An Exploratory Educational Drama: Scenographing with Sound in an Immersive Narrative Space

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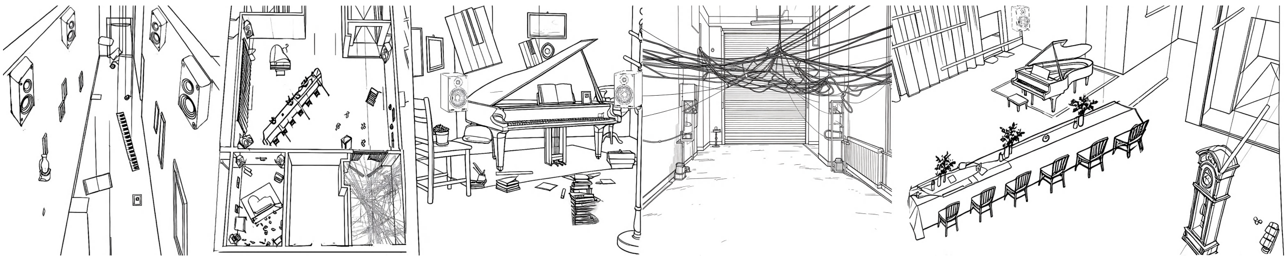

Figure 1: Scenographic concept line art of the project.

Abstract

This paper presents an immersive, actor-less theatrical experience where the physical space functions as a "narrative instrument." Developed as a pedagogical case study in creative technology, the project enabled undergraduate students to develop technical fluency in interdisciplinary system integration. The resulting system utilizes a distributed architecture--integrating distributed sensor networks and multi-channel audio engines--to map audience movement onto performative gestures across five interactive zones. By incorporating a "Wizard of Oz" surveillance system, the architecture ensures organic narrative progression where sound acts as the primary scenographic agent. This work contributes a practical framework for sonic worldbuilding and demonstrates an experimental pedagogy for cultivating applied technical skills within collaborative artistic production.

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Keywords

Immersive Theatre, Sonic Scenography, Spatial Instrument, Embodied Interaction, Acoustic Wayfinding, Interactive Performance, Pedagogy

1 Introduction

Traditional theatre relies on a scenography of the visible sets, lighting, and the physical presence of actors to build its world. This paper asks: what happens when the actor is removed, and sound becomes the primary agent for both narrative and scenography? We present an immersive, sound-driven drama where the physical performance space is transformed into a "narrative instrument," an environment that is played not by musicians, but by the audience themselves through their exploration and interaction. Our work is a purely sonic narrative, a theatrical experience where listening, movement, and discovery become the primary modes of engagement.

The experience casts the audience as "dream investigators" tasked with entering the subconscious of Fanny, a fictional comatose composer whose story is inspired by the historical struggles of 19th-century musician Fanny Mendelssohn [1]. Guided only by a multi-layered soundscape, they navigate through a series of physical spaces--a childhood corridor, a forgotten studio, a chamber of inner conflict, and a collapsing ballroom that represent different facets of her psyche. The audience's embodied interaction is not merely a feature but the central mechanism of the drama. Through acoustic wayfinding and by manipulating sonified objects, they directly uncover the narrative and drive the story to its conclusion.

This paper details the design and implementation of this experience, contributing twofold: 1) a design framework for sound-driven narratives where spatial interaction becomes the performance, and 2) a case study in Project-Based Learning (PBL). By situating undergraduate students as lead developers in a large-scale collaborative production, we examine how "learning-by-doing" fosters technical fluency in interdisciplinary system integration within creative constraints. In the following sections, we first situate our work within immersive theatre, site-specific sound art, and participatory interfaces. We then detail the technical implementation and discuss insights gained focusing on sound's potential as a narrative agent and its value as a pedagogical tool.

