

# Harmonix Series: Accessible Digital Musical Instruments for Mindfulness and Creativity

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## Abstract

This paper introduces the Harmonix series, a collection of Accessible Digital Musical Instruments (ADMIs) designed to enhance mood stability and mindfulness through intuitive and interactive music-making. Recognising the barriers posed by traditional digital musical instruments, including steep learning curves, high costs, and uninspiring outputs, Harmonix prioritises affordability, portability, and user-friendly interfaces to cater to individuals with no prior musical training.

The study evaluates two instruments, ZenithChimes and Equilibrio. ZenithChimes employs touch-sensitive keys mapped to meditative tones in the Aeolian mode, promoting creativity and relaxation. Equilibrio, a 3D-printed "stone stack," uses tilt gestures to modulate soundscapes, symbolising balance and harmony. Both instruments integrate calming auditory outputs and minimalist design aesthetics to create an engaging and meditative experience.

A workshop-based study with 10 participants, spanning diverse backgrounds, demonstrated the instruments' accessibility and therapeutic potential. Results showed that participants found the instruments easy to use, aesthetically appealing, and suitable for mindfulness practices, with 70 percent identifying their integration into meditation or yoga sessions as beneficial. However, feedback highlighted the need for more customisation options, particularly in Equilibrio's soundscapes.

By bridging art, technology, and mindfulness, Harmonix fosters creative exploration and emotional regulation, with implications for therapeutic, educational, and artistic applications. Future work will explore sustainability, inclusivity, and multi-sensory feedback to enhance the instruments' design and impact. This study underscores the potential of ADMIs to transcend conventional music-making, offering innovative tools for well-being and self-expression.

## Keywords

Accessible Digital Musical Instruments (ADMIs), Music and Mindfulness, HCI, Tactile interfaces for music expression

## 1 INTRODUCTION

In today's fast-paced world, individuals increasingly experience stress-related challenges that affect both emotional regulation and cognitive function, including memory, attention, and decision

making[13]. These issues highlight the need for effective and accessible interventions that support mental well-being.

Music therapy and meditation have emerged as non-pharmaceutical strategies for fostering relaxation, resilience, and self-expression. Music-making engages neural plasticity and offers a means of creative exploration, while meditation encourages focus and self-awareness. [3] When combined, their benefits are often amplified, offering valuable tools for holistic well-being[9, 15].

Despite this potential, the integration of music technologies into meditative or therapeutic contexts remains limited. Many practitioners lack formal training in digital tools[4], and existing systems are frequently expensive, unintuitive, or impractical for therapeutic use[6, 9]. Moreover, the sonic output of many digital musical instruments (DMIs) is often perceived as artificial or lacking emotional resonance, diminishing their relevance in mindfulness settings[14].

This paper addresses five key limitations in current DMI design:

- (1) Barriers to entry for novice users,
- (2) High costs and poor portability,
- (3) Unintuitive interfaces,
- (4) Unengaging sound output,
- (5) Limited integration with meditative practice.

We introduce the Harmonix series, a collection of Accessible Digital Musical Instruments (ADMIs) that support creativity, emotional expression, and mindfulness. Harmonix, blending 'harmony' and 'remix' to represent our vision of individuals living in harmony (with self and others) while creatively remixing experiences through music. Through the use of contemporary fabrication techniques and embodied interaction, Harmonix seeks to bridge the gap between music technology, accessibility, and therapeutic engagement.

## 2 RELATED WORK

### 2.1 Sound and Group Meditation

Sound plays a vital role in enhancing group meditation by fostering collective mindfulness and deepening the meditative experience. Tibetan singing bowl meditation has been shown to reduce anxiety and depression while increasing spiritual well-being, especially for individuals without prior meditation experience. Its simplicity and low cost make it widely accessible.

Music also enhances guided meditation through rhythmic qualities that synchronise with breath and bodily movement, promoting a more immersive meditative state[2]. Research suggests that ambient or non-melodic music is preferred by beginners, as it aids focus and breath awareness[10, 14]. Many novice meditators report that music makes meditation more approachable and

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NIME '25, June 24–27, 2025, Canberra, Australia

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increases their motivation to continue the practice. These findings support the integration of music into mindfulness training, particularly for new practitioners.

## 2.2 Music and Meditation in Therapeutic Practices

The integration of music and mindfulness has been shown to support emotional regulation, reduce stress, and improve psychological well-being. For instance, mindfulness-based music therapy has demonstrated greater effectiveness than mindfulness alone in improving mood and emotional regulation in older women with blindness[15]. These findings highlight the value of combining music and meditation in holistic therapeutic contexts, particularly for enhancing mental and emotional health.

