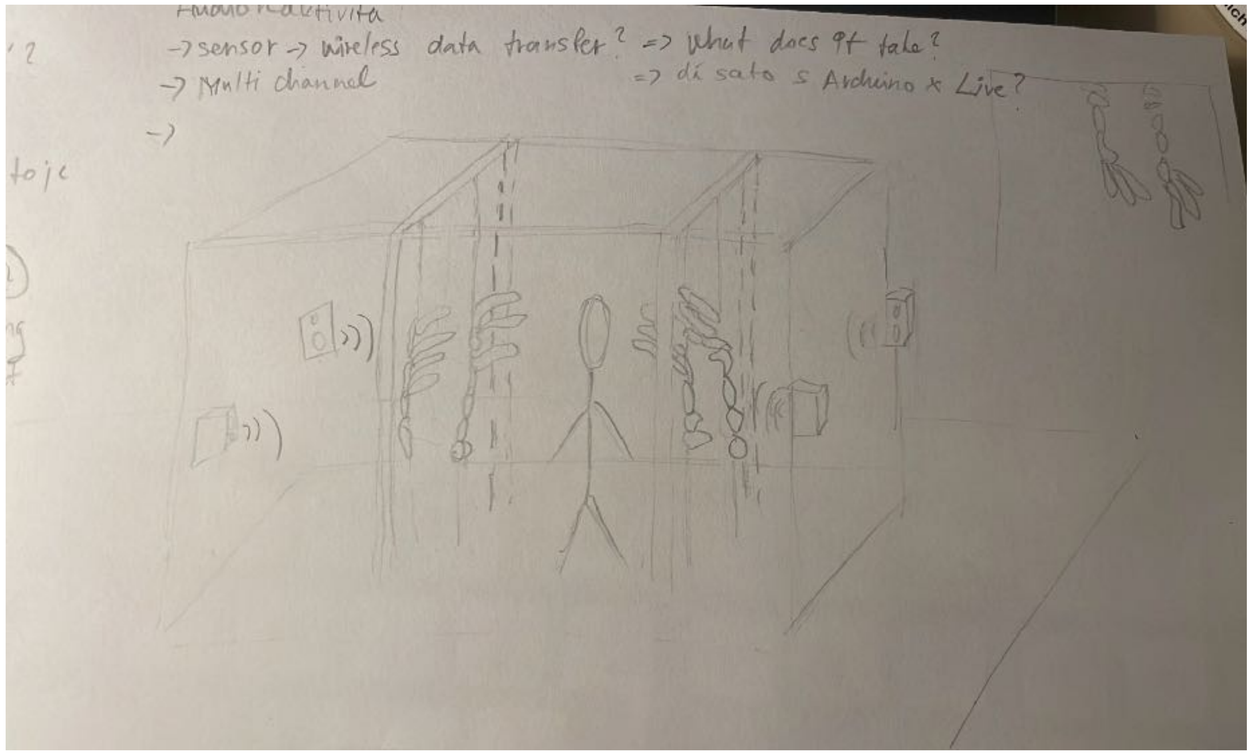
My research on insect communication shifted towards human communication in the digital realm. I realized I could use EMI to make smartphone signal activity audible, feeding it into Ableton to shape the sonic content.

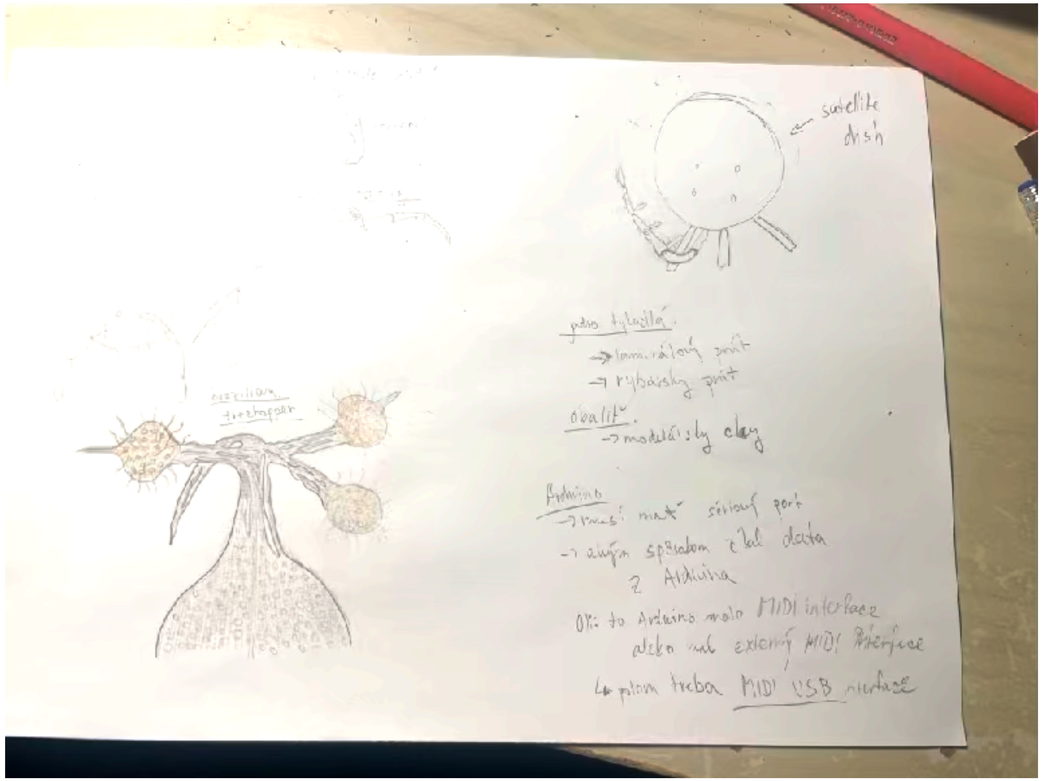
Research & Experimentation

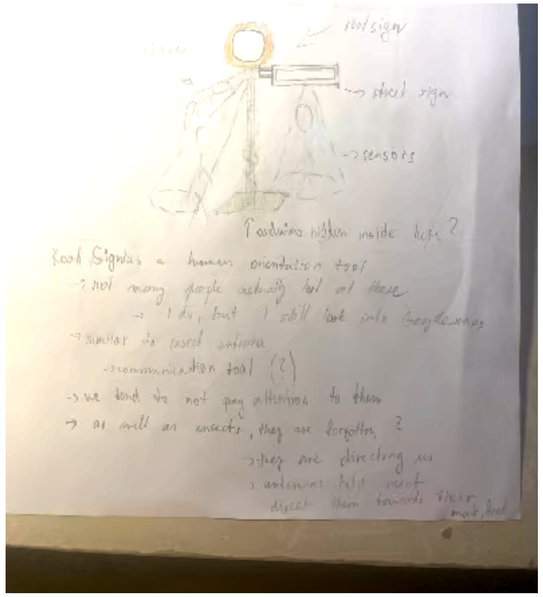
From September to November, I met regularly with my tutor, Tamas Marquetant, refining ideas and researching insect communication. Although it didn't directly impact this project, it inspired future concepts:



Early ideas, initially focusing on creating an Archive from the future of extinct fauna/flora







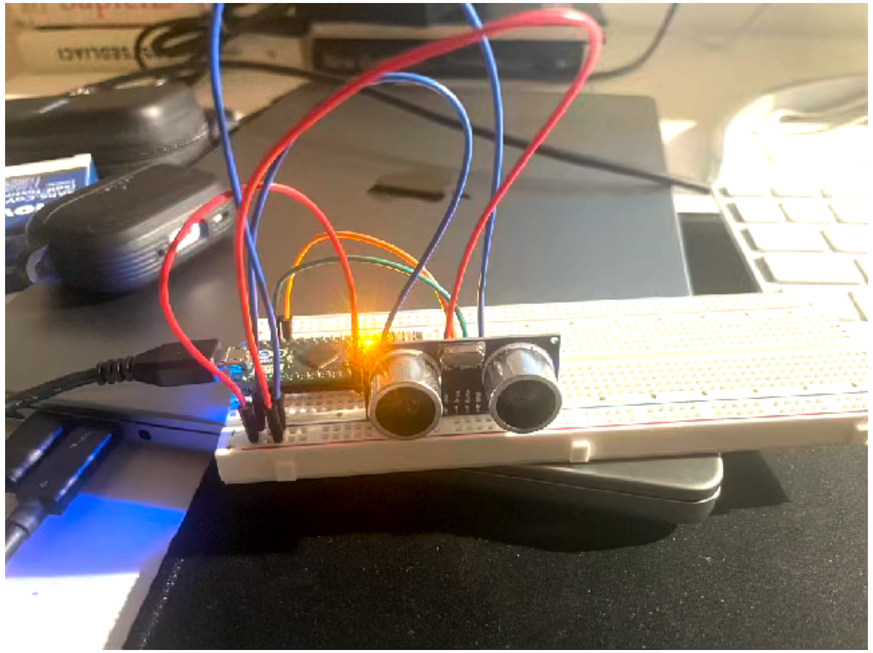
Early Iterations, very focused on insect antennae