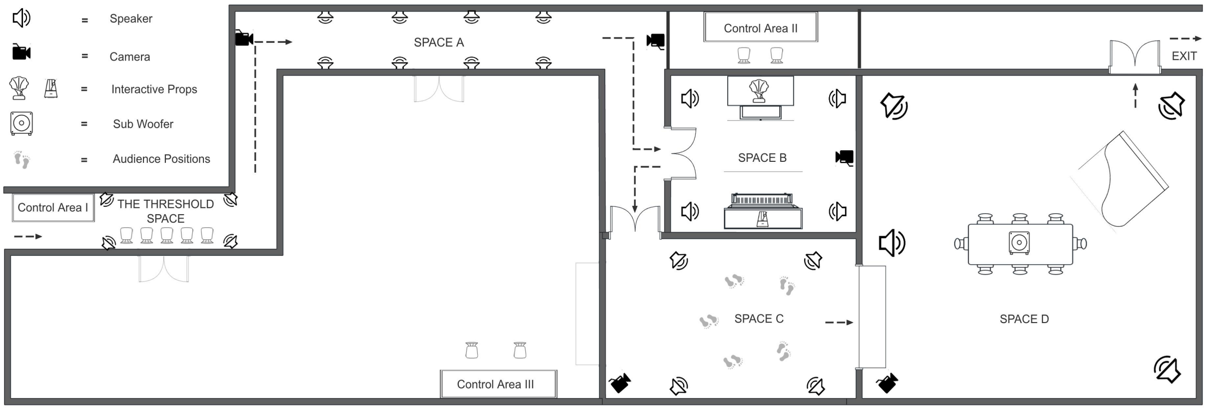

Figure 2: A top-down layout of the basement venue, showing the audience's path through all five spaces.

2 Related Works

2.1 Immersive Theatre and Narrative

Our work reframes performance space as the primary storyteller, drawing from seminal immersive theatre like Punchdrunk's Sleep No More, which prioritizes "visceral immersion" [2]. However, such works typically rely on human actors.

While companies like Darkfield prioritize acoustic immersion by removing visual stimuli and actors, their interactive works, such as ARCADE [3] and EULOGY [4] typically rely on headphones, which often constrains the audience to stationary positions to maintain spatial consistency. Our project synthesizes these approaches: we adopt an actor-less focus but reject the stationary constraint. Using a shared, multi-channel system within a navigable environment, we ensure the soundscape remains the sole protagonist while retaining exploratory agency.

Furthermore, we frame the participant's role through Janet Murray's theory of agency [5]. In our "navigable story," this agency is specifically auditory: while the overarching plot remains fixed, the moment-to-moment sonic unfolding is procedurally generated by the audience's physical presence. We thus define this work as a "spatial cyber-drama" [5], where walking and listening function as the primary mechanics for narrative construction, enabling an emergent narrative rather than a prescriptive sequence.

2.2 Space, Sound, and Interaction

Our approach to transforming a basement into a dreamscape is rooted in site-specific sound art. Sound art is not merely placed in space but actively creates or reshapes it [6]. We employ sound as "acoustic scenography"--actively staging space to define "acoustic territories" [7]. Each room is a unique territory representing Fanny's subconscious.

The choice of a subterranean venue aligns with Bachelard's phenomenological mapping of the psyche, where the basement symbolizes the deepest subconscious [8]. By situating the narrative within this architectural archetype, we utilize sound to mediate the transition from physical confinement to an 'intimate immensity'—a boundless internal landscape where acoustic scenography functions as the primary interface for exploration.

2.3 Tangible and Embodied Interaction

Physical interaction in this project aligns with Tangible User Interfaces (TUI), which give physical form to digital information [9]. Following Ishii's "Tangible Bits," we couple physical objects with digital computation to enable direct manipulation. While projects like GraviTone use this for collaborative music-making [10], we introduce "sonic keys"--interactive props embedded with microcontrollers. These function not just as sound-makers, but as triggers mapped to specific narrative states, effectively "unlocking" subsequent layers of the sonic drama.

Furthermore, Paul Dourish argues we engage with the world through our bodies; interaction is a situated physical practice [11]. In Accessible Digital Musical Instruments (ADMIs), this is critical. For example, *The Sound Tree Project* co-designs instruments attuned to performers' movements [12]. While they emphasize long-term co-design, we explore narrative resonance through short-term, situated embodiment. The audience's movement becomes the interface, turning exploration into the narrative engine.

3 Design And Implementation

3.1 Overall Concept and System Architecture

The audience, in the role of "dream investigators," traverses a sequence of five distinct physical zones within a repurposed basement, each meticulously crafted to represent a specific layer of the protagonist Fanny's psyche, **Figure 2**.

The entire system is orchestrated through a distributed control architecture comprising three distinct zones: Control Area I was responsible for The Threshold Space; Control Area II managed the core narrative progression in Spaces A and B; and Control Area III handled the climactic events in Spaces C and D, **Figure 3**.

