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DESIGNING SOUNDS FOR EXHIBITIONS: TOOLS TO ENHANCE SOUND-DRIVEN DESIGN STRATEGIES

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ABSTRACT

The evolution of exhibition design has been significantly influenced by the recent technological and curatorial transformations along with the conceptual and practical shift from viewing museums as collections to recognizing them as narrative spaces. For exhibition designers, an ever-growing need has emerged: incorporating sounds and listening experiences into their projects. These are considered valuable means of crafting complex narratives and multisensorial *habitats*, capable of designing relationships between space, time, content, and audience.

However, qualitative research conducted as part of a so-called project "Sound Design and Cultural Heritage" funded by Politecnico di Milano – which included literature reviews and fieldwork with semi-structured interviews of professionals and scholars – has revealed the need for shared conceptual and operational tools to address the sonic dimension in exhibitions. In response, we developed three methodological tools to guide the design process: two complementary conceptual tools (*Sound narratives canvas* and *Sound narratives notation*) and a practical design tool (*Exhibit sound score*). The purpose is to facilitate the conception and development of sound-driven exhibition projects by integrating curatorial strategies, spatial design, and sound design into multisensory and interactive narratives. Furthermore, those tools can enhance collaboration among curators, exhibition designers and sound designers, fostering co-design practices.

Keywords: *exhibition design, sound narratives, listening, sound-driven design, tools.*

1. INTRODUCTION: EXHIBITION DESIGN, FROM VISUAL TO AURAL

Recent technological and curatorial transformations have significantly impacted the evolution of the exhibition design discipline, shifting the focus from museums as mere 'collections' to spaces for narratives. As a result, Exhibition Design has increasingly served to orchestrate the complex relationships that intertwine cultural heritage, community and context into a dynamic ecosystem. Narrative strategies have become essential to engage audiences, enhance personal and collective meaning-making, preserve memory, and elicit empathy and emotions [1-2]. Furthermore, advancements in multi-modal and multi-channel technologies, along with cross-media and transmedia strategies, have led practitioners to increasingly adopt multisensory and interactive approaches in their projects, as witnessed by several design interventions such as those of Studio Azzurro, Migliore+Servetto, NEO, Karmachina, Studio Kamp, Studio Uwe Brückner, to name a few.

The field of exhibition design seems therefore to have undergone a major shift from the visual to the aural dimension. As a result, music and sound are increasingly exploited as both artefacts on display and valuable means for generating spaces of memory and emotion [3]. By creating resonant "multidimensional encounters" [4], such projects explore the narrative and immersive potential of sound as a means for embodied listening experiences.

In this paper, we present the first findings and a proposal for *sound-driven methodological tools* as preliminary results of an ongoing research project so-called "Sound Design and Cultural Heritage" (SoundeCH). This research aims at qualitatively investigating the role of sound design within the cultural context, especially in terms of exhibitions and interactions, by means of a design-driven qualitative approach [5].

The study underwent three main phases: 1) An exploratory phase based on secondary research framed the theoretical and practical context of sound design through an extensive

review of literature on exhibition design, narratives and sound design. 2) A second phase involving primary qualitative research included an in-depth analysis of paradigmatic case studies and semi-structured interviews with sound designers, researchers, and exhibition design studios, identifying approaches, practices, methods and tools. 3) The findings then formed the theoretical and empirical basis to develop and test a set of *sound-driven design* tools, which were later tested.

Section 2 briefly presents the SoundeCH research giving an overview of the theoretical framework, especially in terms of exhibition design and sound narratives. We also present the results of the semi-structured interviews analysis that revealed the so-called "semantic gap problem", especially among sound experts and non-experts [6], as well as the need for shared conceptual and operational tools addressed to exhibition designers who deal with the sound dimension in exhibitions. Section 3 introduces *sound-driven design* [7] as a valuable framework for crafting sound and listening experiences in exhibitions. In this section, we also discuss the motivations behind developing methodological tools for sound-driven exhibition projects and present those tools. In Section 4, we present a first evaluation test of the tools and the preliminary results and considerations. Finally, in Section 5, we draw our conclusions.