### Meditation as Therapy

Meditation promotes stress reduction, self-awareness, and emotional resilience. By encouraging a shift from self-deception to self-understanding, it plays a key role in interventions for anxiety, depression, and chronic stress[3].

### Music as Therapy

Music therapy activates multiple brain regions, enhancing cognitive flexibility and emotional processing[4]. Research shows that music increases dopamine and reduces cortisol levels, aiding mood regulation and stress relief[4]. These effects position music as a powerful tool in therapeutic and mindfulness contexts.

### The Synergy of Music and Meditation

When combined, music and meditation create a synergistic effect that enhances the therapeutic impact of both practices. Music can serve as a guide during meditation, with rhythmic qualities synchronizing with breathing or body movements to deepen the meditative state. Ambient soundscapes or harmonic progressions can draw attention inward, reducing external distractions and supporting mindfulness. Studies have shown that the integration of music into meditation practices can amplify relaxation, promote emotional healing, and improve cognitive function [9].

Emerging technologies, particularly Digital Musical Instruments (DMIs) designed for mindfulness, represent a novel approach to this synergy. By enabling users to create immersive soundscapes and engage in intuitive interactions, DMIs foster active participation in music and meditation simultaneously. These instruments offer a platform for personal exploration and self-expression, enriching the meditative experience while encouraging creativity and introspection.

## 2.3 Digital Musical Instruments in Mindfulness Practices

Digital Musical Instruments (DMIs) have begun to explore mindfulness and meditative applications, aiming to bridge traditional contemplative practices with modern technology. However, despite innovations like the Zen Meditation Instrument[5], the Zen Flute[12], and the Mixed Reality Handpan Interface[7], such tools are rarely adopted in real-world mindfulness settings such as yoga studios or therapeutic environments. A major barrier lies in their reliance on screen-based or VR interfaces, which lack the tactile, resonant qualities of traditional instruments like singing bowls. While apps offer convenience, they often sacrifice physical feedback, and immersive systems demand specialised hardware, limiting accessibility. This disconnect reveals a gap between the

design of DMIs and the embodied, sensory nature of established meditative practices.

## 2.4 Accessibility in Digital Musical Instruments

Efforts to develop Accessible Digital Musical Instruments (AD-MIs) have led to promising innovations. For example, Cymis uses pre-programmed scores to enable music-making for individuals with severe disabilities, though it emphasises functionality over creative and social engagement[1]. The Quintet supports group participation with built-in songs but may limit creative expression due to its fixed repertoire and conventional interface. The Strummi, designed for trained disabled musicians, offers performance-focused interaction but requires fine motor control, limiting accessibility for beginners or users with significant physical impairments[8]. These examples highlight the need for ADMIs that are not only functional but also tactile, expressive, and socially integrative—particularly in contexts like mindfulness, where embodied interaction and emotional connection are essential.

The Harmonix series aims to address these limitations by offering tactile, expressive, and socially integrative interfaces that support both individual and group engagement. Designed for users with no prior music training, it minimises technological barriers while bridging the gap between digital instrument design, accessibility, and mindfulness practices.

## 3 DESIGN METHODOLOGY

This section details the design and implementation of the two instruments in the Harmonix series, ZenithChimes and Equilibrio, focusing on their physical interfaces and corresponding audio mapping.

### 3.1 ZenithChimes

**3.1.1 Interface Design.** ZenithChimes is an Accessible Digital Musical Instrument (ADMI) designed for low-threshold music-making through touch. Its form draws inspiration from the calming resonance of wind chimes found in Japanese temples, with a minimalist design featuring seven keys in black and white, echoing the visual language of piano keys.

Interaction is enabled via copper tape embedded with capacitive sensors on each key (Figure 1), allowing users to trigger sounds through gentle contact. An ESP32 microcontroller manages sensor input and communicates via OSC with MAX/MSP, functioning as a MIDI controller. The instrument's sculptural form allows it to serve as both a sound-making device and a displayable art object.

**3.1.2 Audio Design. Key-to-Tone Mapping.** Each of the seven keys is mapped to pitches from the Raga Darbari Kanada (Aeolian mode), known for its therapeutic potential in alleviating anxiety and insomnia[11]. These pitches range from Eb3 to Bb6, ensuring both clarity across speaker systems and accessibility for a wide age range.