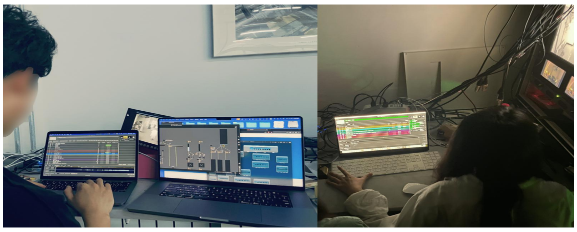

Figure 3: Distributed control infrastructure. Left: Control Area III; Right: Control Area II.

Surveillance cameras fed live video from all spaces to three control areas, allowing student operators to monitor progress in real-time and manually trigger cues or intervene for safety--acting as a "Wizard of Oz" human fail-safe within the automated system. Interactive objects and environmental sensors embedded with ESP32 microcontrollers [13] form the primary input layer. Data is transmitted via Bluetooth or WIFI MIDI to computers running Ableton Live [14], QLab [15], and Max/MSP [16]. These drive a multi-channel sound system and addressable LED strips, creating a closed loop where interaction modulates the scenography, **Figure 4 and Table 1.**

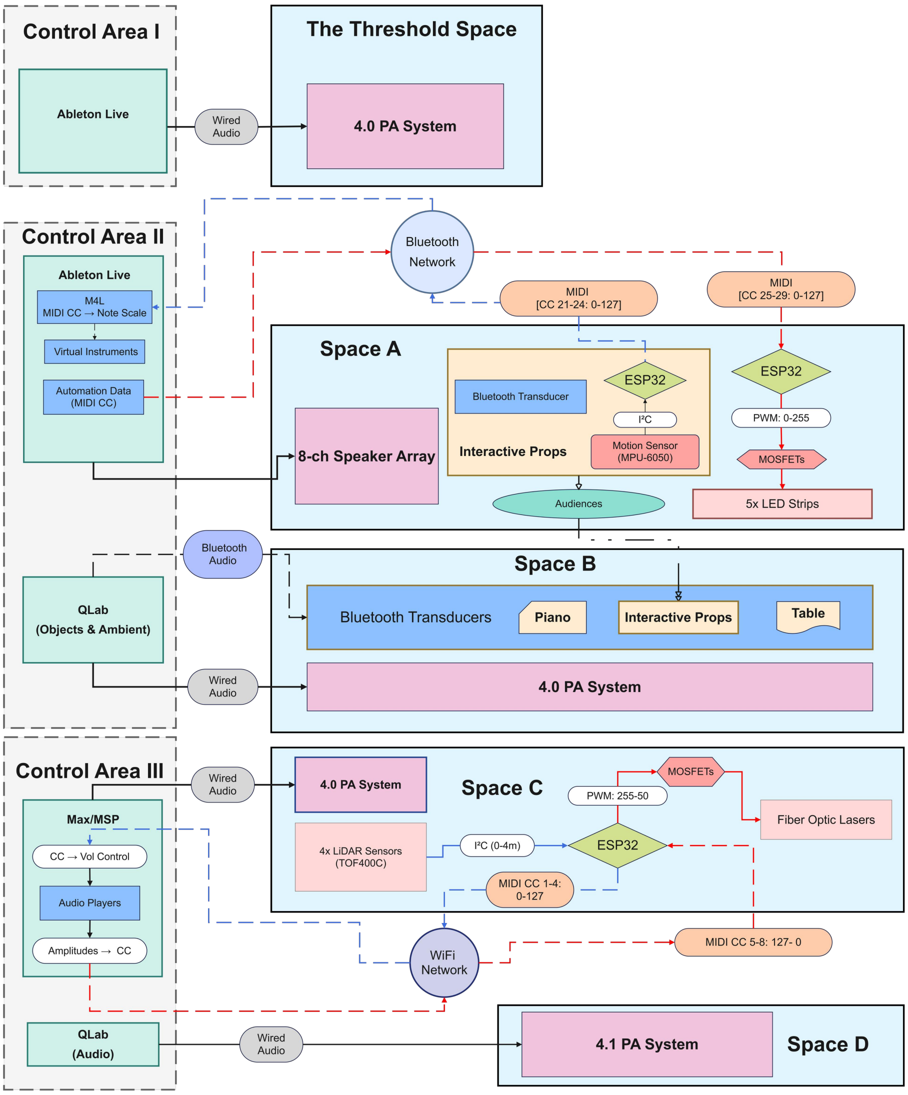

Figure 4: System architecture and signal flow.