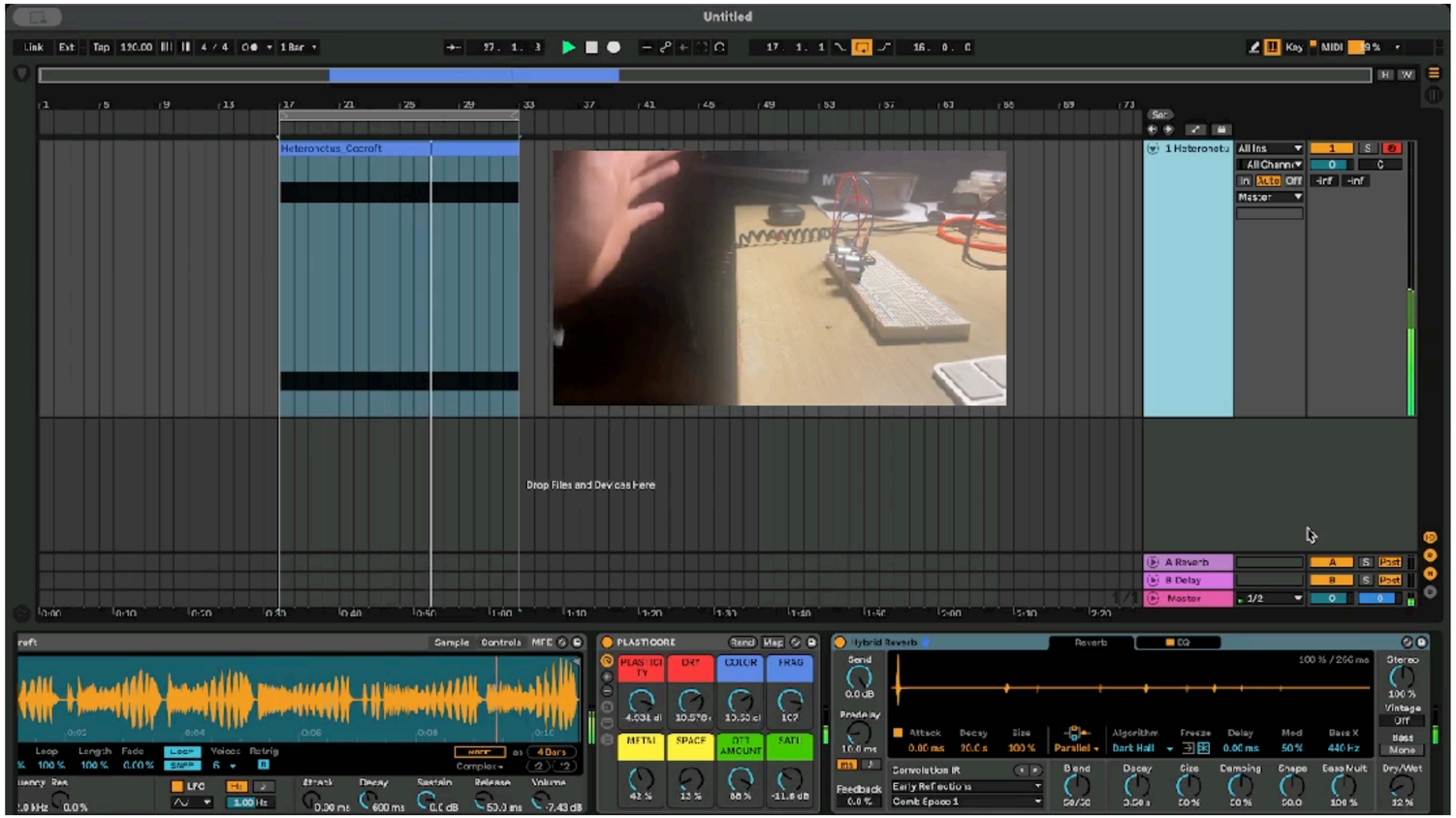
My other tutor Phelan Kane suggested reaching out to Oliver Torr, an experimental sound artist and engineer.

In an October call, Oliver introduced two key principles:

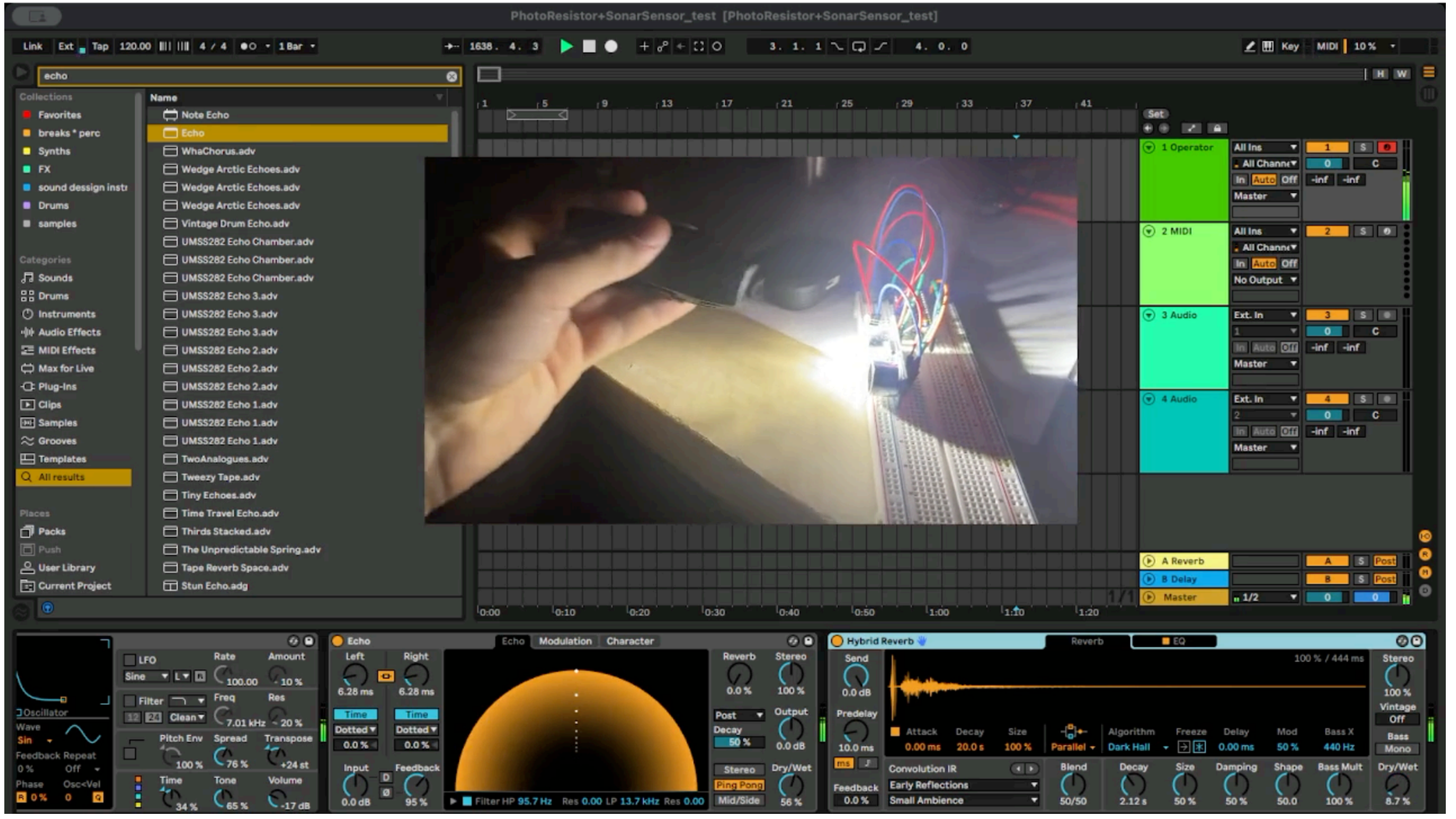
1. **KISS (Keep It Stupid Simple):** Overcomplicating interaction could deter engagement.
2. **Avoid the "IQ Park" Effect:** The installation shouldn't feel like a science exhibit for children.

In November, I experimented with sonar sensors and Arduino circuits, using code shared by Oliver. I collaborated with Titouan Douflo, a colleague from my internship at Jonathan Apelbaum Studio in Berlin, who joined me on the journey to refine the approach. Although we tested sonar sensors and light capacitors, nothing sparked a breakthrough:

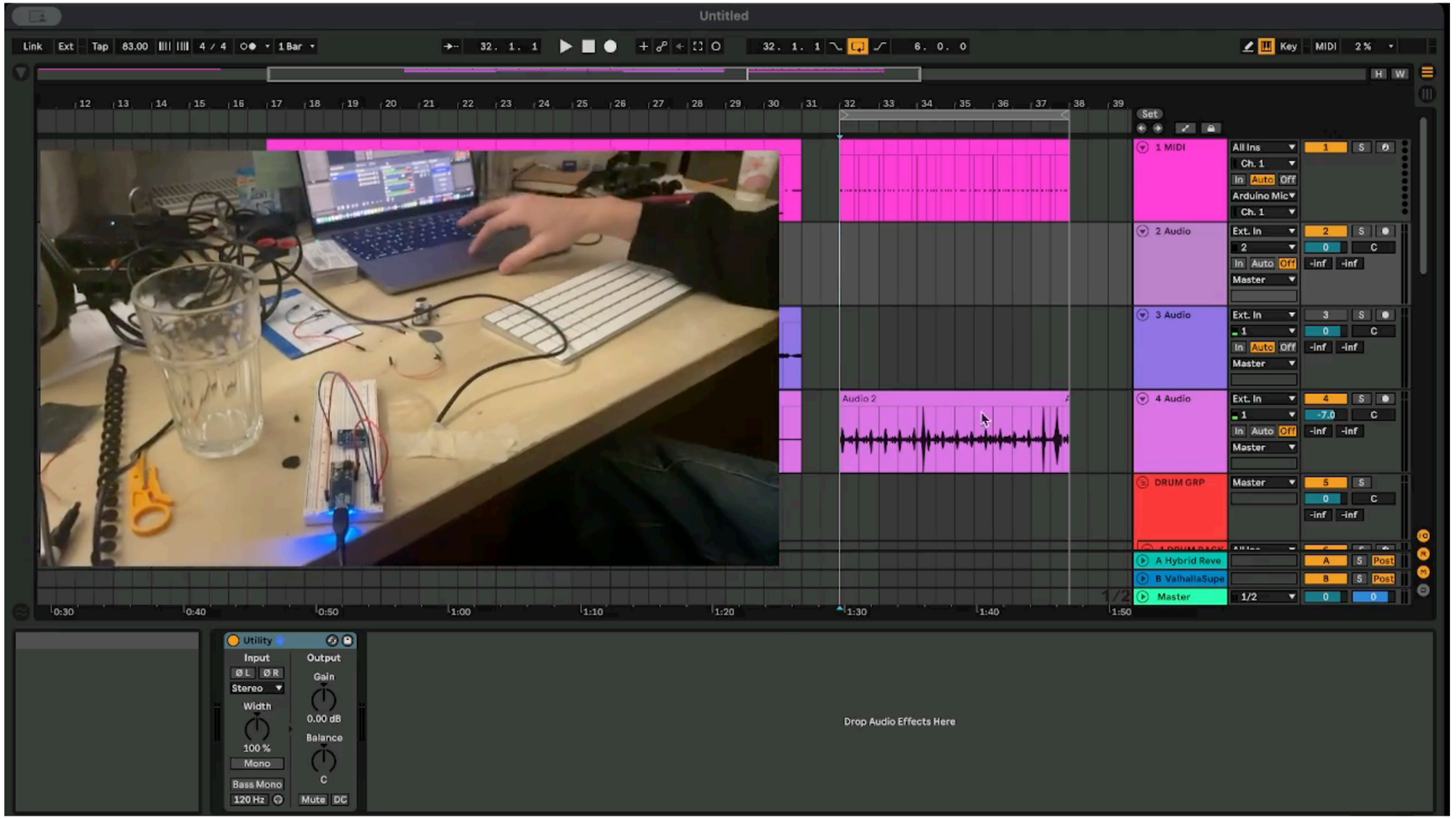




Video: November_SonarSensor Test



Video:Test_Arduino_PhotoR+Sonar_2024-11-30



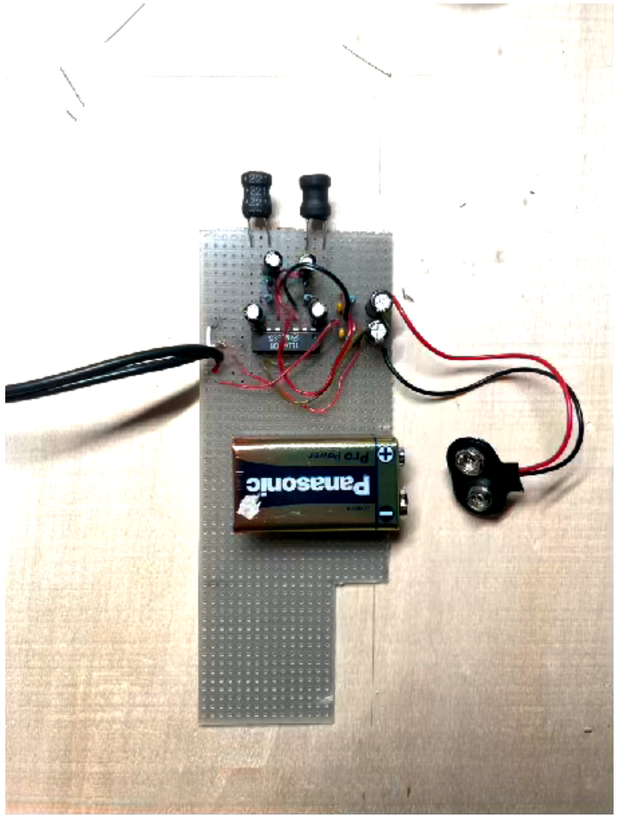
Video:VibrationMIDIControl_2024-12-06 19-08-51

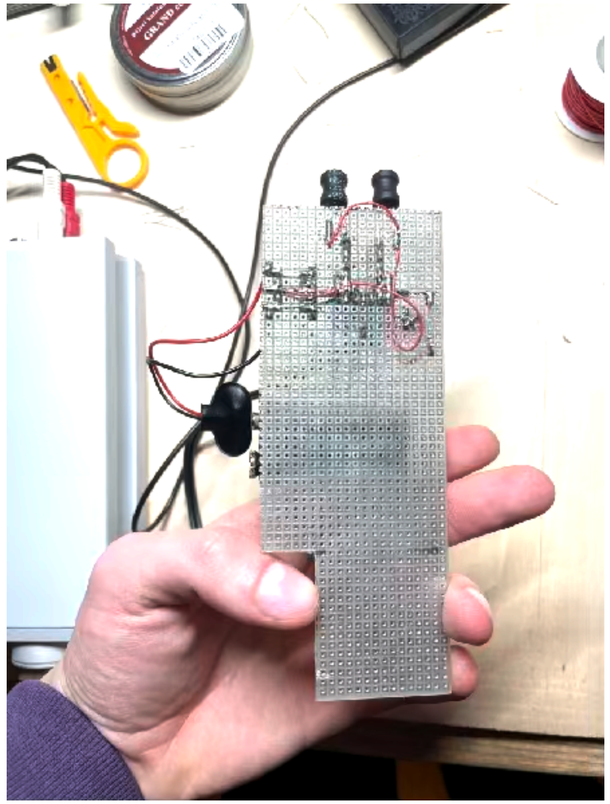
By December, I had lost interest in insects as a theme and needed a new direction.

Everything clicked after Christmas when I watched the Alva Noto interview. I revisited an EMI pickup I had rented for a first-semester project and found an open-source guide by LOM's Jonas Gruska on building one.

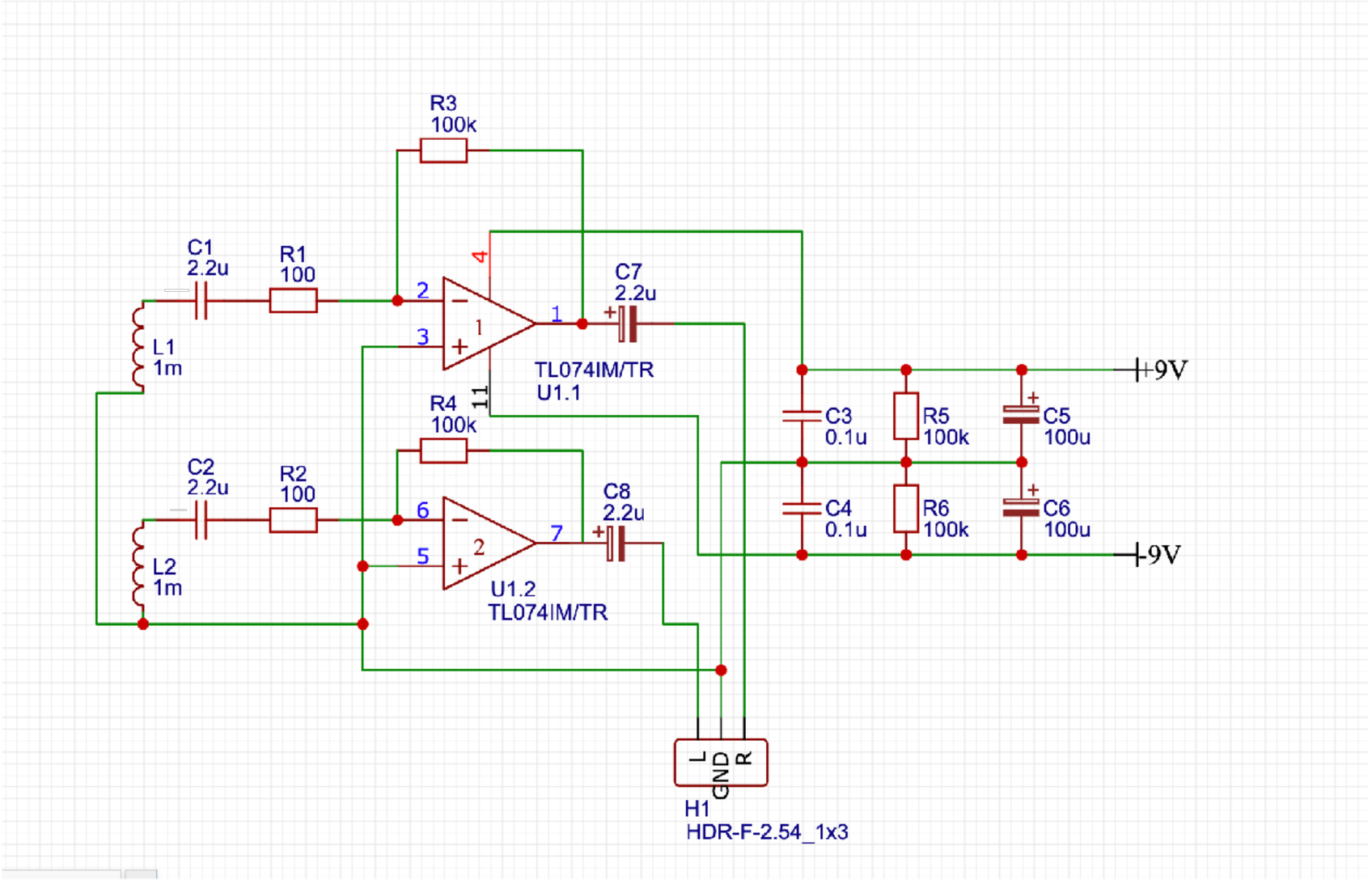
Design & Prototype Testing

In January, I started learning basic electrical engineering to build an EMI pickup. A paper by David Dunn on experimental DIY microphones helped me understand microphone building. With guidance from my father, an electrical engineer, I constructed my own EMI microphone. The first version had two coils (grey), and the second one (yellowish) has four coils, detecting EMI when a phone was placed on top.



