REDEFINING CULTURAL PARTICIPATION

AN EXPLORATION OF MULTIMODAL EXHIBITION ENHANCEMENT FOR BLIND AND VISUALLY IMPAIRED MUSEUM VISITORS

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PREFACE

This project presents valuable contributions concerning the effectiveness of technology when enhancing museum experiences for blind and visually impaired visitors, as well as their post-experience behaviours. Within the broader classification of technological applications in museum context, this project concentrates on exhibition enhancement, i.e., the augmentation of physical museum spaces through multimodal technologies that enrich on-site engagement and extend its impact into the post-visit phase. Exhibition enhancement through accessible wayfinding, narrative-based audio descriptions, and tactile representation provides the foundation of the concept model, which works as the outcome for this project. The aim with the concept is to explore possibilities on how to transform a traditional sight-based experience, visual art exhibitions, into a rich, multisensory exploration for blind and visually impaired museum visitors.

The broader aim of this project is to contribute design insights into how exhibition spaces can be reshaped to become more inclusive and multisensory, especially for audiences traditionally underserved in visual art contexts. Given this context, the decision to limit the project to the initial phases of the design process is both deliberate and aligned with the research-oriented and conceptual goals of the thesis. Rather than proposing a fully developed product or system, the project aims to investigate existing accessibility barriers, understand the interconnected phases of a museum visit (pre-, on-site, and post-visit), and generate a concept model that reflects user needs and theoretical foundations. In addressing barriers, this project adopts the International Classification of Functioning, Disability and Health (ICF) definition: disability is not solely a function of an individual's physical or mental impairment; rather, it emerges from the interaction between these impairments and an environment that is not structured to accommodate their needs (World Health Organization, 2013). This approach provides the opportunity to engage deeply with the problem space, informed by fieldwork, literature, and user perspectives, and to propose a coherent, research-based concept.

This scope also reflects the emphasis on experience-based innovation and critical design thinking. By focusing on the *on-site* phase as a key opportunity for engagement, and understanding its influence on post-visit experiences, the project contributes to the development of design knowledge that can inform future exhibition design and accessibility strategies. The proposed concept model is not intended as a finished solution but as a strategic design proposal rooted in insight, reflection, and methodological rigor. Further, the design process has unfolded through multiple iterative cycles, which involved continuous back-and-forth between the design phases. However, for the sake of clarity, the process is presented in a linear sequence, enabling readers to follow the progression in a logical, step-by-step fashion.

In accordance with good academic practice, I would like to declare my use of generative AI (ChatGPT) in the preparation of this paper. AI tools were used as a sparring partner throughout the writing process of this project to correct grammar and refine the structure of this paper. This use was limited to supporting clarity and coherence, all intellectual, conceptual, and creative work remains my own based on the conducted research and featured literature.

ABSTRACT

In the absence or limitation of vision, individuals synthesise inputs from all available senses to construct coherent meaning (Levent & Pascual-Leone, 2014). In a museum context, this reframes the visit as an embodied encounter, where multiple senses support both cognitive comprehension and emotional resonance (Jantzen et al., 2011). Building on these findings, this project investigates how to enhance the on-site phase with rich multimodal technology and multisensory elements that can create accessible exhibition engagement and inform positive post-visit experiences.

This investigation is guided by the findings emphasising that on-site interaction aided by multisensory technology deepens immediate understanding and memory of artworks can foster meaningful post-visit outcomes and lasting benefits, such as greater learning and personal attachment, after leaving the museum (Kirchberg & Tröndle, 2012). Thus, by extending the sensory, cognitive, and motor functions of visually impaired visitors in a technology-mediated environment, interaction reshapes the exhibition into a co-creative space, reducing practical and perceptual barriers, deepening emotional resonance, and supporting reflective meaning-making. Crucially, not only enhance immediate immersion but also encourage ongoing engagement that can sustain visitors' connection and engagement to the museum itself (Bekele et al., 2018).

Within the broader classification of technological applications in a museum context, the concept model for this project focuses specifically on the enhancement of visual art exhibitions, augmenting exhibitions spaces through accessible navigation, narrative-based audio descriptions, and tactile representations. These technical considerations aim to create a system that transforms traditional, sight-based encounters into rich, multisensory explorations. Ultimately, this project contributes valuable insights and considerations into a range of technological measures, regarding enhancing museum experiences for blind and visually impaired visitors and shaping their post-experience behaviors.

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INTRODUCTION

Museums today are evolving from static repositories of objects into dynamic, participatory environments that prioritise visitor interaction and inclusion. Across disciplines, institutions are rethinking their roles, shifting from being “about something” to being “about someone” (Høffding et al., 2022), and embracing new frameworks that emphasise meaningful engagement, reflection, and co-creation (Vermeeren et al., 2018; Morse et al., 2023). This transformation aligns with third-wave HCI’s focus on emotional, narrative, and experiential dimensions of technology use, complementing traditional concerns of efficiency and usability (Hassenzahl et al., 2013). As a result, museums are leveraging digital tools and collaborative practices in an attempt to meet visitor expectations and create more engaging experiences in an effort to cater to a broader audience (Løssing, 2009, p. 13; Rudloff, 2013; Seale et al., 2020). Within this broader landscape, art museums face particular challenges and opportunities. Historically, art institutions have centered on visual perception, presenting paintings, sculptures, and other visual media with limited interactive elements (Skot-Hansen, 2008). In the context of visual art exhibitions, this has meant that visitors often experience works primarily through sight, while other sensory modalities remain underprioritised.

To address this imbalance, three particular approaches have been widely adopted are: the co-production of exhibitions, removing barriers to access, and the design of multi-sensory experiences, including immersive and interactive exhibits (Rudloff, 2013; Seale et al., 2020). However, while these advancements and efforts have the potential to enhance accessibility and engagement for individuals with disabilities, research indicates that many visitors still face mobility, sensory, and cognitive barriers that limit their ability to fully experience museum content (Zakaria, 2020; Kuflik et al., 2015). Barriers such as restricted access to certain spaces, inadequate or non-existing audio or tactile descriptions, and inaccessible display interfaces continue to hinder participation (Leahy & Ferri, 2022). As a result, ensuring equal access to cultural participation for people with disabilities remains a pressing issue, especially for blind and visually impaired museum visitors, due to the ocularcentric nature of visual art (Vaz et al., 2020; Brandt et al., 2014).

SCOPE OF THE PROJECT

Museums are widely recognised as complex environments, where conveying the concepts embodied in collections, displays, and exhibits is not always straightforward (Seale et al., 2020). Visual-art exhibitions, encompassing fine, contemporary, decorative art, and craft forms, pose particular challenges and accessibility barriers for blind and visually impaired visitors, as these art forms rely primarily on sight to be perceived and interacted with (Li et al., 2023). Some museums have improved accessibility for blind and visually impaired visitors by, e.g. allowing them to touch pre-selected art objects or by providing audio guides (Seale et al., 2020). Even though measurements and practices are widely regarded as the baseline for good accessibility practices, they still remain rare, are often not tailored specifically to the needs of visually impaired audiences, and fall short of conveying the subtle details and rich context of complex or abstract artworks (Li et al., 2023).

In response, research highlights the potential of both low- and high-technological interventions and multimodal strategies, such as 3D-replicas, smart canes, object recognition systems, and more, to expand access to museum knowledge and collections. Other experimental methods go a step further: For example, dialogical verbal descriptions invite visitors to ask questions, offer observations, and help co-construct the meaning of an artwork—breaking the museum's usual focus on sight alone (Seale et al., 2020). However, while many of these solutions hold promise, they often remain unexplored, often focusing on single senses or isolated interventions rather than addressing the interconnected phases of pre-visit expectation, on-site engagement, and post-visit reflection that defines museum visit (Wang et al, 2024).

These phases are the: pre-visit, on-site, and post-visit phases, each of which shape and reinforce the next (Vaz et al., 2020). Pre-visit planning establishes expectations and logistical feasibility; on-site engagement provides the direct sensory and cognitive encounter; and post-visit reflection consolidates learning, emotional resonance, and ongoing cultural participation. Because barriers at any phase can cascade into the others, an intervention that strengthens the on-site phase through exhibition enhancement can unlock more accessible and meaningful post-visit experiences (Vaz et al., 2020). Importantly, accessible museum design needs to consider all three phases, integrating sensory, intellectual, and physical access from start to finish (Vaz et al., 2020).

Accordingly, this project focuses on enhancing accessibility in visual-art exhibitions by situating itself at the intersection of **identifying the barriers that prevent blind or visually impaired museum visitors from interacting with visual art; exploring the relationship between pre-visit expectations, on-site engagement, and the post-visit museum experience; and exploring multimodal technologies for exhibition enhancement, with a deliberate focus on the on-site phase and its subsequent effect on the post-visit phase.** By taking these dimensions into consideration, this project aims to create a concept model that outlines a more accessible on-site experience through multimodal exhibition enhancement, which builds upon a combination of pre-existing solutions. The concept model for this project builds upon these considerations by integrating tactile and auditory elements, wearable personal devices, and interactive audio-descriptions. This inquiry culminates in the following problem statement guiding this project.

PROBLEM STATEMENT

How can the integration of multimodal technologies within exhibition enhancement support blind and visually impaired visitors' engagement with visual art and enhance post-visit experiences?

THEORY

Understanding how museums facilitate meaningful and inclusive experiences for blind and visually impaired visitors requires a grounding in complementary theoretical approaches and perspectives to inform the design of exhibition enhancement. Theoretical approaches to accessibility and meaningful experience emphasise that these concepts are not fixed attributes but emerge through a shared understanding. Relevant for the understanding of accessibility throughout this project is embodied cognition—the notion that understanding develops through physical interaction with one's surroundings. In the context of non-visual interactions, tactile engagement allows blind visitors to build spatial and conceptual models incrementally, relying on bottom-up sensory processing rather than purely ocular-centric modes of perception (Gibson, 1983). By centering haptic and auditory modalities as valid aesthetic and cognitive channels, these insights challenge prevailing assumptions that vision is the default pathway to knowledge (Arnheim, 1990).

Complementing these embodied perspectives, social-constructivist theory posits that reality and meaning are co-created through social interaction and cultural norms (Löwgren & Stolterman, 2004). From this vantage point, museums function not as neutral repositories but as participatory environments where visitors, curators, and communities shape one another's experiences (Meecham et al., 2013; Seale et al., 2021). Finally, a phenomenological lens brings attention to the first-person, lived experience of museum visits. Here, knowledge is rooted in how individuals encounter space, artifacts, and sensory stimuli through their bodies and senses. By capturing the qualitative essence of an experience—its unfolding in time, its emotional resonance, and its lasting memory—phenomenology offers a nuanced account of how blind and visually impaired visitors perceive and make sense of cultural environments (McCarthy & Wright, 2004). Together, these theoretical strands, embodied cognition, pragmatism, social-constructivism, and phenomenology, provide a multifaceted framework for understanding and designing inclusive, meaningful museum experiences.

WHAT IS AN EXPERIENCE?

Experiences range from everyday moments to extraordinary manifestations. While everyone engages in everyday activities, like brushing their teeth or taking a shower, these routine occurrences rarely form lasting memories, even though they are experiences. In contrast, “an experience”, as explained by Dewey (1934), stands out as a defining moment that reshapes our understanding; it is transformative and memorable because it breaks from routine and creates new associations and insights (Jantzen, 2013). The aesthetic dimension of an experience further enriches its impact by transforming an ordinary encounter into something dynamic and memorable.

In the contemporary shift from a service economy to an experience economy, the nature of cultural consumption has evolved. In this new paradigm, museums are no longer viewed solely as repositories of art and history but as immersive environments that stage memorable events (Morse et al., 2023). Pine and Gilmore (1998) describe experiences as economic offerings distinguished from goods and services by their ability to engage visitors on emotional, intellectual, and sensory levels. By framing a museum visit as an experience rather than a transaction, institutions can cultivate deeper personal connections and foster meaningful engagement.

An aesthetic experience can be described as a “lively integration of means and ends, meaning and movement,” where acts of interaction resonate emotionally and intellectually, preserved in memory through ongoing narrative elements, and generates tension and expectation that ultimately leads to reflective transformation (McCarthy & Wright, 2004). When these dynamics are effectively orchestrated, a museum visit becomes an immersive, multifaceted encounter that blends sensory, cognitive, and emotional dimensions. Within a museum context, meaningful experiences go beyond the physical act of being in the space; it is about the personal reflections, narratives, and memories that occur when engaging and interacting with the cultural content (Morse et al., 2023).

For visitors with disabilities, crafting such transformative experiences requires an approach that not only ensures physical access but intellectual and sensory access regarding how content is presented and how interactions are facilitated, which is essential to achieve meaningful experiences.

A MEANINGFUL MUSEUM EXPERIENCE AND TECHNOLOGY

The philosophical perspectives of recent developments in design research emphasises the significance of *meaningful experiences* in the design of products, services, and interactions—particularly within cultural and museum contexts (Hassenzahl et al, 2013). There is a growing call within design research to create moments of meaning; the importance of meaning-making and meaningfulness has also been pointed out as central goals of interaction design. This shift reflects a broader movement within third-wave Human-Computer Interaction (HCI), which emphasises not only usability and efficiency but also the emotional, experiential, and non-instrumental aspects of how people engage with technology (Hassenzahl et al., 2013).

In museum contexts, design researchers have highlighted the importance of cultivating meaningful engagement within a museum context, designing for both individual and group experiences across physical and digital spaces, facilitating reflection, and enabling personally relevant, contextually aware visitor interactions (Vermeeren et al., 2018; Morse et al., 2023). This conceptual alignment is critical to the aim of the present project: to explore how inclusive and accessible post-visit experiences can be developed in ways that resonate with the personal narratives and emotional engagement of visitors, including those with disabilities. For a post-visit experience to hold value, the pre-visit and on-site encounter must not only be accessible but must also enable meaningful engagement that visitors are motivated to revisit and share. The role of digital technology in this context is not only to serve as an accessible tool, but to serve as a mediator of meaningful experience, one that supports personal interpretation, memory formation, and emotional resonance (Hassenzahl, 2010; McCarthy & Wright, 2004).

Despite this emphasis, however, the understanding of *meaning* as a quality of interaction in HCI remains underdeveloped, and the cultural sector has similarly not yet articulated a comprehensive model for how meaning is created and experienced across the full spectrum of a museum visit. In particular, it calls for a reimagining of digital strategies that do not simply extend access but actively support personal meaning-making, especially for those whose ways of experiencing and engaging with culture may differ from dominant normative assumptions (Morse et al, 2023).

CREATING MEANINGFUL EXPERIENCES THROUGH THE SENSES

The brain processes information from various sensory inputs and combines them to create a coherent and unified perception of our surroundings (Gibson, 1983). Sensation and perception are inherently linked, constituting our cognition of the world and what we experience. Sensation is defined as the process by which we organise and interpret the sensory data received, while perception is the process by which we recognise meaningful objects and events in the world (Gibson, 1983). Although vision is often considered as the dominant sense, it is important to recognise that different situations or individuals may prioritise other senses depending on the context, prior experience, personal traits or abilities (Levent & Pascual-Leone, 2014).

Multimodal perception is therefore crucial, as it refers to the human capacity to receive, integrate, and interpret information through multiple sensory channels either simultaneously or in combination. Rather than processing each sense in isolation, the brain naturally fuses input from different modalities to create a unified, coherent understanding of the world. This integration enhances not only spatial orientation and memory but also emotional resonance and cognitive clarity (Levent & Pascual-Leone, 2014). This ability is fundamental to how people engage with their environments and perform everyday tasks, allowing people to navigate the world, communicate effectively, and understand complex information by creating coherent and sometimes meaningful experiences (Levent & Pascual-Leone, 2014).

In the context of museum experiences, multimodal perception plays a particularly critical role. Visitors do not simply observe artworks; they listen to curatorial narratives, navigate through physical space, feel environmental conditions such as light or sound, and sometimes engage directly with tactile or interactive elements. For blind and visually impaired visitors, non-visual senses, especially touch and hearing, become the primary means of accessing and interpreting cultural content. Their engagement relies on how well the environment supports this complex interplay of sensory inputs. For instance, a blind visitor navigating a gallery might simultaneously rely on the spatial layout conveyed through tactile floor maps, the auditory cues embedded in a soundscape, and the kinesthetic feedback of movement through space.

THE SENSES, ATMOSPHERE & AND OCULARCENTRIC NORMS

Museums themselves are not neutral spaces but sensorially curated environments, where light, sound, temperature, and even olfactory stimuli can be orchestrated to produce an "atmosphere" that actively shapes visitor perception (Böhme, 1993). An atmosphere exists in the interaction between artifacts and people, and can be described as a mood that arises with the potential to evoke certain emotions or reactions (Böhme, 1993). The ability to synthesise these sensory and emotional streams allows for a meaningful understanding of an exhibit, even when visual information is absent. Thus, designing for multimodal perception means crafting experiences that deliberately engage more than one sense, not as a compensatory measure, but as a strategy for deepening understanding and accessibility. Aesthetic perception, then, is not only confined to vision but involves a continuous interplay of sensory impressions, bodily awareness, and emotional responses.

For museum visitors that depend on other senses than sight, tactile investigation, tracing textures, and forms, help to construct spatial and conceptual understanding of the artworks incrementally. As Arnheim explains:

> "*The sighted person is capable of seeing a human figure and even an entire landscape as an integrated whole, not equally accessible to the blind. This does not mean, however, that haptic perception must make do with a sequence of elements, which at best can be patched together intellectually. Rather the need to integrate the elements of a coherent whole is as dominant in haptic perception as it is in any other organic process. In fact, the receptor organs of touch are spread all over the surface of the human body, from head to toe; touch is directly coordinated with the complexity of kinesthetic sensations inside the body. Consider, for example, how the recognition of an object by touch is helped when the internal sense of balance supplies the spatial dimensions in which torso, arms and fingers are reaching. The two hands with their many independently mobile joints make for a whole orchestra of touch stimuli, to whose simultaneity vision has no equal*" (Arnheim, 1990, pp. 60-61).

This approach not only affirms the efficacy of haptic engagement but also informs accessible alternatives for exhibition design. Tactile pictures, for example, offer immediate and accessible representations of visual artworks.

However, tactile representations of photo-realistic images, while useful for sighted audiences, can be ineffective or even confusing for blind users, as they lack the structural clarity necessary for haptic interpretation (Arnheim, 1990). Thus, an artwork executed through or supported by haptic perception naturally embodies the constraints and affordances of touch. When blind artists work, they are guided by the sensory vocabulary of their own hands: overall scale must remain manageable for finger-and-hand exploration. The result is an aesthetic rooted in clarity of form, symmetry, clear contours, and bold relational structures, rather than fine surface textures or visually complex nuances that cannot be reliably distinguished by touch (Arnheim, 1990).

In light of these insights, it becomes clear that fostering meaningful museum experiences for blind and visually impaired visitors requires more than simply adapting the dissemination and presentation of existing visual materials—it demands a fundamental reimagining of how aesthetic value is defined and communicated. Such a reframing challenges ocularcentric norms and invites institutions to develop inclusive practices based on diverse sensory literacies (Houghton, 2024). When blind and visually impaired visitors are empowered to engage exhibitions through their preferred sensory channels, they cultivate not only vivid mental models of the artworks but also a deepened confidence in their perceptual and interpretive capacities (Arnheim, 1990).

This goes hand in hand with the idea that visual arts can foster the understanding of complex meaning or concepts by providing an experience that potentially involves multiple senses and that is more accessible for visitors than a mere presentation of facts (Falk & Dierking, 2000). In addition, the arts have the ability to encourage alternative ways of thinking and individual reflection, which may ultimately lead to the inclusion of new perspectives into mainstream discourse or the shifting of ocularcentric norms. This implies that engaging with the arts or with the content of an exhibition can lead to behavioral changes or at least emotional responses, enriching long-term cultural participation (Wilson, 2006). These perspectives can further push participatory engagement to foster genuine inclusivity when rooted in co-creation rather than tokenism (Høffding et al., 2022). For blind and visually impaired audiences, this entails both the affirmation of sensory expertise and the opportunity to inform technological and curatorial strategies that constitute accessible exhibition enhancements.

DESIGN PROCESS

This project is guided by an integrated design framework that brings together the convergent and divergent phases of the Double Diamond framework with the phases of the Design Thinking model, as well as relevant design principles and mixed-methods, ensuring a user-centered approach and inclusive design process.

The Double Diamond framework, developed by the British Design Council[1], provides a robust and structured roadmap by dividing the process into two cycles of divergent and convergent thinking (Design Council, n.d). In the divergent phases, it is possible to deliberately broaden the inquiry—gathering a wide range of user insights, uncovering hidden needs, avoiding bias or assumptions (Lund, 2012). This expansive mindset also ensures that diverse perspectives are brought to light and are taken into consideration. By contrast, the convergent phases support a structured analysis to synthesise information, prioritise concepts against criteria such as feasibility and desirability, aligning findings and insights with the objective of the project (Kochanowska et al., 2022).

The Design Thinking model[2] is suited as an approach to solving complex problems where it is necessary to draw on knowledge from many disciplines to view the problem from different angles. The model unfolds through five iterative phases, guiding designers from uncovering latent user frustrations to validating existing practical solutions. This approach emphasises empathy, creativity, and iteration, supporting a human-centered approach that encourages designers to engage directly with the users to gain a deeper understanding of their needs and perspectives. Further, engagement allows designers to establish a relationship with the users, based on trust and mutual respect. It enables designers to ask open-ended questions, listen actively, and learn from the insights and lived experiences (Cross, 2023).

[1] https://www.designcouncil.org.uk/our-resources/the-double-diamond/

[2] There are many suggestions for process models for Design Thinking, however, this project uses the model defined by Stanford University (2010).