2. SOUND DESIGN AND EXHIBITIONS

The literature review shows that, in recent decades, museums and exhibitions have undergone a significant paradigm shift in curatorial and design approaches, transforming them into "live events" where a dramaturgical use of sound plays a central role [8]. We witnessed a radical transition from simply displaying collections to creating complex ecosystems built around open and performed narratives, that are increasingly interactive and multisensory. As a result, contemporary museums have evolved into meaning-making spaces, inherently multidimensional and embodied. The exhibition narratives unfold in the three-dimensional space and flow in a fluid temporal sequence [9], revealing a dramatic structure involving three fundamental media - space, time and content - [10]. These elements are the key components that inform contemporary exhibition design, transforming it into a highly relational and functional communicative act.

2.1 Sound as a spatiotemporal means for exhibition narratives: a theoretical overview

As a result, within the three leading exhibition spatial typologies - *Narrative, Performative and Simulated* - [11],

time has become a structural exhibition design tool, playing a growing role in shaping the relationship between exhibits, narratives, and audiences [12]. In fact, the interplay between narrative and experiential time, enhanced by new multimedia technologies and strategies, allows for manipulating visitors' perceptions, enabling stories to expand and contract while offering multiple levels of interpretation. Consequently, the inherent spatiotemporal qualities of sound, along with its embodiment in perception, led to a growing interest from both practitioners and scholars who investigated the role of sound "in relation to narrative, atmospherics, and other museum elements" [13].

Some studies highlight the inherent space-time and multisensory qualities of sound experiences in exhibition narratives, particularly the interplay between sound and motion [8]. Others focus on sound relationship with narratives in Popular Music exhibitions, advocating for *narrative-driven strategies* [14] that support a *performatively-driven* curatorial framework, wherein the visitor acts simultaneously as *an actor, director, spectator, and participant* [15-16]. In this context, sound acts as an interpretive tool, enhancing engagement and learning beyond emotional responses. Moreover, sound reveals spatial dimensions [4, 17], contributing to the concept of *museological resonance* and *soundmarks* [18]. Some scholars proposed viewing the museum as a *multi-layered, multisensory and multimodal journey* that includes *proprioceptive, sensory, intellectual, aesthetic, and social* space-time dimensions [19], where sound and listening are crucial. From this perspective, the sonic dimension may also help accessibility issues [20], though the inclusiveness of *aural diversity* remains underexplored [21].

Additionally, contemporary museums have been studied from a spatial and acoustics perspective, leveraging the so-called *sonic placemaking* concept [22-23]. Investigating immersion, interactivity and new media, many scholars explored the role of sound design in audiovisual artefacts, focusing on how sound and images influence perception and cognition [24], as well as ideation processes and sound-sketching methods [25-26]. A thorough body of studies investigated multisensory auditory displays and embodied interactions to understand how non-verbal sounds shape human-object interactions [27-28].

2.2 Sounds as a tool for communication: interviewing professionals and experts

Building on these theoretical foundations, we conducted semi-structured interviews to examine how the exhibition design practice incorporates the sound dimension and what challenges it rises. The interview protocol included

structured and open-ended questions based on the People-Processes-Products framework from the ASDP project [29]. We developed three interview templates tailored to sound designers, exhibition design studios, and researchers. Those templates focused on two main areas of interest: (1) a structured section to gather information and contextual details about the respondents' professional practice – People – and (2) a semi-structured section – Processes & Artifacts – to collect first-hand data on sound design in the cultural heritage sector. This section included insights on Processes and Methods, particularly addressing communication challenges, Languages and Approaches, and Tools.

We interviewed 5 sound designers with backgrounds in multimedia, cinema, VR, and sonic interaction design to explore their different approaches, methods and tools and the main challenges they face in their practice. In addition, we involved 3 exhibition design studio founders whose focus is on music-related exhibitions and multimedia interactive narratives to better understand about their collaboration with sound professionals and deeply grasp when the sound dimension enters their creative process. Lastly, we engaged with 4 academic researchers who study sounds from different design and research perspectives.

