

Sonic metaverses of Odin and LUME theater laboratories: from embodied knowledge to collective memories

Adriana Parente La Selva
IPEM- Institute for Psychoacoustics
and Electronic Music
Ghent University
Ghent, Belgium
ORCID- 0000-0002-8524-5327

Ioulia Marouda
IPEM- Institute for Psychoacoustics
and Electronic Music
Ghent University
Ghent, Belgium
ORCID- 0000-0002-5467-0689

Pieter-Jan Maes
IPEM- Institute for Psychoacoustics
and Electronic Music
Ghent University
Ghent, Belgium
ORCID- 0000-0002-9237-3298

Abstract— This paper addresses the challenge of transmitting embodied theatre knowledge—rooted in corporeal and vocal training—into digital environments. While traditional archives often reduce performance to static documentation, we propose an alternative approach: archi-textures, interactive sonic and visual constraints that translate energetic practices into immersive XR spaces. Our work focuses on Odin Teatret and LUME Teatro, two theatre laboratories with long-standing traditions of actor training. We introduce a translation framework that unfolds across three layers: (1) distilling physical and vocal exercises into data-rich abstractions, (2) designing multisensory XR environments responsive to these dynamics, and (3) crafting feedback loops that bind user gestures and vocalisations to virtual textures. Two prototypes are presented. Work with Resonators transforms vocal vibrations into particle-based sonic-visual traces, while Six States of Water reimagines physical training scores as immersive environments that alter participants’ movement qualities. Preliminary evaluations show how these immersive archi-textures can reactivate energetic states and support new modes of training and transmission. Looking ahead, we outline a roadmap of three XR prototypes that extend this methodology into shared, networked, and AI-powered environments. These developments are grounded in ethical and decolonial protocols, ensuring community consent, cultural sensitivity, and participatory governance of archival data.

Keywords— *sonic and performative metaverses, extended reality, theatre laboratories, dramaturgy, embodied archives, intercultural epistemologies*

I. INTRODUCTION

Odin Teatret and LUME Teatro are two internationally renowned theater groups with a long-held history of embodied theater practices, developed over decades and shaped through diverse cultural exchanges. Their theater and vocal work unfolds through a dynamic interplay between onstage performance and sociocultural activities on the one hand, and offstage actor training and pedagogy on the other—two intimately connected dimensions that continuously inform and enrich one another [1], [2]. The groups’ pedagogical and studio-based practices, grounded in rigorous daily training, research and experimentation, gave rise to the notion of the *theater laboratory*. These laboratories are conceived as spaces for the development and refinement of artistic abilities—

environments that sustain both the aesthetic, technical, ethical, and spiritual foundations of the performer’s craft. They serve to broaden the actor’s physical and vocal techniques, shaping actors’ embodied knowledge, consciousness, and *presence* on stage.

In the context of their theater laboratories, actor training is developed through both individual and collective exercises. A particularly significant part of actors’ training involves awakening, understanding and manipulating different forms of energy in the body. LUME Teatro terms this process *energetic training*. These forms of training consist of rigorous physical work that activates and expands the actor’s corporeal energies, accessing layers of embodiment distinct from those of everyday movement and perception. In doing so, it opens pathways to unfamiliar modes of presence and performative expression, supporting their work onstage.

A large part of the work, practice, and repertoire of both groups revolves around the use of song and the exploration of vocality e.g. [3]. In their training, the voice is not treated as separate from the body, but as an integral extension of it. It is more than an instrument of speech or song—it is a vibratory force, a vital current of energy that is material, affective, and deeply embodied. Just as the body is trained to refine presence and intention, the voice undergoes a parallel process—one aimed at releasing habitual blockages and cultivating projection, clarity, and responsiveness.

Despite the depth and richness of these embodied repertoires, their transmission and preservation remain challenging. Conventional archival methods privilege textual, visual, or audio documentation, but cannot capture the energetic, kinaesthetic, and relational dimensions of training. This creates a gap in how embodied knowledge travels across time and cultures, particularly as the groups’ practices carry genealogies spanning over sixty years.

This paper contributes (1) a framework for translating embodied practices into XR environments, (2) two prototypes that exemplify this framework—Work with Resonators and Six States of Water—and (3) a roadmap toward future applications, positioning these prototypes within the wider discourse of the Musical Metaverse and intercultural digital heritage. Our aim is aligned with the broader agenda of the Musical Metaverse workshop: to situate sound, voice, and corporeality as central agents in immersive, networked, and participatory digital environments. By extending embodied

theatrical practices into sonic metaverses, we expand the notion of the metaverse beyond instrumental interaction, foregrounding dramaturgy, voice, and intercultural heritage as drivers of design. In this paper, we focus on the design principles and prototype realizations that materialize this dual commitment to pedagogy and heritage.

