Turntangilism: Enhancing traditional Turntable Setups with Tangible Controls for Digital Sequencing and Live Sampling

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Figure 1: Photo of Turntangilism 3000 setup with Tamphall8r, Tamplate, Tamplifier, Tamplepack8, Tamputer and Tamples.

Abstract

Turntangilism 3000 is an interactive musical system built around a traditional turntable setup, extended with tangible elements for live sampling and sequencing. It preserves established DJ workflows and gestures while introducing physical tokens and modular devices for real-time audio manipulation.

At its core are reusable tangible objects, termed Tamples (Tangible Samples), which represent digital audio samples. These tokens can be placed on different devices to access and manipulate audio, allowing performers to engage with sequencing and modulation directly, while remaining integrated with the turntable workflow and avoiding screen-based interfaces.

The system includes modular devices for distinct performance roles: the Tamplifier for recording, the Tamputer as a central unit, the Tamplate, a 7" for granular playback and modulation, the Tamphall8r, a magnet-based 10" radial step sequencer, and the Tamplepack8 for loading samples.

Custom hardware uses ESP microcontrollers, color and motion sensors, and a Bela audio platform, providing low-latency, continuous control. The work also introduces ESP-NOW MIDI, a low-latency, low-power wireless MIDI protocol for real-time interaction between distributed devices. Together, these contributions explore how digital technologies can extend analog musical systems while preserving the gestural logics of existing musical practice.

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Keywords

tangible musical interfaces, turntablism, live sampling, sequencing, wireless MIDI

1 Introduction

This paper presents *Turntangilism 3000*, a modular instrument ecosystem that extends a conventional vinyl DJ setup with tangible controls for live sampling and sequencing. The work is grounded in *practice-led inquiry*: it emerges from long-term artistic and design work, iterative prototyping, and performance in real venues, rather than from a controlled user study or comparative evaluation. We therefore aim to articulate a coherent design rationale, a working technical architecture, and reflective lessons from deployment, not to generalize quantitative findings about users or tasks.

Traditional vinyl setups emphasize timing, selection, and mixing; turntablism treats the deck as an expressive instrument through gestures such as scratching and beat juggling. Meanwhile, live sampling and sequencing are central to much electronic music, yet they are still awkward to fold into turntable-centered performance without leaning on screen-heavy workflows or displacing the embodied habits of vinyl practice. Turntangilism 3000 asks how digital sample banks and temporal structure can be manipulated *as physical things*—tokens, rotational layouts, modular controllers—while keeping the turntable and mixer as the familiar backbone of the performance.

Research question. How can a traditional turntable setup be extended with tangible digital controls to support live sampling and sequencing, without displacing the embodied gestures and performative immediacy of vinyl-based practice?

Contributions. This submission contributes (1) a *design-and-practice* account of an extension-kit instrument that couples DJ workflow with tangible sampling and radial sequencing; (2) a *technical* realization based on a Bela-centered audio host, ESP-based peripherals, and ESP-NOW MIDI as a reusable low-latency wireless MIDI layer released to the community; and (3) *reflective evidence* from public performances (including festival and bar/-club contexts) on reliability, expressive use, and limitations of the approach.

A video demonstrating Turntangilism 3000 is available at https://www.youtube.com/watch?v=1JE4SavnOqo.

2 Background

The instrument design draws on turntablism as performance practice, on sampling and sequencing as ways of organizing sound in time, and on tangible sequencers as a family of interfaces that make temporal structure physically manipulable. The following subsections summarize these strands and relate them to the goals of the work.

2.1 Turntablism

Turntablism is the practice of making music by manipulating turntables and a DJ mixer. Techniques such as scratching, beat juggling, and pitch manipulation transform pre-recorded sound and treat the turntable as an expressive instrument. Rooted in hip-hop, turntablism has also influenced experimental and electronic music [17].

The term *turntablism*, coined by DJ Babu of the Beat Junkies in the mid-1990s, distinguished record manipulation from traditional DJing focused on selection and mixing [14]. The practice depends on rhythm, hand coordination, and gestural control, emphasizing embodied interaction over formal music theory [5].

It also exemplifies creative repurposing: like early instruments adapted from hunting tools [10], the turntable evolved from a playback device into a performative instrument with its own techniques and expressive vocabulary. Related practices, such as Graham Dunning's Mechanical Techno project [3], similarly use the turntable as a rotational time base for physical sequencing, underscoring its adaptability beyond conventional DJ workflows.

