TRANSMIXR

CREATING MEANINGFUL INTERACTIONS WITH CULTURAL HERITAGE IN IMMERSIVE ENVIRONMENTS

A guide to get you started exploring the opportunities of XR

Funded by the European Union

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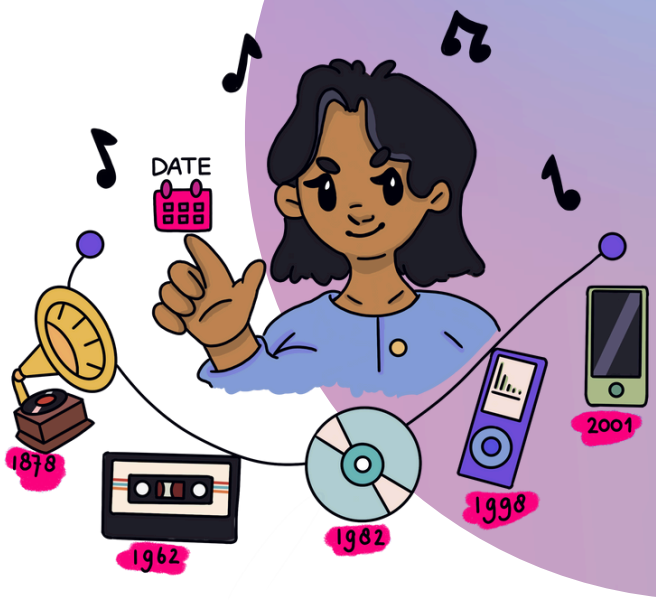

Illustration: VR tagging game | The Evolution of Music

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SOUND&VISION CWI KHORA TUS Midlands Midwest VUB VRIJE UNIVERSITEIT BRUSSEL

Introduction

XR in cultural heritage institutions

Imagine stepping into the hidden depot of a museum collection: aisles of cupboards and boxes, yellowed name tags assigning years to objects, the faint, stale scent of time past. Each object holds a story — of artistry, of people, of their lives and legacies. Now, consider what remains of these stories if the objects cannot be displayed, if visitors don't see them. What happens to these memories when they lie unseen, untold, untouched?

What if we could **change** that?

Imagine — with us, for a moment longer — a depot without physical limits, audiences engaging with artifacts without the risk of damaging them, a collection that feels both living and boundless. In immersive environments, we are no longer constrained by the physical limitations of exhibition rooms that determine what can and cannot be shown.

We can forgo the rules of gravity or measures that regulate what can and cannot be touched. We can expand our ideas of what exhibitions are, embracing interactivity and engaging storytelling. This is the potential of eXtended Reality (XR).

Most XR heritage experiences focus on recreating real environments or objects — whether those that existed in the past (lost historical sites) or contemporary ones (virtual museums). But that's only one way to use XR, so let's explore other possibilities that open different ways to engage with heritage collections.

This guide is a result of research with cultural heritage professionals and XR design studios. The central question we are asking is:

How can we create meaningful interactions with cultural heritage in immersive environments?

This question will guide our exploration as we consider the opportunities, challenges, and practical strategies for bringing XR into cultural heritage spaces in innovative ways.

Does this opportunity excite you? Are you feeling skeptical? Perhaps you're still wondering: What exactly is XR? We hear you, and we're here to explore together.

Is this guide for you?

For Cultural Heritage Professionals

This guide encourages you to explore innovative ways of engaging with audiences, breaking traditional barriers, and preserving stories using XR technologies. Whether you're a curator, archivist, or museum educator, we hope to spark new ideas and practical solutions for your work.

For XR Designers & Design Companies

This guide will inspire you to think creatively about crafting immersive experiences for cultural heritage, expanding your portfolios and pushing the boundaries of audience engagement through collaboration with cultural heritage institutions.

For Students & Researchers

This guide will help expand your understanding of XR technologies, inspiring academic inquiry, sparking innovative projects, and providing a foundation to evaluate and reimagine engagement models.

For anyone else interested

Are you not a cultural heritage professional, XR designer, or student in this field, but nonetheless interested in learning more about reimagining and exploring the opportunities of XR? Then, of course this guide is also for you!