DESIGN FRAMEWORK

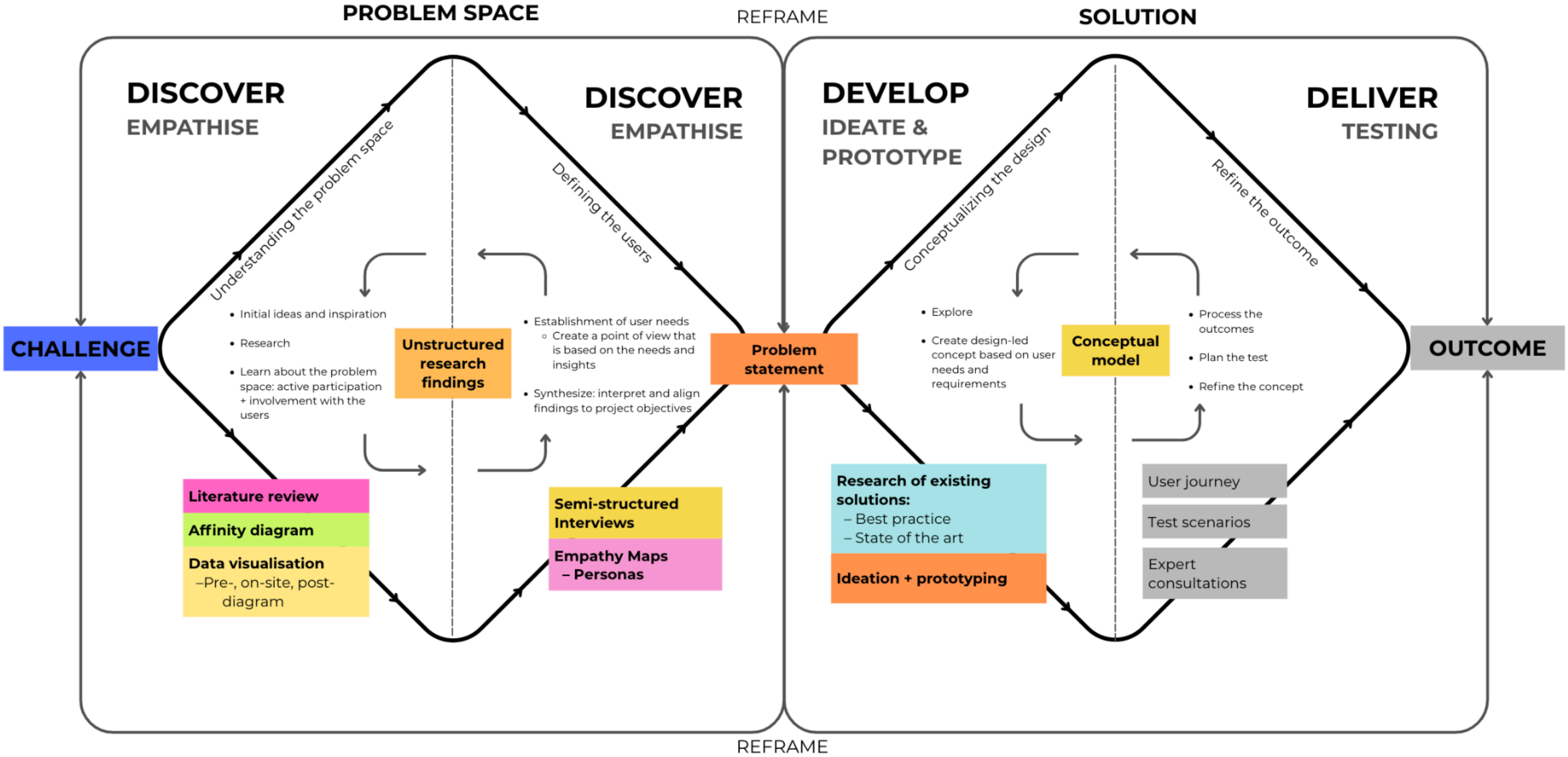


Figure 1: Design framework: combination of the Design Thinking Model and the Double Diamond framework. Own work.

The Design Thinking model and the Double Diamond framework together form a robust, mixed-method approach that guides the design process from an empathetic discovery phase to a well-defined delivery phase. Although each framework can stand alone, their combination overlays Design Thinking's flexibility onto the Double Diamond's clarity about when to expand inquiry and when to narrow toward action.

This approach is further structured around principles such as **empathy**, which guide the early phases by emphasising the importance of understanding users' emotions, needs, and behaviors in context (Bennett & Rosner, 2019). The principle of **putting people first** reinforces this by prioritising actual user experiences and lived realities over assumptions or institutional norms. It ensures that the voices and concerns of those most affected guide problem framing, the definition of success, and the evaluation of proposed solutions (Kochanowska et al., 2022).

Moreover, the participatory design methods used throughout this design process, such as collaboration with experts in the field, semi-structured interviews with blind museum-goers, and the involvement of relevant organisations, ensured that the perspectives gathered were diverse, nuanced, and actionable. Through mutual learning by exchanging knowledge, it was possible to gain insights into design requirements and possibilities, while I as a designer was able to deepen my sense of empathy and expand my creative horizon beyond the limitations of my own experiences, perceptions, and world view (Sharp et al., 2019, pp. 453-454).

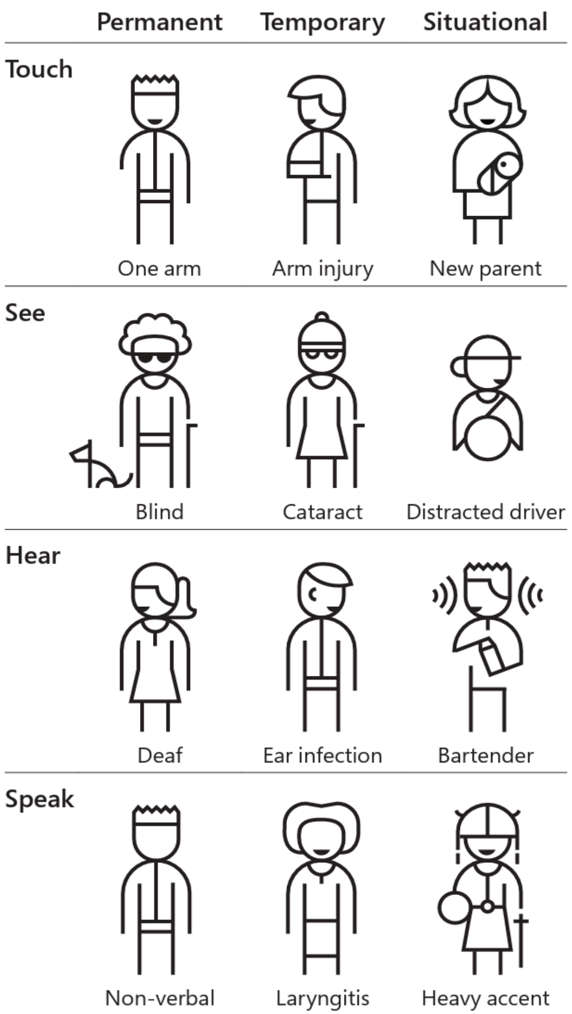
Together, these principles enable a design approach in which each phase, from discovery to definition, ideation, and future testing, was informed by a synthesis of empirical research, user engagement, and reflective practices. This alignment leveraged a broad perspective, taking into account the intricate ways that physical environments, digital interfaces, social dynamics, and individual abilities intersect (Sharp et al, 2019, chap. 9). The following section delves into the methodology that guides this design framework.

METHODOLOGY

In pursuit of a deeply grounded and flexible design process, this project relies on empirical data, mixed methods, and triangulation. The empirical research throughout this project, both embrace quantitative and qualitative data through a mixed-methods approach (Lund, 2012). Such a combination of data not only allows to confirm patterns across multiple sources, enhancing the project's validity through triangulation, but also affords the flexibility to investigate unexpected findings in greater depth which can be necessary to understand nuanced human experiences (Wald, 2014). A mixed-methods approach, allows the design process to remain flexible, allowing researchers to adjust their strategies in response to emerging questions or unexpected results, that can be inherently multidimensional, demanding an approach that can navigate complexity and explore multiple facets simultaneously. Mixed methods meet this need by supporting both exploratory and confirmatory phases of inquiry: qualitative techniques can generate hypotheses and uncover new angles, after which quantitative methods test and confirm those emerging ideas (Lund, 2012).

Triangulation of the qualitative research involves deliberately using multiple, complementary approaches, different data sources, methods, or theoretical perspectives, to study the same phenomenon (Flick, 2018). By comparing and cross-validating findings across these varied inputs, triangulation helps to enhance validity: converging evidence from diverse methods increases confidence in the results or highlights challenges to the design inquiry (Hanington & Martin, 2012). Regarding this project, triangulation was particularly effective when analysing the broad data collection from the contextual inquiry, paired with the insights from the semi-structured interviews (Hanington & Martin, 2012). Crucially, triangulation was a procedural safeguard against bias; it was a generative strategy for deepening understanding (Flick, 2018). In practice, this layered approach kept the divergent phases open to exploratory research and data collection, and narrowed the convergent phases through synthesised evidence and insights, making sure that the design process was informed by a robust nuanced understanding of blind and visually impaired visitors’ needs, experiences and preferences.

UNIVERSAL DESIGN



Layered atop this empirical foundation is a commitment to Universal Design (UD), creating focus during concept generation and evaluation in the later phases of this design process. A universal design approach underpins this project by foregrounding both the social and physical dimensions of accessibility and thereby building upon the 'putting people first' principle. Universal design was originally defined by the American architect Ron Mace in the 1990s as *"the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design"* (Ostroff, 2001). The definition has been expanded over the years as *a process that enables and empowers a diverse population by improving human performance, health and wellness and social participation* (Steinfeld & Maisel, 2012).

The concept of UD has become a dynamic concept which is understood and interpreted in multiple ways. It can, therefore, also be understood and applied as a vision, a principle, a strategic approach, and a concrete design solution (Ryhl et al, 2020). While the concept of universal design has evolved through various definitions and interpretations, its foundation is rooted in barrier-free and accessible design, a notion that has guided the earlier phases of this project. Moreover, universal design challenges the traditional notion that users with special needs require separate solutions. Recognising that all people encounter one or more physical or cognitive limitations whether permanent, temporary, or situational (Ryhl et al., 2020).

Figure 2: *The Persona Spectrum*, examples of permanent, temporary and situational disabilities and impairments, by Microsoft Design, n.d.

This inclusive approach gained international recognition and was adopted by the UN Convention on the Rights of Persons with Disabilities in 2006, defined in article 2 as:

> *"The design of products, environments, programmes and services to be usable by all people, to the greatest extent possible, without the need for adaptation or specialised design, not excluding assistive devices for particular groups of persons with disabilities where this is needed."* — UN Convention on the Rights of Persons with Disabilities (Department of Economic and Social Affairs, n.d.).

This foundational approach emphasises that merely removing barriers is insufficient; designers must broaden their perspective to consider and address the diverse needs of all users (Persson et al., 2015). To guide this comprehensive approach, UD is further elaborated through seven core principles outlined by Story (2001):

1. Equitable Use: Designs should be useful and appealing to people with diverse abilities, ensuring that everyone has access without feeling excluded or stigmatised. This means providing the same or equivalent ways of using a product or space and ensuring that privacy, security, and safety are available to all users equally.

2. Flexibility in Use: Designs should accommodate a wide range of preferences and abilities by offering choices in how things are used. Whether someone is left- or right-handed, works quickly or slowly, or needs precision, the design should adapt accordingly.

3. Simple and Intuitive Use: A well-designed product or environment should be easy to understand, no matter the user's experience, literacy level, language skills, or attention span. This involves eliminating unnecessary complexity, aligning with user expectations, and offering clear feedback and guidance throughout an interaction.

4. Perceptible Information: Important information should be communicated effectively regardless of a user's sensory abilities or environmental conditions. This can be achieved by presenting information in multiple formats and ensuring that elements are legible, distinguishable, and compatible with assistive technologies.

5. Tolerance for Error: Designs should reduce the chance of mistakes and minimise harm when they occur. Such precautions support safer, more forgiving experiences that protect all users, especially in high-stakes or complex environments.

6. Low Physical Effort: Designs should be usable with comfort and efficiency, requiring minimal physical effort to operate. This principle promotes features that allow neutral body postures, reasonable force requirements, and reduced repetitive or sustained actions. For example, doors that open automatically or require a gentle push are easier for everyone to use—whether carrying a bag, using a wheelchair, or simply experiencing fatigue.

7. Size and Space for Approach and Use: Environments should provide appropriate size and space for users to approach, reach, and use components comfortably, regardless of body size, posture, or mobility needs. This includes clear lines of sight, reachable controls, and room for assistive devices or support persons. Whether standing or seated, users should be able to engage with the design without barriers or strain.

In the field of human-computer interaction (HCI), universal design has been defined not only as the result of a design process but also as a way of thinking, described as a:

> ''*conscious and systematic effort to proactively apply principles, methods, and tools of universal design, in order to develop information society technologies that are accessible and usable by all citizens, including the very young and the elderly, as well as people with different types of disabilities, thus avoiding the need for a posteriori adaptations or specialised design*'' (Persson et al., 2015).

Thus, accessibility does not only concern people with physical or cognitive disabilities but becomes an increasingly important aspect to address issues concerning people's access to technology and society in general (Persson et al., 2015).

EMPATHY, IMMERSION & CONTEXTUAL INQUIRY

> *"It is impossible for a person without a disability to ever truly understand what it means to be disabled. True empathy, however, can often take the form of human connection over a shared emotion or experience"* — Durlak, 2018.

In recent years, design handbooks have placed greater emphasis on empathy-building methods when creating solutions that address the needs of users with disabilities (MJV Team, 2021). These methods are embedded in a two-stage immersion process. The preliminary stage establishes initial contact with the problem through field research and contextual inquiry, gathering data on user environments and behaviors to inform later stages (Sharp et al., 2019, p. 400; MJV Team, 2021). By structuring immersion into the methodology for this project, empathy-driven methods have been crucial to obtain firsthand insight into the lived experiences of people with disabilities or impairments, expanding my personal and design perspectives (Bennett & Rosner, 2019). Among these methods, simulations, such as doing blindfolds, are particularly notable in the attempt to experience sensory constraints. Critics, however, argue that without guidance from disabled people themselves, simulations can reproduce negative stereotypes and fail to address relevant challenges and barriers, further reinforcing inaccurate conceptions of disability experiences (Bennett & Rosner, 2019).

To address these issues, this project shifts the understanding of empathy from a goal to be "achieved" towards an ongoing, two-way process of sharing and learning together with the users. This process highlights the importance of contextual inquiry and user involvement as a foundation for a design process focusing on how to "be with" the users, listening and partnering, before trying to "be like" them. This further showcases the importance of achieving a common language between designers and users. Effective communication is crucial when designing with and for people with disabilities, as it ensures that the unique needs and challenges of these users are clearly understood and addressed (Bennett & Rosner, 2019). As such, a shared understanding of the problem space, best practices and user needs, was achieved through active involvement and participation in relevant activities and engaging in meaningful dialogue with the target group of this project, fostering empathy and collaboration with the users

DISCOVER PHASE ≡ EMPATHISE

UNDERSTANDING THE PROBLEM SPACE

The Discover phase corresponds directly with the Empathise stage in the Design Thinking model. This divergent phase involved an expansive exploration of the problem space to understand the diverse and complex barriers faced by people with disabilities or impairments. The following question is the research objective and guides this phase:

> *What are the barriers or challenges that people with disabilities or impairments experience in their everyday lives, and how does that affect their museum experiences?*

To capture the full extent of the lived experiences of PWD, the research scope was deliberately broadened to explore the full spectrum of physical, sensory, cognitive, and procedural barriers. This phase begins, therefore, with a literature review that explores the Danish perspective on disability and the everyday barriers experienced by individuals with disabilities or impairments, emphasising how these challenges affect cultural participation. Towards the end of this phase the insights from the literature, combined with findings from the project *Mapping Disability Access to Danish Art Spaces*, helped shape the framework for a series of semi-structured interviews specifically examining museum experiences from the perspective of blind and visually impaired visitors, which will be unfolded in the Define phase. Together, these components constitute the core empirical foundation for addressing the guiding question of this phase and set the stage for defining clear user needs that will drive the design concept of this project.

LITERATURE REVIEW

This literature review was conducted in the early stages of the research process, functioning as a secondary research of the design space (Ridley, 2012, p. 6). It presents a diverse body of research beginning by presenting the empirical data on the living conditions of people with disabilities in Denmark and their underrepresentation in data (see Appendix A). This extensive review serves two critical purposes. First, it establishes an understanding of where obstacles most acutely disrupt museum access, revealing patterns of exclusion. Second, it creates a solid empirical foundation for the relative severity, prevalence, and complexity of the barriers.

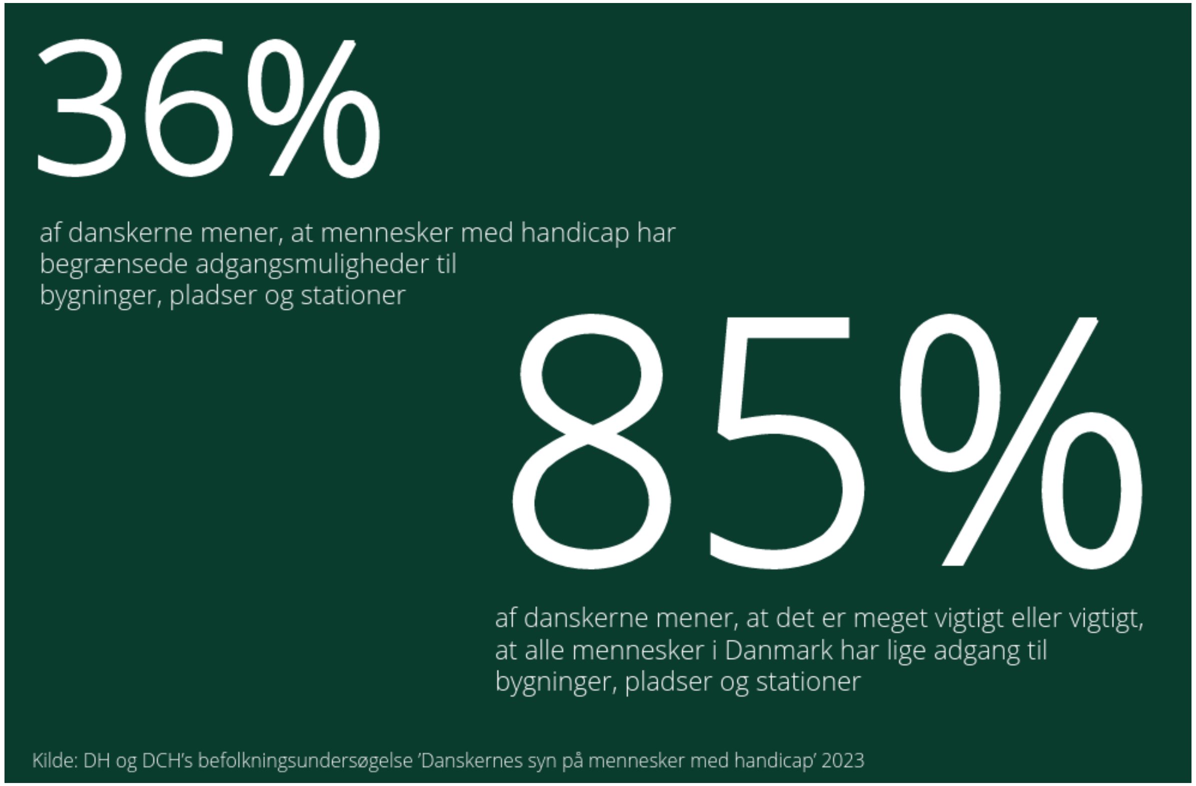
The review focuses on the everyday experiences, challenges, and living conditions of people with disabilities in Denmark, drawing on key findings from national surveys such as the "*Survey of Health, Impairment and Living Conditions in Denmark*" and recent research from Danish disability organisations. It highlights how persistent barriers in physical, digital, and social spaces continue to limit full participation for individuals with disabilities, despite policy efforts to promote equality. By presenting an overview of these challenges this review provides essential context for understanding why inclusive design and assistive technologies are vital for creating equal opportunities.

The literature search was primarily conducted using Google Scholar and Aalborg University Library's search engine Primo, which includes materials from external databases such as Primo Central (Aalborg University, n.d.). The literature is reviewed using a conceptual framework (Randolph, 2009, p. 4), organised around key themes such as museum visitation barriers, the definition of disabilities, inclusive design practices, and the role of technology and multisensory experiences in improving inclusivity, accessibility, and engagement. Following are the most relevant keywords (Cronin et al., 2008, s. 10) used during the search for relevant literature:

Museums; Technology; Cultural Participation; Inclusivity; Multisensory; Interactive; Interactivity; Inclusive museums; Disability; Disabilities; Inclusive design; Accessibility; Museum visitor; Cultural participation; Barriers; Digital access.

DANISH PERSPECTIVE ON DISABILITY— EVERYDAY LIFE AND LIVING CONDITIONS

The "*Survey of Health, Impairment and Living Conditions in Denmark*" (SHILD), conducted in 2012, 2016, and 2020, provides further information about the living conditions of individuals with disabilities and tracks changes over time. This makes it possible to determine whether disability constitutes a barrier and to what extent (Amilon et al., 2021).



The following section presents the findings from the SHILD survey, underscoring the persistent barriers that individuals with disabilities encounter in Denmark, affecting multiple aspects of daily life, including **mobility, social participation, and access to information**. The insights provide a crucial understanding of how such challenges impact their ability to engage and participate fully with society and activities that might already be accessible. Further, this section presents the importance and growing demand for assistive devices that can be used to overcome the manifested barriers and challenges, as well as increase participation.

Figure 3: Population survey supporting the importance of equal access. From 'Danskernes syn på mennesker med handicap' 2023, by Danske Handicaporganisationer, n.d.

CIVIC PARTICIPATION — CULTURAL AND SOCIAL ACTIVITIES

SHILD's description of social participation refers to the use of public transportation, participation in cultural and social activities, democratic participation, and digital participation, including opportunities to access information on public websites (Amilon et al., 2021). Participation in cultural and social activities can significantly enhance the quality of life for PWD (Connell et al., 2012; Jespersen et al., 2019). Although frequent social contact and attendance at cultural events can boost well-being, nearly 18% of people with severe mental disabilities and almost 13% of those with severe physical disabilities feel that they often do not receive the necessary considerations to participate on equal terms (Amilon et al., 2021). People with disabilities, particularly those with major physical disabilities, experience significantly more challenges using public transportation and accessing public spaces compared to those without disabilities. Municipally supported activities, such as free sports and cultural events, are intended to foster inclusion and support social participation.

