Playing Rough: Malleable Instruments for Participatory Performance

Tara Pattenden
tara.pattenden@griffithuni.edu.au
Queensland Conservatorium, Griffith University
Brisbane, Australia

Figure 1: Participants play with an instrument during a live performance. Image by J.Dadds

Abstract

This paper presents a retrospective longitudinal case study of a family of malleable textile NIMEs, developed and deployed over fifteen years in more than 110 public participatory performances and interactive installations. While prior research highlights the participatory potential of malleable NIMEs, longitudinal accounts of their sustained use in real-world settings outside research contexts remain scarce. As the maker-performer, I developed, crafted, and maintained these NIMEs in practice by sewing textile interfaces, building embedded electronics, writing code, and performing with them in public settings. This process generated an archive of maker notes, tour diaries, media documentation, and repair traces. Through analysis of this archive, I demonstrate how repeated public deployment outside the laboratory reshapes instruments for repeatable uptake, and show that interaction and mapping complexity are repeatedly reduced to enhance legibility in noisy, time-limited participatory contexts. I further argue that breakdown and repair traces can serve as longitudinal evaluation data, illustrated by contrasting an installation requiring daily repairs with a subsequent redevelopment that sustained approximately 85,000 guests with minimal intervention. The paper contributes a field-derived taxonomy of failures and issues, along with transferable construction and maintenance heuristics for designers of participatory textile NIMEs intended to withstand rough handling. It is also offered as a deliberate contribution to the NIME historical record, responding to calls for better documentation of instruments, long-term practice, and work outside peer-reviewed research contexts.

NIME '26, June 23–26, 2026, London, UK

Keywords

Malleable instruments, Soft circuitry, Participatory performance, Practice-led research

1 Introduction

Malleable interfaces offer new opportunities for participation and musical performativity [4, 29, 36]. Despite their expressive and performative potential, existing surveys highlight that longitudinal accounts of malleable NIMEs in sustained real-world use remain scarce [4]. In response, this paper presents a retrospective longitudinal case study of the Tentacle Instruments—a malleable NIME family that has undergone multiple iterations and repeated deployments in intensive public contexts.

The Tentacle Instruments are malleable NIMEs constructed from soft, cone-shaped fabric tentacles built with conductive materials and embedded circuitry. Sound is controlled through tactile actions such as squeezing, twisting, and bending. The instruments are used in participatory experimental sound performances and installations that invite uninhibited hands-on interaction. Across the archive, the instruments appear in more than 110 performances and exhibitions in settings including clubs, pubs, art spaces, festivals, and gallery installations.

I use the term malleable to describe these instruments, as it offers more specificity than alternatives such as tangible [15] or non-rigid [5]. While *malleable* appears in existing NIME discourse as a descriptor for deformable interfaces [4, 5, 12, 14, 19, 29, 34, 35], its nuance has not been explicitly theorised. I use it here deliberately: as an adjective, malleable elicits action and invites curious, exploratory interaction.

Bin argues that NIME's historical record remains incomplete — particularly with respect to instruments, long-term practice, and work outside peer-reviewed publications — and calls for collective action to address this [3]. This paper contributes to that record by documenting a sustained, practice-led lineage of instruments.

This paper contributes:

- A 15-year retrospective case study of a malleable instrument family developed through participatory performances and installations, contributing a documented lineage of malleable NIME development outside research contexts.
- A practice-led account of how repeated deployment pressures shaped ergonomic, construction, and mapping decisions, revealing a recurrent reduction of complexity to maintain legibility during uninhibited public participation.
- A synthesised taxonomy of failures and design responses derived from repair traces across development stages, illustrated by the contrast between a failure-prone installation and a later staff-maintainable redevelopment.

Figure 2: Tentacle instruments in use by audience members. L-R: V2, V3 & V5

2 Background & Related Work

2.1 Malleable interfaces

Malleable interfaces are explored in NIME as expressive controls that foreground embodied interaction and performativity [4, 29, 36], including NIMEs such as Noise Bear [14], Pain Creature [20], and ZStretch [9]. Two recent surveys have mapped this emerging field: Boem et al. [4] identified 11 non-rigid NIMEs through an expert survey, while Skach et al. [29] reviewed NIME proceedings to identify 9 textile NIMEs (TIMEs) since 2007. Textiles and plush materials afford intuitive participation, drawing on tacit bodily knowledge and evoking actions such as grasping, squeezing, and bending, while reducing the visibility of technological signifiers such as rigid enclosures and screens [17, 26, 35]. However, malleable instruments are rarely reported as sustained, repaired, and redeployed in public settings [4, 21] — a gap this retrospective case study directly addresses.

2.2 Body Conductivity

Body conductivity, or the variable electrical resistance of the performer's skin between contact points, can be exploited for musical interaction. Most notably, Waisvisz's Cracklebox [33] positions the performer's body within the sound-making circuit by touching conductive contacts, producing sound through direct circuit–body coupling. NIMEs such as Skintimacy [23] and Ground Me [18] use body conductivity as a sensing modality, but within digital audio circuits rather than directly coupled to sound generation; in these cases, attention must be paid to mapping design to maintain expressive legibility [16]. Across different versions, the tentacle instruments use either a body-as-circuit-component approach or a body-as-sensor-input approach.