2.1.1 *Digital Turntablism.*

Digital turntablism uses timecode vinyl and DJ software so turntables drive digital audio while preserving scratching, beat juggling, and related gestures. Loops, cues, effects, sample triggering, and stem workflows extend what decks can do in performance, keeping tactile control central to contemporary DJ practice.

2.2 Sampling

Sampling allows musicians to take a piece of recorded sound and reuse it in new contexts. This can be a drum break, a vocal phrase, a melody, or even environmental noise. Early work in musique concrète, as described by Battier [2], showed how recorded sounds could be physically manipulated, cut, looped, reversed, or layered, to create entirely new textures. Digital samplers in the late 1970s and 80s, such as the Fairlight CMI, EMU Emulator, and Akai MPC, made these techniques faster and more precise, giving producers control over pitch, timing, and repetition [4, 6]. In hip-hop, sampling became a compositional tool: drum breaks and melodic fragments could be rearranged and looped, turning the sampler into an instrument in its own right [4].

Today, sampling is used in both studio and performance settings. Contemporary tools allow incoming audio to be captured in real time and subsequently transformed, looped, and replayed as musical material [9]. Virtual instruments routinely rely on pre-recorded samples to reproduce or approximate acoustic sound sources. Modern DJ software and digital audio workstations further support stem separation, enabling performers to isolate and manipulate individual elements of a mixed track, such as vocals or drums.

2.3 Sequencing

Sequencers organize notes or triggers into editable, loopable structures over time. Traditionally, these structures are linear, with events arranged on a fixed timeline. Radial and circular sequencers instead frame time as cyclical space, letting performers perceive and manipulate repetition as a continuous loop rather than a bounded timeline. Radear [1] is an example of such a system, using a spinning platter and tangible pucks to define rhythmic patterns in a circular layout. More experimental sequencing systems depart from deterministic playback altogether, incorporating probability, conditional rules, or generative processes to introduce controlled variation or emergent unpredictability into performance.

2.4 Tangible Sequencers

Tangible sequencers are physical musical interfaces that allow users to compose, arrange, or trigger musical events through direct interaction with physical objects. These objects, commonly referred to as tokens, represent musical elements such as notes, rhythms, or instruments and are manipulated, by placing, rotating, or moving them, within spatial layouts such as grids or circular tracks to define temporal structures.

By translating abstract sequencing processes into physical space, tangible sequencers instantiate an embodied approach to musical interaction. This tactile and visually legible mode of control can make musical structure more accessible and expressive than screen-based interfaces. In performance contexts, the visible manipulation of tokens becomes part of the performative gesture, often supporting improvisation and fostering a more engaging experience for both performers and audiences.

Many designs follow the *tokens and constraints* idea [16], where tokens represent data and constraints limit how they can move. This makes complicated tasks, like mapping parameters or setting up sequences, more intuitive. Examples like reacTable [7], mediaBlocks [15], DataTiles [13], and the TQuencer [8] show how this kind of setup can give performers real-time control

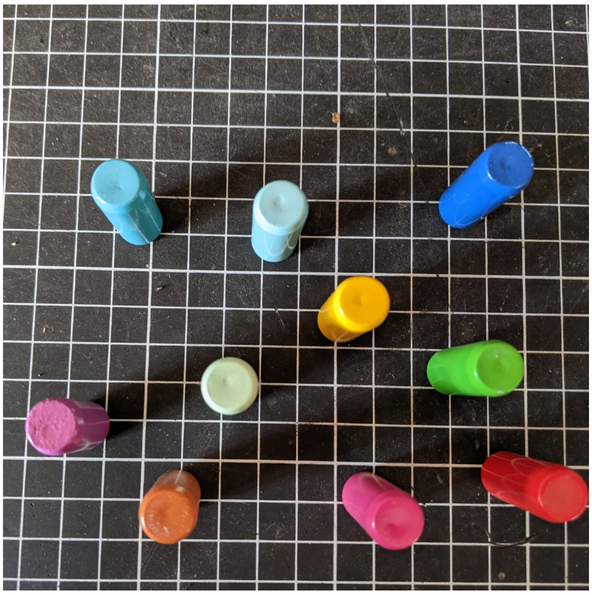

Figure 2: Photo of 10 painted Tamples.