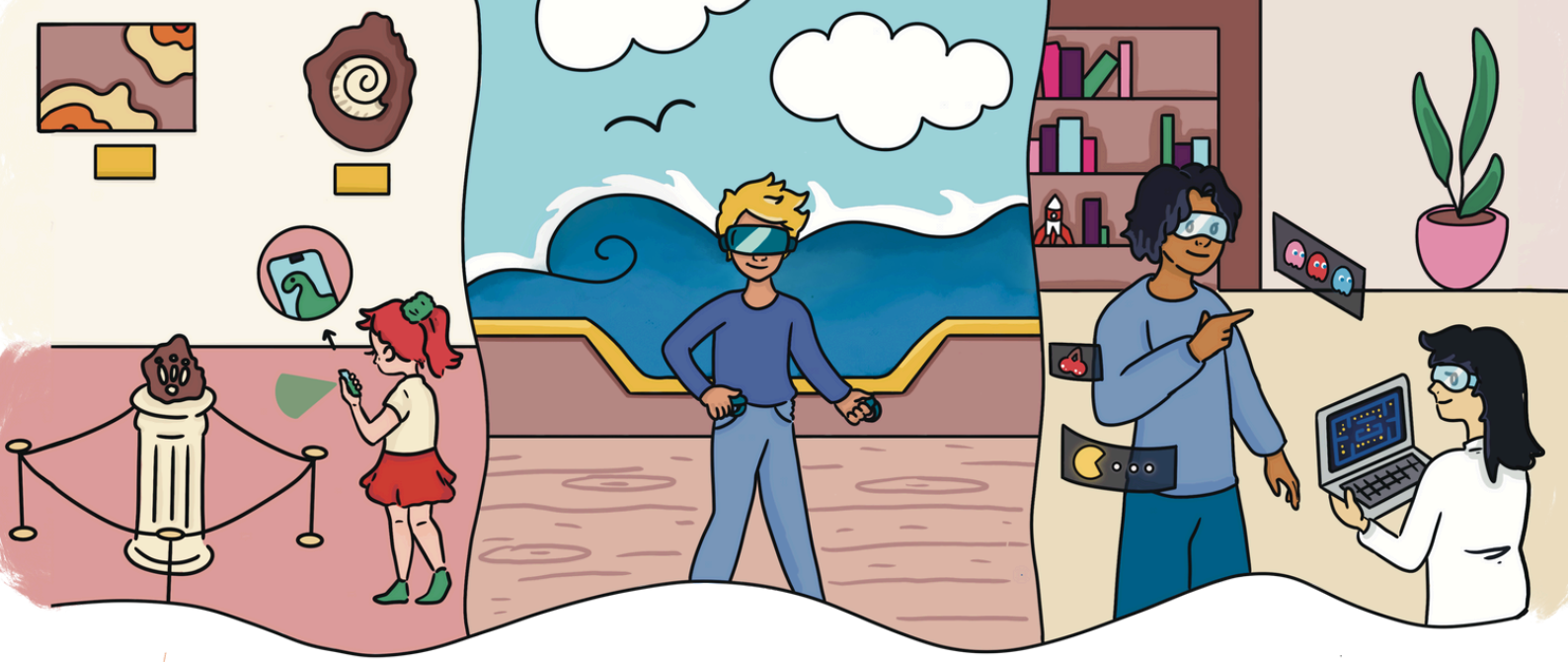


Illustration: AR vs. VR vs. MR

What is XR?

eXtended Reality

There are several immersive technologies that expand our perception of reality, such as Virtual Reality (VR), Augmented Reality (AR) and Mixed Reality (MR).

In VR, a completely computer-generated environment — experienced best using a headset — replaces the real world, whereas AR combines the real world with computer-generated content on a screen, while MR combines reality and virtual content, using a translucent headset. In other words:

Augmented Reality	Enhances the environment with a layer of digital content on a screen.
Virtual Reality	Replaces the environment with digital content through a headset.
Mixed Reality	Allows for interaction between virtual and real environments, using a translucent headset.

XR is a term that encompasses all these immersive technologies.