2.3 Longevity and Maintenance

Robustness is repeatedly identified as a barrier to the design and uptake of malleable interfaces [4, 22, 25], with crafting durable interfaces and sourcing appropriate materials cited as persistent challenges [4]. The recurring emphasis on durability reflects an implicit assumption about how the public interacts with these objects: live music settings encourage a loss of inhibitions through sensory immersion, social intensity, and the temporary social relations of musicking [13, 30], and interactions may involve pulling, twisting, brandishing, and grabbing. Designing for durability is, therefore, not only a technical concern but also a way to afford uninhibited public engagement, and designing for this level of heavy use may support uptake of NIMEs beyond initial deployment.

2.4 Performance as a Research Site

Self-situated performance research [31] provides a vocabulary for inquiry embedded in live encounters rather than separated into controlled evaluation. For participatory instruments, field deployment can reveal requirements that are difficult to reproduce in laboratory studies, including crowd density, uninhibited interaction, unpredictable load cases, and unsupervised handling [8]. This case study leverages a performance and exhibition practice as a site where such conditions repeatedly shaped design decisions over time.

3 Methodology and Methods

This paper presents a retrospective, practice-led qualitative case study drawing on archival research methods [11, 32], document analysis [6], artefact analysis [24], and reflexive thematic interpretation [7]. I draw on a self-assembled archive[1] of images, blogs, reports, travel diaries, correspondence, legacy code, surviving artefacts, and public documentation to trace changes across iterations over fifteen years. Materials documenting concrete iterations, breakdowns, repairs, and redesign decisions were compared across these sources to identify recurring themes and points of convergence. This analysis distinguished three development stages and used breakdown and repair episodes to identify recurring failure types, likely causes, and design responses.

4 Instrument Overview and Timeline

The Tentacle Instruments are malleable textile interfaces featuring soft, cone-shaped tentacles that can be grabbed and squeezed to control sound. While materials and circuitry evolved across versions, the core interface remained consistent: a stuffed fabric cone with conductive traces running along each side. Using embedded sensing [5], the tentacle is played by grabbing it. When this occurs, the performer's hand bridges the conductive traces, and their body resistance controls the sound.

Table 1 summarises ten notable iterations referenced in this case study. The following narrative focuses on the design changes these iterations represent, including shifts in placement, sensing strategy, sound engine, and maintainability, illustrating how

---

[1] A curated selection of archive materials is available at https://www.malleableinstruments.com. The website documents selected items and examples, rather than the full archive drawn on in this study.

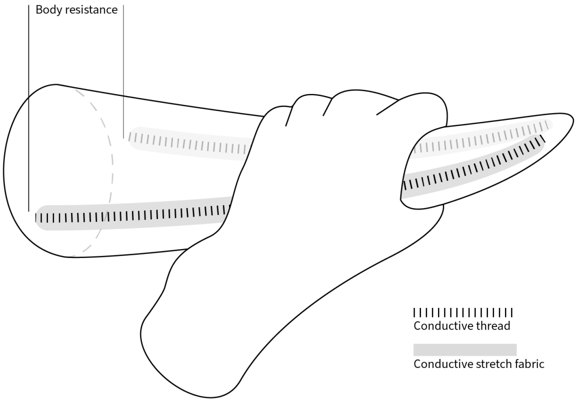

Figure 3: A diagram of the tentacle interface.

public deployment outside the laboratory favoured certain approaches.

5 Case Over Time: Three Development Stages

5.1 Stage 1: Early development (2009–2012)

Stage 1 established the core interaction principle: a soft, stuffed textile tentacle that invites grabbing and controls sound through body resistance. Two face-mounted prototypes (V1–V2; 1) exemplify this phase. V1 used a stripped single-core wire as a conductive trace with an LM386 touch circuit, while V2 replaced the wire trace with iron-on conductive fabric, retaining the same body-contact sensing principle.

5.1.1 Sound Engine and Mapping. V1–V2 employed an LM386 op-amp circuit with five touch points responding to body resistance, identified through exploratory circuit development. As the participant's body completed the circuit, there was no discrete mapping layer to address — sound was produced through combinations of simultaneous contacts and varying pressure, with each tentacle producing sound independently, and combinations of contact points altering the output. Sonic behaviour emerged from the circuit's physical configuration rather than programmatic design, keeping the instrument immediately playable without instruction.

5.1.2 Interaction and Durability. In these early versions, the tentacle form enabled immediate exploratory play, as grabbing reliably produced sound with minimal instruction. However, this stage also revealed constraints that shaped subsequent design decisions: face placement obscured vision, fit varied across head sizes, and the mass of embedded components compromised stability over time. Wire traces were unruly and potentially sharp, prompting a transition to conductive fabric to improve handling safety. Connection points on the circuit board were vulnerable to wear and required repair over time. The key design turn from Stage 1 was that the interaction principle was validated, while the primary limitations were ergonomic, relating to face-mounted wearability, and structural, particularly at the interface between textile conductors and embedded electronics.

Figure 4: Top - V3 body conductivity input, updated with conductive thread, Bottom - V8 using a Velostat pressure sensor as input.