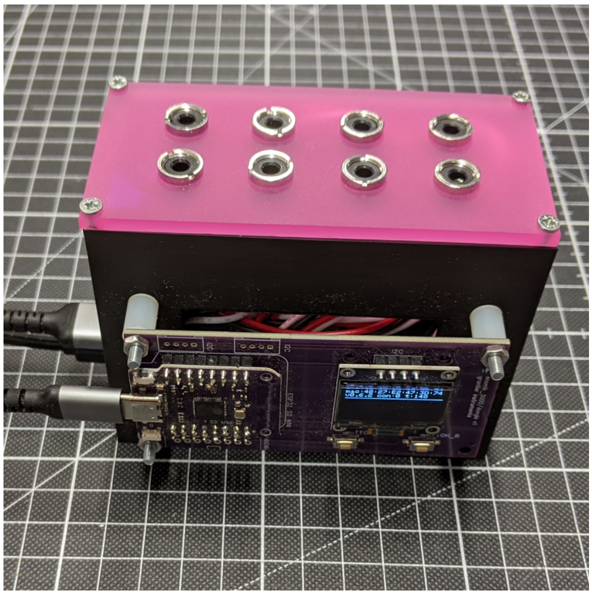

Figure 3: Photo of Tamputer: Bela board with multichannel extension and Enomik dongle.

over musical structure while keeping the interaction tactile and hands-on.

3 Instrument

Turntangilism 3000 is a musical instrument that combines practices from turntablism, live sampling, and sequencing by extending a conventional turntable setup with digital modules, while preserving established DJ workflows and gestures.

3.1 Design Guidelines

The system was developed according to design rules that balanced artistic goals with technical feasibility.

It functions as an extension kit rather than a standalone instrument: the record player remains fully usable on its own, while combining it with the Turntangilism 3000 preserves the analog workflow and adds digital capabilities. The design is modular, allowing modules to be added, removed, or replaced, supporting experimentation and iterative development. It avoids hidden "smart" features, no auto-trimming, pitch correction, or quantization, to maintain manual control and preserve physical expressivity. Visual feedback is minimal, keeping attention on tactile interaction and auditory perception.

3.2 Ecosystem

Having these guidelines and ideas in mind, we designed an ecosystem of tangible musical interfaces that work together to create a flexible and expressive setup for live sampling and sequencing. Figure 8 previews how the central Tamputer, Enomik dongle, peripherals, and audio I/O relate in a multi-module setup; each device is described in the following subsections.

3.2.1 Tample. Tamples are physical tokens used as tangible interfaces to digital sound samples (Figure 2), providing an embodied and immediate mode of interaction within the instrument.

Each Tample acts as a physical handle to a virtual sample, enabling performers to load, arrange, and trigger audio through direct manipulation while remaining modular and reusable across compatible systems. Rather than storing audio data, Tamples function as identifiers linked to samples in software and are detected via color sensing, using standardized painted metal cylinders and controlled illumination to ensure reliable identification and clear visual feedback for both performers and audiences.

3.2.2 Tamputer. The Tamputer (Figure 3) functions as the central control unit of the instrument, managing the entire Tample ecosystem by storing samples, organizing banks, and handling playback and routing. It is implemented as an embedded system based on a Bela board with a multichannel extension, enabling up to eight audio output channels that can be routed to an external mixer. Internally, it runs a Pure Data patch responsible for recording, playback, mapping, and signal routing, and boots autonomously without user interaction. Wireless communication with peripheral devices is handled via an Enomik dongle (3.3), while the system remains modular: the same software can be deployed on a conventional computer with an audio interface for more complex or spatialized setups.

3.2.3 Tamplifier. The Tamplifier serves as the recording unit of the ecosystem, enabling performers to capture audio samples and assign them directly to colored Tamples (Figure 4). Recording is controlled through a momentary interaction: pressing a Tample starts recording and releasing it stops, a design choice suited to short, gesture-based sampling. Vertical movement of the Tample selects one of four sample banks, while audio can be sourced flexibly from headphone cues, auxiliary sends, or other mixer outputs, making the system compatible with both DJ and live mixing setups. All the interactions happen on the token itself.