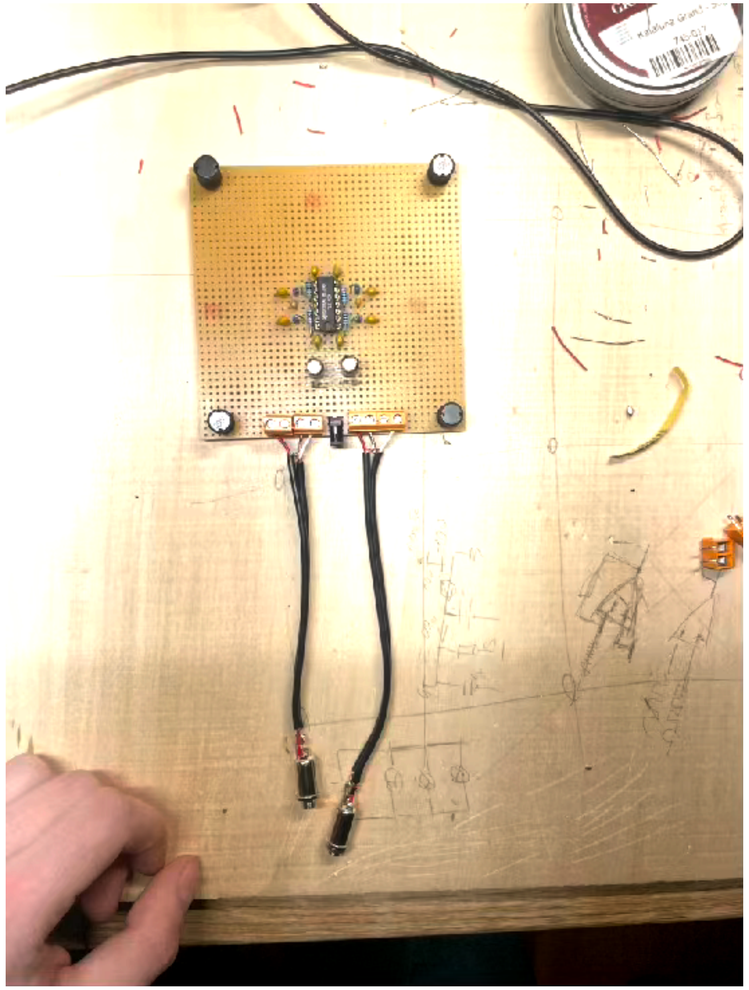


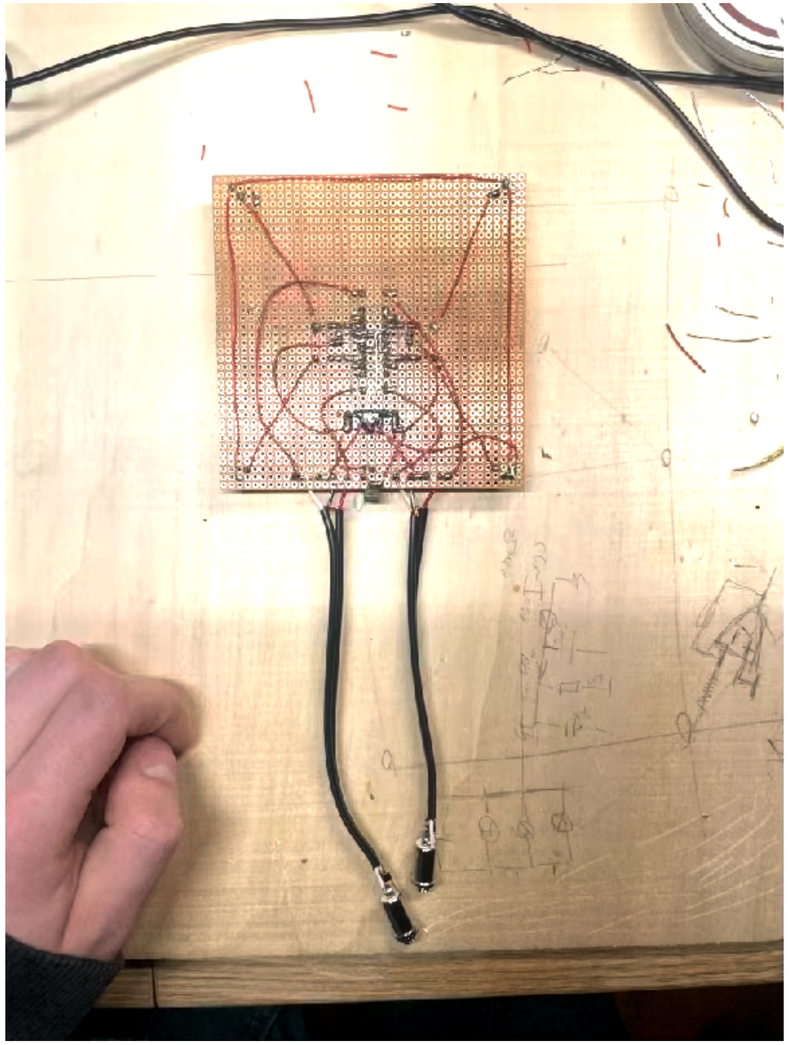
Design & Prototype Testing



The scheme for a two-coil EMI microphone circuit with stereo output, running on a 9V battery. Double it and you get this: (next page)

Design & Prototype Testing





Design & Prototype Testing

By late January, I showed it to Titouan, who found the interaction awkward. User had to position the phone precisely over the coil, limiting engagement, with the hand in a upside down U-shape. Additionally, I struggled to connect the project's sound to insect communication. My tutor Jeff Stern advised stepping back and accepting *concept evolution*. Therefore I decided to reduce the number of coils to one.

In early February, Titouan and I visited a local department store, where we found a PVC pipe to use as a skeleton for a primitive DYI coil antenna (instead of four factory-made coils) and a metal frame from an outdoors lamp case.

Design & Prototype Testing

I built the first demo with LEDs responding to signals received in Ableton, with Titouan writing the Arduino code.

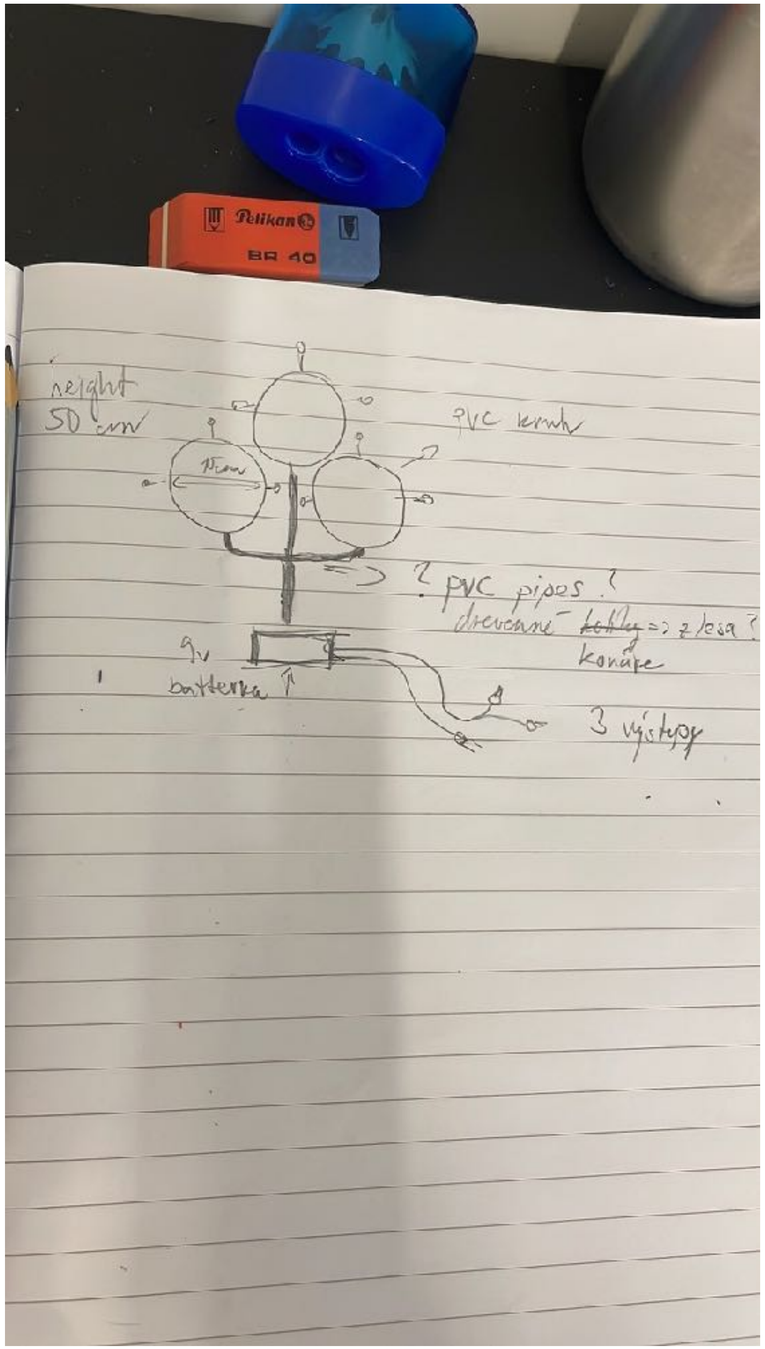
Video:

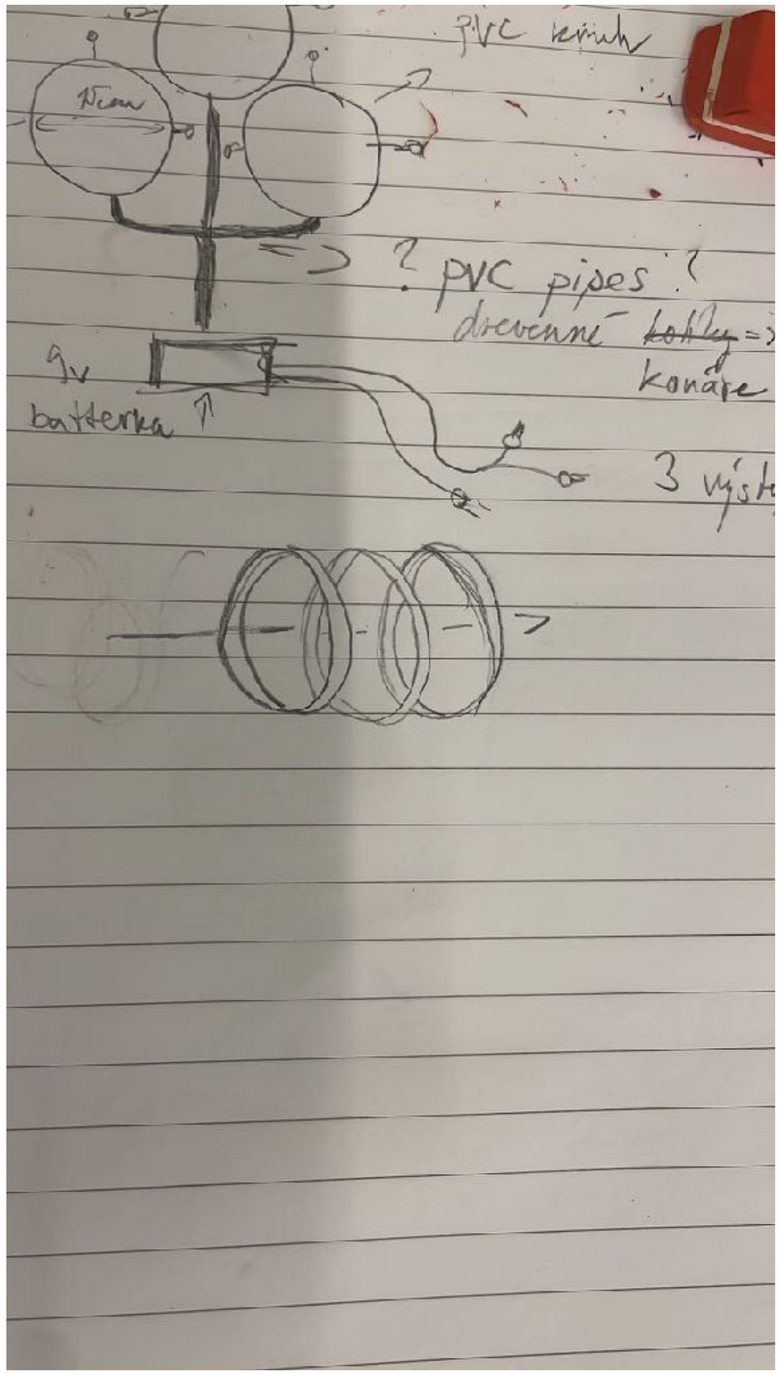
LEDwitMIDI_Final.ino

```
#include "MIDIUSB.h"

const int ledPins[] = {4, 6, 9}; // LEDs for different note ranges

void setup() {
  for (int i = 0; i < 4; i++) {
    pinMode(ledPins[i], OUTPUT);
    digitalWrite(ledPins[i], LOW); // Start with LEDs off
  }
}

void loop() {
  midiEventPacket_t midiMsg;
  do {
    midiMsg = MidiUSB.read();
    if (midiMsg.header != 0) {
      handleMIDI(midiMsg);
    }
  } while (midiMsg.header != 0);
}

void handleMIDI(midiEventPacket_t msg) {
  if (msg.byte1 == 0x90) { // Note ON
    int note = msg.byte2;
    turnOnLED(note);
  } else if (msg.byte1 == 0x80) { // Note OFF
    int note = msg.byte2;
    turnOffLED(note);
  }
}

void turnOnLED(int note) {
  int ledIndex = getLEDIndex(note);
  if (ledIndex != -1) {
    digitalWrite(ledPins[ledIndex], HIGH);
  }
}

void turnOffLED(int note) {
  int ledIndex = getLEDIndex(note);
  if (ledIndex != -1) {
    digitalWrite(ledPins[ledIndex], LOW);
  }
}

int getLEDIndex(int note) {
  if (note >= 48 && note <= 51) return 0; // C to D# → LED 1
  if (note >= 52 && note <= 55) return 1; // E to G# → LED 2
  if (note >= 57 && note <= 60) return 2; // A to C# → LED 3
  if (note >= 62 && note <= 65) return 3; // D to F# → LED 4
  return -1; // No matching LED
}
```

Here I was trying to figure out the placement of the antenna. Initial idea was using multiple rings together.

Due to time pressure, I went with one antenna.





Design & Prototype Testing

Video: Matheus Playing with Early Prototype

Design & Prototype Testing

PulseTrap had to be **compact** and **transportable**, as my public presentation takes place in Bratislava, Slovakia.

I used an outdoor lamp cover for the metal frame

I drilled holes for nylon strings to hold the circular antenna.

Making a prototype of the front panel

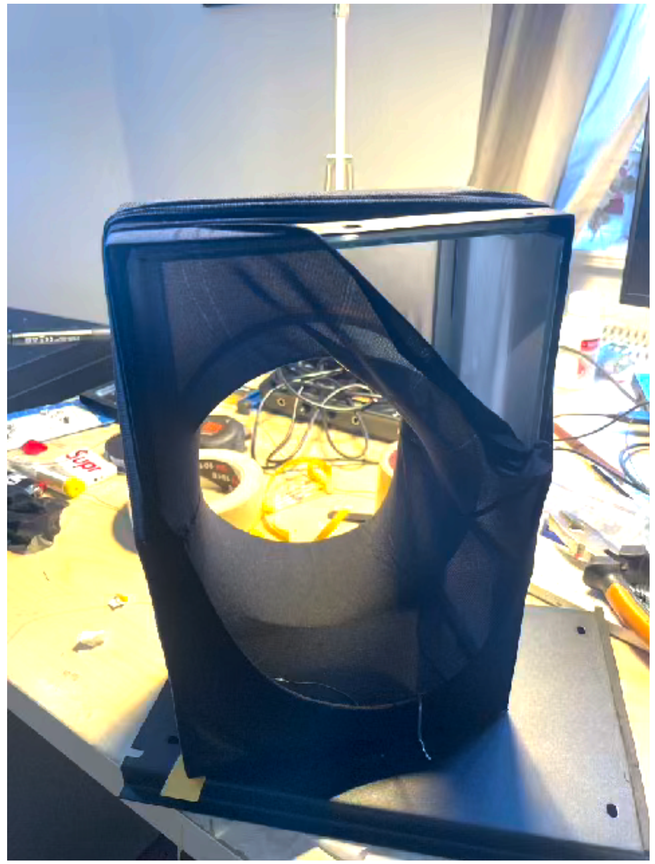
Design & Prototype Testing

And attached a polypropylene sheet for a milky texture

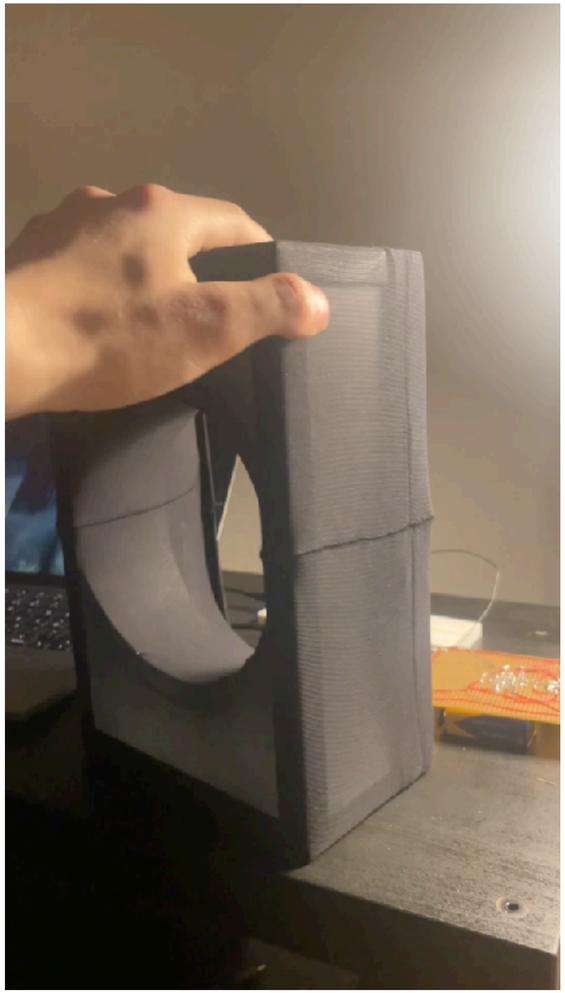
(This looks sick, definitely will use this in the future)

Cut a hole for access… but it felt too uninviting.

Design & Prototype Testing



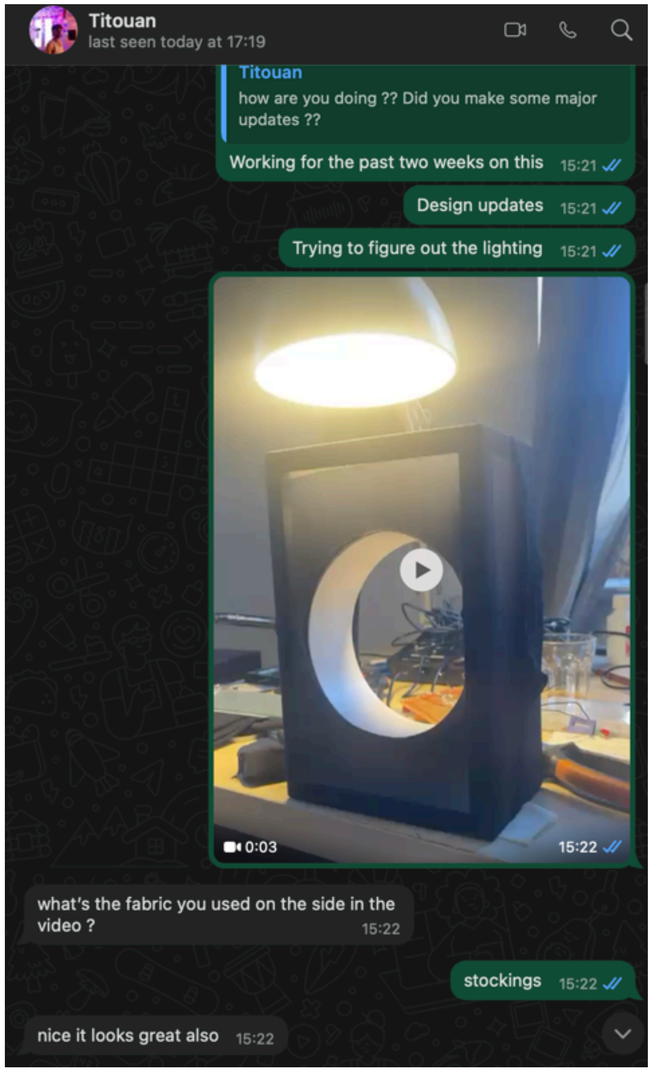
So I bought black stockings and added a dark texture on the outside