5.2 Stage 2: Self-situated Performance Research (2013–2020)

Stage 2 is defined by repeated participatory performances, which transformed the instrument from a novel artefact into a repeatedly deployed interface shaped by wear, repair cycles, and shifting audiences.

5.2.1 Hip-worn Versions (V3–V4, V7-V8). V3 and V4 represent early hip-mounted iterations that retained body-contact sensing but explored interface materials and sound engines, while shifting placement to the hip to afford more stable handling (Table 1). V3 used iron-on conductive fabric, later augmented with conductive thread when the fabric lost conductivity through soiling, while V4 used conductive tape. Both V3 and V4 generated sound with a circuit-bent radio.

V7 and V8 reproduced the same hip-worn structure as V3 and V4 but used hand-built pressure sensors made with Velostat [1] and conductive fabric. These embedded sensor layers were sewn onto the sides of the tentacles.

5.2.2 Sound Engine and Mapping. V3–V4 used circuit-bent radio receivers, exploiting body conductivity through direct circuit manipulation and producing unpredictable but immediately audible tonal shifts.

V7–V8 used a Teensy 3.6 [27] to generate two oscillators, designed using the PJRC Audio System Design Tool [28]. V7 paired a square wave and a triangle wave, while V8 used two triangle waves. The pressure from each Velostat [1] sensor was mapped to the pitch of its corresponding oscillator. A range of wave types and mixing strategies were tested to find a combination that yielded expressive, legible results under live conditions; additive mixing proved unsatisfactory, while XOR mixing introduced a degree of complexity and interaction between the two tentacles that more effectively rewarded exploration. The incoming sensor signal required smoothing to reduce noise, which introduced latency and necessitated a trade-off between response time and signal stability. Output volume was also attenuated when no interaction was registered, reducing unwanted noise during performance.

Further programmatic control — such as dynamic timbre shifting or algorithmic response curves — was not explored in this iteration, representing an area for future development.

5.2.3 Interaction and Durability. The Velostat pressure sensors used in V7 and V8 proved inconsistent during sustained use, becoming unreliable over time and offering a less expressive response range than the body-contact sensing used in Stage 1. The directness of the earlier circuit-bent approach — where the body was itself part of the circuit — produced a more immediate and varied sonic response than pressure sensing through a material intermediary. Connection points between the sensors and the circuit board remained a structural vulnerability, consistent with issues identified in Stage 1.

5.2.4 Mixed Methods with Revised Materials (V9-V10) and Parallel Head-worn Line (V5–V6). V5–V6 and V9 returned to a body-as-circuit-component approach. V5–V6 used a stripboard-based CD40106 sound engine, with V6 upgraded in 2022 to use the PCB later created for E1. Because this circuit supported only a single pair of touch points, head-worn placement provided a more suitable configuration for these versions than a solitary hip-worn tentacle. V9 used an LM386 circuit, with touch points identified through circuit exploration. V10 used a Daisy Seed [10] to implement an arpeggiator. Three tentacles controlled pitch, pitch range, and tempo, respectively.

5.2.5 Interaction and Durability. Shifting placement from the face to the top of the head resolved several ergonomic issues identified in Stage 1: full head coverings accommodated a wider range of head sizes, sat more securely, and were less prone to displacement when grabbed or pulled. The return to body-contact sensing addressed the reliability and expressivity limitations of the Velostat sensors used in V7–V8, restoring the directness and tonal range of the earlier circuit-bent approach.

In V9 and V10, the chronic failure point identified in earlier stages — the junction between circuit board and conductive textile — was addressed through a combination of screw terminals, decorative embroidery to secure wiring in place, and hot glue at connection points. This approach proved effective: V9 has required no circuit or join repairs across its deployment lifetime. The primary maintenance required was cosmetic rather than functional — the shiny fabric used for the tentacles degraded visibly through repeated handling, losing its surface finish and requiring replacement. This distinction between structural and cosmetic wear is itself a useful finding, suggesting that material selection for high-contact surfaces warrants separate consideration from electrical and construction durability.

The key design turn from Stage 2 was a consolidation around three priorities: hip and head placement as participation-supporting ergonomics, construction approaches that reduce downtime through maintainable joins and materials, and mappings that remain legible under conditions of heavy, uninhibited public interaction.

5.3 Stage 3: Installation development (2022, E1 - E2)

Two exhibitions mark a third development stage, in which the instrument family transitions from performer-facilitated participation to long-form public installation. This stage is significant because it removes a key stabilising factor present in earlier stages: my ongoing presence as maker-performer to model interaction, manage extremes, and perform repairs. As a result, the installation's social and structural infrastructure becomes integral to the instrument's effective design.

Both exhibitions used the same custom PCB implementing a CMOS logic oscillator, holding the sound engine constant across the two contexts. This allows differences in outcome to be attributed to context, physical mounting, load paths, and maintenance arrangements rather than to changes in electronics.

5.3.1 Sound Engine. A custom PCB was designed for this installation stage. The circuit used a CD40106 to generate a square wave, which was then divided by a CD4040 to produce multiple square waves at selectable frequency divisions, allowing for differences in tonal range between individual boards. An LM386 op-amp drove a small speaker directly from the board. As in Stage 1, body resistance controlled pitch, with touch points identified through circuit exploration. Mapping decisions were emergent rather than programmatic, directed by the behaviour of body contact within the circuit.