Table 1. System Mapping Specifications and Parameter Ranges

Zone	Input Source	Raw Parameters	Mapping Step I	Mapping Step II	Source	Output Device
The Threshold Space	Visual Monitoring	Discrete Participant Action	Wizard-of-Oz Trigger: LED Controller		Power Adapters	RGB LED Strips
	Visual Monitoring	Discrete Participant Action	Wizard-of-Oz Trigger: Audio Cue		Audio Assets(DAW)	4.0 PA System
Space A	Accelerometer (MPU-6050)	**±10 m/s²** (X, Y axis)	MIDI CC 21-24: ±10 m/s² ⇒ 0 – 127	State-Change: Contact Trigger	Audio Scenes(Ableton)	8-ch Speaker Array
				Discrete Notes: Range-based quantization	Virtual Instruments(Ableton)	
	Visual Monitoring	Discrete Participant Action	Wizard-of-Oz Trigger: Audio & MIDI CC Cues		Synced Audio & Lighting Scenes (Ableton)	
	MIDI CC Messages (from Ableton)	MIDI CC 25-29: **0 – 127**	PWM to MOSFETs: **0 – 127 ⇒ 0 – 255**		AA Batteries	LED Strips
Space B	Visual Monitoring	Discrete Participant Action	Wizard-of-Oz Trigger: Audio Cues		Narrative Cues(QLab)	Bluetooth Transducers
					General Audio Cues (QLab)	4.0 PA System
Space C	LiDAR Sensors (TOF400C)	**0 – 4 m** (distance)	MIDI CC 1-4: **0 – 4 m ⇒ 0 – 127**	Audio Vol. of audio players in Max/MSP: **0 – R – 127 ⇒ 0 dB – -70 dB – 0 dB** (R: Silent Interaction Window) 1.Outside R: Normal volume mapping. 2.Inside R: Fast Fade-out to -70dB (at center)	Audio Assets(Max/MSP)	4.0 PA System
	Amplitudes of Audio Signals (from audio players in Max/MSP)	**-inf dB – 0 dB**	MIDI CC 5-8: **-70 dB – 0 dB ⇒ 127 – 0**	PWM to MOSFETs: **127 – 0 ⇒ 50 – 255**	Power Adapters	Fiber Optic Lasers
	Visual Monitoring	Discrete Participant Action	Wizard-of-Oz Trigger: Audio Cues		Audio Assets(Max/MSP)	4.0 PA System
Space D	Visual Monitoring	Discrete Participant Action	Wizard-of-Oz Trigger: Audio Cues		General Audio Cues (QLab)	4.1 PA System

3.2 The Threshold Space: Induction and Immersion

The journey begins in The Threshold Space, a zone bridging reality and the dreamscape, Figure 5. Guided by a performer, participants don blindfolds before entering a narrow corridor enveloped in a 4.0 surround soundscape. This transition simulates descent into the subconscious. Leveraging the audio's masking effect, the performer who also acts as system operator silently vanishes, leaving the audience alone in the automated environment. Upon completion of the pre-produced audio, a lighting shift concludes the sequence, signaling arrival within the dreamscape.

Figure 5: Participants in the Threshold Space. They undergo sensory deprivation to focus on audio before entering the dreamscape.

3.3 The Narrative Core: Spaces A & B

The next phase of the journey guides participants through the core narrative discovery in Spaces A and B. Guided by distant sounds into Space A, a long corridor representing Fanny's childhood, **Figure 6**, participants encounter pre-recorded footsteps and laughter panned through an 8-channel array to establish suspense.

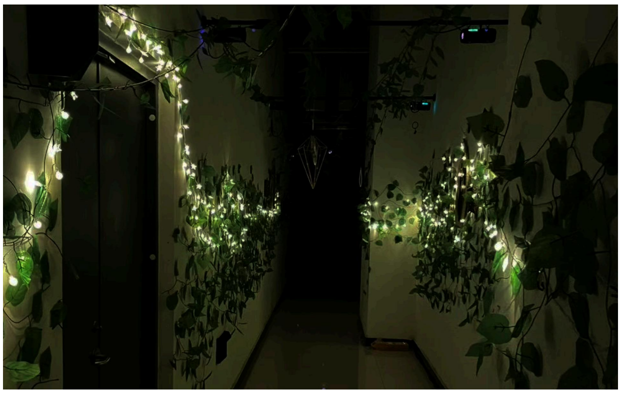

Figure 6: The scenography in Space A, showing the vine-covered corridor illuminated by LED strips.