3.2.4 Tamplepack8. The Tamplepack8 is an eight-slot interface for inserting Tamples (Figure 5), complemented by a global slider for selecting the active sample bank. It primarily functions as an assignment and preview device, allowing performers to map up to eight Tamples to the eight rings of the Tamphall8r by inserting and pressing a token. Each assignment triggers an automatic preview via the headphone channel, enabling rapid inspection of sample content without affecting the main output. By optionally routing the preview signal to the master output, the device can

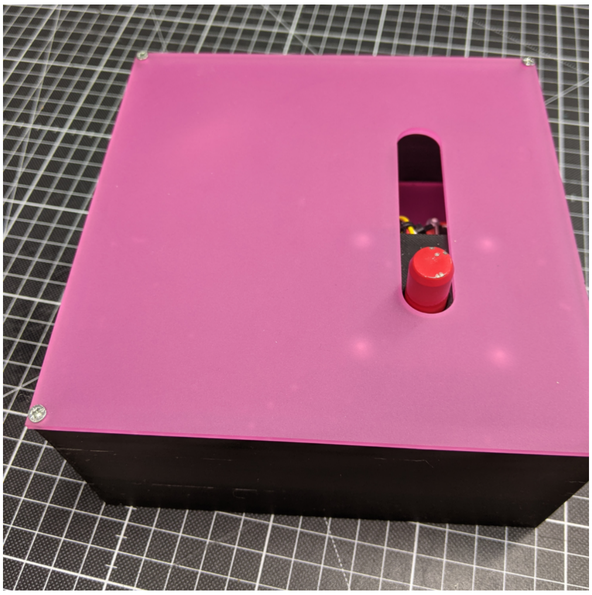

Figure 4: Photo of the Tamplifier, the recording unit of the Turntangilism ecosystem

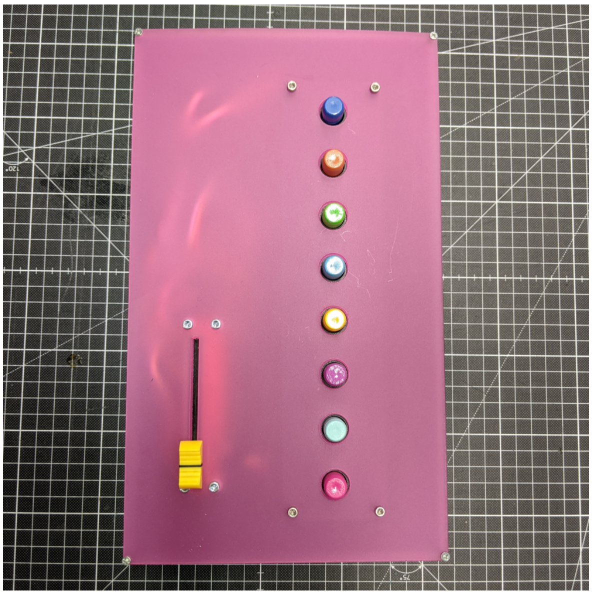

Figure 5: Photo of the Tamplepack8.

Figure 6: Photo of Tamphall8r's static part with 8 rotatable concentric rings.

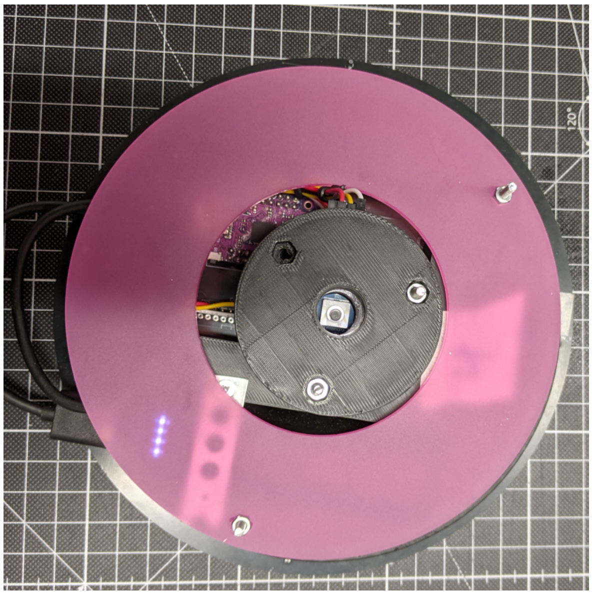

Figure 7: Photo of the Tamplate.

also operate as a simple sample player, an emergent use that, while not central to the design, extends its practical flexibility.

3.2.5 Tamphall8r. The Tamphall8r is an eight-track radial tangible sequencer (Figure 6). It consists of a static part with eight rotatable concentric rings, each representing a track, and a rotating sensor-equipped record that detects magnets placed on the rings.