Although the limited number of interviewees and their heterogeneous backgrounds, a significant concern emerged. In the early stages of the exhibition design process, communicating sound concepts outside established project teams can be challenging, which can negatively affect the integration of sound with other design elements. There are two possible reasons for this issue. Firstly, the term "sound design" lacks a clear definition [29], which often results in non-experts such as curators, exhibition designers, and architects underestimating the significance of sound designers within the design process. Secondly, the absence of a commonly understood vocabulary for describing sound makes it challenging for sound designers to effectively communicate their intentions to non-expert exhibition designers [30], and vice-versa. In addition, both sound and exhibition designers express concern about the absence of standardized design tools that could improve collaboration with other stakeholders, especially when dealing with highly multisensory and interactive contexts. As we have seen, these projects require designing the complex relationships between content, space, time and audience to achieve specific cultural and communicative goals. Consequently, when designing narrative spaces or sounds for an exhibition, both exhibition and sound designers have continuously to mediate and translate the cultural message. As a result, they need to collaborate iteratively to craft embodied and spatial listening experiences that enhance the audience's interpretation of cultural artefacts and stories.

The objectives go beyond simply transmitting messages; the aim is fostering emotional, intellectual and aesthetic engagement.

3. TOWARDS A SOUND-DRIVEN EXHIBITION DESIGN

In this regard, the *sound-driven design* framework [6-7, 31] is well-suited for exhibition design as well since it lays the foundation for a *research-oriented* and *listening-centered* design approach, which aims to create *representational tools* that enable sound designers to effectively collaborate with other stakeholders while overcoming the "semantic gap problem" and the communication challenges previously mentioned. As highlighted earlier, designing interactive and multisensory narrative environments requires a focused approach to crafting sounds and synesthetic languages that meet specific cultural and communicative objectives. The goal is to foster spaces for *social awareness and interpersonal communication*. In the exhibition context, the design of sound narratives should have a clear *auditory intention* [32] and an explicit communicative function supported by aesthetic and evocative qualities. Therefore, a sound-driven design approach could undoubtedly guide the exhibition design process, starting from the initial conceptual stages, allowing to overcome the communication problem that hinders the exchange of ideas among exhibition designers and sound designers.

3.1 Sound-driven exhibition tools

Given these premises and to address this issue, we have developed three interrelated *sound-driven methodological tools* to bridge the communication gap and address the lack of shared tools explicitly designed for exhibition designers to address *sound-driven exhibitions*. The purpose is to include both the design of sound – understood in a broad sense – and the listening experience as fundamental design elements within the design process.

To develop these tools, we drew from scientific literature and crossed concepts and strategies retrieved from research- and design-oriented tools that pertain to different sound design application contexts. These tools are intended to guide the early conceptual and design phases of the design process while enhancing co-design practices, especially among exhibition and sound designers and, potentially, curators. In detail, we have developed two complementary conceptual tools, respectively named **"Sound narratives canvas"** and **"Sound narratives notation"**, that should help designers envision and visually represent the main important features of sound projects, focusing in particular

on listening experiences, curatorial strategies and sound dramaturgy, thus making explicit the existing relationships among content, space, time, audience and media. We then enriched and implemented a previously proposed practical design tool, the so-called "**Exhibit sound score**" [33] to make it consistent with the other conceptual tools[1].