To support continuous and harmonically stable music-making, Keys 1 and 3 are both assigned to Bb (the dominant of Eb Major), while Keys 2, 4, 5, 6, and 7 randomly trigger one of two possible notes to encourage variation.

**Tonal Characteristics.** Each triggered tone produces a soft, bell-like sound followed by a short resonance, emulating a sound bath environment.

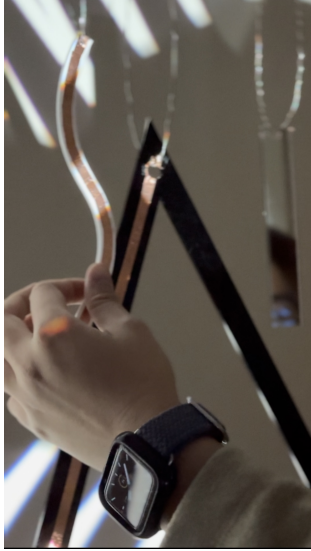


Figure 1: Copper tape on a ZenithChimes key

Key	MIDI	Note(s)
1	82	Bb
2	72 / 75	C / Eb
3	70	Bb
4	58 / 65	Bb / F
5	62 / 67	D / G
6	51 / 53	Eb / F
7	94 / 87	Bb / Eb

Table 1: Key-to-note mapping for ZenithChimes

Note	Probability (%)	Solfège
C	8.33	l
D	8.33	t
Eb	16.67	d
F	16.67	r
G	8.33	m
Bb	33.33	s

Table 2: Probability distribution of triggered notes (Eb Major)

**Output Details.** All synthesis is handled in MAX/MSP, with MIDI data transmitted via OSC for low-latency performance.

## 3.2 Equilibrio

**3.2.1 Interface Design.** Equilibrio is a fully 3D-printed ADMI that integrates principles of sculptural minimalism and meditative interaction. Inspired by the visual and symbolic language of stone stacking, it invites users to explore balance through embodied movement.

Interaction is facilitated by passive changes in conductivity detected by capacitive sensors embedded within the structure. As the user tilts the “stone stack,” these signals are interpreted by an ESP32 microcontroller and transmitted to MAX/MSP via OSC. All electronics are hidden within the object, allowing it to

function as both an interactive instrument and a contemplative art piece (Figure 2).



Figure 2: Equilibrio sound sculpture

**3.2.2 Audio Design.** Equilibrio maps physical tilting to two simultaneous audio controls: panning and modulation.

**Horizontal Tilt Mapping.** The instrument’s horizontal tilt modulates the stereo position of the sound—left tilt moves audio to the left channel, right tilt to the right, and a centred position keeps the audio balanced. Simultaneously, tilt also controls playback speed of an ambient soundtrack (between 0.8x and 1.0x), producing shifts in texture and introducing harmonic dissonance as tilt increases. This dual mapping metaphorically represents states of equilibrium and imbalance.

**Sound Design.** The ambient base layer includes field recordings of rainfall and rivers, alongside synthesised tones modelled on Tibetan singing bowls. These elements were selected to support relaxation and introspection, aligning with research suggesting their effectiveness in meditative practice.[16]

As users tilt the sculpture, sonic dissonance and spatial shifts disrupt the tranquil background, encouraging reflection on physical and emotional balance.

## 3.3 Supplementary Media

To support the documentation of the Harmonix series and provide further insight into user interaction and collaborative potential, two short video clips are included:

- **Collaborative Use of ZenithChimes and Equilibrio**  
<https://youtube.com/shorts/UbaeKQsemv8>  
 This video shows a live interaction in which a participant performs with ZenithChimes while the ambient soundtrack of Equilibrio plays in the background. It offers a glimpse into the potential of the instruments for meditative, collaborative experiences.
- **Touch-to-Sound Demonstration: ZenithChimes**  
<https://youtube.com/shorts/tyEbK3stW3o>  
 This video shows the ease of use and tactile interaction of ZenithChimes. Each touch on the copper tape key immediately triggers a chime-like tone, illustrating the instrument’s simplicity and low learning curve.

## 4 EVALUATION: TEST PLAY SESSIONS

### 4.1 Methodology

This study aimed to evaluate the usability, creative potential, and meditative suitability of the two instruments in the Harmonix series, ZenithChimes and Equilibrio. Both instruments were placed separately in an open venue, allowing participants to freely approach and explore the setup without time restrictions (Figure 3).