Opportunities

That wouldn't exist without XR

We believe XR can bring something new, impactful, and economically sustainable to the sector. It's not just a tool, but a way to make cultural heritage come alive by allowing us to;

Engage with untouchable objects	Break down physical barriers
Artifacts behind "do not touch" signs or too delicate to be displayed can become accessible in entirely new ways.	Overcome accessibility challenges — whether they're physical, sensory, or spatial — to make heritage available to more people.
Visit the inaccessible	**Engage multiple senses**
Step into spaces that are off-limits, long lost, or purely imaginary, giving audiences deeper, more interactive ways to connect with history.	Create immersive, multi-sensory experiences that combine visuals, sounds, and even haptics to deepen audience connection and understanding.

Together, these opportunities highlight how XR can transform cultural heritage into a dynamic, inclusive, and engaging domain for diverse audiences.

While XR solves some accessibility challenges, it might introduce new ones, such as putting a strong emphasis on the visual and causing light motion sickness. And, of course, using XR also comes with other challenges like a complex production process and high costs. In the next section, we will address some of the main challenges that come with XR.

Illustration: A primary affordance of XR is to truly step into cultural heritage objects.

Challenges

Encountered when trying to adopt XR

Despite its promise, XR adoption in cultural heritage faces several challenges that prevent its wide-scale adoption.

Identifying meaningful application areas

Before creating an XR experience, it is crucial to ensure that the XR experience provides valuable impact and engagement opportunities which go beyond what non-XR methods can achieve.

Access to high-quality 3D assets

Digital 3D assets of heritage objects are seen as essential for XR experiences, but most organisations do not have such assets readily available because creating these assets is both time-consuming and costly. We therefore aim to create an experience that allows for immersive storytelling with all kinds of media — like pictures, photographs or audio files — and metadata. In addition, some museums are digitizing heritage objects but don't yet have a space in which to use them, for which XR would be the perfect opportunity.

High short-term investments and long-term costs

Producing XR experiences requires significant financial resources, including the purchase of hardware, maintenance, and the cost of developing content.

Complex multistakeholder production processes

Collaboration between heritage organisations and design companies during the production of immersive experiences can be hindered by a lack of shared vocabulary, competing priorities, and a limited understanding of the affordances of immersive technologies.

Solutions

Accessible to your organisation

With these opportunities and challenges in mind, we started thinking about what would make immersive experiences an attractive and sustainable storytelling format for the cultural heritage sector. After a consultation process with peers, we formulated a vision based on two priorities:

Simplifying Production Processes Through Reusable Templates

1

We aim to streamline the development of immersive storytelling by providing cultural heritage organisations with ready-made templates. These templates allow for consistent design, reducing the complexity of production while maintaining high-quality experiences.

Reducing Costs Without Sacrificing Experience Quality

2

By focusing on reusable assets and innovative approaches to storytelling, we significantly lower both short-term production costs and long-term maintenance expenses, making XR accessible even to organisations with limited budgets.

Building Blocks

For XR innovation

Storytelling with rich collection metadata

Traditional XR projects often depend on expensive 3D assets as their central storytelling tool. We take a different approach by transforming existing collection metadata into immersive narratives. This method not only reduces costs but also enables organizations to craft engaging stories without requiring 3D models.

