Stronger Together: Connecting Europe's Cultural Heritage through 3D, XR and AI Innovation

By bringing cultural heritage into dialogue with advanced scientific research and technological innovation, EUreka3D-XR – European Union's REKonstructed content in 3D to produce XR experiences (2025–2026) has advanced the digital transformation of the cultural heritage sector, building upon the foundations, infrastructure and achievements of its predecessor, the Digital Europe-funded EUreka3D project. Together, these initiatives establish a coherent pathway from the high-quality digitisation and documentation of cultural heritage assets to their meaningful reuse in immersive, interactive and educational experiences as it has been demonstrated in the two Pan-European campaigns of TwinIT Part I and TwinIT Part II. A defining strength of EUreka3D-XR lies in its ability to build upon the distinctive results of EUreka3D, including the EUreka3D Data Hub, its dedicated 3D Viewer, the supporting technical infrastructure, and a knowledge base of documentation, case studies, recordings, guidelines and recommendations for 3D digitisation. Particularly significant is the adoption of a quality-driven, paradata-based documentation methodology grounded in the European Commission's VIGIE2020/654 study, which established a systematic approach to assessing and documenting the quality, reliability and transparency of 3D cultural heritage assets in combination with the FAIR and CARE guidelines. These foundations provide the methodological and technological continuity necessary to transform existing digital resources into trustworthy, reusable and impactful cultural heritage experiences.

Building upon this established ecosystem, EUreka3D-XR delivered three innovative use cases demonstrating the potential of Extended Reality (XR): *Virtual Girona: Discovering the Historical Walls*, *The AR Narrative of the Hidden Side of Bibracte*, and *A New Life for Saint Neophytos' Enkleistra*. The project also developed five digital tools to facilitate the transformation of existing 3D resources into engaging visitor experiences, alongside a substantial portfolio of educational resources, including Open Educational Resources (OERs), three online courses, and additional interactive learning activities. Collectively, these results demonstrate how validated digital assets, innovative technological tools and interdisciplinary expertise can enhance cultural heritage interpretation, accessibility, education and public engagement.

A particularly important contribution is the introduction and practical exploration of the Memory Twin concept, marking a significant conceptual advance in the digital documentation of cultural heritage. Whereas a conventional Digital Twin primarily represents an asset's geometry and associated physical, spatial and material characteristics, a Memory Twin extends this representation by incorporating verified narratives, historical context, collective memory, intangible heritage, lived experiences, identity and cultural values. This holistic perspective seeks to preserve not only the physical evidence of the past but also the meanings and human connections that make cultural heritage significant to present and future generations.

Beyond technological development, EUreka3D-XR strengthened European capacity building through seminars, demonstrations, workshops and participation in events across Europe,

continuing the training and knowledge-transfer activities initiated by EUreka3D. By promoting access to digital resources, supporting collaboration with external organisations, and contributing to initiatives such as the Twin it! campaign, the project encouraged the responsible reuse of cultural heritage assets within the Common European Data Space for Cultural Heritage. It also fostered the exchange of expertise among researchers, cultural heritage professionals, technology developers and institutions, supporting the wider adoption of 3D digitisation and XR workflows.

Key words: Digital Transformation, XR, Metaverse, Capacity Building, 3D, Innovation, Cultural Heritage Institutions