Both Odin Teatret and LUME Teatro have demonstrated a growing interest in the creative potential of emerging technologies, particularly those associated with extended reality (XR) and networked communication like the internet-of-musical-things (IoMT) [4]. In the acknowledgment of the possibility to expand physical embodied practices - whether spatial, temporal, or material—these technologies are approached not as substitutes, but as catalysts for expanded expression, interaction, and poetic invention. They open access to new experiential terrains: dynamic, multisensory and affectively charged environments, or *metaverses*, that provoke rupture, displacement, and reconfiguration. Within these digitally mediated spaces, relationships are no longer fixated but continuously composed and recomposed—shaped by the layered spatialities and temporalities afforded by the internet and immersive virtual architectures. Such environments challenge conventional modes of transmission and presence, inviting performers and audiences alike into alternative forms of agency, expression, and encounter.

In our work, the central aim is to translate, expand, and transmit the embodied practices within Odin’s and LUME’s physical theater laboratories into sonic and performative virtual *metaverses*. This objective is inherently dual—integrating pedagogical and archival dimensions in ways that cannot meaningfully be disentangled. On one hand, we explore how *metaverses* might function as virtual training spaces, enabling practitioners to activate, cultivate and expand corporeal energies. On the other, we envision them as living archives—immersive environments through which users can encounter and engage with the groups’ intangible embodied heritage; practicing the *body-as-archive* beyond documents and texts. This methodological orientation has been articulated in greater depth in earlier writings, [5], [6], [7], [8], [9], [10]. In the present paper, we focus on some of our design principles and prototype realizations that materialize this dual commitment to pedagogy and heritage.

II. PRINCIPLES OF TRANSLATION: FROM PHYSICAL THEATER LABORATORIES TO VIRTUAL METAVERSES

A core feature of our virtual *metaverses* is that their design, and the experiences and interactions they afford, are informed by fundamental principles, tactics, and techniques developed in the physical theater laboratories of Odin Teatret and LUME Teatro. In this sense, our work is essentially a process of *translation*: a translation between the physical and the virtual, and between corporeal actions and *extended* sensing. One specific chain of translations, which defines the two prototypes of sonic and performative metaverses we present in this paper, is outlined in Figure 1.

This translation process unfolds across three layers. The first layer involves the selection of a specific exercise from the extensive repertoire and archive of energetic training practices developed by Odin Teatret or LUME Teatro. From this exercise, we distill and abstract core physical and vocal qualities, in terms of energy, space and time. This step is often supported by quantitative tools, such as microphones, motion

capture systems, and physiological sensors that help translate the performative energy into digital data. The second layer involves designing interactive, multisensory XR environments that are directly informed by the data and qualities extracted from the original exercise. These immersive environments may include multisensory sceneries, objects, particle systems, and other perceptual elements that can be sensed by one or multiple users within the XR space. However, this is not a passive encounter. As illustrated in the third layer of our translation chain, user interaction lies at the core of our design methodology. Our approach draws on theories of phenomenology and embodied cognition—particularly the notions of *action-perception couplings* and *environmental action constraints* [11].

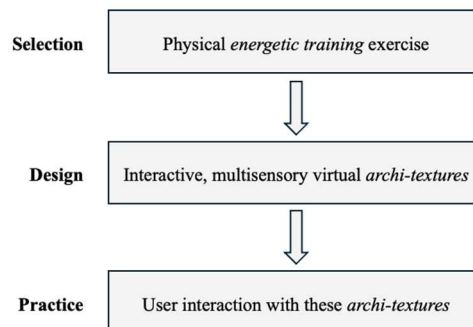


Fig. 1. Schematic overview of the translation principles underpinning our strategy for activating and expanding corporeal energies in sonic and performative metaverses.

At the heart of our design is the creation of feedback loops between users’ corporeal actions—gestures and vocalisations—and the responsive dynamics of the XR environment. These environments impose *constraints* that create a ground for possible defiance of physical rules and experimentation with invisible forces and qualities – as if the users could carve the air of the virtual (im)material space, allowing different kinds of resistance to be at play. The interweaving of dynamic textural elements and formations builds the archive like a net, a fabric of lines, textures that make the materiality of this construction more *archi-textural* than *archi-tectural*, to quote Tim Ingold [12]. The term *archi-texture*, following a tradition of critical thinking in geography and space studies, refers “to the communicative fabric that mediates between the structural properties of space and the spatial or communicative practices that reproduce this space”. [13].