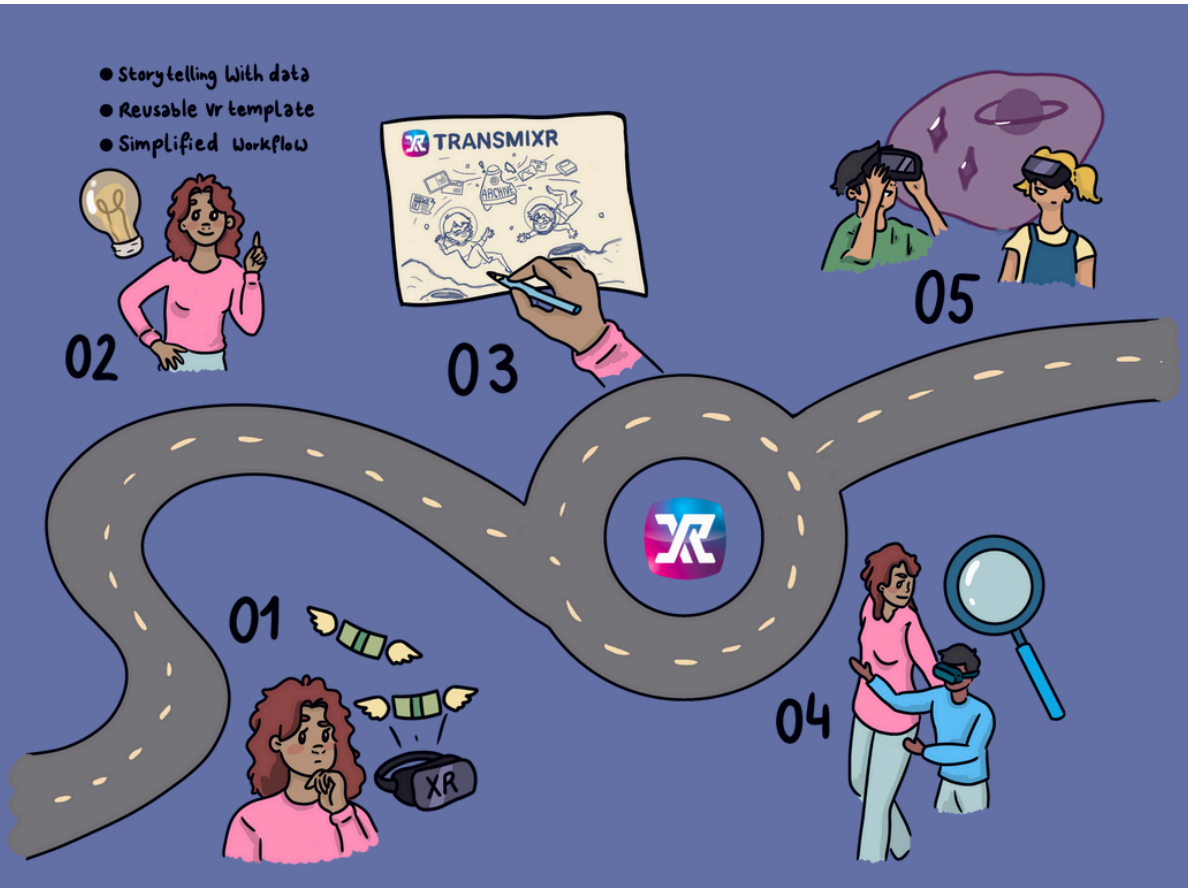
Reusable immersive storytelling format

Data visualisation and interaction templates in XR can be iteratively updated with new data and content. This versatility allows organisations to utilise the same template across multiple projects, resulting in cost-effective experiences.

Social XR production workflow

By incorporating Social XR into the production process, we streamline collaboration by improving stakeholders' comprehension and discussion of creative concepts and technical possibilities. This reduces friction during the production process.

With these building blocks we can begin to imagine new types of immersive experiences that are inclusive, sustainable, and adaptable.



Shaping Our Ideas

from User Insights

To better understand how XR can provide value to both professional curators in cultural heritage institutions as well as the end-users who experience these technologies, a series of design salon workshops were organised. These workshops brought together curators, researchers, and other stakeholders, leading to the following key insights;

Attitude towards XR

Professional curators seek unique experiences that cannot be replicated in real life. They see the added value of XR for instance for educational purposes, allowing end-users to **see the stories beyond artifacts** that are on display.

Social XR

Social interaction in XR settings should be **versatile and collaborative**. Users value creating virtual meeting points for peers, interacting through avatars, and engaging synchronously with other visitors, particularly those they are familiar with. Thus, Social XR is a key technological feature for collaboration.

User Experience (UX)

UX requirements prioritise accessibility to a range of user audiences, focusing on immersion and engagement, with features like independent screen interaction, freedom of movement, video access, and clear entry guidelines. Users want **enriched historical context and detailed artifact information**.

