

# Virtual Reality in Higher Education Cultural Collections: Challenges in Digital Preservation and Interoperability

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## **Abstract**

Virtual Reality (VR) offers unprecedented opportunities for higher education cultural collections to enhance visitor engagement, provide engaging learning opportunities, and preserve fragile artefacts. However, the lack of standardised practices across the sector, coupled with rapid technological obsolescence, pose significant challenges for digitally preserving VR environments and integrating separate experiences into a more cohesive network. This paper argues for the need to establish shared community-led practices to ensure the long-term viability and cross-institutional access to VR heritage environments.

## **Introduction**

Technologies such as VR have the potential to revolutionise the way we interact with digital collections, offering immersive spatial experiences that can enhance learning, research, and cultural engagement (Shehade, 2020). 'Digital spatial experiences', more broadly, can be seductive, impactful and can widen accessibility, especially for groups traditionally excluded from text-based routes into collections such as young people, civic and neurodivergent audiences.

Despite the exciting potential, there are challenges. Interoperability is uncommon, experiences tend to be isolated and users are expected to locate and engage with each experience on its own terms. No community-agreed approach exists.

VR experiences are also invariably short-lived, longevity usually goes entirely unaddressed. Where commercial design agencies are engaged, reusability of assets and ongoing maintenance often do not form part of the brief. Similarly, where third party platforms are used, such as Minecraft Realms, Sketchfab or Spatial.io, the risks of building upon commercial technologies often go unacknowledged.

The seductive nature of immersive experiences brings more challenges; reconstructed real-world environments might seem 'accurate'. But this is often not the case, with gaps in knowledge being filled in invisibly, in favour of a more satisfying user experience. Standards such as the London Charter are usually not implemented.

## **The Challenge of Interoperability**

Heritage VR experiences invariably operate independently, limiting collaboration and sharing of resources.

Establishing networks that connect these separate experiences would enable seamless navigation and interaction between institutions, fostering collaborative exhibitions and enhancing visitor engagement (Cianci, 2023).

The work of Europeana Foundation to connect digital collections, coupled with standards such as WebXR (Jones, 2024): once integrated into the Web 4.0 standard, promise a future landscape of networked experiences.

While the technical ability to network VR applications is a crucial stepping stone toward interoperability, the implementation of these technical standards must be done locally, tailored to the needs of the communities they serve. For example; standard approaches to presenting metadata, especially regarding artefact provenance, the academic citation of 3D spaces, unifying UI design across institutions, handling the assignation of avatars and ensuring a consistency of experience as well as our approach to long-term sustainability, must all be decided upon and adopted by cultural collections, ideally working together, as a community.

## **The Challenge of Digital Preservation**

Nascent technical standards like WebXR should make virtual interoperability possible, but as we know from our experience of Web archiving, technical standards to support wider access to content do not necessarily support our attempts to undertake digital preservation. Yet maintaining the usability of VR environments over time, as user interfaces and interaction paradigms evolve, is crucial if value is to be retained (Lischer-Katz, 2020).

Emulating obsolete hardware and software environments to run outdated VR content can be expensive, technically challenging or even impossible, while migrating VR content to new platforms without losing functionality or fidelity can also be difficult, especially when dealing with proprietary technologies. Yet preservation is central to the mission of HE cultural collections. Addressing these challenges will require a multi-faceted approach, including developing robust preservation standards, investing in adaptable and future-proof technologies, and fostering collaboration among archivists, technologists, and legal experts.