Gameplay revolves around locating five hidden objects. A looping Ableton Live piano melody provides the baseline soundscape; each discovery adds a note, evolving the loop into a complete motif. This additive process is visually reinforced by mapping notes to five LED strips. This one-to-one mapping between discovery and sonic reward enhances agency, transforming searching into an act of composition. Triggered notes pulse corresponding LEDs, creating a synesthetic link between discovery, audio, and light.

Ableton Live serves as the central orchestrator. As illustrated in **Figure 7**, the Session View synchronizes audio with MIDI CC envelopes. Signals are transmitted via Bluetooth MIDI to a custom ESP32 module, **Figure 8**, which drives LEDs via MOSFETs, bridging digital logic with the physical environment.

Figure 7: Ableton Live Session View. Grouped tracks synchronize audio clips with MIDI CC-based lighting automation, managing scene progression in Space A.

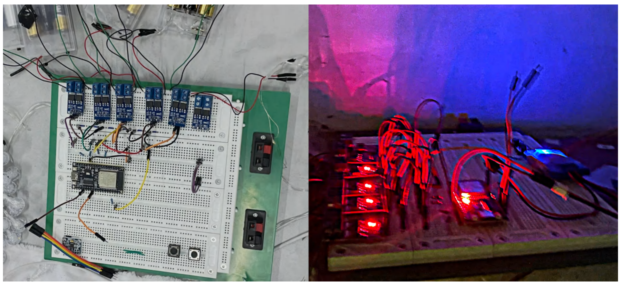

Figure 8: Space A hardware. Left: Circuit prototyping with ESP32 and MOSFETs. Right: Final system operational in situ.

Two props, a music box and a metronome serve as interactive instruments, **Figure 9**. Embedded MPU-6050 motion sensors stream continuous MIDI CC data to a custom Max for Live patch, **Figure 10**, enabling audience improvisation. Following the Space A sequence, participants carry these props into the next space.

Figure 9: Interactive props for Space A and B. Left/Right: Modified vintage metronome and music box. Center: Internal view showing the embedded ESP32, MPU-6050, and transducer for on-board audio.

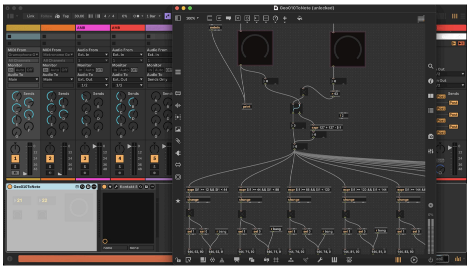

Figure 10: Max for Live patch mapping motion sensor MIDI CC data to musical notes.

In Space B, **Figure 11**, the focus shifts to object-based storytelling. Props from Space A (music box and metronome) "dialogue" with fixed objects via Bluetooth transducers. Placing props on designated spots triggers synchronized conversations emanating directly from the objects, creating an immersive, uncanny effect. This spatial audio reveal serves as a moment of surprise, deepening audience engagement with the physical props.

Testing revealed significant Bluetooth attenuation; closing the studio's wooden door severed the connection. Consequently, the door remained open to ensure reliable transmission. This practical constraint deepened students' understanding of wireless limitations, teaching them to optimize technical performance through spatial adaptation.

Figure 11: The intimate, vintage aesthetic of Space B, featuring a piano and antique furniture.

The sonic architecture of Space B is managed by QLab. Unlike Ableton Live, QLab supports simultaneous output to multiple audio interfaces, essential for managing both the 4.0 system and embedded transducers. Crucially, the triggering of these dialogue sequences relies on a "Wizard of Oz" technique [17] enabled by the surveillance network. Operators in Control Area II monitor the audience via live camera feeds; when they visually confirm that a participant has placed a mobile prop near a fixed one, they manually trigger the corresponding synchronized audio cue in QLab. This human-in-the-loop approach allows for a highly responsive and organically timed interaction without requiring complex proximity sensors on every object.

Developing Spaces A and B empowered students to integrate diverse software with handcrafted electronics. By combining Ableton Live and QLab with custom hardware, they translated complex digital logic into intuitive audiovisual synesthesia. Resolving practical constraints, such as signal attenuation, deepened their grasp of wireless limitations and fostered technical optimization through spatial adaptation.