XR Potential

XR professionals are interested in the potential of XR for creating **immersive experiences** using digital heritage objects and related metadata to raise awareness of societal issues such as LGBTQIA+ visibility, gentrification, global climate change, etc. XR also allows for physical interaction with virtual objects, provides opportunities for self-education, facilitates immersive experiences, showcases the impossible in physical spaces, and offers interactive learning beyond reading.

Building on these insights, we moved from understanding the potential of XR to conceptualising concrete ways to apply these findings in cultural heritage settings. This led to the creation of three creative concepts, the last of which is being developed as part of the TRANSMIXR project:

1. *Marketplace for Stories*
2. *Augmented Exhibitions*
3. *Heart of the Archive*

Marketplace for Stories

Conceptual Idea

The *Marketplace for Stories* concept envisions an online platform that serves as a marketplace for educational storytelling, allowing cultural heritage institutions to exchange resources and collaborate on the creation of AR-based narratives. The platform facilitates the creation of immersive educational experiences tailored to specific topics proposed by educators, enabling school groups to engage with cultural heritage in innovative ways, either within classrooms or directly at cultural heritage institutions.

Key Value Proposition

The core value of the *Marketplace for Stories* lies in its ability to democratise access to cultural heritage materials. By offering an AR storytelling tool educators and heritage organisations can co-create immersive stories around various topics, drawing from a vast pool of digital resources. By combining materials from other heritage institutions, it fosters collaboration and makes learning more interactive, engaging, and relevant to students' curriculums.

How It Works

Cultural heritage institutions can upload a wide range of digital collections — such as artifacts, images, documents, audio files, and video content — into the platform, with the option to source additional resources through aggregator platforms like Europeana. Educators, in turn, can browse the materials, selecting resources that fit their curriculum needs. Using an AR tool, educators can combine these resources to create immersive AR stories that bring historical events, people, and artifacts to life in dynamic ways. The AR experiences can be experienced both in the classroom and on-site at cultural heritage institutions, where students can interact with virtual representations of the objects or sites in ways that traditional teaching methods cannot replicate.

User scenario

On the marketplace, a teacher from a school in the Netherlands posts a request for an AR story on the history of elections and various electoral systems across Europe. In response, curators from seven cultural heritage organisations around Europe upload related materials, including videos, digitised 3D objects, images, audio recordings, and blogs. The curators and the educator then meet in a virtual space using social VR to collaborate on selecting the best template for the story. Together, they populate the template with content, creating a 'choose-your-own-adventure' style AR experience where each student's choices lead to a unique narrative outcome.

The finished AR story is made accessible to students during a school trip to a local museum, where they engage with the story through tablets. As they explore, students interact with dynamic content on electoral systems, immersing themselves in a virtual environment that brings history to life. At the end of the experience, students reflect on the historical context they've learned, gaining a deeper, more personalized understanding of the topic.

Augmented Exhibitions

Conceptual Idea

Museums are often limited to what they can exhibit based on the physical space they have available and how much resources they have to lend objects from other organisations. The *Augmented Exhibitions* concept aims to enrich physical exhibitions with an augmented reality experience. This concept provides a customizable template for an AR-based social game that complements and enriches physical exhibitions. It enables cultural heritage institutions to offer users insights into collections beyond the objects physically displayed in the museum. The game acts as a gateway to deeper understanding, enhancing the visitor's engagement with the exhibits.

Key Value Proposition

The key value of the *Augmented Exhibitions* concept lies in its ability to complement and extend the narrative of physical collections through AR, providing visitors with a more comprehensive, interactive, and complex understanding of the heritage items on display. The template is highly customisable and reusable, allowing institutions to adapt the game to their specific needs. By combining traditional artifacts with dynamic, data-driven AR experiences, the concept encourages collaborative learning and exploration, making exhibitions more engaging and informative.

How It Works

Heritage institutions can tailor the AR experience by selecting specific physical artifacts in their exhibition to associate with the augmented game. Using a predefined template, institutions can create puzzles or challenges tied to the artifacts, and provide datasets that fuel data visualisations within the AR experience. These datasets could include historical context, additional visual content, or detailed metadata that help visitors uncover hidden stories related to the artifacts.