5.3.2 E1: Failure as field evidence. The Cacophony Room (E1) was an installation at a public gallery. Twelve wall-mounted tentacles were installed in a black-walled room with a colour-changing spotlight; each tentacle emerged from a 3D-printed housing and was paired with a speaker hung below. The gallery was unsupervised and situated within a large festival context. The installation had more than 6,000 visitors over one month, including families and unsupervised children. The exhibition's framing as an arcade, combined with explicit signage encouraging interaction, amplified the invitation to touch and shaped the intensity and duration of those interactions.

The primary design pressure was mechanical loading. Breakages occurred almost daily throughout the exhibition: observed behaviours included visitors hanging their full body weight on tentacles, pulling tentacles from their housings, and ripping holders from the wall. Iterative updates to signage requesting gentler use did not reliably shift behaviour. Instead, repairs became a recurring part of the exhibition's operation, and each repair episode exposed new weak points and new requirements for strain management, anchoring, and replaceability. The 3D-printed tentacle holders had been built with insufficient density and were not structurally adequate for sustained public interaction.

Within the logic of this case study, E1 functions as a concentrated stress test that made failure modes visible under extended unsupervised public handling, and the correspondence between the gallery and me — analysed alongside photographic documentation of breakages — provides field evidence that directly informed the redesign for *The Tentacle Parade* (E2).

5.3.3 Interaction and Durability. E1 required daily maintenance throughout its run. The failure pattern was consistent: the weakest points were the tentacle housings, the stem-to-wall attachment, and the stitching joins on the tentacle bodies. These failures were not incidental but reflected the conditions of uninhibited public interaction described earlier in this paper — conditions that the installation's framing actively invited.

5.3.4 E2: Designing for sustained public use. The Tentacle Parade (E2) was developed for *Play Moves*, a group exhibition of touch-based art at the Museum of Brisbane. It treated E1's failures and observed interaction behaviours as design requirements rather than exceptional misuse.

The tentacle holder was redesigned in collaboration with an engineer so that tensile forces from pulling and hanging were borne by the wall structure rather than by the tentacle stem, and

Table 1: Tentacle Instrument iterations and mappings.

Ver.	Year	Conductor	Hardware	Sensor	Mapping	Placement
1	2009	Stripped single-core wire	LM386	Body contact	5 pairs of body-contact touch points (crackles/squeals)	Face
2	2010	Iron-on conductive fabric	LM386	Body contact	5 pairs of body-contact touch points (crackles/squeals)	Face
3	2014	Conductive fabric (then thread)	Circuit-bent radio	Body contact	4 pairs of body-contact touch points (crackles/squeals)	Hips
4	2014	Conductive tape (then thread)	Circuit-bent radio	Body contact	4 pairs of body-contact touch points (crackles/squeals)	Hips
5	2017	Conductive thread	CD40106	Body contact	Pitch control via body-contact touch points	Head
6	2018	Conductive thread	CD40106 (custom PCB)	Body contact	Pitch control via body-contact touch points	Head
7	2018	Velostat + conductive fabric	Teensy 3.6	Pressure	T1–square-wave, T2–triangle-wave (XOR-mixed)	Hips
8	2018	Velostat + conductive fabric	Teensy 3.6	Pressure	T1–triangle-wave, T2–triangle-wave (XOR-mixed)	Hips
9	2022	Conductive thread	LM386	Body contact	4 pairs of body-contact touch points (crackles/squeals)	Hips
10	2023	Conductive tape (then thread)	Daisy Seed	Body contact	Arpeggiator: T1–pitch, T2–pitch width, T3–tempo	Hips

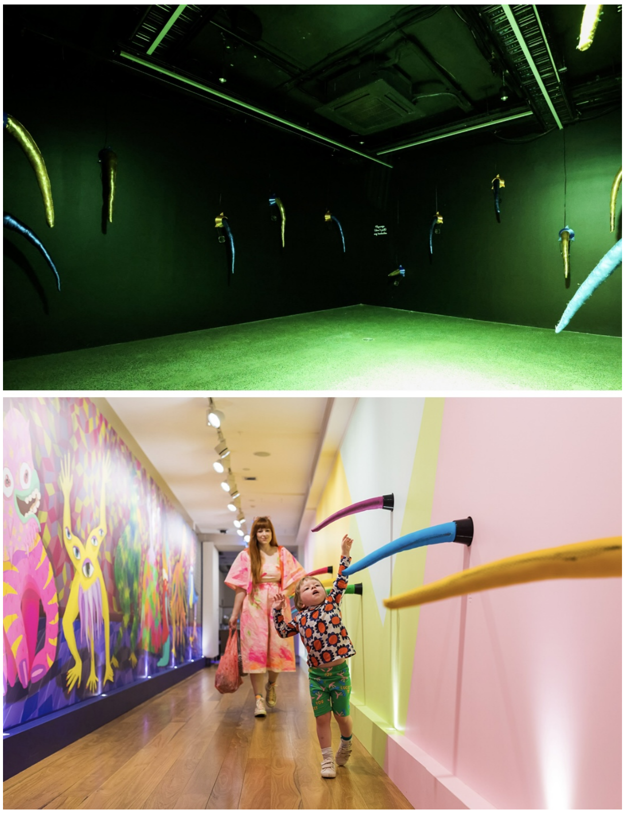

Figure 5: Top - The Cacophony Room, Metro Arts, Brisbane, Australia, September 2022 (E1), Bottom - The Tentacle Parade, in Play Moves, The Museum of Brisbane, Brisbane, Australia, December 2022 (E2). photo by Katie Bennett.