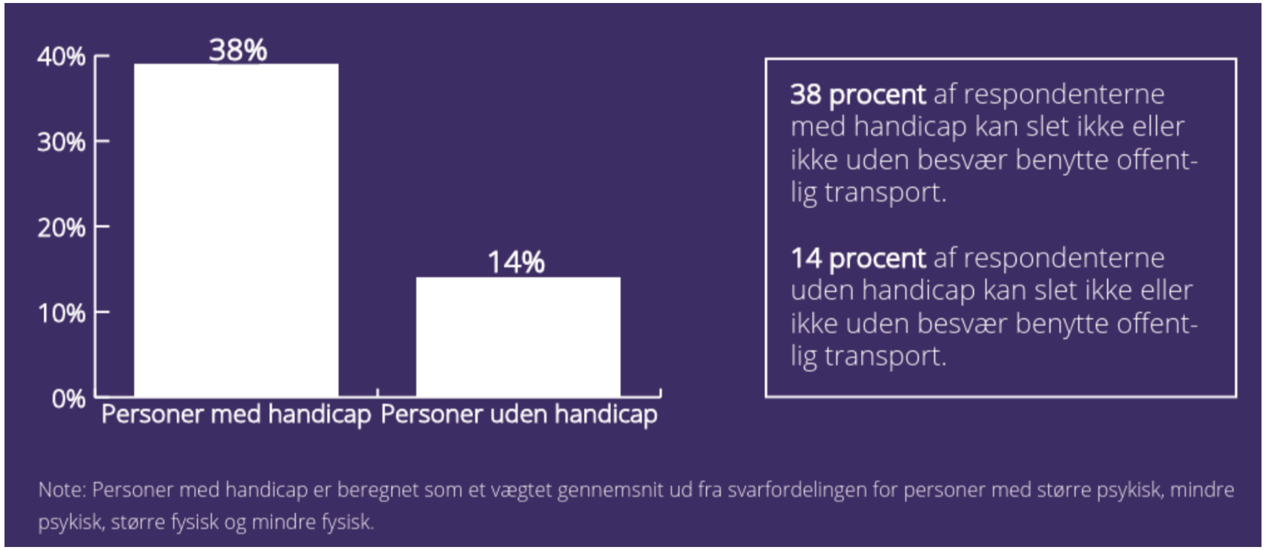
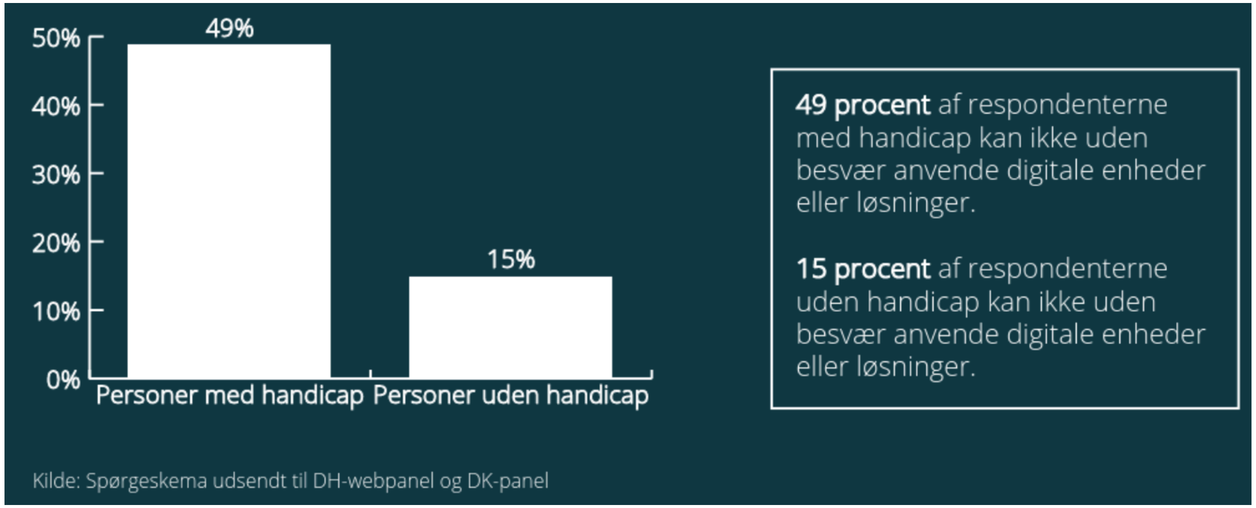


Figure 4: Use of public transportation. From "*Mennesker med handicap-hverdagsliv og levevilkår 2020*", by Danske Handicaporganisationer, n.d.

However, people with severe physical and mental disabilities are less aware of these offerings, and those who are aware often feel that the services are not organised in a way that accommodates their needs. A significant proportion of respondents with disabilities (35% compared to only 6% of non-disabled) believe that the services or activities do not reasonably consider their health problems or disabilities (Amilon et al., 2021).

ASSISTIVE DEVICES AND TECHNOLOGY

Assistive devices play a crucial role in breaking down barriers to transportation, communication, and daily activities, however, design guidelines, funding systems, and public discourse continue to focus primarily on ramps, elevators, and wheelchair access. This creates an imbalance, where environments built for physical accessibility might still be inaccessible for people with sensory, cognitive, or communication disabilities, if they lack the right digital, sensory, or cognitive tools (Amilon et al., 2021).



Digital participation is affected; a notable percentage of individuals with major physical or mental disabilities either do not use public websites or are unable to find the information they need. People with disabilities report that digital communication with the public sector is not easy, with only about 65% finding it accessible (Amilon et al., 2021).

Figure 5: Overview of the use of digital devices or solution between people with disabilities. From "*Mennesker med handicap- hverdagsliv og levevilkår 2020*", by Danske Handicaporganisationer, n.d.

Disability organisations across Denmark are reporting a clear and growing demand for technologies that support independence and participation, not only in daily life, but also in social activities. This is reflected in a recent survey conducted by Tænketanken Mandag Morgen in collaboration with Videnscenter om Handicap, which was distributed to all 36 member organisations of Danske Handicaporganisationer. The data, collected between February and March 2025, is based on responses from 24 representatives of each of these organisations. According to the survey, 59% of the participating organisations state that their members are actively seeking technological solutions to support them in everyday life. They state that their members are aware of the tools available and recognise their potential to enhance independence and communication. In particular, they see value in technologies that can facilitate participation in online communities, support engagement in work and education, and enable a more active leisure life. Preferred solutions include mobile apps, adaptive software for virtual meetings, speech-to-text tools, better hearing aids, and digital communities that enable social interaction for people with limited mobility (Tænketanken Mandag Morgen, 2025).

> *"Technology can help provide structure and overview in many different contexts, enabling our members to participate in school, employment, leisure activities, social contexts, etc."* — Anonymous respondent (Tænketanken Mandag Morgen, 2025).

Despite this enthusiasm, a common challenge among the users is that technology is often seen as complex and inaccessible, as many users lack the digital literacy required to make full use of assistive tools. They, therefore, call for more intuitive and simple solutions tailored to individual needs, as well as targeted training programs that build competence and confidence (Tænketanken Mandag Morgen, 2025). Another challenge is that disability organisations themselves often face limited budgets and insufficient in-house IT expertise. This makes it difficult for staff to recommend, implement, or customise these technological solutions (Tænketanken Mandag Morgen, 2025).

Digital accessibility has become as critical as physical accessibility in our increasingly digital society, prompting recent regulations that require public websites to conform to established accessibility standards (Amilon et al., 2021). Yet, when these standards are not upheld, and as services rapidly migrate online and the use of digital assistive technologies expands, individuals with intellectual disabilities, many of whom once managed independently, find themselves in need of greater support. This situation underscores the imperative to extend accessibility beyond the built environment into all aspects of community life, including digital platforms, educational settings, and social activities (Amilon et al., 2021).

HOW CAN EVERYDAY LIFE DATA INFORM MUSEUM INCLUSION AND ACCESSIBILITY?

Everyday life data provides a detailed picture of the persistent challenges people with disabilities and impairments face—from navigating public spaces and using digital services, to experiencing social isolation and limited civic participation. It is possible to link the same factors that limit everyday civic engagement, such as difficulties with public transportation and digital communication, to lower numbers of participation among individuals with disabilities and impairments at museums. Emphasising that the lack of accessibility in cultural institutions is not merely an issue of physical barriers; it also involves challenges of representation, social attitudes, and policymaking (See appendix A).

Further, the underprioritisation of critical elements, such as digital accessibility, sensory accommodations for visitors with cognitive or sensory impairments, and the lower recognition of non-visible disabilities, contribute to further gaps in social interaction, legal support, education, employment, and public accommodations (Danske Handicaporganisationer, 2023). By not properly recognising less visible conditions, such as ADHD, anxiety, or autism, is problematic given that nearly 37% of Danes self-identify as having a long-term disability, and there has been a significant increase in self-reports of mental disabilities (Amilon et al., 2021). This reinforces a cycle where cultural spaces remain inaccessible, participation rates stay low, and institutions continue to lack the incentive or knowledge to implement the necessary improvements.

A comprehensive understanding of museum accessibility requires, therefore, reliable data on the effectiveness of current accessibility measures, detailed visitor experiences, and the long-term impacts of inclusive design strategies. By doing so, it becomes possible to demonstrate how these practices contribute to the development of a new paradigm—one in which accessibility is recognised not as an obligatory but as a valuable design opportunity that improves overall usability, fosters innovation, and enriches cultural and social experiences and participation. When these positive outcomes are shared across sectors, be it education, transportation, digital services, or the built environment, it is possible to achieve measurable gains in sustained engagement, inclusivity, and overall quality of life (Weisen 2012; Connell et al., 2012; Jespersen et al., 2019).

BARRIERS AND LOW CULTURAL PARTICIPATION

GLOBAL PERSPECTIVES ON ACCESSIBILITY BARRIERS IN CULTURAL INSTITUTIONS

Access to culture refers to the opportunity to benefit from cultural offers, while cultural participation involves consuming various cultural goods and services by the broader public. Several factors impact both access and consumption, acting as barriers to cultural participation (European Parliament, 2017). Understanding and addressing barriers to cultural participation for people with disabilities is critical, as cultural engagement is a fundamental part of social inclusion. However, these spaces are often physically, socially, or financially inaccessible, contributing to the longstanding challenge of low visitation rates at cultural attractions (Brandt et al., 2014).

Reports highlight that ongoing barriers, such as **transportation issues, ticket prices, and lack of information and support at venues**, hinder attendance at arts events, museums, or libraries (Brandt et al., 2014). A survey in the US revealed that nearly half of respondents with disabilities found attending arts institutions challenging, with stigma sometimes presenting a bigger obstacle than physical barriers (Ludwig, 2012). Similar findings indicate that deaf or visually impaired visitors often encounter **negative experiences in museums due to negative attitudes**, which can be exaggerated due to their positioning as "special" guests (Renel, 2019). This perception often extends the invitation of PWD to only engage with specific parts of an exhibit or certain events, perpetuating "othering" that undermines full inclusion (Mesquita & Carneiro, 2016).

Additionally, the study "*A Survey of Universal Design at Museums: Current Industry Practice and Perceptions*" from 2023 focused on a small sample of American museums, highlighting successes in physical accessibility such as installing ramps, creating open-plan spaces, and incorporating multisensory elements. However, there were significant challenges, especially in museums housed within **historical buildings** where structural constraints hinder the integration of accessibility features. Additionally, many museums did not offer **dedicated training** for accommodating visitors with disabilities and **lacked systematic approaches to consulting with people with disabilities** or engaging local advocacy organisations (Fortuna et al., 2023b).

FIRSTHAND ACCOUNTS: ACCESSIBILITY BARRIERS IN COPENHAGEN ART SPACES

The project “Mapping Disability Access to Danish Art Spaces” investigates how physical, sensory, and procedural barriers within Denmark’s cultural institutions constrain the participation of artists, curators, historians, and art workers with disabilities. At the start of 2024, three art workers with varying disabilities began to map their access to art spaces—a research area previously underexplored in the Danish context (Giannelli et al., 2024).

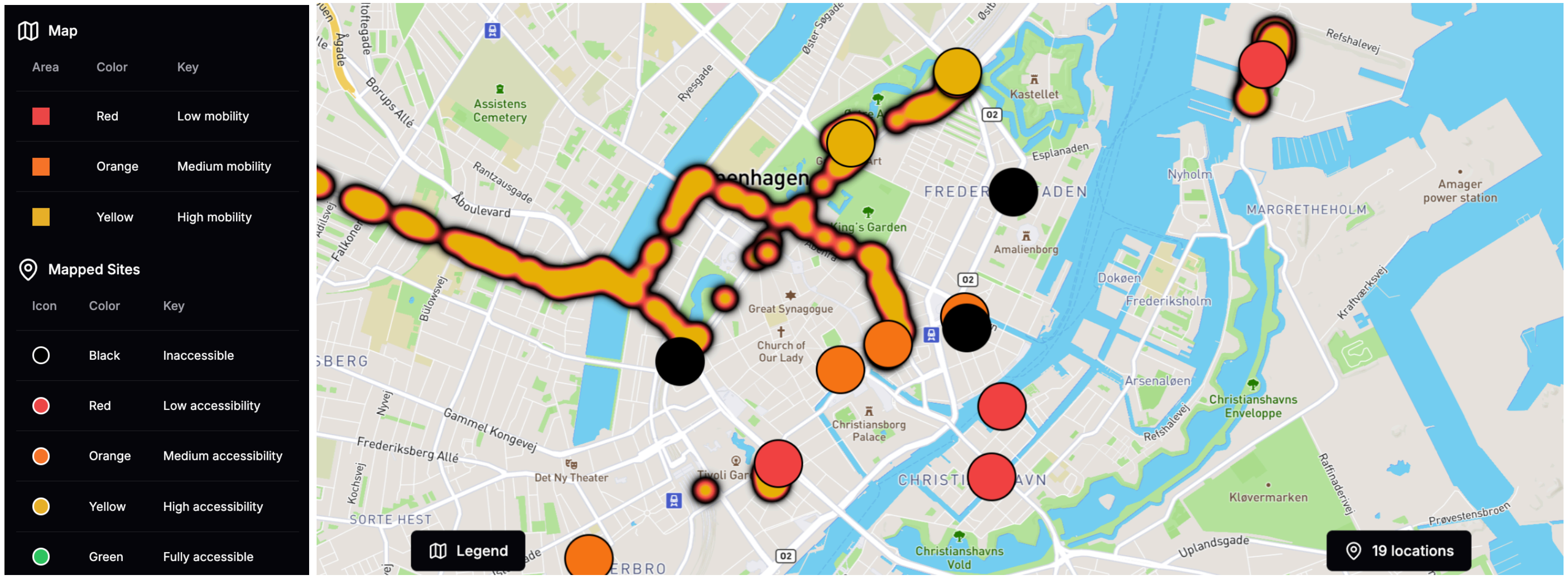


Figure 6: Interactive map overview of one of the participants. From *“Mapping Disability Access to Danish Art Spaces”,* Giannelli et al., 2024.

In total the participant approached up to 19 different spaces in the capital region, ranging from state-recognised museums, to smaller art galleries and artist-run spaces “as if able-bodied,” meticulously documenting every encounter with barriers or challenges at these spaces (Giannelli et al., 2024). The documentation of these encounters resulted in 113 self-reported statements of different barriers. These case-studies have been transformed into an interactive map with the attached self-reported statements of the barriers and access measures encountered.

ANALYSIS OF THE DATA

AFFINITY DIAGRAM

Affinity diagramming was employed to make sense of the extensive data gathered during this phase by externalising, visualising, and grouping the insights **(Hanington and Martin, 2012, p. 12)**. The 113 self-reported statements together with the barriers identified throughout the literature review constitute the data used to create a synthesis of the overall barriers that hinders participation for people with disabilities or impairments.

The synthesis began with the understanding that the many observed challenges needed to be narrowed down into a concise set of key barriers. Under this process all individual statements were then externalised onto a Miro[3] board as individual notes in the form of "sticky notes" organised with different labels, creating a tangible repository of the data. These notes were then arranged and grouped according to emerging themes. Through several rounds of renaming, and consolidation, thematic clusters emerged: **transportation challenges, building inaccessibility, sensory overload, wayfinding difficulties, digital exclusion, staff communication gaps, and economic and policy constraints.**

Figure 7: Excerpt from the affinity diagram analysis on Miro. Own work.

[3] https://miro.com/app/board/uXjVLnpzpOc=/?share_link_id=5978841841

During the clustering phase, groupings were iteratively merged, renamed, or split to ensure that each category represented the lived experiences captured in the statements. As thematic clusters solidified, attention shifted to the relationships among them (Sharp et al., 2019). By converging these clusters, the affinity diagram method not only reduced an overwhelming volume of observations into a manageable set of core barriers, but also revealed how there is a striking resonance with the barriers identified through the broader literature review. While the barriers identified in the Danish art spaces are consistent with barriers around **transport, cost, and stigma,** the analysis also expanded the conversation—adding layers of **sensory, cognitive, digital, and policy-related** barriers.

Combining the barriers identified in the literature with 113 first-person accounts, each high-level obstacle, such as "wayfinding difficulties" or "sensory overload", could be annotated with concrete examples of how it manifests in real life. For instance, the literature's broad finding that confusing signage impedes navigation (Renel, 2019) was grounded in statements of lived experiences, e.g. mislabeled doors and inconsistent braille placement. Likewise, general research on digital exclusion (Brandt et al., 2014) was brought to life by reports of audio-guide apps that crashed in low-signal areas. Further, by using both data sets, it also became possible to decode abstract categories into concrete needs: rather than simply knowing that "transportation is a barrier," it was possible to assess the effect of missing curb cuts, uneven pavement, and inaccessible bus stops on mobility access. This layered interpretation ensures that the barriers were not merely catalogued but understood in terms of their practical, social, and experiential implications.

Analysing both set of identified barriers created a more detailed picture from lived experiences revealing how the complex network of interrelated barriers undermines each stage of the museum visit experience: pre-visit, on-site, or post-visit, and often present in more than one stage at the time, extending their effects into the next stages as well. Some barriers, such as digital exclusion and missing accessibility information, are tightly intertwined and reinforce one another, while others remain distinct yet collectively shape the overall museum experience. Following is a visualisation of the three museums phases and the corresponding barriers identified.

DATA VISUALISATION

This figure displays the overlap of the three phases and the thematic clusters, each representing a grouping of individual barriers identified through the affinity diagram. The size of each barrier corresponds to the number of times it was mentioned across 113 self-reported statements.

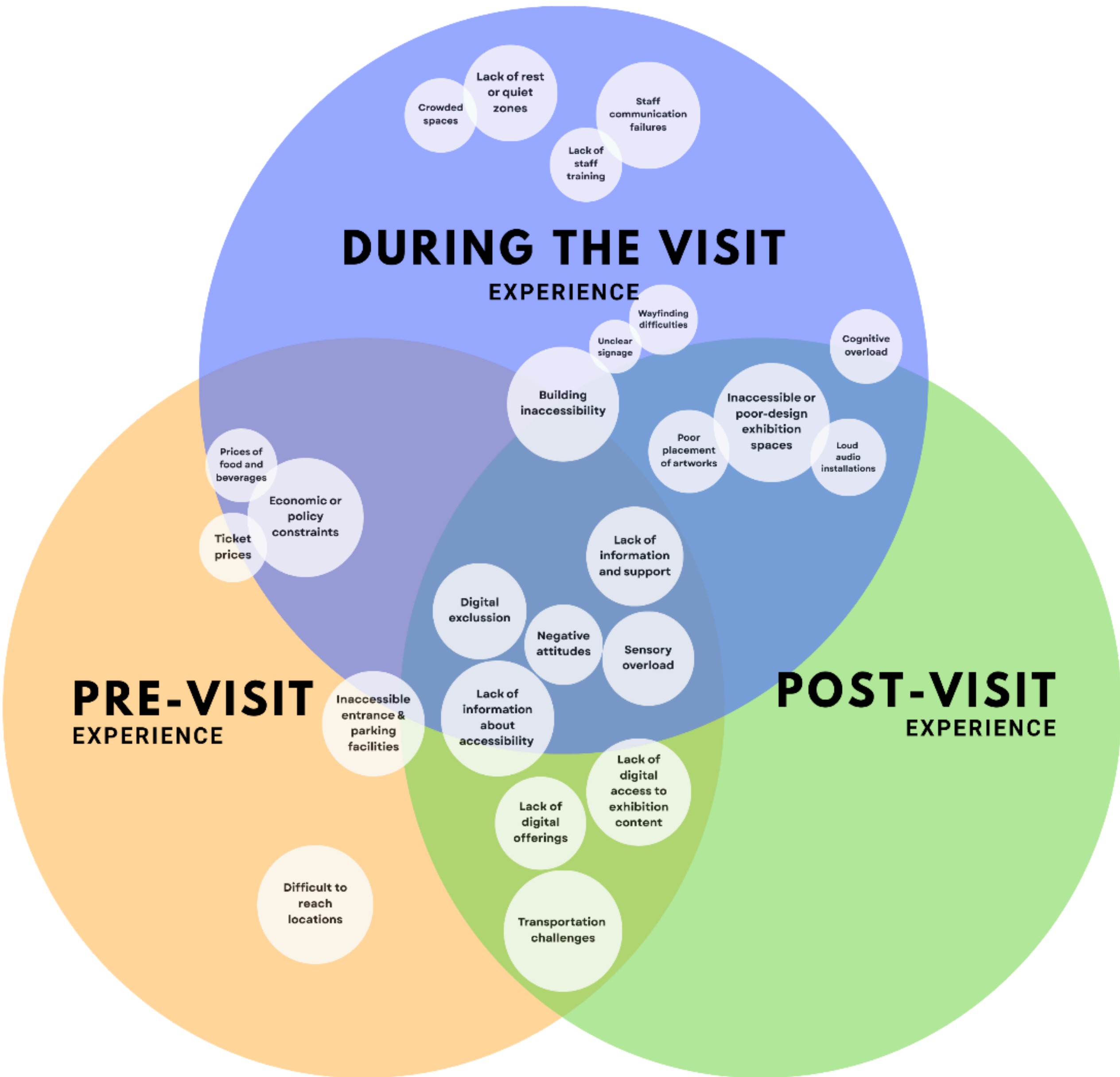


Figure 8: Venn diagram of the three museum phases, pre-visit, during the visit, and post-visit, and barriers identified. Own work.

PRE-VISIT PHASE. Before planning a visit, potential guests must assess whether a museum can meet their needs. Unfortunately, the absence of reliable, accessible details, ramp locations, elevator operational status, or designated quiet-hour schedules, creates an immediate obstacle for those dependent on planning in advance (Brandt et al., 2014). Transportation challenges add further complexity: long journeys by bus or train can be made more difficult by uneven terrain (gravel, cobblestones, broken pavement) and by limited or poorly located accessible parking and entrances (Ludwig, 2012). Economic and policy constraints, high ticket prices or costly concessions, coupled with restrictions on disability benefits or low income, compound uncertainty, as the perceived financial and physical risks may outweigh anticipated cultural benefits (Fortuna et al., 2023b).