User scenario

Visitors entering an exhibition space are offered a tablet or invited to use their own devices to start the AR game. They team up with other visitors to solve a 'scavenger hunt' where each artifact in the exhibit is associated with a different puzzle. Each puzzle takes the form of a data visualisation that provides rich context about the subject of the artifact. Visitors must then interpret the visualisation to answer a curator's question, and their answer leads them to the next artifact in the exhibit.

Throughout the experience, visitors collaborate, discussing their findings and sharing insights to solve each puzzle, making the exhibition a more engaging, social, and interactive experience.

Heart of the Archive

Conceptual Idea

The *Heart of the Archive* concept offers a replicable framework for creating immersive educational experiences tailored to children and families. Combining storytelling, teamwork, and data exploration, this concept revolves around customisable games that engage participants in categorisation tasks, encouraging critical thinking about how archives shape our understanding of history.

Designed as a reusable format, the *Heart of the Archive* allows cultural heritage organisations to adapt the experience to their unique narratives. For instance, a maritime museum might create an underwater environment such as a submarine, while a science museum might design a futuristic spaceship. Despite variations in themes, the core experience remains consistent: participants are placed in a mission-driven scenario and collaborate to solve categorisation-based challenges across multiple chambers.

Key Value Proposition

The *Heart of the Archive* offers a blueprint for a customizable immersive experience tailored to young audiences and families. By combining storytelling, teamwork, and gamified categorization tasks, it facilitates critical and playful engagement with cultural heritage collections and archival practices. This concept empowers cultural heritage organizations to create engaging, mission-driven experiences that educate participants about the importance of archives while fostering collaboration and creativity in a fun and interactive environment.