holders were 3D printed at 100% density. This change in load path redirected forceful participant actions away from the soft body of the tentacle and away from electronic joins toward a structural anchor designed to withstand sustained loading. Upholstery pleather and heavy-duty thread replaced earlier fabric choices to increase surface durability, and an internal conductive fabric layer was added so that the interface remained functional if an external conductive thread trace failed — directly applying the distinction between structural and cosmetic wear identified in Stage 2.

E2 was designed to be modular: tentacles could be replaced or serviced without specialist tools, enabling gallery staff to maintain the installation independently. A maintenance manual was provided, staff cleaned the tentacles daily, and spare tentacles were supplied in advance. During the first few weeks, some stitching failures required repair and replacement; tentacles were triple-stitched to address this, and all issues were resolved within three weeks. Under these conditions, the installation hosted approximately 85,000 guests over three months, replacing only eight spare tentacles, which the museum staff easily did.

5.3.5 Interaction and Durability. The contrast between E1 and E2 is instructive. Where E1 required almost daily intervention by the maker, E2 required intensive attention only in the first few weeks, after which the installation operated with minimal maintenance for the remainder of its run. The primary maintenance burden shifted from structural repair to routine cleaning and cosmetic upkeep — consistent with the pattern observed in V7, where construction improvements eliminated circuit failures while surface wear on high-contact materials remained the principal maintenance concern. This suggests that when structural and electrical durability are adequately resolved, cosmetic wear becomes the primary ongoing maintenance consideration for instruments in sustained public deployment.

The key design turn from Stage 3 was that designing for uninhibited public use requires not only material and construction decisions but also a systems-level approach to installation: load-path engineering, modularity for replaceability, staff-maintenance infrastructure, and pre-supplied spares are all part of the instrument's effective design.

6 Findings and Design Implications (F1–F3)

This section distils three findings that cut across the stages and are grounded in repeated evidence from the archive. While the case is specific, findings are presented as transferable heuristics for designers of participatory textile NIMEs intended to persist beyond initial prototypes.

Table 2 presents a field-derived failure/issue taxonomy for malleable textile tentacle interfaces used in participatory performance and extended unsupervised installations. The table summarises recurring issue types, likely causes in use, design responses, and typical contexts observed in the archive.

6.1 F1. Repeated Deployment Pressures Reshape Instruments Toward Repeatable Uptake

Across the three stages, design, interface, and sound engine decisions were shaped by what could be deployed, worn, and understood quickly in public encounters. Stage 1 established an intuitive tactile interaction but revealed constraints related to face-mounted ergonomics — obscured vision, variable fit, and component weight. The shift to hip and head placement in Stage 2 improved comfort, visibility, and inclusivity across body sizes,

Table 2: Field-derived failure/issue taxonomy and corresponding heuristics (design rules).

Failure/Issue	Likely Cause in Use	Heuristic	Typical Context
Conductivity loss from dirt/soiling	High-throughput handling; sweat/dirt; surface contamination	Design for cleaning/contamination: choose durable conductors; avoid grime traps; make contact surfaces cleanable or replaceable as modules/spares	Long exhibitions; festivals; high-throughput runs
Breakage at wire loop / transition	Stress concentration; repeated flex at a single point	Move joins out of bend zones: immobilise transitions; add strain relief; minimise flex at textile–wire/PCB interfaces	Pulling/dragging gestures
Conductive thread fracture	Abrasion and fatigue under repeated deformation	Assume fatigue: dense stitching; provide redundancy (parallel traces or backup conductive layer) so single breaks don't stop playability	Repetitive squeeze/twist
Shorts / intermittent contact ("thread touches")	Stuffing migration; tip compression; traces contact; frayed ends	Prevent unintended trace contact: keep conductors away from tips; terminate at base; add internal separation; avoid compressive contact zones; mechanically secure ends	Pulling + tip compression
Wire pulled out of board / electronics	Tensile load routed through PCB/solder joint	Route load around electronics: design load paths that bypass PCBs/solder joints; add structural anchors after the electronics exit	Wall installations; hanging/pulling
Confusion / low uptake with complex behaviours	Limited attention; noisy context; unclear cause–effect	Prefer legible mappings: reduce parameter coupling; keep direct gesture–sound relationships; only add complexity if it stays interpretable in situ	High-throughput events; unsupervised exhibitions

supporting more consistent participation and easier sharing between participants. Stage 3 introduced more stringent requirements for robustness, cleaning, and maintenance, as the maker-performer was no longer present to guide interactions or address repairs in real time.

Design implication: For participatory textile NIMEs intended to persist, deployment constraints — wearability, rapid comprehension, setup and repair workflow, and who provides maintenance — should be treated as essential design requirements.