Figure 3: Test play setup of the Harmonix series

### 4.2 Participants

Ten participants took part in the study. Their backgrounds varied as follows:

- 3 participants had formal musical training.
- 7 participants had no prior musical experience.
- 7 participants had experience with mindfulness practices (e.g., yoga or meditation).
- All participants were aged between 20 and 40 years old.

This range of experiences enabled the study to gather insights into the instruments' ease of use, creative engagement, and suitability for meditative contexts.

### 4.3 Procedure

Each participant received a brief 30-second instruction on how to engage with the instruments:

- *ZenithChimes*: "You can touch the metal tape to produce sound."
- *Equilibrio*: "You can tilt the 'stone stack' to explore the sound."

Following this, participants were invited to freely explore the instruments for approximately 10 minutes, either individually or collaboratively. Their interactions were observed, and post-session feedback was gathered through semi-structured interviews, using the following prompts:

- "Did you enjoy playing with the instrument?"
- "On a scale from 1 (very easy) to 10 (very difficult), how difficult was it to learn?"
- "Did you feel relaxed while playing with the instrument?"

Observational notes and qualitative responses were documented during and after each session to assess experiential engagement, learning curve, and perceived relaxation.

## 4.4 Results and Observations

**4.4.1 User Enjoyment and Engagement.** All 10 participants rated the instruments as easy to use, assigning a score of 3 out of 10 or lower on the difficulty scale, suggesting a low learning curve.

- 5 participants remarked that they could "play it all day", citing enjoyment of the sound produced.
- 8 participants found ZenithChimes especially easy to learn and described it as enabling free creative expression.
- 3 participants felt that the use of pre-recorded sound in Equilibrio limited their creative exploration, and suggested future versions might benefit from user-controlled sound parameters.

**4.4.2 Potential for Musical and Mindfulness Applications.** The instruments showed promise for integration into both creative and therapeutic settings:

- 2 participants, including a professional percussionist and composer, expressed interest in incorporating ZenithChimes into future compositions.
- 7 participants believed that both instruments would be suitable for mindfulness and meditative practices, such as yoga or guided relaxation, due to their calming soundscapes and engaging interfaces.

**4.4.3 Instrument Aesthetics and Functionality.** The participants appreciated the aesthetic qualities and sculptural nature of the instruments:

- 8 participants viewed Equilibrio as both a functional meditative device and an aesthetically pleasing sound sculpture.
- 1 participant commented: "*It's something I'd love to have at home, not just as a device, but as a decoration.*"

## 5 DISCUSSION

### 5.1 Ease of Use, Engagement, and Creative Potential

The design of ZenithChimes and Equilibrio prioritised simplicity and immediacy in user interaction. This was reflected in participant feedback: All users reported low difficulty, and 8 out of 10 found ZenithChimes particularly easy to learn. The familiar actions of touching and tilting contributed to the ease of use of the instruments, allowing participants without prior musical training to engage with confidence and curiosity.

ZenithChimes's layout, inspired by traditional piano keys, and its intuitive touch-based interface supported spontaneous music-making with minimal instruction. Similarly, Equilibrio's tilt-based interaction model, underpinned by passive conductivity sensing, offered an embodied form of musical engagement, fostering a tactile relationship between user and sound.

However, some participants noted limitations in creative freedom, particularly with Equilibrio's pre-recorded soundscape. While the instrument was appreciated for its aesthetic and meditative qualities, this feedback suggests a trade-off between artistic control and simplicity. Future iterations could explore incorporating modifiable or user-generated audio content to support a broader range of expression.

### 5.2 Meditative and Aesthetic Value

Seven participants reported that the instruments would be suitable for integration into mindfulness practices such as yoga or

sound baths. This highlights the meditative potential of the Harmonix series, particularly through the use of ambient soundscapes and calming physical gestures.

Equilibrio's interaction design, where sonic dissonance increases as the sculpture is tilted, was noted for its symbolic reflection of imbalance. This tension-disruption model mirrors themes in mindfulness, where awareness of inner imbalance is often a precursor to restoration. That the object could also serve as a sound sculpture further underlines its hybrid nature, existing between functional instrument and contemplative artwork.

### 5.3 Comparison to Related Work

The Harmonix series builds on existing explorations of digital musical instruments for wellbeing, offering distinct contributions in its emphasis on low learning curves, aesthetic design, and minimal hardware barriers. In contrast to systems requiring steep training or reliance on screens and controllers, these instruments enable immediate interaction through familiar and accessible actions.

ZenithChimes's probabilistic tone mapping introduces complexity without demanding musical expertise, creating space for spontaneity within structured tonal parameters. Equilibrio, meanwhile, combines panning and modulation in a single gesture, offering an intuitive, embodied musical control mechanism.