3.4 The Climax and Resolution: Space C & D

The final act unfolds in Spaces C and D, managed via Control Area III. Space C literalizes Fanny's internal conflict, translating overwhelming doubt into a physical challenge. Initially filled with overlapping, critical voices, the space utilizes "sound masking" with audience bodies as the interface. Guided by visual floor cues, **Figure 12**, participants must occupy four locations. Each spot attenuates a specific noise layer, allowing the audience to "carve" silence through their presence.

This embodied interaction utilizes four TOF400C laser sensors connected to ESP32s via I2C, concealed within the scenography. Each node includes an OLED for MIDI Network configuration, **Figure 13**. Due to signal obstruction from a metal door, we opted for Apple MIDI (WiFi) over Bluetooth, supported by a concealed router. A custom Max/MSP patch processes these messages to modulate audio volumes; once all layers are silenced, a faint monologue is revealed. The patch simultaneously transmits data back to the ESP32 to modulate fiber-optic brightness, providing visual feedback. This complex integration taught students to manage signal flow across a multi-node network and resolve signal attenuation in physical environments through protocol switching.

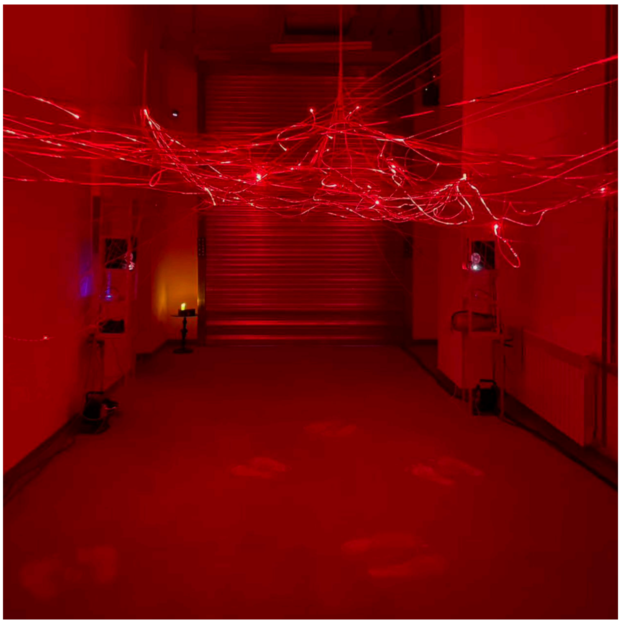

Figure 12: The scenography of Space C, featuring the fiber-optic web and footprint cues.

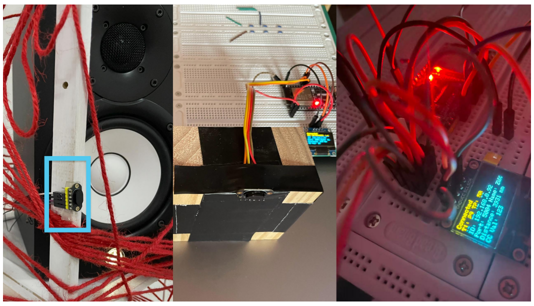

Figure 13: Distance sensing network implementation. Left: Concealed sensor. Center: Prototyping. Right: Active node displaying status data.

The final room, Space D, serves as the narrative climax. Staged as a surreal ballroom, **Figure 14**, the design prioritizes sensory immersion via high-power speakers and a concealed subwoofer. During the "dream collapse," these produce intense, palpable vibrations. This haptic effect conveys the scene's emotional weight more effectively than auditory input alone.

Figure 14: Surreal ballroom (Space D). Right: Audience entry view from Space C. Left: Reverse angle.

In completing Spaces C and D, students progressed from local hardware control to managing a complex, integrated system environment. By balancing delicate sensor-driven interaction in Space C with the high-impact haptic immersion of Space D, they successfully demonstrated how robust technical infrastructure can anchor and amplify a non-linear, emotionally driven narrative.

4 Iterative Design And Audience Feedback

The final version of the experience was shaped by an iterative process centered on audience reception. We conducted several pre-show sessions with test audiences to identify friction between technical implementation and narrative clarity, focusing on how the system's distributed architecture translated into a coherent user experience.