6.2 F2. Mapping and Behavioural Complexity are Repeatedly Reduced and Refined Toward Legibility Under Uninhibited Participation.

Across the archive, complexity was viable only when participants could readily perceive cause–and–effect relationships under noisy, time-limited conditions. In Stages 1 and 2, body-contact control paired with circuit-based sound engines produced expressive behaviour through material and electrical coupling, enabling rich sonic variation without requiring participants to learn multi-step interactions. Microcontroller-based versions (V7, V8, V10) enabled structured synthesis but shifted expressive work into mapping and code, requiring dynamics and timbral change to be explicitly authored to remain noticeable and meaningful in participatory encounters. Over time, the archive documents repeated returns to simpler, more interpretable gesture–sound relationships when complexity became difficult to learn in the moment. This pattern is also reflected in the failure and issue taxonomy: confusion and low uptake with complex behaviours recur, with a consistent design response that prefers legible mappings, reduces parameter coupling, and preserves direct gesture–sound relationships.

Design implication: In uninhibited participatory contexts, mapping legibility is a primary criterion for sustained engagement; complexity should be introduced only when it preserves interpretability in situ.

6.3 F3. Breakdown and Repair Traces Constitute Longitudinal Evaluation Data That Can Be Distilled Into Transferable Heuristics

Across stages, breakdowns were not isolated incidents but repeated evidence of where participatory use loads the instrument mechanically, electrically, and socially. Stages 1 and 2 document recurrent wear and vulnerable points — particularly at joints and at material transitions between textiles and PCBs, in conductive materials under repeated deformation, and on conductive surfaces exposed to sweat, oil, and dirt. These failures drove incremental adaptations to construction to keep instruments playable throughout repair cycles. Notably, construction improvements in V9 eliminated circuit failures entirely, shifting the primary maintenance concern to cosmetic wear on high-contact surfaces — a distinction between structural and cosmetic durability that itself constitutes a transferable finding.

Stage 3 consolidates these lessons through the E1–E2 contrast. E1's daily breakages revealed that extended unsupervised handling produced sustained tensile loads — including visitors hanging from tentacles — and that signage alone did not reliably limit extreme behaviour. E2's redesign succeeded by changing load paths so that forces were borne by the wall structure, strengthening materials, adding redundancy through an internal conductive fabric layer, and shifting maintenance from the artist to gallery staff through modular components, pre-supplied spares, a maintenance manual, and routine cleaning. Under these conditions, the installation sustained approximately 85,000 guests over three months with only eight spare tentacles used. The failure and issue taxonomy in Table 2 summarises recurring issues and practical design responses derived from this longitudinal evidence.

Design implication: Systematic attention to breakdown and repair traces can serve as a longitudinal evaluation method, yielding practical construction and maintenance heuristics for participatory malleable textile instruments.

7 Limitations

This paper presents a single-case longitudinal account grounded in an artist's archive, with uneven documentation spanning fifteen years. To address these limitations, findings are presented as transferable heuristics rather than universal claims, and key claims are grounded in repeated evidence across stages — including contrasts between performance and installation contexts and between a failure-prone and a robust installation redevelopment.

7.1 Future directions

The tentacle instruments remain in active development, and this paper represents one point in an ongoing practice. New iterations are currently in development, continuing to explore the tentacle form across different placements, materials, and sound architectures. Current work focuses on developing mapping strategies and code complexity for the hip-based digital versions, including further exploration of multimodal interaction in which more than one parameter can be controlled simultaneously. Improving how body-contact sensing functions within digital circuits is a continuing priority — this includes pre-digital signal amplification and the exploration of capacitive touch [2], which may offer a more stable and expressive alternative to direct resistance-based sensing. Audible and physical feedback mechanisms are also being explored to better communicate instrument state to participants in live, noisy settings. This paper is offered as a deliberate contribution to the NIME historical record, and future iterations of the tentacle instruments will continue to generate the kind of longitudinal, practice-led documentation that Bin identifies as urgently needed [3].

8 Conclusion

This paper presents a retrospective case study of a family of malleable instruments developed over 15 years of participatory performances and installations. The case shows how repeated public deployment outside the laboratory created selection pressures that reshaped the instruments toward repeatable uptake — including ergonomic shifts in placement and construction changes driven by maintenance realities. Across the archive, mapping and behavioural complexity were repeatedly reduced toward legibility under conditions of uninhibited participation, where noise, limited attention, and forceful gestures made direct gesture–sound relationships critical for confident engagement. The paper also argued that breakdown and repair traces can serve as longitudinal evaluation data: by coding recurrent failure modes and design responses — and by contrasting an installation that required daily repairs with a redevelopment that sustained approximately 85,000 guests while holding the sound engine constant — I distilled transferable construction and maintenance heuristics summarised in the failure and issue taxonomy in Table 2.

Together, these findings provide a long-term account of a malleable instrument in public use and practical guidance for participatory NIMEs intended to persist beyond initial prototypes. The tentacle instruments are still performed, repaired, and reimagined, and this paper is offered as a practice-led contribution and record for the NIME community [3].

