6. Failed Designs and What They Taught Me

6.1 Early Inspirations and Initial Design Logic

My entry into instrument-making was shaped by capoeira, where music is both functional and embodied. Two instruments in particular—the berimbau and the pandeiro—informed the early conceptual structure of my design inquiry. Both are rhythmic, yet serve different acoustic and performative roles: the berimbau is string-based and melodic-percussive, while the pandeiro occupies a more percussive and agile space. I wanted to design two types of instruments that mirrored this structural duality: one string-based and one drum-based.

Rather than replicating the physical form of capoeira instruments, I aimed to translate the relational logic they embody—how they respond to the body, resist sonic standardization, and carry symbolic weight—into a new electroacoustic framework. Drawing inspiration from the berimbau and the pandeiro, I sketched out an initial plan: to design two instruments that, while structurally distinct, would both operate as rhythmically driven devices—one with more analog textures, the other with a more electronic sound character.

6.2 First Designs and the Logic Behind Them

The first prototype took the form of a circular, handheld instrument, loosely resembling a pandeiro. Its sound generation was based on the crackle box circuit, with one contact point positioned on the handle and others embedded across the playing surface. When the performer held the instrument and tapped or stroked the surface with their other hand, their body completed the circuit, producing unstable and expressive sounds. For output, I experimented with two versions: one using a transducer to activate a resonating surface, and another using a basic paper speaker system, where a coiled copper wire and magnet directly vibrated the surface. Both approaches aligned with a broader interest in making the object speak through itself, without relying on external speaker systems. *(See Figure 2)*

The second prototype was loosely modeled after the berimbau, but reimagined through a contact mic and resonant-body logic. A copper wire—serving as a string—was coiled around a cup-shaped resonator. A piezo disc at the point of contact captured vibrations, which were then amplified and rerouted to a speaker built into the same body. The string extended from the cup and was anchored to a ring worn just above the elbow, securing it to the upper arm. The player held the cup with the same arm and used their other hand to strike or pluck the string. The shape of the body and the tension of the string were thus influenced by the player's own arm length and muscle tone. *(See Figure 3)*