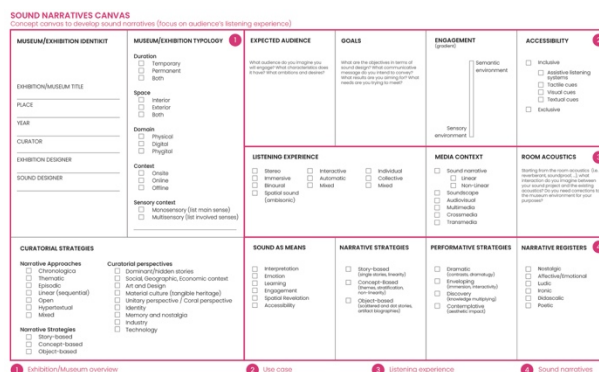*3.1.1 Sound narratives canvas[2]*

During the research fieldwork, we analysed over 20 paradigmatic case studies to explore the growing use of sound as a narrative, interpretative and sensory tool for exhibition from a practical perspective. These case studies encompassed temporary and permanent, indoor and outdoor, multimodal exhibition projects developed since the early 2000s, wherein the sound project was intentional and showed functional, environmental and identity characteristics. Based on that, we built the first sound-driven design tool aimed at guiding the ideation phase of *sound-driven exhibitions*: the so-called **"Sound narratives canvas"** (see Fig. 1).

It consists of a four-step ideation process, the first of which is more analytical, while the others are more project-related:

1) **Museum/Exhibition overview**: a summary of the most important features of the museum/exhibition especially in terms of typology – i.e. duration, space, domain, *context and sensory context* [34] – and curatorial strategies – i.e. narrative approaches [35], narrative strategy [14] and curatorial perspectives [15].

2) **Use case:** the first conceptual step focused on audience, *goals* and levels of *audience engagement*, and accessibility [20-21].

3) **Listening experience and media context**: the second ideation step aimed at better defining the listening experience, the media context, and the sound project-museum acoustics relationships [22-23].

4) **Sound narratives**: the third and last conceptual step, strongly interrelated with the curatorial exhibition strategy defined in step 1, aimed at defining approaches in terms of use of sound as a means [4], narrative and performative strategies and approaches [14-15], and communicative registers [35].

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[1] The three tools have some overlapping concepts. While the conceptual tools guide the overall project approach, different strategies can be used for each exhibition section as long as consistency is maintained.
[2] The idea of the Canvas was inspired by Lenzi and Ciuccarelli's *Data Sonification Canvas* (2024) [34] and it has been adapted to our specific purposes.

Figure 1. Sound narratives canvas, *source: the authors* (link to the original file)

3.1.2 Sound narratives notation: musical and visual metaphors

The above-mentioned analysis of paradigmatic case studies also revealed four main trends within the space-time context of exhibitions that recall music composition structures: *linearity, stratification, contrast*, and *rhythm*.

This finding led us to hypothesize that we could use musical metaphors and compositional structures as a pretext to *designerly* explore the key qualities of sound, spatial design and experiential composition in museum exhibits. Indeed, designers often draw on metaphors, especially visual ones, as inspirational tools that encourage creative thinking and innovative ideas [9].

Inspired by the practice of electroacoustic, electronic and computer music graphic notation, as well as by the different techniques used by sound designers to sketch their sonic intentions [25, 36], and by data viz strategies used by designers to visually represent complex subjects [34, 37], we developed a second tool, which we refer to as **"Sound narrative notation."** This tool serves as a visual translation of the *Sound narratives canvas*. It is an ideation tool that enables designers to translate the spatial, narrative, and aural exhibition structure into a concise, meaningful, and impactful visual representation. It presents a double interpretation, whether seen by exhibition (E.Des) or sound designers (S.Des). It consists of three main elements that make well clear the strong interrelationship among content, space, sound and the audience's experience:

1) the **absolute score** (S.Des point of view) is understood as the place of representation of the space-time of the exhibition experience equivalent to the top-view plan of the spaces, as seen by the E.Des;
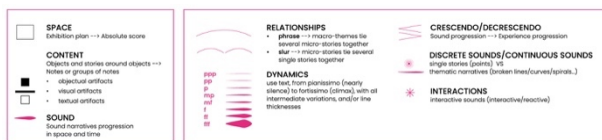
2) the **notes or group of notes** (S.Des point of view), represent the exhibition content – be the object, visual or textual artefacts –, and the stories around the objects (E.Des point of view);
3) the **sounds**, in the form of dynamic graphic colourful signs, are the binders that, like light can do, rhythmically weave together and organize both space-time and content in a meaningful progression.
The main characteristics of the sound narrative progression along the space are then visually represented through graphic symbols, partly retrieved from musical conventions, which are made explicit in a legenda (see Fig.2).