The record is a standard 12" vinyl, allowing familiar interactions such as scratching or pitch changes. Loop length is 1.8s at $33\frac{1}{3}$ RPM, extendable to 3.6s via pitch adjustment. The device uses Hall effect sensors connected to a microcontroller that transmits Note-on events via ESP-NOW MIDI. Currently, it sequences only note events, not velocity or other parameters.

Each concentric ring can be turned on its own, letting performers shift a group of samples, for example, moving all the hi-hat hits by a few degrees, to tweak rhythms in real time. The device encourages experimentation with rhythmic patterns through direct interaction with the sensor board. Scratching or moving the board can also disrupt the short loops, producing glitchy, unpredictable drum variations. A similar concept was explored in Orbita [12], though in that system users must place tokens on a rotating disk, which can limit flexibility and interrupt the flow of performance.

3.2.6 Tamplate. The Tamplate is a seven-inch device with a gyroscope for motion and orientation, a color sensor, and a sample-trigger button, making it a versatile instrument (Figure 7).

Scratcher : By rotating the Tamplate, one can scratch samples intuitively like a turntable. Digital processing allows new possibilities, such as controlling a granular synthesis patch ("Scratcher"). Higher-resolution MIDI pitch bend messages support longer samples.
Panner / Tangible Modulator : The Tamplate can pan sounds in spatial audio systems or act as a tangible modulator, sending rotation values as MIDI CC messages to control parameters like filter cutoff. The raw rotation values alone create a sawtooth-like LFO, and the device can be scratched, stopped, reversed, or sped up like a vinyl record.

3.2.7 Accessories. The system also includes a set of supporting accessories that extend its practical use without introducing additional interaction complexity. One such accessory is the Tample case, a physical storage container designed to hold up to 256 Tamples, supporting transport, organization, and preparation for performance.

In addition to physical accessories, the system includes Tample Crate, a software utility implemented as a lightweight web server. Tample Crate provides a REST API for sample management, enabling users to upload, organize, and assign audio material to Tamples outside of the performance context. This software layer allows Tamples to be bridged with conventional digital music tools, such as digital audio workstations, while preserving their role as tangible identifiers within the system.

3.3 Technical Implementation

The implementation details below follow the connectivity layout of Figure 8, expanded in the *Architecture* discussion and diagram that follow.

3.3.1 Architecture. The system is built around a central Bela audio board, which manages audio recording, playback, sample routing, and the global state of the instrument.

Peripheral devices such as the Tamplifier, Tamplate, and Tamphall8r use ESP microcontrollers to perform local sensing tasks, including color detection, motion tracking, and magnetic position sensing. Each device operates as a self-contained controller, producing and consuming MIDI messages, which allows the system to function as a distributed collection of musical interfaces.

Wireless communication is handled via ESP-NOW MIDI, a custom protocol developed for this work built on top of ESP-NOW, a protocol for low-latency wireless communication on ESP microcontrollers [11]. The protocol encapsulates standard MIDI messages over ESP-NOW, so devices exchange MIDI events without interacting with ESP-NOW directly. A dedicated ESP-NOW MIDI dongle bridges the peripherals and the Bela host, forwarding incoming messages to Pure Data and supporting bidirectional communication for state synchronization and parameter feedback. Figure 8 summarizes ecosystem connectivity for a setup with multiple peripheral modules.

ESP-NOW MIDI is released as an open-source protocol for low-latency, peer-to-peer MIDI over WiFi. It is available on github[1] and via the Arduino Library Manager. It requires no network infrastructure or pairing procedures, making it suitable for ad hoc setups. A no-code configuration editor allows users to define device roles, MIDI mappings, and communication behavior without modifying firmware.[2]

[1]https://github.com/grantler-instruments/ESP-NOW-MIDI
[2]https://grantler-instruments.github.io/enomik-app

This architecture separates interaction design from networking, allowing tangible devices to be treated as musical instruments while relying on a lightweight wireless layer for coordination.

3.3.2 Sensing Design. The system relies on a small number of sensor types shared across devices, keeping the architecture simple and improving reliability through standardization.

All devices that accept Tamples use the same momentary button to detect press and release events, the same slider for bank selection, and the same color sensor for Tample identification. This consistency simplifies calibration and maintenance across the ecosystem.