DURING THE VISIT PHASE. Once inside, physical inaccessibility becomes evident through heavy doors without automatic openers, narrow corridors, small or unreliable lifts, and accommodations dependent on untrained staff (Giannelli et al., 2024). Wayfinding difficulties, confusing signage and exhibitions cluttered with dense wall text or artworks placed either too high, too low, or behind obstacles, impose cognitive overload and detract from meaningful engagement (Renel, 2019). Sensory overload, crowded spaces, loud audio installations, and harsh or fluctuating lighting can overwhelm visitors, especially if designated rest areas to recuperate are not present (Mesquita & Carneiro, 2016). Inconsistent availability of assistive devices, such as audio guides, further reinforces the perception that institutions are unprepared for diverse needs (Fortuna et al., 2023b).

POST-VISIT PHASE. After leaving, the lack of accessible digital content often impacts visitors with visual or hearing impairments and those requiring assistive technology or extra processing time. Disparities in online participation and the unavailability of inclusive digital extensions undermine continued engagement with museum materials (Mesquita & Carneiro, 2016). Because these barriers accumulate across every stage of the museum journey, negative experiences at any point can deter return visits. They function not as isolated issues but as mutually reinforcing obstacles that compromise accessibility.

DEFINE ≡ DEFINE

UNDERSTANDING THE USER

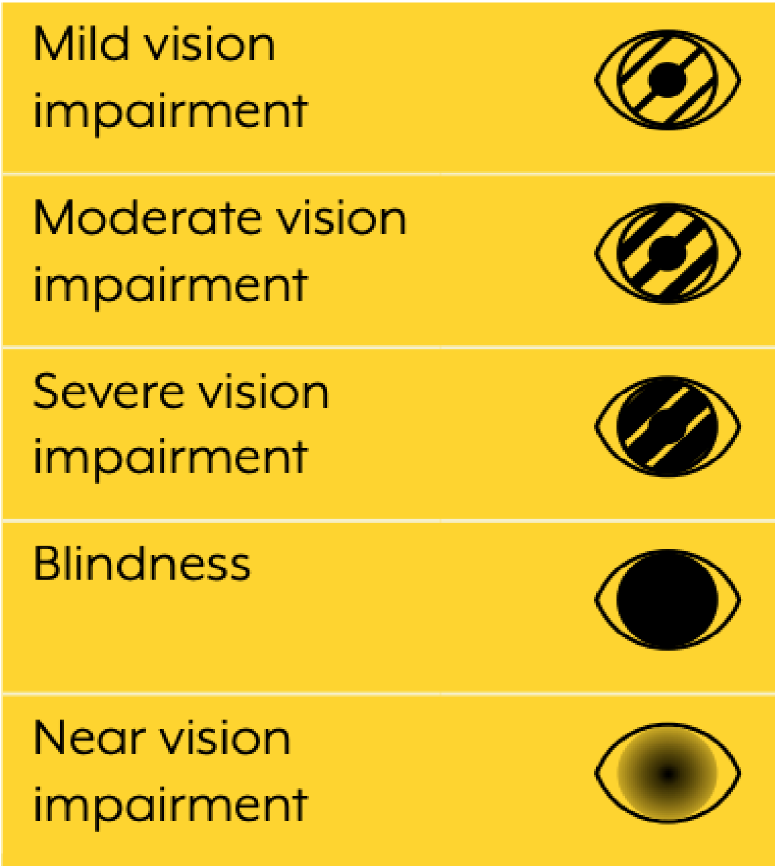
The Define phase marks the transition from exploration to synthesis, aligning with the second stage of the Design Thinking model, and outlines the convergence of the first diamond. The focus of this phase is to emphasise the implications of the barriers faced by blind and visually impaired museum visitors by examining their impact on the visitor experience and engagement with visual art.

This phase also provides a comprehensive discussion of strategies that ensure museums deliver an accessible and equitable museum visit, leaving an overall positive and meaningful experience. Building on this foundation, the following question guides this phase:

> *What barriers do blind and visually impaired individuals face in a museum context, what are their specific needs regarding accessing visual art?*

This focus shifts from broad exploration to addressing specific, user-centered challenges by employing ethnographic methods for data collection, an analysis of the data and the alignment of the findings to the project objectives. Particular attention is given to how digital solutions can extend and enhance the museum encounter, transforming post-visit engagement into a reflective, social, and ongoing process.

MUSEUM EXPERIENCES OF BLIND & VISUALLY IMPAIRED VISITORS



In this phase this project narrows its focus to museum visitors who are blind or visually impaired. In this case, it is important to address that blindness and visual impairments encompass a spectrum of conditions, each with distinct functional implications[4].

Visitors with low vision may experience reduced visual acuity or contrast sensitivity, often struggling to read standard-sized labels, signage, or exhibit texts without high-contrast formatting, large-print typefaces, or exceptionally bright lighting. These individuals might rely on magnification tools to access printed materials, yet they remain vulnerable to glare, inadequate illumination, and cluttered exhibit layouts **(Fortuna et al., 2023a)**.

Individuals who are legally blind may retain some residual sight. Such visitors often benefit from audio-based information, whether through prerecorded guides or live narration. Nevertheless, obstacles arise when maps, wayfinding signs, and gallery labels remain primarily visual or lack clear, high-contrast demarcation **(Fortuna et al., 2023a)**.

Figure 9: Classification of severity of vision impairment, from "*World report on vision*" by World Health Organization, 2019.

[4] There are an estimated 196 million people globally with age-related macular degeneration, 10.4 million (5.3%) have moderate or severe distance vision impairment or blindness from more severe forms of the condition. Similarly, an estimated 64 million people globally have glaucoma, of which 6.9 million (10.9%) only are reported to have moderate or severe distance vision impairment or blindness resulting from more severe forms of the condition **(World Health Organization, 2019)**.

For visitors who are totally blind, tactile exploration and auditory narration become essential. These individuals rely predominantly on haptic feedback to understand spatial relationships within an exhibition. Without accessible access points or audio cues, totally blind visitors may face disorientation, spend excessive time locating exhibits, or miss key interpretive content altogether. In each case, designers and curators must recognise that visual-impairment profiles differ not only in terms of residual perception but also in cognitive and navigational strategies (Fortuna et al., 2023a).

First-hand accounts at museums underscore these shortcomings: **low-vision participants struggle with dim lighting, small fonts, and poorly located signage; legally blind visitors are unable to discern which exhibits are interactive or off-limits; and those with total blindness struggle with static Braille labels that are often inconsistent in placement**. Overall, sensory obstacles, loud ambient noise, or poor acoustics diminish the ability to engage with audio guides or verbal descriptions (Fortuna et al., 2023a).

Suggestions for improving accessibility for blind or visually impaired museum visitors include adding assistive technology, increased staff involvement, **good spatial design and accessible way-finding, appropriate lighting and audio systems, good visibility of text and figures and the ability to explore based on senses other than sight**, e.g. through audio or tactile experiences (Fortuna et al, 2023a). Despite these already existing and well-known solutions, a study across 28 European museums found that accessibility for people with visual disabilities remained limited even in institutions with accessibility strategies implemented. This can be a result of a growing focus on guidelines that primarily focus on physical or sensory challenges, neglecting the intellectual and cognitive aspects (Seale et al., 2020).

To validate and enrich these insights, a series of semi-structured interviews were conducted with key stakeholders. Each interview built upon the initial findings to capture both details about current practice and actionable ideas for more coherent, multi-modal accessibility. Each of the identified barriers informed the thematic domains used to create focus throughout the different interview guides. The following sections outline the development of the semi-structured interviews and the analysis of the results.

SEMI-STRUCTURED INTERVIEWS

OPEN QUESTIONNAIRE

To carefully recruit a dedicated focus group (Hanington & Martin, 2012, p. 142), whose experiences would directly inform and shape the project's scope, one of the first data-collection methods employed was a general questionnaire (Hanington & Martin, 2012, p. 267-68). Rather than targeting any specific disability or impairment, this questionnaire invited all potential users to share basic demographic information, museum-going habits, professional backgrounds, and general experiences with accessibility (see Appendix B).

At the end of the questionnaire, respondents were given the option to submit an email address if they were willing to participate in a follow-up interview. This approach aligns with established practice for using a questionnaire to obtain initial responses that can then be analysed both to select interviewees and to gain a broader perspective on emerging issues (Sharp et al., 2019, p. 365). The questionnaire was responded to by 14 individuals in total.

FOCUS GROUP

Focus groups are a qualitative method often used to assess the opinions, feelings, and attitudes from a group of carefully recruited participants about a product, service, etc. (Hanington & Martin, 2012, p 142). The focus group for this project was selected out of the 14 respondents, where seven indicated interest in a follow-up discussion and five of them were invited and agreed to participate.

One of these five preferred an informal, unrecorded conversation rather than a formal interview—its principal insights nonetheless guided several design decisions in the upcoming phases. The remaining four volunteers took part in fully recorded, semi-structured interviews. Collectively, these five individuals constitute the project's core focus group (Hanington & Martin, 2012). They not only emerged as the most engaged respondents but also represent the primary stakeholder groups essential to this project: practicing designers, regular museum-goers that are blind or have visual impairments, and representatives from relevant advocacy organisations.

INTERVIEW GUIDES

In order to explore the chosen focus group's lived experiences in depth, a semi-structured interview format was selected as the principal qualitative method for this phase. Four respondents were recruited through purposive sampling (Kvale & Brinkmann, 2015, p. 19). Accordingly, three distinct interview guides were drafted (see Appendix C), each tailored to the group or individual being interviewed: *a former designer at tactile-focused studios, two representatives from the Danish Blind Society, and a blind museum-goer*. The interview guides are constructed around four domains identified in the previous sections: *wayfinding and orientation; multisensory engagement; staff interaction and support; and post-visit reflection and sharing*. For each domain I created open-ended questions, while also leaving space for open dialogue (Kvale & Brinkmann, 2015, p. 19).

The guide for the designer began by inviting reflections on past projects and tools, then probed how technology had been employed to extend museum experiences and which phases of the design process proved most critical. The guide for the members of the Danish Blind society opened with participants' roles and the society's accessibility initiatives, then explored how pre-visit information, partnerships, and advocacy shaped museum practices, and concluded by soliciting strategic ideas for future collaboration. Finally, the guide for the museum-goer focused on personal narratives, typical visit routines, sensory strategies, and attitudes towards technological assistive devices.

TRANSCRIPTION

All interviews were conducted online via Zoom[5] and recorded with the participants' explicit consent. The professional transcription service, Good Tape[6], was used to produce the transcripts (see Appendix D). Transcripts were then anonymised by removing names and instead using anonymous identifiable codes. The transcriptions were also subjected to a two-step verification process in which each transcript was compared line-by-line to the audio recording to correct transcription errors. This rigorous process supports transparency and reliability, ensuring that subsequent thematic coding remains grounded in participants' exact expressions (Kvale & Brinkmann, 2015, pp. 236–239). All the chosen quotes have also been carefully translated from Danish to English.

[5] https://www.zoom.com
[6] https://goodtape.io/blog/about/

ANALYSIS OF THE RESULTS

The results from the semi-structured interviews not only provide detailed insights into the barriers faced by blind or visually impaired museum visitors, but also provide an understanding of current practices, preferences, useful devices and strategies used in their everyday life that could be translated to a museum context. The following quotes were chosen as they were recurring themes highlighting the four primary non-visual strategies visitors currently employ during a museum visit: *sighted peer descriptions, pre-recorded audio guides, tactile graphics, and smart-device support*.

The interviews revealed that in-person visits are the most preferred way for blind and visually impaired museum visitors to engage with visual art, as being at the actual space automatically gives an experience that can be shared:

> ***"And you might think, what the hell am I doing there [as a visually impaired person]? It is the desire to experience our common culture. That's what it is. To be part of being able to… (…) be part of the conversation… if you have some kind of relationship with it [the art]"*** – P2

This testimony underscores that, for many, the museum visit is first and foremost an act of cultural participation—one whose richness derives from being physically present in the same space as other viewers.

It was also revealed that visitors strongly prefer descriptions from sighted peers, rather than static descriptions from audio guides, as they can ask follow-up questions. However, when a sighted person has to describe visual art to a blind or visually impaired person, perceptual and conceptual gaps often lead to partial or misleading descriptions. Sighted people naturally rely on visual categories, such as color gradients, perspectival depth, and subtle interplay of light and shadow, that may lack a meaningful translation in a non-visual sensory vocabulary (Arheim, 1990). Moreover, without specialised training in verbal description, sighted-peers tend to project their own aesthetic judgments and cultural assumptions onto the work:

> ***"…when I go to museums with my wife, she… Well, she wants to describe it, but she sees something other than what I would have seen. Even though she wants to, it takes a lot of the experience (…) she has to describe it all the time"*** – P2

Another popular approach is pre-recorded audio descriptions provided by art galleries or museums. However, one challenge visitors often experience with existing audio description technologies is the additional effort involved, such as have the technical literacy required, the need to stand in a specific position in the room or scan objects in certain ways or areas:

> *"But it also says something about what has happened technologically (...) at one point in time, the Walkman was the most used aid. And then there was an audio guide where you could use a flashlight-like thing to point at a small pentagon that was stuck to either the plinth or the wall, and if you hit it, you got the story"*– P2

This reflection points out the technological advancements that have been adopted at some museums, but it also highlights how well-intentioned technological innovations can falter without careful alignment to user capabilities, revealing critical insights. One of the critical insights is the demands that hosts (museums) and guests (visitors) share a responsibility: technological features must be compatible with visitors' comfort levels and habitual practices. In the case described, museums assumed that handing over a flashlight-like device would feel intuitive and unobtrusive, neglecting to consider whether guests could easily locate small markers or use the device intuitively. Conversely, visitors also bear responsibility as they must adopt, learn, and engage with the tool as intended. In this way, technological features become in itself a site of co-creation (Pine and Gilmore, 1998).

The second critical insight, which from a multimodal standpoint, encompasses the additional technological layer to the experience, does not always guarantee richer sensory integration; the experience might in some cases, if not mastered, remain inaccessible. Although the audio-system promised to deepen engagement by personalising the experience, it inadvertently imposed new cognitive and physical barriers (Löwgren & Stolterman, 2004). The statement also highlights the importance of understanding how users think, process and interact with technology, as it creates a picture of how activities are carried out, and learn from this when designing interactive products or experiences. It also shows how cognition is inherently contextual: it unfolds not only within the mind but also through interactions with artifacts, environments, and other people (Sharp et al., 2019, chp. 4).

At the same time, the same participant also acknowledged the potential technology could have regarding opportunities for a more independent exploration and engagement with visual art:

> *“Like my wife could say: “Okay, you're probably more interested in Golden Age paintings, and I want to look at tapestries... And so, now you're here, and I'll go down here and meet you in half an hour”. Then I could use my technology to access the images that were in that room. I could just sit on one of the chairs in the middle and listen to the description of the images that were there. That would be amazing for me personally. Especially if I could ask further questions.”* – P2

Apart from the technical barriers, there is also the technicality of having to listen to the description and orient yourself in the space, which can create issues, as most audio-guides are designed from an able-bodied standard. Moreover, existing audio descriptions are also mostly designed for sighted visitors, and thus lack detailed descriptions needed for blind and visually impaired visitors to understand the visual artwork:

> *“Then I got one of those headsets where they cover both ears, so not much sound comes in from the outside. This means that now I'm both deaf and blind, because I can't orient myself. And it was good that I had a companion with me because it's an unfamiliar area, and I would walk into all sorts of people walking by or waiting because I can't hear the surrounding environment. So my concentration is divided in a way that means that I could still walk into people, because you both have to hear what the guide is saying and you also have to move after the guide. (...) Even though we have the technological possibilities, in relation to the completely blind, who have no sight to orient themselves with, there are some special challenges with this.”* – P1

Multitasking, for people that use assistive devices, e.g. during a museum visit, can impose additional demands. For blind or visually impaired visitors relying on headphone-delivered audio guides must divide their attention between processing narrated content and maintaining spatial awareness. Frequent shifts in focus incurs a “switch cost,” slowing overall performance and increasing the likelihood of errors—especially when distractions are unrelated to the visitor’s primary goal (Burgess, 2015; Ophir et al., 2009).

Participants also mentioned other underestimated barriers of a museum visit, such as cognitive overload that leads to tiredness, even before entering the museum or exhibition space:

> *"It takes a lot of energy to go out (...) you have to analyse the sound impressions you get (...) and then you also have to understand what the exhibition itself is about. (...) You're in competition with that fatigue."* –P1

Accessing visual arts through tactile graphics, presented two main challenges for the museum visitors. First, tactile graphics are not available in many art galleries and museums. Second, some participants find it particularly time-consuming or just not sufficiently accessible:

> *“If you don't know what the [tactile] image represents, I personally think it's insanely difficult to get an impression of what it should represent. And it's somehow a bit mean if the description just tells you: “Now you're standing in front of a picture of a tree and a bike”. Because then it's just about finding it [on the tactile picture]. Then I almost think my own imagination is better.”* – P3

Some participants mentioned the use of smart device supports (e.g., visual interpretation technologies such as Be My Eyes). While these tools are useful for object recognition and description in an everyday context, they are not widely recognised throughout the blind society in a museum context, as they are still not sufficient in detail or narrative descriptions:

> *“...I tried using some [object recognition or image description] apps on my phone. The one I used mostly told me things like: There are two people on the beach and a dog. There is almost no contextual information about the painting, like what is happening between the two people etc...”*– P2

Relying exclusively on verbal descriptions, whether delivered by a sighted guide or an audio-tour script, risks privileging the describer’s personal impressions over the artwork’s formal and tactile qualities. For blind or visually impaired visitors, such accounts can obscure critical information about texture, spatial relationships, and material presence, thereby weakening the fidelity of their mental representation. This misalignment highlights the imperative for description protocols rooted in multimodal translation: approaches that foreground haptic vocabulary, three-dimensional spatial cues, and narrative framing rather than purely visual terminology (Arnheim, 1990).

A participant also vocalised the dual challenge of pre-visit uncertainty and lack of information on-site:

> *"...it [the experience] starts when you arrive [at the museum]... and then there's the exhibition itself, which you come to see. So it's about both getting the information about the museum and what you want to see... and then you can get a companion to accompany you. [But] can you figure out how to get there? And what can you actually get out of it when you're there*? – P1

This statement touches on preparatory engagement: advance information and clear expectations prime visitors for deeper learning. Yet when potential guests cannot easily discover accessibility features, whether online or through museum outreach, they experience barriers before the museum visit even begins. Such negative encounters are often precipitated by barriers, which can fundamentally shape the way individuals perceive and remember the overall experience, often leading to heightened vigilance, narrowed attention, and lasting negative impressions (Jantzen, 2013). When an experience falls short of expectations, whether through sensory overload, confusion, or frustration, people tend to fixate on those moments of discomfort, allowing them to dominate their overall recollection (Falk & Dierking, 2000).

The same participant also uses previous experiences to explain the lack of motivation among the blind and visually impaired community regarding attending museums regarding past experiences:

> *"There will definitely also be a group of blind people whose motivation may not be so great, because back then, at least when I was a child, there were posters where you could read, and then there were some displays... and that was about it. And people were nice enough to read [out loud], that wasn't the problem... but then you could retain some of what's written in seconds it is being read out loud. But it also disappears quite quickly from your memory. So if you want to make sure that knowledge is retained, you have to make sure that... gives you a multi-experience. Because then the chance of it [information] sticking is much higher. And that's the whole purpose of museums, that [is how] you get an experience (...) that you can remember for more than five minutes."* – P1

From a social constructivist lens this statement touches upon how visitors do not come as blank slates. The meanings and expectations they bring are shaped by cultural context, education, language, and social interaction. Experiences are generated “in concrete circumstances,” and their quality depends on “how physical and social aspects of the situation influence the acts and perceptions of the experiencing person” (Jantzen, 2013). In other words, knowledge about the exhibit’s concept is co-constructed: what is learned or enjoyed depends not only on the exhibit itself, but on the visitor’s social background and interactions.

This insight also underscores the critical role of multimodal engagement in strengthening memory, which also reflects the aesthetic and educational realms, where multisensory inputs fortify memory encoding (Sparrow et al., 2011; Gratton, 2020). This was also highlighted by another participant:

> *"If I was really going to learn, it has to be something you can feel. Some authentic sounds, or something you can smell or taste."* – P3

In conclusion, the interviews illuminate a complex interplay between desire, agency, and constraint in the museum experiences of blind and visually impaired visitors. Participants articulate a strong motivation to be physically present, to claim their place in shared cultural discourse, and to forge a personal relationship with artworks in situ. Yet, this is challenged by a landscape of technological, cognitive, and social barriers. Sighted peer descriptions, while valued, frequently fail to convey the formal and tactile nuances that ground a blind visitor’s perceptual understanding. Pre-recorded audio guides, despite promising autonomy, often replicate able-bodied design assumptions, requiring precise positioning, or limiting spatial orientation, so that the medium itself becomes a barrier. Poorly designed tactile measures, where available, can demand time and effort to interpret and sometimes leave visitors with incomplete or misleading mental reconstructions. Accordingly, the following phases of this design process will focus on exploring a multimodal approach that foregrounds texture, spatial relationships, and narrative framing. To ensure these features align with user needs, the next section presents two personas and their accompanying empathy maps, distilling interview insights into clear depictions of users’ thoughts, feelings, needs, and pain points (Hanington & Martin, 2012, p 206-207).

PERSONAS AND EMPATHY MAP

For user-centered design, it is imperative to understand who you are designing for. However, attempting to design for everyone results in unfocused or incoherent solutions, so some level of consolidation is needed. Personas crafted from information collected from real users through field research provide an ideal solution by capturing common behaviors in meaningful and relatable profiles. Their human description facilitates easy empathy and communication, while their distinctions create useful design targets for responsible design (Hanington & Martin, 2012, p 206-207).

For this project, two distinct personas were developed to represent the nuanced experiences, preferences, and needs of blind and visually impaired museum visitors. They embody common patterns of behavior, motivations, and technology preferences uncovered during the data gathering, field research, interviews, and direct dialogue with blind and visually impaired individuals. These personas serve as concrete design targets for tailoring the requirements and the concept model for this project. These two personas also served as the foundation for the empathy maps, ensuring that each map reflects realistic motivations, behaviors, and pain points uncovered through the data gathering, interviews, and direct dialogue with blind and visually impaired individuals.