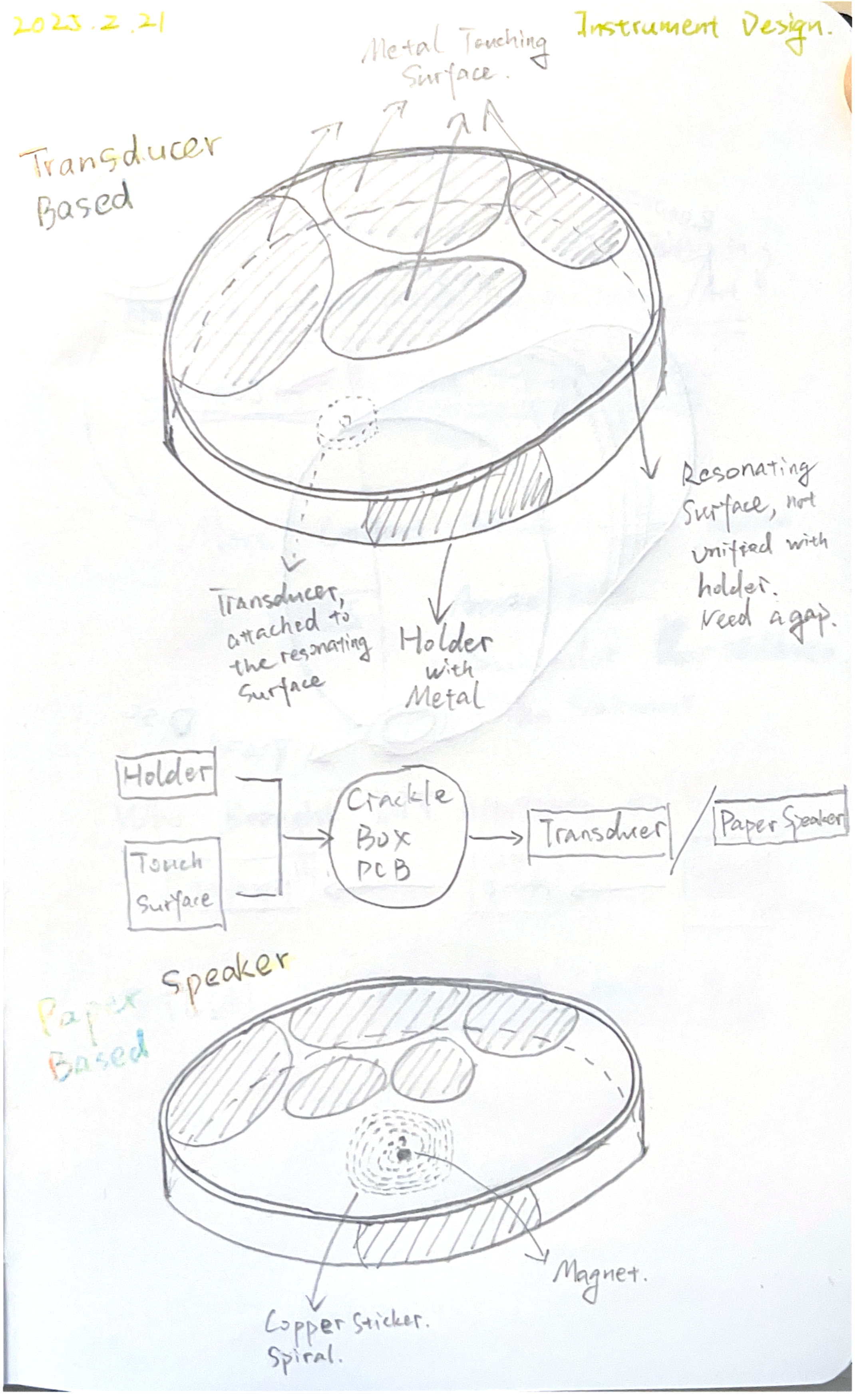

Figure 2. The first design of the pandeiro inspired instrument. Source: Author

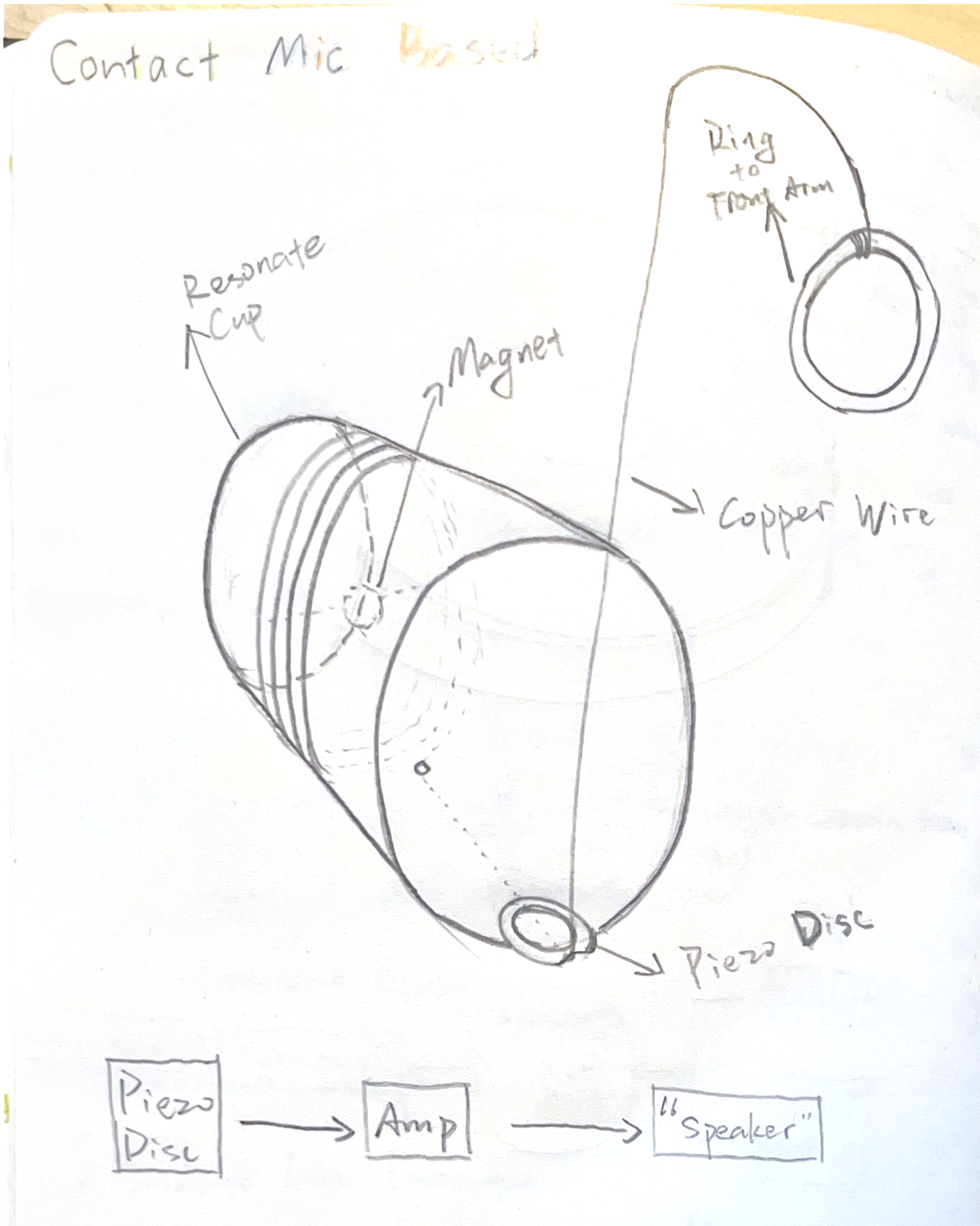

Figure 3. The first design of the berimbau inspired instrument. Source: Author

These designs were early attempts to bring sonic and bodily feedback into the same loop, letting physical variation across individuals—skin conductivity, arm shape, strength—become a creative variable rather than a limitation. They laid the groundwork for deeper investigations into the body–instrument relationship that would inform later iterations.

6.3 A Design That Pulled Too Hard

One of the earliest challenges I encountered emerged even before the construction phase began. While practicing my berimbau, I attempted to increase the instrument's tension in hopes of producing a stronger, more defined sound. In doing so, I accidentally snapped the wooden stick. This incident, though unfortunate, revealed a critical flaw in my initial design thinking.

My prototype borrowed this same tension logic, using the performer's arm to hold the string under load. But this meant the full force of the tension would be exerted on the forearm, raising serious risks of physical strain or injury. It also placed considerable stress on the piezo disc acting as a bridge—an element never designed to bear mechanical pressure.

In practical terms, this setup presented a material contradiction: strings strong enough to hold tension (like steel wire) were not suitable as speaker coils, while copper wire—ideal for coil building—was far too weak to act as a functional string. The whole structure was at odds with its own technical needs.

What began as a routine practice session ultimately became a lesson in the conflicting demands of physical tension and acoustic design. The breakage of the berimbau helped me realize that my conceptual model needed rethinking—not just for safety and durability, but to better align with the limitations and possibilities of electroacoustic materials.

6.4 When the Instrument Became the Speaker

There is a video accompanied with this section: https://youtu.be/FPU6_CnJHLM

As I moved into the prototyping phase, I became increasingly preoccupied with the idea of integrating the speaker directly into the physical structure of the instrument. This obsession—though partially inspired by Jenny Gräf's ceramic speaker sculptures—preceded a full understanding of her work. In hindsight, I realize that my early enthusiasm may have led me into an overambitious territory without the necessary acoustic foundations.