9 Ethical Standards

This research has received ethical clearance through Griffith University, obtained in the context of the author's current PhD candidature, and adheres to the ethical guidelines established by the NIME community. The paper draws from the author's practice archive (maker notes, build documentation, tour diaries, repair traces) and public documentation of deployments; the majority of this work predates the current research framing and was not conducted as a prospective human-participant experiment. In line with the NIME Principles & Code of Practice on Ethical Research, the paper avoids collecting or reporting personal data, focuses on instrument behaviour and maintenance, and minimises identifiability in any media used (e.g., avoiding faces and identifying details, and excluding identifiable imagery of minors without explicit permission). As the research draws on the author's own artistic practice, the authors acknowledge the inherent reflexivity this entails and have sought to mitigate interpretive bias through critical distance and systematic documentation. No financial or institutional conflicts of interest are declared.

Acknowledgments

This retrospective case study draws on a long-running practice of making and public deployment. I gratefully acknowledge research and development funding from the Australia Council (2011), Central Station (2012), the British Council, PRS and Novas Frequências Festival (2017). I also thank the venues, organisers, collaborators, and participants whose repeated engagements and feedback shaped the instruments over time. Special thanks to my supervisors Andrew Brown and John Ferguson for their guidance and support.

References

[1] Adafruit Industries. [n. d.]. Pressure-Sensitive Conductive Sheet (Velostat/Linqstat). Product datasheet, Adafruit Industries. https://www.farnell.com/datasheets/1815591.pdf Accessed: 2026.

[2] Bela. [n. d.]. *Get started with Trill.* https://learn.bela.io/using-trill/get-started-with-trill/

[3] S. M. Astrid Bin. 2021. Discourse is critical: Towards a collaborative NIME history. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Shanghai, China, Article 8. https://doi.org/10.21428/92fbeb44.ac5d43e1

[4] Alberto Boem, Giovanni M Troiano, , Giacomo Lepri, and Victor Zappi. 2020. Non-Rigid Musical Interfaces: Exploring Practices, Takes, and Future Perspective. (June 2020). https://doi.org/10.5281/ZENODO.4813288

[5] Alberto Boem and Giovanni Maria Troiano. 2019. Non-Rigid HCI: A Review of Deformable Interfaces and Input. In *Proceedings of the 2019 on Designing Interactive Systems Conference* (San Diego, CA, USA) *(DIS '19)*. Association for Computing Machinery, New York, NY, USA, 885–906. https://doi.org/10.1145/3322276.3322347

[6] Glenn Bowen. 2009. Document Analysis as a Qualitative Research Method. *Qualitative Research Journal* 9 (08 2009), 27–40. https://doi.org/10.3316/QRJ0902027

[7] Virginia Braun and Victoria Clarke. 2019. Reflecting on reflexive thematic analysis. *Qualitative Research in Sport, Exercise and Health* 11, 4 (2019), 589–597. https://doi.org/10.1080/2159676X.2019.1628806 arXiv:https://doi.org/10.1080/2159676X.2019.1628806

[8] Benjamin Carey and Andrew Johnston. 2016. Reflection On Action in NIME Research: Two Complementary Perspectives. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Queensland Conservatorium Griffith University, Brisbane, Australia, 377–382. https://doi.org/10.5281/zenodo.1176006

[9] Angela Chang and Hiroshi Ishii. 2007. Zstretch : A Stretchy Fabric Music Controller. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. New York City, NY, United States, 46–49. https://doi.org/10.5281/zenodo.1177067

[10] Electro-Smith. 2026. Daisy Seed. https://daisy.audio/hardware/Seed/ Accessed 2026-04-27.

[11] Andrew Flinn. 2011. Archival Activism: Independent and Community-led Archives, Radical Public History and the Heritage Professions. *InterActions: UCLA Journal of Education and Information Studies* 7 (05 2011). https://doi.org/10.5070/D472000699

[12] Adrian Freed. 2008. Application of new Fiber and Malleable Materials for Agile Development of Augmented Instruments and Controllers. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Genoa, Italy, 107–112. https://doi.org/10.5281/zenodo.1179539

[13] Ben Green. 2021. *Peak Music Experiences: A New Perspective on Popular Music, Identity and Scenes.* Routledge, London.

[14] Mick Grierson and Chris Kiefer. 2013. NoiseBear: A Malleable Wireless Controller Designed In Participation with Disabled Children. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Graduate School of Culture Technology, KAIST, Daejeon, Republic of Korea. https://doi.org/10.5281/zenodo.1178536

[15] Eva Hornecker and Jacob Buur. 2006. Getting a grip on tangible interaction: a framework on physical space and social interaction. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Montréal, Québec, Canada) *(CHI '06)*. Association for Computing Machinery, New York, NY, USA, 437–446. https://doi.org/10.1145/1124772.1124838

[16] Andy D. Hunt, Marcelo M. Wanderley, and Matthew Paradis. 2002. The importance of Parameter Mapping in Electronic Instrument Design. In *Proceedings of the International Conference on New Interfaces for Musical Expression* (24-26 May, 2002). Dublin, Ireland, 88–93. https://doi.org/10.5281/zenodo.1176424

[17] Giulio Jacucci and Ina Wagner. 2007. Performative roles of materiality for collective creativity. In *Proceedings of the 6th ACM SIGCHI conference on Creativity & cognition - C&C '07*. ACM Press, Washington, DC, USA, 73. https://doi.org/10.1145/1254960.1254971