The Tamphall8r uses digital Hall effect sensors to detect the presence of magnetic trigger tokens on its concentric rings. The Tamplate uses a gyroscope to capture orientation and rotational motion, which is mapped to MIDI output for scratching and modulation gestures.

3.3.3 Tample Detection. Tample detection was a foundational design challenge that shaped the entire ecosystem. The Tamploop concept (see 5.2), in which Tamples are detected in real time as they pass a sensor on a rotating record, was the original motivation for the system and imposed strict latency requirements on token identification. Early tests with RFID and NFC technologies were abandoned because detection times were too unreliable to meet this requirement.

Color sensing emerged as the solution: each Tample is painted a unique color and identified via a TCS34725 color sensor, which provides RGB values processed to classify the token. This approach has proven reliable in practice, provided all devices are properly calibrated and sensors are mounted at a consistent distance from the Tample.

4 Performance Experience and Reflection

The system has been used in several live performances, including at Ars Electronica Festival 2025 and in various DJ sets. At Ars Electronica, the Tamplate controlled an ambisonics setup, showing that the tangible interface approach works beyond traditional stereo configurations. In bar settings, the sequencing and sampling modules were integrated into standard DJ workflows alongside conventional mixing techniques.

4.1 Technical Performance in Practice

In practice, the ESP-NOW MIDI wireless protocol proved reliable across different venue conditions. No noticeable latency issues occurred, even in crowded festival settings where audience members' active Bluetooth devices and venue technical equipment created potential interference. This is consistent with benchmarks documented in the ESP-NOW MIDI repository.

The color sensing for Tample recognition remained stable under changing stage lighting, including during dramatic lighting shifts that are common in live electronic music performances.

4.2 Musical Expressivity

The system is designed to invite creative appropriation. Just as turntablists transformed record players from playback machines into expressive instruments through techniques like scratching and beat juggling, Turntangilism 3000 provides physical constraints and affordances rather than fixed functions. In practice, this openness has led to unexpected performance strategies:

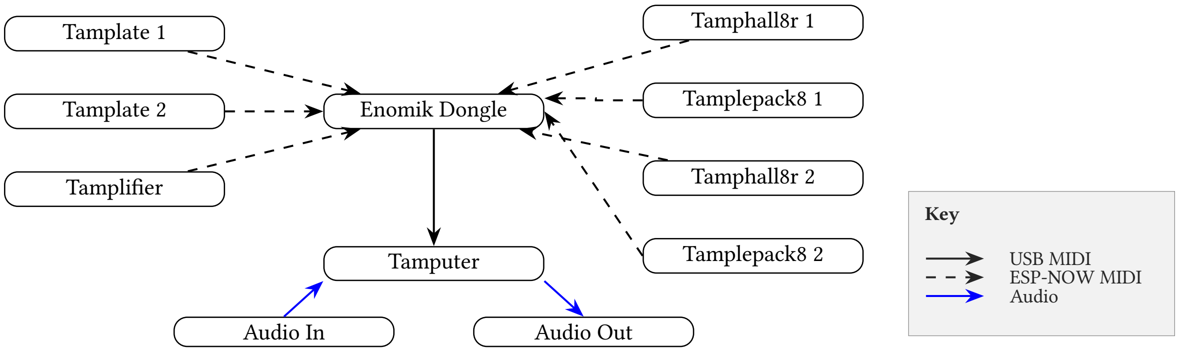

Figure 8: Ecosystem connectivity: peripherals exchange ESP-NOW MIDI via the Enomik dongle; the dongle connects to the Tamputer (Bela) over USB. Audio enters and leaves the Tamputer through the multichannel interface.

touching the needle directly with a finger to generate textural noise, sampling live vocals, or routing external processors through the mixer's insert points, in one case a digital tape delay, to shape samples before they are captured. These uses were not planned during design but emerged naturally from the workflow. This suggests potential applications beyond solo DJ performance, including collaborative settings where the tangible interface could allow performers to manage samples and loops while remaining physically and visually engaged with other musicians rather than focused on a screen.

4.3 Limitations

The most significant practical limitation is that Tamples provide no indication of their audio content. They do not change size, texture, or label themselves based on what sample they contain. A Tample holding a kick drum looks identical to one with a vocal or ambient pad. Performers must either memorize their Tample assignments or use headphone pre-listening, a standard DJ technique, before placing tokens on sequencers or playback devices. This requires performers to develop familiarity through practice, similar to how a guitarist learns their fretboard or a DJ knows their record collection by label and sleeve. Unlike adaptive interfaces that display waveforms or provide visual feedback about content, the system demands that the performer develops their own color mapping strategies and workflows.