In both instrument designs, I experimented with embedding speaker mechanisms into the playable surfaces themselves. For the drum-inspired crackle box, I attempted to merge the sounding surface with the vibrating membrane, so that the surface producing sound was also the one being played. I tried various methods: spiral copper foil patterns, fixed wire coils, and different resonating materials, including hard plastics and ceramics. But the result was consistently underwhelming. The volume was so faint that even in a quiet room it barely registered.

Similarly, for the cup-based instrument, I experimented with wrapping coils around plastic, glass, and ceramic vessels. But the coils—limited in turns and paired with modest magnets—failed to generate sufficient force to vibrate such heavy materials. Even plastic cups, while slightly better, proved sonically unsatisfying. Ironically, the sound output was often weaker than that of a basic paper speaker constructed from a single sheet of paper and copper tape.

In search of louder sound, I attempted to place multiple coil-magnet pairs on a single vibrating surface. But this, too, led to disappointing results. Instead of amplifying the vibration, the spatial distribution seemed to produce interference or dampening effects, possibly canceling each other out across the surface.

It was only upon revisiting Jenny Gräf's work that I began to understand why her designs functioned differently. First, her ceramics were custom-designed both materially and acoustically—not something easily substituted with off-the-shelf cups. Second, her projects were not attempts to make sculptural speakers per se, but to explore what else a speaker could be. In some works, the coil's motion leads to percussive contact with the ceramic, emphasizing gesture and sonic impact over acoustic fidelity.

By contrast, my designs needed the speaker to behave as a speaker—to project sound clearly and sufficiently within a performance context. My use cases demanded reliable volume and resonance, something neither plastic panels nor ceramic cups could provide.

This led me to revisit the paper speaker, particularly its use of lightweight, flexible membranes. I pivoted to using stretched balloons—rubber membranes that offered low mass and high responsiveness. Balloons could be integrated across both instruments, as cup coverings or as drum-like skins. Onto these, I affixed copper tape spirals, paired with rear-positioned magnets. The results were modestly successful: the balloon speakers performed comparably to my earlier paper-based prototypes, and in some cases, the cup-shaped enclosure even improved projection.

Still, I wasn't fully satisfied. While balloon-based speakers showed promise, the exploration required more time than I had in this production phase. With CPM4's performance tests approaching, I needed a more stable and sonically powerful solution. I chose to put this direction on hold—not abandoned, but left open. Depending on the needs and possibilities of the next phase, I might return to this area in CPM5 to explore further possibilities in speaker-material integration.

This exploration also opened an unexpected line of inquiry. During a class presentation of one failed prototype, my tutor Andrea Parkins offered a compelling provocation: What if the instrument is simply a quiet one? Instead of fixing the problem of low volume, could I embrace it —and build a sonic world around subtlety, intimacy, and near-silence?

While my test performance did not ultimately take this direction, the suggestion left an imprint. It challenged my assumptions about what a successful instrument "should" do, and invited me to imagine alternative relationships between sound and attention. I do not rule out the possibility of pursuing this quieter path in CPM5, should it align with the emerging needs of the performance and participants.