An empathy map is a simple, visual framework that helps capture and organise what a user *says, thinks, does*, and *feels* in a given context. This creates a more concrete understanding of user needs, uncovering unarticulated insights that drive more empathetic, human-centered designs (Gibbons, 2018). This process not only deepens empathy among stakeholders but also sharpens the focus of the concept, ensuring that the concept model for this project directly addresses the lived realities of blind and visually impaired museum visitors. By mapping these quadrants for each persona, it is possible to translate abstract needs and motivations into concrete insights. Following are visual overviews of each persona:

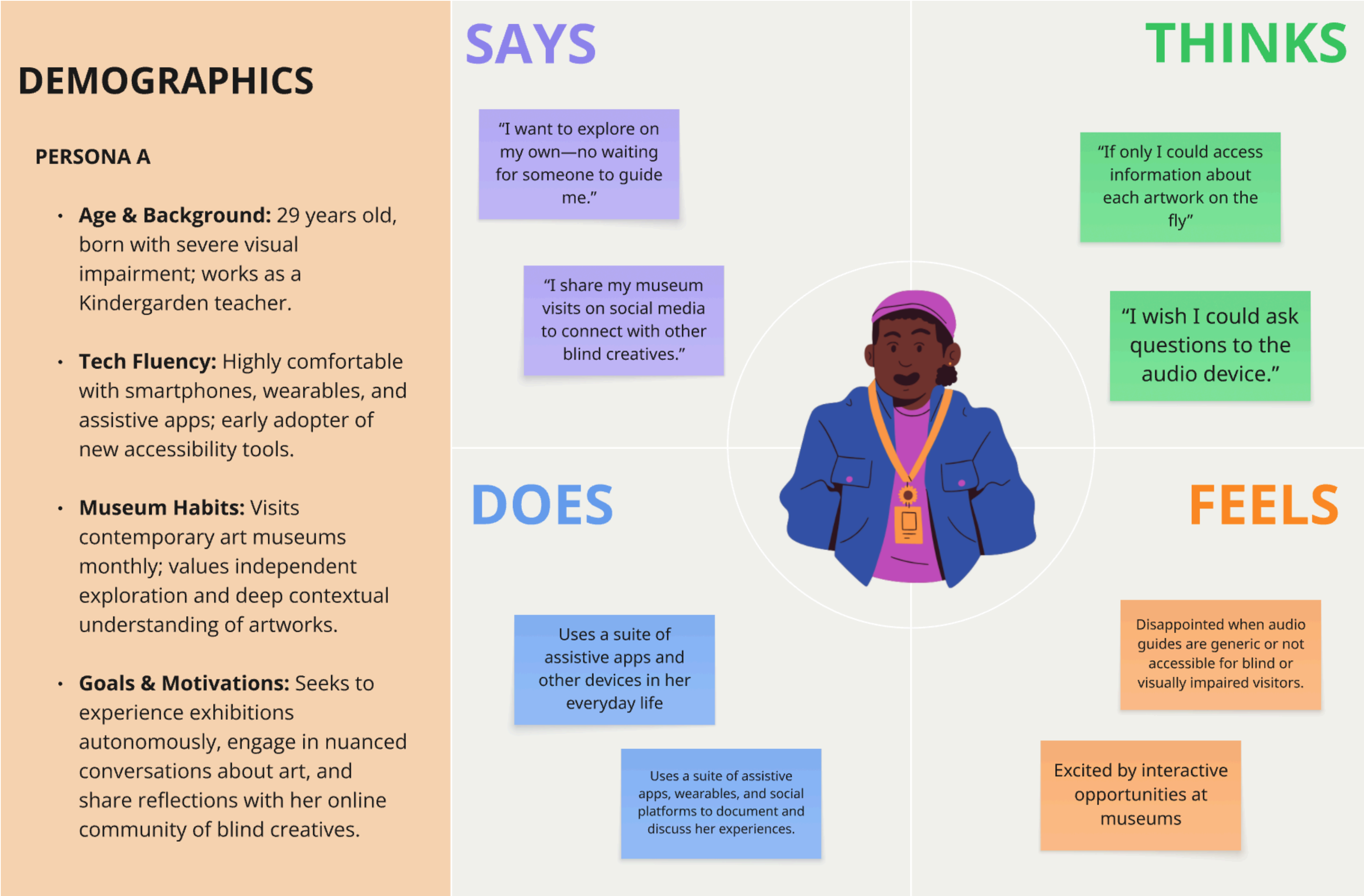


Figure 10: Visualisation of Persona A's demographics and empathy map. Own work.

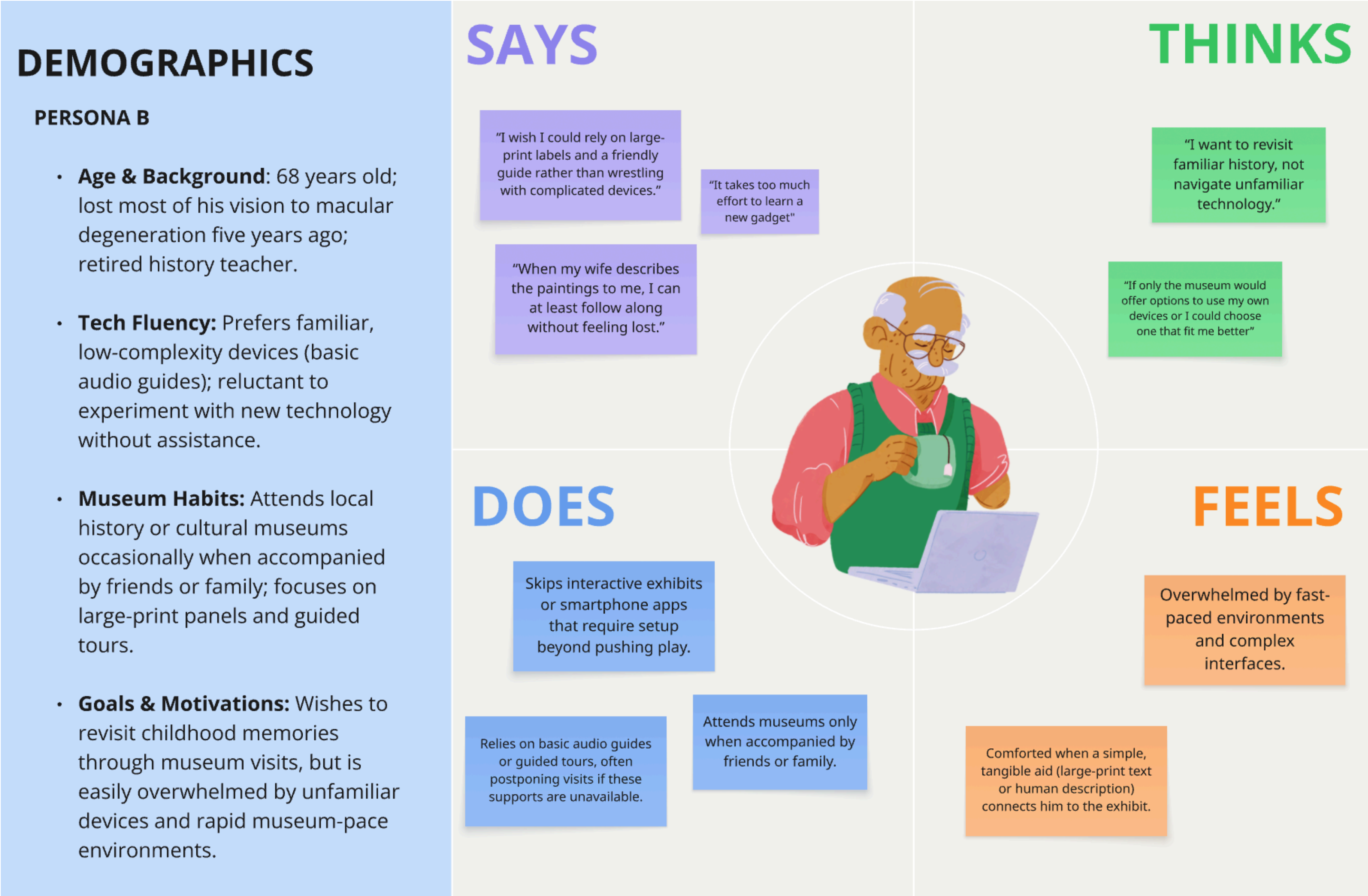


Figure 11: Visualisation of Persona B's demographics and empathy map. Own work.

In line with insights gained from the semi-structured interviews and the broader field research on blind and visually impaired museum visitors, the development of the personas and empathy maps was not based on assumptions or abstract generalisations. Rather, they were grounded in direct dialogue, participant quotes, and behavioural patterns identified in the collected data. The interviews highlighted the diversity of blind and visually impaired visitors. Participants varied widely in their degree of visual impairment, their comfort with technology, their preferred support strategies, and their underlying motivations for visiting museums. Some emphasised their desire for independent engagement with exhibitions through assistive technology or intelligent audio systems. Others expressed a preference for being accompanied by sighted peers, highlighting the importance of shared cultural participation and real-time dialogue.

Insights such as the desire for independent exploration directly shaped the design of Persona A. This persona reflects a tech-savvy individual who values self-guided, multimodal experiences and is motivated by the need for flexible, accessible tools that offer meaningful content and interaction. The empathy map for this persona reflects statements about preferring rich, descriptive content and the ability to ask follow-up questions, while frustrations are centered around inaccessible interfaces or technology. On the other hand, the interview data also revealed important concerns about cognitive load, fatigue, and the emotional cost of navigating complex exhibition spaces. Participants voiced how overwhelming it can be to simultaneously listen to an audio guide, orient oneself in a crowded room, and engage with the exhibit. These insights were foundational in shaping Persona B, who may be less comfortable with complex technological systems and more dependent on clear, low-effort solutions such as human support, tactile information, and simple orientation tools. This persona’s empathy map reflects concerns about getting lost or feeling mentally overwhelmed, alongside desires for calm, intuitive, and socially connected experiences.

By building these personas and empathy maps directly from the voices of users, the design process was firmly anchored in user reality and nuanced experiences. In short, the personas and empathy maps created for this project translate the qualitative data into actionable design insights, enabling a more targeted and empathetic approach to creating meaningful museum experiences for blind and visually impaired visitors.

ESTABLISHING REQUIREMENTS & DESIGN LIMITATIONS

Requirements come from several sources, e.g. from the user community or as a result of the technology to be applied. As such, requirements are statements about a product, service, or experience, that specifies what it should do or how it should perform (Sharp et al. 2019, pp. 356). For this project the physical environment is relevant, as lighting, noise, and movement are essential factors of the operational environment, this being the exhibit spaces (Sharp et al., 2019, pp. 357-358). In order to assess the physical environment, it is possible to outline environmental requirements, or context of use, referring to the circumstances in which the experience will unfold.

In addition to environmental considerations, it is equally important to outline *functional requirements*, which specify the features a system must provide, and *non-functional requirements*, which place constraints on system performance, usability, and development (Sharp et al., 2019, pp. 356–358). However, as this project explores how to implement already existing devices and platforms to the concept model, this phase will focus on the most relevant functional requirements in order to develop a conceptual design that supports exhibition enhancement for blind and visually impaired visitors. The functional requirements will help outline *how* the concept model should work by specifying the main features (Knudsen et al., 2020).

These functional requirements emerge directly from user insights regarding barriers, needs, and non-visual strategies currently employed by blind and visually impaired individuals during a museum visit: *sighted peer descriptions, pre-recorded audio guides, tactile graphics, and smart-device support*. The following requirements will focus on tactile and interactive options, narrative and dialogue-based audio-descriptions, as well as spatially aware wayfinding approaches. By focusing on these requirements, the concept development will ensure and prioritise modality with the aim to give users the possibility to select and engage with the combination of devices and sensory channels that best suit their individual preferences, abilities, and situational needs of the user, as well as the exhibit's real-time conditions.

FUNCTIONAL REQUIREMENTS

CONTEXTUAL AND ADAPTIVE AUDIO NARRATION

The audio system should be triggered either by location or proximity to specific exhibits and respond with the pre-recorded audio content. This content should be modular, allowing visitors to choose between brief overviews or more detailed narrative-based descriptions. Choosing the level of description must be simple and intuitive, ideally activated by the visitor's position in the exhibition space, e.g. depending on the visitor distance from the artwork, in order to remain immersed without needing to manipulate a complex interface.

COMPLEMENTARY TACTILE ENGAGEMENT

Visitors should have access to corresponding tactile representations to key artworks or abstract artworks that can be difficult to convey the meaning of only through verbal description. These tactile representations could be raised graphics or 3D-printed scaled-down recreations, either available on-site or on demand. These could be linked to the audio descriptions, ensuring an integrated sensory experience where touch and hearing reinforce each other in conveying spatial and material qualities.

SPATIALISED AUTOMATED OR AUDIO WAYFINDING

The system should deploy directional audio cues (e.g., a gentle tone or voice prompt) delivered through the same device as the audio-descriptions. Another option is an automated guiding device that guides visitors by leading the way. Both options should guide the visitors to exhibit zones and provide wayfinding support in the exhibition spaces to reach the desired artworks.

ON-DEMAND SUPPORT INTEGRATION

Visitors must be able to easily activate live support, such as a remote guide, volunteer or assistive intelligence capable of recognising artworks and providing real-time responses, at any time during the visit. This functionality could be seamlessly integrated as an automated system so that users can ask questions and receive context-specific help without restarting their experience. After the live interaction, the system should resume from where it left off.

REFRAMING

The development of functional requirements marks a pivotal transition from the Define phase into the Develop phase of the design process. Until this point, the process has been driven by research into the experiences, needs, and preferences of blind and visually impaired museum visitors. Through interviews, personas, and user insights, a nuanced understanding of the barriers to access and the preferred current strategies used during museum visits has been established. These insights now culminate in a clearly defined set of functional requirements, reflecting the emergence of a design rationale, which is the underlying foundation that justifies the concept model (Knudsen et al., 2020). These functional requirements represent not only features but meaningful components that, when composed into a coherent whole, define the identity and intent of the future solution (Andreasen et al., 2015). In this light, the requirements serve not only as technical specifications but as expressions of the design rationale—they are decisions grounded in evidence, informed by the lived experience of users, and shaped by the framing of what matters in this design context.

In this project, the act of framing, seeing a problematic situation in a new light (Dorst, 2015), has meant shifting from a broad and at times ambiguous understanding of accessibility in museums to a focused commitment to accessible exhibition enhancement in non-visual engagement. This underscored that understanding evolves through iterative cycles of action and reflection. Schön's (1983) description of "reflection-in-action" illustrates how designers continually adapt their thinking in response to real-world practice, by refining ideas through tangible interventions. This suggests that new opportunities often emerge from direct engagement with complex problems (Dalsgaard, 2014). In this way, the requirements developed so far do more than define what the concept should do, they define why it should do it and for whom, offering a clear direction for the next phase of the process.

DEVELOP ≡ IDEATE & PROTOTYPE

CONCEPTUALISING THE DESIGN

In the Develop phase, aligned with the *Ideate* stage of the Design Thinking model, reintroduces divergence, this time focused on ideation and the development of the concept model. This phase will begin with a brainstorm that leads to the exploration of a wide range of possibilities throughout best-practice and state-of-the-art solutions. The goal of this phase is to conceptualise a cohesive concept model by exploring the following:

> *How might multimodal technologies support an accessible experience that extends seamlessly into a meaningful post-visit engagement for visitors who are blind or have visual impairments?*

Through low- and high-fidelity prototypes and assessment of the concept through expert consultations, a discussion of the different possibilities will converge to synthesising the insights into a refined concept model that binds together on-site engagement and post-visit reflection. Together, the following sections will translate the initial divergence of ideation into a structured pathway, guiding the creation of a cohesive concept model.

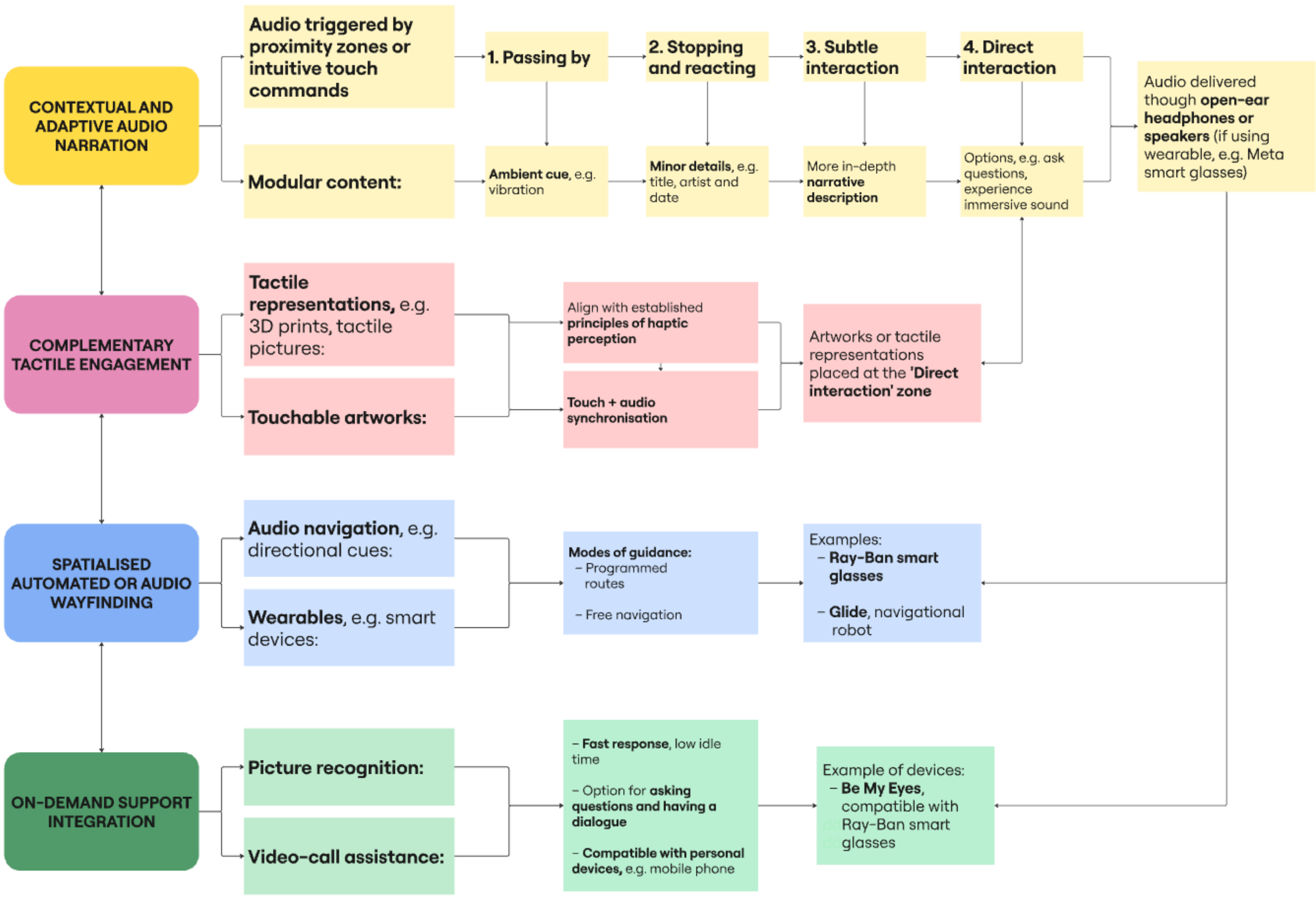
CONCEPT DEVELOPMENT

IDEATION OF CONCEPT MODEL: BRAINSTORMING

Creating a conceptual model is essential in such projects, as it promotes open-minded exploration of different solutions. Once defined, the conceptual model provides a high-level description of how users will understand and engage with the final solution. As such, a conceptual model serves as a blueprint for developing user-centered design concepts (Sharp et al., 2019, p. 408-410). The concept development for this project started out with an ideation phase guided by a brainstorming session. Here brainstorming encouraged the generation, refinement, and exploration of multiple design directions. In this phase, the primary goal was to produce a wide range of alternative designs that can enhance the exhibition experience. Rather than converging on a single idea too early, the aim was to surface diverse possibilities that respond to the requirements outlined in the previous stage (Sharp et al., 2019, p. 373).

Rather than following a specific framework, this brainstorming session was conducted in an informal manner intentionally, with a starting point in the requirement outlined in the previous phase (cf. FUNCTIONAL REQUIREMENTS). This informal brainstorming process explored possible trigger methods, content modalities, interface simplicity, etc. By exploring several perspectives, ranging from different visitor profiles to various technical affordances, the session generated a diverse set of multimodal possibilities. Each idea was sketched or noted to encourage divergent thinking. This requirement-centric method ensured that the brainstorm remained anchored to the project's objectives: contextual audio, tactile reinforcement, spatial orientation, and on-demand support, while still allowing enough freedom to challenge conventional solutions and surface novel interactive possibilities.

Multiple paper-based brainstorming sessions generated a wide range of ideas, which were then reviewed, organized, and distilled into a concise, coherent overview. The following is the final synthesis, which highlights the most relevant concepts, presents them logically, and provides a structured foundation for further development:


CONTEXTUAL AND ADAPTIVE AUDIO NARRATION
Audio triggered by proximity zones or intuitive touch commands
1. Passing by
2. Stopping and reacting
3. Subtle interaction
4. Direct interaction
Modular content:
Ambient cue, e.g. vibration
Minor details, e.g. title, artist and date
More in-depth narrative description
Options, e.g. ask questions, experience immersive sound
Audio delivered though open-ear headphones or speakers (if using wearable, e.g. Meta smart glasses)
COMPLEMENTARY TACTILE ENGAGEMENT
Tactile representations, e.g. 3D prints, tactile pictures:
Touchable artworks:
Align with established principles of haptic perception
Touch + audio synchronisation
Artworks or tactile representations placed at the 'Direct interaction' zone
SPATIALISED AUTOMATED OR AUDIO WAYFINDING
Audio navigation, e.g. directional cues:
Wearables, e.g. smart devices:
Modes of guidance:
– Programmed routes
– Free navigation
Examples:
– Ray-Ban smart glasses
– Glide, navigational robot
ON-DEMAND SUPPORT INTEGRATION
Picture recognition:
Video-call assistance:
– Fast response, low idle time
– Option for asking questions and having a dialogue
– Compatible with personal devices, e.g. mobile phone
Example of devices:
– Be My Eyes, compatible with Ray-Ban smart glasses

For each of the different ideas, I took into consideration both strengths and limitations. By synthesising these annotations, mapping which interaction modes produced the most seamless engagement, I was able to construct a preliminary idea of a conceptual model. This concept idea does not yet represent a finalised model; rather, it highlights clusters of complementary features (e.g., pairing narrative-based audio narration with tactile options) and surfaces potential trade-offs (e.g., more immersive multimodal experiences versus simplicity of use). In essence, these considerations opened up for an investigation of existing solutions that addressed similar objectives, in alignment with the divergent nature of this phase.