Pilot runs revealed a critical narrative gap in Space D, where the initial "escape room" mechanic proved insufficient. Originally, the climax required audiences to find a hidden key guided solely by audio. However, feedback categorized as narrative-teleological indicated that while the scene was emotionally intense, it lacked "agency" and "playability." Participants felt like "lost observers" rather than "investigators" and desired a more conclusive final action. Furthermore, developing complex new digital assets was unfeasible given the proximity of the premiere.

In response, the team introduced a social deduction mechanic to heighten engagement. One participant was covertly assigned the role of a "Dream Lurker" via an identity card to subtly sabotage the escape. Simultaneously, the operator (The Dream Master) from Control Area I--after triggering the induction cues--would covertly enter Space D to portray the "Nightmare," the only live character. This character emerges from the sonic chaos to preside over a "trial," where audiences must identify the Lurker through reasoning and voting, leading to multiple open-ended narrative outcomes.

This adjustment received significant acclaim, notably enhancing the drama's replayability and emotional resonance. Audiences noted that the sudden human intervention provided a visceral sensory "jolt" that resolved the preceding sensory overload. Furthermore, the introduction of the "Dream Lurker" and branching outcomes sparked a strong desire for re-experience; many participants expressed they were "left wanting more" and wished to undergo the narrative again to explore alternative endings. Although this pragmatically departed from our original "actor-less" goal, we analyzed it as a "necessary hybridity" that effectively "anchored" the complex sonic narrative through minimal human presence. Through this transition, students learned to employ "necessary hybridity"--blending game mechanics with human performance--to resolve narrative lulls and re-anchor audience focus within the complex sonic environment.

Continuous observations during the public run identified further technical refinements. The project culminated in a successful three-day run in late June 2025, comprising over 20 sessions. Its popularity was so significant that additional evening performances were added, and the initial five-person group limit was carefully raised to meet demand. During this high-intensity period, it was observed that the dim lighting in Space C, relying solely on fiber optics, occasionally led to participants missing essential cues, causing system "deadlocks". Future iterations will focus on more conspicuous visual cues and detailed voice guidance to ensure fluid narrative progression even under the pressures of a public-facing event.

5 Discussion

5.1 Design Framework: Narrative, Interaction, and Entanglement

Our contributions include framing the performance space as a playable "narrative instrument." While interactive environments are well-established, we push this further by removing actors and positioning sound as the primary scenographic and narrative agent. In Space A, the additive musical structure transforms discovery into a compositional process; in Space C, the audience's physical presence "tunes" the room. This reframes the audience's role from triggering pre-set events to engaging in a continuous performance where their journey is the composition. This extends Tangible User Interface (TUI) principles [9] from single objects like GraviTone's gravity well [10] to an entire architectural environment, effectively treating the space as a Large-Scale Digital Musical Instrument (DMI).

By replacing traditional actors, sound fulfills roles typically held by human performers: conveying emotion, exposition, and character. We employed a multi-layered strategy: diegetic "dialogue" in Space B creates intimacy, while non-diegetic soundscapes establish emotional tone across all zones. Furthermore, audience-driven sound-making functions as an internal monologue, allowing them to embody the protagonist's inner state. This demonstrates that an interactive soundscape can serve as a viable form of dramatic actor.

Finally, our design philosophy evolved from simple "interactions" to "entanglement," where boundaries between performer, instrument, and environment blur [11]. Space C's feedback loop, where movement, sound and light are co-dependently linked illustrates this state. In this system, traditional control hierarchies dissolve. This moves beyond the pleasure of agency identified by Murray [5] toward a holistic, embodied experience where participants feel inseparable from the narrative world.

5.2 Pedagogical Context and Value

This project was developed as a pedagogical experiment. It was undertaken as part of an undergraduate course for third-year students in a sound design program. To simulate a professional production environment, the core team of five sound design students, acting as co-creators, worked together through all phases of the project, **Figure 15**.

The students began the project with virtually no prior experience in programming or electronic prototyping. Through this "learning by doing" approach rooted in Project-Based Learning (PBL), we strategically selected a toolkit tailored to their background to bridge the technical gap. Max/MSP was chosen for its intuitive visual programming interface, which aligns seamlessly with the signal-flow logic of audio production. Complementing this, we utilized the ESP32 microcontroller for its affordability and ease of integration, along with accessible components like MOSFET modules, gyroscopes, and LiDAR sensors. These choices proved highly effective, with a minimal learning curve, students were able to rapidly prototype interactions, translating physical gestures into MIDI data, or conversely, converting MIDI signals into control voltages for physical outputs like LED strips.