[18] Javier Jaimovich. 2010. Ground Me ! An Interactive Sound Art Installation. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Sydney, Australia, 391–394. https://doi.org/10.5281/zenodo.1177813

[19] Chris Kiefer. 2010. A Malleable Interface for Sonic Exploration. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. Sydney, Australia, 291–296. https://doi.org/10.5281/zenodo.1177823

[20] Vincenzo Madaghiele and Arife Dila Demir. 2024. Pain Creature. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, Laurel Smith Pardue and Palle Dahlstedt (Eds.). Utrecht, Netherlands, Article 32, 5 pages. https://doi.org/10.5281/zenodo.15028083

[21] Gaël Stéfan Moriceau, Yulin Yan, Marcelo Wanderley, and Dominic Thibault. 2024. The Obstacle Course of DMI Performance: Two Case Studies with T-Stick and Karlax. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, S M Astrid Bin and Courtney N. Reed (Eds.). Utrecht, Netherlands, Article 48, 9 pages. https://doi.org/10.5281/zenodo.13904869

[22] Fabio Morreale and Andrew McPherson. 2017. Design For Longevity: Ongoing Use Of Instruments From Nime 2010-14. (June 2017). https://doi.org/10.5281/ZENODO.1176217

[23] Alexander M ́uller-Rakow and Jochen Fuchs. 2012. The Human Skin as an Interface for Musical Expression. In *Proceedings of the International Conference on New Interfaces for Musical Expression*. University of Michigan, Ann Arbor, Michigan. https://doi.org/10.5281/zenodo.1178335

[24] Maarit Mäkelä. 2007. Knowing Through Making: The Role of the Artefact in Practice-led Research. *Knowledge, Technology & Policy* 20 (10 2007), 157–163. https://doi.org/10.1007/s12130-007-9028-2

[25] Albert-Ngabo Niyonsenga and Marcelo Wanderley. 2023. Tools and Techniques for the Maintenance and Support of Digital Musical Instruments. (May 2023). https://doi.org/10.5281/ZENODO.11189159

[26] Jon Pigrem and Andrew P. McPherson. 2018. Do We Speak Sensor? Cultural Constraints Of Embodied Interaction. (June 2018). https://doi.org/10.5281/ZENODO.1302632

[27] PJRC. 2023. Teensy ® 3.6 Development Board. https://www.pjrc.com/store/teensy36.html Discontinued product page.

[28] PJRC. 2026. *Audio System Design Tool for Teensy Audio Library*. https://www.pjrc.com/teensy/gui/ Web-based graphical design tool for configuring signal-flow graphs in the Teensy Audio Library..

[29] Sophie Skach, Victor Shepardson, and Thor Magnusson. 2024. About TIME: Textile Interfaces for Musical Expression. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, S M Astrid Bin and Courtney N. Reed (Eds.). Utrecht, Netherlands, Article 76, 9 pages. https://doi.org/10.5281/zenodo.13904939

[30] C. Small. 2012. *Musicking: The Meanings of Performing and Listening*. Wesleyan University Press. https://books.google.com.au/books?id=7vS8yQwvuGcC

[31] Robyn Taylor, Jocelyn Spence, Brendan Walker, Bettina Nissen, and Peter Wright. 2017. Performing Research: Four Contributions to HCI. In *Proceedings of the 2017 CHI Conference on Human Factors in Computing Systems*. ACM, Denver Colorado USA, 4825–4837. https://doi.org/10.1145/3025453.3025751

[32] Andrew H. van de Ven and George P. Huber. 1990. Longitudinal Field Research Methods for Studying Processes of Organizational Change. *Organization Science* 1, 3 (Aug. 1990), 213–219. https://doi.org/10.1287/orsc.1.3.213

[33] Michel Waisvisz. 2004. The CrackleBox ('75). Archived web page via the Internet Archive Wayback Machine. https://web.archive.org/web/20210224112832/http://www.crackle.org/CrackleBox.html Crackle history written March 2004. Archived snapshot captured 2021-02-24. Accessed 2026-02-13.

[34] Zhen Wu, Ze Gao, Hua Xu, Xingxing Yang, and Tristan Braud. 2024. SoundMorphTPU: Exploring Gesture Mapping in Deformable Interfaces for Music Interaction. In *Proceedings of the International Conference on New Interfaces for Musical Expression*, S M Astrid Bin and Courtney N. Reed (Eds.). Utrecht, Netherlands, Article 58, 12 pages. https://doi.org/10.5281/zenodo.13904891

[35] Jianing Zheng and Nick Bryan-Kinns. 2022. Squeeze, Twist, Stretch: Exploring Deformable Digital Musical Interfaces Design Through Non-Functional Prototypes. In *NIME 2022*. PubPub, The University of Auckland, New Zealand. https://doi.org/10.21428/92fbeb44.41da9da5

[36] Jianing Zheng, Nick Bryan-Kinns, and Andrew P. McPherson. 2022. Material Matters: Exploring Materiality in Digital Musical Instruments Design. In *Designing Interactive Systems Conference*. ACM, Virtual Event Australia, 976–986. https://doi.org/10.1145/3532106.3533523