Figure 2. Sound narratives notation legend, *source: the authors* (link to the original file)

By way of example: **Sound/content relationships** are represented as *phrases* indicating macro-themes/stories that tie together several micro stories or as *slurs*, here understood as single stories tied together in micro-themes or stories. **Sound/engagement dynamics** represent the dynamic evolution of sound narratives through texts, from *pianissimo* to *fortissimo*, or through line thickness.
Sound/experience crescendo/decrescendo represents the simultaneous progression of sound narratives and audience experience in space-time. **Discrete/Continuous sounds** illustrate either a single story, taking place in a specific moment-place, or thematic sound narratives that unfold along the whole or part of the exhibition path. **Interactive sound/content** graphically represents where the designers envision interactive and/or reactive content to enhance audience's experiences.
All or part of those elements are placed on the visual board according to the main sound-narrative approaches (*linearity, stratification, contrast, rhythm*) defined in the *Sound narratives canvas*. This graphic representation is needed as the grounding for the advanced design phase guided by the *Exhibit sound score* tool.

3.1.3 Exhibit sound score (updated)

The **Exhibit sound score** is necessary as both an analysis and an advanced design tool, as proposed by Zhang and Trocchianesi in 2023 [33]. This methodological tool primarily focuses on the audience's experience as it is shaped by the sonic dimensions of the exhibition. It allows for the representation of the sound narratives unfolding along the path through a diagram of parallel horizontal lines, each line corresponding to a specific design variable.
In line with the objectives and findings of this research, we have enriched the content section, providing greater detail on sound dramaturgy. Unlike the previous version, the updated *Exhibit sound score* is now organised according to the three aforementioned key *loci* of the exhibition: *Content, Time (of the experience) and Space* (see Fig.3).

Figure 3. Exhibit sound score, *source: the authors* (link to the original file)

The **Exhibition Sections** row outlines all the sections or rooms of the exhibition along a linear and sequential timeline, following the curatorial structure, and serves as the base for the design process.
The **Content** section proposes a detailed analysis of the sound dramaturgy, defining a sonic proposal for each specific part of the exhibition. In detail, it explores: *Media context* (e.g. audio, linear/non-linear storytelling; soundscape; audiovisual; multimedia; crossmedia; transmedia); *Sound narratives approaches* (e.g. linearity, contrast, stratification, rhythm); *Sound functions* (value range among e.g. evocative, functional-informative, aesthetic functions; indexical, iconic, symbolic [34]); *Narrative strategies* in terms of *Performativity* (e.g. dramatic, enveloping, discovery, contemplative) [15], *Registers* (e.g. nostalgic, affective, ludic, ironic, didascalic, poetic) [35], *Sound categories* (e.g. diegetic, non diegetic [24]; music; narratives: scripts, theatrical presentations, readings, interactive dialogues, oral stories, interviews; ambient sounds), *Sound expressions* (e.g. voice, sound effects, music, natural sounds, noise, silence), *Type of sounds* (e.g. *concrete, synthetised*) [34], and *Sound features* (e.g. General qualities; Timbre; Morphology) [38].

In the **Time** section we highlight how long the audience should engage with all the provided content.

Finally, the **Space** section presents spatial and technical proposals for sound narratives focusing on the ***Artefacts mise-en-scène*** (e.g. displays and exhibit design, materials, shapes, spatial distribution, etc.); ***Interactions***, in terms of interrelations among sounds and other design elements (e.g. light, materials, artefacts, visuals, etc.), *Interactivity* (e.g. interactive, non-interactive, reactive sounds), and *Systems of mediation* (e.g. touch screens, mobile devices, haptic, sensors, body movement); and ***PA and audio systems technologies***, defined by *Appearance* (e.g. visible, hidden), *Typology* (e.g. loudspeakers, actuators, transducers, directional panels, sound showers, headphones: intra-aural, supra-aural, circumaural; semi-open, open), *Transmission channels* (es. mono, stereo, surround; standard or site-specific), *Spatialisation* (eg. 0D, 1D, 2D, 3D, SPATIAL) [23], and *Room acoustics correction.*