One student from lighting design and one from stage technology were invited to collaborate as co-creators. The sound design students led the construction of auditory narratives and interactive logic, while their collaborators from lighting and stage technology steered the visual atmosphere and scenographic fabrication, **Figure 16**. This cross-disciplinary model fostered a vital dialogue: the sound-led creative vision found concrete expression through visual and spatial languages, while the lighting and stage technology students deepened their understanding of sound-driven storytelling through this collaborative process.

Figure 15: Four-phase pedagogical pipeline of student role evolution and skill acquisition.

Figure 16: On-site documentation: students managing all aspects of installation and system integration.

5.3 Lesson Learned

The core objective of this project was to cultivate "technical imagination" rather than requiring a mastery of low-level engineering skills. By providing a streamlined, modular toolkit, we lowered the barrier to entry, allowing sound design students to focus on the expressive potential of interactive technology.

Our goal was not for undergraduate sound design students to attain technical mastery of programming or interactive hardware design through this project; rather, it was to open a door to new creative horizons, equipping them with the interdisciplinary literacy required for future collaborative theater-making and broadening their individual career trajectories.

In pursuit of this goal, we identified a primary challenge within our PBL framework: the management of student cognitive resources within a single-semester cycle. We observed that students without relevant technical backgrounds faced significant pressure when simultaneously balancing narrative creation, sound design, and hardware deployment. This cognitive load often created a bottleneck, where the anxiety of technical troubleshooting could potentially stifle creative risk-taking.

To further enhance student agency, future iterations should consider integrating a preparatory foundational module prior to the main course. By introducing core concepts of programming and sensor logic earlier, students can achieve the "technical fluency" needed to enter the PBL phase as "informed creators" rather than "struggling beginners." This pedagogical scaffolding ensures that during high-intensity production, cognitive energy is preserved for high-level sonic interaction design and content innovation, allowing the technology to function as a seamless extension of their artistic vision.

6 Conclusion And Future Works

This paper presented the design, implementation, and evaluation of an immersive, sound-led theatrical experience. We have demonstrated a novel model where the performance space is transformed into a "narrative instrument," anchored by minimalist live performance yet played by the audience through their physical exploration and interaction. Our key contributions are threefold: 1) a set of practical design strategies for sound-driven scenography and narrative; 2) a theoretical framing of the audience's role that moves from simple interaction towards a more holistic "entanglement" within a co-creative system; and 3) a pedagogical experiment demonstrating how creative technology skills are organically cultivated through a Project-Based Learning (PBL) approach, specifically within the practice of collaborative artistic production.

For future work, on the artistic level, we will further explore the potential of the 'spatial interactive instrument' within sound-driven narrative and theatrical environments. This includes investigating how real-time generative composition can be driven by audience members' physical participation and verifying how such an audience-led soundscape can effectively evoke emotional resonance and drive narrative progression.

On the technical level, we will continue to refine the system's signal chain by adopting hybrid transmission models and mesh network architectures to address signal attenuation and latency, thereby enhancing overall robustness. Furthermore, we aim to establish more stable cross-modal mapping models between sound, light, and video within immersive theatre settings.

On the pedagogical level, we plan to optimize the PBL framework by decoupling technical skill acquisition from high-pressure creative production. By front-loading foundational technical literacy--such as programming and sensor logic--through a modular preparatory course, we enable students to enter the PBL phase as 'informed creators' who can focus on conceptual innovation rather than basic troubleshooting.

Finally, to ensure pedagogical continuity and institutional knowledge preservation, the project's technical framework--encompassing Max patches, hardware configurations, and associated code--has been systematically archived. While this archive is not yet publicly available due to ongoing refinement, we remain committed to the spirit of open-source technology. Our future efforts will focus on transitioning these 'creative building blocks' into a modular, public repository, inviting others to reconfigure and evolve these tools within their own experimental contexts.

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8 Ethical Standards

This paper complies with the NIME ethical standards. All participation was voluntary. Test audiences were recruited via internal announcements, informed of the experimental nature of the project, and gave their verbal consent to participate. Audience members consented that their verbal responses could be used anonymously in a research paper. This project was conducted with the necessary ethical consent and permissions through The Central Academy of Drama.

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