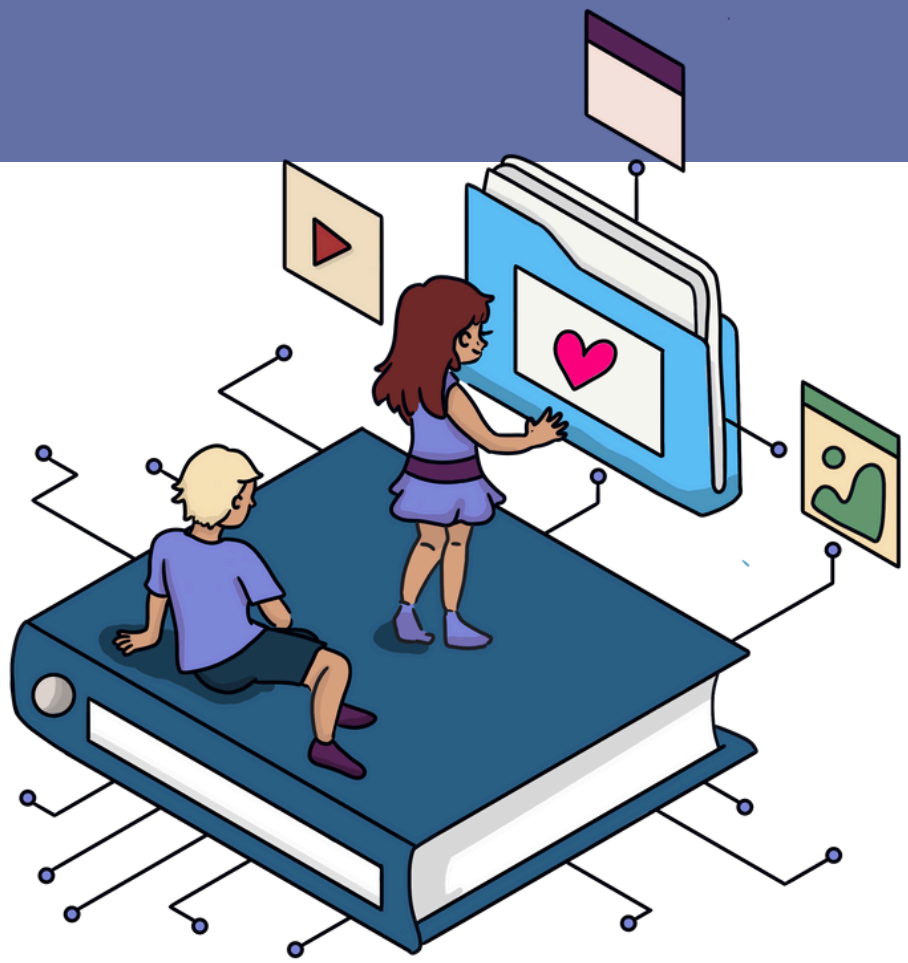
How It Works

Cultural heritage organisations provide selected datasets of media assets — images, videos, music files, and more — complete with metadata. These datasets are integrated into the customisable framework, which includes specifications for media and metadata formats. Organisations then design an immersive environment tailored to their thematic needs and populate it with categorisation-based games that align with their overarching narrative.

User scenario

During a visit to the Netherlands Institute for Sound & Vision, a mother and daughter decide to try a social VR experience called *The Space Archivists*. The narrative begins with an end-of-the-earth scenario where humanity has sent an archive into space to preserve its memory and energy patterns. However, a meteorite strike has disrupted the archive, scattering its contents.

Players take on the roles of future space archivists tasked with repairing the archive. Together, they navigate three chambers, each featuring a different categorisation challenge. In one chamber, they might organise scattered images by date; in another, they could sort objects by cultural origin or theme. As they solve the challenges, the heart of the archive gradually illuminates, and a melody builds to signify their progress. Upon completing the final chamber, the archive is fully restored. A celebratory sequence plays, featuring the complete melody and a glowing archive. To conclude, participants can remix tagged photos and GIFs from the archive into a personalised story, which they can share on a digital "wall of hidden stories."



The Space Archivists

Currently in Development by TRANSMIXR

The interactive Social VR game *The Space Archivists* — derived from the conceptual idea the *Heart of the Archive* — is currently being developed by TRANSMIXR, and will be on display at the Mediamuseum of The Netherlands Institute of Sound & Vision in 2025.

Practical Takeaways

For Designing Engaging XR Experiences

Building on the insights from our user research and the core concepts, we've identified several practical considerations for creating impactful XR experiences. These takeaways emphasise the importance of balancing playfulness, storytelling, and social interaction to engage young audiences effectively. Here's what to keep in mind when designing for this context:

Game Mechanics & Playfulness

Kids aren't always drawn to data and graphs, so it's crucial to present information in ways that are playful, interactive, and visually appealing. Children also want to have a clear goal to encourage them to explore the VR environment. A way to do this would be to integrate data storytelling with game elements, like puzzles or treasure hunts. Game mechanics not only capture attention but also sustain engagement throughout the experience.

Social Dynamics

Cooperative social experiences can add richness to XR experiences. Children prefer cooperative and complementary tasks to having a solo experience. Collaboration can happen in different ways; players could work together to solve a puzzle, or navigate separate journeys, and come together to solve a final puzzle at the end of a game.

Clear Storylines

Open-ended exploration can be overwhelming, especially for younger users. Providing structured paths with multiple but manageable options fosters a sense of direction. Children involved in our playtesting emphasised the value of multiple perspectives, which can lead to continued conversations after the experience ends.

Practical Takeaways

For Designing Engaging XR Experiences

A Combination of Data, Objects & Avatars

While data visualisations are powerful storytelling tools, they need to be paired with tangible examples, such as collection objects, to bring stories to life and help kids think more abstractly about data. Additionally, avatars or voice-overs can serve as guides, helping visitors navigate and connect with the narrative.

Considering Audience Needs

Finally, always consider audience needs by including them in your design and evaluation process. It is important to understand their needs and challenges, as well as the type of content that engages them. When designing for children, make sure to use concrete examples and simple language that they can understand, include rest breaks and account for motion sickness. Remember to test your design with your audience as you continue making progress! As your design becomes more concrete, feedback from end-users will help make your designs even better.

Future Plans & Milestones

April ’25

Prototype and training development

May & June ’25

Usability tests for end-users

Summer ’25

The Space Archivists on Display

Fall ’25

Visiting Industry Events

Want to be involved?

Make sure to sign up for our newsletter and receive the latest updates, including to invites to our events, directly in your inbox.

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We hope this short guide inspired you to explore the wonderful possibilities of XR for the cultural heritage sector!

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