FAIR 3D HERITAGE
Documentation, Publication and Preservation of the Digital 3D Heritage on the Web

Mapping Interaction Spaces: A Matrix for Transitional Interfaces in Virtual Reconstruction Research

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Abstract

Museums, archives, and research projects are producing 3D reconstructions at scale, enriching them with 2D sources, metadata, paradata, and semantic relations. Initiatives addressing FAIR (Wilkinson et al., 2016) and TRUST principles (Lin et al., 2020) and platform solutions such as the DFG-Viewer tackle questions of standardisation and technical integration (Kuroczyński et al., 2023; Bajena & Kuroczyński, 2023). Despite growing sophistication, viewer technologies remain largely presentation-driven. What is missing is a coherent model of collaborative, knowledge-oriented research practice designed to support interpretative work, hypothesis formation, and team-based inquiry. Our contribution addresses this gap, asking how such environments can be designed to support diverse data types and context-appropriate interaction.

We introduce a conceptual conjunction not yet articulated in this domain: Transitional Interfaces (TIs) and multidimensional models of collaboration. TIs are cross-reality user interfaces enabling seamless transitions along the reality-virtuality continuum, including 2D screens, augmented reality (AR), and immersive virtual reality (VR) (Schröder & Jetter, 2023; Schröder et al., 2023). Collaboration is integral to the TI concept, characterised across physical, temporal, and social dimensions as teams shift between tightly and loosely coupled activity (Schröder & Jetter, 2023; Neumayr et al., 2018).

We identify three central requirements: (1) Virtual reconstructions constitute multidimensional data spaces demanding differentiated modes of visualisation and interaction. Immersive VR supports spatial analysis, AR facilitates annotation, and 2D interfaces remain most suitable for structured metadata work (Schröder et al., 2023). (2) Reconstructions are inherently hypothetical and processual (Boukhelifa et al., 2017; Panagiotidou et al., 2023). Research environments must support parallel representation of alternative hypotheses and transitions between variants and paradata, enabling navigation through hypothesis spaces (Schröder et al., 2023). (3) Reconstruction work

unfolds within dynamic configurations across co-located, hybrid, and distributed settings, synchronous and asynchronous modes, and shifting degrees of social coupling shaped by the physical workspace (Schröder & Jetter, 2023; Neumayr et al., 2018; Jetter et al., 2014). In each dimension, TIs provide the integrating mechanism for seamless transitions without disruptive changes of device or interaction paradigm.

Therefore we present a systematic matrix mapping interaction spaces and design requirements (Fig. 1). Its x-axis spans the reality-virtuality continuum. Its y-axis distinguishes synchronous and asynchronous as well as co-located and remote collaboration, yielding sixteen fields each characterising a distinct interaction space. For instance, a field combining immersive VR with synchronous co-located collaboration defines a shared spatial workspace for joint hypothesis exploration, requiring shared viewpoints and gesture-based annotation. The matrix functions as both an analytical tool for evaluating whether a system meets the requirements of a given research situation, and as a shared vocabulary for guiding design processes.

The proposed matrix addresses user experience and interaction design for 3D heritage, integrating 3D with 2D and textual sources. A key application context is the collaborative investigation of virtual reconstructions with international partners, navigating between immersive exploration, annotation, and structured metadata work. It provides the collaborative and epistemic layer that technical infrastructure alone cannot supply, serving as a conceptual tool for developing 3D infrastructures and research workflows that are interoperable, sustainable, epistemically and collaboratively robust.

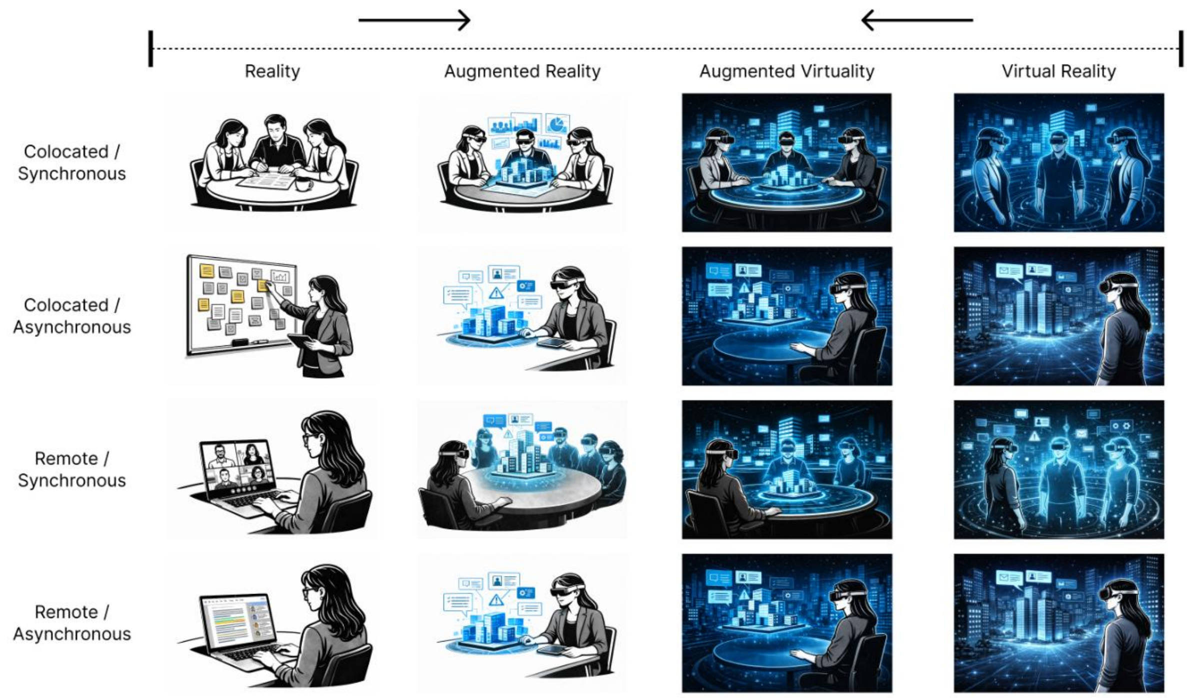

Fig. 1 Matrix mapping interaction spaces along the reality–virtuality continuum (x-axis) and collaborative configurations (y-axis), images within the matrix are AI-generated.

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