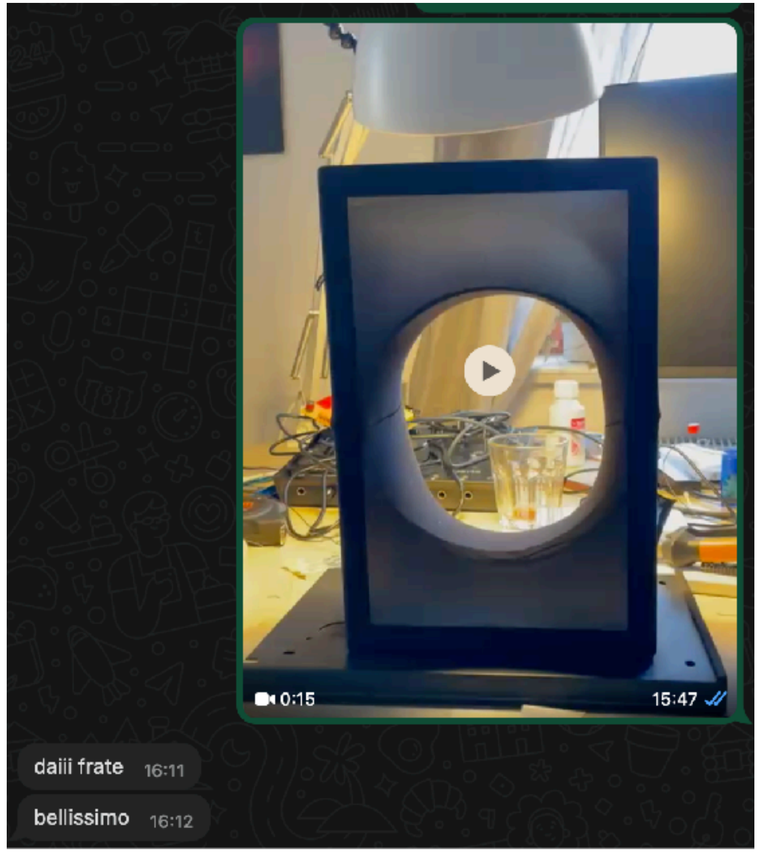
Design & Prototype Testing

Feedbacks on the design:

Matheus:

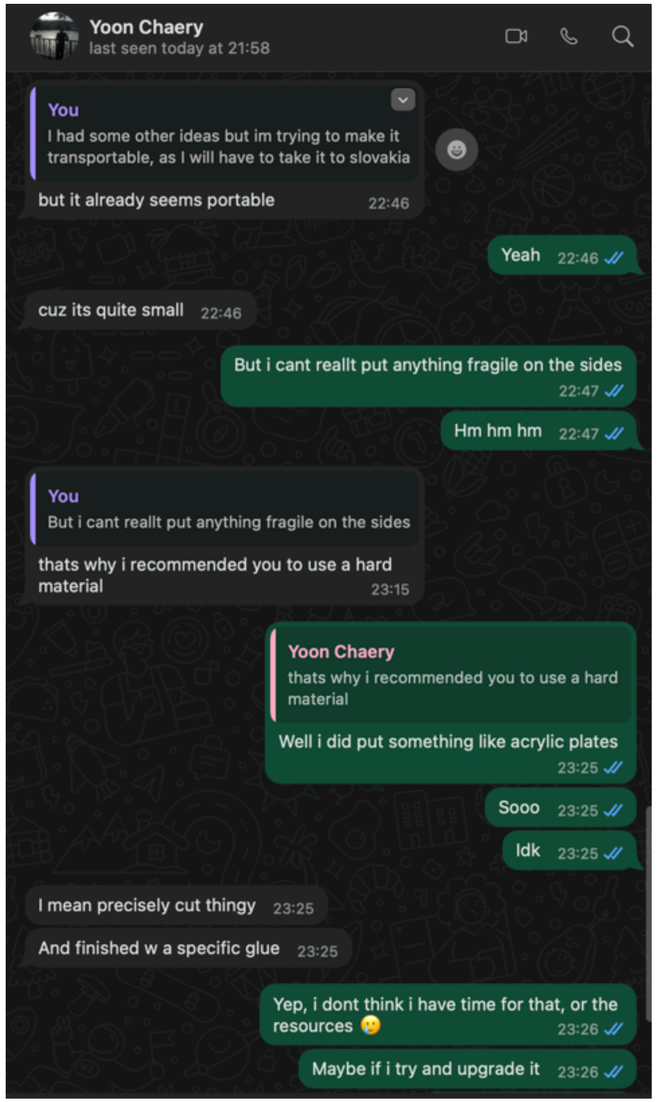


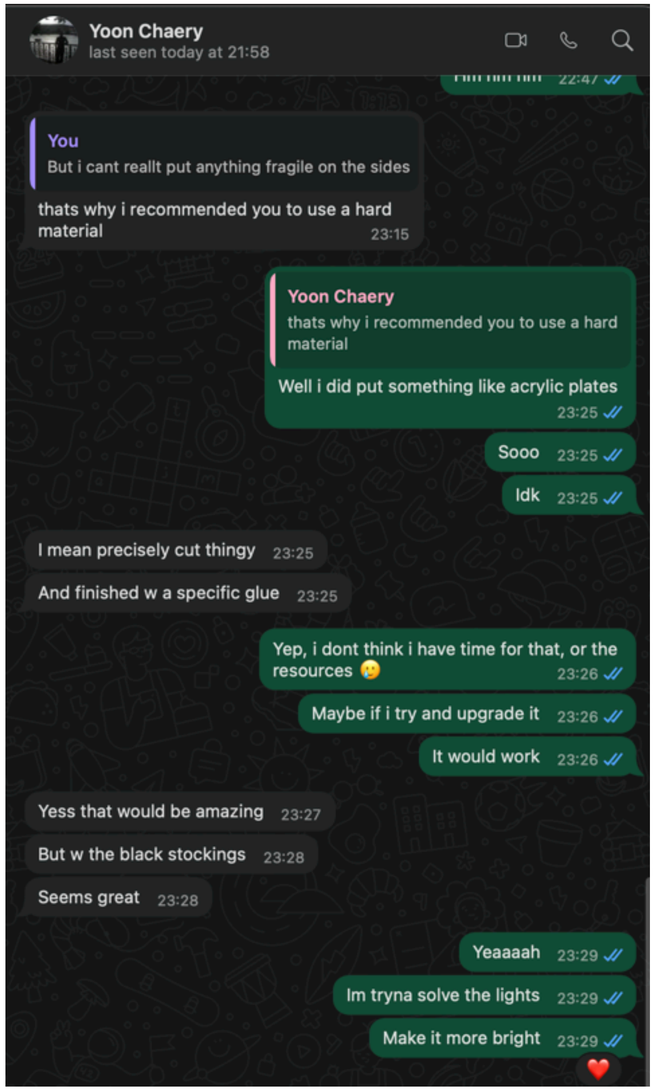
Samuel:

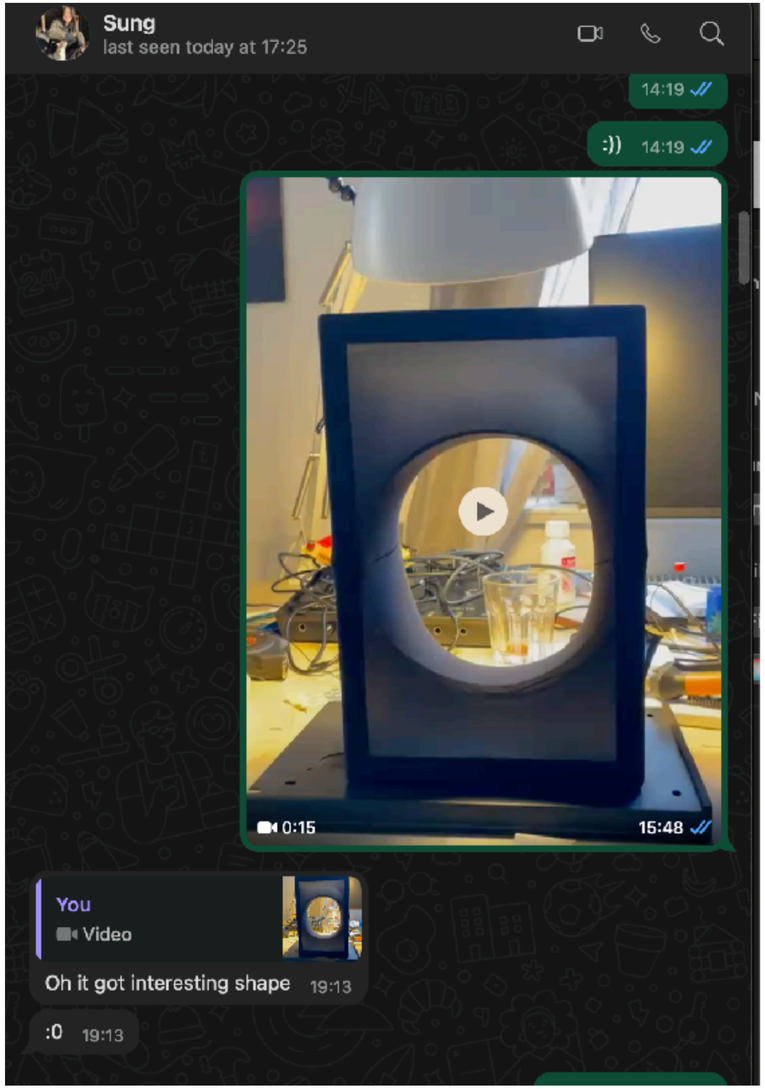


Design & Prototype Testing

Feedbacks on the design:







I sought feedback from peers, and Samo Benko raised an important issue:

what would make people put their phone near it?

A simple solution emerged—placing a QR code inside the opening. Scanning it would generate an EMI signal while directing users to a website explaining the installation. This was a big question mark finally answered.

The circumference of the circle is the perfect size - people have to put it fairly close to the top of the circle to scan the code and activate the sound.