By examining best-practice implementations as well as state-of-the-art innovations, it becomes possible to draw lessons that refine the current concept idea and preempt common pitfalls (Sharp et al., 2019, p. 366). In other words, studying comparable systems, devices or experiences not only provides concrete examples of what works well but also helps anticipate challenges that have already been addressed. However, focusing exclusively on cutting-edge solutions or devices carries its own risks. While state-of-the-art solutions often showcase the latest technological breakthroughs, they are frequently untested in diverse, real-world contexts. Such early-stage implementations can introduce unforeseen complexities: they may require specialised infrastructure, demand extensive user training, or assume a level of digital literacy that not all visitors possess. By contrast, best-practice solutions, those that have evolved through multiple cycles of user feedback, usability testing, and incremental improvement, provide a rich repository of practical wisdom. These implementations have typically navigated real-world constraints and can reveal which interface elements reliably enhance usability.

In order to build on these insights and ensure a well-rounded foundation for the evolving concept, a dual investigation, encompassing both state-of-the-art innovations and established best-practice examples, was undertaken. Several of those are a part of these investigations already surfaced during the brainstorming sessions, underscoring their relevance and potential.

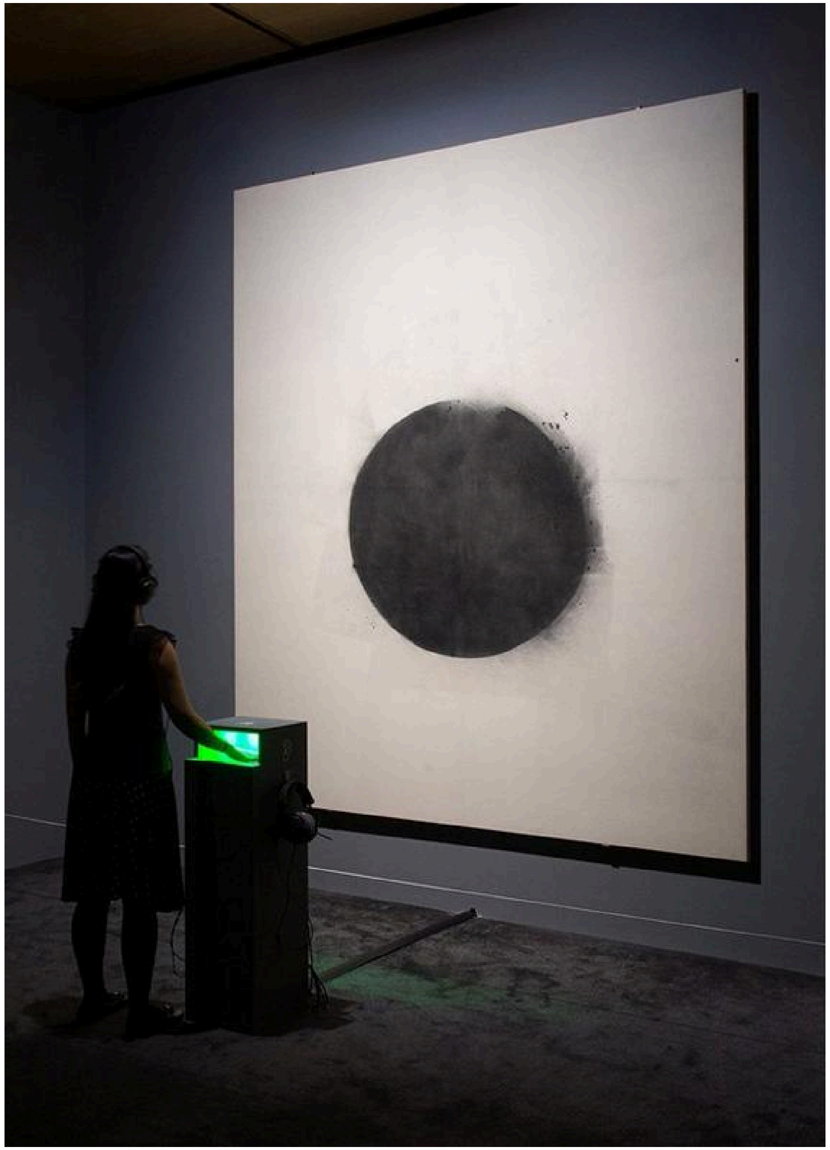
EXAMPLES OF BEST PRACTICE

TATE SENSORIUM

Integrating multimodal technologies into exhibitions presents a great possibility for museums to move beyond the visual dominance that has historically excluded blind and visually impaired visitors. An example of this is the 'Tate Sensorium'. In 2015 Tate Britain presented this interactive art experience that involved four paintings from the Tate collection and used different sensory elements to enhance the understanding of the artworks (Tate Britain, 2015). Each painting was presented alongside other sensory stimuli, e.g., sound, smell, or taste. More than 80% of visitors rated the experience highly appealing and showed interest in returning for more multi-sensory experiences (Pursey & Lomas, 2018).

Technology was used to stimulate visitors' senses to change the way visitors perceived the artworks. The goal of this project was to design an art experience for museum visitors that was immersive rather than isolated, and that was more explicit and memorable by engaging all senses, not just sight. The visual artworks were prioritised as key elements in the design process, with the goal being to reinforce and complement the visual, cognitive, and emotional connection to each painting. Each of the four selected artworks was presented in a visually isolated setting, with the painting illuminated in a way that emphasised its details (Pursey & Lomas, 2018).

A multi-sensory installation was created around each painting. A multidisciplinary team helped to develop each sensory stimulus and create an atmosphere that would highlight the role of the senses. The design process was iterative, using prototypes and workshops, with museum visitors also involved in the process and given the opportunity to participate in hands-on experiences to provide feedback and insights. The iterative approach allowed for constant improvement and fine-tuning (Pursey & Lomas, 2018). The digital technologies used included mid-air haptic technology to activate the sense of touch, directional speakers, headphones, and lighting design to illuminate the artworks (Pursey & Lomas, 2018).



The mid-air haptic technology was used in the presentation of the artwork 'Full Stop'. The painting itself is a three-meter-high white canvas, with a large, spray-painted black circle. To complement the visual aspect of the artwork, a tactile experience was added by placing a hand inside the “ultrahaptics machine”. This created the sensation of sprayed dots on the hand, referencing the spray paint that had been used to create the piece. The experience was further supported by sound, which played spray sounds through headphones, echoing the idea of paint hitting the canvas (Pursey & Lomas, 2018).

Throughout this multi-sensory experience, visitors were given wrist straps to measure their biometric responses to the artworks and completed questionnaires after the experience. By comparing these responses with their biometric data, the designers gained insight into visitors' cognitive and instinctive reactions to the art. The results have then been used to customise tours of Tate Britain's permanent collection.

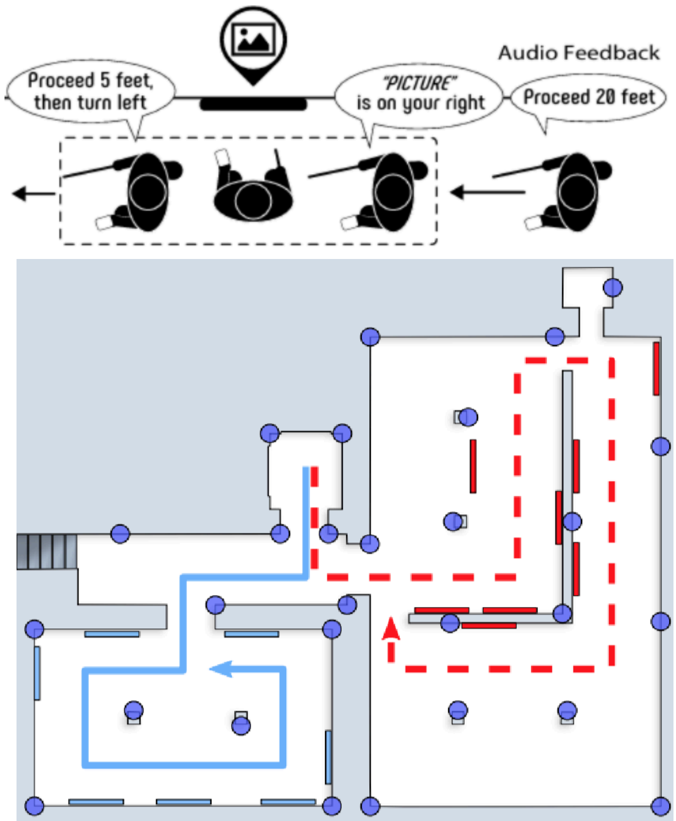
Figure 12: Visitor with hand in an “ultrahaptics machine” in front of the work 'Full Stop' by John Latham (Tate Britain, 2015).

The Tate Sensorium exhibition has been widely praised in the media and received enthusiastic reactions from the press and visitors alike, and was recognised for its innovative approach to combining art and sensory experiences (Pursey & Lomas, 2018).

STATE OF THE ART

APPLICATION BASED CONTEXT-AWARE DESCRIPTIONS AND WAYFINDING ASSISTANCE

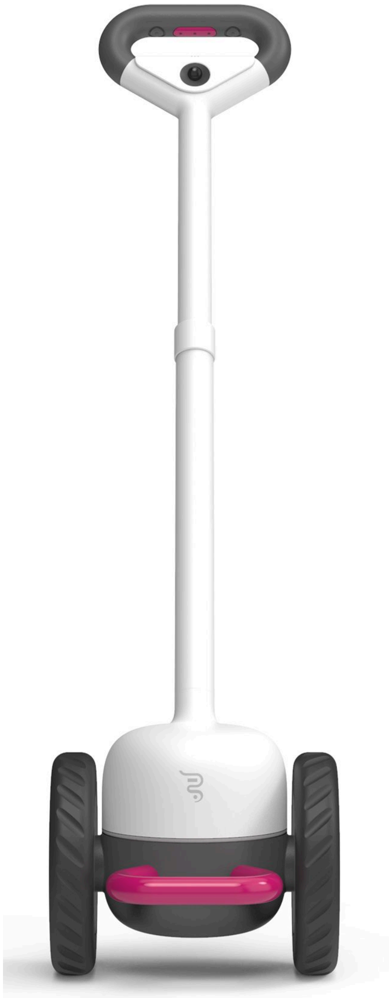
(Asakawa et al., 2019) explored how mobile technology can streamline an independent and interactive museum journey for blind and visually impaired visitors. The application developed is a smartphone-based system designed to support blind and visually impaired museum visitors by combining precise indoor navigation with context-aware audio descriptions of artworks. Using Bluetooth Low Energy beacons and built-in smartphone sensors, the app continuously tracks the user's position and orientation within the space. Real-time localisation enables two complementary interaction modes: *Navigation Mode and Art Appreciation Mode* (Asakawa et al., 2019).



In Navigation Mode, users receive turn-by-turn spoken directions and placement details, such as "Turn right" or "The next artwork is on your left", to guide them along predefined routes. In Art Appreciation Mode, simply turning the device toward a nearby exhibit triggers a detailed audio narrative about that work. During a test-run at The Andy Warhol Museum, 9 blind participants successfully used the app to follow interest-based routes, smoothly transition between navigation and appreciation, and access audio content precisely when they faced each artwork. Participants reported high levels of satisfaction and expressed greater confidence and motivation to visit museums independently (Asakawa et al., 2019).

Figure 15: Navigation and interaction between Navigation and Art Appreciation modes. From "*An Independent and Interactive Museum Experience for Blind People*" by Asakawa et al., 2019.

GLIDE: SMART WAYFINDING DEVICE



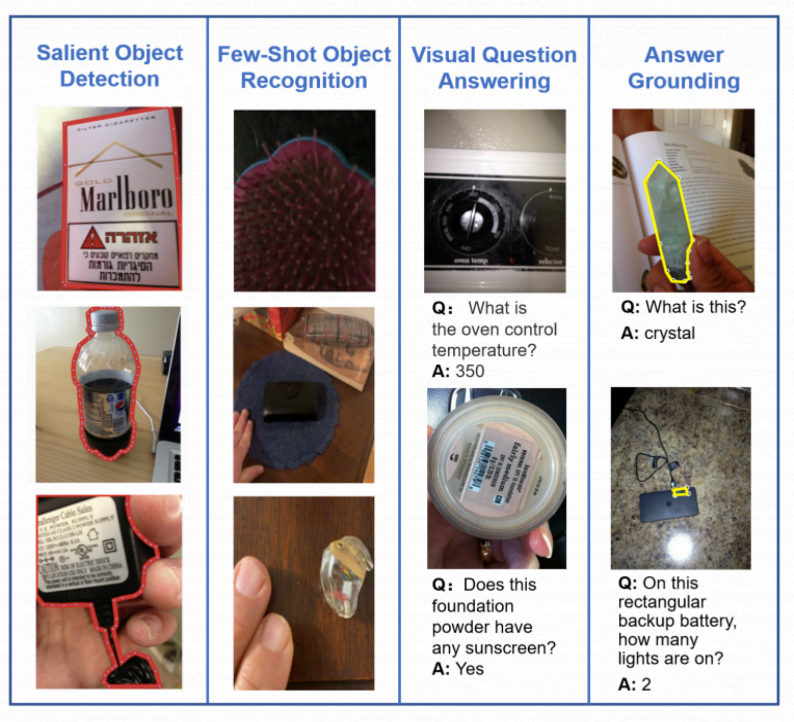
Glide represents a groundbreaking step in assistive mobility, functioning as the world's first autonomous, self-guided aid specifically designed for individuals who are blind or have low vision. Developed by Glidance, this AI-driven device seeks to transform traditional notions of independent navigation, offering an alternative to canes and guide dogs (Glidance.io, n.d.). At its core, Glide is a compact mobility device, propelled by two motorised rubber wheels. It features a vertical stem topped by an ergonomic handle, and houses its forward-facing camera and sensors just beneath the grip. It is controlled by a Sensible Wayfinding system: a high-intensity computer vision and artificial intelligence platform that continuously processes real-time data from an array of advanced sensors.

As users gently push Glide forward at their own pace, the device autonomously maps optimal routes, identifies doors, elevators, stairs, and other key landmarks, and avoids both stationary and moving obstacles, whether indoors or outdoors (Glidance.io, n.d.). Users can choose to program frequent routes in advance. During the museum visit, Glide could guide a visitor from exhibit to exhibit, steer them safely around crowds and display cases, and even offer scene descriptions that provide context about nearby artworks or installations, thereby enhancing both accessibility and the overall visitor experience (Glidance.io, n.d.). In a museum context, by combining autonomous route-finding, obstacle avoidance, and real-time scene description, it transforms a museum visit into a self-guided, immersive experience. From pre-programmed tours to on-demand artwork narrations, Glide could guide visitors confidently through the exhibition space, and adapt to crowd patterns.

Figure 16: Product picture of Glide, by Glidance.io, n.d.

PICTURE RECOGNITION: VizWiz & BE MY EYES

VizWiz is a smartphone application designed to help blind and visually impaired users obtain information about the world around them. Using VoiceOver, the user frames and photographs an object or scene, then records a short spoken question, up to fifteen seconds. Once submitted, the image and audio clip are routed in parallel to one or more chosen services: crowdworkers via Mechanical Turk, a hybrid computer-vision platform like VisionIQ, or the user's own contacts through email or social media. As soon as any source returns a response, it is delivered via VoiceOver speech output **(Brady et al., 2013)**.



In 2011, a year-long research study of VizWiz Social was conducted. An analysis of more than 40,000 queries revealed a clear dichotomy in user needs: the majority sought *concrete, objective information such as currency identification or text transcription, while a significant minority requested descriptive or aesthetic judgments, including color identification and style assessment* **(Brady et al., 2013)**. Importantly, the study also highlighted several technical barriers, such as **low-quality images and asynchronous response times that resulted in unanswered urgent questions**. Even though VizWiz provides a flexible, on-demand aid for identifying text, objects, and other visual details, the application underscores both the promise and the limitations of early hybrid systems that rely on still photography and offline human computation to bridge gaps in computer-vision capabilities.

Figure 17: The taxonomy of VizWiz picture recognition types, from "*2023 VizWiz Grand Challenge Workshop*" by VizWiz, n.d.

In 2015, Be My Eyes transformed this paradigm by enabling instantaneous, two-way video connections between blind users and sighted volunteers who can, e.g. guide users through complex spatial tasks, and provide rich verbal descriptions that static images cannot capture (Be My Eyes, n.d). The application is available in more than 150 countries worldwide, and the volunteers speak more than 180 languages. The app is free and available for both iOS and Android. Further, with the 'Specialised Help' feature, blind and low vision users can also directly connect with company representatives for accessible customer support (Business Wire, 2023).

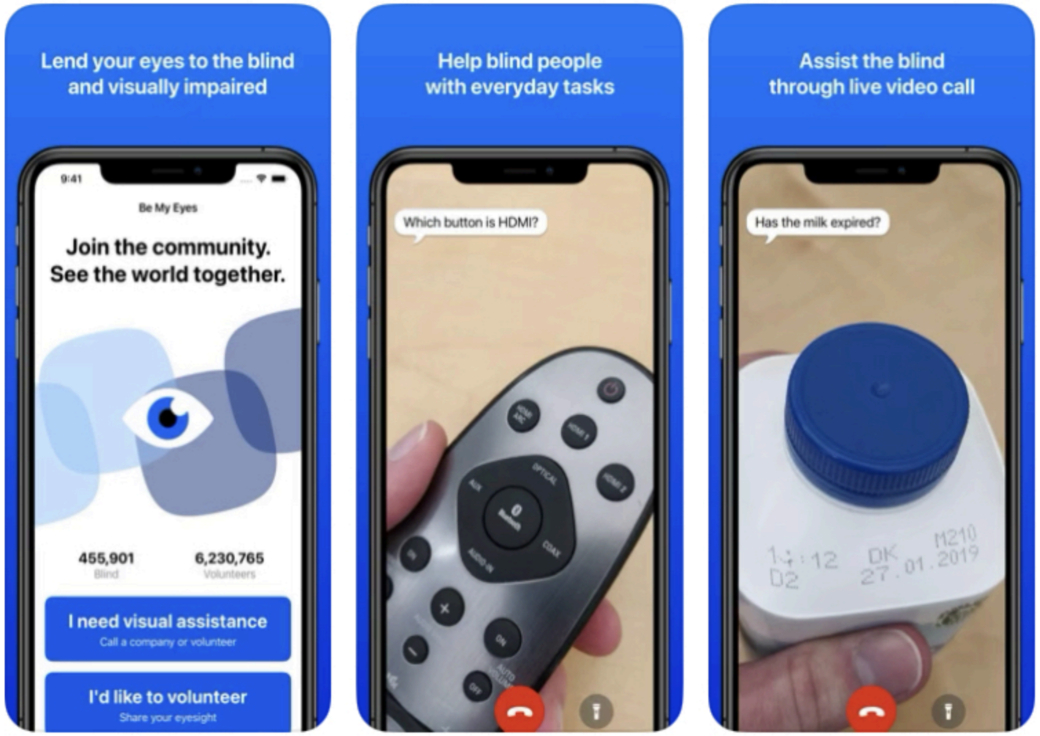
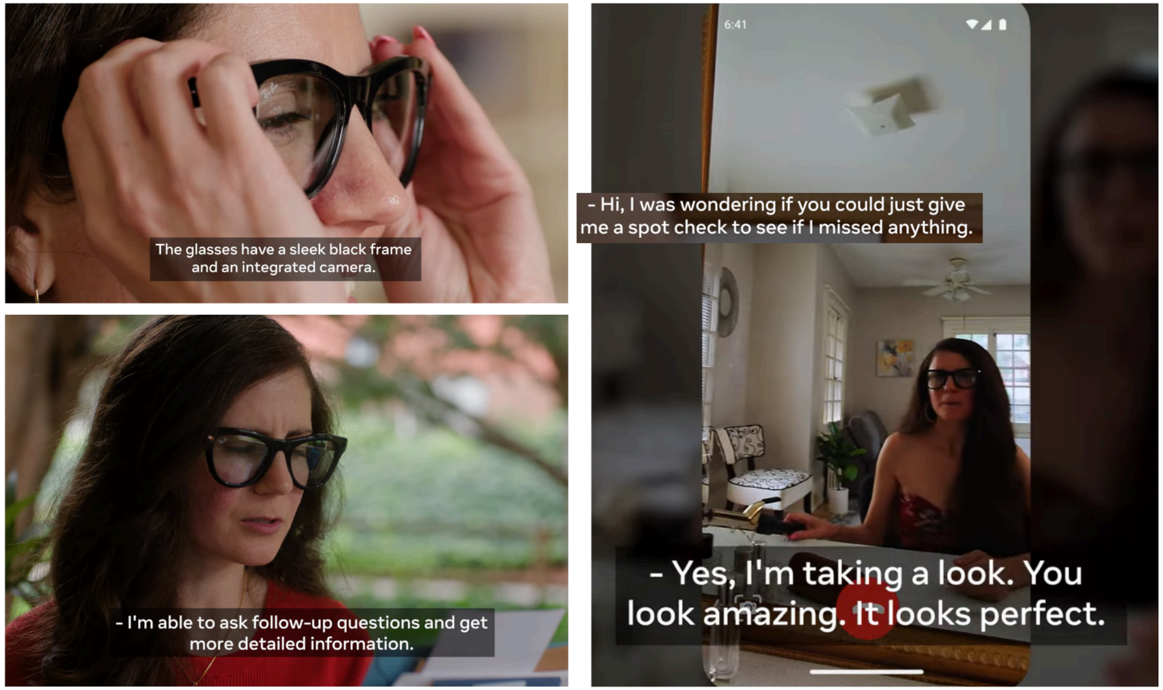


Figure 18: User interface frames of the app in use. From Be My Eyes, n.d.

Gradually, with the rapid advancement of digital technology, the platform developed *Be My AI*. This feature offers users the ability to receive instant, AI-generated visual assistance directly through the app. Powered by OpenAI's image-to-text technology, Be My AI allows users to take a photo and receive detailed descriptions of the image within seconds, through AI-based natural language conversations, meaning that the responses are presented in natural language, and users can ask follow-up questions to get more specific or additional information, creating a dialogue rather than a one-time description (Business Wire, 2023). This approach provides context-aware explanations that can describe complex scenes, read and summarise text, recognise objects, identify locations, and even interpret visual cues such as facial expressions.

MULTIMODAL APPROACH: WEARABLE TECHNOLOGY AND PICTURE RECOGNITION

Ray-Ban Meta smart glasses combine a forward-facing camera and open-ear directional speakers, creating a hands-free visual assistance for wearers. The glasses allow users to capture still images or video via a button on the right temple, or use the voice commands. The audio subsystem includes five microphones that enable immersive audio capture for clearer calls or voice commands even in crowded spaces.



Through integration with the Be My Eyes app, wearers can say “Hey Meta, call Be My Eyes” to connect with the app. Once connected, the volunteer sees a real-time video feed from the glasses’ camera and speaks back through the open-ear speakers. If the user prefers, the built-in AI assistant can also provide automated image descriptions instead. As such, volunteers or AI can answer follow-up questions, or offer navigational cues, without requiring the wearers to use their phone (Be My Eyes, n.d.).