Our main hypothesis for this present research is that environmental responsive textures, act as virtual constraints, and carry kinaesthetic qualities and information, guiding the user to discover “extra-ordinary” energetic features and qualities of movement. This communicative fabric has been designed by us in the virtual space, constantly being tested in order to set the right environmental constraints that will articulate the conditions for extra-daily action, for new energetic qualities to appear in the body of the user of the virtual archive. They were designed with and for the body, allowing a *porous* and dynamic exchange. To interact with these environments and their constraints is, we argue, to align one’s actions in counterpoint to the modulations of the designed textures, understanding the affordances – the potential – of the virtual for theater training. With these design principles, we aim to extend the possibilities and goals

of the physical theater laboratory of Odin Teatret and LUME Teatro into sonic and performative metaverses.

III. DESIGNS OF SONIC AND PERFORMATIVE METAVERSES

In the following section, we present two sonic and performative XR spaces—*virtual metaverses*—conceived as training environments that extend and transmit the embodied knowledge and practices cultivated within the physical laboratories of Odin Teatret and LUME Teatro. The designs exemplify the principles of translation outlined above, offering immersive experiences that are both pedagogical and archival in nature. They articulate the concept of *archi-textures*, introduced in the previous section, as communicative fabrics that mediate between corporeal action, environmental response, and *extended* sensing. Moreover, these designs serve as empirical grounds for inquiry, allowing us to test and refine our approaches, and to gain deeper knowledge into embodied experience, cognition and interaction.

Tables 1 and 2 (below) provide an overview of the two prototypes, their technical specifications, and their intended pedagogical focus.

Category	Work with Resonators
Origin exercise	Vocal and breathing resonator practices (head, nose, mouth, chest, abdomen)
Participants	10
Capture hardware	LD U508 BPHH 2 wireless microphone system, Qualisys Oqus 7+ IR system (sampling rate = 120 Hz)
Interaction mapping	Pitch → particle height; Volume → radius of particle ring
Software platforms	Unreal Engine 5, Ableton and Max for Live, Houdini and Blender
Pedagogical/Archival Focus	Exploring vibratory energy, sonic presence, voice-as-body

Table 1. Work with Resonators

Category	Six States of Water
Origin exercise	Structured physical actions linked to water states (fog, creek, iceberg)
Participants	12
Capture hardware	Qualisys Oqus 7+ IR system (sampling rate = 120 Hz)
Interaction mapping	Hand gestures emit attractive/repulsive forces on particles
Software platform	Unreal Engine 5
Pedagogical/Archival Focus	Exploring metaphorical embodiment, energetic states, kinaesthetic awareness

Table 2. Six States of Water

A. Work with resonators- energy as sound vibration

This work builds on vocal and breathing practices that activate distinct resonating chambers in the body—such as the top of the head, nose, mouth, neck, chest, and abdomen. These resonators can also be subdivided into more subtle and

specific zones of vibration. Our design draws on the expertise and longstanding work of Iben Nagel Rasmussen, Roberta Carreri, and Patrick Campbell. Their embodied techniques were captured and reimagined as an interactive sonic metaverse.



Fig. 2. Left: Practitioner Patrick Campbell performing a song. Right: The sonic metaverse feedbacking his vocal qualities. Screenshots.

In *Work with Resonators*, participants engage their voices through singing or speaking across varied pitches, exploring how vocalisation affects their own bodily sensation and the surrounding virtual environment. A ring of particles is programmed to emerge at the participant's core and follow their movement in space. The size and height of the particle ring and cloud is controlled by the voice. Using an external application, the pitch and volume of the participant's voice are extracted in real time—parameters chosen for their relevance to the energetic and vibratory nature of the original exercise.

This data governs the particle system: the higher the pitch, the higher the ring ascends; the louder the voice, the wider the radius around the body. Given the particles' short lifespan (approximately three seconds), they leave behind dynamic, organic traces—fluid, asymmetrical visualisations that poetically reflect the participant's vocal presence. These visual traces serve both as evocative manifestations of vocal energy and as invitations to explore new energetic qualities of voice, in alignment with the core practices of Odin Teatret and LUME Teatro. In this context, *translation* becomes an imaginative strategy—anchored in embodied expertise while open to the expressive affordances of new technologies.