4. TESTING SOUND-DRIVEN EXHIBITION TOOLS

In order to test those co-design and communication tools and the derived design methods, we organized 6 workshop days entitled "Designing sound narratives for exhibitions". It took place in February and was assisted by a sound expert and an exhibition expert tutor. It was addressed to young Interior, Interaction and Communication designers (*average years*: 23). The participants had some musical skills but little or even no experience in the exhibition design field. We paired them up, combining their diverse backgrounds, and tasked them with designing immersive and interactive sound narratives using the sound-driven exhibition tools provided by the research team.

The aim was to envision new perspectives and novel forms of storytelling within an existing museum context, enhancing the cultural experience for visitors.

The project context was the historical collection of the ADI Design Museum in Milan, presenting the Compasso d'Oro winning products and projects from 1954 to 1984, where the sound component - except for the acoustics of the spaces – is absent. We organised a guided tour of the museum with the exhibit designer of the ADI Design Museum and a design collector and expert.

During those six days, we conducted a few frontal lectures (6 out of 44 hours) to introduce the project context and the workshop challenge. We provided a brief overview of topics such as the physics of sound, auditory perception, sound-space relationship, listening perspectives, exhibit design, and sound narratives. Moreover, we showed the

participants a series of paradigmatic case studies. After this, we briefly explained how to use the sound-driven design tools, allowing them to focus entirely on developing their proposals. Finally, the young designers presented their final projects to external reviewers.

4.1 Preliminary results

Considering the participants' unfamiliarity with exhibition and sound design, the limited time available, and the novelty of these tools, the final proposals were promising. Through the *sound-driven design tools*, all pairs of young designers provided interesting concepts and good visual representations of how to enhance the exhibition contexts by exploiting the sound dimension. After the project delivery, we asked them to fulfill a Questionnaire that generally showed a positive response. All the participants agreed on the value of the tools in guiding the design process and framing intentions, objectives and narrative paths during the conceptual phases. They also glimpsed the possibility of making the *Sound Narratives notation* 'universal,' with a commonly shared legend that designers can apply to every project. However, some concerns emerged. Especially the *Sound narratives canvas* and the updated *Exhibit sound score* seemed excessively rich in details for inexperienced designers, lacking a clear representation of nodes and relationships from which to derive the main design choices. Moreover, some participants felt the lack of specific tools addressed to room acoustics.

5. CONCLUSIONS AND PROJECTIONS

In this paper, we presented the first findings of the SoundeCH research aimed at exploring the role and practice of sound design within the exhibition design field. The review of scientific literature has revealed a prominent shift in exhibition design approaches. There is a growing emphasis on narratives and active audience engagement, which highlights the importance of multisensory experience and embodied listening. As a result, the design of sound narratives is becoming increasingly significant and challenging. Fieldwork conducted through a series of interviews addressed to sound designers, exhibition designers and researchers, although limited in number, raised the issue of communication among the various stakeholders involved in the exhibition design process, especially among exhibition and sound designers, as well as a lack of shared tools to address the so-called "communication gap problem" [6-7]. We argued the exhibition design field could be inscribed within the *sound-*

driven design framework [6-7, 31]. Therefore, we proposed three sound-driven methodological tools – *Sound narratives canvas, Sound narratives notation*, and *Exhibit sound score* – to guide the first conceptual and design phases and enhance co-design practices towards sound-driven exhibitions. The use of the tools in a real-world design context has proved promising despite critical issues that need consideration to improve and validate their effectiveness.

We plan to broaden the user base by testing the tools in different educational and professional contexts. Additionally, we intend to engage in discussions with academics, professionals, and experts to refine our representation and communication methods to create an ecosystem around sound design and cultural heritage. In this regard, the SoundeCH project connects with other research initiatives[3] that explore the role of sounds in cultural experiences. Finally, we will promote the field through dissemination events, scientific publications, and a special issue of an international Museum Studies journal.

6. ACKNOWLEDGMENTS

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