Figure 19: User wearing the smart-glasses and calling a volunteer on the app.

In a museum context, Ray-Ban Meta smart glasses could help alleviate the “attention tug-of-war” created by traditional audio guides. Instead of wearing over-ear headphones, which block important ambient cues like footsteps, voices, and echoes, visitors hear volunteer-delivered or AI-driven descriptions through open-ear speakers, maintaining continuous awareness.

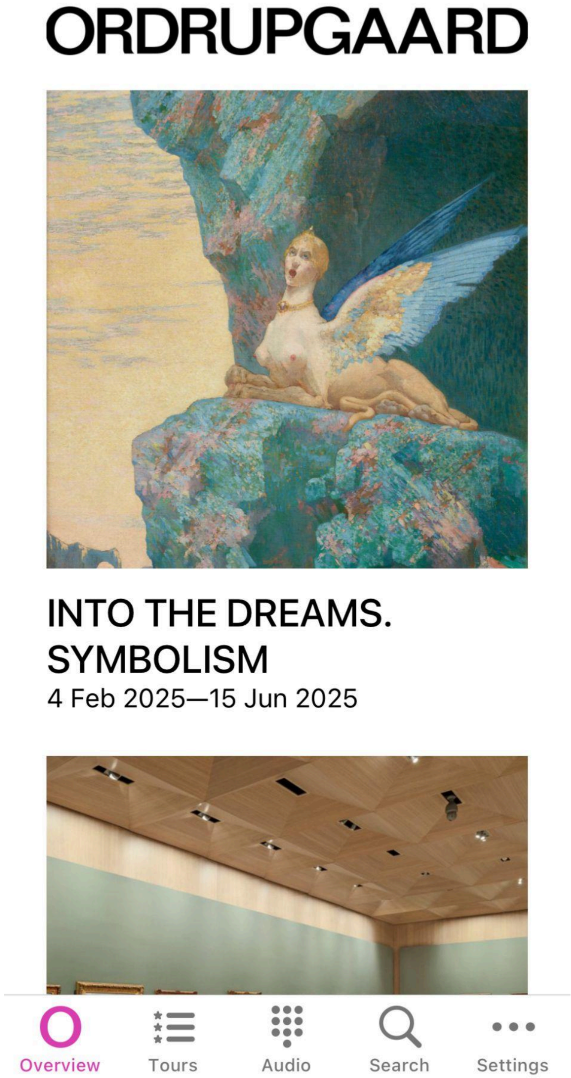
TACTILE REPRESENTATIONS OF VISUAL ART

Translating visual art into tactile form requires careful attention to how individuals who are blind or have low vision process and interpret information through touch. Tactile learners rely on variations in texture, contour, and elevation to build mental representations of an artwork's composition. When these representations align with established principles of haptic perception they enable a more nuanced and meaningful engagement with art (AmRev360, 2022).

Figure 20: Example of a tactile graphic of a picture at the Museum of the American Revolution, by AmRev360, 2022.

The Clovernook Center's partnership with the Museum of the American Revolution exemplifies this complementary approach: by translating richly detailed paintings into raised-texture tactile graphics accompanied by Braille annotations that explain each texture's meaning, the collaboration affords blind and visually impaired museum visitors the ability to interpret compositional elements, spatial relationships, and narrative content through touch—dimensions of art appreciation that even the most sophisticated audio description cannot fully convey (AmRev360, 2022).

ORDRUPGAARD – APPLICATION BASED AUDIO DESCRIPTION



The Ordrupgaard app was developed to bring the museum's collections to life through detailed audio descriptions that invite visitors into deeper conversations about art and provide an inclusive experience for those with visual impairments **(Dynesen, 2025)**. By offering narrated insights into selected paintings, sculptures, and architectural features, the app encourages users to engage with artworks on multiple levels, fostering both individual reflection and group dialogue. These audio tracks were crafted in close collaboration with museum educators and trained volunteers to ensure that each description conveys not only factual information, such as historical context, materials, and artist intentions, but also the atmosphere and emotional resonance of the works **(Dynesen, 2025)**.

Rather than relying on shared headsets, each participant can tune in through their own smartphone, enabling families, friends, or guided groups to experience the narration together and pause at will to discuss particular details. This synchronised listening feature transforms what might otherwise be a solitary audio-guide moment into a shared conversation, reinforcing Ordrupgaard's mission of making art accessible. All audio content can be accessed at all times, under the 'Audio' feature in the bottom menu of the app.

By integrating high-quality audio description, group listening capabilities, and thematic tours the app aligns with Ordrupgaard's broader commitment to inclusivity, ensuring that every visitor has the opportunity to engage fully with the depth and diversity of its collections.

Figure 21: Screenshot of the 'Overview' page of the Ordrupgaard mobile app, own picture.

CONCEPT MODEL

A MULTIMODAL MUSEUM EXPERIENCE FOR BLIND AND VISUALLY IMPAIRED VISITORS

The proposed model rests on the premise of cross-modal perception theories (Arheim, 1990; Falk & Dierking, 2000), as such the framework posits that congruent stimuli across sensory channels (e.g., synchronous audio and haptic cues) creates an accessible experience for blind and visually impaired museum visitors. At the heart of this framework lies a commitment to modularity: each module, navigation, audio, on-demand assistance, tactile, can be deployed in isolation to address specific accessibility needs, yet the true potential emerges when these modules operate together.

Modularity confers two principal advantages. First, it allows museums to deploy individual components according to budget, space, or staffing constraints. Second, it empowers visitors with choice: a blind or visually impaired individual might select to rely exclusively on Glide's autonomous navigation if they are already comfortable with audio narration, or they might choose to bypass tactile stations and depend solely on detailed verbal descriptions. By contrast, when a visitor uses all four modules simultaneously, the overlapping sensory cues, congruent haptic feedback, layered narrative, real-time assistance, and autonomous steering, create a unified sensory scaffold that reinforces spatial orientation and aesthetic comprehension (Falk & Dierking, 2000; Arheim, 1990).

The system integrates three components: *tactile representation options aligned with established principles of haptic perception; smart autonomous navigation, based on the affordances of Glide; and a combined audio narration and on-demand assistance module, inspired by Be My Eyes, the Ordrupgaard app, and the Art Appreciation Mode* presented in the project conducted by Asakawa et al., (2019). Following is a detailed overview of the established concept model.

CONCEPT OVERVIEW AND COMPONENTS

The concept model for this project integrates a spectrum of low- and high-tech strategies into a unified system that accommodates diverse needs and preferences. At its core, the model emphasises modality modularity: each component is capable of functioning independently, yet delivers amplified value when combined with others. This approach empowers visitors to tailor their experience according to individual abilities, whether through auditory, tactile, or haptic pathways, while also benefiting from the synergies created by intersecting modalities. What follows is a detailed presentation of the core components that comprise this cohesive concept model.

Glide's intuitive navigation and wayfinding support lies at the foundation of this concept. By continuously sensing nearby obstacles, whether display cases, walls, or fellow visitors, Glide alleviates the cognitive burden of pathfinding, enabling blind and visually impaired guests to focus on the artworks. Moreover, by functioning seamlessly under both pre-programmed tour and free-exploration modes, Glide ensures that visitors can follow a curator-designed sequence of waypoints while still retaining the freedom to diverge or pause at will. In so doing, Glide not only serves as a standalone navigation aid but also becomes the temporal and spatial anchor upon which the audio and tactile modules depend. The audio module leverages Glide's real-time positioning to deliver interpretive content in the four progressive stages inspired by 'The Audience Funnel' described by Michelis and Müller (2011):

1. **Passing By:** The visitor is "passing by" a tagged artwork and triggers a brief, nonverbal ambient cue, either delivered by the app or by Glide.
2. **Stopping and Reacting:** When the system confirms that the visitor has paused and reoriented toward the work, it immediately provides a concise introduction, announcing e.g. the title, artist, and date alongside a single salient detail (for example, the interplay of sunlight on a figure's garment).
3. **Subtle Interaction:** If the visitor continues facing the piece, the app recognizes this sustained engagement and transitions into a richer narrative over the course of a few minutes.

4. **Direct Interaction :** At the conclusion of this in-depth segment, the app presents three complementary pathways, e.g. visitors can choose to hear an immersive soundscape that evokes the artwork's depicted environment, proceed to a nearby tactile station, or request on-demand assistance.

By issuing an intuitive voice or haptic command, the visitor can activate a live video stream via smartphone or wearable camera (e.g., Ray-Ban Meta glasses). That feed connects to a remote sighted volunteer who can describe nuanced visual elements, guide tactile exploration, or answer open-ended questions. If other options are preferred, the system should also provide assistance, such as AI-driven image-to-text features, providing rapid, context-aware descriptions, such as done by Be My Eyes.

As an optional addition to the audio component, the tactile modularity offers a hands-on approach to engage with visual and spatial content. When designed in line with established principles of haptic perception, this approach holds significant potential—particularly in conveying compositional elements, spatial relationships, and narrative content through touch. Glide is designed to stand upright independently, without the need for continuous physical support. This self-supporting capability allows it to remain securely in place when not actively guiding movement.

LOW-FIDELITY PROTOTYPES

STORYBOARD, SKETCHES AND SCENARIOS

Prototypes stimulate reflections, and can be used to frame, refine, and creatively explore possibilities in a design space. Prototypes have a role in enabling designers to reflect on their design activities, providing questions and support in choosing between alternatives (Sharp et al., 2019, p. 391). There are two key dimensions: prototypes as filters that focus on particular features, and prototypes as manifestations, that enables the realisation of particular conceptual design ideas (Lim et al., 2008). Low-fidelity prototypes played a dual role throughout this phase, acting both as manifestations of specific design concepts and as filters that draw attention to particular dimensions while setting aside others (Lim et al., 2008). As manifestations, through simple sketches, they bring abstract ideas into the tangible realm, enabling discussion of foundational elements. At the same time, low-fidelity prototypes served as filters by isolating critical dimensions, such as user flow, spatial arrangement, and core interactions, temporarily excluding details like precise technical implementation. This selective focus helped validate key concepts before committing to higher-fidelity development (Lim et al., 2008).

As the primary goal of this phase is to validate core interactions and ideas, as well as develop a robust concept model, low-fidelity prototyping techniques were particularly well suited. For this ideation phase, storyboarding was paired with user scenarios to create a more actionable concept model. In practice, storyboarding involved sketching a sequence of scenes that illustrated the user's journey through the proposed system, depicting the overall interaction steps, and the evolving context of use (Sharp et al., 2019, p. 393). By translating abstract concepts into a visual narrative, storyboarding provided a detailed overview of the functions, behaviors, and structures envisioned for the final concept. Rather than focusing on the underlying technical architecture, storyboarding emphasised how users would accomplish tasks, how the system should guide them, and where potential challenges may arise. What follows is the storyboard outlining the concept model, based on a user scenario.

PRE-VISIT PLANNING

The visitor downloads the museum's accessibility application onto their personal smartphone. From home, they explore some of the artworks exhibited at the museum, reading brief meta-data and adjusting settings: choosing preferred language, narration speed, and depth of detail. Using the same interface, they create a custom tour by selecting works that interest them; the app translates this selection into a sequence of location waypoints. As a result, the visitor arrives equipped with a clear mental map of the collection, lowering potential anxiety and enabling efficient use of time.

1

ENTRY AND BEGINNING THE TOUR

Upon arriving at the museum, the visitor checks in at the accessibility desk, where they receive a Glide unit (or enable the app's built-in guidance if they prefer not to use Glide). They secure open-ear or bone-conduction earphones and confirm that the app is active. As the visitor steps into the entry hall, Glide's sensors scan the environment for obstacles to avoid. Together, these systems establish the visitor's precise position and orientation within the exhibition space.

2

STOPPING AND REACTING

Moving toward their first waypoint, the visitor feels/hears a soft vibration or chime, signalling that an artwork lies ahead. This "passing-by" cue, corresponding to the first audio layer, indicates that the visitor is within range of an artwork. No spoken content plays yet; instead, Glide's unobtrusive steering ensures the visitor approaches the correct spot. The visitor reaches the designated location and stops.

3

SUBTLE INTERACTION

The visitor is notified that they are standing in front of the artwork. A brief introduction—title, artist, date, and a single compositional detail—is provided since the visitor has paused and oriented toward the painting

After three seconds of stillness, Glide remains stationary, and the app transitions into an in-depth narrative. Over the next few minutes, the visitor hears information about the artwork, historical context and emotional resonance.

4

DIRECT INTERACTION CHOICES

After the in-depth description, the app offers three options:

Immersive Soundscape: The visitor can select "Play Soundscape" to hear a short audio track that conveys the ambience of the artwork.

Tactile Representations: By saying "Go to Tactile Station," the visitor prompts Glide to resume guidance, this time steering them to the nearby tactile option.

On-Demand Assistance: By issuing the voice command or tapping the call-icon on the app, the visitor initiates a live video stream to a remote sighted volunteer.

POST-VISIT REFLECTION: LATE-VISIT SUMMARY AND REVIEW

As the scheduled tour concludes, the visitor reaches the museum's final waypoint. Glide delivers a gentle vibration to signal the end of the route. After the visit, the app stores a log of waypoints visited, narratives heard, and any on-demand questions asked. Through their personal account, the visitor can revisit audio segments, review high-resolution images, and read augmented text versions of tactile prompts. This post-visit archive reinforces memory retention and allows deeper reflection, making the entire experience an extended, self-directed dialogue with the museum's collection.

DISCUSSION OF THE CONCEPT MODEL

From the brainstorming session, three critical areas shape the focus for the next phase: validating core interactions between the user and the different components of the concept, and ensuring precise synchronization between navigation cues and audio prompts. For the next step, I will be focusing on testing the actual content, short orientation cues and the extended narratives. This next phase of prototyping and testing will take place after the thesis has been handed in, due to multiple factors, such as time constraints and difficulties outreaching participants.

However, a testing session has already been scheduled, with two blind and visually impaired visitors to evaluate these elements. During this session, I will observe how well the short orientation cues guide them through an exhibition space, noting whether each cue clearly communicates direction and timing. Then I'll present the extended narratives at predetermined waypoints, measuring how long they listen, which descriptive elements resonate or cause confusion, and how well this approach maintains their engagement. These testing sessions will be based on the Ordrupgaard app, which provides both short and more in-depth descriptions. However, these descriptions are not dependent or triggered by any spatial positioning in the space, they are purely controlled through the app.

At the same time, I will test Be My Eyes in an art-museum context. Participants will be asked to use the app, as they would use it at home (one of the participants already knows the app). I will focus on the sound level of the environment, whether participants require additional context to give accurate descriptions and if the use of the app interferes with their intended museum visit. This will highlight any technical or logistical hurdles so I can refine the workflow accordingly. By concentrating on low-fidelity user interactions, verifying real-time coordination of guidance cues, and refining content modules through direct testing with visually impaired participants and Be My Eyes integration, I will establish a solid foundation for the technical build. These steps will expose practical limitations—such as response latency, ambiguous haptic signals, confusing tactile graphics, or challenges in live assistance.

CONCLUSION

While prior research has explored various technological approaches to access visual arts, such as those the concept model consists of, it still remains unknown how these approaches are adopted by people in the blind community under different contexts of use, such as at museums. Exploring this is crucial, in order to include blind and visually impaired museum visitors' preferences among different access technologies and design implications towards more accessible and enjoyable art experiences.

Museums are gradually becoming more accessible to blind people, who have shown interest in visiting museums Yet, their ability to visit museums is still dependent on the assistance from others. It is, therefore, important to recognize that while museums have increasingly embraced activity-based and interactive practices, capitalizing on multi-sensory environments and digital experiences, technology alone cannot dismantle barriers to access and representation. Everyday barriers continue to hinder cultural participation and the opportunity to benefit from cultural offers, goods, and benefits. Accessibility should go beyond simply ensuring physical access to spaces; it now encompasses digital access and the inclusive design of services and experiences, addressing informational, social, and attitudinal dimensions that shape visitor engagement. As such, museums must consider not only the immediate engagement of visitors but also the anticipatory and reflective processes that occur before and after a visit, as these aspects are equally significant to cultural participation.

Clear, accessible pre-visit information reduces uncertainty and encourages attendance, while on-site interventions such as tactile models, synchronized audio narratives, spatially coherent haptic wayfinding, and wearable guidance devices enable blind and visually impaired visitors to explore galleries with autonomy and confidence. By aligning these tools with non-visual perceptual modalities, museums transform static displays into interactive, multisensory encounters that foster deeper cognitive processing and emotional immersion. During the visit, congruent multimodal stimuli, touchable replicas, context-aware audio descriptions, and interactive feedback systems, help blind and visually impaired visitors construct richer mental models of artworks.

This co-creative approach reframes disability through a social lens, recognizing that impairments arise from environmental barriers rather than individual deficits. As a result, blind and visually impaired visitors transition from passive recipients to active participants, co-constructing meaning through touch, sound, and narrative. Such embodied engagement not only enhances on-site satisfaction but also strengthens memory encoding: multisensory experiences bind more effectively in working memory than visual or verbal information alone. Post-visit, digital extensions, transcripts of audio narratives, downloadable tactile guides, and asynchronous virtual tours, reinforce learning and sustain emotional connection. When these resources are thoughtfully designed and made widely accessible, they bridge the gap between policy intentions and lived experiences, fostering long-term engagement. In practice, effective post-visit follow-up might include interactive online galleries with descriptive audio, remote haptic tutorials, or community forums that invite BVI visitors to share their reflections. These elements ensure that the museum's impact extends beyond its physical walls, supporting continued exploration and social inclusion.

Ultimately, a holistic, visitor-centered strategy, combining low- and high-technology solutions, universal design principles, and ongoing collaboration with disability communities and experts, redefines what it means to experience art. By embedding multimodal technologies into every stage of the visitor journey, museums not only dismantle practical and perceptual barriers but also affirm blind and visually impaired visitors' autonomy, agency, and right to cultural participation. This integrated approach makes the museum visit a participatory, multisensory dialogue, ensuring that all individuals can engage meaningfully with visual art and carry that engagement into lasting, post-visit experiences.

BIBLIOGRAPHY

Aalborg University (n.d.). https://kbdk-aub.primo.exlibrisgroup.com/discovery/search?vid=45KBDK_AUB:AUB

Amilon, A., Østergaard, V. S., & Olsen, F. R. (2021). Mennesker med handicap – Hverdagsliv og levevilkår 2020. VIVE - Det Nationale Forsknings- og Analysecenter for Velfærd.

AmRev360. (2022). AmRev360: Making Art Accessible with Clovernook Center for the Blind & Visually Impaired. Museum of the American Revolution. https://www.amrevmuseum.org/amrev360-making-art-accessible-with-clovernook-center-for-the-blind-and-visually-impaired

Andreasen, M.M., Hansen, C.T. and Cash, P. (2015), Conceptual Design: Interpretations, Mindset and Models, Springer.

Arnheim, R. (1990). Perceptual Aspects of Art for the Blind. The Journal of Aesthetic Education, 24(3), pp. 57–65. https://doi.org/10.2307/3332799

Asakawa, S., Guerreiro, J., Sato, D., Takagi, H., Ahmetovic, D., Gonzalez, D., Kitani, K. M., & Asakawa, C. (2019). An Independent and Interactive Museum Experience for Blind People. Proceedings of the 16th International Web for All Conference, pp. 1–9. https://doi.org/10.1145/3315002.3317557

Baber, C. (2022). Embodying Design: An Applied Science of Radical Embodied Cognition. The MIT Press.

Be My Eyes (n.d.). https://www.bemyeyes.com

Bekele, M. K., Pierdicca, R., Frontoni, E., Malinverni, E. S., & Gain, J. (2018). A Survey of Augmented, Virtual, and Mixed Reality for Cultural Heritage. Journal on Computing and Cultural Heritage, 11(2), 1–36. https://doi.org/10.1145/3145534

Bennett, C. L., & Rosner, D. K. (2019). The Promise of Empathy: Design, Disability, and Knowing the ‘Other’. Proceedings of the 2019 CHI Conference on Human Factors in Computing Systems, pp. 1–13. https://doi.org/10.1145/3290605.3300528

Bienvenu, B., Tuzzolino, L., Hughes, J., Spearman, C., & Rogowski, K. (2021). Disability design: Summary report from a field scan. National Endowment for the Arts, pp. 1–49.

Brandt, D. E., Ho, P.-S., Chan, L., & Rasch, E. K. (2014). Conceptualizing disability in US national surveys: Application of the World Health Organization’s (WHO) International Classification of Functioning, Disability, and Health (ICF) framework. Quality of Life Research, 23(10), pp. 2663–2671. https://doi.org/10.1007/s11136-014-0740-6

Brady, E., Morris, M. R., Zhong, Y., White, S., & Bigham, J. P. (2013). Visual challenges in the everyday lives of blind people. CHI 2013 : Changing Perspectives : Conference Proceedings of the 31st Annual CHI Conference on Human Factors in Computing Systems : 27 April - 2 May 2013, Paris, France, pp. 2117–2126. https://doi.org/10.1145/2470654.2481291

Böhme, G. (1993). Atmosphere as the Fundamental Concept of a New Aesthetics. 36, pp. 113–126.

Burgess, P.W. (2015) Serial Versus Concurrent Multitasking: From Lab to Life. In J. M. Fawcett, E.F. Risko and A. Kingstone (eds.) The Handbook of Attention. pp. 443–462. Cambridge, MA: The MIT Press.

Business Wire (2023). Be My Eyes Integrates Be My AI™ into its First Contact Center with Stunning Results. https://www.proquest.com/wire-feeds/be-my-eyes-integrates-ai™-into-first-contact/docview/2889975521/se-2

Buxton, B. (2007). Sketching user experiences: Getting the design right and the right design. San Francisco, CA: Morgan Kaufmann.

Caddick, R., & Cable, S. (2011). Communicating the user experience : a practical guide for creating useful UX documentation (1st ed.). Wiley.

Carroll, J. M. (1999). Five reasons for scenario-based design. In Proceedings of the 32nd Hawaii International Conference on System Sciences (Vol. 3, p. 3051). New York, NY: ACM Press

Connell, J., Brazier, J., O'cathain, A., Lloyd-Jones, M., & Paisley, S. (2012). Quality of life of people with mental health problems: a synthesis of qualitative research. Health and Quality of Life Outcomes, 10(138), pp. 1–16.

Cross, N. (2023). Design thinking : understanding how designers think and work (Second edition.). Bloomsbury Visual Arts.