To make this experience feasible, the coordination of various techniques and software was imperative. The main programming and real-time effects were facilitated through the deployment of the Unreal Engine 5 game engine, while 3D software tools Houdini and Blender were used for non-real-time models and animations. Additionally, a script was developed to extract the pitch and volume of the voice using Ableton and Max for Live. A LD U508 BPHH 2 wireless microphone system was used for capturing the actor's voice. The Qualisys motion capture system was employed in the laboratory for capturing movements. The project is built for Meta Quest 2 with the utilisation of its hand-tracking capabilities.

Participants engaged individually in XR sessions lasting approximately 20 minutes, during which their vocal practices dynamically shaped the visual and sonic environment. These strands of practices were mapped into data and performed several times, with intermissions for feedback on the capturing process, by 10 practitioners, both performers from Odin Teatret and long-term pupils of them, which throughout their

own careers have incorporated and transformed the original practices, adapting them accordingly to situated cultural circumstances, professional careers and contemporary politics that have affected the theatre landscape. Through qualitative feedback, they reported heightened awareness of their vibratory resonance and increased perception of the voice as a corporeal energy. In addition, feedback indicated that participants perceived the particle traces as both aesthetic feedback and mnemonic devices—visual echoes of vocal presence that encouraged experimentation with new registers.

B. Six States of Water

The second environment is based on the exercise *Six States of Water*, developed by Odin actress Roberta Carreri. The original exercise involves performing a structured sequence of physical actions, each representing a distinct energetic quality metaphorically linked to a state of water. Within the XR environment, we investigate how immersive, computer-generated spaces—what we term *immersive archi-textures*—can function as virtual constraints that elicit new creative states, unanticipated in physical space yet pedagogically valuable.

For the purpose of this prototype, we focused on three of the six states: *fog*, *little creek*, and *iceberg*. From each, we extracted key energetic qualities and translated them into interactive audiovisual environments. *Fog* evokes slowness and density (Figure 3); *little creek* is marked by quick, sudden deviations (Figure 4); *iceberg* communicates coldness and rigidity (Figure 5). 12 participants' full-body movements were tracked using a 12 camera Qualisys Oqus 7+ IR system (sampling rate = 120 Hz), with data mapped in real time to interactive particle systems designed in Unreal. Sessions lasted 30 minutes each.

Participants perform the score with the support of a virtual tutor—an avatar that guides them through the exercise. Interaction is central: in all three environments, participants emit an attractive force through their hands, which turns into a repulsive force when virtual particles come within a 15 cm radius. This dynamic is calculated in real time and is carefully tuned to evoke movement qualities aligned with each energetic state. Additional parameters—such as particle speed, trail, and force responsiveness—vary according to the specific environment.

To assess how these immersive *archi-textures* shape physical expression, we developed a layered method of analysis. This includes a Laban-inspired categorisation of expressive movement, participant self-reports via questionnaires, expert observations, and quantitative analysis using motion capture data. The results of the experiment were striking: the archi-textural metaverses significantly and spontaneously altered the corporeal articulations and movement qualities of trainees performing the *Six States of Water* exercise.



Fig. 3. Fog environment. Screenshot.



Fig. 4. Little Creek environment. Screenshot.



Fig. 5. Iceberg environment. Screenshot.

IV. A LOOK TOWARDS THE FUTURE: PLURAL EPISTEMOLOGIES FOR XR ARCHIVES.

Building on the methodologies and design tactics developed in these previous prototypes, and aligning with LUME Teatro's long-standing pedagogical ethos, our next research phase expands into new epistemological and technological territories.

The geopolitical shift towards recognizing and empowering the voices of the Global South represents a critical moment in contemporary historical and cultural discourses. As the Global South gains prominence, it is paramount to re-evaluate and restructure archival processes that have historically marginalized its diverse cultures. In Brazil, this shift is evident in the growing movements led by Afro-centered and Indigenous communities, challenging historical narratives imposed by colonial legacies. Traditional archival methods have predominantly favoured Western

epistemologies, often overlooking or misrepresenting non-Western cultures and knowledge systems. There is a significant gap in comprehensively understanding how the narratives and embodied knowledge of diasporic movements have influenced cultural identities and knowledge systems, particularly in contexts of survival and resilience [14], [15], [16]. The historical and cultural contributions of underrepresented communities remain insufficiently explored within global discourses, necessitating a focused study of their legacies and epistemologies.