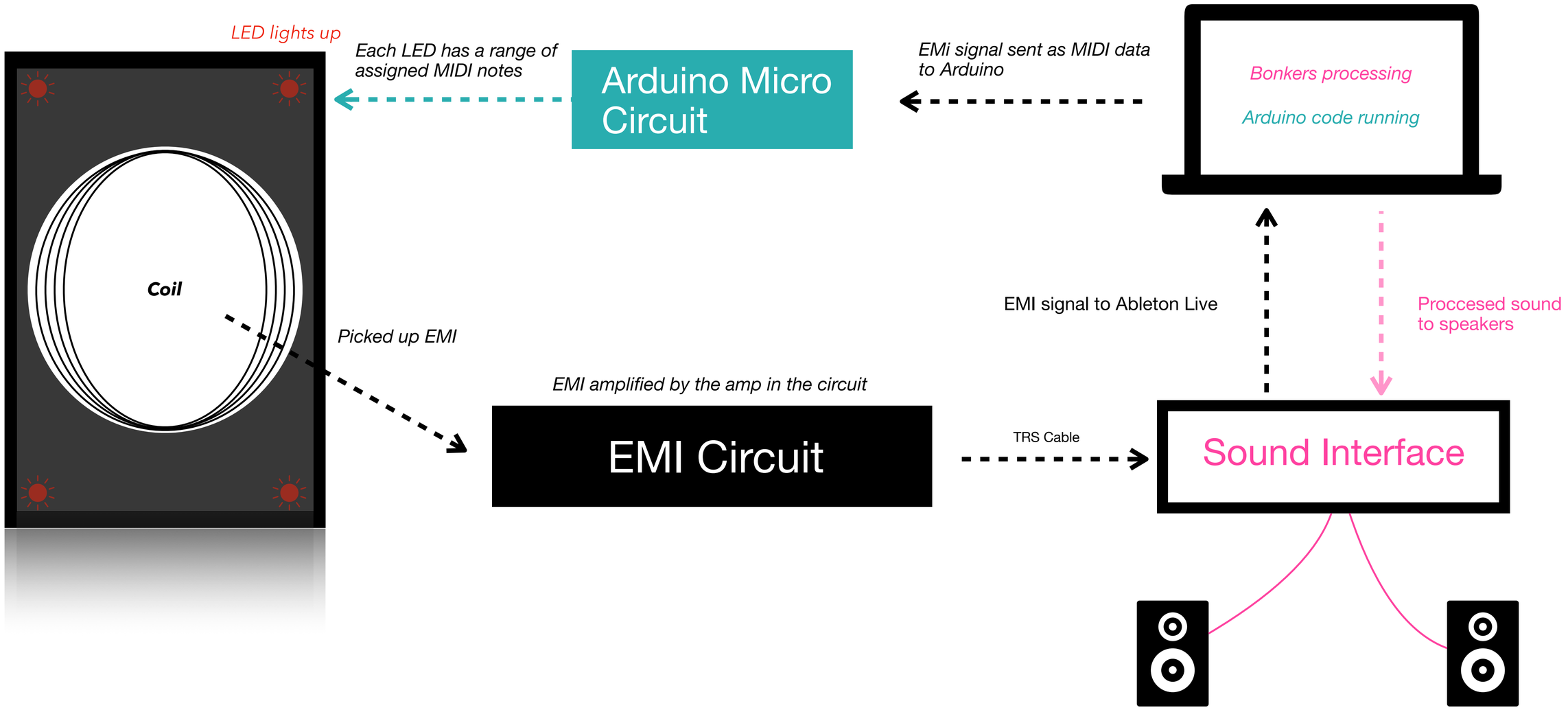
As my project does not traditionally fit in the PUSH123 framework, my tutor advised to make this project accesible so anyone can experience it.

If someone has the circuit components, soldering machine, Arduino and Ableton Live, they should be able to run the installation anywhere in the world.

The contents of the Ableton Live 12 Suite project file are therefore all stock plugins available to everyone. (Except one SoundToys effect rack).

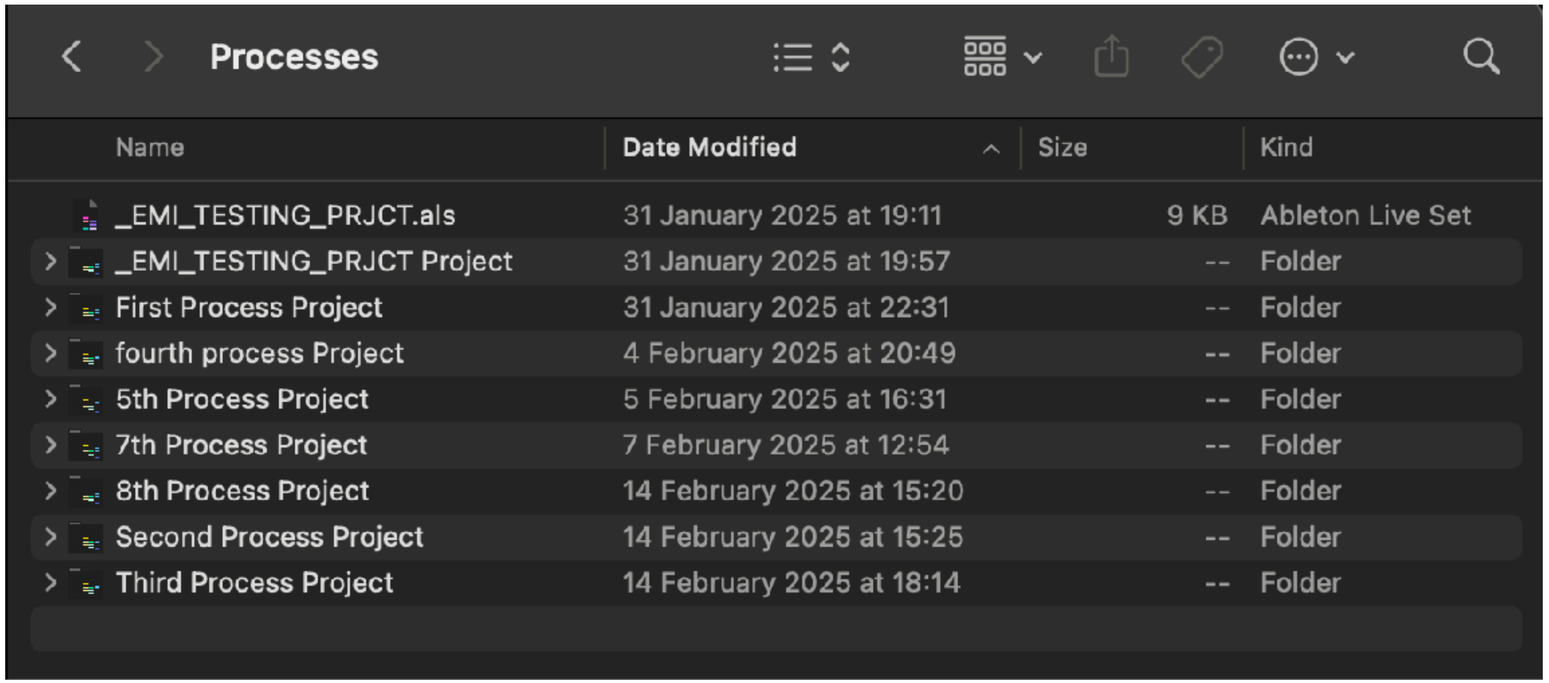
The signal flow of the whole system is explained in the next slide.

The signal flow of PulseTrap explained



Sound Design

Once I had the final coil, I experimented with using only the EMI signals it picked up.



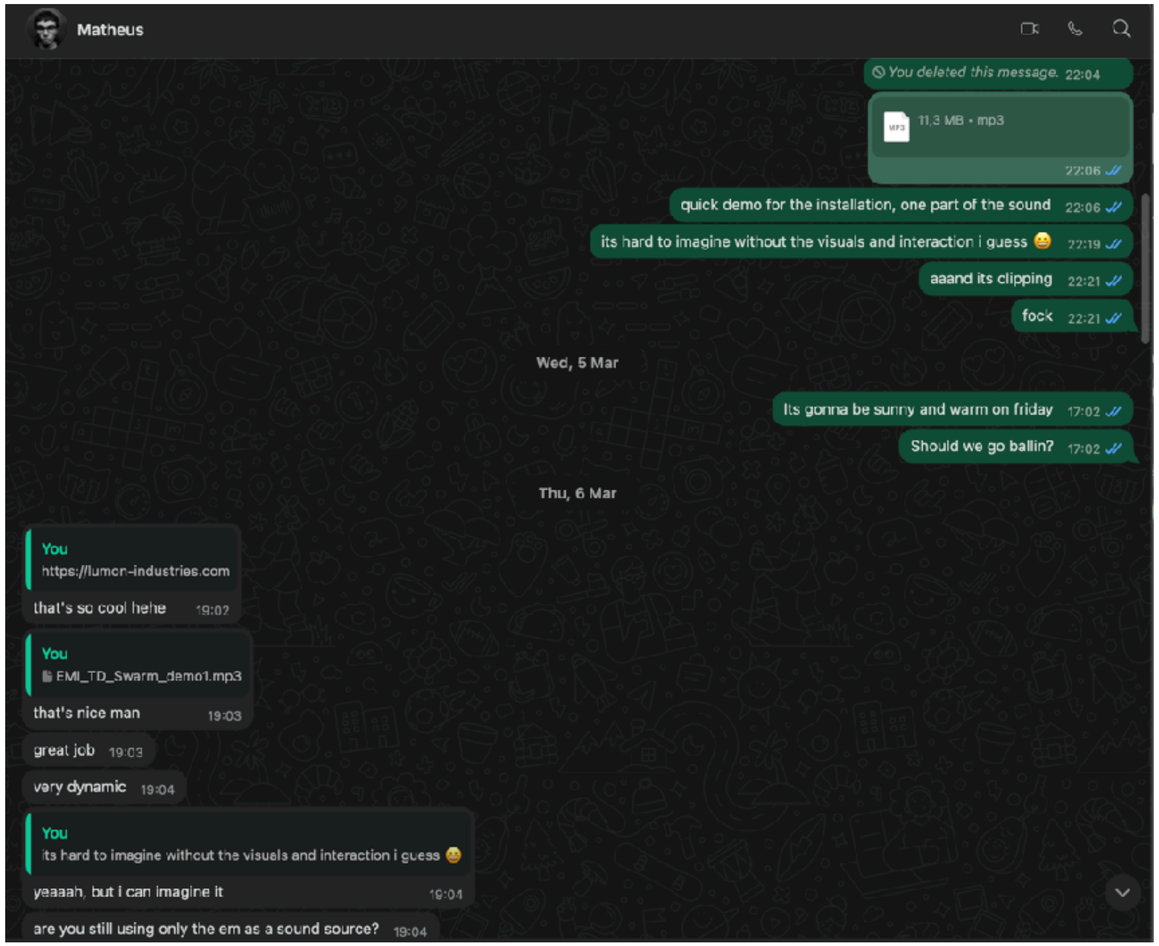
I have called my sessions "Process #", each one was different, experimenting with audio processing techniques.