Cronin, P., Ryan, F., & Coughlan, M. (2008). Undertaking a literature review: A step-by-step Side 98 af 108 approach. British Journal of Nursing, 17(1), 1–24. https://doi.org/10.12968/bjon.2008.17.1.28059

Csikszentmihalyi, M. (2001). Finding flow : the psychology of engagement with everyday life (12. printing.). BasicBooks.

Dalsgaard, P. (2014). Pragmatism and design thinking. International Journal of Design, 8(1), 143-155.

Dansk Blindesamfund. (n.d.). https://blind.dk

Danske Handicaporganisationer. (n.d.). SAMMEN MOD EN TILGÆNGELIG FREMTID (Handicapbevægelsens Handicapbevægelsens forslag til et samfund med lige muligheder for alle forslag til et samfund med lige muligheder for alle). https://handicap.dk/files/media/document/Tilg%C3%A6ngelighedspolitik%202024%20__.pdf

Danske Handicaporganisationer (2023). Danskernes syn på handicap (En undersøgelse om danskernes kendskab og holdninger til mennesker med handicap, pp. 1–50).

Department of Economic and Social Affairs. (n.d.). United Nations DESA programme on Disability | Division for Inclusive Social Development (DISD). United Nations. https://social.desa.un.org/issues/disability

Design Council. (n.d). The Double Diamond. A universally accepted depiction of the design process. https://www.designcouncil.org.uk/our-resources/the-double-diamond/

Dewey. J. (1934) Having an Experience. In Art as Experience (1939). New York, Capricorn Books, pp. 35-57.

Dorst, K. (2015), "Frame Innovation: Create New Thinking by Design", In: Friedman, K. and Stolterman, E. (Ed.), The MIT Press, London, England.

Drotner, K., & Schrøder, K. (Eds.). (2013). Museum communication and social media: The connected museum. pp. 1–197. Routledge.

Durlak, M. (2018). Unlocking Creativity in the Name of Inclusion. Retrieved March 1, 2025 from https://www.ideo.org/perspective/creative-inclusion-and-bias-breaking

Dynesen, S. M. (2025). Synstolkning åbner døren til samtale og kunstens dybde på Ordrupgaard. I applaus. https://applaus.nu/artikel/synstolkning-aabner-doeren-til-samtale-og-kunstens-dybde-paa-ordrupgaard/

Eid, H. (2021). Experimental innovation in museums: Encouraging creativity, building confidence and creating social

value. In M. Achiam, M. Haldrup, & K. Drotner, Experimental Museology (1st ed., pp. 133–146). Routledge. https://doi.org/10.4324/9780367808433-8-11

European Parliament: Directorate-General for Parliamentary Research Services & Pasikowska-Schnass, M. (2017).

Access to culture in the European Union : in-depth analysis, European Parliament. https://data.europa.eu/doi/10.2861/741583

Faiola, A., Newlon, C., Pfaff, M., & Smyslova, O. (2013). Correlating the effects of flow and telepresence in virtual worlds: Enhancing our understanding of user behavior in game-based learning. Computers in Human Behavior, 29(3), 1113–1121. https://doi.org/10.1016/j.chb.2012.10.003

Falk, J., H & Dierking, L., D (2000). Learning From Museums: Visitor Experiences and the Making of Meaning.

Flick, U. (2018). Doing triangulation and mixed methods (2nd edition). SAGE.

Fortuna, J., Harrison, C., Eekhoff, A., Marthaler, C., Seromik, M., Ogren, S., & VanderMolen, J. (2023a). Identifying Barriers to Accessibility for Museum Visitors Who Are Blind and Visually Impaired. Visitor Studies, 26(2), pp. 103–124. https://doi.org/10.1080/10645578.2023.2168421

Fortuna, J., Thomas, K., Asper, J., Matney, L., Chase, K., Ogren, S., & VanderMolen, J. (2023b). A Survey of Universal Design at Museums: Current Industry Practice and Perceptions. The Open Journal of Occupational Therapy, 11(1), pp. 1–15. https://doi.org/10.15453/2168-6408.1994

Gibbons, S. (2018). Empathy mapping: The first step in design thinking. Nielsen Norman Group. https://www.nngroup.com/articles/empathy-mapping/

Gkatzola, K., & Papadopoulos, K. (2024). Social media actually used by people with visual impairment: A scoping review. The British Journal of Visual Impairment, 42(3), 832–848. https://doi.org/10.1177/02646196231189393

Giannelli et al. (2024). Mapping Disability Access to Danish Art Spaces. https://mappingdisability.com

Gibson, J. J. (1983). The Obtaining of Stimulation. I The senses considered as perceptual systems (s. 31–46). Westport, Conn.: Greenwood.

Glidance.io, n.d. https://glidance.io/product/

Gratton, N. (2020). People with learning disabilities and access to mainstream arts and culture: A participatory action research approach. British Journal of Learning Disabilities, 48(2), pp. 106–114. https://doi.org/10.1111/bld.12303

Haldrup, M., Achiam, M., & Drotner, K. (Eds.). (2021). Experimental museology : institutions, representations, users. Routledge. https://doi.org/10.4324/9780367808433

Hanington, B., & Martin, B. (2012). Universal Methods of Design: 100 Ways to Research Complex Problems, Develop Innovative Ideas, and Design Effective Solutions (Digital ed.). Quarto Publishing Group USA.

Hassenzahl, M., Eckoldt, K., Diefenbach, S., Laschke, M., Lenz, E., & Kim, J. (2013). Designing moments of meaning and pleasure. Experience design and happiness. International Journal of Design, 7(3), pp. 21–31.

Hassenzahl, M. (2010). Experience Design: Technology for all the right reasons. San Rafael, CA: Morgan & Claypool

Harmat, L., Ørsted Andersen, F., Ullén, F., Wright, J., & Sadlo, G. (Eds.). (2016). Flow Experience: Empirical Research and Applications. Springer. https://doi.org/10.1007/978-3-319-28634-1

Hitchins, S. (2022). Compare the models. https://www.stephanhitchins.com.au/compare-the-models/

Holtzblatt, K., and Jones, S. (1993) Contextual Inquiry: A Participatory Technique for Systems Design. In D. Schuler and A. Namioka (eds) Participatory Design: Principles and practice. Lawrence Earlbaum Associates, Hillsdale, NJ, pp. 177–210.

Hornecker, E., & Buur, J. (2006). Getting a grip on tangible interaction: A framework on physical space and social interaction. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, pp. 437–446. https://doi.org/10.1145/1124772.1124838

Houghton, Sophie J., (2024). “What the Eye Doesn’t See: The Power of Non-Ocularcentric Engagement in Museum Learning”. Undergraduate Honors Theses. 384. https://scholarsarchive.byu.edu/studentpub_uht/384

Høffding, S., Rung, M., Roald, T., & Høffding, D. (2022). Deltagelse og æstetiske oplevelser på kunstmuseet? En Fænomenologisk Analyse. Curator: The Museum Journal, 65(2), pp. 281–294. https://doi.org/10.1111/cura.12478

Jantzen, C., Mikael, V., & Bouchet, Julie. (2011). Oplevelsesdesign (1. udgave, s. 1-271). Samfundslitteratur.

Jantzen, C. (2013). Experiencing and experiences: A psychological framework. In J. Sundbo & F. Sørensen (Eds.), Handbook on the Experience Economy. Edward Elgar Publishing. https://doi.org/10.4337/9781781004227.00013

Jespersen, L. N., Michelsen, S. I., Tjørnhøj-Thomsen, T., Svensson, M. K., Holstein, B. E., & Due, P. (2019). Living with a disability: A qualitative study of associations between social relations, social participation and quality of life. Disability and Rehabilitation, 41(11), pp. 1275–1286.

Kay, P. L., Wong, E., & Polonsky, M. J. (2009). Marketing cultural attractions: Understanding non-attendance and visitation barriers. Marketing Intelligence & Planning, 27(6), pp. 833–854. https://doi.org/10.1108/02634500910988717

Kelly, L., Drotner, K., & Schrøder, K. C. (2013). The Connected Museum in the World of Social Media. In Museum Communication and Social Media (1st ed., pp. 54–71). Routledge. https://doi.org/10.4324/9780203500965-5

Kirchberg, V., & Tröndle, M. (2012). Experiencing Exhibitions: A Review of Studies on Visitor Experiences in Museums. Curator (New York, N.Y.), 55(4), 435–452. https://doi.org/10.1111/j.2151-6952.2012.00167.x

Kochanowska, M., Gagliardi, W. R., with reference to Jonathan Ball, Raposo, D., Silva, J., & Neves, J. (2022). The Double Diamond Model: In Pursuit of Simplicity and Flexibility. In Perspectives on Design II (Vol. 16, pp. 19–32). Springer International Publishing AG. https://doi.org/10.1007/978-3-030-79879-6_2

Knudsen, L. S., Haase, L. M., & Gonçalves, M. (2020). DESIGN RATIONALE IN CONCEPTUAL DESIGN: A LONGITUDINAL STUDY OF PROFESSIONAL DESIGN TEAMS' PRACTICE. In Proceedings of the Design Society: DESIGN Conference (Vol. 1, pp. 1315-1324). Cambridge University Press. https://doi.org/10.1017/dsd.2020.11

Krahn, G. L., Walker, D. K., & Correa-De-Araujo, R. (2015). Persons With Disabilities as an Unrecognized Health Disparity Population. American Journal of Public Health, 105(S2), pp. 198–206. https://doi.org/10.2105/AJPH.2014.302182

Kuflik, T., Wecker, A. J., Lanir, J., & Stock, O. (2015). An integrative framework for extending the boundaries of the museum visit experience: Linking the pre, during and post visit phases. Information Technology & Tourism, 15(1), pp. 17–47. https://doi.org/10.1007/s40558-014-0018-4

Kvale, S., & Brinkmann, S. (2015). Interview: Det kvalitative forsknings interview som håndværk (3. udgave). Hans Reitzel.

Leahy, A., & Ferri, D. (2022). Barriers and Facilitators to Cultural Participation by People with Disabilities: A Narrative Literature Review. Scandinavian Journal of Disability Research, 24(1), pp. 68–81. https://doi.org/10.16993/sjdr.863

Levent, N. S., & Pascual-Leone, A. (2014). The Multisensory museum: Cross-disciplinary perspectives on touch, sound, smell, memory, and space (N. Levent & A. Pascal-Leone, Red.). Rowman & Littlefield.

Li, F. M., Zhang, L., Bandukda, M., Stangl, A., Shinohara, K., Findlater, L., Carrington, P., Goyal, T., Peters, A., Mueller, S., Väänänen, K., Kristensson, P. O., Schmidt, A., Williamson, J. R., & Wilson, M. L. (2023). Understanding Visual Arts Experiences of Blind People. Proceedings of the 2023 CHI Conference on Human Factors in Computing Systems, pp. 1–21. https://doi.org/10.1145/3544548.3580941

Lim, Y.-K., Stolterman, E., & Tenenberg, J. (2008). The anatomy of prototypes: Prototypes as filters, prototypes as manifestations of design ideas. ACM Transactions on Computer-Human Interaction, 15(2), s. 1–27. https://doi.org/10.1145/1375761.1375762

Ludwig, E. (2012). Stigma in the Arts: How Perceptual Barriers Influence Individuals' with Disabilities Participation in Arts Organizations. The Journal of Arts Management, Law, and Society, 42(3), pp. 141–151. https://doi.org/10.1080/10632921.2012.729498

Lund, T. (2012). Combining Qualitative and Quantitative Approaches: Some Arguments for Mixed Methods Research. Scandinavian Journal of Educational Research, 56(2), pp. 155–165. https://doi.org/10.1080/00313831.2011.568674

Löwgren, J., & Stolterman, E. (2004). Thoughtful Interaction Design: A Design Perspective on Information Technology. The MIT Press. https://doi.org/10.7551/mitpress/6814.001.0001

Løssing, A. S. W. (Red.). (2009). Digital museumsformidling i brugerperspektiv. (s. 9-13) Kulturarvsstyrelsen. https://slks.dk/fileadmin/user_upload/kulturarv/publikationer/emneopdelt/digitalisering/digital_museumsformidling.pdf

McCarthy, J., & Wright, P. (2004). Technology as experience. Interactions, 11(5) https://doi.org/10.1145/1015530.1015549

Meecham, P., Drotner, K., & Schrøder, K. C. (2013). Social Work: Museums, Technology, and Material Culture. In Museum Communication and Social Media (1st ed., pp. 33–53). Routledge. https://doi.org/10.4324/9780203500965-4

Mesquita, S., & Carneiro, M. J. (2016). Accessibility of European museums to visitors with visual impairments. Disability & Society, 31(3), pp. 373–388. https://doi.org/10.1080/09687599.2016.1167671

Michelis, D., & Müller, J. (2011). The Audience Funnel: Observations of Gesture Based Interaction With Multiple Large Displays in a City Center. International Journal of Human–Computer Interaction, 27(6), 562–579. https://doi-org.zorac.aub.aau.dk/10.1080/10447318.2011.555299

Microsoft Design (n.d.). The Persona Spectrum. In Inclusive 101 Playbook. https://inclusive.microsoft.design/tools-and-activities/Inclusive101Guidebook.pdf

Miro. (n.d.). About Miro. Miro. https://miro.com/about/ https://miro.com/app/board/uXjVLnpzpQc=/?share_link_id=5978841841

MJV Team. (2021). The Three Phases of Design Thinking: Immersion, Ideation and Prototyping. MJV Technology and Innovation. https://www.mjvinnovation.com/blog/three-phases-of-design-thinking-immersion-ideation-prototyping/

Morse, C., Niess, J., Bongard-Blanchy, K., Rivas, S., Lallemand, C., & Koenig, V. (2023). Impressions that last: Representing the meaningful museum experience. Behaviour & Information Technology, 42(8), pp. 1127–1154. https://doi.org/10.1080/0144929X.2022.2061375

Nikerman, M., & Churakova, K. (2015). Museum adaptation for blind people. Behance. Retrieved from https://www.behance.net/gallery/18642065/Museum-adaptation-for-blind-people

Ophir, E., Nass, C., Wagner, A. D., & Posner, M. I. (2009). Cognitive Control in Media Multitaskers. Proceedings of the National Academy of Sciences - PNAS, 106(37), pp. 15583–15587. https://doi.org/10.1073/pnas.0903620106

Ostroff, E. (2001). Universal Design: An Evolving Paradigm, In Preiser, W.F.E. and Smith, K.H. (Eds.) Universal Design Handbook. First edition, 2001, McGraw-Hill. pp. 34-42.

Persson, H., Åhman, H., Yngling, A. A., & Gulliksen, J. (2015). Universal design, inclusive design, accessible design, design for all: Different concepts—one goal? On the concept of accessibility—historical, methodological and philosophical aspects. Universal Access in the Information Society, 14(4), pp. 505–526. https://doi.org/10.1007/s10209-014-0358-z

Petrelli, D., Marshall, M. T., O'Brien, S., McEntaggart, P., & Gwilt, I. (2017). Tangible data souvenirs as a bridge between a physical museum visit and online digital experience. Personal and Ubiquitous Computing, 21(2), pp. 281–295. https://doi.org/10.1007/s00779-016-0993-x

Pine, B. J., & Gilmore, J. H. (1998). Welcome to the experience economy. Harvard Business Review, 76(4), pp. 97–105.

Pursey, T., & Lomas, D. (2018). Tate Sensorium: An experiment in multisensory immersive design. The senses & society, 13(3), pp. 354–366. https://doi.org/10.1080/17458927.2018.1516026

Rani, S., Jining, D., Shah, D., Xaba, S., & Singh, P. R. (2023). Exploring the Potential of Artificial Intelligence and Computing Technologies in Art Museums. ITM Web of Conferences, 53, 01004. https://doi.org/10.1051/itmconf/20235301004

Randolph, J. J. (2009). A Guide to Writing the Dissertation Literature Review. Practical Assessment, Research & Evaluation, 14(13), pp. 1-13.

Renel, W. (2019). Sonic Accessibility: Increasing Social Equity Through the Inclusive Design of Sound in Museums and Heritage Sites. Curator: The Museum Journal, 62(3), pp. 377–402. https://doi.org/10.1111/cura.12311

Ridley, D. (2012). The Literature Review - A Step-by-Step Guide for Students. London: SAGE. S. 1-22. https://uk.sagepub.com/en-gb/eur/the-literature-review/book236719

Romanelli, M. (2020). Museums and Technology for Value Creation. In J. Strandgaard Pedersen, B. Slavich, & M. Khaire (Eds.), Technology and Creativity (pp. 181–210). Springer International Publishing. https://doi.org/10.1007/978-3-030-17566-5_8

Rudloff, M. (2013). Det medialiserede museum: Digitale teknologiers transformation af museernes formidling. MedieKultur: Journal of Media and Communication Research, 29(54). https://doi.org/10.7146/mediekultur.v29i54.7299

Ryan, R. M., & Deci, E. L. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. American Psychologist, 55(1), pp. 68–78. https://doi.org/10.1037/0003-066X.55.1.68

Ryhl, C., Eiriksson, M., Overby Sørensen, R. (2021). Universal design–Introduction to a design principle that challenges the idea of being human. Universal Design Hub, Bevica Fonden. https://universaldesignhub.dk/wp-content/uploads/Ryhl-C.-Eiriksson-M.-Overby-Soerensen-R.-2021-Universal-design_Eng.pdf

Schön, D. A. (1983). The reflective practitioner: How professionals think in action. London, UK: Temple Smith.

Seale, J., Garcia Carrizosa, H., Rix, J., Sheehy, K., & Hayhoe, S. (2020). A participatory approach to the evaluation of participatory museum research projects. International Journal of Research & Method in Education, 44(1), pp. 20–40. https://doi.org/10.1080/1743727X.2019.1706468

Sharp, H., Rogers, Y., & Preece, J. (2019). Interaction design: Beyond human-computer interaction (Fifth edition). Wiley.

Skot-Hansen, D. (2008). Når oplysning bliver til en oplevelse. kulturforvalterne unlimited. https://kunstogkulturvidenskab.ku.dk/ansatte/?pure=files%2F47055266%2Fkulturforvalterne_-_Museer_i_oplevelses_konomien_

Sonne-Ragans, V. (2020). Videnskabsteori i opgaven. I L. Rienecker & P. Stray Jørgensen, Den gode opgave: Håndbog i opgaveskrivning på videregående uddannelser (5. udgave, s. 183–218). Samfundslitteratur.

Sparrow, B., Liu, J., and Wegner, D. M. (2011) Google Effects on Memory: Cognitive Consequences of Having Information at Our Fingertips. Science, 333(6043), pp. 308–314.

Srivastava, A., & Gupta, D. (2023). Chapter 5: Creative Expression with Generative AI. In The Potential of Generative AI: Transforming technology, business and art through innovative AI applications. (1st ed., pp. 153–190). New Delhi, India: BPB Publishers

Stanford University, d.school (2010). An Introduction to Design Thinking PROCESS GUIDE.

https://web.stanford.edu/~mshanks/MichaelShanks/files/509554.pdf

Steinfeld, E., & Maisel, J. L. (2012). Universal design : creating inclusive environments (1st ed.). pp. 27–256 .John Wiley & Sons.

Story M.F (2001) Principles of Universal Design. Universal Design Handbook, Edited by: Preiser, W.F.E & Ostroff, E. New York: McGraw-Hill. Chapter 10, pp. 1–10.

Szulevicz, T. (2020). Deltagerobservation. In Kvalitative metoder: En grundbog (3rd ed., pp. 97–116). Hans Reitzel.
Tactile Studio. (n.d.). https://tactilestudio.co

Tate Britain (2015). IK Prize 2015: Tate Sensorium. Tate Britain Exhibition. https://www.tate.org.uk/whats-on/tate-britain/ik-prize-2015-tate-sensorium

Trunfio, M., Jung, T., & Campana, S. (2022). Mixed reality experiences in museums: Exploring the impact of functional elements of the devices on visitors' immersive experiences and post-experience behaviours. Information & Management, 59(8), 103698. https://doi.org/10.1016/j.im.2022.103698

Tænketanken Mandag Morgen (2025). Hvordan forholder handicaporganisationer sig til teknologiske løsninger for mennesker med funktionsnedsættelse (KLADDE). https://taenketanken.mm.dk/analyser-rapporter-viden-og-publikationer/

Vaz, R., Freitas, D., & Coelho, A. (2020). Perspectives of Visually Impaired Visitors on Museums: Towards an Integrative and Multisensory Framework to Enhance the Museum Experience. 9th International Conference on Software Development and Technologies for Enhancing Accessibility and Fighting Info-Exclusion, 17–21. https://doi.org/10.1145/3439231.3439272 91

Vermeeren, A. P. O. S., Calvi, L., Sabiescu, A., Trocchianesi, R., Stuedahl, D., Giaccardi, E., & Radice, S. (2018). Future

Museum Experience Design: Crowds, Ecosystems and Novel Technologies. In A. Vermeeren, L. Calvi, & A. Sabiescu (Eds.), Museum Experience Design (pp. 1–16). Springer International Publishing. https://doi.org/10.1007/978-3-319-58550-5_1

VizWiz. (n.d.) https://vizwiz.org

Wald, A. (2014). Triangulation and Validity of Network Data. In Mixed Methods Social Networks Research (pp. 65–89). Cambridge University Press. https://doi.org/10.1017/CBO9781139227193.005

Wang, A., Song, X., & Lucero, A. (2024). Linger: Extending Museum Experiences to Post-Visit Phases. Adjunct Proceedings of the 2024 Nordic Conference on Human-Computer Interaction, 1–5. https://doi.org/10.1145/3677045.3685436

Weisen, M. (2012). Digital access to culture. Journal of Assistive Technologies, 6(2), pp. 163–166. https://doi.org/10.1108/17549451211235028

Wilczek, C., & Li, Q. (2023). Unlocking the power of inclusion: The imperative for disability-inclusive data. UNESCO. https://www.unesco.org/en/articles/unlocking-power-inclusion-imperative-disability-inclusive-data

Wilson, R. A. (2006). [Rev. of Seeing, Doing, and Knowing: A Philosophical Theory of Sense Perception]. Canadian Journal of Philosophy, 36(1), pp. 117-132. https://doi.org/10.1353/cjp.2006.0006

World Health Organization. (2013) How to use the ICF: A practical manual for using the International Classification of Functioning, Disability and Health (ICF). https://cdn.who.int/media/docs/default-source/classification/icf/drafticfpracticalmanual2.pdf?sfvrsn=8a214b01_4&download=true

World Health Organization. (2019). World report on vision. World Health Organization. https://iris.who.int/handle/10665/328717

Zakaria, N. N. (2020). Barriers to Social Inclusion with the Egyptian Museums; New Approach Towards Disability. Curator: The Museum Journal, 63(1), pp.115–130. https://doi.org/10.1111/cura.12353