Rufino [17] identifies “cracks” imposed by colonialism that represent both ruptures and possibilities. These cracks open spaces of negotiation and resilience, where alternative ways of being in the world emerge—what he terms “crack cultures,” survival transcultures that cross knowledge, memories, and experiences to create new forms of community. Following Bharucha [18], we understand culture as a shared “field of practices” and intraculturalism as the mobilizing consciousness of difference among participants. This project approaches intraculturalism dialogically, using XR to create virtual meeting grounds where difference becomes a generative force.

A central *field of practices*, a particular performative crack culture linking all these elements, has been developed for the past 40 years by LUME Teatro. Alongside their energetic training practices, LUME has been developing a creative and relational methodology called Corporeal Mimesis, which seeks to perform affective encounters between actor-observers and bodies/materials/images [19]. In other words, through living together, active observation and expanded attention to other bodies and sounds, LUME’s researchers recreate the affective materiality of these encounters in their bodies and voices. These direct relationships are organised within what LUME calls “artistic field research”. This is how LUME’s performers travel the open countryside and live with fishing villages in the south of the state of Minas Gerais, with indigenous tribes in the states of Pará and Amazonas, with oralities, and local legends told by elderly people in remote cities, with socially forgotten homeless people on the streets and alleys of São Paulo and Rio de Janeiro, with workers in a hat factory in a time and world where this accessory is no longer used. And from these underrepresented, invisibilised worlds, left out by history and the official episteme, LUME researchers learned songs, created oralities, recreated bodies, rhythms, postures, shared the sound and bodily stories of these worlds, generating immaterial archives of affectivities. It is precisely this material that will form the basis of this project, potentiating and activating plural epistemologies.

LUME’s sounding practices will methodologically afford a tried and tested approach to dialogically meeting the other through deeply embodied tactics that allow for more horizontal encounters, countering the colonial gaze haunting ethnography and archiving as fields. We believe this project will spark discussions on research processes in the Global North and South, offering diverse perspectives to decolonize HCI studies. Viewing decolonization as a living practice of mutual capacity building, we aim to create a broader narrative about intangible heritage through sound and listening, promoting dialogical exchange, recognition, and new social structures beyond the verbal and visible.

This framework will allow us to explore plural epistemologies through innovative navigation/dramaturgical tactics. We see the archive as a space for distributed

engagement, where the navigational tools suggest narratives for intracultural encounters. From this context, this research proposal also aims to trace the hierarchical structures of knowledge production in the transmission of songs and sounding practices and seeks to expand the current organization of transmission pedagogies. Our hypothesis is that approaching LUME’s practices and repertoire through spatial dramaturgies will unfold them as geopolitical objects, renegotiating intracultural worldmakings.

We aim to develop concrete prototypes of shared virtual spaces, or ‘living archives,’ to transmit intangible heritage based on the vocal exercises in the LUME repertoire. Three prototypes will be created in an iterative process over three cycles, addressing technological and dramaturgical challenges.

To achieve these prototypes, the project introduces four key technological innovations. First, it will capture LUME’s unique singing and sounding practices through advanced immersive audio and motion recording, expanding existing databases and forming the basis for immersive 3D content. Second, these multimodal data will be transformed into audiovisual sceneries that combine real-time and pre-recorded elements, experienced through head-mounted displays and state-of-the-art 3D audio rendering. Third, the project will establish a low-latency network enabling quasi-real-time collaboration across its international hubs, complemented by novel synchronisation strategies and a focus on repertoire elements such as drone-like textures and slow tempi that are less sensitive to delay. Finally, AI-based methods will be developed to allow intuitive voice- and gesture-driven querying of the databases, enabling real-time retrieval and interactive exploration of sound and movement archives.

A. Prototype 1: Listening to the Archive

Inspired by the memory palace method, we will develop an archival architecture within a shared virtual space. Visitors can explore and engage with LUME’s intracultural song repertoire in an immersive and embodied way. The design includes pre-recorded vocal exercises, full-body movement performances, and volumetric captures of the LUME theater. This first phase will be displayed in December 2025 at Itaú Cultural, an art center in São Paulo.

B. Prototype 2: Singing the Archive

This prototype adds an interactive layer to the previous one, allowing the visitors to engage with sounding practices via real-time remote social interaction. With this prototype, we explore how immersive spaces become a springboard to expressive and creative states, unforeseen in physical spaces, and useful for pedagogical transmission.