5 Conclusion

We close by restating the contribution of Turntangilism 3000 in relation to turntable-based practice, then outline planned technical extensions and evaluation work.

5.1 Summary

Turntangilism explores how traditional turntable practice can be extended through tangible digital interaction without displacing the embodied knowledge and gestural fluency associated with vinyl performance. Rather than treating the turntable as a legacy interface to be augmented or automated, the system approaches it as an active site of musical authorship, around which new forms of sampling, sequencing, and modulation can be organized.

By externalizing digital samples and temporal structures into physical tokens and rotational interfaces, the system reframes sequencing and live sampling as gestural activities. Performers engage musical structure through acts of placement, rotation, and manual manipulation rather than through screen-based representations. The radial sequencer makes cyclical time explicit and manipulable, in parallel with the continuous temporal control of the turntable.

From a design perspective, the project suggests that tangible interfaces can coexist with established musical instruments when they respect existing performance logics rather than replacing them. The modular architecture allows performers to assemble configurations that range from minimal augmentation to more complex hybrid setups, supporting both exploratory use and integration into familiar DJ workflows.

5.2 Future Work

Future work will extend the expressive range of the sequencing and playback devices. The Tamphall8r currently sequences only note events; performance use indicates a need for velocity sequencing to support more nuanced rhythm. In parallel, development is exploring another sequencing device, the Tamploop (Figure 9), where Tamples themselves are the primary tangible tokens. Unlike the Tamphall8r, which is sequenced by magnets, this approach treats Tamples as temporally indexed elements detected directly as they pass a sensor on the rotating record. Further progress is currently postponed because reliably integrating token detection into a rotating record requires complex industrial design.

Systematic user studies with turntablists and DJs from different musical backgrounds will examine how the system is appropriated in practice, how performers manage unlabeled Tamples, and whether the interface preserves the gestural fluency of traditional turntablism while enabling new forms of expression. Beyond this implementation, Turntangilism points to a broader design space where digital musical structures become legible and manipulable through physical form, preserving immediacy while expanding the expressive vocabulary of traditional instruments.

6 Ethical Standards

This work is based on research conducted as part of the author's Master's thesis. The project was carried out within an academic context and did not receive external funding from public, commercial, or not-for-profit agencies. The author declares no competing financial or non-financial interests.

This research did not involve human participants, animal subjects, or the collection of personal or sensitive data requiring formal ethical approval. The study was conducted in accordance with standard academic and professional ethical guidelines.

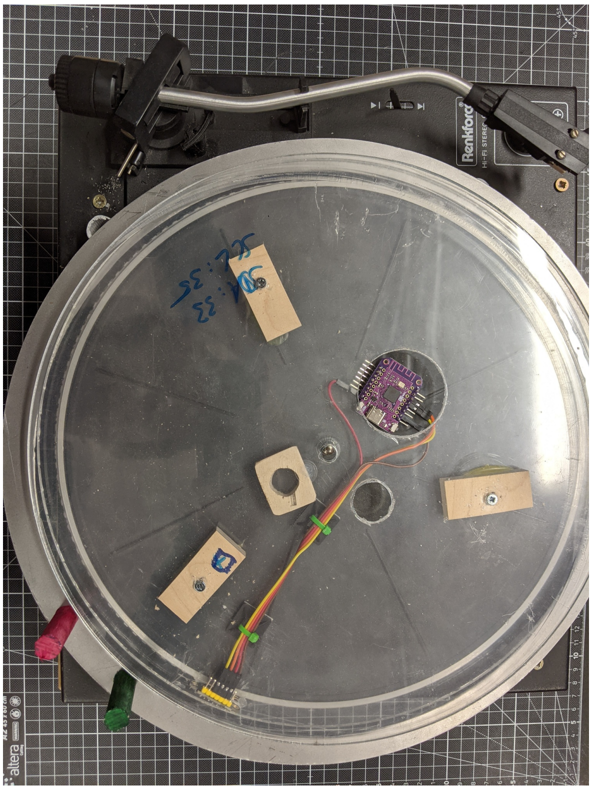

Figure 9: Photo of the Tamploop.

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