Digitally preserving VR environments presents several key challenges, including:

- **Hardware obsolescence:** VR environments depend on specific hardware (e.g., Meta VR headsets, controllers) which will become obsolete. Future hardware may not support current VR content.
- **Software obsolescence:** Operating systems and VR platforms evolve, potentially losing compatibility with older VR applications.
- **Rapidly evolving data formats:** Ensuring the longevity of VR content requires stable, standardised data formats. Proprietary or rapidly changing formats risk becoming unreadable.
- **Preserving complex interactivity:** Preserving not just the visual and auditory content but also the interactivity and user experience is especially challenging. This may include haptic feedback, motion tracking, and spatial audio. The preservation of dynamic textures, models, lighting, and physics can be complex and resource-intensive.
- **Dataset size:** VR environments can be vast and data-intensive, requiring significant storage and processing power to preserve and recreate.
- **Legal issues:** Licensing agreements, intellectual property rights, and digital rights management (DRM) can be richly layered and immensely complex and hamper preservation efforts. Multiple permissions may be required to archive and access VR content.
- **Metadata and documentation:** Comprehensive metadata and documentation are necessary to understand the VR environment's complex nature, original context, purpose, and use. A lack of standardised practices for documenting and preserving VR environments can lead to inconsistent preservation quality.

Preserving VR content poses unique challenges when compared to traditional media. VR environments are dynamic and interactive, incorporating spatial and temporal elements that require specialised preservation techniques. VR environments may incorporate multi-channel audiovisual elements, which further complicated preservation. Issues such as format obsolescence, hardware dependencies and the complexity of capturing immersive experiences complicate long-term access and sustainability (Murillo, 2018).

Standardisation is critical to addressing preservation challenges and ensuring the interoperability of VR systems across different platforms and institutions. Like the Internet's evolution from disparate networks to a cohesive global infrastructure, VR technologies require agreed-upon standards for file formats, metadata schemas, and preservation strategies (Ensom, 2021). Without such standards, heritage institutions risk isolating their VR environments and limiting their impact on education and cultural preservation (Runde, 2023).

## **The need for HE community standards**

Open, community-defined workflows, standards and protocols offer several advantages for the development and deployment of VR technologies in the UK's higher education museums and archives;

### **1. Interoperability and Compatibility**

Open standards promote interoperability between different VR systems and hardware platforms. By adopting open formats and protocols, institutions can help ensure that their VR content is accessible and functional across various devices and software environments.

### **2. Innovation and Flexibility**

Community-defined standards foster innovation by allowing diverse stakeholders, including researchers, developers, and cultural heritage experts, to contribute ideas and improvements. This collaborative approach supports continuous innovation in VR content creation, preservation techniques, and interactive experiences.

### **3. Cost-Effectiveness**

Open standards reduce dependency on proprietary technologies, lowering costs associated with software licensing, hardware upgrades, and maintenance. Museums and archives can allocate resources more efficiently towards content development and visitor engagement initiatives.

### **4. Accessibility**

By ensuring that VR content adheres to open standards, cultural institutions enhance accessibility for diverse audiences, including individuals with disabilities, neurodivergent audience, and those in underserved communities.

### **5. Promoting longevity**

Open standards help mitigate the risk of content obsolescence, helping preserve cultural heritage materials for future generations.

### **5. Community Engagement and Support**

Community-defined standards foster a vibrant ecosystem of support and collaboration among museums, archives, technology developers, and researchers. This community engagement facilitates knowledge sharing, best practices dissemination, and collective problem-solving, strengthening the sustainability of VR initiatives.

## Conclusion

In conclusion, virtual reality holds immense promise for transforming HE museums and archives by offering immersive and educational experiences. Providing virtual spatial access to digital collections, as an alternative to well established *textual* access routes, can help remove physical, cultural and neurological barriers to accessibility. However, realising this potential requires addressing significant challenges in digital preservation and network integration through standardised practices. By embracing open, community-defined technical standards, institutions can establish a framework that promotes interoperability, innovation, and accessibility in VR applications. Future research and collaborative efforts among stakeholders are essential to overcoming these challenges and ensuring the continued enrichment of cultural heritage collections through VR technologies.

Working together to design shared workflows, to establish common norms, and decide just how emerging technical standard should be implemented locally will not only widen access to collections but also support conservation & digital preservation efforts.

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