C. Prototype 3: Singing with the Archive

This prototype aims to explore the power of dialogue between human and non-human entities. Our goal is to create an AI-powered environment where embodied practices from previous prototypes generate social interactive, musical 3D spaces. Actions and vocalizations foster real-time intracultural dialogue, creating dynamic soundscapes, activating LUME’s song repertoire through intentional bodily movements.

To avoid reproducing extractive archival models, we will implement:

- Community consent procedures (informed agreements with performers and communities whose practices are included).
- Tiered access and licensing models to govern how data is stored, shared, and re-used.
- Participatory design methods that involve LUME practitioners and associated communities in iterative testing and decision-making.
- Cultural sensitivity audits to review how XR translations respect the affective and political context of the practices.

Through these measures, we aim to frame the XR archive not as a neutral repository but as a shared, dialogical practice of worldmaking.

V. CONCLUSION

With the advent of new motion capture technologies, interactive digital platforms, and extended realities, we see possibilities for approaching what has never been easily documented: tacit and embodied knowledge, oral and bodily histories, immaterialities, that which is volatile and fluid. Countering the *archive fever* triggered by these technological developments, our new endeavours seek to go further than aiming at safeguarding as many singing practices and songs as possible from oblivion. Instead, we have become interested in understanding how archives can be *experienced* as spaces of cultural memory. We ask, therefore, how embodied knowledge as a cross-media phenomenon can invoke dialogical practices of cultural transmission.

The translation of embodied knowledge into virtual *metaverses* runs along the fast-paced development of new technologies devoted to finding solutions to the human presence in such spaces. This race though, enacts a call for refiguring pedagogies of cultural transmission. State-of-the-art reviews assert that there is a lack of studies that unpack the epistemological impact of the travelling of embodied knowledge to other media platforms and its assimilation back into physical bodies [20], [21]. The migration of movement to digital and virtual platforms as data assets captured by different technologies- most prominently through motion capture systems- does not imply that such knowledge remains confined in these platforms. Further, Barber [22] and Warren-Crow [23] have shown how racial markers persist in motion capture data, even when they are displayed as animalistic, robotic, or anthropomorphic avatars. They describe how the migration of this racialized data entails a return into the ‘real world’ through the arts, video games, social media and entrepreneurial efforts, influencing a growing continuum of physical worldmakings and relationships that still reinforce colonial narratives and bodies.

On the other hand, communities at the margins of normative colonial discourses are increasingly experimenting with digital and virtual platforms to potentialize their own cultures- their own fields of practices. They are motivated by an opening up to the plurality of cultural others, and to the tensions that result from the collision with new technological paradigms with the cultural experiences inscribed in the bodies that inhabit it. Digital recording and preservation strategies are being applied to a diverse array of expressive practices, e.g. [24], [25], [26], [27]. Nevertheless, most of the interventions are object-centric and cater to conserving material-based, pre-recorded, passive knowledge. Few

endeavors thus far have fully supported an embodied interaction with the living nature of praxical knowledge as documents. A key challenge, therefore, is to develop suitable forms and effective methods to interact with archived embodied knowledge’s transient aspects and actively dialogue with cultural memories [28].

Thus the virtual archive at the heart of this project asks us to question our own preconceived disciplinary epistemes whilst platforming and potentializing plural cultural practices. As a form, song fuses narrative and feeling: it takes us to the complex world of the emotions that rhetoric alone is not always able to access. For Dyson [29], sound forms a critical vocabulary by which to confront the complexity of today’s crises; from ecological to economic, social to political. He emphasizes the possibilities afforded by way of sounding dialogues to “move toward a shared sensibility” from which to build “sense, the common, and common sense simultaneously”.

The investigation of human embodied presence in virtual spaces call evidently for an involvement of various humanities disciplines and practices. In the proposed project, we aim to investigate specifically how dramaturgical tactics may contribute to a dialogical and embodied engagement with ICH. Dramaturgy is gaining a crucial role in addressing plural epistemologies within XR spatial navigation, as it unfolds opportunities to trace and address hierarchical structures of knowledge production, expanded upon transmedial practices of embodied transmission [30], [31], [32]. By tying sounding narratives to virtual ecosystems, we follow and expand new dramaturgical research on the importance of spatial storytelling as cognitive and participatory activities for the senses of collective worldmaking and empathy towards cultural difference.

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