While the instruments were not tested in ensemble settings, their tonal design prioritises harmonic compatibility. Most notes in ZenithChimes belong to a common scale and consonant intervals, suggesting potential for group music-making. Future studies could investigate this collaborative dimension more thoroughly.

### 5.4 Limitations and Challenges

Several limitations must be acknowledged. The participant group, although varied in experience, was small ( $n = 10$ ) and restricted in age (20–40). No participants had physical disabilities, limiting insight into the instruments' physical accessibility. As such, this study does not claim to fully address accessibility for all user groups.

Additionally, sessions were conducted in an informal setting rather than during structured meditative practices. While participants reported feelings of relaxation, further investigation in guided environments would provide more robust insights into the instruments' efficacy for mindfulness.

Finally, although the aesthetic and ambient qualities of Equilibrio were praised, some participants expressed a desire for greater sonic control. Future developments may include adjustable sound sources or interactive generative audio systems to support meditative and expressive needs.

## 6 CONCLUSION AND FUTURE DIRECTIONS

This study introduced the Harmonix series, two Accessible Digital Musical Instruments (ADMIs), designed to facilitate intuitive music-making and promote mindful engagement. The design of ZenithChimes and Equilibrio prioritises tactile interaction, aesthetic quality, and ease of use, aiming to lower barriers for users regardless of musical training.

### 6.1 Creative and Reflective Interaction

ZenithChimes enabled participants to quickly engage in musical expression, offering a low learning curve and the harmonic sound design that encouraged creativity without overwhelming the user.

Equilibrio, meanwhile, invited reflection through its tilt-based interaction, creating an embodied relationship between movement and sonic response. Although the instruments were not tested in formal meditative or therapeutic settings, user feedback suggests calming and engaging qualities that warrant further exploration.

### 6.2 Limitations and Research Opportunities

While the instruments showed promise, the scope of evaluation was limited. The test sessions involved a small participant pool ( $n = 10$ ) within a narrow age range (20–40), and did not include individuals with physical or neurodevelopmental conditions. Additionally, all interactions took place in informal, individual settings rather than structured meditation or ensemble contexts. Future studies should explore these instruments in more diverse and longitudinal settings to better assess their accessibility, therapeutic potential, and collaborative capabilities.

### 6.3 Potential Applications

The Harmonix series sits at the intersection of art, technology, and mindfulness, offering possibilities for wider applications:

- (1) **Therapeutic Use:** While further validation is required, participants' responses suggest the instruments may hold value in therapeutic contexts—particularly in supporting stress reduction, emotional expression, and introspective focus.
- (2) **Community and Educational Engagement:** The simple interfaces and non-verbal modes of interaction may suit creative workshops and inclusive environments, particularly those that encourage shared music-making and emotional expression.
- (3) **Inclusive Music Technology:** The use of capacitive touch and passive tilt sensing enables interaction with minimal physical effort, potentially making the instruments suitable for individuals with reduced motor control. However, direct testing with these communities remains an important next step.

### 6.4 Future Development

Looking ahead, several paths for advancement are envisioned:

- (1) **Expanded User Testing:** Including older adults and individuals with diverse abilities to assess usability, engagement, and emotional impact.
- (2) **Structured Context Trials:** Deploying the instruments in meditation sessions, therapy settings, or collaborative sound-making workshops.
- (3) **Customisation and Multi-Sensory Feedback:** Adding user-controlled soundscape options, haptic feedback, or visual indicators to increase personalisation and immersive experience.
- (4) **Material and Sustainability Improvements:** Exploring alternatives to 3D-printed PLA and acrylic by adopting more durable and eco-friendly materials.
- (5) **Modular and Scalable Design:** Investigating how instrument components might be adapted or reconfigured to serve different user needs or group formats.

In sum, the Harmonix series proposes a new model of accessible, reflective digital instrument design, one that values creativity, simplicity, and mindful interaction. Although still in the early stages of development and evaluation, the work lays a foundation

for continued exploration into how musical instruments can support well-being, connection, and creative expression in a range of settings.

## 7 ETHICAL STANDARDS

This research was conducted as an independent study, and therefore no formal ethical approval was required. However, all ethical principles regarding human participation were followed. Participants were fully informed about the nature of the study and verbal consent was obtained prior to participation. No personally identifiable information was collected, and participants were free to withdraw at any time. This study did not involve any financial support or conflicts of interest.

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