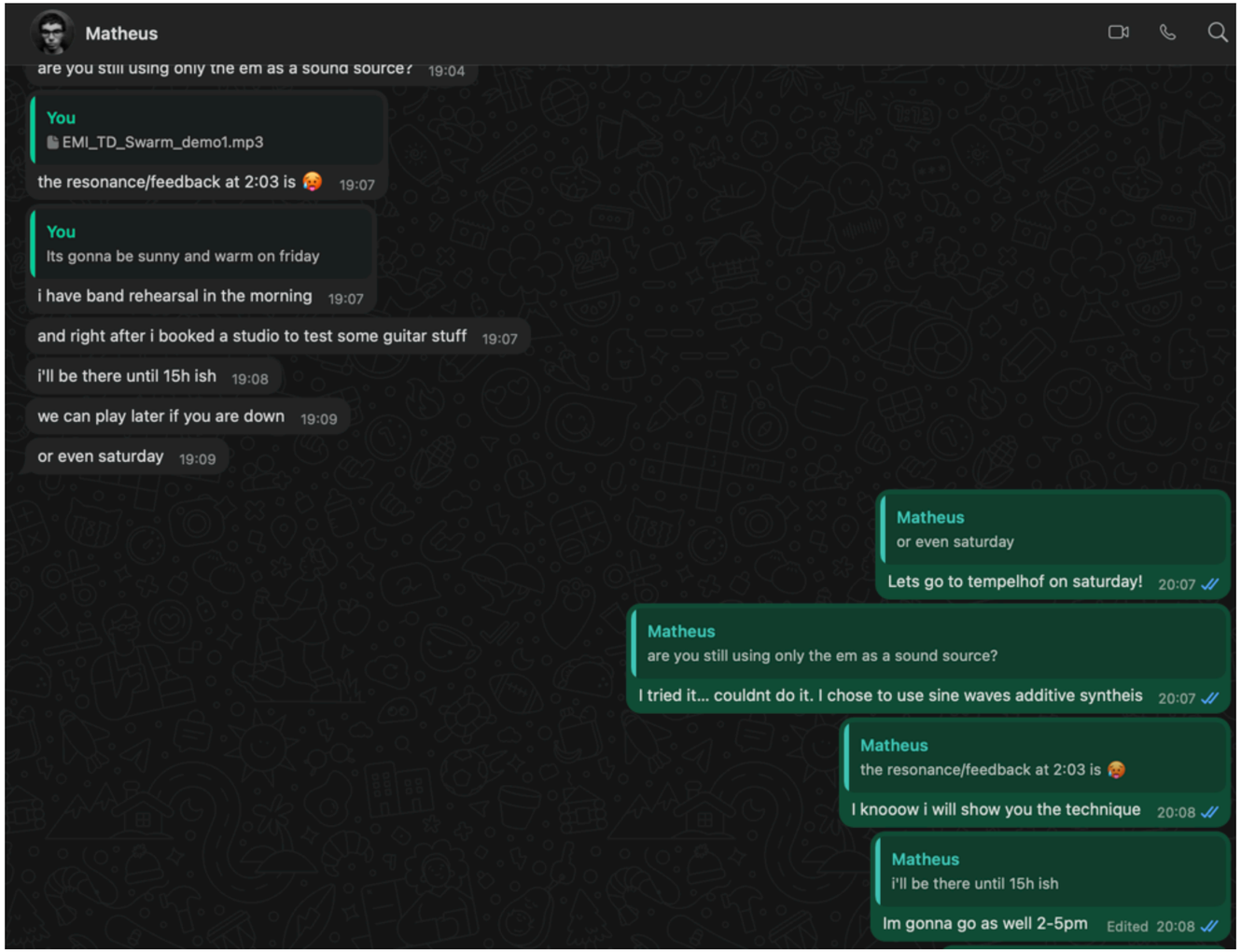
The final soundscape is approx. 30-minute loop of 3 sections, each differently processed EMI signals or EMI used as trigger for MIDI devices.

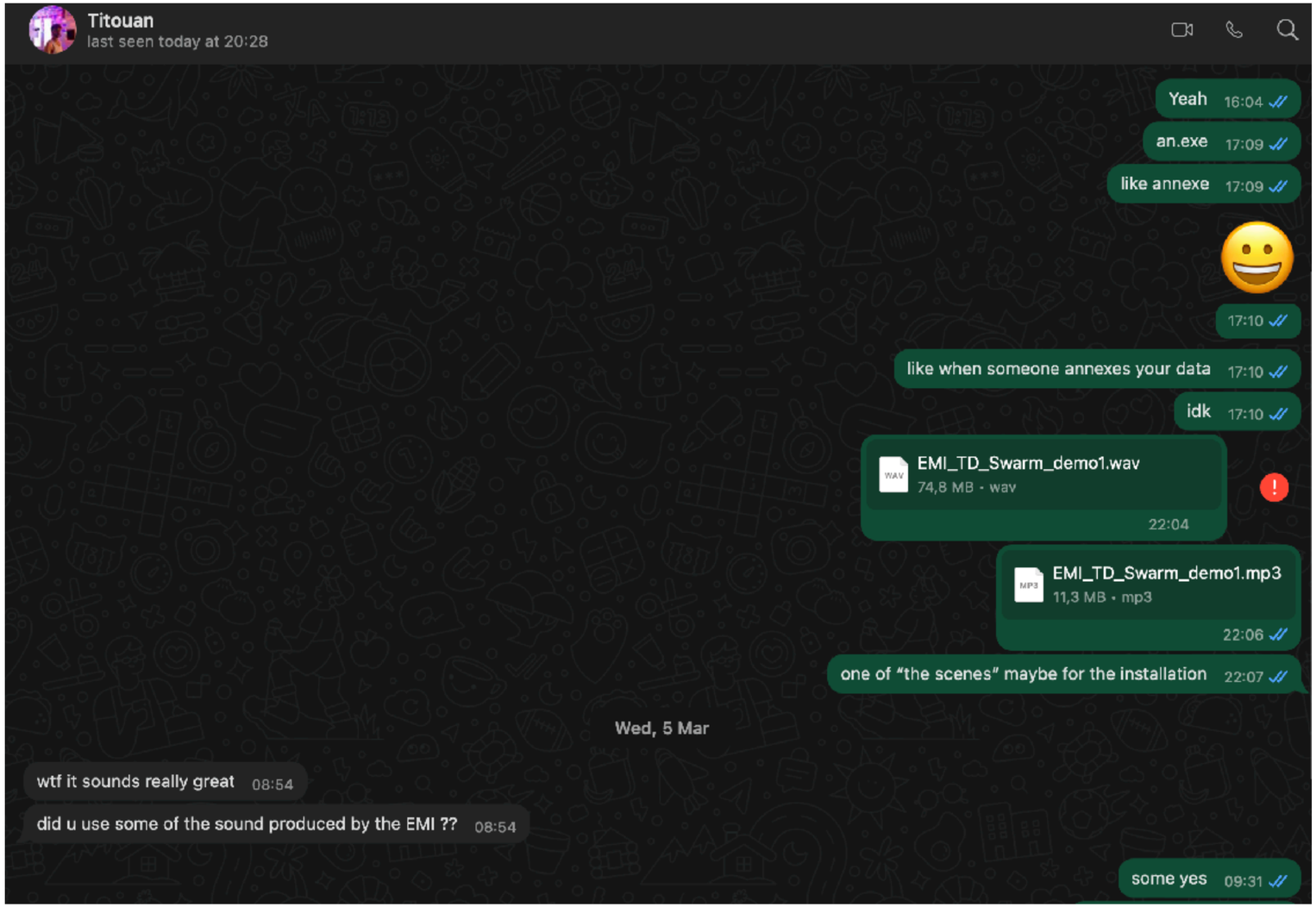
My goal was to make the EMI signals sound organic, as if they are speaking, a disturbed swarm moving around dynamically, sometimes agressively or iritated.

The video explanation of my methodology is here.

Feedback on the sound:






Titouan
last seen today at 20:28
Yeah 16:04
an.exe 17:09
like annexe 17:09
17:10
like when someone annexes your data 17:10
idk 17:10
EMI_TD_Swarm_demo1.wav
74,8 MB · wav
22:04
EMI_TD_Swarm_demo1.mp3
11,3 MB · mp3
22:06
one of "the scenes" maybe for the installation 22:07
Wed, 5 Mar
wtf it sounds really great 08:54
did u use some of the sound produced by the EMI ?? 08:54
some yes 09:31

Major Technical Difficulties & Solutions

1. **Power Supply:** Initially, I used an AC/DC converter, but it introduced noise due to poor grounding. Switching to a 9V battery provided cleaner power.

2. **Audio Output:** While re-soldering the 3.5mm jack, I accidentally short-circuited it. I fixed this by modifying a stereo cable and soldering straight to the board.

3. **Operational Amplifier:** A short circuit damaged it, requiring a replacement. To prevent future issues, I added a clamp for easy detachment.

4. **Design:** The project had to be cost effective and transportable, therefore I opted for simple solutions.

The details about
“ Funding ”

The details of
“ Time Management ”

Website screenshots
“Website”

Link to all extra Workbook content

Thanks for stopping by !