6.5 A Miswired Mic: When Contact Became Output

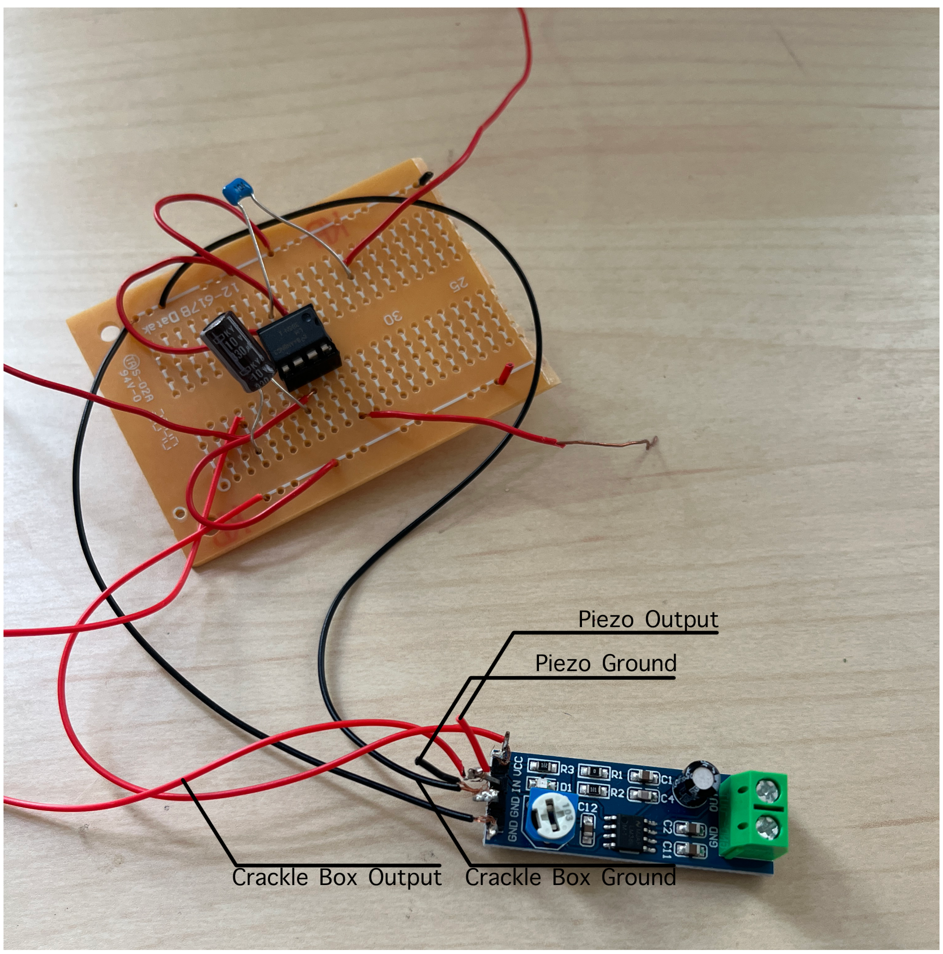

Figure 4. The Yellow Chip is Crackle Box Chip. The Blue Chip is an Amplifier Chip. I'm trying to send both crackle box and contact mic signal to the amp, but the result is the crackle box signal didn't go into the amp, but directly go into the piezo disc, so the piezo disc is not acting as a contact mic, but a speaker. Source: Author

In both of my instrument designs, I had planned to include a contact microphone—a piezo disc —to capture surface vibrations. In the crackle-drum instrument, this would introduce an additional layer of acoustic texture beneath the electronic noise. In the cup-shaped instrument, the contact mic was meant to serve as part of the sound collection and amplification system, acting as a bridge between mechanical resonance and electrical signal.

However, early prototypes revealed a surprising issue. When I wired the piezo disc directly into the input of my amplifier circuit, it failed to behave like a microphone. Instead, it began acting like a speaker—vibrating audibly and resonating with signal output. What I thought was an input device had become an output.

This unexpected reversal led me to investigate the working principles of piezo discs and amplifier chips more closely. Through this research—drawing on online documentation and exploratory conversations with an AI assistant (ChatGPT)—I learned how to resolve the issue using a TL072 chip, which ultimately allowed the piezo to function properly as a contact microphone.

During this research, I also realized that the amplifier chip I had selected—the LM386—was the same as the one used in the crackle box circuit I had been working with from the start. This discovery prompted me to explore how different wiring choices and component combinations might affect the LM386's behavior.

This inquiry significantly shaped the final design direction. I developed multiple versions of the crackle circuit, each with distinct sonic behaviors—an approach that later found resonance with capoeira's layered instrument structure, though that connection would only become clear during later stages of development.

6.6 Toward the Final Instruments

Each misstep clarified what mattered. From these lessons, two instruments gradually took shape—embodying both conceptual clarity and material responsiveness.